Ministry of Education
Department of Higher Education
Shwebo University

Shwebo University Research Journal

Vol. 10, No. 2

June, 2020

Ministry of Education

Department of Higher Education

Shwebo University

Shwebo University Research Journal

Vol. 10, No. 2

June, 2020

Shwebo University Research Journal 2020

Vol. 10, No. 2

Editorial Board

ကုန်းဘောင်ခေတ်ရွှေဘိုဒေသရှိ စာဆိုလူဦးမင်းနှင့် သာဝတ္ထိဦးကြီးတို့၏ စာပေများလေ့လာချက်

မူမူအုန်း[၁]

စာတမ်းအကျဉ်း

"ဤစာတမ်းသည် ကုန်းဘောင်ခေတ် ရွှေဘိုဒေသရှိ စာဆိုလူဦးမင်းနှင့် သာဝတ္ထိဦးကြီးတို့၏ စာပေများလေ့လာချက်" စာတမ်းဖြစ်ပါသည်။ အလေ့လာခံအဖြစ် ကုန်းဘောင်ခေတ်ရွှေဘိုဒေသရှိ စာဆိုများဖြစ်သော ငါးရာနဲ့ရွာဇာတိ လူဦးမင်းနှင့် သာဝတ္ထိရွာဇာတိဦးကြီးတို့၏ စာပေများကို လေ့လာတင်ပြထားပါသည်။ ထိုစာဆိုများ၏ စာပေများဖြစ်သော ဒုံးချင်းနှင့်လွမ်းချင်းများကို လေ့လာတင်ပြထားပါသည်။ ဤစာတမ်းတွင် စာဆိုများ၏အတ္ထုပ္ပတ္တိအကျဉ်းနှင့်စာဆိုများ၏ စာပေစွမ်းရည်များကို အခန်းခွဲကာ လေ့လာတင်ပြထားပါသည်။

နိဒါန်း

ကုန်းဘောင်ခေတ်တွင် စာဆိုများစွာပေါ်ထွန်းခဲ့ပါသည်။ ထိုစာဆိုများတွင် ရွှေဘိုဒေသမှ စာဆိုများလည်းပါဝင်သည်။ ရွှေဘိုဒေသမှ စာဆို လူဦးမင်းနှင့် သာဝတ္ထိရွာဇာတိ ဦးကြီး၏စာပေများ လေ့လာတင်ပြထားပါသည်။ ရွှေဘိုဒေသဆိုင်ရာ စာပေနှင့်ပတ်သက်၍ ခေတ်သမိုင်းတစ်ရပ်ကို ပိုင်းခြားသိမှတ်နိုင်ပြီး ဒေသတွင်းရှိ စာပေပညာရှင်များ ပေါ်ထွက်လာစေရန်အတွက် ရည်မှန်းလျက် ဤသုတေသနစာတမ်းကို လုပ်ဆောင်ရခြင်းဖြစ်ပါသည်။ ကုန်းဘောင်ခေတ် ရွှေဘိုဒေသရှိ စာဆိုများ၏ စာပေစွမ်းရည်ကို သိရှိရပြီးနောက် ဇာတိချစ်စိတ်မှသည် နိုင်ငံချစ်စိတ်ဆီသို့ဦးတည်လျက် မြန်မာစာပေ ဖွံ့ဖြိုးတိုးတက်လာစေခြင်းကို ဖြစ်ပေါ်စေရန် လေ့လာတင်ပြထားပါသည်။

လူဦးမင်း၏ စာပေများ

လူဦးမင်းသည် ဖိုးသူတော်ဦးမင်းနှင့် စာပြိုင်စပ်ဆိုဖက်ဖြစ်သည်။ လူဦးမင်းဟု အမည်တွင်ခြင်းမှာလည်း ဖိုးသူတော်ဦးမင်းနှင့် တစ်တွဲတည်း အမှတ်ရစေပါသည်။ မင်းထင်သက်ရှည် လူဦးမင်းဟုခေါ်တွင်သည်မှာ နန်းမတော်ကြီးဖုရားထံ ညစဉ်ခစားလျက် စာဆိုကြသောကြောင့် နန်းမတော်ကြီးဖုရားက ဖိုးသူတော်ဦးမင်း၊ လူဦးမင်းဟုခေါ်ရမည့် မိန့်တော်မူချက်အရဖြစ်သည်။

လူဦးမင်းသည် ဖိုးသူတော်ဦးမင်းနှင့်အတူ ကဗျာအရာ၌ တခဲနုပွတ္တိဉာဏ်ဖြင့် လက်တန်းစပ်ဆိုနိုင်သူဖြစ်သည်။ တစ်နေ့သောအခါ ည,ညီလာခံ ဖိုးသူတော်ဦးမင်းက –

"ကုဏ္ဍလာ၊ ဒုမ္မာကပေါ" ဟု အခံပိဒ် ရွတ်ဆိုလိုက်သောအခါ လူဦးမင်းက –

"ဂုမ္ဘော ဂုမ္ဘိ နှင့် တပသီဇာမိုရ်ဝိဇ်ကယ်၊ ဆေးကြိတ်တဲ့တော"

ဟုအုပ်ပေးလိုက်သည်။ အချို့ကလူဦးမင်းစပ်ဖွဲ့လိုက်သောစာအုပ်ပိဒ်သည် အခံပိဒ်နှင့် မလိုက်ဖက်ကြောင်း ဝေဖန်ကြသည်။ ကြူအိုင်နှင့်တောသည် မည်သို့မျှမအပ်စပ်ဟု မှတ်ချက်ချကြသည်။ ကုဏ္ဍအိုင်အတွင်း ပဒုမ္မာကြာ၏ အပွင့်ဖူးနေပုံ၊ ပျားပိတုန်းတို့ ဝဲပျံနေပုံတို့ကိုစပ်၍ အုပ်ပေးလိုက်ပါက ပို၍ကောင်းမည်ဖြစ်ကြောင်း ဆိုကြသည်။ လူဦးမင်းသည် ကုဏ္ဍလာအိုင်သည် တောခ္ဍရှိသည်။ ထိုအိုင်ကို နတ်ဘီလူးများ စောင့်ရှောက်သည်။ ထိုအိုင်မှ ရေကိုသုံးလျက် တပသီ၊ ဇော်ဂျီ၊ ဝိဇ္ဇာတို့သည် အိုင်အနီးတွင် ဆေးဖော်လျက်ရှိကြသည့် အကြောင်းကို ဖွဲ့ခြင်းဖြစ်ပေမည်။ ထိုသို့ လူဦးမင်းသည် ကဗျာဉာဏ်အတွေးတွင် သူတစ်ပါးနှင့်မတူ တမူထူးခြားစွာ တွေ့နိုင်စွမ်းရှိသူဖြစ်ပါသည်။ အတွေးဆန်းကိုပင် လက်တန်းရွတ်ဆိုနိုင်သူဖြစ်သည်။

---

[၁] တွဲဖက်ပါမောက္ခ၊ ဒေါက်တာ၊ မြန်မာစာဌာန၊ ရွှေဘိုတက္ကသိုလ်။

တစ်ခါကမိဖုရားခေါင်ကြီးသည် ညအခါလသာသာ၌ လရောင်ခံလျက် ပဲဖြူကလေးပြုတ်ကို ဆီနှင့်ဆားနှင့်သုတ်ပြီး သုံးဆောင်တော်မူလေသည်။ ထိုသို့သုံးဆောင်တော်မူရင်း ပဲဖြူကလေး၏ အရသာဆိမ့်ပုံကို ချီးမွမ်းတော်မူလေသည်။ ပဲဖြူကလေး၏ အရသာဆိမ့်ပုံကို လူဦးမင်းက အခံဖွဲ့ ဖွဲ့စေပြီး ဖိုးသူတော် ဦးမင်းက စာအုပ်ဖွဲ့. ဖွဲ့ရမည်ဟုဆိုလေသည်။ ထိုအခါ လူဦးမင်းက –

"ပဲကလေးက ဆိမ့်လိုက်တာ၊ ပြောစရာရဘူး" ဟု တမုဟုတ်ချင်း စပ်လိုက်သည်။
ဖိုးသူတော် ဦးမင်းကလည်း –

"ညအခါ၊ လသာမှာကိုယ်တော်သုံးတယ်၊ လေပုန်းကမြူး"ဟု အုပ်လိုက်ရာအခံနှင့် အအုပ်လိုက်လျောအောင် စပ်ဆိုနိုင်ပြီး ဟာသကိုလည်း ဖြစ်စေသည်။

ဘကြီးတော်ဘုရားလက်ထက်တွင် ရွှေကြက်ယက်မှ စစ်ကိုင်းဘက်သို့ လှေနှင့်ပြန်လာခဲ့စဉ် လူဦးမင်းက လှေဝမ်းဦးရှေ့က ထိုင်ပြီး ဖိုးသူတော်ဦးမင်းက လှေဝမ်းနောက်က ထိုင်လျက် လာကြသည်။ ထိုစဉ် ငါးကလေးတစ်ကောင်ခုန်၍ လူဦးမင်းရှေ့လှေဝမ်းထဲသို့ကျလာရာ လူဦးမင်းက ငါးကလေးကို ကောက်ယူပြီးနောက် –

"မင်္ဂဖိုလ်ကိုရွယ်၊ ကယ်ပါတော့လား" ဟု စာချိုးပြီး ဖိုးသူတော်ဦးမင်းထံပေးလိုက်ရာ–

"ကြံ့ပလေတစ်ကောင်ထဲ၊ ဖော်ကွဲတဲ့ငါး"ဟု အုပ်လိုက်ပြီးရေထဲသို့ ချလိုက်လေသည်။ ထိုအချိုးကဗျာကလေးသည် အဓိပ္ပါယ်အလွန်စပ်ဆက်လှပါသည်။ အခံစာဆိုနှင့် အအုပ်စာဆို (၂)ဦးတွင် အခံစာဆိုက ဦးစွာ အကြံဉာဏ်ထုတ်ရပေသည်။ အအုပ်စာဆိုက အခံစာဆိုကိုလိုက်၍ အုပ်နိုင်ရန်အတွက် ကဗျာဉာဏ် အလွန်လျင်မြန်ရပါသည်။

ဖိုးသူတော် ဦးမင်းသည် သေခါနီးဆဲဆဲတွင်ပင် ကဗျာဉာဏ် ပေါ်ထွက်လာနိုင်ပေသည်။ ဖိုးသူတော် ဦးမင်းကွယ်လွန်သောအခါ ဝတ်ဆင်ထားသော အင်္ကျီအိတ်ထဲတွင် ထန်းရွက်နှင့် ရေးထား သော စာလွှာလေးတစ်ခု တွေ့ရပါသည်။ ထိုစာလွှာတွင် –

အဇ္ဈတ္တေ ဇနရေလိုလွမ်း၊ နှမ–မောင့်ကိုချစ်ဖြင့်၊
နဲရစ်တော့ဝမ်း[၁]

ဟုအချိုးသဖြန်းကလေး ရေးစပ်ထားသည်ကို တွေ့ရသည်။ ဆွေမျိုးသားချင်းတို့က မောင်စံရွှင် (လူဦးမင်း)ကမှာထားခဲ့သော သေတမ်းစာဖြစ်သည်။ ထိုသေတမ်းစာအတိုင်း အမြဲကျင့်ပေတော့ဟု လူဦးမင်း၏ဇနီးကိုပြော၍ ပေးအပ်ကြလေသည်။

ထိုအချိုးသဖြန်း၏ အဓိပ္ပာယ်မှာ–"အသက်ရှည်သမျှ ကာလပတ်လုံး လင်မယားဖြစ်သည့် အချိန်မှစ၍ ယနေ့တိုင်ပေါင်းသင်းလာကြရာတွင် အဆိုးအကောင်းတို့ကို ပြန်လှန်တွေး၍ တဖြည်းဖြည်းအောက်မေ့ လွမ်းဆွေးနေရစ်ပါတော့။ မောင်ကြီးကို ချစ်ခင်နှစ်သက်ခြင်း စိတ်မကုန်သည်မှာ ယူကျုံးမရလွမ်းဆွတ်လျက် တစ်နေ့မပြတ် ဝမ်းနည်းခြင်းရှိရစ်ပါတော့"[၂] ဟု ဆိုလိုပါသည်။ လူဦးမင်းသည် သေအံ့ဆဲဆဲ၌ပင် ကျန်ရစ်သူဇနီးသည် လွမ်းကျန်ရစ်အောင် တစိမ့်စိမ့်တွေး၍ တရေးရေး တမ်းတလာအောင်ပင် ကဗျာစပ်နိုင်ခဲ့သူ ဖြစ်ပါသည်။

လူဦးမင်းသည် ဇာတိမာန်စိတ်ဓာတ်ထက်သန်သူလည်းဖြစ်သည်။ လူဦးမင်း၏ ဇာတိမာန်စိတ်ပြင်းထန်ပုံကို "တောင်ပူစာပျော်မငြီး" ဒုံးချင်းကဗျာတွင် သစ်ခုတ်သမား၏ အသွင်ဖြင့် တွေ့

[၁] လှမောင်၊ ဦး၊ ၁၉၅၇ ၊ ၁၇၈။
[၂] – ယင်း –။

နိုင်ပါသည်။ ဘကြီးတော်ဘုရားလက်ထက် အောင်မြေလောကဘုရား၊ တပေါင်းပွဲတော်တွင် တောင်သူကြီးရုပ်ဒုံးချင်းကို ရေးစပ်ခဲ့သည်။ တောင်သူကြီးသည် ဘဝပေးအကျိုးကံအရ တောတောင်ထဲတွင် သစ်ခုတ်သမားဘဝဖြင့် ကျင်လည်နေရပါသော်လည်း မိမိအားလာရောက် ထိပါးစော်ကားပါက ငုံ့ခံနေမည့် လူမျိုးမဟုတ်ပေ။ မိမိကိုလာရောက် ယှဉ်လိုသူများကို "သေသွားမည်"ဟု ကြိမ်းဝါးပြောဆိုနိုင်လောက်အောင်ပင် သတ္တိ၊ စွမ်းရည်ထက်မြက်လှကြောင်းကို –

ဇမ္ဗူပေါ်သေချင်ရင်မော်ကြအုံ့
တော်တော်သဘားမ
သွေးလက်စမသိမ်း[၁]

ဟုဖွဲ့ဆိုထားသည်။ မြန်မာလူမျိုးတို့သည် နေထိုင်စားသောက်မှု၊ ဝတ်စားဆင်ယင်မှု ဆင်းရဲနွမ်းပါးသော်လည်း မိမိကို ထိပါးလာပါက မဟုတ်မခံစိတ်များမှာမူ ရင်ထဲ၌ ကိန်းအောင်းလျက်ရှိနေပါသည်။ ထိုသို့မြန်မာတို့၏ ဇာတိမာန်စိတ်ဓါတ်ကို ဖွဲ့ဆိုထားနိုင်သော လူဦးမင်းသည်လည်း ဇာတိမာန် စိတ်ဓာတ်တို့ ပြင်းထန်နေမည်ဖြစ်ကြောင်း ခန့်မှန်းနိုင်ပါသည်။

ထို့အပြင်–

ချစ်ရင်လိုက်ခဲ့မပဇော၊ နဘူးချုံသာလှကယ်၊
တောင်ပူစာပျော်မငြိုးတယ်၊ ကုန်းမြေပေါ်ကျက်တီး[၂]

ဟုရေးဖွဲ့ထားသည်။ မိမိနေထိုင်ရာဒေသကို ချစ်ခင်သူ ဖြစ်ကြောင်းတွေ့ရပါသည်။ ဇာတိမြေ၏ သာယာလှပပုံကို ချစ်မြတ်နိုးရာမှ ဇာတိမြေကို ထိပါးစော်ကားလာလျှင် ခုခံတတ်သောစိတ်ထားကို ရရှိနိုင်ပါသည်။

ထိုသို့လူဦးမင်း၏စာပေများကိုလေ့လာပါက ကဗျာဂါဏ်အလွန်လျင်မြန်လျက် လက်တန်းစပ်ဆိုနိုင်ဖြစ်ကြောင်း စပ်ဆိုရာ၌လည်း ရသမြောက်အောင်စပ်ဖွဲ့နိုင်ကြောင်း တွေ့ရသည့်အပြင် ဇာတိ မာန်စိတ်ရှိသော စာဆို၏ လေးစားချီးကျူးဖွယ်စိတ်ဓာတ်တို့ကို တွေ့နိုင်ပါသည်။

သာဝတ္ထိဦးကြီး၏ စာပေများ

သာဝတ္ထိဦးကြီးသည် လွမ်းချင်းစာဆိုအဖြစ် ထင်ရှားခဲ့ပါသည်။ ဦးကြီး၏ လွမ်းချင်းကဗျာများတွင် ရှေးကကျေးလက်နေ တောသူတောင်သားတို့၏ ဓလေ့စရိုက်သဘာဝများကို နှစ်သက်ဖွယ်တွေ့ရပါသည်။ ကျေးလက်နေတောသူတောင်သားတို့၏လုပ်ကိုင်စားသောက်ပုံ၊ ဝတ်စားပုံများကိုရေးဖွဲ့ထားပါသည်။ ထိုသို့ ရေးဖွဲ့ချက်များမှ အညာကျေးလက်၏ အသုံးအဆောင် အသီးအနှံမှစ၍ရေးဖွဲ့ထားပါသည်။

ဦးကြီးသည် အညာကျေးလက်၏ အကြောင်းကို "မန်ကျည်းသီး" လွမ်းချင်းတွင် တွေ့ရပါသည်။ မန်ကျည်းပင်နှင့် တမာပင်သည် အညာဒေသတွင်ရှိသော အညာကျေးတောနေပြည်သူတို့နှင့် အကျွမ်းဝင်သော အပင်များဖြစ်ပါသည်။ စာရေးရာတွင် ဖြစ်စေ၊ စကားပြောရာတွင် ဖြစ်စေထည့်သွင်းရေးဖွဲ့လေ့ရှိပါသည်။ ဆံတောက်တခါခါရှိသော တောသူလုံမပျိုလေးကို လုလင်ကချစ်မိ သောအခါ အချစ်ကို ဖွင့်ပြောရန် လိုအပ်လာသည်။ အချစ်ကို တင်စားပြောရာတွင် အမြင့်၌သီးနေသော မန်ကျည်းသီးကို လောက်လေးနှင့်ပစ်ကာ ချွေချစားမြိုဖူးသော လုလင်အဖို့တွေးမိသည်။

---

[၁] လှမောင်၊ ဦး၊ ၁၉၅၇ ၊ ၁၈၀။
[၂] ----ယင်း---- ၊ ၁၈၁။

မန်ကျည်းသီးကောက်ကွေး၊ လောက်လေးနှင့်ပစ်၊

ဟိုဆံတောက်လေး၊ မောင်လွေးလို့ ချစ်နေမိသည်[၁] ဟူ၍ တစ်ရွာသားကို ရည်းစားထားမိသော အပျိုလေးသည် လွမ်းနေမိသည်၊ ထိုမိန်းကလေးလွမ်းနေသည်ကို ဘေးမှကြည့်ကာ "တမာသား ကျည်သားလုပ်တော့ ကျိုးတတ်တယ်၊ တစ်ရွာသားရည်းစားလုပ်တော့ လွမ်းတတ်တယ်" ဟူ၍ ဥပမာပေး၍ စာချိုးခဲ့ကြသည်။ မန်ကျည်သား၏ သဘောမှာမာသည်။ အဆစ်မှာ ခွေကောက်ကောက် သဘောဖြစ်သည်။ ထိုမန်ကျည်း၊ တမာတို့ကို တင်စားကာစပ်ဆိုခဲ့ကြသည်။ အညာသူ အညာသားတို့၏ ပြောဆိုပုံမှာ မိမိပတ်ဝန်းကျင်ရှိ မန်ကျည်း၊ တမာနှင့် တင်စားပြော တတ်ကြသည်။

ထိုအညာ၏ ဓလေ့ကို ဦးကြီးက လွမ်းချင်းအဖြစ် "မန်ကျည်းသီး" လွမ်းချင်းကဗျာကို ရေးဖွဲ့ခဲ့ပါသည်။

ထန်းစေ့ခွက်ကယ်နှင့်
လက်ဖက်ကိုထည့်ကာ
တောကငယ်လာ အိတ်ထဲဘာပါသတုံးလို့
နှိုက်ကာမေးတဲ့ အမိရယ်လေး[၂]

ဟု ရေးဖွဲ့ထားပါသည်။ ထန်းစေ့ခွက်ထဲ လက်ဖက်ထည့်ပြီး တောကပြန်လာခဲ့စဉ် မောင်ကြီး၏ အိတ်ထဲကို လက်ဖြင့်နှိုက်ကာ 'ဘာပါသတုံး' ဟုမေးလာသော အမိရယ်လေးဟူ၍ တောကပြန်လာသော ချစ်သူကို မေးဟန် ရေးဖွဲ့ထားပါသည်။

ထိုသို့မေးသောအခါ

ငယ်ငယ်တုန်းက၊ လုံးထွားကတစ်
ကြီးချောင်ကျစ်နှင့် တဆစ်ကယ်ခွေခွေ
မန်ကျည်းသီးမောင်ကြီးချွေခဲ့တယ်

အိမ်နေသူအသာရုံ့လို့၊မြုံတော့ကွယ်[၃] ဟူ၍ ဖြေကြားခဲ့သည်။ ငယ်စဉ်တွင် အလုံးအဖန်က ထွားကြိုင်း တစ်ရစ်နေကာ ကြီးလာသောအခါမှ အစေ့ချောင်အသားကျစ်လာသည့် အဆစ်ခွေသော မန်ကျည်းသီးကို မောင်ကြီးချွေယူခဲ့ပါသည်။ အိမ်နေသူသည် အသာကလေးရုံ့ပြီး မြုံကာစားပါတော့ အမိရယ်လေးဟုရေးဖွဲ့ထားပါသည်။

အိမ်နေသူက တောမှပြန်လာသူကို အိတ်ထဲနှိုက်ပြီး "ဘာပါသတုံး" ဟုမေး၏။ တောပြန်ယောကျ်ားက မန်ကျည်းသီးပါလာသည်ဟု တုံးတိမပြော စကားပရိယာယ်ဖြင့်ပြောသည်။ သူ့အပြော သူ့ပရိယာယ်မှာ အဖုံးနှင့်အဖော်ပါသော စကားတစ်ဆက်တစ်စပ်တည်း ဖော်ပြထားပါသည်။

မန်ကျည်းသီး၊ မောင်ကြီးချွေခဲ့တယ်[၄] သည် ပြောခဲ့သော စကားပရိယာယ်၏ အဖော်ဖြစ်သည်။ မန်ကျည်းသီးစားလျှင် ပါးတောင်သည်။ သွားကျင်သည်။ တောပြန်ယောကျ်ားက အိမ်နေသူ ဇနီးပါး တောင်သွားကျင်မှာစိုးသည်။ ထို့ကြောင့်

အိမ်နေသူ အသာရုံ့လို့

---

[၁] မိုးကြည်၊ မေမြို့ ၊ ၁၉၉၉၊ ၅၈။
[၂] မိုးကြည်၊ မေမြို့၊ ၁၉၆၆၊ ၅၈။
[၃] --- ယင်း------။
[၄] --- ယင်း------။

မြဲတော့ကွယ်လေး”[၁] ဟု ကြင်နာသံဖြင့် ပြောရာသည်။ မန်ကျည်သီး လွမ်းချင်းအစသည် ပြဲမြိချင်စရာဖြစ်သော်လည်း အဆုံးတွင် ကြင်နာသံပါသဖြင့် နှစ်သိမ့်လှိုက်မောမှုကို ခံစားရပါသည်။

အညာကျေးလက်ဒေသ၏ အဓိကလုပ်ငန်းမှာ လယ်ယာစိုက်ပျိုးရေးလုပ်ငန်းဖြစ်ပါသည်။ ကျေးလက်ဒေသရှိ အမျိုးသားများက ပျိုးနှုတ်သည့် အလုပ်ကိုလုပ်ကြသည်။ အမျိုးသမီးများက ကောက်စိုက်ကြသည်။ ထိုသို့လယ်ယာလုပ်ငန်းလုပ်ကိုင်ကြပုံ လုပ်ငန်းခွင်တွင် စားသောက်ကြပုံများကို“ပျိုးနှုတ်ပြန်”လွမ်းချင်းတွင် တွေ့ရပါသည်။ ထိုလွမ်းချင်းတွင် ပျိုးနှုတ်သွားနေသော ချစ်သူမောင်က အိမ်နေသူ အမျိုးသမီးကို မှာကြားပုံတွင်

ပီလဝန်း
ကန်စွန်းနှင့် ကင်းပုံ
ကင်းအငုံ
ပျဉ်းထုံထုံ မှိုသင်္ကန်းငယ်နှင့်
မောင်ဖမ်းတဲ့လယ်ပုဇွန်ကို
အခွံကိုခွာမခွဲခဲ့နဲ့
အထဲမှာအဆီကုန်ရှော့

နီရုံချက်အမိရယ်လေး[၂] ဟူ၍ ရေးဖွဲ့ထားသည်။ စားသောက်စရာစီမံရာတွင် အသီးအရွက်များအဖြစ် ပီလောရွက်ဝန်း၊ ကန်ဇွန်းရွက်၊ ကင်းပုံရွက် အငုံအကင်းနှင့် ပျဉ်းတွဲသည့် မှိုသင်္ကန်းတို့ကို မောင်ဖမ်းလာသော လယ်ပုဇွန်နှင့် ရောချက်စေသည်။ လယ်ပုဇွန်ကို အခွံမခွာပါနှင့် ခွာလျှင် အဆီကုန်သွားပါလိမ့်သည်။ နီရုံသာချက်ပါဟု မှာကြားသည်။ ထိုချက်ပြုတ်သော အရွက်များသည် အညာကျေးလက်ဒေသမှ တွေ့ရသောအပင်များနှင့် လယ်ထဲမှ သူကိုယ်တိုင်ဖမ်းလာသောပုဇွန်တို့ ပါရှိသည်။

ထို့ပြင်ဟင်းနှင့် လိုက်ဖက်သော အချဉ်အဖြစ်“ တောခါချဉ်” ပါသည်။ ထိုတောခါချဉ်ကို ငပိဖုတ်နှင့် ရောထည့်ပြီးပျိုးနှုတ်ရာ ယူခဲ့ပါရန်မှာကြားသည်။ ပျိုးနှုတ်ရာသို့ ချစ်သူဇနီးကိုယ်တိုင် ချက်ပြုတ်ပြီး လာပို့ရန်ကိုလည်း

လဲ့လုပ်တဲ့နန်းသူ
ပျိုးနှုတ်ရာယူခဲ့ပါ
အိမ်သူရဲ့ လမ်းတာကို
ပက္ကလာမော်ကာမပါလို့

မျှော်ပါ့မယ်လေး[၃] ဟူ၍ ရေးဖွဲ့ထားပါသည်။ လာပို့မည့် ချစ်သူကို နွဲ့နှောင်းသော နန်းသူကဲ့သို့လှသောအမိ၊ အိမ်သူဟုတင်စားကာအိမ်သူလာမည့် လမ်းကို ခမောက်ရှည်ပင့်မကာ မျှော်နေပါမည်ရေးဖွဲ့ထားပါသည်။ ထိုလွမ်းချင်းတွင် ပါသောအလုပ်မှာလည်း အညာကျေးတောနေသူတို့၏ လုပ်ငန်းခွင် “ပျိုးနှုတ်ခြင်း”၊ အစားအစာအဖြစ် အညာကျေးတောမှာရှိသော ကင်းပုံ၊ ကန်စွန်း၊ လယ်ပုဇွန်၊ ခါချဉ်တို့ပါ ရေးဖွဲ့ထားပါသည်။

---

[၁] မိုးကြည်၊ မေမြို့၊ ၁၉၆၆၊ ၅၈။
[၂] မိုးကြည်၊ မေမြို့၊ ၁၉၉၉၊ ၅၆။
[၃] -----ယင်း------။

ရွှေဘိုသည် အညာဒေသဖြစ်သကဲ့သို့ အညာသူအညာသား ပီပီရိုးသားသည်။ ပျူငှာဖော်ရွေ သည်။ မိမိ၏ အညာဒေသကို အလည်လိုက်ခဲ့ရန်အတွက် ရေးဖွဲ့ထားပုံကို "စပ်ဟင်းသို့" လွမ်းချင်း တွင်

တစ်ခါလေလိုက်ခဲ့တော့၊ စရိုက်ကယ်ဘာသာ
တို့တောရွာမှာ၊ စားစရာဆန်ထမင်းမှာလ
မုရင်းနီတျာနဲ့ သီတာရောတဲ့ချိန်ကိုလေး[၁]

ဟူ၍ ရေးဖွဲ့ထားပါသည်။ နီရဲသော မုရင်းဆန်နှင့် သီတာစပါးဖွပ်ထားသော ဆန်တို့ရောနှောထား သောထမင်းချက်စားသောအချိန်ဖြစ်သည်။

ထိုထမင်းနှင့် လိုက်ဖက်စွာ

စပ်ဟင်းချိုမူ၊ လောရွှေပီနှင့် ပတီရုံး
ဖြူးစပ်ကာ ကျိုပြီးလျှင်
ဆီးချိုပင်ရိပ်သာမှာ
နှစ်မျက်နှာယှဉ် ဖြိုင်ဖြုံးလို့
သုံးရအောင်လေး[၂]

ဟူ၍ ရေးဖွဲ့ထားပါသည်။ ပီလောရွက်နှင့် ရုံးပတီသီး ဟင်းချိုကို သာယာသော ဆီးချိုပင်ရိပ် အောက်မှာ မျက်နှာချင်းဆိုင်ယှဉ်ပြိုင်စားသောက်ကြရအောင်ကွယ်ဟုခေါ်ပါသည်။ ဤလွမ်းချင်း မှာ ရိုးသားသော စိတ်ကိုတွေ့ရသည်။ အဆောင်အယောင်မပါ။ မိမိရှိသည့်ထမင်းနှင့် ဟင်းကို ကျွေးချင်သော စေတနာကို တွေ့ရပါသည်။

ခြုံငုံသုံးသပ်ချက်

မြန်မာ့စာပေနယ်တွင် ခေတ်အလိုက်ထင်ရှားသည့် ဒေသအသီးသီးရှိ စာဆိုများရှိကြပါသည်။ ကုန်းဘောင်ခေတ်ရွှေဘိုဒေသတွင် မွေးဖွားကြီးပြင်းခဲ့သော ထင်ရှားသည့် စာဆိုများမှာ ငါးရာနဲ့ရွာ ဇာတိဖွား လူဦးမင်းနှင့် ခင်ဦးမြို့နယ် သာဝတ္ထိရွာဇာတိဖွားဦးကြီးတို့ ပါဝင်ပါသည်။ ထိုစာဆိုတို့ ၏စာပေများကိုလေ့လာသောအခါ စာပေနယ်တွင်ထင်ရှားရသည့် အကြောင်းအချက်များရှိကြောင်း တွေ့ရပါသည်။

စာဆိုလူဦးမင်းသည် ဖိုးသူတော်ဦးမင်းနှင့် စာပြိုင်ဖက်ဖြစ်သည်။ ဖိုးသူတော်ဦးမင်းနှင့် စာပြိုင်စပ်ဆိုရာတွင် တန်နုပွတ္တိဉာဏ်ဖြင့် လက်တန်းစပ်ဆိုရသည်။ လူဦးမင်းသည် ဟာသဉာဏ်၊ ထွင်ဉာဏ်ရွှင်ဉာဏ်နှင့် ပြည့်စုံသူလည်းဖြစ်ပါသည်။ ထို့ကြောင့် လူဦးမင်း၏ စာပေများသည် ထင်ရှားရခြင်းဖြစ်ပါသည်။

စာဆိုဦးကြီးသည် တောဓလေ့သဘာဝတို့ကို လွမ်းချင်းတို့ဖြင့် ရေးဖွဲ့ခဲ့သူဖြစ်ပါသည်။ ဦးကြီး၏ လွမ်းချင်းကဗျာများသည် ရှေးကကျေးလက်နေတောသူတောင်သားတို့၏ ဓလေ့စရိုက် သဘာဝများကို လွမ်းမောဖွယ်ကောင်းအောင်ရေးဖွဲ့နိုင်ပါသည်။ ထို့ကြောင့် ဦးကြီး၏ လွမ်းချင်း ကဗျာများသည် ယနေ့ထက်တိုင်ထင်ရှားလျက်ရှိပါသည်။

---

[၁] မိုးကြည်၊ မေမြို့၊ ၁၉၉၉၊ ၅၆။
[၂] မိုးကြည်၊ မေမြို့၊ ၁၉၆၆၊ ၆၃။

နိဂုံး

ဤစာတမ်းတွင် ကုန်းဘောင်ခေတ်ရွှေဘိုဒေသရှိစာဆိုလူဦးမင်းနှင့် သာဝတ္ထိဦးကြီးတို့၏ ရေးဖွဲ့ခဲ့သောစာပေများကို လေ့လာတင်ပြထားပါသည်။ အလောင်းမင်းတရားကြီး တတိယမြန်မာနိုင်ငံကို တည်ထောင်ရာတွင် အစပြုတည်ထောင်ခဲ့သော ရတနာသိဃ်ကုန်းဘောင်ဒေသအဖြစ် ထင်ရှားခဲ့သော ရွှေဘိုဒေသ ဇာတိဖွား စာဆိုအချို့တို့၏ စာပေလက်ရာများကို ဂုဏ်ယူဖွယ်အတု ယူဖွယ်ဖြစ်အောင်လေ့လာတင်ပြထားပါသည်။ ကုန်းဘောင်ခေတ်က မြန်မာ့စာပေနယ်တွင် မှတ်တမ်းတင်လောက်အောင် စာပေအရာ၌ ထူးချွန်ထက်မြက်ခဲ့သော စာဆိုတို့ကိုအားကျလျက် ယခုခေတ်အခါတွင်လည်း ရွှေဘိုဒေသမှ စာဆိုကောင်းများ ပေါ်ထွက်လာစေချင်ပါသည်။

ကျမ်းကိုးစာရင်း

ခင်အေး၊ ဦး၊ (၁၉၉၃)။ ***မြန်မာစာညွှန့်ပေါင်းကျမ်း (စတုတ္ထတွဲ)***။ မြန်မာ့အလင်းသတင်းစာတိုက်နှင့် ဂါဒီယန်သတင်းစာတိုက်။
မိုးကြည်၊ မေမြို့၊ (၁၉၉၉)။ ***စာပေခေတ်ဥခေတ်မှ မြန်မာကဗျာများအဖွင့်***။ ရန်ကုန်၊ မဟာဝိဇ္ဇာပုံနှိပ်တိုက်။
မြင့်ကြည်၊ ဦး၊ (၁၉၉၂)။ ***မြန်မာစာညွှန့်ပေါင်းကျမ်း (ဒုတိယတွဲ)***။ မြန်မာ့အလင်းသတင်းစာတိုက်နှင့်ဂါဒီယန်သတင်းစာတိုက်။
လှမောင်၊ ဦး၊ (၁၉၅၇)။ ***အနုစာပေကောက်နှုတ်ချက်***။ ရန်ကုန်မြို့၊ လယ်တီမဏ္ဍိုင် ပိဋကတ်ပုံနှိပ်တိုက်။

ရွှေဘိုမြို့နယ်ကျေးလက်မောင်းထောင်းတေးများမှကျေးလက်လူမှုဘဝပုံရိပ်များ

တိုးတိုးစိုး[၁]

စာတမ်းအကျဉ်း

"ရွှေဘိုမြို့နယ် ကျေးလက်မောင်းထောင်း တေးများမှ ကျေးလက်လူမှုဘဝပုံရိပ်များ" သုတေသနစာတမ်းသည် ရွှေဘိုမြို့နယ် အတွင်းတွေ့ရှိရသော ကျေးလက်မောင်းထောင်းတေးများကို အလေ့လာခံနယ်ပယ်အဖြစ် သတ်မှတ်၍ လေ့လာထားပါသည်။ ရည်ရွယ်ချက်မှာ ရွေးကျေးလက်မြန်မာတို့၏ လူနေမှုဘဝကို ဖော်ထုတ်လိုခြင်း ဖြစ်ပါသည်။ ရွှေဘိုမြို့နယ် ကျေးလက်မောင်း ထောင်းတေးများ ဖြစ်သည့် ရွှေနောင်သူ မောင်းထောင်းတေး၊ ပေါက်တုံရွာ မောင်းထောင်းတေး၊ ကဗြူရွာမောင်းထောင်းတေး၊ တအုံရွာ မောင်းထောင်းတေးတို့ကို လေ့လာ၍ ကျေးလက်လူမှုဘဝပုံရိပ်များကိုဖော်ထုတ် တင်ပြထားပါသည်။ ဒေသအကျိုးပြု သုတေသနစာတမ်းအဖြစ် အကျိုးရရှိနိုင်ပါသည်။

နိဒါန်း

ရှေးအခါက စပါးစိုက်ပျိုးရာ ကျေးလက်ဒေသတွင် စပါးမှဆန်ရရှိရန်အတွက် မောင်းကို ပြုလုပ်၍ အသုံးပြုခဲ့ကြရသည်။ ယနေ့ နည်းပညာတိုးတက်လာသောခေတ်တွင်မူ ရှေးကကဲ့သို့ စပါးမှ ဆန်ရရှိရန် မောင်းထောင်းရန်မလိုတော့ပါ။ ဆန်ကိုလိုအပ်သလိုရအောင် ခေတ်မီစက်များ အသုံးပြု၍ ဆောင်ရွက်နိုင်ကြပါသည်။ ထို့ကြောင့်မြန်မာတို့၏ ကျေးလက်ဒေသတွင်မောင်းသံများ ဆိတ်သုဉ်းခဲ့လေသည်။ ရှေးကမြန်မာ့အလှူမင်္ဂလာ သားရှင်ပြုပွဲနှင့် မြန်မာ့မောင်းသည် တွဲစပ်နေပေသည်။ မောင်းမရှိပါက အလှူမင်္ဂလာ မဖြစ်နိုင်သောအခြေသို့ ရောက်ရမည်မှာအမှန်ပင်။ အလှူပွဲတွင် သင်္ဃာတော်များအား ဆွမ်းအတွက်နှင့် ဧည့်ပရိသတ်တို့ကို ဧည့်ခံကျွေးမွေးရန်အတွက် ဆန် တင်းပေါင်းများစွာ လိုအပ်ပေသည်။ ထို့ကြောင့် အလှူမတိုင်ခင် တစ်လလောက် အလိုကတည်းက ရွာသူရွာသားများသည် အလှူပေးမည့်အိမ်သို့ ဝိုင်းဝန်းရောက်ရှိလာကြပြီး မောင်းထောင်းသူထောင်း၊ စပါးပြာသူပြာ၊ ဆန်ကာဖြင့်ချသူချ စည်ကားလှပါသည်။ ဆုံအကျမောင်းသံကို နားဆင်ရင်း သီချင်း သံပြိုင်ဖောက်၍ သီဆိုကြသည်။ မောင်းထောင်းရင်းမပြတ်သီဆိုကြသည်။ အချင်းချင်း စကြသည်။ လှောင်ကြ ပြောင်ကြသည်မှာ ပျော်ဖွယ်ကောင်းလှသည်။ ထိုသို့မောင်းထောင်းရင်း သီဆိုကြသော မောင်းထောင်းတေးသံတို့သည် နှုတ်ဆင့်ကမ်းလျက်ကျန်ရစ်ခဲ့သည်။

ထိုကျန်ရစ်သောမောင်းထောင်းတေးသံများအနက် "ရွှေဘိုမြို့နယ်ကျေးလက် မောင်းထောင်းတေးများမှလူမှုဘဝပုံရိပ်များ"ကို ဒေသအကျိုးပြုအတွက် လေ့လာလိုစိတ်များ ဖြစ်ပေါ်လာခြင်းကြောင့် သုတေသန စာတမ်းကို လေ့လာပြုစုရခြင်းဖြစ်ပါသည်။

မောင်းထောင်းတေးသဘောသဘာဝ

ပါမောက္ခဦးဧမောင်က

> **မောင်းထောင်းတေးဆိုသည်မှာအလှူမင်္ဂလာ၊သားရှင်ပြုပွဲများမတိုင်မီအလှူအတွက်**
> **အသုံးပြုရန်စပါးဆန်များထောင်းသည့်အခါသီဆိုရသည့်သီချင်းမျိုးဖြစ်သည်ဟု**[၂]

ဟူ၍ဖွင့်ဆိုထားသည်။

အလှူရှင်၏အိမ်တွင် အလှူမတိုင်မီ အလှူအတွက်ဆန်ရှိရန် စပါးတို့ကို မောင်းဆုံထဲသို့ ထည့်ကာ မောင်းထောင်းရသည်။ ကျေးတောသူကျေးတောသားတို့သည် ဝိုင်းဝန်းကူညီကြရင်း လူပျို

---

[၁] ကထိက၊ မြန်မာစာဌာန၊ ရွှေဘိုတက္ကသိုလ်။

[၂] ဧမောင်၊ ဦး၊ ၁၉၇၂၊ ၄၃။

အပျိုတို့ လွတ်လပ်စွာစကားပြောဆိုရန် အခွင့်ရကြသည်။ အချင်းချင်း စကားတင်း ဆိုကြသည်။ စောင်းမြောင်းကျီစယ်ကြသည်။ အနိုင်အထက်လုပ်၍ပြောကြသည်။ ဦးတည်ချက်မရှိဘဲ မိမိတို့ခံစားချက်အတိုင်း ပြောဆိုကြသည်။ ပြောဆိုရင်းဖြင့်ပင် မောင်းသံနှင့်အညီ စည်းချက်ကျကျ တေးသီကြသည်။ ဤသို့မောင်းထောင်းရင်းသီဆိုကြရာမှ မောင်းထောင်းတေးများ ဖြစ်ပေါ်လာရပါသည်။ မောင်းထောင်းတေးသီဆိုကြပုံကို ကျေးတောနေတို့၏ ကဗျာများစာအုပ်တွင်

> **မောင်းထောင်းတေးကဗျာများကို ဆန်ဖွတ်မောင်းထောင်းကြသော ကျေးတောသူတို့ သီဆိုကြသည်။ အိုင်ချင်းကဗျာများ၏ သဘောသည် ကျေးတောသူတို့၏စရိုက်ကို ဖွင့်လှစ်ပြသကဲ့သို့ မောင်းထောင်းကဗျာများသည်လည်း ကျေးတောသူတို့၏ မဲ့ဟန်၊ ရွဲ့ဟန်၊ စောင်းမြောင်းဟန်၊ ကဲ့ရဲ့ဟန်၊ ကလူကျီစယ်ဟန်၊ ကရုဏာဒေါသထွက်ဟန် စသည်တို့ကို ရေးခြယ် ပြသလေသည်**[၁]

ဟုဖွင့်ဆိုထားပါသည်။

မောင်းထောင်းတေးသီဆိုရာတွင် အတိုင်အဖောက်သီဆိုကြသည်။ အဆွဲအငင်အဖြတ် အတောက်လေယူလေသိမ်းဖြင့် သီဆိုကြသောကြောင့် ငြိမ့်ညောင်းသာယာလှပါသည်။ မောင်းသံနှင့် ယှဉ်လျက် တေးသံတို့သည်အလှူရှင်၏အိမ်၌ ပဲ့တင်ရိုက်ဟည်းလျက်ရှိမည် အမှန်ပင်။ ကြားရသူတို့သည်လည်း အပျော်များကူးစက်ခံစားစေနိုင်သည်ဟု ယူဆမိပါသည်။ ပါမောက္ခ ဦးဇမောင်က

> **မောင်းထောင်းတေးတွင် တူရိယာဖြင့် တွဲဖက်သီဆိုလေ့မရှိ။ သို့သော်လည်း စည်းချက်တော့ရှိပါသည်။ စည်းချက်သည် မောင်းသံပင်ဖြစ်သည်။**[၂]

ဟုဆိုထားပါသည်။

ထို့ကြောင့် မောင်းထောင်းတေးသည် ကျေးလက်ဒေသ သားရှင်ပြုပွဲမတိုင်မီ အလှူရှင်၏ အိမ်တွင်တစ်လလောက်ကတည်းက ဝိုင်းဝန်းကူညီလုပ်ဆောင်ပေးကြသည့် ကျေးတောသူ ကျေးတောသားတို့ စပါးထောင်းရာတွင်သီဆိုကြသည့် တေးသီချင်းတစ်မျိုးဖြစ်ပါသည်။ အတိုင်အဖောက်ညီညီဖြင့် မောင်းသံကို စည်းချက်ပြုကာ ဝိုင်းဝန်းသီဆိုကြသော သီချင်းလည်းဖြစ်သည်။ မောင်းထောင်းတေးသည် ကျေးလက်ပြည်သူတို့၏ ဘဝခံစားမှုတို့ကို လှစ်ဟဖွင့်ဆိုသော သီချင်းကဗျာမျိုးဖြစ်သည်ဟုလည်းဆိုနိုင်ပါသည်။

လူမှုဘဝပုံရိပ်များ

မြန်မာနိုင်ငံတွင် လူအများစုကိုးကွယ်သော ဘာသာမှာ ထေရဝါဒဗုဒ္ဓဘာသာပင် ဖြစ်သည်။ မိမိတို့ယုံကြည်ကိုးကွယ်ရာ ဗုဒ္ဓသာသနာကို ထိန်းသိမ်းစောင့်ရှောက်ကြသည်။ သာသနာအကျိုးကို သယ်ပိုးထမ်းရွက်ကြသည်။ သီတင်းသီလဆောက်တည်ခြင်း၊ အလှူဒါနပြုခြင်းတို့ မပြတ်ပြုကြသည်။ မိဘတို့သည် သားရတနာမွေးဖွားစကပင် နောင်တစ်ချိန်တွင် သားရှင်ပြုပွဲပြုလုပ် လှူဒါန်း နိုင်ရန်အတွက် ကြိုးပမ်းခဲ့ကြသည်။ သားဖြစ်သူအား သာသနာ့ဘောင်သို့ သွတ်သွင်းကာ ဘုရားရှင်၏ တပည့်သားရဟန်းအဖြစ်ခံယူစေပြီး မိမိတို့က သာသနာ့ဒါယကာ၊ သာသနာ့ဒါယိကာမ အဖြစ်ခံ ယူလိုကြသည်။

မြန်မာ့ဓလေ့အစဉ်အလာနှင့်အညီ သားရှင်ပြုပွဲကျင်းပတော့မည်ဆိုလျှင် အလှူရှင်မိသားစုတစ်စုတည်းဖြင့် မဖြစ်မြောက်နိုင်။ အလှူမကျင်းပမီကပင် ကျေးရွာသူ၊ ကျေးရွာသားများနှင့် တိုင်ပင်

---

[၁] မြသန်းတင့်၊ ၁၉၇၅၊ ၆၄။

[၂] ဇမောင်၊ ဦး၊ ၁၉၇၂၊ ၄၃။

ကြသည်။ အလှူရက်ကို သတ်မှတ်ရသည်။ ဗာဟီရတာဝန်များကို ခွဲဝေယူကြရသည်။ ရွာသူရွာသားများ ဝိုင်းဝန်းကူညီ လုပ်အားဒါနပြုကြရသည်။

ကြီးငယ်ရွယ်လတ်အမျိုးသမီးတို့သည် အလှူတွင် ရဟန်းသံဃာများအား ဆွမ်းကပ်နိုင်ရန် ဧည့်ပရိတ်သတ်တို့အားကျွေးမွေးနိုင်ရန် စပါးများကိုမောင်းဖြင့် ထောင်းကြဖွတ်ကြရသည်။ မောင်းထောင်းတေးများကို ပျော်ပျော်ပါးပါးသီဆိုကြရင်း အလှူပွဲတွင် ကုသိုလ်ပါဝင်ယူကြရသည်ကိုပင် ကျေနပ်ပီတိ ဖြစ်ကြရသည်။ ဆုံအကျမောင်းသံဖြင့် စည်းချက်ညီညီမောင်းထောင်း တေးသံတို့သည် အဝေးကပင် ကြားရပြီး စီစီညံလျက်ရှိကြောင်းကို

ဟိုရွေ့ကဆူညံ ဆူညံ၊ ဘာသံလို့မေး။ မေးပါနဲ့အေ ရွှေနောင်သူအလှူပေးတယ် မောင်းသံတဲ့လေး။[၁]

ဟူ၍တွေ့ရပါသည်။ ထို့ပြင်အရှေ့ရပ်ဆီမှနေဝန်းထွက်လာသည့်အလား ဖန်ရေဆွတ်သင်္ကန်း ဆင်မြန်းထားသော ရဟန်းများဆွမ်းခံကြွလာသည်ကို တစ်ရွာလုံးက ဆွမ်းများလောင်းကြသည်ကိုလည်း

ဟိုရွေ့ကနီရွှေရွှေ နေထွက်ပြီလေ။
ဟုတ်ပါဘူးအေ ဖန်ဆွတ်ရေသင်္ကန်း
ရဟန်းတွေဆွမ်းခံကြွတယ် လောင်းလာကြစမ်း။[၂]

ဟူ၍ ရေးဖွဲ့ထားသည်မှာ ကျေးရွာသူ၊ ကျေးရွာသားတို့၏ အလှူရေစက်လက်နှင့်မကွာပုံ၊ ရွှေနောင်ရွာတွင် သာသနာရောင်ဝါ ထွန်းလင်းတောက်ပပုံတို့ကို တွေ့ရပါသည်။

ကဗြူရွာ မောင်းထောင်းတေးတွင် အလှူရှင်သည် လှူဖွယ်ပစ္စည်း၊ သင်္ကန်းပရိက္ခရာ သပိတ်အစုံအလင်နှင့် လှူဒါန်းသည်။ ဖောဖောသီသီ ကျွေးမွေးဧည့်ခံသည်။ အလှူရှင်၏ သဒ္ဒါတရားထက်သန်သည့် ဒါနအကျိုး၊ ဝေယျာဝစ္စကုသိုလ်ယူကြသည့် ပျိုမေတစ်စု၏ ကောင်းမှုအကျိုးတို့သည် သိကြားဘုံသို့ စံမြန်းနိုင်မည်။ နိဗ္ဗာန်ခရီးသို့ အတူလှမ်းနိုင်မည်။ ဤသို့သောဒါနအား၊ စေတနာအားတို့ကို

"အလှူစုံ ရွှေသပိတ်နှင့် ပရိက္ခရာစုံ၊ ပွဲလယ်မှာပုံလေ့။
အလှူပေါလို့ ပြောမကုန်
သိကြားဘုံ ရွှေလွှာခင်းတယ်၊ ရေးရေ့စာရင်း။
မဂ္ဂင်ရွှေဖောင် ပြောင်ပြောင်ကြီး
စီးရအောင်လို့ လှူရှာလေ၊ သားကိုဖြိုးမောင်မေလေ။
ဖောင်မဂ္ဂင်ရွှေလေ၊ အပျိုတွေတူမကွဲအောင် စီးရမယ့်ပွဲ။[၃]

ဟူ၍တွေ့ရပါသည်။ ထို့ကြောင့် ကဗြူရွာသူရွာသားတို့၏ သဒ္ဓါတရားထက်သန်သည့် စိတ်ထားကို တွေ့ရပါသည်။

ထို့ပြင် တအုံရွာ မောင်းထောင်းတေးတွင်လည်း တအုံရွာ အလှူဒါယကာ၊ အလှူဒါယိကာမ၏ သဒ္ဓါစိတ်ကိုလည်း တွေ့ရပါသည်။ တအုံရွာသူသည် သားရတနာမွေးလာသည် ကတည်းကပင် သားရှင်ပြုရန်အတွက် အားခဲခဲ့သည်။ အလှူပေးနိုင်ရန် ရှာဖွေစုဆောင်းပြီးနောက် သားမောင်အား ရှင်ပြု ပေးနိုင်တော့မည်။ မိဘတို့သည် သားမောင်အား သာသနာ့ဘောင်အတွင်း သွတ်သွင်းပေးနိုင်တော့မည်။ လိုသမျှဝယ်၊ လာသမျှကျွေး၊ ပြည့်စုံအောင် လှူဒါန်းမည်။ မည်မျှပင်ကုန်ပါစေ မတွန့်

[၁] ရွှေနောင်သူ မောင်းထောင်းတေး။
[၂] ------ယင်း---------။
[၃] ကဗြူရွာ မောင်းထောင်းတေး။

မဆုတ်ဘဲ လှူဒါန်းမည်။ မင်းဝေဿန္တရာပမာ အလှူကို ရဲရဲရင့်ရင့် လှူဒါန်းနိုင်ခဲ့ပြီ။ ထိုသို့ တအုံရွာ အလှူရှင်၏ အလှူရဲသည့်စိတ်ဓာတ်ကို

မိဘရယ်စုံနှစ်ဖြာနှင့်လေ၊ သားပုတ္တာမြတ်ရာတွင်းကို၊ သွင်းမယ်တဲ့လေး။
အလှူရဲတဲ့ မောင်ရင့်အမေ၊ ကုန်ပလေစေ ဆုတ်ကာကြွတယ်
သားရှင်ပြုပွဲ။
ကုန်လိုကုန် ပုံလို့သုံးတယ်၊ မင်းဝေဿန်ထုံး။
ထမင်းရေချောင်းလိုစီး အလှူကြီးတဲ့ဒါယကာ
ကိုသာအောင် လှူတဲ့ပွဲ သဲခြိမ့်ကြေငြာ။[၁]

ဟူ၍တွေ့ရပါသည်။ ထို့ကြောင့် တအုံရွာ အလှူရှင်၏ ရဲရင့်ပြတ်သားစွာ လှူဒါန်းနိုင်သည့် သဒ္ဓါစိတ်မှာ လေးစားဖွယ် ကောင်းလှပါသည်။

တစ်ဖန် ပေါက်တုံရွာ မောင်းထောင်းတေးတွင်လည်း အလှူရှင်တို့သည် အလှူမဏ္ဍာပ်ကြီးကို ဝါးတစ်ထောင်ကုန်အောင်ပင် ကြီးကျယ်ခမ်းနားစွာ ဆောက်မည်။ မြေကြီးများ တုန်ဟည်းသွားသည်အထိ အတုမရှိ အလှူကြီးပေးမည်။ သားနှစ်ဖြာအား ရှင်ပြုသည့်ပွဲဖြစ်သောကြောင့် နမြောတွန့်တိုခြင်းမရှိ။ စည်ကားသိုက်မြိုက်စွာ ကျင်းပမည့် အလှူရှင်တို့၏ စေတနာသဒ္ဓါတရားထက်သန်ပုံကို

မဏ္ဍာပ်ဆောက်ပုံ ဝါးတစ်ထောင်ကုန်
မြေကုန်အောင် လှူမယ်ဟဲ့လို့
စာတိုက်ပေါ် ရွှေမှုန်ကြဲတယ် သားရှင်ပြုပွဲ။
အလှူအမတိုင်ပင်တော့
မနမြောနဲ့ အလှူဒါယကာ
သားရွှေစင် နှစ်ပင်တွဲ ပွဲနဲ့ပြုပါ။[၂]

ဟုဖွဲ့ဆိုထားသည်။ ထို့ကြောင့် အလှူဒါယကာနှင့်အလှူဒါယိကာမတို့၏ စိတ်တူကိုယ်တူ စေတနာဖြူဖြင့် လှူဒါန်းကြကြောင်းမှာ ကြည်နူးဖွယ်ရာဖြစ်ပါသည်။

အလှူတွင်လာရောက်ကူညီကြသူတို့ကို လက်ဖက်၊ ကွမ်းတို့နှင့်ဧည့်ခံတတ်ကြသည်။ လက်ဖက်နည်း၍မလောက်မငဖြစ်ရာ အလှူရှင်ကို

လက်ဖက်မချ ကွမ်းမချပြန်ရတော့မလား၊
အလှူသခင် ညောင်ကိုးပင် လှူချင်ရက်နှင့်ကုန်နိုးနိုး[၃]

ဟူ၍သီဆိုကာ နောက်ပြောင်ကျီစယ်ကြသည်။ အလှူရှင်အားပြန်ရတော့မလားဟု ခနဲ့ဟန်ပြောဆိုကြသည်။ ထိုနောက်မှ အလှူရှင်ကို ပျော်လွန်းသဖြင့် နောက်ပြောင်ခြင်းဖြစ်ကြောင်း တောင်းပန်ဟန်ဖြင့် သီဆိုကြပါသည်။

ကျေးရွာများတွင်မြို့ပြကဲ့သို့ ပွဲလမ်းသဘင်ပေါများခြင်းမရှိ။ အလှူပွဲများ၌ပွဲဖြင့် ဧည့်ခံမှုသာကြည့်ကြရရှာသည်။ ထို့ကြောင့်လည်းအလှူရှင်သည် မိမိအလှူတွင် ပွဲငှားဧည့်ခံလိုကြသည်။

ကိုသာအောင်ရဲ့သူ့ခမြာ၊ ပွဲထဲ့(ထည့်)ချင်ရှာလေ။
ကိုချမ်းသာရယ် သူကလယ်လို့၊ ပွဲမထည့်နဲ့လေး။[၄]

---

[၁] တအုံရွာ မောင်းထောင်းတေး။
[၂] ပေါက်တုံရွာ၊ မောင်းတောင်းတေး။
[၃] တအုံရွာ မောင်းထောင်းတေး။
[၄] -----ယင်း ------။

ဟူ၍အလှူရှင်ကပွဲထည့်ရန် စိတ်ကူးသော်လည်း ငွေကုန်ကြေးကျများမည်စိုးသောကြောင့် တားသူက တားလေသည်။ ထိုအခါပွဲကြည့်လိုသူအပျိုအပေါင်းက

ပွဲငှားလို့ငွေကုန် အပျိုပုံ ဆုံလို့ပေးတယ်၊ ငှားပါ့ရှပ်သေး။[၁]

ဟူ၍ ပွဲအတွက် ကုန်ကျမည့်ငွေတို့ကို စုကာပေးပါမည်။ ထို့ကြောင့် ရှပ်သေးပွဲကို ငှားပါဟု ပြောဆို ကြပါသည်။

နံနက်ပိုင်းတွင် ဧည့်ခံကျွေးမွေးပြီးနောက် ရှင်လောင်းကို ရွှေထီးဆောင်းလျက် ထမ်းစင်တွင် ထမ်းပြီး ရွာသူရွာသားတို့ စီတန်းကာတဖျော်တပါး ရှင်လောင်းလှည့်ကြသည်။ ထိုနောက် ရှင်လောင်း ကိုဆံချကာ ရှင်သာမဏေအဖြစ် ခံယူစေသည်။ ရေစက်ချ အမျှဝေပြီးနောက် အလှူပွဲကြီး အောင်မြင် လေသည်။

နံနက်ကပင် ပုဆိုးအညိုချိတ်နဲ့
ထီးရိပ်မှာမြင်။
ညနေရှင်ဖြစ်တယ် ရွှေတုံသူငယ်ကချစ်
လွမ်းရစ်ပြီလေး။[၂]

ဟု မောင်ရင်လောင်း၏ချစ်သူ ကျေးတောသူလေးမှာလွမ်းကျန်ရစ်ခဲ့ပြီဖြစ်ကြောင်း အလွမ်းခံစားချက် တို့ ဖွဲ့သီထားပါသည်။

သားရှင်ပြုအလှူပွဲတွင် မောင်ရင်လောင်းအား မင်းကိုယ်ချည်ကို လည်တွင်စွပ်ပေးလိုက်သည် နှင့် သင်္ကန်းဝတ်ရတော့မည်ဖြစ်သည်။ **သာလွန်မင်းလက်ထက်ကတည်းက ပရိတ်ရွတ်ပြီးသော မင်းကိုယ် ချည်ကို မင်းသားမင်းသမီးတို့လည်ပင်းတွင် စွပ်ပေးသည့် ဓလေ့အရ နောင်အခါ မောင်ရင်လောင်းတို့ကို လည်တွင် ချည်မျှင်ကို စွပ်ပေးသည့်ဓလေ့ပေါ်ပေါက်လာခဲ့သည်။**[၃] မောင်ရင်လောင်းဖြစ်သူ မယ်ကလေး၏ ချစ်သူကို မခွဲနိုင်။ မယ်လေးကတားလျှင် မောင်ငိုရှာရော့မည်။ မယ်ကလေးသည် မောင့်အားသာသနာ့ ဝန် ထမ်းနိုင်ရန်အတွက် ခံစားချက်တို့ကိုမြိုသိပ်ပြီး မင်းကိုယ်ချည်ကိုမြန်မြန်စွပ်ပါဟု ဒွေးခွေးအား လက်ဆွဲ၍ ပြောလိုက်ရှာသည်။ ချစ်သူမောင်ရင်လောင်းသည်လည်း မင်းကိုယ်ချည်ကို လည်တွင် စွပ်လျက် ခန်းပေါက်မှာ ငိုနေရှာသည်ကို

မင်းကိုယ်ချည် လည်မှာစွပ်လို့၊ ပျိုမလွတ်ချင်လေ။
ပျိုတားရင် မောင်ငိုရော့မယ်၊ မင်းကိုယ်ချည်မြန်မြန်တဲပါ၊ ဒွေးခွေးလက်ဆွဲ။
သင်္ကန်းကြီးတဲ့ လဲပါဆို၊ မင်းကိုယ်ချည်
လည်မှာရောက်တယ်၊ ခန်းပေါက်မှာငို။[၄]

ဟုသီဆိုထားသည်။ မယ်နှင့်မောင်ချစ်စက ပန်းကြိုက်သည့်မယ့်အား မောင်က ပန်းများသီကုံးကာ အမြတ်တနိုး ပေးလေ့ရှိသည်။ မယ်ကလည်းတယုတယ ပန်ဆင်သည်။ ယခု မောင်သီတင်းသုံးရာ ကျောင်းတော်ကြီး ဝန်းကျင်တွင် ပုန်းညက်၊ သရဖီပန်းများ ပွင့်နေကြသည်။ မောင်သည် ယခုအခါ သာသနာ့ဘောင်သို့ ရောက်နေချေပြီ။ လူဝတ်ကြောင်ဘဝထင်မှတ်ကာ ပန်းများသီကုံး၍မယ့်အား ပေးမလာပါနှင့်။ မောင်၏ဆရာရဟန်းက မောင့်အားရိုက်မည်ကို စိုးရိမ်မိသည် ဟူ၍

ပုန်းညက်နဲ့သရဖီ၊ မောင်ရှင်လောင်းနေတဲ့ကျောင်းမှာ၊ ပန်းပေါင်းစုံညီ။
ကုံးသီကာ မောင်မပေးနှင့်၊ မောင်ရှင်လောင်းရဲ့ ဆရာရိုက်မှာ၊ စိုးလိုက်လှလေး။[၅]

---

[၁] တအုံရွာ မောင်းထောင်းတေး။
[၂] ပေါက်တုံရွာ မောင်းထောင်းတေး။
[၃] သန်းသန်းနွယ်၊ မ၊ ၁၉၇၆၊ ၇၅။
[၄] ကဗြူရွာ မောင်းထောင်းတေး။
[၅] ပေါက်တုံရွာ မောင်းထောင်းတေး။

ဟူ၍ဖော်ကျူးထားသည်။ ချစ်သူအားလွမ်းသည့်စိတ်၊ ချစ်သူနှင့် ကြည်နူးပျော်ရွှင်ခဲ့ရသည်များကို အောက်မေ့တမ်းတစိတ်၊ မောင်ထိခိုက်နာကျင်မည်ကို စိုးရိမ်သည့်စိတ်ဖြင့် ကျေးတောသူလေး၏ အချစ်ရေးကို ထင်ဟပ်နေပါသည်။

ကျေးရွာသူ ကျေးရွာသားတို့သည် မွန်မြတ်သည့်စိတ်ထားရှိကြသည့်အပြင် လူမှုဆက်ဆံရေး ကောင်းမွန်မှုရှိကြကြောင်းကိုလည်း မောင်းထောင်းတေးများအရတွေ့ရပါသည်။ သားရှင်ပြုအလှူတွင် အလှူရှင်သည် မိမိတို့တစ်ရွာလုံးသာမက အနီးအဝေးရွာများနှင့် မြို့တော်ထိတိုင် ဆွေမျိုးအပေါင်း အသင်းတို့ထံ ဖိတ်စာနှင့်တကွ အရေးတယူဖိတ်ကြားကြသည်ကို

စက်စက္ကူ ရွှေမင်သလို့၊ ပရိတ်နာဘယ်ရွာကျအောင်၊ ပါးပမယ်လေး။
မြင်းနယ်ကကျော်၊ မြို့တော်ပါအကုန်ဘိတ်မယ်၊ ဒေါင်းတံဆိပ်ရေး။[၁]

တွေ့ရပါသည်။ ကျေးတောသူတို့၏စိတ်ထားသည် ရိုးသားဖြူစင်သည်။ ဖော်ရွေပျူငှာသည်။ ကူညီ စရာရှိလျှင် ကူညီတတ်ပြီး ဘွင်းဘွင်းရှင်းရှင်း ပြောတတ်သည်။ ရပ်နီးရပ်ဝေးမိတ်ဆွေမရွေး ခင်မင် တတ်သည်။ သို့သော်လိမ်ညာလှည့်ပတ်၍ ဝေ့လည်ကြောင်ပတ်လုပ်လာလျှင်မူ အပြတ်ပြောပစ်တတ် သည်။

ဟိုနားကယောင်ပေပေ၊ သားတစ်ယောက်အဖေ။
ခေါင်းပေါင်းစရှည်၊ ဟန်နေကကြော့။
လူပျိုပုံလာမလုပ်နဲ့၊ ရွာရှုပ်တယ်တော့။[၂]

ဟူ၍ခေါင်းပေါင်းစရှည်ရှည်ချပြီး ကိုယ်နေဟန်ကြော့ကြော့မော့မော့နှင့် လူပျိုယောင်ဆောင်ကာ မိမိ တို့ ရွာသို့မလာပါနှင့်။ ရွာရှုပ်ပါသည်ဟု ရန်ထောင်လိုက်ပါသည်။

ရှေးအခါက မြန်မာ့ကျေးတောသူတို့သည် အောက်သူအောက်သားများအား လည်သည် ပတ်သည် လှည့်ဖျားတတ်သည်ဟု ထင်မြင်ယူဆကြလေသည်။ အောက်ပြည်သို့စုန်၍စီးပွားရှာသွား မည့် ပျိုလေး၏မောင်သည် အကယ်၍အောက်ပြည်၌ အငယ်မယားရခဲ့ပါက အလျော်ပေးကာမကွာခဲ့ ပါနှင့်။ အိမ်သို့သာ အပါခေါ်ခဲ့ပါ။ မယ်လေးက အိမ်မှုကိစ္စအားလုံး ခိုင်းပစ်မည်။ ထင်းခွေ၊ ရေခပ်၊ ဆန်ဖွတ် စသည့် နေရာတိုင်းခိုင်းပါမည် ဟူ၍ပြောကြားဟန်ကို

အောက်ပြည်စုန် ပျို့မောင်လှ၊ မှာလိုက်ရမယ်
မယားရရင် မလျော်ခဲ့နဲ့၊ ခေါ်ခဲ့ပါ့ကွယ်။
အိမ်ထောင်ဝယ် လုပ်ဆောင်ဖွယ့်အရေး
ထင်းခွေရေခပ်နှင့် ဆန်ဖွတ်ပါနေရာတိုင်းမှာ၊ ခိုင်းလိုက်မယ်လေး။[၃]

ဟု အားမနာတမ်း ပွင့်ပွင့်လင်းလင်းပြောတတ်ပါသည်။

တစ်ခြားရပ်နီးရပ်ဝေးမှ သူစိမ်းသူကျက်တို့ ရောက်လာပါက ဧည့်ဝတ်ကျပွန်ကြသော်လည်း အောက်သားများ ရောက်လာလျှင်မူ ဖျာစုတ်ကိုသာ ခင်းပေးမည်ဖြစ်ကြောင်း၊ အောက်သားတို့၏ ရင်ဘတ်ကို ခုံဖိနပ်နှင့်ပင်နင်းလိုက်ချင်ကြောင်း စိတ်ထဲရှိသည့်အတိုင်း ပြောတတ်သည်ကို

အောက်သားတွေလာ ဖျာစုတ်ကိုခင်း။
သုံးထောင်ထွာ ခုံဖိနပ်နဲ့ ရင်ဘတ်ကိုနင်း။[၄]

ဟူ၍သီဆိုဟန်ကိုတွေ့ရပါသည်။

---

[၁] ကဗြူရွာ မောင်းထောင်းတေး။
[၂] ရွှေနောင်သူ မောင်းထောင်းတေး။
[၃] --------ယင်း----------။
[၄] --------ယင်း----------။

ခြုံငုံသုံးသပ်ချက်

ရွှေဘိုမြို့နယ်ကျေးလက် မောင်းထောင်းတေးများသည် ကျေးတောနေတို့၏ သားရှင်ပြုအလှူ အတွက် အလှူရှင်၏သဒ္ဓါတရာနှင့် ဝိုင်းဝန်းကူညီကြသောသူတို့၏ ကောင်းမြတ်သောစိတ်စေတနာ ထားတတ်ကြပုံ၊ အချင်းချင်းစနောက်ကျီစယ်ပြီး တပျော်တပါးနေတတ်ပုံ၊ ဟန်ဆောင်ခြင်းမရှိ ရင်ထဲကအတိုင်း ဆက်ဆံတတ်ပုံတို့အပြင် လူငယ်မောင်မယ်တို့၏ အချစ်ရေးခံစားချက်တို့သည်လည်း လူမှုဘဝပုံရိပ် များအဖြစ် ထင်ဟပ်နေကြောင်း လေ့လာတွေ့ရှိရပါသည်။

နိဂုံး

အတိတ်ဆီက ကျေးလက်ဒေသများတွင် သားရှင်ပြု အလှူကျင်းပနိုင်ရေးအတွက် မောင်းထောင်းရင်း သီဆိုခဲ့ကြသော မောင်းထောင်းတေးသံတို့သည် နှုတ်ဆင့်ကဗ်းလျက် ကျန်ရစ်ခဲ့သည်။ ထီးသံနန်းသံ လွမ်းသော ရွှေကြိုးသတ်နယ်မြေနှင့် မည်သို့မျှမသက်ဆိုင်သော ကျေးလက်ဒေသများတွင် အလှူပွဲ မတိုင်မီ ရက်များ၌ မောင်းထောင်းတေးသံတို့ လွမ်းလျက်ရှိပေမည်။ လက်လှမ်းမှီသမျှ ရွှေဘိုမြို့နယ် ကျေးလက် မောင်းထောင်းတေးများကို သုတေသနပြုထားသောကြောင့် ဒေသအတွက် အကျိုးရှိပါက ပြုစုရကျိုးနပ်ပါသည်။

ကျမ်းကိုးစာရင်း

စန္ဒာစိုး၊ မ။ (၂၀၁၀)။ ***ရွှေဘိုခရိုင်ဝန်းကျင်ရှိ နှောင်းတွေ့ ကျေးလက်တေးများ လေ့လာချက် (ပါရဂူဘွဲ့ကျမ်း)***။ မန္တလေးတက္ကသိုလ်။

မြသန်းတင့်။ (၁၉၇၅)။ ***ကျေးတောနေတို့၏ကဗျာများ***။ ရန်ကုန်၊ မြမြဝင်းပုံနှိပ်တိုက်။

သန်းသန်းနွယ်၊ မ။ (၁၉၇၆)။ ***သျှိုးလိုက်ရတုနှင့် ရိုးရာလေ့ကြေးမုံများ (မဟာဝိဇ္ဇာကျမ်း)***။ မန္တလေးတက္ကသိုလ်။

အထက်ဗမာနိုင်ငံစာရေးဆရာအသင်း၊ မန္တလေး။ (၁၉၆၅)။ ***လယ်ကွင်းထဲက လူထုတေးသံ***။ မန္တလေး၊ သပြေပုံနှိပ်တိုက်။

ဇမောင်၊ ဦး။ (၁၉၇၂)။ ***မောင်းနှင်မောင်းထောင်းတေးသံများ***။ လက်ရေးမူ။

ကုန်းဘောင်ခေတ်ကဗျာများမှ ပြောသူ၊ နာသူနှင့် အပြောခံ ပုဂ္ဂိုလ်အညွှန်းစကားများ

သီတာနွယ်[၁]

စာတမ်းအကျဉ်း

ကုန်းဘောင်ခေတ် ကဗျာများဖြစ်သော တြိချိုး၊ လေးချိုး၊ အိုင်ချင်း၊ အဲချင်း၊လွမ်းချင်း၊ အထွေထွေသီချင်း ကဗျာများကို အလေ့လာခံအဖြစ် တင်ပြထားပါသည်။ ထိုသို့တင်ပြရာ၌ ကဗျာများရှိ ပြောသူ၊ နာသူနှင့် အပြောခံတို့၏ ပုဂ္ဂိုလ်အညွှန်းစကားများကို လက်တွေ့အတ္ထဗေဒရှုထောင့်မှ တင်ပြထားခြင်းဖြစ်ပါသည်။ ကုန်းဘောင်ခေတ် ကဗျာများတွင်တွေ့ရသောကျေးလက်သဘာဝ၊ မြန်မာဓလေ့၊ မြန်မာ့ဟန်၊ စာဆိုတို့၏ စိတ်ခံစားမှုများ ထင်ဟပ်နေပုံကို ဆက်နွယ်၍ ချိတ်ဆက်တင်ပြထားပါသည်။

သော့ချက်ဝေါဟာရများ။ ။ ပြောသူ၊ နာသူနှင့် အပြောခံ ပုဂ္ဂိုလ်အညွှန်းစကားများ၊ တြိချိုး၊ လေးချိုး၊ အိုင်ချင်း၊ အဲချင်း၊ လွမ်းချင်း၊ အထွေထွေသီချင်း၊ လက်တွေ့အတ္ထဗေဒ။

နိဒါန်း

ဤစာတမ်းသည် ကုန်းဘောင်ခေတ်ကဗျာများမှ ပြောသူ၊ နာသူနှင့်အပြောခံ ပုဂ္ဂိုလ် အညွှန်းစကားများကို လက်တွေ့အတ္ထဗေဒရှုထောင့်မှ လေ့လာတင်ပြထားခြင်းဖြစ်ပါသည်။ ဤစာတမ်းသည် ကုန်းဘောင်ခေတ် မြန်မာ့လူမှု ဓလေ့ထုံးစံများကို ပြန်ဝင်ရန် ရည်ရွယ်ရင်း ဖြစ်ပါသည်။ ထို့ကြောင့် ကုန်းဘောင်ခေတ်တွင် အညွှန်းစကားများ ထူးထူးခြားခြား ဖော်ညွှန်းထင်ဟပ်နေသော ကဗျာများကို ရွေးချယ်တင်ပြသွားမည်ဖြစ်ပါသည်။ ဤသို့တင်ပြရာတွင် ကုန်းဘောင်ခေတ် စာဆိုတို့၏တြိချိုး၊ လေးချိုး၊ အိုင်ချင်း၊ အဲချင်း၊ လွမ်းချင်း၊ အထွေ ထွေသီချင်း ကဗျာများကို အလေ့လာခံ အဖြစ် သတ်မှတ်တင်ပြထားပါသည်။

၁။ အညွှန်းစကား အဓိပ္ပာယ်ဖွင့်ဆိုချက်

အညွှန်းစကား[၂] နှင့်ပတ်သက်၍ **Concise Dictionary of Linguistics** တွင်

> **“စကားခွန်း ထုတ်လုပ်လိုက်သည့် တိကျသောအချိန်၊ နေရာနှင့် တိကျသော ပြောသူနှင့် သူတို့၏ဆက်နွယ်မှုသည် ဝါကျရှိအချို့သောအကြောင်းအရာတို့၏ ညွှန်းဆိုမှုကို ဆုံးဖြတ်ပေးနိုင်သည့် နည်းလမ်းဖြစ်သည်။”**[၃]

ဟု ဖွင့်ဆိုထားသည်။

ထို့ပြင် ဒေါက်တာခင်အေး၏ ‘အတ္ထဗေဒနိဒါန်း’ တွင်

> **“အညွှန်းဟူသည် ပြောသူ၏ ခွဲခြားဖော်ပြလိုသော ရည်ရွယ်ချက်နှင့်ထိုသို့ပြောလျှင် ထိုအကြောင်းကိစ္စကို နာသူသိလိမ့်မည်ဟူ၍ ပြောသူကကြိုတင်မျှော်လင့်ထားချက်အပေါ်တွင်မူတည်နေသည်။”**[၄]

ဟူ၍ လည်းကောင်း၊

> **“အညွှန်းဆိုသည်မှာ ပြောသူရေးသူတို့က နာသူဖတ်သူတို့ တစ်စုံတစ်ရာကို ခွဲခြား သိရှိနိုင်ရန်ဘာသာစကားကို အသုံးပြု၍ ပြုမူသော အပြုအမူတစ်ရပ်ဖြစ်သည်။”**[၅]

ဟူ၍လည်းကောင်း၊

> **“အညွှန်းစကားဟူသည် စကားအပြုအမူ သို့မဟုတ်အရေး အပြုအမူတစ်ခုတွင် ပါဝင်သူတစ်ဦးတစ်ယောက်၏ ရှုထောင့်မှညွှန်ပြသည့် လုပ်ဆောင်ချက် သို့မဟုတ် သတ်မှတ်ပြဋ္ဌာန်းသည့်လုပ်ဆောင်ချက် ဖြစ်သည်။”**[၆]

ဟူ၍လည်းကောင်း၊

> **“အညွှန်းစကားသည် လက်တွေ့အတ္ထဗေဒနှင့် ဘာသာဗေဒ နယ်ပယ်တွင် အဆက်အစပ်အပေါ်တွင် အပြည့်အဝမှီတည်နေသည့် စကားလုံး သို့မဟုတ် ဖော်ပြချက်တို့ဖြင့် ညွှန်ပြနေသည့်လုပ်ငန်းစဉ် တစ်ခုဖြစ်သည်။”**[၇]

---

[၁] ကထိက၊ ဒေါ်၊ မြန်မာစာဌာန၊ ရွှေဘိုတက္ကသိုလ်။

[၂] deixis

[၃] Mathew, P H, 2005, 89.

[၄] ခင်အေး၊ ဒေါက်တာ၊ ၂၀၀၄၊ ၂၄၈။

[၅] – ယင်း –၊ ၂၄၇။

[၆] http://www.increasemyvocabulary.com/ definition of/ Deixis.

[၇] http://www.google. com/ webdefinition.

ဟူ၍လည်းကောင်း၊

> "အညွှန်းစကားသည် စကားခွန်း၏ ဘာသာဗေဒပြင်ပ အဆက်အစပ်နှင့် အစဉ်ဆက်နွယ်နေသောအနက်အဓိပ္ပာယ် ကောက်ယူမှုဆိုင်ရာ ဖော်ပြချက်အားဖြင့်ညွှန်းဆိုမှုဖြစ်သည်။"[၁]

ဟူ၍လည်းကောင်း၊

> "အညွှန်းစကားဟူသည် အဆက်အစပ်တစ်ခုတွင် အညွှန်းခံကို သတ်မှတ်ပြဋ္ဌာန်းရာတွင် ညွှန်းဆိုသည့် စကားလုံးတစ်ခု၏ လုပ်ဆောင်ချက်ဖြစ်သည်။"[၂]

ဟူ၍လည်းကောင်း၊

> "အညွှန်းစကားဟူသည် စာသား သို့မဟုတ် စကားခွန်း အဆက်အစပ်ဖြင့် သာနားလည်နိုင်သည့်စကားလုံးများ သို့မဟုတ် ပုဒ်စုများဖြစ်သည်။"[၃]

ဟူ၍လည်းကောင်း ဖွင့်ဆိုထားသည်ကို တွေ့ရပါသည်။

၁၊ ၁။ ပုဂ္ဂိုလ်အညွှန်းစကား အဓိပ္ပာယ်ဖွင့်ဆိုချက်

မည်သည့်ဘာသာစကားတွင်မဆို စကားဖြစ်ရပ်တိုင်း၌ ပြောသူ၊ နာသူနှင့် ပြောသူ၊ နာသူ မဟုတ်သည့်အပြောခံတို့ပါဝင်လေ့ရှိသည်။ ထိုပြောသူ၊ နာသူနှင့် ပြောသူ၊ နာသူမဟုတ်သည့် အပြောခံတို့ကို ညွှန်းဆိုသည့်စကားကို ပုဂ္ဂိုလ်အညွှန်းစကားဟုပင် သတ်မှတ်ကြပါသည်။

ပုဂ္ဂိုလ်အညွှန်းစကားနှင့်ပတ်သက်၍

> "ပုဂ္ဂိုလ်အညွှန်းစကားသည် စကားဖြစ်ရပ်အတွင်း ပါဝင်သူများ၏ အခန်းကဏ္ဍရှိ အနက်ဖွဲ့.ယှက်ခြင်းနှင့် သက်ဆိုင်သည်။ ပြောသူပုဂ္ဂိုလ်အမျိုးအစားသည် ပြောသူ၏ မိမိကိုယ်ကို ညွှန်းဆိုမှုဆိုင်ရာ သဒ္ဒါဖွဲ့စည်းမှု ဖြစ်သည်။ နာသူတစ်ဦး သို့မဟုတ် တစ်ဦးထက်ပိုသော နာသူများအတွက် ပြောသူ၏ ညွှန်းဆိုမှုဆိုင်ရာ အနက်ဖွဲ့.ယှက်မှုမှာ နာသူညွှန်း အညွှန်းစကားဖြစ်ပြီး စကားခွန်းနှင့် ပတ်သက်၍ ပြောသူလည်းမဟုတ်၊ နာသူလည်း မဟုတ်သည့် တည်ရှိနေသော အရာများနှင့် ပုဂ္ဂိုလ်များအတွက်ညွှန်းဆိုမှု ဆိုင်ရာအနက် ဖွဲ့.ယှက်မှုမှာ အပြောခံ အညွှန်းစကားဖြစ်သည်။"[၄]

ဟူ၍လည်းကောင်း

> "ပုဂ္ဂိုလ်အညွှန်းစကားများကို ကျွန်ုပ်တို့ နေ့စဉ်ပြောဆိုနေသည့် စကားများတွင် တွေ့နိုင်သည်။ ကျွန်ုပ်တို့သည် နေ့စဉ်မိမိ အကြောင်း (သို့) ကျွန်ုပ်တို့၏ မိတ်ဆွေ အပေါင်းအဖော်များအကြောင်း၊ မိမိနှင့် စကားပြောဖော် စကားပြောဖက်များ အကြောင်းကို မေးမြန်းဆွေးနွေးလေ့ ရှိကြသည်။ ယင်း မေးမြန်းချက် ဆွေးနွေးချက်များတွင် ပုဂ္ဂိုလ်အညွှန်း စကားများကို တွေ့နိုင်သည်။"[၅]

ဟူ၍လည်းကောင်း

> "ပြောသူ (ကျွန်ုပ်)၊ နာသူ(သင်) နှင့် အပြောခံ (သူ (သို့) သင်း)အတွက် နာမ်စားများဖြင့် အရိုးရှင်းဆုံး ပြထားသော အခြေခံ အဓိပ်ပာယ် ၃ ပိုင်းအပေါ်တွင် ပုဂ္ဂိုလ်အညွှန်း စကားသည် ရှင်းလင်း စွာလုပ်ဆောင်သည်။"[၆]

ဟူ၍လည်းကောင်း၊

> "ပုဂ္ဂိုလ်အညွှန်းစကားများသည် အဓိကအားဖြင့် ပုဂ္ဂလနာမ်စားများ ပါဝင်သည်။"[၇]

ဟူ၍လည်းကောင်း၊

> "ငါ' ၊ 'မင်း' ၊ 'သူ' ၊ ' **I** ' ၊ '**you**' ၊ '**he**' ၊ '**she**' ၊ '**it**'စသည်တို့ကို ပုဂ္ဂိုလ်အညွှန်းစကားဟု ဆိုလိုခြင်းဖြစ်သည်။"[၈]

ဟူ၍လည်းကောင်း၊

---

[၁] http://www.sil.org/linguisyics/glossary of linguistics terms.

[၂] http://www.the free dictionary .com/glossary/deixis.

[၃] http://www.usingenglish.com/glossary/deixis.

[၄] Levinson, Stephen.C, 1983, 62.

[၅] Finegan, Edward, 1999, 204-205.

[၆] Yule, George, 1996, 10.

[၇] Yu Yan Xue, Dang Dai. 2000, 20.

[၈] ခင်အေး၊ ဒေါက်တာ၊ ၂၀၀၈၊ ၂၄၀။

> **"မြန်မာစကားအပါအဝင် ဘာသာစကား အတော်များများတွင် ပုဂ္ဂိုလ်အညွှန်း စကားများကိုအသုံးပြုရာ၌ အသက်အရွယ်၊ ဂုဏ်အဆင့်အတန်း၊ ကျားမကွဲပြားမှု၊ ရင်းနှီးကျွမ်းဝင်မှုအတိုင်းအတာတို့ကို အခြေပြု၍ ခွဲခြားအသုံးပြုခြင်း၊ အထူးပြု စကားများဖြင့် ချဲ့ထွင်အသုံးပြုခြင်းများကို တွေ့ရသည်။"**[၁]

ဟူ၍လည်းကောင်း၊

> **"လူပုဂ္ဂိုလ်အညွှန်းများသည် သဒ္ဒါဆိုင်ရာ အမျိုးအစားများနှင့် တိုက်ရိုက်ထင်ဟပ်နေသည်။ နာမ်စားစနစ်ကို အမျိုးအစားခွဲ၍ ယင်းသွင်ပြင်လက္ခဏာများကို သိရှိထားရန် လိုအပ်သည်။ ပြောသူ၊ နာသူ၊ အပြောခံတို့၏ သရုပ်သကန်ကို အပေါ်လွင်ဆုံးမှာ နာမ်စားစနစ်ဖြစ်သည်။"**[၂]

ဟူ၍လည်းကောင်း ဖော်ပြကြပါသည်။

ထို့ကြောင့် **"** ပုဂ္ဂိုလ်အညွှန်းစကား ဆိုသည်မှာ **စကားဖြစ်ရပ်** [၃]တစ်ခုအတွင်း ပါဝင်ကြသော **ပြောသူ**[၄]၊ **နာသူ**[၅] နှင့် **အပြောခံ**[၆] တို့ကို ရည်ညွှန်းသည့် **စကားလုံးများ**[၇]၊ **ပုဒ်စုများ**[၈]ဖြစ်သည်**"**ဟု ကောက်ချက်ချရပါမည်။ ယင်းသို့ ရည်ရွယ်ရာတွင် သဒ္ဒါဆိုင်ရာ သတ်မှတ်ထားသော **နာမ်စား**[၉] များဖြစ်ပြီး ထို နာမ်စား အသုံးများကို **အညွှန်းစကားစစ်စစ်**[၁၀] ဟုသတ်မှတ်နိုင်ပါသည်။

၂၊ ၁။ ကုန်းဘောင်ခေတ်ကဗျာများမှ ပြောသူ ပုဂ္ဂိုလ်အညွှန်းစကားများ

ကုန်းဘောင်ခေတ်ကဗျာများတွင်လည်း ပုဂ္ဂိုလ်အညွှန်းစကားများကို တွေ့ရပါသည်။ စကားဖြစ် ရပ်တစ်ခုအတွင်း ပြောသူ၏ မိမိကိုယ်ကို ညွှန်းဆိုသောစကားကို ပြောသူပုဂ္ဂိုလ် အညွှန်းစကားဟုခေါ်သည်။

မြန်မာသဒ္ဒါ၌ ပြောသူနာမ်စားဟု ပြဋ္ဌာန်းသတ်မှတ်ပါသည်။ မြန်မာစကားကို လက် တွေ့အသုံးပြု ပြောဆိုကြရာ၌ ပြောသူအညွှန်းစကားအဖြစ် **ငါ၊ ကျွန်တော်၊ ကျွန်မ၊ ကျွန်ုပ်၊ ကျုပ်၊ တို့** နှင့် **ကိုယ်**ကို အသုံးပြုကြသည်။ ယင်းသို့အသုံးပြုရာ၌ ကျား၊ မကွဲပြားမှုသဘော၊ အသက်အရွယ် ကွာခြားမှုသဘောထက် ပြောသူနာသူတို့၏ ခင်မင်ရင်းနှီးမှု အတိုင်းအတာ၊ ပြောသူ၏အလေ့အထ၊ ပြောသူ၏ စိတ်ခံစားမှုအခြေအနေ စသော နောက်ခံ အကြောင်းအရာများသည် အရေးပါလှသည်။ လူမှုစည်းမျဉ်းအရ မသုံးသင့်၊ မသုံးရ၊ မသုံးအပ်ဟူသော အသုံးများကိုပင် နောက်ခံအခြေအနေ၊ နောက်ခံအကြောင်းအရာပေါ် မူတည်၍ အသုံးပြုကြသည်ကို တွေ့ရသည်။ ယင်းတို့၏ သက်ရောက်အနက်သည် နာသူ၏အခြေခံ ဗီဇစိတ်ကို မှီတည်၍ကွဲပြားသည်။ ကုန်ဘောင်ခေတ်ကဗျာများမှ ပြောသူအညွှန်းစကားများကို အောက်ပါအတိုင်း လေ့လာတွေ့ရှိရပါသည်။ သာဓကအားဖြင့်–

အင်ခွင်ကြီးတဲ့မြင်းစီးသားမို့အိုင်ချင်းကဗျာတွင်

"ငါ့ကိုလွယ်သည်၊ အမယ်လေး မလို၊
မကြည်ညိုလည်း၊ မဆိုရှာဘူး။"[၁၁]

ဟူသောအဖွဲ့တွင် **ငါ** ဟူသော အသုံးသည် ကဗျာပါမိန်းခလေးက မိမိကိုယ်ကို ညွှန်းဆိုထားခြင်း ဖြစ်သည်။ ယခင်က မိမိသဘောကျသူသည် အမှုထမ်းအရာရှိ ဖြစ်၍ အရှိန်အဝါကြီးခဲ့၍ လက်ခံခဲ့ကြပြီး ယခုမူ ရာထူးမှနုတ်ထွက်ရသောအခါ မထောက်ထားဘဲ မထီလေးစားစိတ်ဖြင့် နှင်လွှတ်ပါက ကြား၍

---

[၁] ခင်အေး၊ ဒေါက်တာ၊ ၂၀၀၈၊ ၂၄၀။
[၂] စိုးစိုးမြင့်၊ မ၊ ၂၀၀၇၊ ၄၇–၄၈။
[၃] speech event
[၄] first person/ spear/ addresser
[၅] second person/ hearer/ addressee
[၆] third person
[၇] words
[၈] phrase
[၉] pronoun
[၁၀] pure-deitis
[၁၁] ရွှေသိမ်းမင်း၊ ကို၊ ၂၀၁၂၊ ၁၁၄။

မတော် ဖြစ်ချေမည်။ မိမိက မပြောဆိုသော်လည်း ဆွေမျိုးများက မကြည်ဖြူကြကြောင်း ရေးဖွဲ့ထား ခြင်းဖြစ်သည်။

ရေစီးတစ်ခါ ရေသာတစ်လှည့်တြိုချိုးကဗျာတွင်–

"မဲဇလီပင်ပျိုအောက်၊ ပေါက်လာတဲ့ ရွှေတမာ၊
ခါးချက်ကနာ။
ရေစီးရယ် တစ်ခါ၊ ရေသာငယ့် တစ်လှည့်၊
သူများလို တို့မရိုင်းတယ်၊ တိုင်းသိပါရဲ့။"[၁]

ဟူသောကဗျာအဖွဲ့တွင် မိမိကိုယ်ကို **ငါ**၊ **တို့** ဟုသုံးပြီး အပြောခံကို **သူများ** ဟုသုံးထားပါသည်။ **တို့** ဟူသော အသုံးသည် ပြောသူက **ငါ** အညွှန်းစကားကို ရှောင်လိုသည့်အတွက် သိမ်မွေ့နူးညံ့စွာ ညွှန်းဆိုလိုသောအခါ အသုံးပြုသကဲ့သို့ နာသူကလည်း စကားပြော သိမ်မွေ့မှုကို သဘောပေါက် နားလည် စေသည့်အပြင် **တို့** ဟုသုံးနှုန်းလိုက်ခြင်းဖြင့်လည်း ခင်မင်ရင်နှီးမှု အတိုင်းအတာသဘောကိုလည်း ပေါ်လွင်စေပါသည်။ **တို့** အသုံးကို ယောကျ်ားလေးရော မိန်းကလေးပါ အသုံးပြုကြသည်ကို တွေ့ရ ပါသည်။ တစ်နည်းအားဖြင့် ပြောသူ နာမ်စားအဖြစ် သုံးထားခြင်းဖြစ်သည်။ ဤ ကဗျာတွင် **တို့** ဟူသောအသုံးသည် ယခင် အခါးဓာတ်ရှိသော မဲဇလီပင်၏အောက်တွင် ပေါက်လာသော တမာပင် သည် ပို၍ ခါးတတ်သကဲ့သို့ အရိုင်းစိတ်ရှိသူသည် မည်မျှပင် ရိုင်းစိုင်းစေကာမူ မိမိမှာ သူများရိုင်း သော်လည်း မရိုင်းတတ်ကြောင်း၊ လောကတွင် ကိုယ်အသာရှိတတ်သော်လည်း ကိုယ့်ဘက်က အနာ လည်း ရှိတတ်ကြောင်း လောကတွင် ဖြစ်တတ်သော သဘောတရားကို သိရှိကြောင်း အခြားသူများ နှင့် နှိုင်းယှဉ် တင်ပြထားခြင်းဖြစ်သည်။

တို့ အသုံးသည် မူလကနာမ်အများပြ ကိန်းညွှန်းပစ္စည်းဖြစ်သည်။ ယင်းကို ပြောသူ အား ရည်ညွှန်းသည့် အညွှန်းစကားအဖြစ် အသုံးပြုသောအခါ အများသဘောကိုမဆောင်သည့် နာမ်စား အသုံးဖြစ်သွားသည်။ **တို့တာဝန်** အရေး(၃)ပါး၊ **တို့တိုင်းပြည်** တို့တွင် ပါဝင်သော **တို့** သည် ပြောသူ၊ နာသူ၊ အခြားသူအားလုံးပါဝင်သည့် အများပြကိန်းညွှန်းနာမ်ပစ္စည်း သဘောကို ညွှန်းဆိုသည်။ အခြေအနေအဆက်အစပ်ပေါ် မူတည်၍ အနက်ကောက်ယူရသည်။ သာမန်အားဖြင့် အများပြသဘော ညွှန်းဆိုလိုလျှင် **တွေ** ပစ္စည်းနှင့်တွဲဖက်၍ **တို့တွေ**ဟု ညွှန်းဆိုလေ့ရှိကြသည်။ ထိုသဘောကို ကုန်း ဘောင်ခေတ် တေးကဗျာ တစ်ခုဖြစ်သော

အထွေထွေ သီချင်းသံချပ် ကဗျာတွင် –

"ဘုန်းတော်ကြီးလို့ သက်တော်ရှည်
တို့တစ်တွေ[၂]

ဟူသော အဖွဲ့တွင် **တို့တစ်တွေ** ဟူသော အညွှန်းစကားသည် အလောင်းမင်းတရား၏ ဘုန်းတန်ခိုး ကြီးမားပုံနှင့် ပြည်သူများ အေးချမ်းမှုကို ဖော်ညွှန်းခြင်းဖြစ်သည်။ ပြောသူနှင့်အပြောခံတို့ပါဝင်သည့် သဘောသက်ရောက်သည့် ပုဂ္ဂိုလ်အညွှန်းစကား ဖြစ်ပါသည်။

ကျွန်မဟူသော အညွှန်းစကားကို အမျိုးသမီးက မိမိကိုယ်ကို ညွှန်းဆိုသည့်အခါ အသုံးပြုလေ့ ရှိသည်။ ပြောဆိုသည့်အခါ ပြောသူသည် မိမိကိုယ်ကို **ကျွန်မ** ဟုနှိမ့်ချကာ ညွှန်းဆိုလေ့ရှိပါသည်။ ဤသဘောကို

စာဆိုဦးယာ၏ သစ္စာတိုင်ဘွဲ့အဲချင်းကဗျာတွင်–

"စက်လျောင်း ငယ်မှုဆာ၊ မချင်နွမ်းလျ၊
ဩော် – ဖြစ်ရလို ကျွန်မမှာလည်း
မျှော်ကာယောင်ယမ်းမိတော့တယ်"[၃]

---

[၁] ဖိုးလတ်၊ ဦး၊ ၂၀၁၁၊ ၇၅။
[၂] ––– ယင်း ––––၊ ၁၇။
[၃] ရွှေသိမ်းမင်း၊ ကို၊ ၂၀၁၂၊ ၂၂၉။

ဟူသောအဖွဲ့တွင် ချစ်သူကို မျှော်သော်လည်း လာရမည့်အချိန် မလာသဖြင့် မျှော်လင့်စောင့် စားနေရသော မိမိ၏အဖြစ်ကို သနားစိတ်ဝင်စေရန် **ကျွန်မ** ဟူသော အသုံးဖြင့် သုံးနှုန်းရေးဖွဲ့ထားခြင်း ဖြစ်သည်။ နာသူအနေဖြင့် ပြောသူအပေါ် သနားချစ်ခင်စိတ်ဖြစ်ပေါ်စေပါသည်။ ထို့ပြင်

ဗုံကြီးဖွဲ့များမှကျီးကဗျာတွင်–

"ရွှေကျီးညိုငယ်လေ၊ တောင်ဆီကိုပျံသွား၊
မြင်ပါလိုက်ကဲ့လား။
ကျွန်တော်မ ငါးကိုတဲ့၊ ချီသွားပြန်သလေ၊
လားလားမှစိတ်မကျေ၊"[၁]

ဟူသောအဖွဲ့တွင် **ကျွန်တော်မ** ဟူသောအသုံးသည် ပြောသူက မိမိကိုယ်ကို ရည်ညွှန်းထားခြင်းဖြစ်သည်။ မိမိစားရန်ငါးကို ရွှေကျီးညိုက ချီသွားသောကြောင့် မျက်စိရှေ့တွင် မြင်လိုက်ရက်နှင့် ဆုံးရှုံးလိုက်ရသောအဖြစ်ကို စိတ်ထဲတွင် မကျေမချမ်းဖြစ်ကာမချင့်မရဲစိတ်ဖြင့် ပြောဆိုရာ၌ ကြားရဖတ်ရသူ စိတ်မကောင်းဖြစ်အောင် သုံးနှုန်းထားသည်။ နှိမ့်ချသည့်သဘော ကျေးတောနေတို့၏ ရိုးသားပွင့်လင်းမှုကို မြင်သာစေပါသည်။

စာဆို ဦပုညဏ်၏ တောဓလေ့လွမ်းချင်းကဗျာတွင်–

"အိမ်ကိုပြန်လျှင် အကျွန် ကျွန်ုပ်၊ ယုန်တစ်ထုတ်ကို
ခွာဆုတ် ရေလှန်၊ ကျပ်ခိုးခံလို့၊ ပရုန်နဝါ၊ ရွက်နုညှာကို၊
ဝါးပြာထည့်ကျို၊ အိုးနားတိုနှင့်၊ ခပ်ချိုညစ်တေ၊
ဆောင့်ကြောင့်ထိုင် မွေလိုက်တယ်၊ ချိုပေစွယ်ငင်းချိုကို၊"[၂]

ရေချမ်းအိုးကြီး" ဟူသောအဖွဲ့တွင် **အကျွန်ကျွန်ုပ်**သည် ပြောသူက မိမိကိုယ်ကို ရည်ညွှန်းသော အညွှန်းစကား ဖြစ်သည်။ မိမိတောလိုက်၍ ရလာသော သားကောင်နှင့် ဟင်းသီးဟင်းရွက်များကို ချက်ကာ ချစ်ခင်ကြင်နာသူနှင့်အတူ စားသောက်ရန် ဖိတ်ခေါ်ရာ၌ သုံးနှုန်းထားခြင်း ဖြစ်သည်။ **အကျွန်ကျွန်ုပ်** ဟူသော အညွှန်းစကားသည် ရှေးခေတ်မှ ယနေ့ခေတ်တိုင် ယောကျ်ားလေးရော မိန်းကလေးပါ အသုံးပြုသော သဘောတွေ့ရပါသည်။

ထို့ပြင်–

စာဆို ဦးကြီး၏ တောဓလေ့လွမ်းချင်းကဗျာတွင်

"ခါတလဲ့ လာခဲ့ပ ကျုပ်တို့ရွာ။"[၃]

ဟူသော ကဗျာအဖွဲ့တွင်ပါသော **ကျုပ်တို့** ဟူသော အညွှန်းစကားသည် ကျေးလက်ဒေသ ကျေးလက်သူ ကျေးလက်သားများ၏ ခင်မင်ရင်းနှီးပွင့်လင်းစွာ အားရပါးရပြောသည့် အနက်သဘော သက်ရောက်သည့် အခြေအနေကို ညွှန်းဆိုသည့်အသုံးအဖြစ် နှစ်သက်ဖွယ်တွေ့ရသည်။ ယနေ့ခေတ်တွင်လည်း ရင်းနှီးသည့်သဘောဖြင့် အမျိုးသားရော အမျိုးသမီးများပါ သုံးလေ့ရှိပါသည်။ ပြောသူက မိမိကိုယ်ကို ရည်ညွှန်းသော **ငါ၊ တို့၊ ကျုပ်၊ ကျုပ်တို့၊ အကျွန် ကျွန်ုပ်** အသုံးတို့သည် ကျား၊ မ မရွေး အသုံးပြုလေ့ရှိပါသည်။

၂၊ ၂။ ကုန်းဘောင်ခေတ်ကဗျာများမှ နာသူနှင့် အပြောခံ ပုဂ္ဂိုလ်အညွှန်းစကားများ

စကားဖြစ်ရပ် တစ်ခုအတွင်း နာသူအားညွှန်းဆိုသော စကားကို နာသူအညွှန်းစကား ဟုခေါ်သည်။

ယင်းကို အစဉ်အလာ မြန်မာသဒ္ဒါ၌ **နာသူ နာမ်စား** ဟု ခေါ်ဆိုပါသည်။ ယင်းနှင့် ပတ်သက်၍

"နာသူနာမ်၏ အစားသုံးသောပုဒ်ကို နာသူနာမ်စားဟု ခေါ်သည်"
သာဓက။ ။ မင်း၊ ခင်ဗျား၊ ရှင်၊ နင်၊ သင်၊ ညည်း ....."

ဟု ဖွင့်ဆိုထားပါသည်။

---

[၁] ဖိုးလတ်၊ ဦး၊ ၁၉၅၄၊ ၃၂။
[၂] – ယင်း –၊ ၁၂၇။
[၃] – ယင်း –၊ ၁၂၆။

နေ့စဉ်သုံး မြန်မာဘာသာစကားတွင် မြန်မာဘာသာ စကားကို လက်တွေ့အသုံးပြု ပြောဆို ရာ၌ နာသူအညွှန်းစကားအဖြစ် **"နင်၊ မင်း၊ ခင်ဗျား၊ ညည်း၊ ရှင်၊ တော်၊ သင်"**တို့ကို တွေ့ရသည်။ ဘာသာစကားကို လက်တွေ့အသုံးပြုသောအခါ ကျား၊ မကွဲပြားမှု သဘော၊ အသက်အရွယ် ကွာခြား မှုသဘောထက် ပြောသူ၊ နာသူတို့၏ ခင်မင်ရင်းနှီးမှု အတိုင်းအတာ ပြောသူ၏ အလေ့အထ၊ ပြောသူ ၏ စိတ်ခံစားမှု အခြေအနေစသော နောက်ခံအကြောင်းအရာများသည် အရေးပါလှသည်။ ယင်းသို့ အရေးပါသကဲ့သို့ ဘာသာစကား၏ သက်ရောက်မှု အနက်ကောက်ယူခြင်းမှာ နာသူ၏ ပင်ကိုဗီဇ စိတ်ပေါ်တွင်လည်း မူတည်နေသည်ကို တွေ့ရပါသည်။

ကုန်းဘောင်ခေတ် ကဗျာများမှ နာသူအညွှန်းစကားများကို အောက်ပါအတိုင်း တွေ့ရှိရပါ သည်။

ဗုံကြီးသံကဗျာတွင်—

"မောင့်ဗုံညို အစာကောင်းလို့၊ မောင်းသံလိုဟီ။
ချစ်ကြိုးသီတဲ့ ပင်ကိုလှရယ်၊ မင်းကြွခဲ့ဦး။"[၁]

ဟူသောအဖွဲ့တွင် **မင်း** ဟူသောအသုံးသည် နာသူကို ရည်ညွှန်းခြင်း ဖြစ်သည်။ မိမိဗုံသည် ပတ်စာ ကောင်းသောကြောင့် မောင်းသံကဲ့သို့ မြည်ဟိန်းပုံကို နားထောင်ရန် ချစ်သူကို ခေါ်ရာ၌သုံးနှုန်း ထားခြင်းဖြစ်သည်။ မိမိ၏အရည်အသွေးကို ချစ်သူအား မိမိနှင့်အတူ ဂုဏ်ယူစေချင်ပုံဖြင့် ရင်းနှီး သည့် သဘောလည်းပါအောင် သုံးထားခြင်းဖြစ်သည်။ **မင်း** အသုံးမှာ ယောကျ်ားလေးရော မိန်း ကလေးပါ ယခုတိုင် အသုံးပြုနေဆဲ ဖြစ်ပါသည်။

ရွှေဘိုဗုံကြီးသံများကျန်စစ်သားဇာတ်ကဗျာတွင်

"ဟဲ့–ကြောင်ဖြူ နင်အယ်ျ၊ သည်လူကို နင် မငြင်းပါနှင့်၊
ငါ့ကျောင်းတွင်းမှာ ရှောက်ချဉ် ချိုး။"[၂]

ဟူသောအဖွဲ့တွင် **နင်** ဟူသော အသုံးသည် နာသူကို ရည်ညွှန်းထားခြင်းဖြစ်သည်။ ကျန်စစ်သား၏ အစွမ်းကို သိသောအခါ ဆရာတော်က တူမ ကြောင်ဖြူနှင့် သဘောတူပုံကို သုံးနှုန်း ရေးဖွဲ့ထားခြင်း ဖြစ်သည်။

ကောက်စိုက်သီချင်းများကဗျာတွင်

"တို့နန္ဒာ လယ်တော်တိုက်၊
ညည်းစိုက်တဲ့ ကောက်သွယ်ငယ်၊ မှန်းဘယ်မျှကြီး။"[၃]

ဟူသော ကဗျာတွင် **ညည်း** ဟူသော အသုံးသည် ဘုရင့်လယ်တော်မှ ကောက်စိုက်သမများ အချင်း ချင်း အပြိုင်အဆိုင် ကြွားဝါဂုဏ်ယူနေကြပုံကို သုံးနှုန်းထားခြင်းဖြစ်သည်။ **ညည်း** ဟူသော အသုံး သည် မိန်းကလေးအချင်းချင်း သုံးလေ့ရှိသော်လည်း တချို့ယောကျ်ားလေးများသည် မိမိထက်ငယ် သော မိန်းကလေးများ၊ သူငယ်ချင်း မိန်းကလေးများကိုလည်း ရင်းနှီးသည့် သဘောဖြင့် သုံးနှုန်းလေ့ ရှိကြပါသည်။ နာသူအသုံးများအဖြစ် **မင်း၊ နင်၊ ညည်း** အသုံးများကို တွေ့ရပါသည်။ ထိုအသုံးတို့ သည် ကျား၊ မ မရွေး အသုံးပြုလေ့ ရှိပါသည်။ **အပြောခံ** မှာ ပြောသူ၊ နာသူ မဟုတ်သော **အခြားသူ** ကို ဆိုလိုခြင်းဖြစ်သည်။ ကုန်းဘောင်ခေတ် ကဗျာများတွင်လည်း **အပြောခံ** ပုဂ္ဂိုလ်အညွှန်း စကား များကိုလည်း တွေ့ရှိရပါသည်။

သာဓကအားဖြင့်

ချိမယ်မှချိမယ်အိုင်ချင်းကဗျာတွင်

"သနားငယ်မှစရာ၊ သူ့ရွာတကျေး၊ ဟိုရပ်ဝေးမှာ၊
မလေးငဲ့ သဇင်၊ မှိုင်းညိုစင်ငယ်၊
မောင်ရှင်လူထွက်သစ်တကား။" [၄]

---

[၁] ဖိုးလတ်၊ ဦး၊ ၁၉၅၄၊ ၂၉။
[၂] – ယင်း –၊ ၂၀၁၁၊ ၃၀၇။
[၃] ဖိုးလတ်၊ ဦး၊ ၁၉၅၄၊ ၂၀၁၁၊ ၄၉။
[၄] ရွှေသိမ်းမင်း၊ ကို၊ ၂၀၁၂၊ ၁၀၂။

ဟူသောအဖွဲ့တွင် **သူ** ဟူသောအသုံးသည် **အခြားသူ** ကို ရည်ညွှန်းခြင်း ဖြစ်သည်။ မိန်းမပျိုလေးက မိမိချစ်သူမောင်သည် ရှင်လူထွက်ခါစ ငယ်ရွယ်သူ ဖြစ်သော်လည်း တိုင်းပြည်အတွက် အခြားသူများ၏နေရာ ဝေးလံသောအရပ်ကိုပင် စစ်ချီတက်ရပုံကို ချစ်သူအတွက် စိုးရိမ်စိတ်နဲ့အတူ ဂုဏ်ယူဝင့်ကြွားစွာ ရေးဖွဲ့ထားခြင်းဖြစ်သည်။

ရွာစရိုက် လေးချိုးကဗျာတွင်–

"မယ်တို့ရွာစရိုက်။ အလိုက်ကယ်ဘာသာ။
အခက်ကယ်ဝေဝေနှင့်၊ ဖက်ပင်ကြွေ ရာတိုင်လိပ်မှာ။
မဲမိတ်နှင့်သာ။ သူများလို မရေတတ်ပါဘူး၊
ဘိလက်ရက်ရုံပုဝါ။ ဆာပါနှင့် တန်ဆိုင်း။"[3]

ဟူသော ကဗျာအဖွဲ့တွင် **သူများ** ဟူသောအသုံးသည် **အခြားသူ(အပြောခံ)** ကိုရည်ညွှန်းခြင်း ဖြစ်သည်။ မိမိတို့ရွာ ဓလေ့စရိုက်အရ မည်းချည်ဖြင့် ထိပ်၌ချည်ထားသော အပတ်တစ်ရာခန့်ရှိ အစီခံနှင့် လိပ်ထားသော ဆေးပေါ့လိပ်ကိုသာ သုံးနိုင်ကြောင်း၊ ချမ်းသာသော သူများကဲ့သို့ နိုင်ငံခြားဖြစ်ပိတ်စများ မသုံးနိုင်ကြောင်း ရေးဖွဲ့ထားခြင်း ဖြစ်သည်။

ချွေဘိဗုံကြီးသံများပဋ္ဌာဇာတ်ကဗျာတွင်

"မနေသောင့် မထိုင်သာ၊ လမ်းကောက်ကွေ့ရှာ။
မိမာတာမြေမှာ လူးတယ်၊ သင်းတို့ကြောင့်ရူး။"[4]

ဟူသောအဖွဲ့တွင် **သင်းတို့** ဟူသောအသုံးသည် အခြားသူ(အပြောခံ)ကို ရည်ညွှန်းခြင်း ဖြစ်သည်။ ပဋ္ဌာစာရီ လင်သေ၊ သားဆုံး၊ မိဘမောင်ဖွားများ သေကြေပျက်စီးသောအခါ ဆောက်တည်ရာမရ ရူးသွပ်ရပုံကို တင်ပြရာ၌ သုံးနှုန်းထားခြင်းဖြစ်သည်။ မိမိမှလွဲ **အခြားသူ**(သို့မဟုတ်) **အပြောခံ** ဟူသော အနက်သဘောဖြင့် **သူ**၊ **သူများ**၊ **သင်း** ဟူသော အသုံးများကို တွေ့ရပါသည်။ ထိုအသုံးများမှာ ပြောသူက အပြောခံကိုရည်ညွှန်း အသုံးပြုထားသော စကားအဖြစ် တွေ့ရပါသည်။

အပြောခံကိုရည်ညွှန်းသော ပုဂ္ဂိုလ်အညွှန်းစကား **သူများ** အသုံးမှာ မျက်မှောက်ခေတ်တွင် မြန်မာမိန်းကလေးတို့က မိမိအမည် မပြောလိုသောအခါမျိုးတွင် မိမိကိုယ်ကို ရည်ညွှန်းသော စကားအဖြစ်လည်း အသုံးပြုနေကြသည်ကို တွေ့ရပါသည်။ ထို့ကြောင့် အခြားသူ ကိုရည်ညွှန်းသော **သူများ** အသုံးမှာ ယခုအခါ ပြောသူအဖြစ်ရော နာသူအဖြစ်ပါ အသုံး ပြုလျက်ရှိသည်ကို တွေ့ရပါသည်။

ခြုံငုံသုံးသပ်ချက်

မြန်မာဘာသာစကားရှိ လူမှုညွှန်းအညွှန်းစကားများသည် မြန်မာလူမျိုးတို့၏ လူမှုဓလေ့ ပြောသူ၏ စိတ်ကူးစိတ်သန်း၊ နောက်ခံလူမှုဝန်းကျင်၊ ပြောသူ၊ နာသူ၊ အခြားသူနှင့် အညွှန်းခံတို့၏ ဆက်နွယ်မှုများပေါ်တွင် လုံးဝမှီတည်နေသည်။

မြန်မာတို့၏ လူမှုစိတ်သဘော၊ဂုဏ်ဝုဒ္ဓိ၊ ဝယဝုဒ္ဓိ တရားတော်များကို အလေးထားမှု၊ ဂါရဝတရား၊ နိဝါတတရားရှေ့ထား ဆက်ဆံမှုများ ပေါ်လွင်နေသည်။ မြန်မာလူမျိုးတို့၏ သိမ်မွေ့နူးညံ့သောစိတ်ထား၊ ခံစားမှုကိုဖော်ကျူးလိုသော စေတနာတရား၊ မေတ္တာတရားတို့သည် မြန်မာ့လူမှုညွှန်းအညွှန်းစကားများ ကြွယ်ဝလာရခြင်း၏အကြောင်းရင်းများ ဖြစ်ပါသည်။

ပြောသူတစ်ဦးသည် အညွှန်းစကားကို ပုံသေကားကျ အသုံးပြုမှုမရှိပေ။ ပြောသူ၏ စိတ်ခံစားမှု အခြေအနေကိုလိုက်၍ ညွှန်းဆိုသည့် အညွှန်းစကားသည် ပြောင်းလဲသွားသည်။ ပြောင်းလဲသည်နှင့်အမျှ သက်ရောက်အနက်လည်း ပြောင်းလဲသွားသည်။ ကုန်းဘောင်ခေတ် ကဗျာများရှိ ပြောသူ၊ နာသူ အညွှန်းစကားများတွင်လည်း ပြောသူ၏ စိတ်ခံစားမှုများ၊ ပြောသူ၊နာသူ၊ အပြောခံတို့၏ ဆက်နွယ်မှုများ ထင်ဟပ်နေသည်။

---

[3] ဖိုးလတ်၊ ဦး၊ ၁၉၅၄၊ ၇၇။
[4] ဖိုးလတ်၊ ဦး၊ ၂၀၁၁၊ ၃၁၁။

ထို့ကြောင့် ကုန်းဘောင်ခေတ်ကဗျာများမှ ပုဂ္ဂိုလ်အညွှန်းစကားများသည် ပြောသူက နာသူနှင့် အခြားသူများ၏ ရင်းနှီးကျွမ်းဝင်မှုနှင့် ခံစားချက်သဘောထားကို ပေါ်လွင်စေပါသည်။ ကုန်းဘောင်ခေတ်မြန်မာ့လူမှုဓလေ့ ထုံးတမ်းများနှင့်အညီ နူးညံ့သိမ်မွေ့မှု၊ တစ်ဦးပေါ်တစ်ဦးထားရှိသော လေးစားချစ်ခင်မှု၊ လူတန်းစား အမျိုးမျိုးတို့၏ နေထိုင်မှုဓလေ့ထုံးစံ၊ ဘဝအခြေအနေ အဆင့်အတန်း များကို ပေါ်လွင်စေသော အညွှန်းစကားများဖြစ်ပါသည်။ ထိုပုဂ္ဂလနာမ်စား အညွှန်းစကားများသည် မြန်မာသဒ္ဒါနည်းအရလည်းကောင်း၊ မြန်မာ့လူမှုနယ်ပယ်တွင် တစ်ဦးနှင့်တစ်ဦး ဆက်ဆံရေးချောမွေ့ စေရန် များစွာအထောက်အကူ ပြုမည်ဟုဆိုရမည်ဖြစ်ပါသည်။

နိဂုံး

ကုန်းဘောင်ခေတ်ကဗျာများဖြစ်သော တြိချိုး၊ လေးချိုး၊ အိုင်ချင်း၊ အဲချင်း၊ လွမ်းချင်း၊ အထွေ ထွေသီချင်း ကဗျာများမှ ပုဂ္ဂိုလ်အညွှန်းစကားများကို လေ့လာတင်ပြထားခြင်း ဖြစ်ပါသည်။ ဤ စာတမ်းပါ ကုန်းဘောင်ခေတ် ကဗျာများမှ ပြောသူ၊ နာသူနှင့် အပြောခံ ပုဂ္ဂိုလ်အညွှန်း စကားများ သည် ကျေးလက်အခေါ်အဝေါ်များ(တစ်နည်း) မြန်မာ့ဓလေ့၊ မြန်မာ့လူမှုဆက်ဆံရေး အခြေအနေ တို့ကိုသိရှိနိုင်ပါသည်။ မြန်မာစာပေကို ချစ်မြတ်နိုးသော မြန်မာမှုကို နှစ်သက်သောသူများ၊ မြန်မာ စကား လေ့လာလိုသူများအတွက် အထောက်အပံ့ဖြစ်စေမည်ဟု ယုံကြည်မိပါသည်။

ကျမ်းကိုးစာရင်း

မြန်မာဘာသာ

ကိုလေး၊ ဒေါက်တာ။ (၂၀၀၇)။ ***လူမှုဘာသာဗေဒဝေါဟာရအဖွင့်***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
ကျော်အောင်စံထားဆရာတော်။ (မ−၁၃၂၀)။ ***ဝေါဟာရတ္ထပကာသနီ***။ ရန်ကုန်။ လယ်တီမဏ္ဍိုင်ပုံနှိပ်တိုက်။
ခင်မင်၊ မောင် (ဓနုဖြူ)။ (၂၀၁၀)။ ***လက်တွေ့အတ္ထဗေဒနိဒါန်း***။ ရန်ကုန်၊ ဒေါင်းစာပေ။
ခင်အေး၊ ဒေါက်တာ။ (၂၀၀၄)။ ***အတ္ထဗေဒနိဒါန်း***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
ခင်အေး၊ ဒေါက်တာနှင့် အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၀၈)။ ***သုတေသနအခြေခံသုတေသနပုံစံ***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
စိုးစိုးမြင့်၊ မ။ (၂၀၀၇)။ ***မြန်မာဘာသာစကားရှိ အပြန်အလှန်အပြောစကားပုံစံများကို လက်တွေ့ အတ္ထဗေဒအမြင်ဖြင့်လေ့လာချက်***။ ရန်ကုန်တက္ကသိုလ်၊ မြန်မာစာဌာန၊ ပါရဂူဘွဲ့အတွက် တင်သွင်းသောကျမ်း။
ဖိုးလတ်၊ ဦး။ (၁၉၅၄)။ ***ကျောင်းသုံးသီချင်းပဒေသာ***။ ရန်ကုန်၊ ပညာနန္ဒပုံနှိပ်တိုက်။
ဖိုးလတ်၊ ဦး။ (၂၀၁၁)။ ***သီးချင်းပဒေသာပေါင်းချုပ်***။ ရန်ကုန်၊ ပန်းရွှေပြည်စာအုပ်တိုက်။
မြန်မာစာညွှန့်ပေါင်းကျမ်း။ (၁၉၉၂)။ ရန်ကုန်၊ မြန်မာ့အလင်းသတင်းစာတိုက်။
မြန်မာစာအဖွဲ့။ (၁၉၉၉)။ ***ခရီးဆောင်မြန်မာအဘိဓာန်***။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။
မြန်မာစာအဖွဲ့။ (၂၀၀၅)။ ***မြန်မာသဒ္ဒါ***။ ရန်ကုန်၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။
မြန်မာစာအဖွဲ့။ (၂၀၀၆)။ ***အင်္ဂလိပ်မြန်မာအဘိဓာန်***။ ရန်ကုန်၊တက္ကသိုလ်များပုံနှိပ်တိုက်။
ရွှေသိမ်းမင်း၊ ကို (စုစည်းခင်းကျင်းသူ)။ (၂၀၁၂)။ ***ပန်းရွှေပြည်ရှေးကဗျာစု***။ ရန်ကုန်၊ ပန်းရွှေပြည်စာအုပ်တိုက်။
ဝင်းဖေ၊ ဦးနှင့်အခြား။ (၂၀၀၈)။ ***ဘာသာပြန်ရည်ညွှန်း***။ ရန်ကုန်၊ စိတ်ကူးချိုချို။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၀၅)။ ***လူမှုဘာသာဗေဒသဘောတရား***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၀၉)။ ***ဘာသာပြန်သဘောတရား ဘာသာပြန်လက်တွေ့***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။
အောင်မြင့်ဦး၊ ဒေါက်တာ။ (၂၀၁၀)။ ***ဘာသာစကား သုတေသန***။ ရန်ကုန်၊ ပညာတန်ဆောင်ပုံနှိပ်တိုက်။

အင်္ဂလိပ်ဘာသာ

Dang Dai, Yu Yan Xue Congshu (2000) ***Pragmatics***. Peking: Peking University Press.
Finegan, Edward. (1999). ***Language It's Structure and Use***. Third Edition. Orlando: Harcourt Brace College Publishers.
Levinson, Stephen. C. (1983). ***Pragmatics.*** Cambridge: Cambridge University Press.
Methews, P.H. (2005). ***Concise Dictionary of Linguistics,*** Oxford: Oxford University Press.
Yule, Geogre. (1996). ***Pragmatics***. Oxford: Oxford University Press.

အင်တာနက်အကိုးအထောက်များ

http://www. increasemyvocabularly.com/definition of/Deixis
http://www.sil.org/linguistics/Glossary of linguistic terms
http://www.the freedictionary.com/deixis
http://www.usingenglish.com/glossary/deixis

Study of the Dialects of Shwebo

Yee Mon Oo[1], Thaung Naing[2], Kyaw Soe Win[3]

Abstract

This research investigates and analyses Shwebian dialects which are also called Shwebo dialects. Despite the title, the dialects found in this researchare not only confined to the first capital of the last dynasty, Shwebo. Dialects in some places in Shwebo townships are included to spice up the contents of the paper. Dialects, mainly those in Shwebo region and Shwebian dialects, are especially investigated and analysed in this research. Most of them include dialects concerning with fruits, flowers and food followed by furniture, equipment and tools and miscellaneous dialects.Data were collected from the interviews of the resource persons in Shwebo region.

Key words: Shwebian dialects, different perspective, dialects concerning with fruits, flowers and food

Introduction

A language is a dialect that has an army and a navy (M. Weinreich, 1894–1969)[4]. It is an essential communicative tool. A language by nature has such linguistic spices as idiomatic expressions, slangs, jargons and dialects and so on. As such dialect is a part of a standardized language. And it is a different form of the language due to the geographical position and different classes of the people in that particular region. Among these different dialects especially in our upcountry, not to mention other dialects in different regions, Shwebian dialect is deemed to be something fantasticto do research on and to put into record for the posterity before they certainly fall into oblivion since literally the globe is shrinking with the advent of IT technology and the most prevalent social media like Facebook while even hard-as-nails book wormshave started to scamper away and switched to Facebook. Like it or not, the number of these readers of the printed media or books are markedly dwindling especially among the new generation.

Aim and Objectives

The aim of the research is to investigate and analysethe dialects of Shwebo and its region. The objectives of the research are:

(1) to investigate more about Myanmar culture and society in Shwebo region and
(2) to analyze Shwebo dialects concerning with fruits, flowers and food followed by furniture, equipment and tools and miscellaneous dialects.

Literature Review

The term dialect is applied most often to regional speech patterns, but a dialect may also be defined by other factors, such as social class or ethnicity. A dialect that is associated with a particular social class can be termed a sociolect, a dialect that is associated with a particular ethnic group can be termed an ethnolect, and a geographical/regional dialect may be termed a regionalect (alternative terms include 'regionalect', 'geolect' and 'topolect'). According to this definition, any variety of a given language can be classified as "a dialect",

[1] Lecturer, Daw, Department of English, Shwebo University
[2] Lecturer, Department of English, Shwebo University
[3] Lecturer, Department of English, Shwebo University
[4] *Introduction to Sociolinguistics and Psycholinguistics*

including any standardized varieties. In this case, the distinction between the "standard language" (i.e. the "standard" dialect of a particular language) and the "nonstandard" (vernacular) dialects of the same language is often arbitrary and based on social, political, cultural, or historical considerations or prevalence and prominence.In a similar way, the definitions of the terms "language" and "dialect" may overlap and are often subject to debate, with the differentiation between the two classifications often grounded in arbitrary or sociopolitical motives. The term "dialect" is however sometimes restricted to mean "non-standard variety", particularly in non-specialist settings and non-English linguistic traditions. Shwebo District is a town located in Sagaing region, Upper Myanmar. It lies on Mandalay-Myikyina railway line. It is 75 miles to the northwest of Mandalay, and 17 miles from Kyaukmyaung, a town on the western bank of Irrawaddy and 24 miles from Ye-u.

The main product in Shwebo area is rice while other crops like sesamum, groundnuts ,cotton, corns, maize, pulses and beans. And another produce is jiggery or palm sugar. Other famous produce and products are finished garments made of cotton, *thanakha* (bark cream) and earthen wares.

Throughout the history, it has been popular in terms of economic, religion and literature. On the demise of Alaungpaya, starting from his eldest son, Naung Taw Gyi to the successive kings moved around their capitals to Sagaing, Ava and Amarapura. Despite these, Shwebo remained to be a holy and victory ground to tread to ensure whenever situation called for.

Data collection and Data Analysis

Data were collected from interviews of the resource persons in Shwebo region. The data are classified into three types and they are regionalects concerning with trees, fruits, food and flowers in Shwebo.

1. Regionalects Concerning with Trees, Fruits, Food and Flowers in Shwebo

Regarding the names of the trees, fruits, food and flowers, Shwebian regionalect are fantastic enough to do some study. “Hnin-pan” in standard language is called “Ngwa-kyaung-pan” in regionalect especially at the village called Kyauk-taing, to the west of Swebo. It is a kind of flower that is usually offered by Myanmar Buddhists to the image of Buddha or at a pagoda. Since it blooms in the cold season, befittingly it seems to be called “Hnin-pan”in standard language. The time when the flowers are in blooms corresponds with the time of post-harvest when all the farming tasks are through. Therefore cows are released from tasks and let roam in the fields as they fancy but not without being herded by a cowboy (herdsman). Here “cows being herded” literally means “Nwa-kyaung”. Not surprisingly, that is the reason the flower that blooms at the Nwa-kyuang time is called “Ngwa-kyaung-pan”.

Again, “Youn-pa-di-thee” is called “Ma-ya-ngae-thee”meaning lesser wife (in the village tracts of Tebingaung, to the west of Shwebo. By nature, a lesser wife tends to wheedle (‘chwe, which literally means ‘slimy', and ‘Youn-pa-di-thee’ is really slimy. Which is why, figuratively, “Youn-pa-di-thee”, therefore, is called “Ma-ya-ngae-thee”. It is interesting to note that they figuratively use this in comparison with the nature of the vegetable.

In standard Myanmar language, a green bean that is one feet long is called “Pe`-daung-shae:” (long bean or string bean; however in Shwebo region, its name is “Taing-htaung-pe”. It is likely to be so called because a pole (‘Taing’ in Myanar) is used to prop up the vine so as to grow, clinging onto it.

Additionally, roselle (*hibiscus sandariffa*) comes in two different tastes--one tastes sour, the other bitter. In and around Shwebo, the bitter roselle is called “Bilatt-ywet”. The

bitter roselle is not a native of Myanmar but it is a foreign variety. 'Bilatt' (Vilayat in Hindi) stands for Britain. Which is why, figuratively it is called 'Billat or Vilayat'.

A variety of banana which is pungent and tastes extremely sweet in standard Myanmar is called "thee-hmwei" whereas in regionalect it is "khun-sein or green-skinned" banana since the skin is green even though it is ripe.

And bitter gourd that can be fired or cooked and serves as a popular dish is called "Kyet-hin-ga-thee" in standard language while in regionalect, it is better known as "Boh-ta-htaung-thee" (literally it means a thousand humps) since it has a thousand bumps or humps like cows and buffalos on it. It is interesting to note that the locals name the fruits as the way they look and the shape they have. Moreover the shape of the creepers or vines give a certain idea to the locals; they wittily call the calabash sprouts and tendrils "boo-nyunt or boo-nguak".

In this region, "mont-hin-ga" (vermicelli fish gravy dish) is called "Ta-bin-daing" (literally it means 'going solo') since one rice strand stays separately from the other –even in the gravy dish. And agin the locals interchangeably call it " Ah-yi-phyaw" (literally it means gravy with rice noodles) since the dish tends to be watery. This indicates the richness of vocabularies. When it comes to having this "Ta-bin-daing, in regionalect, the locals use drink (thauk) to take "Ta-bin-daing" instead of 'eat'. Perhaps, the main ingredient of this popular dish is fish. In lower Myanmar, when people prepare it, they use a lot of fish and when they eat it they like to put a lot of greens like rings of banana cores, onions, coriander leaves, bean sprouts, long beans, duck eggs, fried gourd fritters, chilies, 'i-kya-kwei' (actually it is *youzhagui* in Chinese) and so on. Then the dish becomes thick. That is why they have to eat it instead of drinking it. In Shwebo region, fish is not so abundant as in lower Myanmar, and when the locals prepare it, they do not use much fish. They put some vegetables but not much. They like to drink it with coriander leaves, rings of banana cores, onions, chilies and some pieces of fritters and egg (not the whole egg) that is all they have in their dish. Therefore, the gravy is thin or watery. Then one has no choice but to drink rather than to eat it.

Among the Shwebian regionalects, names of some snacks are way too different from those of standard language. A certain snack which is made of rice floor is tender and the color is whitish brown. Therefore it looks like brains and is called "Mont-ou-nauk" (literally brains snack). However in Shwebo region, especially in Kyaukmyaung area, the snack is a little bit like jelly and eely or slippery in one's hand; therefore, it is called 'Mont-phet-shaw' ('shaw' here means eely or slippery). A fish species, which is featherback (chitala chitala), is cut open in the bowel and scraped the meat and the meat is rolled into a ball and fried, and it is called "Nga-phe-sout" (fish meat ball) in regionalect.

In Shwebo region, a circular fritter made of mung or green gram (*phaseolus mungo*) is "akwin-kyaw" (akwin means circle) while in standard language it is called "Baya-kyaw" (barar in Hindi means fritter or 'akyaw'in Myanmar.

"Kyak-hnyin-kyi-tauk" (sticky rice cooked in a green bamboo tube) is called "Paung-tinn" or "Paung-tinn-kyi" in regionalect. However there is a slight variation –"Pauing-thin" in a small village, Ohn Bauk, 9 miles to the east of Shwebo. It is so called by the locals since glutinous rice is cooked in a green bamboo tube (Paung-tinn) or Paung-tin-kyi (bamboo tube). The name got stuck as it is named after the way sticky rice is cooked.

2. Dialects for Personal Belongings and Job-related Dialects in Shwebo

In Shwebo region there are some unique regionalects, which is quite different from that of standard language. "*Done-tote*" is a good example. Nowhere else across the country will one hear suchwords. It is "*kut-pyit*" for standard language. It is a kind of low wooden or bamboo bedstead usually erected around a tree. But sometime it can be a seat on the culvert or drainage. In days gone by, in small villages near Shwebo, this kind of " Done-tote" is a meeting place of village elders as a social gathering and they had a chitchat over a kettle of green tea and pickled tea leaves.

In standard language, a cup of hot water with a pinch of tea leaves in is called "*yay-nwe*"; literally it means warm water. However in Shwebo region, it is "*yay-new-gyan*" or "*Laphet-yay-gyan*" literally meaning raw warm water or raw and rough tea leaves in hot water. And the cup for this purpose is called *"Akyan-bagan"*.

It is learnt that a wok which is normally used for frying vegetables , meat and fish and the like, in regionalect is called "Dae-bine" or "Dae-ou" interchangeably while in standard language it is commonly called "Ou-kin" or rather "Ah-kyaw-ou". In standard language, a small pouch mostly outside a garment for carrying small articles is called "Eik-kat"; however in Shwebo region, it is called "Eik-htaung". It is assumed that it looks like a prison cell or custody as "Htaung" literally means lock-up or jail. Interestingly enough, the pockets on the either lower part of a female's dress are called "Bei-htou", literally meaning side-pouch (since one has to keep his hands in those pouches) at Da-bin-gaung Village, to the west of Shwebo. Therefore, in Shwebianregionalect, "Eik-kat" is "Eik-htaung" or "Bei-htou", depending upon the place where pockets are placed.

A stick commonly used in our country in washing clothes is called "Chi-htuq-dote" (chi is linin and 'dote' is stick). or "Lat-yite-dote"(hand-held stick) in a small village named Kyauk-taing, a few kilometers from Shwebo. In Standard language it is "Ah-wut-phut-dote.

One of the household items in some village tracts in Shwebo region where water is scarce, a common thing of a household is a "Chaung" with which the village folk carry or fetch water. It is a bucket. In lower Myanmar especially in Yangon, it is called "Bone". "Bone" is an incorrect pronunciation. In standard language it is "poun". Only if one keeps something in it, unvoiced "p" sound changes to voiced sound "B" as in 'Si-bone (oil pail) or yay-bone (water pail). It is used as a receptacle used for general purposes in rural areas. In regionalect, one will hear "yay-chaung (water pail), hsan-chaung (rice pail) and so on.

Nowadays, three-wheeled vehicle or three-wheeler (auto-rickshaw or a slang term bone-shaker) is commonly called "Thone-bee-cycle" (thone-bee means three-wheels). In Shwebo region, it is called "Tote-tote or htote-htote or Side-twel." It is so called because the vehicle sounds Tote-tote-tote. Side-twel seems to be named after the appearance of the vehicle. The way they name the vehicle is fascinating and praise-worthy.

Three decades ago, almost all the village folk around Shwebo are farmers. They are no longer farm hands now since they lost most of their farm lands during the military dictator's time. In the past and still now to some extent, "Taung" or basket is a part of their everyday life. One keeps fruits, farm produces and the like in these baskets. Baskets are made of toddy palms. Which is why, it is called "Htan-khauk-taung", literally meaning toddy palm baskets. Additionally, when they go to their farms, they say they go to the Taw (woods) instead of Lae (farm).

A slingshot or catapult is called "Bat-khwa" in regionalect while in standard language, it is "Lauklay or Laygwa".

"*Wet-u-hle*" in standard language (screwdriver) is called "Kyauk-hle" in regionalect. When one irons his creased shirt, in standard language it is called "Mee-puu-tike" (press with heat) while in regionalect it is "Mee-kywei-tike" (press with an fiery iron). For a person, he may need a hat or head gear (Oo-htoke) to protect himself from the heat. In Shwebo region it is called "Gaung-hsaung", or "Ah-puu-ka", literally meaning "head-protector" or "head-cover".

In Myanmar-English Dictionary first and second edition published by Myanmar Language Commission, an ornamental earpiece that both man and woman wear is of three types—"Na-gat" (earing with a screw-on back piece), "Nah-swe"(eardrops) and "Nah-daung" (ear-plug). In monarchical days, both man and woman wore "Na-gat" and "Nah-daung". While Na-gat has a screw-on back piece, "Nah-daung" does not have such piece. These days, in standard language, "Na-gat" is called "Nah-daung" in regionalect, especially in Seikkhun Village, seven miles to the west of Shwebo. Shwebo used be a seat of King Alaung Phaya. That is the reason, the old term Nah-daung got stuck as a regional dialect.

Bi-fold or wallet normally used by men is called "Gat-eik" or "Patta-eik" in Kyaukmayng, a river side town near Shwebo.

Moreover, a fluorescent lamp is called "Phan-pyaung" (glass cylinder) and "Mee-lone" (bulb) is Mee-thee (literally fire fruit).

A rubber band is called "Tha-yay-gwin" in standard language while it is "Kyet-paung-gwin" in regionalect.

In standard language, clothes are called "Ah-htae". However in regionalect, "Ah-htae" means "gold and jewelry". When someone says she buys "Ah-htae", she means she has bought gold or jewelry.

A kite made of wax paper to fly as a plaything is "Hsun" in standard language. In Shwebo region, it is called "lei-tagun" (flying banner) since it is flying in the air like a banner. It looks like standard language is not actually standardized language because it is something concerning with your attitude and perception. When 'standard language' is mentioned, the question tends to arise—"Who died and made you king of anything?" Suppose it to say, nobody has an authority to make a decision whether it is standardized language or not.

3. Miscellaneous Dialects Found in Shwebo

In standard language when a person is in a daze, or does not understand what is going on around him, or feels out of place, he is said to be "Kayng-taung-taung" or "Oo-kyaung-kyaung". In regionalect, it is "Kyiq-ti-kyet-tat".

In addition, a person finds tough and difficult to do a task by himself . When helping hands will get the task done much easier in no time flat, it is called in Shwebo region "Ohn-lote" or "Wain-lote".

When someone is having a hard time or financial or social problems, it is said that he feels" Seik-pyet" (disheartened) while in and around Shwebo it is "seik-lay" (literally dejected).

At Khun-daung-Gyi village when a person is carrying out an arduous task with might and main, the folk like to say he is "Ah-tin-adhammaLote". At Kyauk-taing Village tracts, if a person gobbles or wolfs down food, he is "Khwa-hsa"(gobbling the food) or if he speaks too much, he is said to be "Khwa-pyaw" (Khwa means without any control or constraint) Almost all the village folk at Chiba, a small village very close to Shwebo, are hardworking. Only after their work, they while away their time at a café, having a chitchat over tea. If

somebody is found doing so at a café after tiresome tasks, he would be asked “Daung-seiq-bi-la” (everything is done?).

At Hanlin, ancient Pyu city, when the locals cannot see bright and blaring sun due to clouds or rain clouds, it is called “Nay-kyit” (the sun is being constricted).

When children play in most mischievous ways most boisterously, it is “Walet-chee-sekkya-lae”. Although it does not give any meaning, the sound of the phrase makes clear to get across the message.

In Shwebo region, when someone who is a multi-tasker is as busy as a bee and his hands are fully tied, the locals say,“Bwet-pauk”, literally meaning swampy or muddy. For instance, I have been way too busy doing all manners of work and find no time to take a break, it is all “Bwet-pauk.

If something is in such a situation that it is messy, untidy, dirty and yucky, in standard language it is “Nyit-pat-pay-yay”. In regionalect it is “Pwa”. Take this for an example—You are all “Pwa” or dirty. Go take a bath.

At a small busy town named Wetlet, 22 miles south of Shwebo, if a young woman beautifies herself too much the locals tend to say approvingly that she is “Ah-pyo-lote” (beautifying oneself extremely).

In standard language, a funeral is called “Ah-thu-ba” or “Na-yay” while in regionalect, it is “Kissa”. In Standard language, Kissa is a business or work (to be done). In Shweboregion, the locals use this in two ways—one as in the standard language the other as in their regionalect. For example, I am escorting or attending a “Kissa” (funeral). The Kissa is to be cremated today (inregionalect). Have you done the Kissa (work) you are asked? (in standard language).

In rural areas, it is a Myanmar Buddhist culture that if a family has son, the family heads are all eager to send their son to an abbot to become a novice. And when a family hold a novitiation ceremony to initiate their son, among the village folk they vie one another to be able to hold grander one than that of the rest. They spare no cent nor dime nor penny in doing so—a bigger pavilion,more guests, the best music band, the biggest feast, the most flamboyant procession and so on. What a fortune they would spend! As a result, they end up being in deep debt. At Youn-tha Village, Wetlet township, it is called “Man-dat-pi” (“being pressed by the pavilion”).

Again, when someone does something heartily and satisfactorily, the locals use such adverbs as “Tha-chyo” or “Khwe” or “Thaatt” as in “Lotetha-chyo”or “lote-gyo” (do /box something till it is broken), “Lotethaett” or “Has-thaett (do/box or eat something to death).

If someone does something in a slipshod manner or speaks uncertainly, in standard language, it is “Hsan-ta-wa-wa” “Ma-thay-ma-cha” while in regionalect it is “Poun-taw-tha-lo Lote” and “Poun-taw-tha-lo-Pyaw”. At Wetlet and Hanlin area it is “Taw-i-yaw-i” instead.

“Poun-taw-yin” has some other usages. It also mean “opportune” as in –

“Where are you going? I am coming with you if it is “Poun-taw-yin.”

“I will give the message to her if it is “Poun-taw-yin”c (it is opportune.)

Findings and Discussion

Shwebo, as it is the first capitalof the third Myanmar Empire founded by King Alaung Phaya, the locals speak crystal pure Myanmar. Therefore some dialects are assumed to be handed down from ancestors of Konbaung era to the current generation.When it comes to

standard language, there will be a flurry of heated debates over which usage should be standard language or which should not be. Whatever it takes, these dialects or regionalects reflect the lifestyle and everyday life of the local people, descendants of their forefathers of Konbaung Era. Theseregionalects stemmed from their everyday life experiences.

It is found that some regionalects regarding with fruits, vegetables and food have their roots in the nature, shape of them and their culinary culture; for instance, the regionalects for 'Water Lily", "Okra", "Bitter Gourd" and "Mont-hin-ga" and "Kauk-hnyin-kyi-dauk" are unique and quite different from so-called standard language. One can see the art of creativity as well as the gift of gab inherently embedded in them.

Again one will find that some regionalects for some pieces of furniture, personal stuff are unique and only confined to the Shwebian region; they are not even used in some other parts of the country. "Done-dote" is a good example for this. In standard language, "Tone" or "Done" is a plank of wood (here fastened to a tree at low level so people can sit on it) and "tote" means tie or fasten with a rope or plant fiber .Such being the case, it is named after the method and the material used for that the plank wood is tied to a tree with plant fibers.

Not only that, the three-wheeler or "(h)Tote-(h)tote" is used as the vehicle sounds. And "Side-twel" is named after the shape of the vehicle—"side" means "bay" and "Twel" means "attached to (something)". Therefore it can be concluded that in Shwebain region, the shape, the sound, the nature of something gives an idea to the locals to give them names. With the advent of IT and internet and TV programs plus movies, not only the globe but the country itself is literally shrinking. Standard language and dialects are widely and extensively adopted, adapted, and they permeate every nook and corner of the country.

Most Myanmar people love to uphold Myanmar culture. In social dealing they are friendly, humble and polite. One can see that when they address their relatives. A married woman when she speaks of her husband, would use "Ein-tha" (her husband).

Some regionalects evolve around the situation of their livelihood and the community they belong to. For example "Bwet-pauk" (literally swampy or muddy), "Pwa-si-khat" (literally swarming) and "Pwa" (messy). "Pwa-si-khat" normally concerns with disorderliness at a work place while "Pwa" with the fact that someone's body is dirty with grime, grease and dust. No one can deny that the Swebians are rich in vocabulary, at home with eloquentness and well-versed in coining picturesque phrases.

It is learnt that the locals use some words in different contexts but these words retain the same meaning both in standard language and in regionalect. For instance—"Adhamma" and "Khwa". Even in the same region they use the same words in different ways sometime giving slightly different meaning. To put it in a capsule, studying dialects or regionalects and putting them in records is tantamount to upholding the culture and the value of a language. They mirror regional characteristics. By studying them, one can vicariously fell and see the Shwebain lifestyle, their livelihood, their imagination and a good mastery of the language they have. When it comes to dialects versus standard language, the on-line Cambridge Dictionary defines "stand language" as follows—

"A standard language is a variety of language that is used by governments, in the media, in schools and for international communication. There are different standard varieties of English in the world, such as North American English, Australian English and Indian English. Although these standard varieties differ in terms of their pronunciation, there are few differences in grammar between them. In contrast, there are non-standard forms of a language that are used, for example, in different regional dialects and these non-standard varieties are different from each other."

The definition here concerns with the English language; it can be applied for Myanmar language as well, though. Standard Myanmar Language is the same as mentioned above. However, in this case, Shwebo used to be a monarchical capital, historically more important than Yangon, the former first capital. The so-called standard language actually encompasses around Yangon region only and it is mostly used by Yangonites. This point calls for intellectually heated debates. Matter-of-factly, Shwebian regiolect is a Royal Language. The point to be made here is why not the Royal language is standard language as it should have been. Which is why, scholars are encouraged to do research on this and to come up with a remedy to calm down the smoldering un-satisfaction of the natives of Shwebo region.

Conclusion

This paper deals with only accessible Shwebian dialects; there may be some that remain yet to be studied or rather researched and recorded. Future scholars are encouraged and advised to do more detailed, fuller and further research. The locals' insightful imagination, their skillfulness at putting their ideas into words using wonderful regionalects. With the introduction of state-of-the art technology, people have switched to favoritism toward materialism. They spend most of their precious time on using social media like Facebook; as a result, our language is degrading drastically and diagonally due to it, before it is too little too late and before these dialects fall into oblivion, they should be researched and recorded.

Acknowledgments

I am deeply grateful to Dr. Win Swe, Acting Rector, Shwebo University, for his kind permission to carry out this research. I would like to extend my sincere thanks to Dr. Khin Maung Soe, Professor and Head, English Department, Shwebo University, for his encouragement to do this research. My heart-felt thanks go to U Kyaw Thu, who gave insightful answers to my questions with untiring energy, U Hla Baw, who helped me with the stories behind some dialects and, last but not least, U Moe Aungwho provided me with necessary data.

References

Third Year Honours and M.A. Qualifying Textbook. *Introduction to Sociolinguistics and Psycholinguistics* Merrium Webster Dictionary. (1999). (11th Ed.).

John, A. (1998). *The Oxford dictionary of slang*.

English Idioms and Idiomatic Expressions Regarding the Parts of Human Body

San San Tin[1]

Abstract

Idioms are essential everyday expressions that can be investigated in speaking, as well as in writing. It is necessary for students to learn idioms not only in overt methods, but also in a covert way. The literal meaning of an idiom should be distinguished from its figurative meaning. The Myanmar learners may get acquainted with Myanmar equivalents of the English idioms they learn. This research explores the significance of idioms in everyday speech and writing and the data are analysed in terms of Types of Translation Methods for English Idioms retrieved from the website (https://culturesconnection.com>7-tr…) are applied to analyse the data in which are:*Borrowing, Calque, Literal Translation, Transposition, Modulation, Equivalence and Adaption*. The descriptive method is employed in this research. In this research, it is found that among the idioms related to the parts of the human body, those related to the nose are the minimum in number.

Key words: idiom, idiomatic expression, figurative meaning

Introduction

In learning a language, students are usually engaged in studying grammar and vocabulary. It is a fact, however, that without the working knowledge of idioms of a foreign language, his or her speech or writing sounds awkward, or unnatural, to the native speaker. English idioms and idiomatic expressions are often noted in everyday conversations, in media and literature. English idioms can be misunderstanding for non-native speakers, especially students, and even experienced translators, who often take the literal meanings of these everyday expressions and make the wrong interpretations of the intended meanings. In this research, common English idioms related to the human body parts, as found in the texts and dictionaries, are investigated and analysed, together with its literal translation and its equivalent figurative meaning.

Aim and Objectives

The aim of this research is to investigate and analyse English idioms relating to the parts of the human body found in the various dictionaries selected for the research. Based on this aim the following objectives are set:

- To enable the Myanmar learners studying English as a foreign language to make sense of the literal, as well as the figurative, meaning of idioms, regarding the parts of human body.
- To support the learners to be confident in using idiomatic expressions in writing and speaking correctly.
- To understand and use a wide range of idiomatic expressions soundly.

Literature Review

Idioms represent as an area of language full of figurativeness and metaphor.In learning idioms, English idioms have been approached from different points of view, especially in the field of translation.It is impossible to cover all existing idioms in this research paper and so this research focuses on an area of idioms with parts of the human body. The students may run into difficulty in learning the language if they do not understand

[1] Lecturer, Daw, English Department, Shwebo University

its idiomatic expressions. In this research, the various types of dictionaries were used, but idioms with only just the parts of human body have been investigated and analysed. Therefore, it is expected this research may support some language proficiency to the EFL students in their pursue of English language and their confidence in using English idioms.

Longman Idioms Dictionary (1998) defines an idiom as "a sequence of words which has a different meaning as a group from the meaning it would have if you understand each word separately". In other words, an idiom is an expression that means something different from the meaning of the disconnected words.According to Simpson (2004), idioms have their origin in metaphors which have become fixed phrases in language. They are frequently referred to as clusters of words whose meaning can be hardly deduced from their constituent parts (Simpson, 2004: 93).

In *Myanmar-sar Thute-thana Sartan-myar* by Cho Cho Tint (2011), it is advised that studying idioms is one of the most effective ways to study Myanmar Language. Some idioms arranged in categories are also presented in that book. In Barthar-amyin Sarpay amyin by Maung Khin Min (Danubyu) (2014), idioms regarding the body parts are also discussed.

Data Collection and Data Analysis

The required data for this researchare collected from *Longman Idioms Dictionary* (1998)[1]and Types of Translation Methods for English Idioms[2] are applied to analyse the data in this research and they are:

1. Borrowing
2. Calque
3. Literal Translation
4. Transposition
5. Modulation
6. Equivalence
7. Adaption

1. Borrowing

It uses the same word or expression in original text in the target text. It reproduces an expression in the original text.

Example: The *Thingyan* Festival

2. Calque

It is a technique of adopting the structure of the source language.

Example: The English term *water pot* is *Ye* (water)-*O* (pot).

3. Literal Translation

It is a word-for-word translation. According to Vinay and Darbelnet, a literal translation can only be applied with languages which are extremely close in cultural terms. The translated text retains the same syntax, the same meaning and the same style as the original text.

Example: Good morning ⇒ Kaung-tho-nan-net-khin

4. Transposition

This translation technique involves a change in grammatical structure.

Example: How's things? ⇒ Ache-ne (things; conditions)+be-lo-lè(How?)

[1] K. Stern, *Longman Idioms Dictionary*, 1998, pp. 3-27 (http://www.amazon.com>logma...)

[2] *Types of Translation Methods for English Idioms*retrieved from the website (https://cultures connection. com> 7-tr…)

5. Modulation

It introduces a semantic change or perspective, changing the form of the source text.

Example: Who knows? ⇒ Min-be-lo-pyaw-ma-lè

6. Equivalence or Reformulation

This is a translation technique which uses a completely different expression to transmit the same reality. Through this technique, names of institutions, interjections, idioms or proverbs can be translated.

Example: Make hay while the sun shines ⇒ Moe-ywa-don-ye-khan

7. Adaptation

Adaptation makes use of cultural substitution or cultural equivalent. A cultural element in the original text is replaced with an expression close to the culture of the target language so that the text sounds familiar to the reader: Sherlock Holmes is adapted into U San Shar.

Example: Thingyan Festival ⇒ The Water Festival

There are some literation translations in Myanmar equivalent are "drag one's feet (to do something very reluctantly) it literally means in Myanmar အချိန်ဆွဲသည်။ လေးကန်ဖင့်နွှဲသည်။" The English Idiom "play it by ears to do something without any plan literally means in Myanmar မီးစင်ကြည့်ကသည်။ အခြေအနေကိုကြည်ပီးလုပ်ကိုင်ဆောင်ရွက်သည်။"

(မြန်မာစာအဖွဲ့၊ (၂၀၁၃) " *ခရီးဆောင်မြန်မာ အဘိဓာန်၊ နေပြည်တော်* "၊ မြန်မာစာအဖွဲ့ ဦးစီးဌာန၊ မြန်မာစာအဖွဲ့၊ (၁၉၉၃) "*မြန်မာ့အဘိဓာန်ရုန်ကုန်*" ဖိုတိုလစ်သို ပုံနှိပ်စက်ရုံ၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန)

Although there are seven types of translation techniques according to the theory of translation methods, only three translation methods (literal translation, modulation, adaption) are applied in analysing the datain this research. Then, myanmar equivalent idioms are also compared and expressed at the same time.

In this research, English idioms relating to the parts of the body are investigated in the selected dictionaries and the body parts included in this investigation are the head, the face, the hair, the eye, the ear, the nose, the mouth, the neck, the shoulder, the back, the arm and the leg. The idioms relating to them are investigated and analysed and they are expressed in the tabular format. The analysis includes English idiom relating to the body part, its literal tyranslation and its Myanmar equivalent idiom. The data are stated in tables.

The Head

It refers to the top part of the human body. It also contains the brain, mouth, and main sense organs. For example, the English idiom "put your heads together", it has a figurative meaning "to solve a difficult problem together/ ခေါင်းချင်းရိုက်ကြသည်။" Some expressions based on motion or position of head can also be found in figurative meaning. For instance, "shake one's head" means "to show disapproval or disagreement". There are some idioms with head which carry figurative meanings.

They are expressed in the following table.

Table 1: English Idioms Relating to the Head

English Idioms	Literal Translation	Myanmar Equivalent Idiom
keep one's head down	to try to keep away getting involved in something or responsibility	to avoid trouble ခေါင်းသျှိသည်။ ခေါင်းတိမ်းသည်။ (NB: Literal translation is used.)
lose one's head	to become unable to behave calmly in a difficult situation	to be at loss or to become delirious ကတောင်ချောက်ချားဖြစ်သည်။ (Adaptation technique is used.)

English Idioms	Literal Translation	Myanmar Equivalent Idiom
have one's head in the clouds	to think about something that is not practical	to live in a fantasy world စိတ်ကူးယဉ်သည်။
head start	to start further ahead than someone else	to give a handicap in a competition အကျောပေးသည်။ အသာပေးသည်။
head over heel	to be very much in love with someone	to be deeply in love အရူးအမူးချစ်မိသည်။
get in over one's head	to be involved in something that is difficult to cope with	to take on a task that someone can't handle မနိုင်ဝန်ထမ်းသည်။ တစ်စုံတစ်ယောက်ကိုမနိုင်ဝန်ထမ်းစေသည်။

The Face

Face is the front part of the human head because we have to speak to each other face to face when communicating. The English idiom "save one's face' means "to do something that will stop you from feeling embarrassed", but the meaning is "to avoid humiliation, to do something which makes other people respecting you/ မျက်နှာပျက်စရာတစ်စုံတစ်ရာဖြစ်သည်။ အရှက်ပြေပြောသည်။" The expression "keep a straight face" means "to keep down someone's feeling of laugh/ မျက်နှာပိုးသတ်သည်။ အိန္ဒြေပြန်ဆယ်သည်။" We can also read the feelings of someone's face as the mirror of his or her behavior. Therefore, the English idiom "show one's face" has a figurative meaning, "to appear (to show to be present) မိမိရှိကြောင်းပြသည်။ ကိုယ်ထင်ပြသည်။" In term of the face, there are also some more idioms as follows:

Table 2: English Idioms Relating to the Face

English Idioms	Literal Translation	Myanmar Equivalent Idiom
face to face	to meet somebody personally to talk something	to have direct contact between two persons in the same direction. မျက်နှာချင်းဆိုင်(တွေ့သည်။) (Literal translation is used.)
wink of an eye	to close in a single eyelid swiftly	to close one's eye quickly as a signal မျက်ရိပ်ပြသည်။ တစ်စုံတစ်ရာကိုအချက်ပြသည်။ (NB: Modulation is used. The word 'eye' is changed into မျက်ရိပ်facial expressions.)
pull a face	to make someone grimace	to strain abnormally or to make a wry face မျက်နှာရှုံ့မဲ့ပြသည်။ မဲ့ရွဲ့ပြသည်။ (NB: Adaptation is used.The word 'pull' is adapted in meaning.)

Facial features

Facial features several features like hair, eye, nose, etc. In this paper, English idioms with some facial features are expressed below:

The Hair

The hair is a thin thread growing uncountably from the skin of human head. To show the fear of danger, the idiom "make one's hair stand on head" does not literally mean "it rises on air" but it means "to make a flesh tingle/ ကြက်သီးမွေးညှင်းထသည်။" The English idioms "keep

one's hair on" literally means "to harden one's heart" and its real meaning is "not to become too excited/ စိတ်တင်းသည်။ အားတင်းသည်။"

The Eyes

Eye is an organ of the upper body part, having the faculty of sight. Concerning the idioms related to the eye, some of the examples are "keep an eye on" (to watch carefully and pay attention to or to wait and see cautiously/ စောင့်ကြည့်သည်။ မျက်စိဒေါက်ထောက်ကြည့်သည်။" "to shut one's eyes to something/ မသိကျိုးကျွံပြုသည်။ မမြင်ချင်ယောင်ဆောင်သည်။ " We are able to use eyes as an organ but also strong feeling of motivation. The English expression "an eye for an eye" may be literally translated as “to rebut one's in kind", but its real meaning "to take reprisals/ လက်စားချေသည်။ လက်တုံ့ပြန်သည်။"

The Ears

It refers to the organ of hearing. Concerning the idioms related to the ears, some of the examples are "play it by ear" literally means "to act according to circumstance" but figuratively means "to do something without any plan/ မီးစင်ကြည့်ကသည်။ အခြေအနေ ကြည့် လုပ်ကိုင်ဆောင်ရွက်သည်။" If someone knows something exactly, we can also use the idiom “keep one's ear to the ground/ အပ်ကျတာကအစသိအောင်လုပ်သည်။ အသေးစိတ်သိအောင်လုပ်သည်။"
From this, there are also some more idioms as follows:

Table 3: English Idioms Relating to the Ear

English Idioms	Literal Translation	Myanmar Equivalent Idiom
be all ears	to very eager to hear	to listen attentively နားစိုက်သည်။ နားစွင့်သည်။ (NB: Modulation is used.)
with half an ear	to not hear completely	to not easy to hear clearly မကြားတစ်ချက်ကြားတစ်ချက်ကြားရသည်။ (NB: Adaptation is used.)
go in one ear and out the other	to give no attention and instantly something forget it	to listen to something in one ear and then out the other တစ်ဖက်နားကဝင်၍တစ်ဖက်နားကထွက်သည်။ Literal translation
smile from ear to ear	to look intensely happy or pleased	to smile someone satisfactorily နားရွက်ချိတ်အောင်ပြုံးပြသည်။ အားရပါးရပြုံးသည်။ (NB: Literal translation is used.)

The Nose

The nose is an organ of sense of smell. There are only a few of idioms related to the nose express smelling. They mostly describe about feeling. Some idioms are: "keep your nose clean" means "not to do anything incorrect or wrong"; it figuratively means "to avoid corruption or ill legal/ ဥပဒေနှင့်မညီစွန်းအောင်နေသည်။" The English phrase "get up one's nose" (to annoy someone very much means "to feel someone uneasy/ တစ်စုံတစ်ယောက်ကို စိတ်ကသိ ကအောက်ဖြစ်စေသည်။") When we say "with one's nose in the air" it literally translates as "to behave as you are more important than other people". Its figurative meaning is "to be haughty or self-important/ ကိုယ့်ကိုကိုယ်အထင်ကြီးသည်။ အထင်ကြီးတစ်ခွဲသားနှင့်နေသည်။"

The Mouth

It refers to the part of the face for speaking or oral. Man uses the idioms with the mouth for oral or speaking. The English idiom "to have a loud mouth" means "to talk too much (or "to be a voluble protest/ အာပေါင်အာရင်းသန်သန်ပြောသည်။" The English idiom (to have a big mouth) means "to be show off/ ကြွားဝါပြောဆိုသည်။" We can also use the mouth for eating. For instance, the literal meaning (to stream much liquid coming from the mouth) can be expressed by saying, "It makes our mouth water သရေယိုသည်။ သရေကျသည်။"

Some more examples are mentioned in the following table:

Table 4: English Idioms Relating to the Hair

Body parts	English Idioms	Literal Translation	Myanmar Equivalent Idiom
Hair	split hairs	to make trivals distinction (or to make something great exagge ration)	to pay too much concentration to unimport details ရေကြီးခွင်ကျယ်လုပ်သည်။ မလိုရာအသေးစိတ်သည်။ (NB: Adaptation is used.)
	let one's hair down	to feel relax after working hard	to take a rest (from hard work) much more freely and enjoy စိတ်လွတ်ကိုယ်လွတ်နေသည်။ (NB: Adaptation is used.)
	to make one's hair stand on end	to make someone to feel scared	to cause someone to be very frightened ကြက်သီးမွေးညှင်းထလောက်အောင်ထိတ်လန့်ဖွယ်ကောင်းသည်။ (NB: Adaptation is used.)

Table 5: English Idioms Relating to the Eye, the Nose and the Mouth

Body parts	English Idioms	Literal Translation	Myanmar Equivalent Idiom
Eyes	see eye to eye	to agree with someone	to show agreement သဘောတူသည်။ လက်ခံသည်။ (NB: Adaptation is used.)
	raise one's eye-brows	to show surprise	to cause surprise မျက်စပစ်သည်။ အံ့ဩသည်။ (NB: Modulation is used. The word 'eyebrows' is changed into 'eyes'.)
	be all eyes	to pay attention	to watch someone with a lot interest စူးစူးစိုက်စိုက်ကြည့်သည်။ စိတ်ဝင်တစား ပြုံကြည့်သည်။ (NB: Adaptation is used.)
Nose	get up nose	to have put someone to bother	to have caused someone so much trouble စိတ်အနှောက်အယှက်ဖြစ်သည်။ စိတ်ကသိကအောက်ဖြစ်သည်။ (NB: Adaptation is used.)
	turn one's nose up	to refuse to receive something	to be disgusted နာခေါင်းရှုံ့သည်။ စက်ဆုပ်ရွံရှာသည်။ (NB: Adaptation is used.)
Mouth	be all mouth	to say something to impress	to be full of bragor to talk with excessive pride. လေလုံးထွားသည်။ ကြွားသည်။ (NB: Adaptation is used.)
	keep one's mouth shut	not to tell other people about secret	to say someone nothing ရင်ဝှေ့နှတ်ပိတ်နသေည်။ ခပ်မဆိတ်နေသည်။ (NB: Adaptation is used.)

The Neck

The part of the body between the head and the shoulders or the rest of the body. Idioms are used with a figurative meaning, based on the position of neck.

Table 6: English Idioms Relating to the Neck

English Idioms	Literal Translation	Myanmar Equivalent Idiom
risk one's neck	to take a great risk	to risk harm စွန့်စားသည်။ (NB: Adaptation is used.)
save one's neck	to escape from a difficult situation	to be free from dangerous situation အခက်အခဲ၊ အကျင်းအကျပ်မှလွတ်မြောက်သည်။ (NB: Adaptation is used.)
wring someone's neck	to be extremely angry	to be furious with anger စိတ်ဆိုးဒေါသထွက်သည်။ ဒေါကန်သည်။ (NB: Adaptation is used.)
to be stiff necked	to be obstinate	to be stubborn ခေါင်းမာသည်။ ဇွတ်တရွတ်နိုင်သည်။ Modulation is used. The word neck is changed into head (ခေါင်း).

The Shoulders

The shoulders refer to the parts of human body at each side of the neck where the arm is connected. The shoulder sometimes carries something. Its figurative meanings of some idioms are: "look over one's shoulder" is literally translated as "to be worried"; it figuratively means "to think about possibility that something unpleasantpwyon". The English phrase "a shoulder to cry on" means "to give you sympathy"; its figurative meaning is "to be willing to listen your problem and give you emotional support/ဆွေးနွေးနှစ်သိမ့်သည်။"

The English phrase "shoulder to shoulder" means "to challenge"; it figuratively means "to work together to achieve something/ ပခုံးချင်းယှဉ်သည်။ ရည်မှန်းချက်ရောက်အောင်ကြိုးစားသည်။"

The Back

The part of the body is opposite to the stomach and chest. In English language, there are also some idioms with the human back. There are someidioms as follows:

Table 7: English Idioms Relating to the Back

English Idioms	Literal Translation	Myanmar Equivalent Idiom
have one's back to the wall	to be in difficult situation	to be in a bad situation ဘေးကျပ်နံကျပ်ဖြစ်သည်။ အခက်အခဲကြုံတွေ့သည်။ (NB: Adaptation is used.)
turn one's back on	to refuse to support someone	to ignore someone ကျောခိုင်းသည်။ လျစ်လျူရှုသည်။ Literal translation is used.
to break one's back	to work extremely hard	to make great effort အလုပ်ကြိုးစားသည်။ မနားမနေလုပ်သည်။ (NB: Adaptation is used.)

The Arm

The arm refers to the portion of the upper human from the shoulder to the wrist.

Table 8: English Idioms Relating to the Arm and Hand

Body parts	English Idioms	Literal Translation	Myanmar Equivalent Idiom
Arm	with open arms	to greet someone heartily	to welcome someone eargely တစ်ဦးတစ်ယောက်ကိုလှိုက်လှဲစွာကြိုဆိုသည်။ (NB: Adaptation is used.)
	keep one's at arm's length	to stay away from someone	to keep someone at a distance ခပ်တန်းတန်းခပ်ခွာခွာနေသည်။ Literal translation is used.
Hand	hand in glove	to have a very close relationship	to be of the same opinion တစ်ကျိတ်တည်းတစ်ညာဏ်တည်းဖြစ်သည်။ (NB: Adaptation is used.)
	throw one's hand	to stop trying to do something	to give something up လက်မြှောက်သည်။ Literal translation is used.
	play in to one's hand	to do exactly what someone needs for their plans	to help someone without knowing their plans သူခိုးဓားရိုးကမ်းမိသည်။ (NB: Adaptation is used.)
	hold's sb's hand	to grasp someone to encourage	to hold someone's hand to give an encourage အားပေးကူညီသည်။ (NB: Adaptation is used.)
Hand	caught someone red handed	to catch someone on (the spot) or in the middle of committing a crime	to catch someone in the very act လက်ပူးလက်ကြပ်မိသည်။ (NB: Adaptation is used.)
	have one finger in every pie	to have an interest or to be involved in everything	to meddle in one's affairs နေရာတကာဝင်စွက်ဖက်သည်။ ရှုပ်သည်။ (NB: Adaptation is used.)
	lay a finger on somebody	to touch someone as a treat	to commit something physically or in person တစ်စုံတစ်ရာကိုကိုယ်ထိလက်ရောက်လုပ်သည်။ ကျူးလွန်သည်။ (NB: Adaptation is used.)
	under one's thumb	to being completely controlled by someone	to be under the control of someone တစ်စုံတစ်ယောက်၏ထိန်းချုပ်မှုဖြင့်လုပ်ကိုင်ဆောင်ရွက်သည်။ ကြိုးစွဲရာကသည်။ (NB: Adaptation is used.)

The leg

The long part of the body connecting the feet to the rest body. Leg is also an active organ of the body like hands. Based on this ability, there are connected with joke, support or situations. For example, the English idioms

1. "pull one's leg" means "to make someone as a joke" has a figurative meaning "to make fun of someone/ အတည်ပေါက်နှင့်ယုံလောက်အောင်ပြောသည်။" (NB: Adaptation is used.)

2. stand on one's own feet (to do something as one's own wish) means "to rely on oneself/ ကိုယ့်ခြေထောက်ပေါ်ကိုယ်ရပ်တည်သည်။" (Literal translation is used.)
3. put one's foot in it (to tell something that cause to be upset) means "to be in disorder from something/ကသောင်းကနင်းဖြစ်သည်။ကစဉ့်ကလျားဖြစ်သည်။"(NB: Adaptation is used.)
4. put a spoke in someone's whets means (to cause problems someone's achievement) means "to give someone trouble/ ခြေထိုးသည်။တစ်စုံတစ်ယောက်ဒုက္ခရောက်အောင်လုပ်သည်။" (NB: Adaptation is used.)
5. have a foot in both camps (to support for two opposing group of people) means "to give a hand for groups with opposing interests/ လှေနှစ်ဖက်နင်းသည်။" (NB: Adaptation is used.)

Some idioms give a very positive meaning. For example, "put your feet up" literally means "to take a rest without worry". However, its figurative meaning is "to stay away from all responsibilities/ စိတ်လွတ်ကိုယ်လွတ်နားသည်။ (NB: Adaptation is used.) The English idiom "full on one's feet" literally means "to get back a good situation", but the meaning is "to be free from a bad situation/ ထူထူထောင်ထောင်ဖြစ်လာသည်။ (NB: Adaptation is used.)

Table 9: English Idioms Relating to the Knee and Foot

Body parts	English Idioms	Literal Translation	Myanmar Equivalent Idiom
Knee	bring someone to their knees	to force someone to surrender	to submit to one's opponent or to the enemy အညံ့ခံသည်။ ဒူးထောက်သည်။ Literal translation is used.
	have a cold feet	to feel suddenly nervous or frightened	to tremble with great fear ကြောက်ဒူးတုန်သည်။ (NB: Adaptation is used.)
Foot	throw oneself in to something	to do a work very actively	to do something firmly or with enthusiasm ခြေစုံပစ်ဝင်သည်။ အလုပ်တစ်ခုကိုစိုက်စိုက်မတ်မတ်လုပ်သည်။ (NB: Adaptation is used.)

Findings and Discussion

Taking the literal meanings of idioms lead to the wrong interpretation since they have specific figurative meaning. As each language has idioms, there are also many idiomatic expressions in English language. Among them just only idioms, with the parts of human body have been discussed in this research.

Idioms are a part of language. To have a better understanding of a foreign language as the target language, we should not fail to learn idioms and idiomatic expressions. Idioms are always easy to understand literally. To be able to use an idiom correctly, we have to know its figurative meaning very well. The English language is rich in idioms. This research presents idioms regarding the body part that are commonly used in American movies, TV shows, in both written and spoken and in every day conversation, with literal translation and an equivalent in Myanmar. Where there is an exact equivalent in another language, some idioms could simply be translated. Some idioms need to be understood literally, if there exists no proper equivalent. Sometimes the literal translation of idiom can cause uncertainty because its meaning is not predictable from the meaning of their combined constituents. The translation methods common in translating English idioms into Myanmar are literal

translation, modulation and adaptation. It is observed that adaptation technique is mostly used in translating English idioms into Myanmar.

Conclusion

It can be deduced that idioms are essential parts of learning a foreign language because a good use of idioms gives the natural flow of the language, and idioms are common in everyday conversations, as well as in literary language. Students are required to have the skill of using the right idiom in the right place. Like teaching vocabulary, teaching idioms should be fun so that students will enjoy learning. Idioms related to the parts of human body should be learned so that students will be able to distinguish the literal meanings from the figurative meanings, and use themcorrectly.

Acknowledgements

I would like to give my special thanks to Dr. Win Swe, the Acting Rector, Shwebo University, for his advice to do this research.In particular, I wish to express my heartfelt thanks to Dr. Khin Mg Soe, professor and Head, English Department, for his guidance, encouragement and support in doing this research.

References

ခင်မင်၊ မောင်၊ (ဓနုဖြူ)၊ (၂၀၁၄) " *ဘာသာအမြင်၊ စာပေအမြင်* " (ဘာသာစာပေသုတေသန စာတမ်းဆောင်းပါးစု)၊ ရန်ကုန်၊ စိတ်ကူးချိုချိုပုံနှိပ်တိုက်၊ ပုဂံစာအုပ်တိုက်မူ

ချိုချိုတင့်၊ပါမောက္ခဒေါက်တာ (မြန်မာ)၊ (၂၀၁၁)၊ "*မြန်မာစာသုတေသနစာတမ်းများ*" ရန်ကုန်၊ Wisdom House စာပေ

မြန်မာစာအဖွဲ့၊ (၂၀၁၃) "*ခရီးဆောင်မြန်မာအဘိဓာန်၊ နေပြည်တော်*"၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

မြန်မာစာအဖွဲ့၊ (၁၉၉၃) "*မြန်မာ့အဘိဓာန်ရုန်ကုန်*" ဖိုတိုလစ်သိုပုံနှိပ်စက်ရုံ၊ မြန်မာစာအဖွဲ့ဦးစီးဌာန။

Ei Ei Khing, (2018). *German Idioms and Idiomatic Expressions Regarding the Parts of Human Body.* Mandalay University of Foreign Languages Research Journal.Vol.9, No.1

Stern, K. (1998). *Longman Idioms Dictionary*. Longman. Retrieved from https:// http:// www.amazon.com>logman *Types of Translation Methods for English Idioms*.

Retrieved from the website (https://cultures connection.com>7-tr…) https://examples. your dictomary.com>…

https://englishclub.com>idiom...

https://idioms.the free dicitonary.com>…

https://www.easypacelearnting.com>...

https://www.strongspace.com>...PDF

https://www.merriam.webster.com>...

Geographical Assesment on the Concentration Patterns of Rural Population in Wuntho Township

Cho Mar Sein[1], Khin Mar Tin[2], Than Than Win[3], Thi Thi Khaing[4], Zaw Min Htun[5]

Abstract

Population factors are very important for the development of the region. Population has brought a tremendous change over the territory of the country. In the study of population, the level of population is essential for any given population in a unit area. Themajority of the population of Wuntho Township is rural population. The main aim of this research is to analyze the rural population concentration within Wuntho Township. Wuntho Township was selected as the study area which is located in the Northern Myanmar. It is between 200 and 1000 feet above sea level. Inorder to assess the areal difference in the population concentration, Dr.S.S Bhatia's Location Quotient Method has been used in this research. According to the analysis, it is found that the high concentration of the rural population occurs in the plain region. This medium concentrated area can be found on elevation between 200 feet and 400 feet above sea level.In contrast, the low concentration of rural population areas is found in hills and mountains region. In the study area, the areal differences in ruralpopulation concentration are related with topography, climate, soil types, accessibility like distance from other towns, sufficient opportunities for their life and migration.

Key words : Concentration, Accessibility, Opportunities, Migration

Introduction

The rural population varies from place to place. As the population distribution varies from place to place, the areas differentially progress. Distribution and concentration differ from the location and area point of view. Distribution is known as their spatial spread of population in the regionand concentration explains the actual location of the particular population in the region applying some statistical techniques (CIPS 2013)[6]. In this paper, the study intended to find out by calculating the actual concentration of population in the rural through applying location quotient method. The concentration of rural population is studied from the geographical point of view.

Study area

Rural settlements in this study area are those of villages, numbering about 177 villages, which are grouped into 38 village tracts for administrative purpose. Most of these villages are found along the Daungyu Chaung and on the plains of central low land. Wuntho Township is covered with the unevenly topography because it relates to the mountain ranges and Wuntho Massif. This physical feature influences upon the population distribution pattern. Therefore, Wuntho Township is chosen as the study area to analyze the concentration pattern of rural population.

[1] Associate Professor, Dr, Department of Geography, Shwebo University
[2] Professor, Dr, Department of Geography, Shwebo University
[3] Associate Professor, Dr, Department of Geography, Shwebo University
[4] Associate Professor, Dr, Department of Geography, Shwebo University
[5] Associate Professor, Dr, Department of Geography, Shwebo University
[6] CAMBODIA INTER-CENSAL POPULATION SURVEY 2013

Aim and Objectives

The aim of this research is to demonstrate how spatial variations of rural population arerelated to the natureof places.

The objectives of this research are:

- to study the physical factors that affecting upon the population concentration
- to identify how population has changed over the time
- to assess the concentration patterns of rural population and
- to find out the influencing factors upon the concentration patterns.

Data Collection and Methodology

In doing research, essential data have been collected from numerous sources and they include census data, map, unpublished data from official source and personal field investigation. Then the collected data were analyzed and illustrated with respective figures, maps, graphs, tables etc. The processed data were analyzed by means of graphical methods and quantitative methods. Spatial concentration pattern of rural population was calculated and illustrated by the Location Quotient method. By using this Location Quotient method population concentration index is estimated.

Findings and Discussion

The population of Wuntho Township has changed over time. In 2019, the rural population is over 72 percent of township population in study area. According to the distribution of population by township wise, the populated areas can be found in central low land plain area. The climatic condition of the study area favoursto agricultural activity and growth of the vegetation. This area has good agricultural land, fertile soil and supported stream such Daungyu Chaung and Dondok Chaung. Thus population can concentrate in this area due to sufficient opportunity for their life. In study area, population in this township sparsely distribute in mountain area. The transportation facilities are constrained by these topographic features. The highlands have rugged topography, poor soil and shortage of water for agricultural operations which give rise to overall sparse population. Therefore the concentration pattern of rural population in Wuntho Township is influenced by the topography.

According to the analysis, it is found that the high concentration of the rural population occurs in the plain region. It is located on level land where under 200 feet above sea level. This area is mainly agricultural land. The medium rank of rural population area includes the largest number of village tracts with about 20 village tracts. This medium concentrated area can be found on elevation between 200 feet and 400 feet above sea level. These areas have fairly agricultural land and usable transportation routes. In contrast, the low concentration of rural population areas is found in hills and mountain regions. The elevation of these areas is over 400 feet above sea level.

By comparing of 2004, 2014 and 2019 datamnotably that Paykone, Yaewaimyinthar, Kyeinchaung, Kyingkhwin and myauklel have maintained the high concentration level. These village tracts locate the plain area, available of agricultural land, development of communication network and favourable climate for agriculture. Moreover, these factors pull to migrate from adjacent area to these village tracts. So the internal migration affects the population concentration rank.

In analysing, there are two village tracts which have shifted rank with ascending order. Namawgyi village tracthas moved down to the low concentration rank in 2014 and 2019 from medium positions in 2004. This village tract is located on elevation over 820 feet above sea level. Thetkeikyin village tract has shifted low concentration rank in 2019 from medium rank in 2004-2014. These village tracts are located on elevation over 400 feet above

sea level. This area cover rugged terrain, poor transportation line connects to this area and it has limited the agricultural land. Some people have been pushedto migrate other area by these factors. They migrate to near villages and Wuntho town. It is assumed that the main factors determining the population concentration pattern are topography, climate, transportation network and migration.

Physical Bases Affecting the Concentration of Rural Population

Wuntho Township is located in Sagaing Region and included within Katha District.It lies between 23° 11´ N and 23 °43´ N latitude and 95º 33´ E and 98°8´E longitudes[1]. This Township is composed of a town including 4 wards and 38 village tracts[2]. It has a total area of 510.13 square miles. The shape of WunthoTownship is look like the compact shape. It is bounded in the north by Bamauk township, in the east by Indaw Township, in the south by Kawlin Township, in the southeast by Hteegyaint Township and in the west by Pinlebu Township respectively.

The topographic features of Wuntho Township are related to Wuntho Mass if in the northwest and Hmankin ranges in the eastern part. There is a wide plain between Hmankin ranges and Minwun range. Physically Wuntho Township can be divided into the Eastern Minwun Range, the Western Hmankin rangeand Central lowland plain. The central lowland is covered with the fertile alluvial soil thus most favourable for agriculture. This township has only small streams. The prominent streams in this area are Daungyuchaung, Bon chaung, Tazuchaung, Donedokchaung, Taungchaung and Nanmachaung. These streams rise from the mountain ranges in the north.

According to 1992-2017 data, the average temperature of the Township is 93 48ºF in maximum, 77.30ºF in mean and 61.19º F minimum. Thistownship receives an annual rainfall of 64.98 inches from the southwest monsoon induced from the Bay of Bengal[3]. The study area receives a Tropical Savanna Climate (Aw) according to the Koppen's Climatic classification. This climatic condition favoursto agriculture.Generally, the soil types of Wuntho Township can be found Red Brown Forest Soil, Yellow Brown Forest Soil, Meadow Soil, Alluvial Soil and Laterite Soil.

By observing the physical factor of study area, it is found that the topography composes of mountain ranges and plain area. The concentrated areas of rural population are located on plain area and it has good agricultural land and supported stream such Daungyu Chaung and Donedok Chaung. On the other hand the sparsely population areas are mountain area covered with the forest land. The transportation facilities are constrained by these topographic features. This factor can affect the concentration of population.

[1] UTM Map No.2395
[2] Township Report 2019, General Administrative Department, Wuntho
[3] Ayoade, J.O, 1983, Introduction to Climatology.

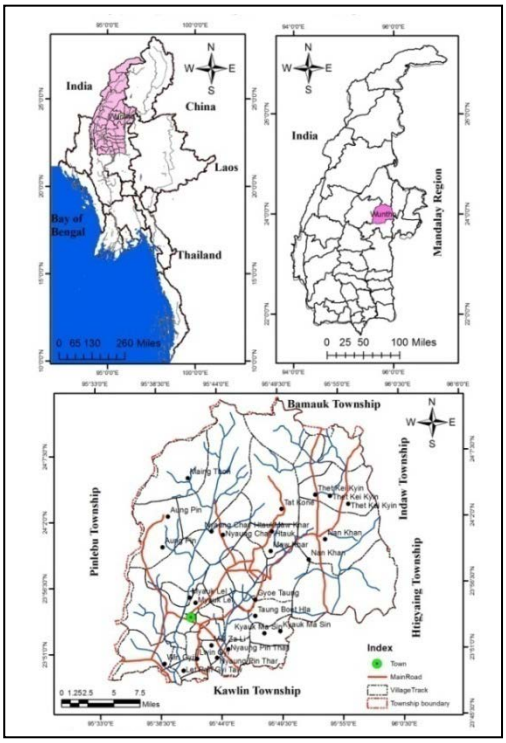


Figure (1) Location of Wuntho Township
Sourec: 2395,249 UTM Map

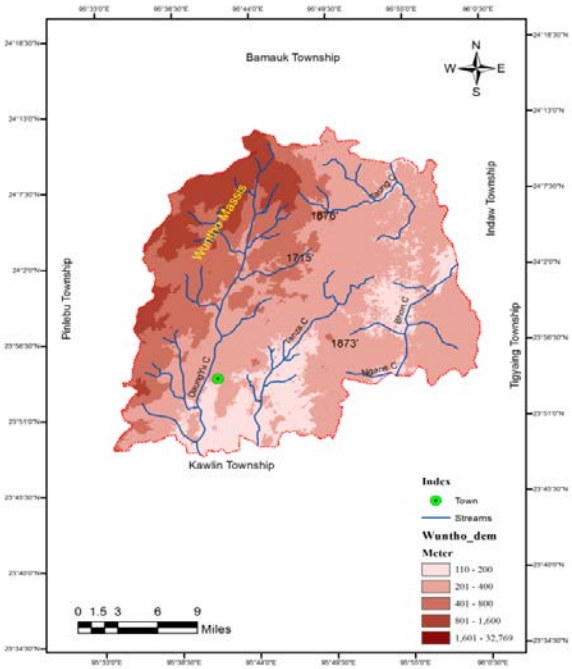


Figure (2) Topography of Wuntho Township
Sourec: UTM Map No.83-P/12,16,84-P/9,13

Trend of Rural Population

In Myanmar, the proportion of rural population is more than urban population in any township. The rural population was reported at 69.42 percent in 2018, according to World Bank collection of development indicators[1]. Majority of the population of Wuntho Township

[1] Tradingeconomic.com/n, Myanmar Rural Population, 2018.

is rural population. The rural population percentage has increased from 80.79% in 1973 to 83.69% in 2014. In 2019 the percentage of rural population reached to 71.28%. Within the 47years of 1973-2019, rural population has changed from 31,809 persons to 55,129 in Wuntho Township. Most of the people in Wuntho Township settle in rural area because of agro-based economy.

Table 1: Urban and Rural Population of Wuntho Township for 1973-2019

	Urban Population	Percent	Rural population	Percent	Total
1973	7,563	19.21	31,809	80.79	39,372
1983	8,666	18	39,779	82	48,445
1993	12,360	21	46,498	79	58,858
2003	13,272	20.3	52,240	79.7	65,512
2014	11,972	16.31	61,423	83.69	73,395
2019	22,309	28.72	57,129	71.28	79,438

Source: Township Immigration and National Registration Department, Wuntho

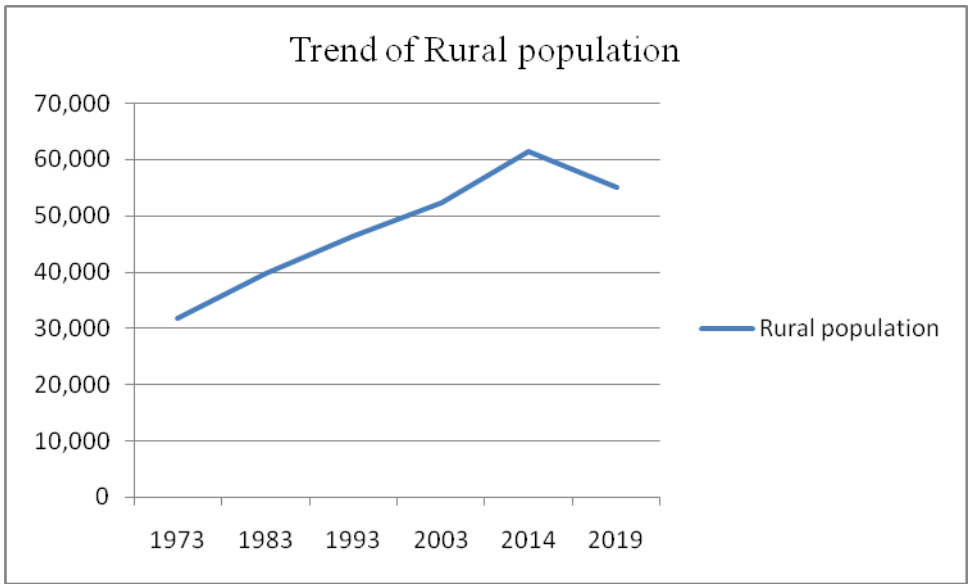


Figure (3) Trend of Rural Population in Wuntho Township (1973-2019)

Analysis onconcentration Patterns of rural Population

The spatial distribution of population is one of the most important topics of human development and geography spreading. It is significantly important, because population has brought tremendous change over the territory of the country[1]. This spatial distribution can be derived from results of administrative recorded, survey data and commonly from population census. It provides the patterns of population settlement across the country. Inorder to assess the areal difference in the ruralpopulation concentration, Dr.S.S Bhatia's Location Quotient Method has been used in this research. By using this Location Quotient Method, concentration index is estimated with high, medium and low ranks based on mean value and standard deviation.

According 2019 data, 71.28 percent of Township population resides in the rural areas mainly depending on the agriculture sector. Thus, the pattern of population distribution in the

[1] Cambodia Inter-Censal Population Survey 2013.

area mostly corresponds to the factors governing agricultural practices. The population distribution in the township has been traditionally determined by the availability of land for cultivation, quality of soil, water resources, favourable climatic condition, topography and availability of transportation facilities.

The high concentration of the population occurs in the plain region. It is located on level land where the elevation is under 200 feet above sea level. This area is mainly agricultural land. Themajority of concentrated areas arePaykone, Yaewaimyinthar, Myauklel and Ahrmakahn village tracts. The concentration becomes more conspicuous as one move from poor villages toward the plain area. According to analysis, the medium rank of rural population area includes the largest number of village tracts with about 20 village tracts. This medium concentrated area can be found on elevation between 200 feet and 400 feet above sea level. These areas have fairly agricultural land and usable transportation routes.By contrast, the low concentration of rural population areas is found in hills and mountains region. The elevation of these areas is over 400 feet above sea level. The highlands have rugged topography, poor soil and shortage of water for agricultural operations which give rise to overall sparse population. These factors push to migrate other areas associated sufficient opportunities for their life.

The general pattern of population distribution had also undergone changes during the decades from 2004 to 2014 and then 2019. Among the shift ranks of village tracts, some are shift ascending and descending order while some are not changed in rank. Notably, Kyeinchaung, Paykone, Yaewaimyinthar, Myauklel and Ahrmakahn village tracts have maintained the high concentration rank since 2004 to 2019. These village tracts have high growth rates, available of agricultural land, development of communication network and favourable climate for agriculture. Moreover these factors pull to migrate from adjacent area to high concentrated areas. So the internal migration affects the population contration. On the other hand, Magyipin, Nyaungchayhtauk, Hpilay, Maingthon, Kyingyi andTatlwinvillage tracts continue to be low concentration ranks in term of population size. This area cover rugged terrain, poor transportation line connects to this area and it has limited the agricultural land. These factors push to migrateother area. Thus the hilly area continuesto low population concentration.

In this township, there are two village tracts which have shifted rank with ascending order. Namawgyi village tracthas moved down to the low concentration rank in 2014 and 2019 from medium positions in 2004. This village tract is located on elevation over 820 feet above sea level.Thetkeikyin village tract has shifted low concentration rank in 2019 from medium rank in 2004-2014. These village tracts are located on elevation over 400 feet above sea level. It is assumed that the main factors determining population distribution are: topography, climate, soil, transportation network and migration.

Table 2: Concentration Rank of Rural Population in 2004

High concentration (more than 4.33)		**Medium Concentration (between 0.74 - 4.33)**		**Low concentration (less than 0.47)**	
Village Tracts	Index	Village Tracts	Index	Village Tracts	Index
Kyein Chaung	6.08	Mei Za Li	4.23	Chaung Hpyar	0.41
Pay Kone	6.04	Kyauk Pauk Khon	4.19	Aung Pin	0.39
Yae Wai Myin Thar	6.01	Ma Gyi Kone	3.84	Ma Gyi Pin	0.37
Kying Khwin	5.52	Lwin Gyi	3.50	Naung Chay Htauk	0.32

High concentration (more than 4.33)		Medium Concentration (between 0.74 - 4.33)		Low concentration (less than 0.47)	
Myauk Lel	5.46	Aung Kone	3.32	Hpi Lay	0.29
Ahr Ma Khan	4.98	Maw Naing	3.07	Tat Lwin	0.19
Let Pan Gyi Taw	4.69	Kin Myin Thar	2.57	Maing Thon	0.14
Pan Tein Kone	4.41	Nyaung Pin Thar	2.47	Kyin Gyi	0.04
		Kyein Bu Kone	2.27		
		Say Khin Khon	2.04		
		Maw Khar	1.98		
		Gyoe Taung	1.63		
		Met Ka Let	1.61		
		Tat Kone	1.49		
		Taung Boet Hla	1.41		
		Win Gyi	1.27		
		Kyauk Ma Sin	1.24		
		Taung Kone	1.18		
		Nan Khan	0.75		
		Tin War Chaung	0.65		
		Thet Kei Kyin	0.56		
		Na Maw Gyi	0.50		

Source: Compiled by Researcher base on data from Department of Agricultural Land Management and Statistics, Wuntho

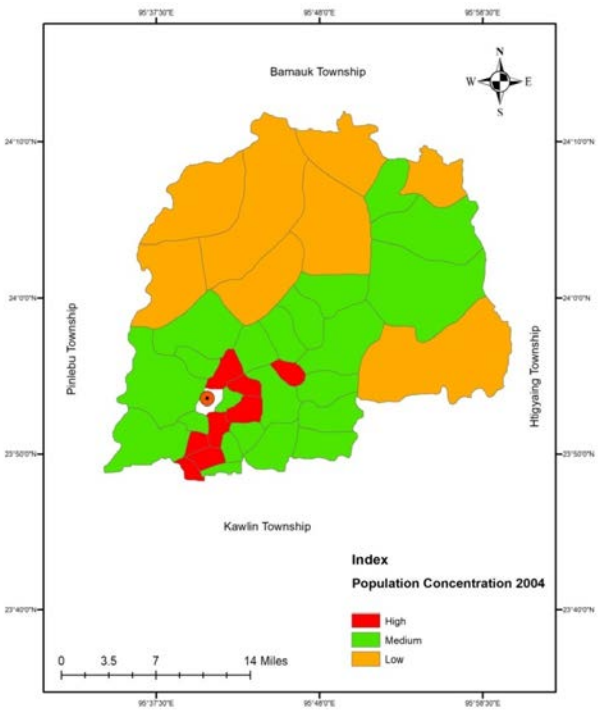


Figure (4) Concentration pattern of Rural Ppulation in Wuntho Township (2004)

Source: Based on table (2)

Table 3: Concentration Rank of Rural Population in 2014

High concentration (more than 3.78)		**Medium Concentration (between 0.54 -3.78)**		**Low concentration (less than 0.54)**	
Village Tracts	Index	Village Tracts	Index	Village Tracts	Index
Pay Kone	6.33	Let Pan Gyi Taw	3.61	Ma Gyi Pin	0.52
Yae Wai Myin Thar	5.00	Ahr Ma Khan	3.61	Na Maw Gyi	0.42
Kyein Chaung	4.96	Mei Za Li	3.46	Aung Pin	0.41
Kying Khwin	4.36	Pan Tein Kone	3.35	Chaung Hpyar	0.36
Myauk Lel	4.36	Maw Naing	3.23	Tat Lwin	0.35
Ma Gyi Kone	4.33	Kyauk Pauk Khon	3.21	Naung Chay Htauk	0.33
		Lwin Gyi	3.18	Hpi Lay	0.31
		Taung Kone	3.03	Maing Thon	0.13
		AungKone	2.69	Kyin Gyi	0.03
		Kin Myin Thar	2.05		
		Nyaung Pin Thar	2.03		
		Maw Khar	2.03		
		Say Khin Khon	1.99		
		Kyein Bu Kone	1.97		
		Met Ka Let	1.38		
		Gyoe Taung	1.38		
		Kyauk Ma Sin	1.36		
		Tat Kone	1.35		
		Win Gyi	1.21		
		Taung Boet Hla	1.20		
		Nan Khan	0.98		
		Tin War Chaung	0.83		
		Thet Kei Kyin	0.69		

Source : Compiled by Researches base on data from Department of Agricultural Land Management and Statistics, Wuntho

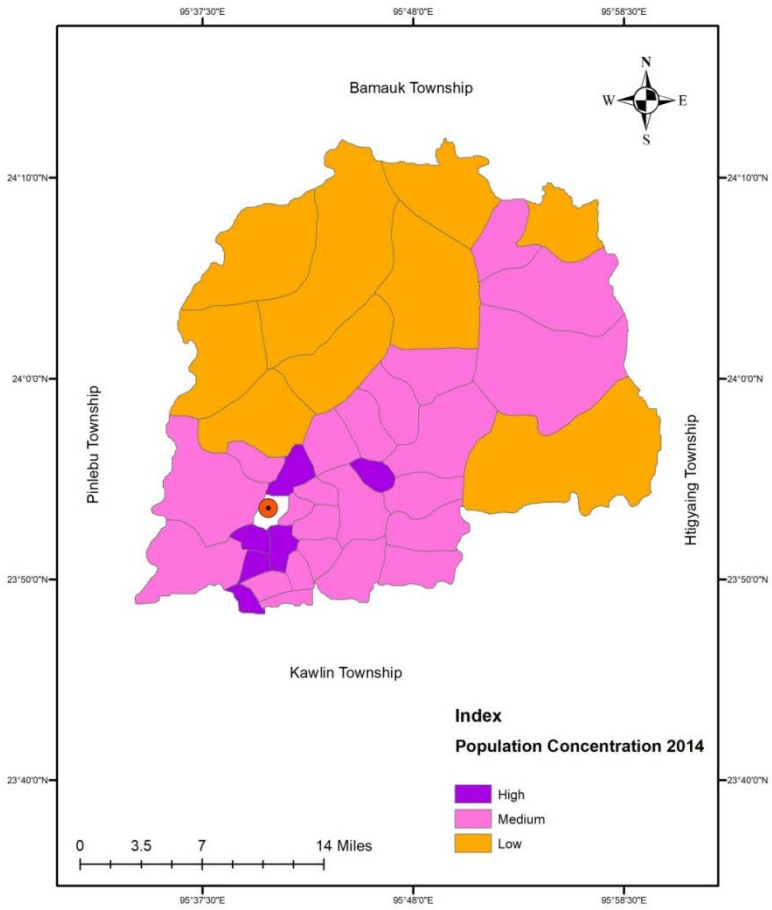


Figure (5) Concentration pattern of Rural Population in Wuntho Township (2014)

Source: Based on table (3)

Table 4: Concentration Rank of Rural Population in 2019

High concentration (more than 3.79)		**Medium Concentration (between 0.55 - 3.79)**		**Low concentration (less than 0.55)**	
Village Tracts	Index	Village Tracts	Index	Village Tracts	Index
Kyein Chaung	4.99	Kin Myin Thar	3.71	Thet Kei Kyin	0.47
Pay Kone	4.88	Mei Za Li	3.46	Na Maw Gyi	0.44
Yae Wai Myin Thar	4.81	Kyauk Pauk Khon	3.37	Aung Pin	0.37
Myauk Lel	4.63	Pan Tein Kone	3.30	Chaung Hpyar	0.35
Ma Gyi Kone	4.47	Kyein Bu Kone	3.01	Ma Gyi Pin	0.32
Maw Naing	4.32	Lwin Gyi	2.98	Hpi Lay	0.25
Let Pan Gyi Taw	4.07	Aung Kone	2.61	Naung Chay Htauk	0.24
Ahr Ma Khan	3.85	Gyoe Taung	1.97	Tat Lwin	0.23
Kying Khwin	3.82	Nyaung Pin Thar	1.96	Maing Thon	0.16
		Taung Kone	1.85	KyinGyi	0.07
		Say Khin Khon	1.78		
		Met Ka Let	1.72		
		Maw Khar	1.68		
		Win Gyi	1.23		

High concentration (more than 3.79)		Medium Concentration (between 0.55 - 3.79)		Low concentration (less than 0.55)	
		Tat Kone	1.22		
		Taung Boet Hla	1.15		
		Nan Khan	0.89		
		Kyauk Ma Sin	0.87		
		Tin War Chaung	0.84		

Source: Compiled by Researcher base on data from Department of Agricultural Land Management and Statistics, Wuntho

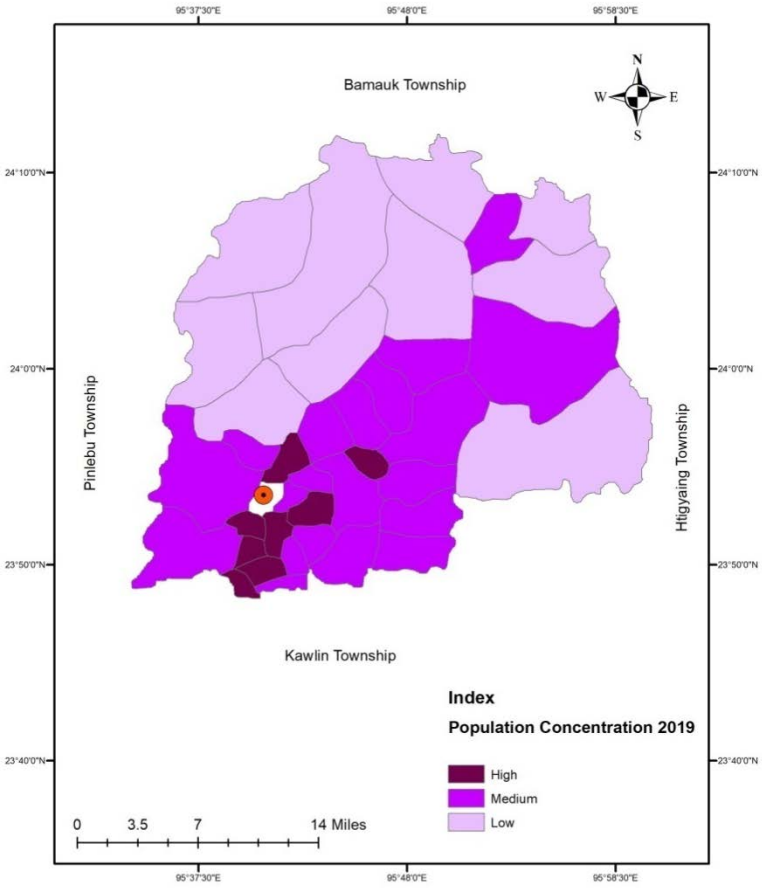


Figure (6) Concentration pattern of Rural Population in Wuntho Township (2019)

Source: Based on table (4)

Conclution

Wuntho Township is located in Sagaing Region and included within the Katha District. Rural settlements in study area are those of villages, numbering about 177 villages, which are grouped into 38 village tracts for administrative purpose. The rural population percentage has increased from 80.79% in 1973 to 83.69% in 2014. In 2019 the percentage of rural population reached to 71.28%. Inorder to assess the areal difference in the rural population concentration, Dr.S.S Bhatia's Location Quotient Method has been used in this research.In study area, population in this township sparsely distribute in mountain area. The transportation facilities are constrained by these topographic features. Therefore the concentration pattern of rural population in Wuntho Township is influenced by the topography.The high concentration of the population occurs in the plain region. It is located

on level land where the elevation is under 200 feet above sea level. This area is mainly agricultural land. According to analysis, the medium concentrated area can be found on elevation between 200 feet and 400 feet above sea level. The low concentration of rural population areas is found in hills and mountains region. The elevation of these areas is over 400 feet above sea level. This area cover rugged terrain, poor transportation line connects to this area and it has limited the agricultural land. Some people have been pushed to migrate other area bythese factors. According to observation, it is found thatthe main factors determining rural population concentrarion are: topography, climate, soil, transportation network and migration.

Acknowledgements

We are greatly indebted to Pro-Rector Dr Win Swe (Rector Duty) and Pro-rector Dr Myo Myo, Shwebo university for their permission to do this research. We wish to express our special thanks to Dr Than Than Win, Professor and Head, Geography Department, Shwebo University, for her guidance and encouragement for this research. We also thank to our teachers for their invaluable advice, kind help in carrying out this research. We wish to express our thanks to many government officials, heads of various departments for their help with data collection for our research.

Rererences

1. Ayoade, J.O,1983, Introduction to Climatology.

2. Bhatia, S.S (1965), Patterns of Crop Concentration and Diversification in India, Economic Geography, Clark University. Spatial Distribution and Growth of population,

3.Caambodia Inter Censal Population Survey (2013), National Institute of Statistics, Ministry of Planning, Phnom Penh, Cambodia

4. Clarke, I.I. (1968), Population Geography, Pergaman Press Ltd, Oxford, London.

5. General Administrative Department Township Report, 2019, Wuntho

6. HlaTunAung, U, (2002) Myanmar, The Study of Processes and Patterns, National Centre for Human Resource Development, Ministry of Education, Myanmar.

7. World Bank collection of development indicators, Myanmar Rural Population, 2018

ကျမ်းကိုးစာရင်း

၁။ မိုးလေဝသနှင့် ဇလဗေဒညွှန်ကြားမှုဦးစီးဌာန၊ လအလိုက်အပူချိန်၊ လအလိုက်ာမိုးရေချိန်စာရင်း၊ ကသာမြို့ (ပုံနှိပ်ထုတ်ဝေခြင်းမရှိပါ)။

၂။ မြို့နယ်အထွေထွေဦးစီးဌာန၊ မြို့နယ်မှတ်တမ်း (၂၀၁၉) ဝန်းသိုမြို့၊ (ပုံနှိပ်ထုတ်ဝေခြင်းမရှိပါ။)

၃။ သန်းခေါင်းစာရင်း (၂၀၁၄)၊ မြန်မာနိုင်ငံလူဦးရေနှင့်အိမ်အကြောင်းအရာ၊ ဝန်းသိုမြို့

၄။ လူဝင်မှုကြီးကြပ်ရေးနှင့်အမျိုးသားမှတ်ပုံတင်ဦးစီးဌာန၊ ရပ်ကွက်၊ ကျေးရွာအုပ်စု၊ ကျေးရွာအလိုက် အိမ်ခြေ၊ အိမ်ထောင်စုကျား/မလူဦးရေစာရင်း၊ ဝန်းသိုမြို့။

A Geographical Analysis on the Agricultural Landscape in Wetlet Township

Than Than Win[1], Khin Mar Tin[2], Cho Mar Sein[3], Thi Thi Khaing[4], Zaw Min Tun[5]

Abstract

Agriculture plays a vital role in shaping the Myanmar economy. This paper attempts to analyze the agricultural landscape concentration pattern of Wetlet Township from a geographical point of view. The main objectives of this research are to examine the general land cover of Wetlet Township, to analysis the spatial distribution pattern of agricultural landscape, to investigate the favourable condition for the development of agriculture sector and to indicate the beneficial conditions to develop the economy of study area. In the study of general land cover, it is found that cultivated land is largest. It covered about 252, 772 acres and it is 76.75 percent of the township area. The major agricultural landscape of Wetlet Township is reflection of the effects of various physical factors. The spatial variations in the degree of agricultural land concentration area are found to be the result of different interaction such as physiographic, climate, hydrological, socio-economic and technological factors of an area. The agricultural landscape is divided into four types of study area. Then, their spatial concentration pattern was analyzed by using Dr. S.S Bhatia's Location Quotient Method.

Key words: Landscape, Concentration, Spatial distribution, Physiography

Introduction

The agriculture is one of the leading occupations in Myanmar and it plays a vital role in shaping the economic condition of farmers as well as the whole country. Based on the different kinds of cultivated land, various crops have been grown in all parts of the rural areas. In the agricultural sector, the chief crops are paddy, sesamum, groundnut, gram, green gram, fodder, wheat, pulses and the other crops. Paddy and sesamum are mainly grown on *Le* land and groundnut and green gram are grown on both *Le* land and *Ya* land. Fodder and other crops are grown on *Ya* land. Groundnut and pulses are grown in *Kaing-Kyun* land. In this township, the agricultural activities are carried out intensively. The agricultural landscape varies from season to season and from place to place.

Aim and Objectives

The main aim of this research is to analyse the concentration of agricultural landscape in rural areas. To meet the major aim of this research, three major objectives are also adopted as follows:

- to understand the present situation of land cover
- to analyses the spatial distribution of agricultural landscape in study area and
- to suggest the way that can improve the agricultural sector.

Study Area

Wetlet Township is located in Shwwebo District, Sagaing Region. It lies between north latitudes 22˚ 10′ and 22˚ 32′and east longitudes 95˚ 35′ and 96˚ 5′. It has an area of 514.581 square-miles (329,332 acres). It is about 250' to 550' above sea level with 2 distinct

[1] Associate Professor, Dr., Department of Geography, Shwebo University
[2] Professor, Dr.Department of Geography, Shwebo University
[3] Associate Professor, Dr. Department of Geography, Shwebo University
[4] Associate Professor, Dr. Department of Geography, Shwebo University
[5] Associate Professor, Dr. Department of Geography, Shwebo University

physical features. The eastern portion is the continuation of Sagaing Minwun Range, so that it has rolling character. While, the Western portion is almost level a plain with natural drainage system of Mu River and man-made canal networks. Therefore, different types of agriculture can be practiced in the study area. Although, the Ayeyarwady River serves as the eastern boundary of the township, high escarpment restricts for water pumping. Hence, the eastern part of the township is occupied by *Ya* land and rain-fed areas. *Le* land is mainly dominant in western part. Moreover, the existing of soil types also leads to differentiate the various types of crop cultivation.

Materials and Method

Primary and secondary data are used to present the agricultural landscape. Primary data includes field observations, interviews and informal talks. Then collected data were recorded in a database and divided the range of data. Moreover, secondary data derived from departmental offices, reports, research paper and reference books were also used in the analysis. In order to assess the regional differences of agricultural landscape concentration indices have been calculated in all rural areas the help of Dr.S.S Bhatia's Location Quotient Method.

Findings and Discussion

This research paper highlights the concentration of agricultural land in Wetlet Township. The agricultural landscape is emphasized with the dominant crops for the respective village tracts. This research finds that agricultural land is more than other kinds of land and it is about 76.75 percent of land cover. Wetlet Township has flat plains where agriculture is the main economic activity. The major agricultural land of Wetlet Township is reflection of the effects of varied physical factors. The erratic rainfall as a climatic factor is the most important determinant for major crop cultivation on agricultural land in the study area. As the soil is natural phenomena for the agriculture, the infertile soil is improved by applying the various chemical fertilizers to get high yield per acre. On the other hand, the island area like "*Kaing-Kyun*" land is still mode fertile again by the deposition of silt and sand after the receding of annual flood. Therefore, it is find that to get high yield of the specific crop The garden land cover is small amount of the agricultural land in Wetlet Township. In analyzing the agricultural land, this research finds that the "*Le*" land more than half of agricultural land and it is about 58.51 percent of agricultural land. The "*Ya*" land is the second largest area of agricultural land in Wetlet Township and it is about 40.40 percent. So, the spatial variation of agricultural land concentration area is found to be the result of different interaction such as relief, soil type and rainfall conditions in study area.

According to this research, the most important need for agricultural development is to extend the "*Le*" land and garden land. The irrigation water should be sufficiently supplied in the study area. Because paddy was the only crop which was selected by most farmers. It is suggested that the "*Le*" land should be extended to develop the economy of Wetlet Township. The garden land should be replaced in "*Ya*" land for cultivation of mango tree and other long-term trees. The more the agricultural landscape is changed, the more the agricultural sector improves. Therefore, it can be accepted that the long-term plantation will be developed if the garden land is extended in the study area.

Geographical Basis

Wetlet Township lies in the Dry Zone of Central Myanmar and it is one of eight townships in Shwebo District, Sagaing Region. According to the astronomical coordinate system, this township situated between north latitudes 22˚ 10′ and 22˚ 32′ and east longitudes

95˚ 35′[1] and 96˚ 5′. It has an area of 514.581square-miles (329,332 acres). It is about 1.41% of the total area of Sagaing Region.Wetlet Township is composed of three wards, 69 village tracts and 228 villages[2]. The length of the township from north to south is 19 miles. The breadth of the township from east to west is about 27 miles. Therefore, it is nearly rectangular in shape.

It is bounded on the east by Ayeyarwady River, on the south by Sagaing Township, on the west by Mu River and on the north by Shwebo township. Topography of Wetlet Township mainly influences on the agricultural land and crops cultivation. For the development of the agricultural activity, topography and drainage conditions affect and influence the agricultural land use and crops cultivation. In observing the topography of Wetlet Township, in the western part of the township the land gradually slopes towards the Mu River. This area is mostly flat land. The eastern part of the area lies on the west bank of the Ayeyarwady River. This area is mostly flat land but it has a few rolling land areas along the Minwun Range. The main rivers of Wetlet Township are the Ayeyarwady River and the Mu River which serve as the eastern and western boundaries of township. Moreover, important canals and *in* (lakes) are also found. During the flood season, the low-lying plain of Ayeyarwady river banks are flooded. Along the Ayeyarwady and Mu Rivers bank, these area are made up of sandy silt soils. This region is suitable for "Kaing-Kyun" crops cultivation. The alluvial islands always change in size and shape due to erosion and deposition. The most importance of agricultural lands are as the source of irrigation water supply for the Hladaw Branch canal and Moksogyon Branch canal.

Climate is important to develop the agricultural sector. Climatic conditions of Wetlet Township is directly related to the agricultural landscape. During the 30–year period (from 1989 to 2019) with the average maximum, mean and minimum temperature were 88.9°F, 81.0°F and 73.2°F respectively. April was the hottest month with the average mean temperature of 86.1°F. January was the coldest month with the average mean temperature of 68.8°F. That is why the range of temperature is 17.3°F. During the 30–year period (from 1989 to 2019) of rainfall of Wetlet Township, the average annual rainfall is 45.7 inches. September is the month which receives the highest rainfall with average annual rainfall of 9.9 inches. These periods are suitable for groundnut cultivation in this township. December and January are the month with the least average rainfall of 0.1 inches. Small amount and unreliability of rainfall of Wetlet Township naturally determine the dry farming "Ya" cultivation associated with multi-crop cultivation. During the 30–year period from 1989 to 2019 in studying the annual mean temperature and rainfall of Wetlet Township, and by determining the classification of climates according to Koppen's Formula, it was found that type of climate is Aw (Tropical Savanna Type of Climate).

Social Aspects

According to 1973 census, the total population of Wetlet Township was 168,452 persons. In 1983, the total population of this township became 170,429 persons. During the ten years period, (1,977) persons had increased. Its annual growth rate is about 0.12% and in 1993 the total population reached 179,429persons. During the period from 1983 to 1993, and the percentage of annual growth rate is 0.52%[3]. In 2003, the total population increased to 182,905 persons. Thus, during a decade from 1993 to 2003 the annual growth rate is about 0.17%.According to 2014 Myanmar population and housing census data, the population of Wetlet township was 196,216 persons which includes the urban population was 10,814

[1] UTM Map No. 2295, 2395
[2] Report, General Administrative Department, Wetlet
[3] Clarke, I. J (1968)

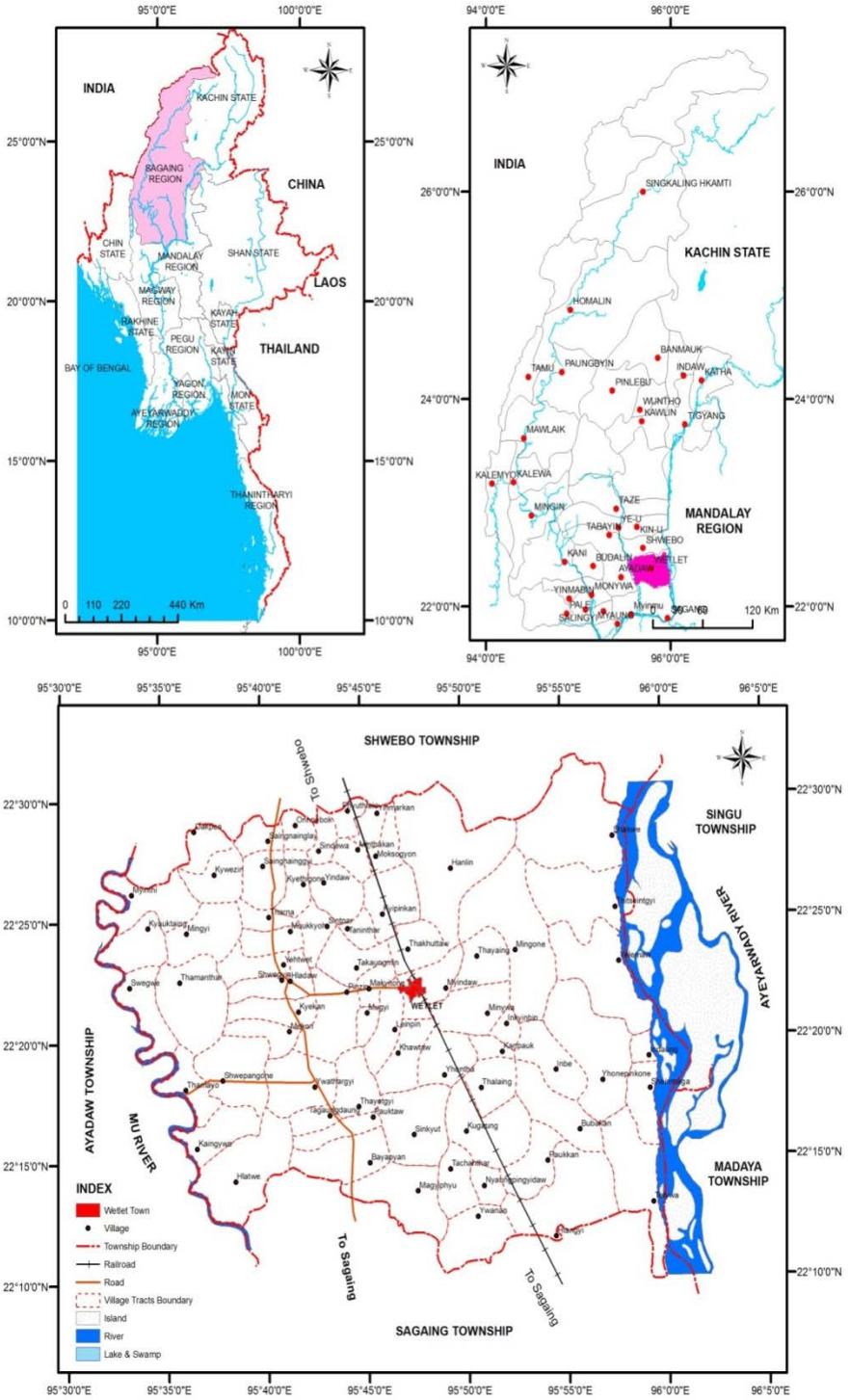


Figure (1): Location of Wetlet Township (2019)
Source: UTM Map No. 2295, UTM Zone 46, WGS_84

persons and rural population was185,402 persons. In 2019 data, the total population was 259,551 persons. The official data mentioned above reveal that rural population is higher than urban population. This indicates that most of people in Wetlet Township mainly depend on agricultural activities.

In 2019, the area of Wetlet Township is 514.581 square miles and residing 259,551 persons. Thus, population density of this township was about 504 persons per square mile. The highest population area can be found western part of study area. The low population density area can be found in the eastern part of study area.

Types of Land Cover

The land cover of Wetlet Township varies from place to place, based on the topography, climate, soils and drainage. General land use in the study area was mainly influenced by the land configuration. The general land cover of Wetlet Township can be classified into four types. They are cultivable land, cultivable waste land, uncultivable land and forest land. In the study of general land cover, the largest land area is cultivable land. Cultivable land includes the net sown land and fallow land. It covered about 252,772 acres in 2019 and it is 76.75% of total township area. The second largest land cover area is uncultivable land. It occupies about 38,352 acres and it has 11.64% of township area. The forest lands compose of reserved forest and unclassified forest. They cover on Minwun mountain ranges along eastern part of the study area. It is composed of 23,878 acres and it is 7.24% of township area. The cultivable waste land which covered the township was about 14,330 acres or 4.35% of the township area.

Table (1): Types of Land Cover in Wetlet Township (2019)

No.	Types of land	Acres
1	Cultivable land	252,772
2	Uncultivable land	38,352
3	Forest land	23,878
4	Cultivable waste land	14,330

Source: Department of Land Management and Statistic in Wetlet

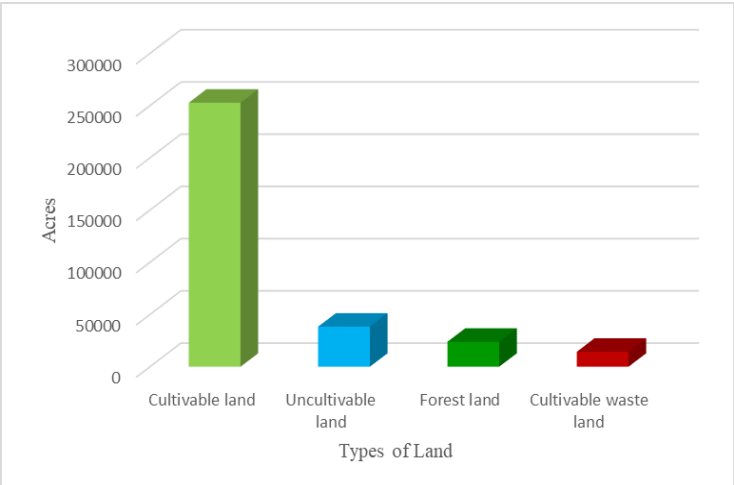


Figure (2): Types of Land Cover in Wetlet Township (2019)
Source: Based on Table (1)

The Cultivated Land

Depending upon the condition of physical feature, the agricultural land can be found in various kinds. These kind of land are *Le, Ya, Kaing-Kyun* and Gardern land. Majority of lands are located on the hill slopes and could cultivated as *Ya* (dry cultivation). Some agricultural lands located in the flat plain area are generally called as *Le* (wet cultivation). However, the land plot would be cultivated with rain-fed paddy or *Ya* crops such as gram, sesamum or groundnut depending on the condition of rainfall. It rains enough to grow paddy they grow paddy. If rainfall is not sufficient, *Ya* crops are substituted. Most of the western portion of the township is generally leveled, so that irrigated agriculture are mainly observed. So these area can be found *Le* land. The eastern hilly portion cannot be supplied water by gravitational method, so that "*Ya*" land and rain-fed agricultural lands are mostly occupied. Along the Ayeyarwady and Mu rives, there are found of "*Kaing-Kyun*" land on the islands because of the retreat of water after flood. The chief agricultural lands are "*Le*" land and "*Ya*" land which are distributed throughout the township. On those agricultural lands, the cultivated crops differ from place to place due to relief, climate and soil conditions. According to 2019 data, the current cultivated lands of Wetlet Township are (252,772 acres). The agricultural land use is divided into four types in this township. They are "*Le*" land (147,885 acres), "*Ya*" land (102,077 acres), "*Kaing-Kyun*" land (2,799 acres) and "Garden" land (11 acres). The major agricultural land is "*Le*" land. Only a small area of garden land is found in the township.

Table (2): Agricultural Landscape in Wetlet Township (2019)

No.	Types of Agricultural Land	Sown Area (Acres)	Sown Area (%)
1.	*Le*	147,885	58.51
2.	*Ya*	102,077	40.40
3.	*Kaing-Kyun*	2,799	1.11
4.	Garden	11	0.004
	Total	252,772	100

Source: Department of Agricultural Land Management and Statistics in Wetlet

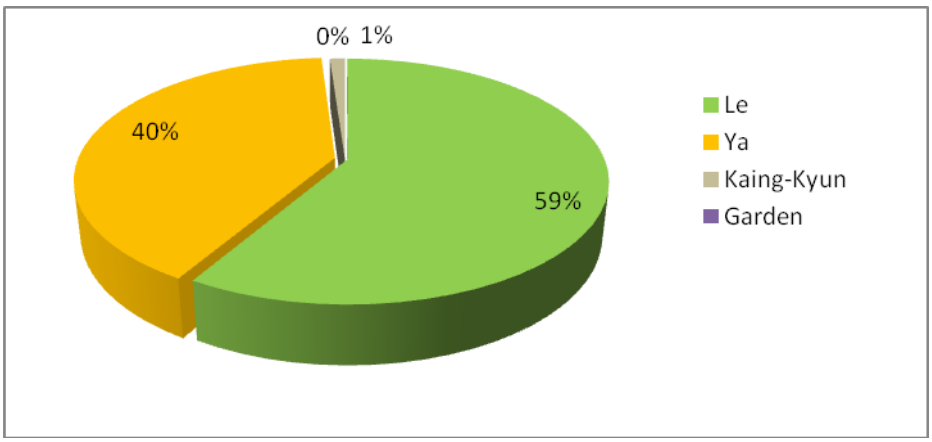


Figure (3): Agricultural Landscape in Wetlet Township (2019)
Source: Based on Table (2)

Landscape of Le Land

"*Le*" land is the chief type of agricultural land in Wetlet Township. "*Le*" land can be divided into irrigated "*Le*" land and rain-fed "*Le*" land. Irrigated "*Le*" land is found western part of the township. Among 69 village tracts, 47 had plots with irrigation system by canals

or lateral canals or sub-lateral canals. These area are most of the flat plain area in Wetlet Township. The main source of irrigated water is Thaphanseik Dam. The distribution of water from Kabo Dam are available by Moksogyon and Hladaw branch canals. Rain-fed "*Le*" land is found eastern part of the township. These "*Le*" lands rely on rainfall. In Wetlet Township, "*Le*" land 147,885 acres and it accounted to 58.51% of current cultivated land. In calculating the location quotient of the concentration of "*Le*" land in Wetlet Township could be divided into three concentration group. They were

1. High concentration areas greater than 1.5
2. Medium concentration area between 0.5 and 1.5and
3. Low concentration area less than 0.5.

There were 29 village tracts within Wetlet Township with high concentration of "*Le*" land. They are Moksogyon, Mintharkan, Oakpon, Phyutlie, Yinmarkan, Thakhwattaw, Kyipinkan, Makyitone, Leinpin, Mugyi, Thayetgyi, Pauktaw, Saingnainggyi, Tharnar, Kywezin, Saingnainglay, Oakhnaibok, Kyethikone, Yintaw, Minkyi, Sindewet, Pinzin, Sintpar, Thaninthar, Hladaw, Kyekan, Megon, Ywathargyi and Takaungdaung village tracts. These village tracts are irrigable village tracts in Wetlet Township by Hladaw and Moksogyon branch canals. Moreover, they are situated in the flat plain on dark compact savanna soil and irrigated savanna soil and meadow alluvium soil. Most of the cultivators are instructing in the cultivation of paddy because these crop is mainly the marked oriented crops. Where there are fertile soils for the cultivation of paddy and where also adequate water for cultivation of paddy. In 2019 data, the paddy cultivated area on "*Le*" land was over 170,000 acres. Areas with medium concentration of "*Le*" land were found in19 village tracts. They were Myinthe, Hanlin, Myindaw, Khawtaw, Yhonethar, Thakaungmin, Mukkyoh, Yehtwet, Thamanthar, Shwepankone, Kaingywa, Buyapyan, Hlatwe, Makyiphyu, Thayaing, Minywa, Bubukan, Tachanthar, and Singyut, village tracts. These village tracts are mostly rain–fed croplands and irrigated cropland. Areas with low concentration of "*Le*" land were found in 20 village tracts. They are Kyauktaing, Swegwe, Thamayoh,Shwekyin,Minkone, Inkyinpin, Shakwe, Thitseintgyi, Kanphyu, Paukkan, Kanpauk, Nyaungpingyitaw, Inbe, Yhonepinkone, Thalaing, Ywanan, Htangyi, Tetywa and Kugaung village tracts. Most of these village tracts are found in the eastern part of Wetlet Township. Apart from the village tracts of Swegwe, Kyauktaing and Thamayoh village tract are not irrigable by canals. These village tracts which lie on the western part of the study area but these village tracts depend on rain water for the cultivation of crops. In Sheinmaga and Indaung village tracts, there are no "*Le*" lands. These area is mainly due to the high topography and unavailability of water supply.

Table (3): Spatial Pattern of *Le* Land Concentration in Wetlet Township (2019)

No	Concentration level	Name of Village Tracts	Number of Village Tracts
1	High level over1.5	Moksogyon, Mintharkan, Oakpon, Phyutlie, Yinmarkan, Thakhwattaw, Kyipinkan, Makyitone, Leinpin, Mugyi, Thayetgyi, Pauktaw, Saingnainggyi, Tharnar, Kywezin, Saingnainglay, Oakhnaibok, Kyethikone, Yintaw, Minkyi, Sindewet, Pinzin, Sintpar, Thaninthar, Hladaw, Kyekan, Megon, Ywathargyi and Takaungdaung	29
2	Medium Level (0.5-1.5)	Myinthe, Hanlin, Myindaw, Khawtaw, Yhonethar, Thakaungmin, Mukkyoh, Yehtwet, Thamanthar, Shwepankone, Kaingywa, Buyapyan, Hlatwe, Makyiphyu, Thayaing, Minywa, Bubukan, Tachanthar, and Singyut	19
3	Low Level under 0.5	Kyauktaing,Swegwe, Thamayoh, Shwekyin, Minkone, Inkyinpin, Shakwe, Thitseintgyi, Kanphyu, Paukkan, Kanpauk, Nyaungpingyitaw, Inbe, Yhonepinkone, Thalaing,Ywanan, Htangyi, Tetywa and Kugaung	19
4	Nil	Sheinmaga and Indaung	2

Source: Compiled by Researcher

Landscape of "*Ya*" Land

The "*Ya*" land is the second most important type of agricultural land in Wetlet Township. The eastern part is made up of undulating relief features so that the irrigation by gravitational method cannot be applied. Consequently, "*Ya*" crops dominate in that portion and are mostly cultivated. "*Ya*" crops are sesamum, gram, pigeon pea, maize, groundnut, other pulses and fodder. While paddy is also grown especially for their daily food but not for commercial purpose. In 2019, total area of "*Ya*" land 102,077 acres accounting for 40.40% cultivated land in Wetlet Township. The area of concentration of "*Ya*" land were divided into 3 categories. They were

(1) High concentration greater than 1.0
(2) Medium concentration between 0.5 and 1.0 and
(3) Low concentration less than 0.5

In Wetlet Township, there were 24 village tracts within the area of high concentration of "*Ya*" land. These village tracts are Swegwe, Minkone, Kanphyu, Paukkan, Thalaing, Ywanan, Kugaung, Myinthe, Kyauktaing, Hanlin, Thamayoh, Kaingywa, Makyiphyu, Inkyinpin, Shakwe, Thitseintgyi, Bubukan, Kanpauk, Nyaungpingyitaw, Htangyi, Inbe, Yhonepinkone, Tetywa and Sheinmaga village tracts. The high concentration of these area where the soil is favorable for "*Ya*" crops cultivation such as groundnut, pigeon pea, sesamum and maize. The highest concentration rate of "*Ya*" land was observed in Shakwe village tracts with index 2.38. It is located in the eastern part of study area. It is located on the hill slopes of Minwun range. Areas with medium concentration of "*Ya*" land were found in 9 village tracts. They were Myindaw, Leinpin, Thamanthar, Hlatwe, Buyapyan,Thayaing, Minywa, Tachanthar and Singyut village tracts. Most of these area are widely spread in "*Le*" land. There were 34 village tracts within the area of low concentration of "*Ya*" land. These village tracts are Moksogyon, Oakpon, Phyutlie, Yinmarkan, Thakhwattaw, Kyipinkan,

Makyitone, Khawtaw, Yhonethar, Tagaundmin, Shwekyin, Mokkyoh, Yehtwet, Shwepankone, Mugyi, Thayetgyi, Pauktaw, Saingnainggyi, Tharnar, Kywezin, Saingnainglay, Oakhnaibok, Kyethikone, Yintaw, Minkyi, Sindewet, Pinzin, Sintpar, Thaninthar, Hladaw, Kyekan, Megon, Ywathargyi and Takaungdaung village tracts. These village tracts are located in western part of township. In Indaung and Mintharkan village tracts, there are no "*Ya*" land. Figure (5)

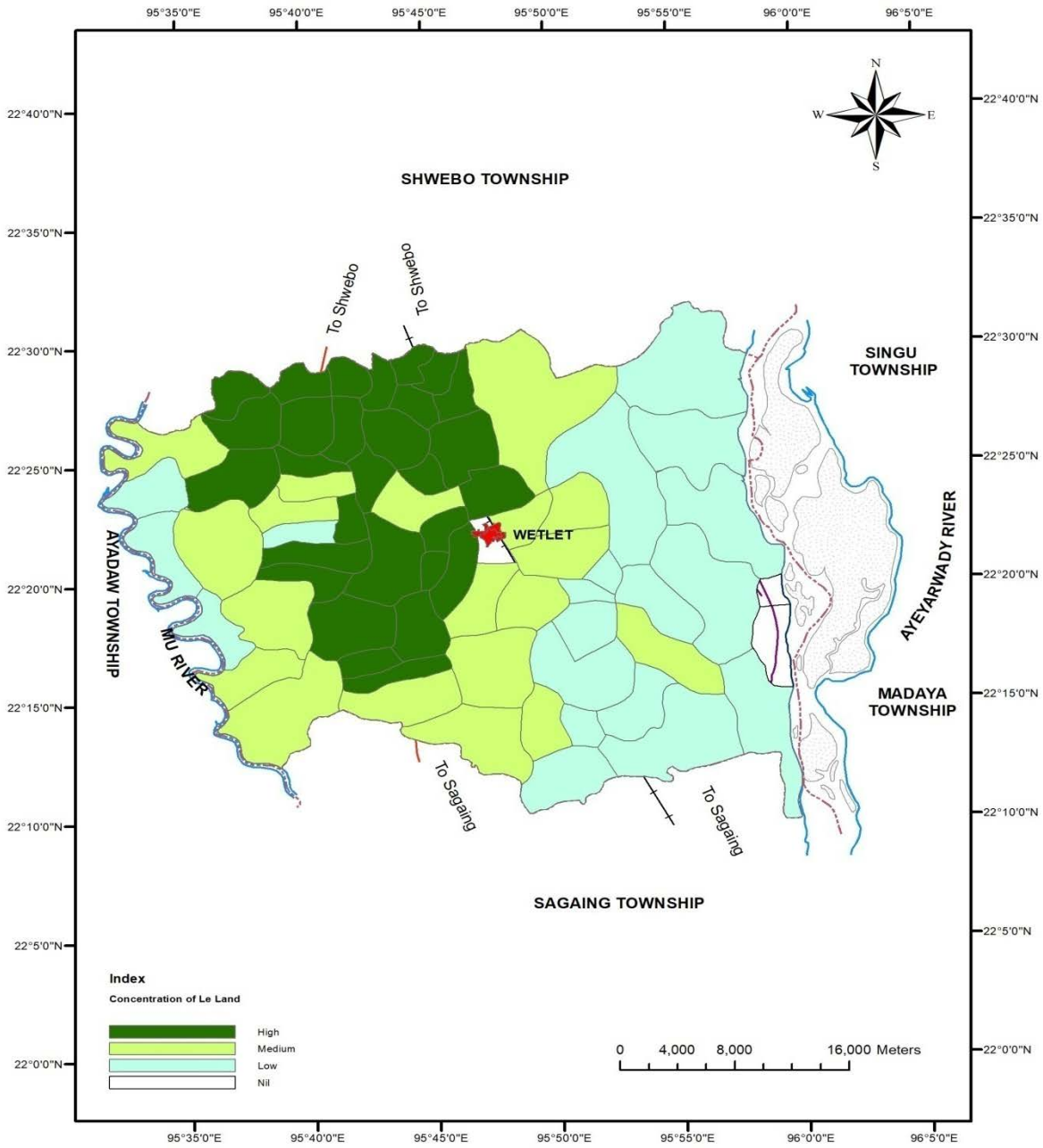


Figure (4): Concentration pattern of Le Land in Wetlet Township (2019)

Source: Department of Landmanagement and Statistics, Wetlet.

Table (4): Spatial Pattern of *Ya* Land Concentration in Wetlet Township (2019)

No	Concentration level	Name of Village Tracts	Number of Village Tracts
1	High level over 1.0	Swegwe, Minkone, Kanphyu, Paukkan, Thalaing, Ywanan, Kugaung, Myinthe, Kyauktaing, Hanlin, Thamayoh, Kaingywa, Makyiphyu, Inkyinpin, Shakwe, Thitseintgyi, Bubukan, Kanpauk, Nyaungpingyitaw, Htangyi, Inbe, Yhonepinkone, Tetywa and Sheinmaga	24
2	Medium Level (0.5-1.0)	Myindaw, Leinpin, Thamanthar, Hlatwe, Buyapyan, Thayaing, Minywa, Tachanthar and Singyut	9
3	Low Level under 0.5	Moksogyon, Oakpon, Phyutlie, Yinmarkan, Thakhwattaw, Kyipinkan, Makyitone, Khawtaw, Yhonethar, Tagaundmin, Shwekyin, Mokkyoh, Yehtwet, Shwepankone, Mugyi, Thayetgyi, Pauktaw, Saingnainggyi, Tharnar, Kywezin, Saingnainglay, Oakhnaibok, Kyethikone, Yintaw, Minkyi, Sindewet, Pinzin, Sintpar, Thaninthar, Hladaw, Kyekan, Megon, Ywathargyi and Takaungdaung	34
4	Nil	Indaung and Mintharkan	2

Source: Compiled by Researcher

Landscape of Kaing- Kyun Land

"*Kaing-Kyun*" land is the third important agricultural land in Wetlet Township. There are 12 village tracts which practice "*Kaing-Kyun*" land cultivation in study area. They are namely Myinthe, Kyaukting, Swegwe, Thamayoh, Kaingywa, Hlatwe, Shakwe, Thitseintgyi, Kanphyu, Indaung, Tetywa and Sheinmaga village tracts. According to study of agricultural land, Indaung and Swegwe village tracts have hight concentration area of "*Kaing-Kyun*" land because Swegwe village tract lies east bank of Mu river and Indaung village tract is located west bank of Ayeyarwady River. In 2019 the "*Kaing-Kyun*" land area of this township amount of 2,799 acres that make up of 1.11% of township current cultivated land. These land are suitable for cultivation of groundnut and pulses and vegetable.

Landscape of Garden Land

This type of agricultural land is the less importance in this township. The "Garden" land is very small in comparing to the current cultivated area were found in very limited number of village tracts such as Moksogyon, Thamayoh, Swegwe and Kaingywa.

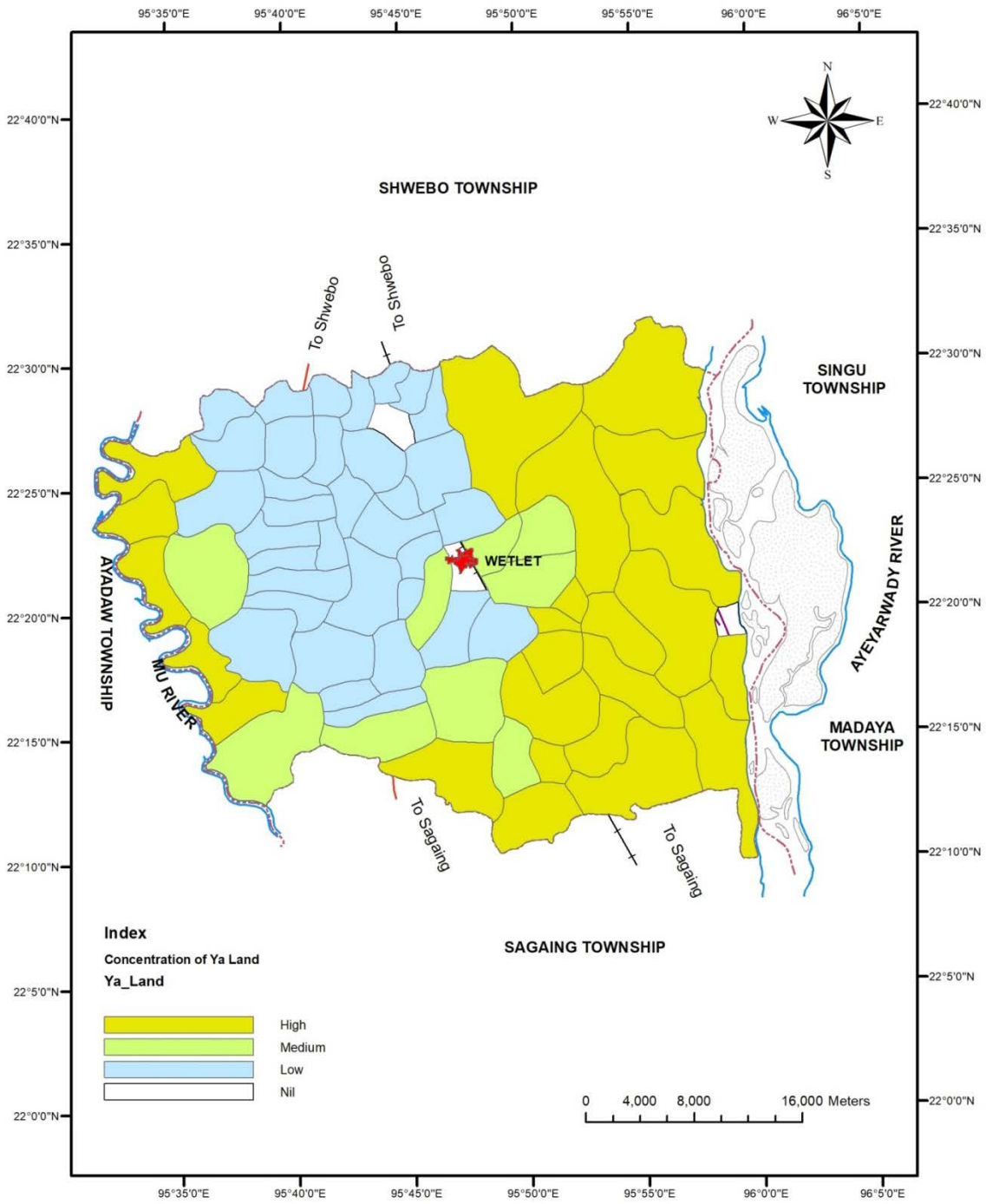


Figure (5): Concentration Pattern of Ya Land in Wetlet Township (2019)
Source : Department of Landmangement and Statistics, Wetlet.

Conclusion

Wetlet Township lies in the Dry Zone of Central Myanmar and it is one of eight townships in Shwebo District, Sagaing Region.Agricultural landscape is one of main types of land cover in Wetlet Township.Of all of the physical factor, climate is quite significant that determines the agricultural land use and agricultural patterns of a region. As the economy of Wetlet Township depends mainly on agriculture, the majority of people live in rural areas. The economic activity of Wetlet Township is agriculture. When the study is made the net sown area for year of 2019, the total net sown areas was 557,689 acres. Among the total cultivated acres in the year of 2019, 252,772 acres among them "Le" land, 147,885 acres (58.51%) "Ya" land, 102,077 acres (40.40%) of "Kaing- Kyun" land and 2,799 acres (1.11%) of "Garden" land are included. So it can be observed that "Le" land largest area, "Ya" land are the second largest, "Kaing- Kyun" land and "Garden" land was the least portion of the cultivated area. There were 29 village tracts within Wetlet Township with high concentration of "*Le*" land. In Wetlet Township, there were 24 village tracts within the area of high concentration of "*Ya*" land. There ar e 12 village tracts which practice "*Kaing-Kyun*" land cultivation in study area.The concentration of agricultural land largely depends on its terrain, temperature, moisture and pathological conditions.

Acknowledgements

I would like to thank to Pro-rector Dr. Win Swe (Rector Duty) and Pro-rector Dr. Myo Myo for their permission to do this research. I would deeply thank to Dr. Than Than Win, Professor and Head, Geography Department, Shwebo University, for her permission and encouragement. I also thank to Professor Dr. Khin Mar Tin, Geography Department, Shwebo University for editing the manuscript of the present paper. Special thanks are due to several departments of certain Ministries operation and help in data collecting work. It is recorded that I thank to cultivators for their kindly help in our field works. Finally I also thank every person who directly and indirectly this paper presentation.

References

1. Cho, U, (1995), **Practical Geography**, University of Distance Education, Department of Higher Education.
2. Cho Mr Sein, Dr. (2013) **Geogaphial Analysis on the Agricultural Landscape of Mohnyin Township**, Department of Gegraphy, University of Mohnyin.
3. Clarke, I. J (1968) **Population Geography**, Pergaman Press Ltd, Oxford London.
4. H,Nagarraj, Dr. (2016) **Changing Pattern of Land Use and its Impact on Agriculture: A Case Study of Mysore District,** Scholarly Research Journal Interdisciplinary Studies.
5. Hla Tun Aung, U, (2003) **Myanmar, The Study of Process and Pattern** Ministry of Education, National Center for Hunman Resource Development Publishing Committee, Yangon. Research, India.
6. Joginder Ahlawat, (2017) **A Geographical Review of the Land Use Patterns of Kanpur City,** Journal of Humanities and Social Science, India.
7. Singh, J and Dhillon, S.S. **Agricultural Geography**. Third Edition, (2004) Tata Mc Graw Hill Co.Hd, New Delhi, India.

A Spatial Analysis of Paddy Production and Consumption in Ye-U Township

Zaw Min Tun[1], Khin Mar Tin[2], Cho Mar Sein[3], Than Than Win[4], Thi Thi Khaing[5]

Abstract

Paddy is one of the important agricultural productions in Ye-U Township. Ye-U Township is situated inthe Dry Zone of Central Myanmar. A large number of multiple crops are practiced in this region to reduce the risk factor of crop failures due to drought. The main aim of this research is to examine the spatial pattern of paddy production and consumption, to find out the significance of agricultural sector for regional development and to know the spatial distribution and temporal variation pattern of paddy production. To measure the extent of paddy cultivation and production, Dr.S.S. Bhatia's Location Quotient Method (1905) was used. Based on the analysis of Location Quotient Index of paddy cultivation, it was found that there are spatial variations as well as temporal changes in the degree of paddy cultivation and production of Ye-U Township. And then, Spearman's Rank Correlation Coefficient Method is used to find the correlation between paddy cultivation and production. Therefore, the study of paddy production could be a benefit for future agricultural planning in Ye-U Township.

Key words: Location Quotient Index, Spearman's Rank Correlation Coefficient Method.

Introduction

Agriculture is the major economic activity in Ye-U Township. Ye-U Township is located in Shwebo District, Sagaing Region of Central Myanmar. Shwebo District is composed of six townships. Among them, Ye-U Township is the second largest township whose economy is based on agriculture.

Aim and Objectives

The main aim is to analyze the spatial distribution of paddy cultivation and production in Ye-U Township. Supported elements for the above aim, the following objectives are also adopted. They are

- to study the significance of agriculture sector for regional development
- to observe the spatial distribution pattern of paddy cultivation and production of study area
- to understand the correlation of paddy cultivation and production in Ye-U Township

Materials and Methods

All of the data related of this research are collected from both primary and secondary sources. The primary data and secondary data are analyzed by using statistical techniques such as correlation and location quotient method. Moreover, the paddy cultivation and production are calculated by Sperman's Rank Correlation method.

[1] Associate Professor, Dr, Department of Geography, Shwebo University
[2] Professor, Dr, Department of Geography, Shwebo University
[3] Associate Professor, Dr, Department of Geography, Shwebo University
[4] Associate Professor, Dr, Department of Geography, Shwebo University
[5] Associate Professor, Dr, Department of Geography, Shwebo University

The Study Area

Ye-U Township is located in Sagaing Region of Central Myanmar. It is located between North Latitude 22° 42' and 23° 2' and East Longitude 94° 56' and 95° 28'. It has an area of 559.14 sq-mile or 357,549 acres. It is composed of Ye-U Town and 62 village tracts.

It is bounded on the north by Taze Township, on the east by Khin U Township, on the south by Depeyin Township and on the west by Kani Township and Minkin Township. These boundaries are administrative boundary. The average annual rainfall of Ye-U Township was 36.30 inches. This area receives the annual average maximum temperature of 93.54°F and annual average minimum temperature of 65.65° F. According to Koppen's classification, the township belongs to the Tropical Savanna Climate (Aw).

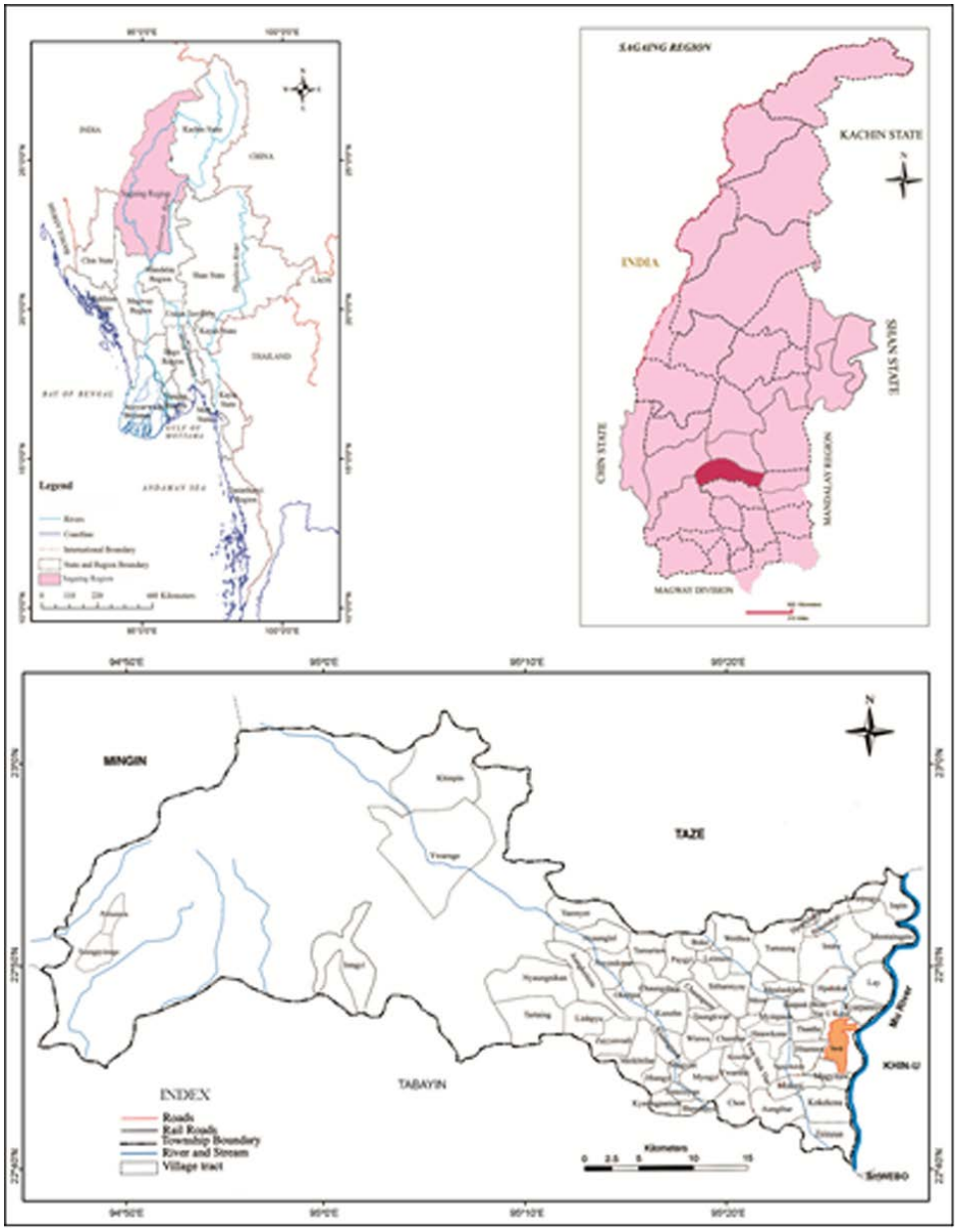


Figure (1) Location of Ye-U Township
Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Finding and Result

Ye-U Township is one of the six township in Shwebo District. Themain economic activity of Ye-U Township is agriculture. Paddy is the main staple food of the people living in Ye-U Township. Therefore, the study area has good fertile soils and adequate irrigated water for the cultivation of paddy. Ye-U Township is the largest percentage of “Le” land amounting to 73.84 percent of the total agricultural land.
Spatial pattern of Paddy Cultivation

Spatial pattern of Paddy Cultivation and Production

The paddy cultivation of Ye-U Township (2018-2019) is presented by using the pattern analysis (Location Quotient). Paddy cultivation is divided into two types. They are monsoon paddy and summer paddy. Monsoon paddy is divided into three groups. The largest monsoon paddy cultivation (above 1) is found in 45 village tracts, These village tracts are located in eastern part of the study area and are formed of fertile Mu River alluvial plain. The medium monsoon paddy cultivation (0.5-1) is found in 13 village tracts. They are found in eastern and middle part of the study area. The lowest monsoon paddy cultivation (below 0.5) is found in four village tracts. This village tract is located in western and southern part of the study area. The decrease was due to insufficient rainfall during the paddy sown period in July and in August. Spatial pattern of monsoon paddy cultivation (2018-2019) is shown in Figure (2) and Table (1). In old days, traditional cultivation methods such as using farm cattle were used in agriculture. But now agricultural machinery is being used. There is paddy crop grown in this area and their net sown acreage, matured acreage, yield per acre and total outputs are increased.

Summer paddy cultivation is irrigated by the Ye-U canal and Mayagan canal. These canals are connected with the Kindat and Kabo Dams. Summer paddy cultivation is classified into three grades as high, medium and low. The high summer paddy cultivation (above 1) is found in 31 village tracts. Most of the irrigated works are located in the eastern part of the study area. The paddy sown regions in these village tracts can get water from the high rainfall or by irrigation. Water needed for cultivation of paddy is obtained from the Ye-U main Canal and Mayagan Branch Canal.The paddy production of these regions exceeds the own consumption. The medium summer paddy cultivation (0.5-1) is found in six villagetracts. These regions are situated in the central part of the township. These regions are situated near the regions where water is available.The lowest summer paddy cultivation (below 0.5) is found in eleven village tracts. In these regions, paddy production is low because cultivation by irrigation is not done. In analysis of monsoon and summer paddy cultivated production is found that can be variation. Only monsoon paddy is more cultivated production of the study area. These village tracts are depended on rainwater. The non-cultivated of summer paddy is found in 14 village tracts. Spatial pattern of summer paddy cultivation (2018-2019) is shown in Figure (3) Table (2).

Table (1) Spatial Distribution of Monsoon Paddy Cultivation (2018-2019)

High (LQ) above 1	Medium (LQ) 0.5-1	Low (LQ) below 0.5
Aungkeitzin, Meoe, Kyaungpantaw, Chanthar, Htangyi, Tumaung, Naypukone, Linhpyu, Meikhtila, Tinteinyan, Hpankharsin, Intaw, Ywarpugyi, Magyini, Myogyi, Tamataw, Kanpauk, Mokesi, Taungkwin, Ponetaker, Hpeinkar, Chuangson, Lay, Shawhpyu, Hpalankhon, Winwa, Htantaw, Konethar, Sitharmyay, Zeinzun, Yaemyet, Hnawkone, Ywarmeikthar, Aungthar, Wetthea, Ywarthit, Kunohn, Ye-U Kone, Chaungshey, Tanthe, Ngayoketon, Boke, Magyitaw, Chon, Myinpauk,	Paygyi, Inpin, Nyaunglel, Zeyyawadi, Khaungnwet, Okehpo, Kokekosu, Kyarpannyo, Leintaw, Montaingpin, Yawrgne, Nyaungnikan, Khinpin	Tartaing, Paluzawa, Taungpyinnge, Inngyi

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

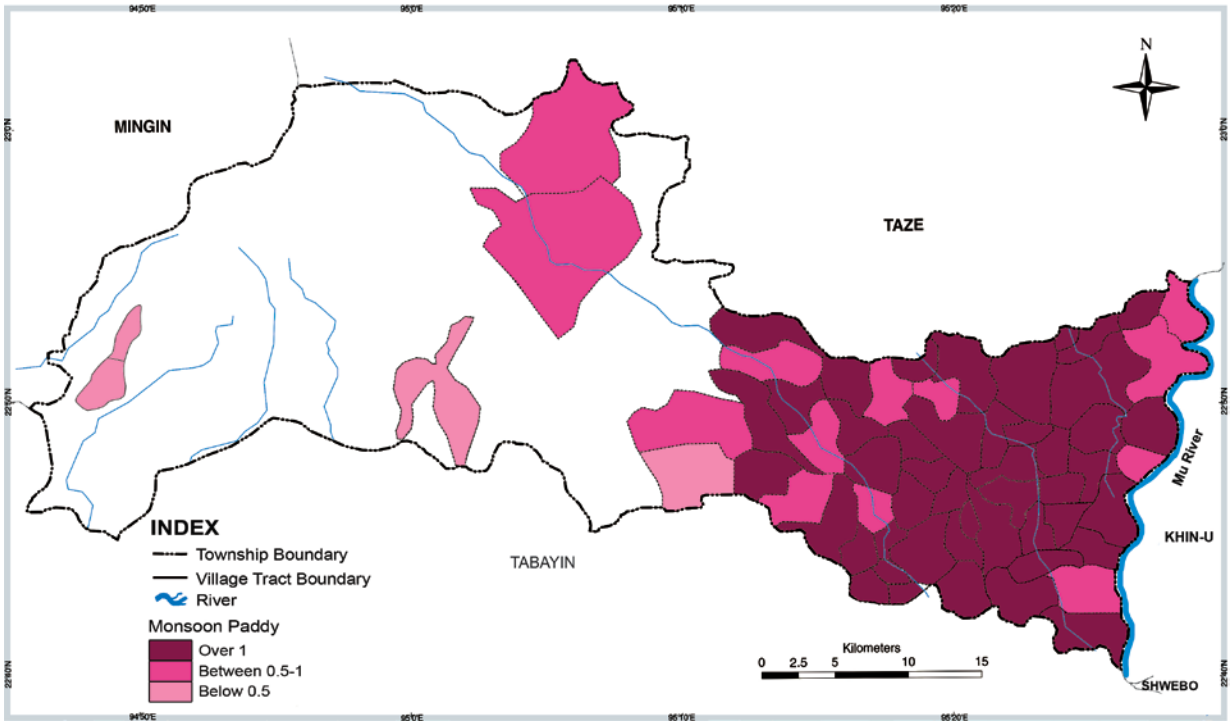


Figure (2) Spatial Distribution of Monsoon Paddy Cultivation (2018-2019)
Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Table (2) Spatial Distribution of Summer Paddy Cultivation (2018-2019)

High(LQ) above 1	Medium(LQ) 0.5-1	Low(LQ) below 0.5	Nil
Boke, Ye-U Kone, Htantaw, Thanthe, Ngayoketon, Kunohn, Shawhpyu, Chon, Paygyi, Winwa, Wetthea, Kanpauk, Ywarmeikthar, Mokesi, Chaungshey, Tamataw, Hpankharsin, Chuangson, Zeyyawadi, Hnawkone, Aungthar, Ywarthit, Okehpo, Sitharmyay, Taungkwin, Khaungnwet, Lay, Hpeinkar,Leintaw, Konethar, Zeinzun,	Kokekosu, Meikhtila, Myogyi, Magyitaw, Linhpyu, Tumaung	Naypukone, Magyini, Intaw, Tinteinyan, Myinpauk, Meoe, Ponetakar, Aungkeitzin, Htangyi, Hpalankhon, Nyaunglel,	Ywarnge, Khinpin, Inngyi, Paluzawa, Taungpyinnge, Nyaungnikan, Tartaing, Kyaungpantaw, Yaemyet, Chanthar, Ywarpugyi, Inpin, Montaingpin, Kyarpannyo

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

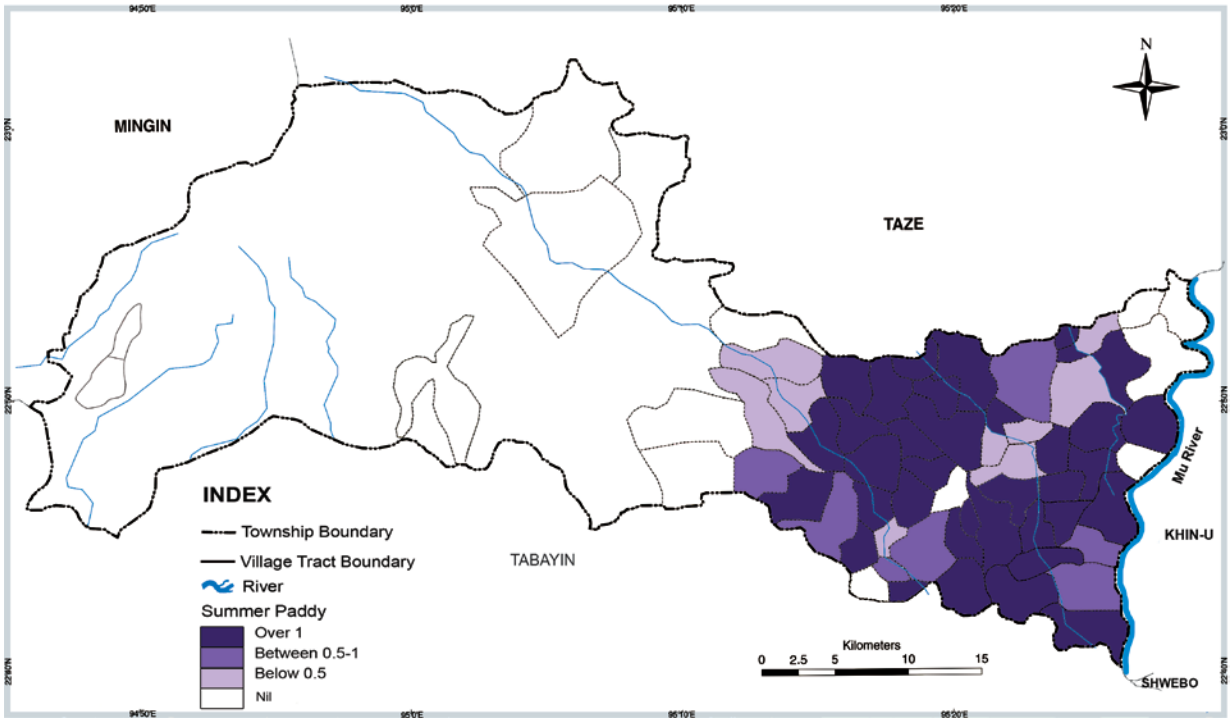


Figure (3) Spatial Distribution of Summer Paddy Cultivation (2018-2019)
Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Temporal Variation of Paddy Production

Paddy is the main crop in Ye-U Township. The paddy is mostly grown in the rice land (Le Mye). In Ye-U Township, the rice lands area was 83,074 acres comprising 73.75 percent of total cultivated area. Although the soil type in the township is suitable for paddy cultivation, it is successful in the years of good rainfall. The hot and humid climate is suitable for paddy growing and the soil must be able to conserve and absorb sufficient water for the crops. In Ye-U Township, paddy sown acreage is high because cultivation by irrigation are done. Temporal Variation of Paddy Cultivation and Production in Ye-U Township (from 2009-2010 to 2018-2019) is shown in Table (3).

During the ten year period, the average paddy sown area was 124,544 acres and the standard deviation was 11,620. The coefficient of variation for paddy sown area was 9.33 percent. In 2010-2011, the paddy sown area comprises 11.17 percent of total cultivated area and 73.75 percent of net sown area. During that period, the least paddy sown area was 2014-2015 with 102,331acres. It was less than the average by 22,213 acres. The decrease was due to insufficient rainfall during the paddy sown period in July and in August. During the ten year period, the most paddy sown area was 2009-2010 with 139,125 acres and it was more than the average by 14,581acres. The difference between the above two years was 36,794 acres.

During the ten year period from 2009-2010 to 2018-2019, the average paddy matured area amounted to 124,446 acres and standard deviation was 11,706. The coefficient of variation for paddy matured acres was 9.41 percent. The least matured year was in 2014-2015 with 101,800 acres. It was less than the average by 22,646 acres. In that year, the matured acreage was 8.18 percent of net sown acres. The low matured area in 2014-2015 was due to the low rainfall of this year. The most matured year was 2009-2010 with 139,030 acres comprising 99.93 percent of the total sown area. The high increase of paddy matured area in 2009-2010 was due to implementation of summer paddy cultivation programmes. The difference of the matured acre between these two years was 37,230 acres.

During the ten year period, the average yield of paddy was 91.13 baskets per acre. The year with an output more than the average was 2009-2010 with 94.90 baskets per acre. The year with an output less the average was 2018-2019 with 93.01 baskets per acre. The difference between the yields of the two year was 11.89 baskets.

The average output of paddy was 10,165,670 baskets. The year with the most output was 2009-2010 with 13,202,289 baskets. The year with the least output was 2012-2013 with 10,070,041 baskets. The difference of the output between these two years was 3,132,248 baskets.

Table (3) Temporal Variation of Paddy Cultivation and Production in Ye-U Township (from 2009-2010 to 2018-2019)

No	Year	Sown Acre	Matured Acre	Yield per acre	Output(Basket)
1	2009-2010	139,125	139,030	94.96	13,202,289
2	2010-2011	137,062	137,026	94.185	12,905,794
3	2011-2012	124,882	124,812	94.235	11,761,659
4	2012-2013	106,912	106,912	94.19	10,070,041
5	2013-2014	125,915	125,915	92.975	11,706,947
6	2014-2015	102,331	101,800	92.995	9,466,891
7	2015-2016	128,101	128,074	93.085	11,921,768
8	2016-2017	125,722	125,719	88.64	11,143,732
9	2017-2018	129,408	129,195	83.03	10,727,061
10	2018-2019	125,986	125,986	83.005	10,457,468

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

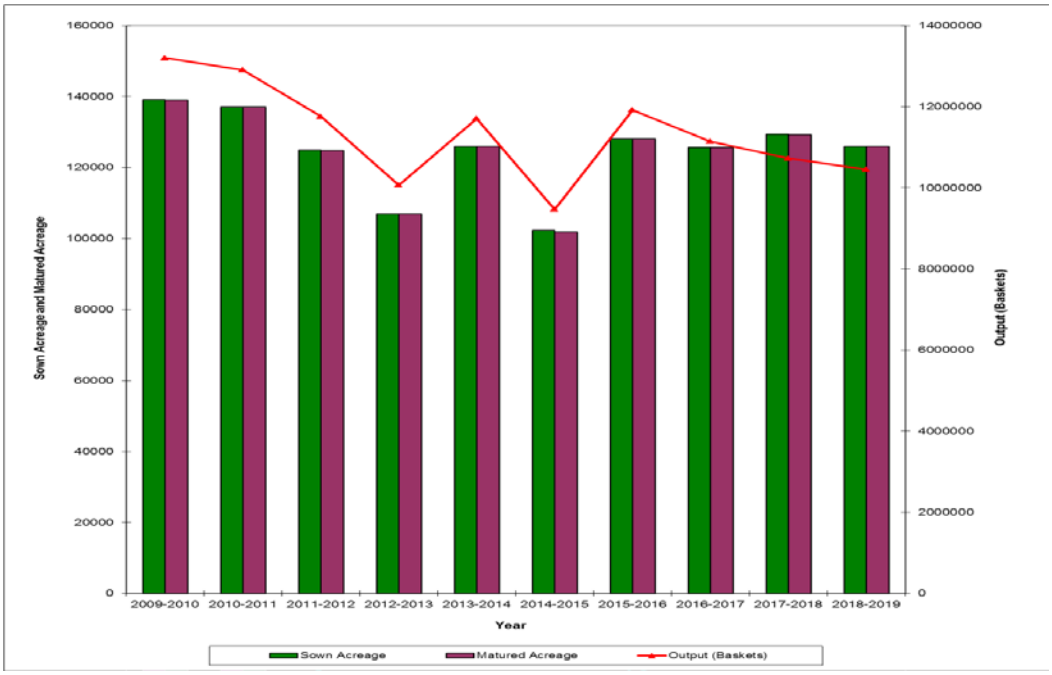


Figure (3) Temporal Variation of Paddy Cultivation and Production in Ye-U Township (from 2009-2010 to 2018-2019)

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Correlation of Paddy Cultivation and Production

Paddy is one of the cereal crops and an important crop in Ye-U Township. Total paddy cultivation and production of Ye-U Township (2018-2019) is shown in table (4).

According to 2018-2019 data, paddy cultivation and production of Ye-U Township was varied from village tract to village tract. The average paddy production was 36,233.55 baskets. The least production of paddy was 18,743 baskets in Ywarnge village tract. The largest production of paddy was 657,200 baskets in Chanthar village tract. The difference between the least and the largest production was 638,457 baskets.

It is proposed to test this hypothesis by statistical method in order to determine whether there is any such positive relationship or not, and if there is, the extent of such relationship. A number of methods are used in statistics per determining the relationship between two variables. Of these, the "Spearman's Rank Correlation Coefficient" has been selected because it is more suitable for ungrouped data with a positive and negative relationship.

The two series variables for study area are the cultivation of paddy (X) and the production of paddy (Y) in every village tracts. Two steps were taken to study the relationship between these two variables. The first stage is to tabulate the data in terms of "rank". Then obtain the difference between cultivation and production in each village tract (d) when the value of correlation coefficient is worded out, it has been found to be +0.99, which is considerably high. Therefore, the degrees of correlation were to be perfect and positive, with the ranking the cultivation and production of paddy in each village tracts. High correlation of cultivation and production depends on physical features. Paddy cultivation also depends on fertile soil, available cultivated water, use of modern mechanism, natural fertilizer and chemical fertilizer, choose the good quality seeds and pesticide. These areas export the surplus rice to other regions.

Tale (4) Total Paddy Cultivation and Production by Village Tracts of Ye-U Township (2018-2019)

No	Wards and Village Tracts	Sown Acreage	Production (Baskets)
1	Ywarnge	259	18,743
2	Khinpin	350	26,291
3	Inngyi	485	36,200
4	Paluzawa	961	73,248
5	Taungpyinnge	877	64,654
6	Nyaungnikan	1,872	139,412
7	Tartaing	927	69,894
8	Aungkeitzin	1,934	155,208
9	Linhpyu	1,886	151,926
10	Tinteinyan	1,162	97,772
11	Htangyi	1,273	106,016
12	Khaungnwet	1,788	90,095
13	Magyini	725	59,589
14	Kyaungpantaw	292	23,630
15	Myogyi	2,857	235,644
16	Shawhpyu	1,113	91,346
17	Zeyyawadi	3,679	318,594
18	Meikhtila	2,549	208,910
19	Okehpo	3,472	297,668
20	Naypukone	1,001	79,744
21	Nyaunglel	1,308	102,766
22	Yaemyet	2,150	165,720
23	Sitharmyay	3,999	348,674
24	Leintaw	2,180	183,618
25	Paygyi	3,708	324,733
26	Boke	2,956	262,226
27	Tamataw	2,985	262,793
28	Chaungshey	1,474	127,632
29	Winwa	2,105	180,673
30	Kunohn	4,940	437,517
31	Chanthar	825	657,200
32	Taungkwin	1,642	142,407
33	Chuangson	1,182	99,537
34	Ngayoketon	2,535	250,655
35	Hnawkone	3,540	317,319
36	Ye-U Kone	3,305	308,180
37	Kanpauk	1,983	177,762
38	Myinpauk	1,345	113,021
39	Hpalankhon	807	65,662
40	Meoe	1,541	129,550
41	Tumaung	5,042	438,855
42	Wetthea	4,097	365,745
43	Ponetakar	999	80,959

No	Wards and Village Tracts	Sown Acreage	Production (Baskets)
44	Hpankharsin	392	33,594
45	Ywarpugyi	1,000	81,562
46	Inpin	622	50,762
47	Montaingpin	1,607	134,147
48	Lay	1,722	147,632
49	Kyarpannyo	555	45,630
50	Hpeinkar	2,598	224,316
51	Intaw	4,007	342,833
52	Thanthe	2,157	192,000
53	Htantaw	1,997	183,177
54	Magyitaw	965	82,931
55	Mokesi	2,133	194,328
56	Kokekosu	2,716	241,505
57	Aungthar	3,766	343,812
58	Zeinzun	2,939	255238
59	Chon	3,980	356,829
60	Ywarthit	2,526	223,374
61	Konethar	580	51,414
62	Ywarmeikthar	4,072	373,782

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Varieties of Paddy

Varieties of paddy cultivated in Ye-U Townhip are Shwethweyin, Ayarmin, Pawsan, IR-747, Palethwe and Day 90 etc. Among them, Shwethweyin is extensively grown because of its good quality and high yield per acre. Therefore, in 2018-2019, its cultivation is about 43.34 percent. After Ayarmin and Pawsan varieties are mostly grown due to high yield and short life period. There were 14.83 percent in Ayarmin varieties and 29.74 percent in Pawsan variety. The rest varieties are very small. The varieties of paddy grown in Ye-U Township are shown in Table (5).

Table (5) Varieties of paddy Grown in Ye-U Township (2018-2019)

No	Varities	Sown Acreage	Matured Acreage	Yields per acre	Outputs
1	Shwethweyin	51779	51763	86.21	4452488
2	Ayarmin	19963	19963	82.24	1640797
3	Pawsan	37837	37837	86.95	3289974
4	IR-747	8680	8680	93.94	815358
5	PalethwePalethwe	1038	1038	142.52	147936
6	Day-90	7853	7853	89.63	703876

Source: Department of Agricultural Land Management and Statistics, Ye-U Township

Surplus Areas of Paddy

The surplus area of paddy in Ye-U Township is directly related to the population. In a year, a person may eat only the 15 baskets of paddy. It is based on the 2018-2019 data. All village tracts in Ye-U Township are surplus areas of paddy. In Ye-U Township, alone the total population is 131,736 persons, the consumption is 1,976,040 baskets, and the production is 10,773,019 baskets. Therefore, the paddy production in Ye-U Township is found to be surplus.

Conclusion

Ye-U Township is located in Shwebo District, Sagaing Region. It is situated between the north latitude 22º 42' and 23º 2' and between east longitude 94º 56' and 95º 28'. Ye-U Township is about 48 miles from east to west, the narrowest part from north to south is about 17 miles and the widest part about 19 mile. Ye-U Township is only 338 feet above sea level. The area of township is about 559.14 square miles or 357,549 acres. It is composed of Ye-U Town proper and 62 village tracts.

In Ye-U Township, cultivated land (agricultural lands) and uncultivable waste lands are the most common. Out of the total area of 357,549 acres, the total agricultural lands amounted to 11,425 acres. Of this acreage, "Le" land is 83,074 acres (73.75%). Multiple crops are grown in Ye-U Township. The main crops are cereal crops, oil seed crops and pulses. The most dominant crop is paddy. It is widely grown in the township.

In Ye-U Township, the paddy land area was 62,993 acres comprising 56.53 percent of total cultivated area. During the 10 year period from 2009-2010 to 2018-2019, the average paddy sown area was 124,544 acres, including monsoon and summer paddy and the standard deviation was 11,621. The coefficient of variation for paddy sown area was 9.33 percent.

The correlation between cultivation and production of paddy in each village tracts is found to be a positive correlation. Therefore, these area sexport the surplus of paddy to other regions.

Acknowledgements

I would like to convey my gratitude to Dr Win Swe, Pro-Rector (Rector's duty), Shwebo University for his kind permission to undertake this research. I would like to thank DrMyoMyo, Pro-Rector, Shwebo University for her invaluable guidance. I am especially grateful to DrThan Than Win, Professor and Head, Department of Geography, Shwebo University, who encouraged me to write research papers. Special acknowledgement also goes to Dr Khin Mar Tin, Professor, Department of Geography, Shwebo University for her kind help in carrying out my research work.

References

Gregory. S. (1987): **Statistical Methods and the Geographer**; 4th edition, The Chauces Press, Great Britain.

Getis, A., Getis, J., Fellmann, J. D. (2006): **Introduction to Geography;** tenth edition, published by McGraw Hill, New York.

Grigg, David. (1984): **An Introduction to Agriculture Geography**: Hutchison, London, Melbourne.

HlaTunAung (2008): **Myanmar: The Study of Processes and Patterns; National Center for Human Resources Development**, Yangon, Myanmar.

KhinNyo Win, Ma. (2009): **A Geographical Study of Agricultural Land Use in Monywa District**; (Ph.D Dissertation), Department of Geography, University of Mandalay, (Unpublished).

Singh, Jasbir, and Dhillion, S.S. (1984): **Agricultural Geography**; Tata McGraw-Hill Publishing Company Limited, New Delhi.

Singh, R. L., Singh, Rana P. B. (1992): **Elements of Practical Geography**; Kalyant publishers New Delhi-Ludhiana.

Analysis on Land Use Patterns in Banmauk Township

Khin San Win[1], Khin Mar Tin[2], Theingi Aye[3], Htay Htay Myint[4], Thin Hlaing Hlaing Tun[5]

Abstract

The research title is “Analysison Land Use Patterns in Banmauk Township”. The study area is located in north-western part of the Katha district, upper Sagaing Region. The main aim of this research paper is to find out the more effective land use pattern for regional development in Banmauk Township. In carrying out this research, the primary and secondarty data collected during the field survey are used and the spatial land use pattern is analyzed by using Dr. S. S. Bhatia's Location Quotient Method. According to 2019 data, there are eight types of spatial land use pattern. Agricultural land area has only 38,196 acres with 4.52% of the whole township. Agriculture is the main economy of Banmauk Township. Therefore, it is necessary to carry out a systematic land use pattern within the Banmauk Township.

Introduction

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures and managed woods. Land use by humans has a long history, first emerging more than 10,000 years ago. It has also been defined as “the total of arrangements, activities and inputs that people undertake in a certain land cover type”.

Banmauk Township is located in Katha district upper Sagaing Region. The area between the Mu River valley in the western part and the Meza River in the eastern part is flat plain. Thus, land use in Banmauk Township is conditioned by the physical factors which limit the use capabilities of land. Together with the growth of population, the land use pattern of Banmauk Township changed with time. Based on physical and social factors, the land use pattern in Banmauk Township is attempted on the geographical point of view.

Study Area

The study area is located between north latitudes 24º 10' and 25º and east longitudes 95º 17' and 96º 02'. It has an area of about 1319.79 square miles (844668 acres) and is composed of three wards and 47 village tracts.

Aim and Objectives

The main aim of this research is to find out more effective land use patterns for the regional development in Banmauktownship. The objectives of this resarch are:

1. To study the physical environment in the study area
2. To analyze the spatial land use pattern of the study area.
3. To find out the relaitonship between land use and socio-economic condition of the study area.

[1] Lecturer, Dr, Department of Geography, Shwebo University
[2] Professor, Dr, Department of Geography, Shwebo University
[3] Lecturer, Daw, Department of Geography, Shwebo University
[4] Lecturer, Dr, Department of Geography, Shwebo University
[5]Assistant Lecturer, Daw, Department of Geography, Shwebo University

Materials and Methods

The study area is based on primary and secondary source of data. The general background information for the research problems is obtained from the library source. Primary data are collected by means of questionarie method, interview and field survey.Secondary data are collected from govenment offices, various departments and statistical year books. Quantitative and qualitative analysis of data are based on statistical methods in this paper.

Finding and Discussion

In studying the land use of Banmauk Township, there are eight types of spatial land use pattern; agricultural land, forest land, cultivable waste land, residential land, water body area, transportation land, religious and cementery land and other land. Among them, forest land is the largest area in Banmauk Township. Agricultural land is the second largest area in this township. Agriculture is the main economy of Banmauk Township.

According to 2019, there are seven village tracts in Banmauk Township with high concentration of agricultural land. They are Banmauk Town, Aungthagon, Setaw, Lenetgyi, Kanywa, Lethi and Kyaukten, These village tracts are found in western bank of Meza river and agriculture is carried out with the help of irrigation.

Area with medium concentration of agricultural land is found in 39 village tracts. Area with low concentration of agricultural land is two village tracts. They are Nanmar and Nanantun. These village tracts are situated in northern part of the township. The northern part is not suitable for agriculture because of densely forest.

Forest land is the largest area in Banmauk Township. According to 2019 data, forest land has 571,171 acres with 67.62% of the township. There are 16 village tracts with high concentration of forest land in Banmauk Township. They are Kywegawgyi, Pinsinte, Pinbon, Hechein, Inbauk, Naungpat, Nanmar, Nanantun, Mansigyi, Mingon, Manlongpebin, Manlu, Naungkan, Nannyin, Mutha, and Hekwee. Most of these village tracts are found in northern part of the township. Timber extraction was carried out since the timber of Myanmar Kings in the upper region of Meza river.

There are six village tracts in Banmauk Township with low concentration of forest land. They are Aungthagone, Kandaw, Lethi, Tohlaw, Sarkhan and Manyupegon. These village tracts are located in eastern part of the township.

Generally in examining the land use pattern in Banmauk Township, the main land use pattern is the agricultural land with 4.52% of the total area. Le land, Ya land, Kaing Kyun land and garden land are the main agricultural lands. The main crops are paddy, groundnut, sesamum, wheat, pulses and vegetables. Therefore, township's economy is based on agriculture and finally concluded that the main type is agricultural land use pattern in Banmauk Township.

Geographical Factors

Banmauk Township is situated in the north-western part of the Katha district, Upper Sagaing region. It lies between north latitudes 24° 10' and 25° and east Longitudes 95° 17' and 96° 02'. The total area is 1319.79 sq.miles (or) 844,668 acres. Banmauk Township is constituted by three wardsand 47 village tracts. Banmauk Township has a triangular shape. Most of the boundaries of Banmauk Township is generally demarcated along the mountain ranges and rivers. In the east by Indaw Township, in the south by Wuntho and Pinlebu Township, in the west by Phaungpyin and Homalin Township, in the north by Moehnyin Township. Nearly the whole area of Banmauk Township is mountainous and also composed

of the valley plains. In the eastern part of the township, the land slope is gradually gently sloping towards Meza river. Banmauk Township are continuation of Zeebin and Hmankin mountain ranges. The height of the mountains is found between 1000 and over 5000 feet in the west of Banmauk Township. The prominent ranges are Kyetmauk Taung 2921 feet, Onhmin 2724 feet and Mode 20145 feet, in height. The highest peak in the township is the Taungthonlon Taung with 5693 feet height which is located in the northern most part. The mountain regions are covering about two- third of the Banmauk Township. The valley plains along the Mu River and Chaunggyi chaung are plains lying between western mountain ranges and central mountain ranges. This plain has a height of below 1000 feet. The Mu river, Chaunggyi chaung, Namkyin chaung, Mode chaung and their tributaries are all flowing the valley plain. The valley plain along the Meza river and chaung is the eastern plain which extends to the boundary of Indaw Township. The principal drainages are the Mu river, Meza river, Mode chaung, Chaunggyi chaung and Taung chaung. These rivers and chaungs are ofgreat importance for agricultural activity of the township. The Mu River, takes its source in the south of Shwekyaung and Tonpat village, flows from north to south passing through the township of Pinlebu. The Meza river is one of the rivers in Banmauk Township. The Meza river originates in the middle ranges of Banmauk Township and drains from north to south. The tributaries which joins into the Meza river are the Khamo chaung, Kalat chaung, and Banmauk chaung. The Banmauk Township is located at the north-eastern part of the Wuntho Massif. Thus, the township area is characterized by hilly terrains. Most of the hills are made up of granodiorites, whereas the plains and valleys occupied by clastic sediments and alluvial deposits. As Bamauk Township is situated in the north of the Tropic of cancer, it is lying within the sub-tropical zone. According to Koppen's climatic classification, the township enjoystropical savanna climate (Aw) type of climate. The soil types in Bammauk Township are Red Brown Forest Soil, Yellow Brown Forest Soil, Dark Meadow Soil, Loamy Soil**.** Natural vegetations in Banmauk Township are Hill forest, Evergreen forest, Mixed Deciduous forest, Indaing forest and, Swampy forest.

Land use Pattern is the product of varying Factor in which social factors such as demographic factor and governmental policy have their own importance. According to 2019 populaion data, population of Banmauk Township was 111,422 persons, of which 7,011 persons or 6.3% lived in urban area of Banmauk Township and the remaining 104,411 persons or 93.7% lived in rural area of Banmauk Township. In 2019, Banmauk Township has a total population of 111,422 persons, of which 49.76% or 55,442 persons were male and 50.24% or 55,980 persons were female. Gender ratio of Banmauk Township in 2019 is about every 100 females by 98 males.

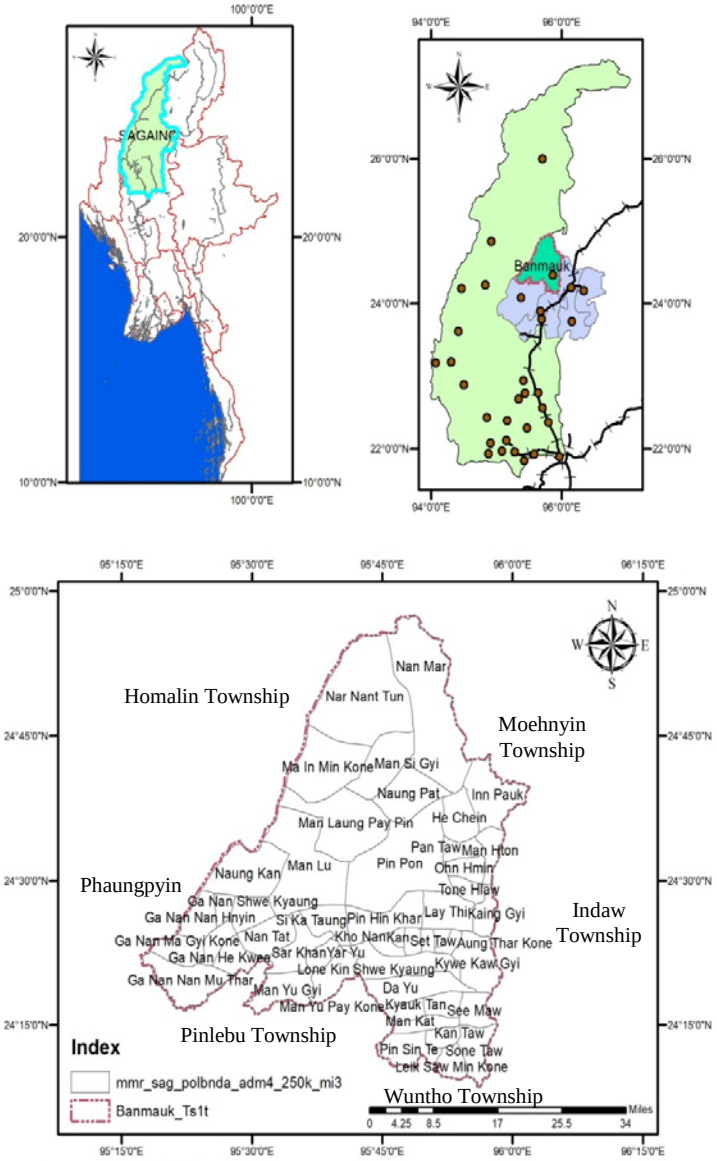


Figure (1) Location Map of Banmauk Township
Source: Department of Agricultural Land Management and Statistics in Banmauk Township

General Land Use of Banmauk Township

Land is a natural resource for human being. The types of land use depend the relief, climate and social society. Eight types of land use in Banmauk Township were classified as follow:

1. Agricultural Land
2. Forest Land
3. Cultivable waste land
4. Residential land
5. Water body Area.
6. Transportation Land
7. Religious and cementery Land
8. Other Land

1. Agricultural Land

Agriculature is the main economy of Banmauk Township. Paddy, groundnut, sesamum, sunflower, vegetables, and pulses are grown in this area that receive water from canals, chaungs and in the Meza river basin. The agricultural land may be classified as *Le, Ye, Kaing-Kyun and Graden Land*. According to 2019 data, there were 38,196 acres under agriculture. Of which 33,360 acres or 87.34% was under *Le Land,* 3,226 acres or 8.45% was under *Ya Land,* 719 areas or 1.88% was under *Kaing-Kyun Land*and 891 acres or 2.33% was under *graden Land*. So it can be observed that *Le* land covers the largest area.*Ya*lands are the second largest area in Banmauk township.

Table (1) General Land Use of Banmauk Township (2019)

No	Type of Land use	Acres	Percent
1	Agriculture	38,196	4.52
2	Forest	571,171	67.62
3	cultivable waste land	178,774	21.17
4	Residential	2,173	0.26
5	Water body Area	4,010	0.48
6	Trasportation	407	0.05
7	Religious and Ceinentery	1,318	0.15
8	Other land	48,619	5.75
	Total	844,668	100

Source: Department of Agricultural land Management and Statistics in Banmauk Township

Table (2) Agricultural Land use of Banmauk Towship (2019)

No	Type of Land use	Acres	Percent
1	Le Land	33,360	87.34
2	Ya Land	3,226	8.45
3	Garden Land	891	2.33
4	Kaing-Kyun Land	719	1.88
	Total	38,196	100

Source: Department of Agricultural Land Management and Statistics in Banmauk Township

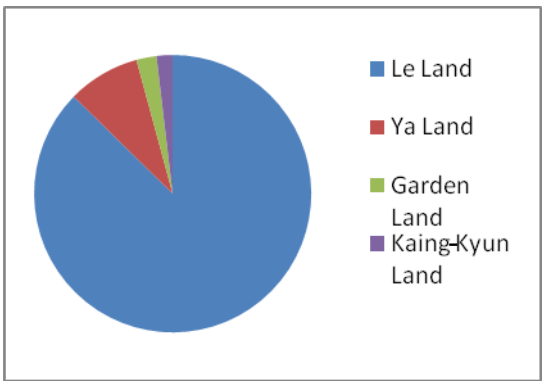


Figure (2) Agricultural Land Use of Banmauk Township (2019)

Source: calculated by researcher based on table (2)

2. Forest Land

Forests are a kind of the natural environment from which man can extract food, fuel and construction materials. Forest can influence on climate and can help to provide the same

climate. Forest land is the largest area in the township. In 2019 data, the reserved forest covers an area of 571,171 acres.On the whole township, the forests cover 67.62% of the township.

3. Cultivable Waste Land

In Banmauk township, the cultivable waste land is 178,774 acres in 2019. Therefore, it accounts for 21.17% of the township area. The cultivable waste land is only found in the poor soil areas.

4. Residential Land

There are two types of residential land use in Banmauk township; urban land use and rural land use. Among them, urban land use was 131 acres with 6.03% of the residential land use and rural land use was 2,042 acres with 93.97% of the residential land area. In Banmauk township, the most residential land is found in good transportation places, low lands and agricultural land.

5. Water Body Area

Rivers, streams, lakes, dams and canals are included in this type. The principal drainages in Banmauk township are the Mu river, Meza river, Mode chaung, Chaunggyi chaung and Taung chaung. According to 2019 data, water body area is 4010 acres with 0.48% of the total area.

6. Transportation Land

Transportation is important for the development of a region. Motor road is the main transportation in Banmauk township. In 2019 data, transportation land occupied 407 acres with 0.05% of the township area. Banmauk and Indaw is themain road in this township.

7. Religious and Cemetery Land

According to 2019 data, the religious and cemetery land use area are 1,318 acres with 0.15% in the township. Monastery mosque, christian church, temple, pagoda and cemetaries are included in this land use type.

8. Other Land

Follow land, uncultivable land, virgin land and unclassified land use including in other lands. According to 2019 data, other land area was 48,619 acres with 5.75% of the total area.

Spatial Analysis of Land Use Patternsin Banmauk Township

In analyzing the land use pattern in Banmauk township, it is found that agricultural land use, forest land use, cultivable waste land, residential land use, waterbody area, transportation land use, religious and cemetery land use and otherland use are dominant lands. According to 2019 data, among the variety of lands, agricultrual land is the important land in Banmauk township. In order to determine the concentration of the lands, Dr SS. Bhatia's location Quotient Method was used in this research.

Index for determiningconcentration of lands= $\frac{\text{Area of land in a component areal unit}}{\text{Area of all lands in the component areal unit}} \div \frac{\text{Area of land in the entire region}}{\text{Area of all lands in the entire region}}$

Concentration of Agricultural Land

In area of Banmauk township, agricultural land is in every village tracts. Concentration of agricultural land is calculated by Dr. SS Computer Center Bhatia's Location Quotient method. It can be divided into three groups.

There are seven village tracts in Banmauk township with a high concentration of agricultural land. They amounted to 15.62% of total agricultural land. They ate Banmauk town, Aungthagon, Settaw, Lenetgyi, Kanywa, Lethi and Kyaukten. These village tracts are located in the eastern and south-easten part of the township. In these village tracts, agriculture is carried out with the help of irrigation canal. So, these village tracts are high concentration areas of agricultural land.

Areas of medium concentration of agricultural lands are found in 39 villages tracts. They amounted to 79.80% of the total agricultural land. These village tract are found in easten, western, southetn and northern part of Banmauk township. Most of these village tracts are found to be cultivated with the help of irrigation. These village tracts are also suitable for kaing crops.

Areas with low concentration of agricultural lands are found in two village tracts. They are Nanmar and Nanantun. They amounted to 4.58% of total agricultural land. These villages tracts are located in northern part of the township.

Table (3) Concentration of Agricultural Land in Banmauk Township (2019)

No	Indexof Concentration	Name of Village Tracts	Number of VRs
1	High > 2.7	Banmauk town, Aungthagon, Settaw, Lenetgyi, Kanywa, Lethi, Kyaukten	7
2	Medium 0.3and 2.7	Kywegawgyi, Sinmaw, Sondaw, Pinsinte, Kandaw, Yedwingon, Mankat, Dayu, Lonkin, Shwekyaung, Khonon, Pinhinga, Tonhlaw, Pinbon, Ohnmin, Pantaw, Manhton, Hechech, Inbauk, Naungpat, Mansigyi, Mingon, Manlongpebin, Manlu, Naungkan, Kainggyi, Nanzar, Shwekyaung, Nannyin, Leiksaw, Magyigon, Mutha, Nantat, Sarkham, Manyugyi, Manyupegon, Hekwee, Yayu, Siketaung	39
3	Low <0.3	Nanmar, Nanantun	2

Source: Compiled by researcher based on Department of Agricultural land Management and Statistics in Banmauk Township

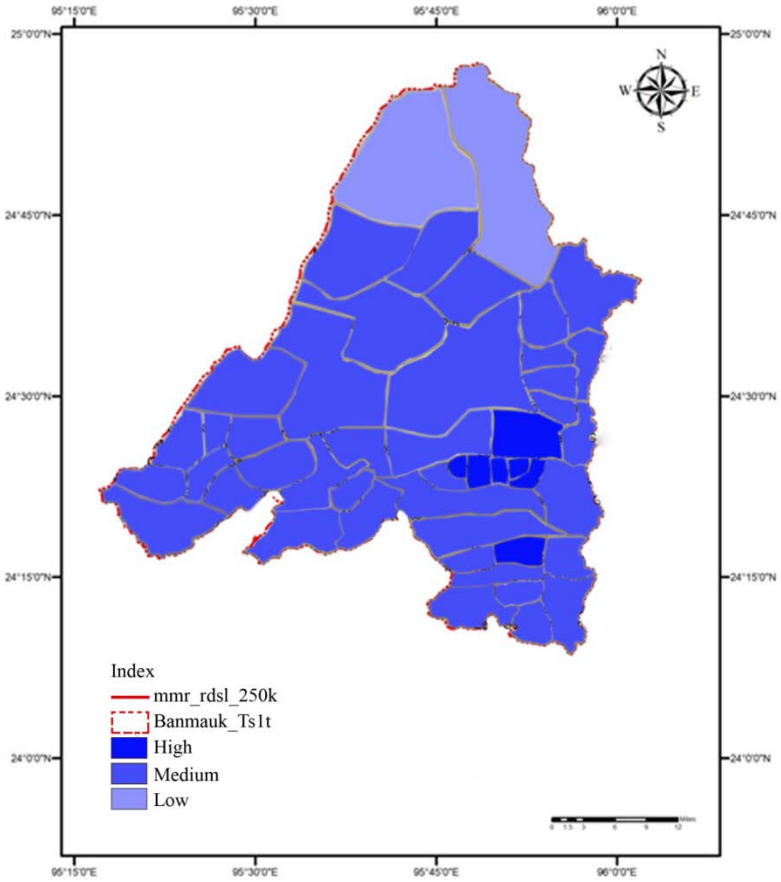


Figure (3) Concentration of Agricultural land in Banmauk Township (2019)
Source: Based on table (3)

Concentration of Forest Land

In Banmauk township forest land is only 40 village tracts which amounted to 67.62% of total land area. Forest land is the largest area in Banmauktownship.The concentration of forest land is calculated by Location Quotient method. The concentration of forest land can be divided into three groups.

There are 16 village tracts in Banmauktownship with high concentration of forest land. They amounted to 84.46% of the total forest land area. They are Kywegawgyi, Pinsinte, Pinbon, Hechein, Inbauk, Naungpat, Nanmar, Nanantun, Mansigyi, Mingon, Manlongpebin, Manlu, Naungkan, Nannyin, Mutha and Hekwee. Most of these village tracts are located in northern part of the township. Some of these village tracts lie in western and southern part of the township. The northern part is mountainous region and densely forest. So high concentration of forest land is in northern part.

Area with medium concentration of forest land in Banmauk township are found in 18 village tracts. They are amounted to 14.8% of the total forest land. They are Sinmaw, Sondaw, Mangon, Mankat, Dayu, Lonkin Shwekyaung, Khonon, Pinhinga, Ohnmim, Pantaw, Kainggyi, Nanzar, Shwekyaung, Leiksaw, Mangyigon, Nantat, Yayu and Sikataung. These village tracts are found in south-eastern and western part of the township.

Areas with low concentration of forest land are occupied in six village tracts. They accounted for 0.74% of the total forest land. They are Aungthagon, Kandaw, Lethi, Tohlaw, Sarkhan and Manyupegon. These village tracts are located in eastern and south-western part of the township. These areas are efficient land use. So, these areas are low concentration of forest land.

Table (4) Concentration of Forest Land in Banmauk Township (2019)

No	Index of Concentration	Name of Village Tracts	Number of VRs
1	High >1.09	Kywegawgyi, Pinsinte, Pimbon, Hechein, Inbauk, Naungpat, Nanmar, Nanantun, Mansigyi, Mingon, Manlongpebin, Manlu, Naungkan, Nannyin, Mutha, Hekwee,	16
2	Medium 0.25and 1.09	Sinaw, Sondaw, Mangon, Mankat, Dayu, Lonkin Shwekyaung, Khonon, Pinhinga, Ohnmin, Pantaw, Kainggyi, Nanzar, Shwekyaung, Leiksaw, Mangyigon, Nantat, Yayu, Sikataung	18
3	Low <0.25	Aungthagon, Kandaw, Lethi, Tonhlaw, Sarkhan, Manyupegon	6
4	Nil	Banmauk Town, Yedwingon, Settaw, Lenetgyi, Kanywa, Manhton, Manyugyi, Kyaukten	8

Source: Compiled by researcher based on Department of Agricultural land Management and Statistics in Banmauk Township

Concentration of Residential Land

In Banmauk Township, residential land area is in every village tracts. The concentration of residential land is calculated by Location Quotient method. It can be divided into three groups:

These are Banmauk town and two village tracts in Banmauk township with high concentration of residential land. They amounted for 12.38% of the total residential land area. They are Aungthagon and Kyaukten village fracts. These village tracts are found insouthern part of the township. These village tracts are lying on the Banmauk-Indaw motor road.

In Banmauk township, area with medium concentration of residential land are found in 36 village tracts. They amounted to 70.13% of the total residential land area in this township. These village tracts are found in southern, eastern and western part of the township. These village tracts are irrigated agricultural activities and good accessibility in motor road transportation.

Areas with low concentration of residential land are found in nine village tracts. They are occupied by 17.49% of the total residential land in Banmauk township. They are Mangon, Pinhinga, Pinbon, Naungpat, Nanmar, Nanantun, Mingon, Manlongpebin, Naungkan. These village tracts are located in northern part of the township. Being densely forest, low concentration of residential land in Banmauk township.

Table (5) Concentration of Residential Land in Banmauk Township (2019)

No	**Index of Concentration**	**Name of Village Tracts**	**Number of VRs**
1	High >3.7	Banmauk town, Aungthagon, Kyauk ten	3
2	Medium 0.5and 3.7	Kywegawgyi, Sinmaw, Sondaw, Pinsinte, Kandaw, Yedwingon, Mankat, Dayu, Lonkin Shwekyaung, Settaw, Khonan, Lenetgyi, Kaingywa, Lethi,	36

No	Index of Concentration	Name of Village Tracts	Number of VRs
		Tohlaw, Ohnmin, Pantaw, Manhton, Hechein, Inbauk, Mansigyi, Manlu, Kainggyi, Nanzar, Shwekyaung, Nanyin, Leiksaw, Magyigon, Mutha, Nantat, Sarkhan, Manyugyi, Manyupegon, Hekwee, Yayu, Sikataung	
3	Low <0.5	Mangon, Pinhinga, Pinbon, Naungpat, Nanmar, Nanantun, Mingon, Manlongpebin, Naungkan.	9

Source: Compiled by researcher based on Department of Agricultural land Management and Statistics in Banmauk Township

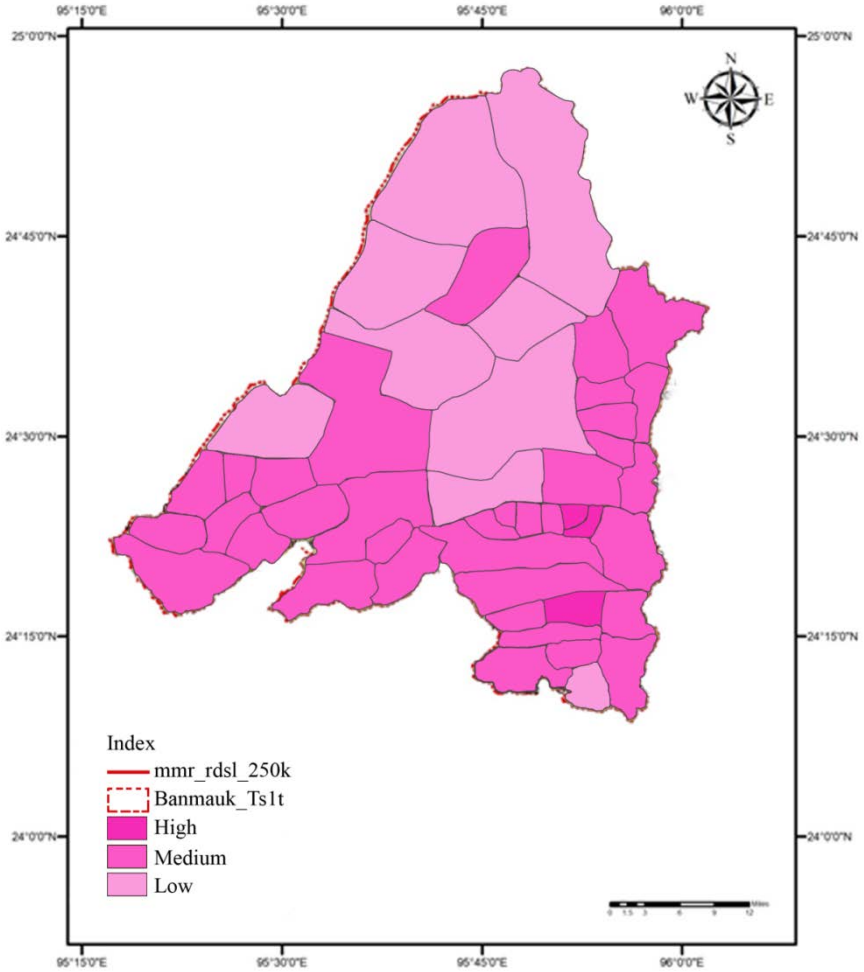


Figure (4) Concentration of Residential Land in Banmauk Township (2019)

Source: Based on tables (5)

Concentration of Water Body Area

In Banmauk Township, water body area is in every village tracts. The concentration of water body area is examined by Location Quotient method. The concentration of water body area can be divided into three groups:

There are five village tracts in Banmauk Township with high concentration of water body area. They are occupied with 12.54% of total water body area. They are Settaw, Lenetgyi, Kanywa, Nanzar and Kyaukten. Most of these village tracts are located in south eastern part of the township. Nanzar village tract is only found in eastern bank of the Mu River. These village tracts are found in western bank of Meza river. These village tracts are fertile soil and adequate water for agriculture. So, the concentration of water body area is high.

Areas with medium concentration of water body area are found in 37 village tracts. They amounted to 76.94% of the total water body area of Banmuk township. Medium concentration of water body area is found in widely spread. Most of these village tracts are located in south eastern and western part of the township. These village tracts are found in the bank of Mu River, Meza river and chaung.These regionsare suitable for agriculture.

Areas with low concentration of water body area are found in six village tracts. They are accounted for 10.52% of the total water body area. These village tracts are Pinbon, Nanmar, Nanantun, Manlongpebin, Naungkan and Nanzar. Some of these village tracts are located in the northern part of the township.

Table (6) Concentration of Waterbody Area in Banmauk Township

No	Index of Concentration	Name of Village Tracts	Number of VRs
1	High >3.17	Settaw, Lenetgyi, Kanywa, Nanzar, Kyaukten	5
2	Medium 0.29 and 3.17	Banmauk Town, Aungthagon, Kywegawgyi, Sinmaw, Sondaw, Mangon, Pinsinte, Kandaw, Yedwingon, Mankat, Dayu, Lonkin Shwekyaung, Khonon, Pinhinga, Lethi Tonhlaw, Ohnmin, Pantaw, Manhton, Hechein, Inbauk, Naungpat, Mansigyi, Mingon, Manlu, Kainggyi, Shwekyaung, Nannyin, Leiksaw, Magyigon, Mutha, Nantat, Sarkhan, Manyugyi, Manyupegon, Yayu, Sikataung.	37
3	Low <0.29	Pinbon, Nanmar, Nanantun, Manlongpebin, Naungkan, Hekwee	6

Source: Compiled by researcher based on Department of Agricultural land Management and Statistics in Banmauk Township

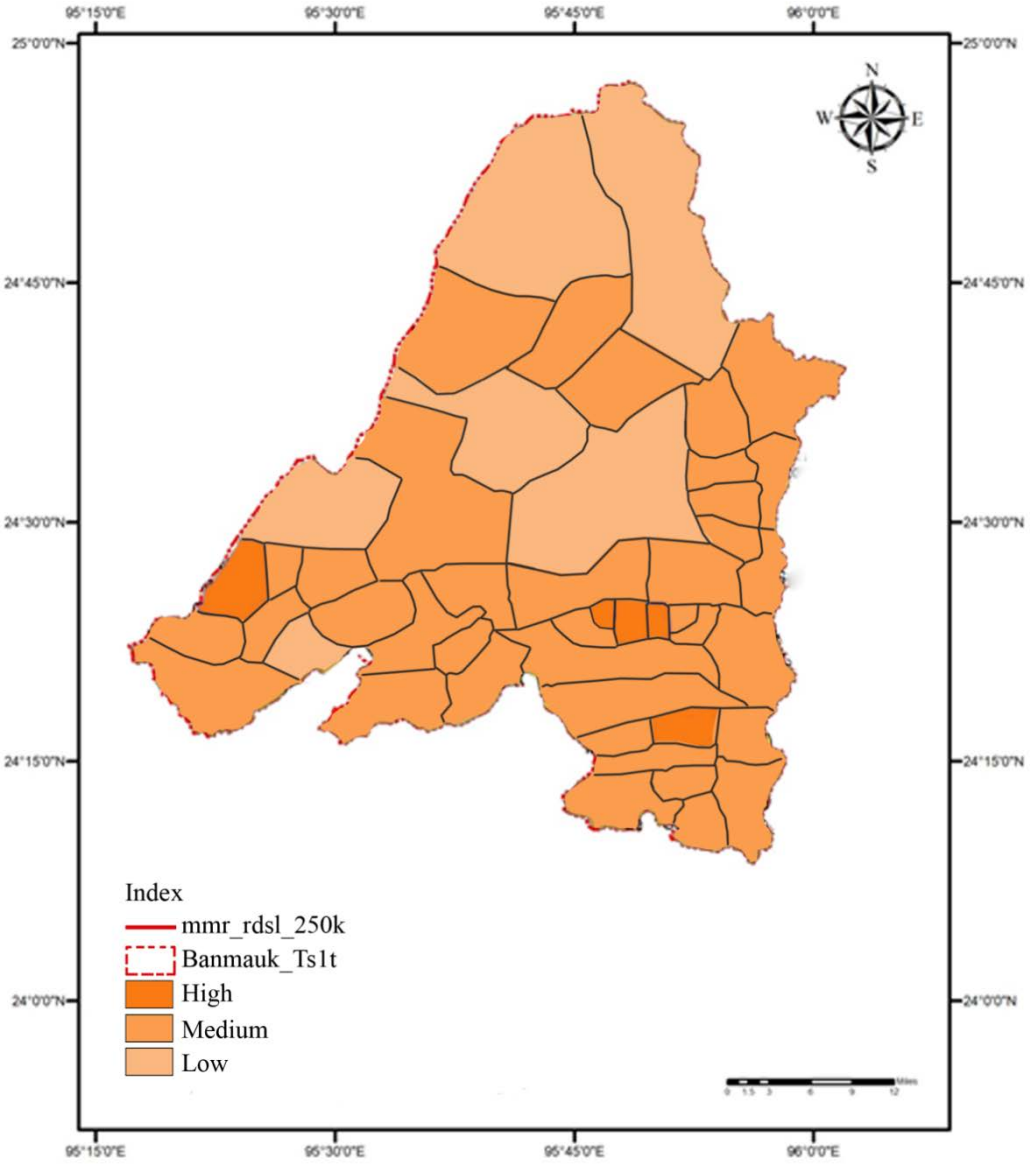


Figure (5) Concentration of Waterbody Area in Banmauk Township (2019)
Source: Calculated by researcher

Conculsion

Banmauk Township is located on the western bank of Meza river between north latitude 24º 10' and 25º and east longitudes 95º 17' and 96º 02'. The total area area is 1319.79 sq miles (or) 844,668 acres. It is bounded on the north by Moehnyin Township, on the south by Pinlebu and Wuntho Township, on the west by Phaungphin and Homalin Township, on the east by Indaw Township. In Banmauk Township, about two-third is covered with mountain and one-third of the plain. The northern part is the highest of the township with over 5000 feet. The main drainage arethe Mu river, Meza river, Mode chaung, Chaunggyi chaung and Taung chaung. These rivers and chaungs are very important foragricultural activity of the township.

Banmauk Township is located at the north-eastern part of the Wuntho Massif. Thus, the township area is characterized by hilly terrains. As Banmauk Township is situated in the north of the Tropic of Cancer, it lies within the subtropical zone. According to Koppen's climatic classification, the township enjoy tropical savanna climate (Aw). According to 2019 data, the total population of Banmauk Township was 111,422 persons.

The general land use of Banmauk Township can be divided into eight types. These are agricultural land use, forest land use, cultivable waste land, residential land, water body area, transportaion land, religious and cemetery land and other land. Agriculture is the main economy of Banmauk Township. According to 2019 data, agricultural land area has 38,196 acres with 4.52% of the township. The forest land area has 571,171 acres with 67.62% of the whole township. The cultivable waste land area has 178,774 acres with 21.17% of the township. Residential land area has 2,173 acres or 0.26%. Waterbody area has 4,010 acreas with 0.48% of the township. In Banmauktownship, transportation land has 48,619 acres with 5.75% of the township area.

In analyzing the spatial land use pattern of Banmauk Township, it is found that agricultural land, forest land, residential land, water body area and other lands are the dominant land. According to statistics of the 2019 data, althougha variety of land use, agricultural land is the most important land in Banmauk Township. The distribution of agricultural lands varies from place to place. There are seven village tracts in Banmauk Township with high concentration of agricultural land. They are Banmauk town, Aungthagon, Settaw, Lenetgyi, Kanywa, Lethi and Kyauk- ten. These village tracts are found in western bank of Meza River and south eastern part of the township. Areas with medium concentration of agricultural land were found in 39 village tracts. There are two village tracts with low concentration of agricultural land. In studying the land use pattern of Banmauk Township, agricultural land use has 38,196 acres 4.52% of the total area.

Suggestion

Agriculture is the main economy of Banmauk Township. By extending the agricuktural activities, there will be advantages in the development of economy in the township. When extending the agricultural activities, the farmers are using the scientific method such as utilizing the fertilizers, selecting the good seeds and spraying the pesticides in farming. Moreover, the cultivable waste land and other lands should be changed into other suitable land use types in order to make the regions within Banmauk Township become more developed than before.

Acknowledgements

I am greatly indebted to Rector Dr Win Swe, and pro-rector Dr Myo Myo, Shwebo University for their permission to carry out this research work. I would like to express my special thanks to Dr Than Than Win (Professor and Head of Geography Department, Shwebo University) for her guidance and encouragement to enhance this research. Moreover, I am also thankful to all staff from Department of Agricultural Land Management and Statistics in Banmauk Township.

References

Bunnett, R.B. (2002): Interactive Geography 4, SNP Pan Pacific Publishing Pte Ltd, Singapore.

Mandal, R.D (1982) Land Utilizing: Theory andPractice Concept Publishing Company H-13 Bali Nagar New Dalhi-110015 (India).

Singh, Jasbir and Dhillon, S.S (2004) Agricultural Geography, Third Edition, Teta Me Grow- Hill Publishing Company Limited, New Dalhi.

The Political Importance of Myedu during the reign of Myanmar Kings

Nu Nu[1]

Abstract

I would like to describe the political importance of Myedu during the reign of Myanmar kings. Because of the situation of Myedu, it was a place for resisting the intrusion of Northern Shans. It had been the town which had resisted internal and external enemies for many years. It was a fortress town from the Bagan Period. Myedu produced faithful and qualified soldiers.

Introduction

Myedu had been successively ruled by *Myowun*, *Myosa*, *Thanmhu*, *Myingaung* and *Thugyi* during the reign of Myanmar kings. By the situation of Myedu, it had stood as a fortified fortress town. It had been the Strategic fortress in resisting against Mohnin Mogoung Shans, Kathes and Gwe Shans. It was famous for it's active and faithful soldiers. It became the recruiting ground for the rebellions of princes in the later Konbaung Period.

The Political importance of Myedu during the reign of Myanmar Kings

There were many fortress towns with brick walls in the Thunanpranta region before the Konbaung Period. The fortress towns expressed the importance of these areas. While the central administration was strong these fortress towns had to stand as strategically important fortress. While the central administration collapsed, these fortress towns became the stronghold for the enemies. Myedu was one of the fortress towns in the Thunanpranta region during the Bagan Period.[2]

Myedu is situated in the Kanbalu township, Kanbalu District, Sagaing Division, Upper Myanmar. It is thirty three miles away in the north of Depaiyin, eight miles away in the West of Kanbalu, one mile away from the bank of Mu River and it stands in the middle of Mu Delta. Geographically, it lies near the point between eastern longitude 95˚24' and north latitude 23˚12'[3].

Although Myedu is not well known today, it has been an important historic town for many years during the reign of Myanmar Kings. We can still see the old Myedu town's walls[4].

The nine places of Myedu had been built at the same time. Those were; Down town Myedu, four abodes for gods, nine pools, nine caves, nine satellite towns, nine lakes, nine moats, Yaza Thinchan home and fire steps. In constructing the downtown area, four sides of the moat had four gates, each of which was forty two feet wide[5].

Out of the four abode of the gods, the eastern abode, namely, Tholamaing, Southern abode, namely, Myinbyushin[6], eastern abode, namely, Saw Bilu[7], northern abode namely,

---

[1] Professor and Head. Dr. Department of History, Shwebo University

[2] Dr Toe Hla; Chindwin Myittha Mu Ayar (The land of Chindwin Myittha, Mu and Ayeyarwaddy) Yangon, Monywa Offset Press, 1995, P.37-38 (Henceforth; Toe Hla, 1995)

[3] Maung Kyaw Shin; Myetu, Yangon, Sapay Beikman, 2003, First Edition, P1 (Henceforth; Kyaw Shin, 2003)

[4] See photo 1, 2, 3, 4

[5] History of Myedu, Palmleaf Manuseript (Kar, obverse, line, 3-6), Wet_to village, Anuk Kyaung Sayadaw U Thu Zana's Collection (Henceforth; Myedu Palmleaf)

[6] See Photo 5

[7] See Photo 6

Salonmaw, were constructed respectively[1]. The nine pools were; Wettoe Inn, Southeast Pay Pin Inn, Southwest, Inn Petlet, northeast Taung Pyo Inn, Southeast, Wet Tite Inn, West Hlei Daunt Inn, West, Hmi Pyit Inn, West, Moe Thay Inn, north, Nat Inn, northeast. Nine caves were; Kanbya Zedi in the east, Okpho Zedi in West corner, Kutet in north, Kuni[2] northeast, Kuphyu[3] inside the town, Ku Pauk in South west respectively[4].

Nine satellite towns which were built at the same time with Myedu were Meiktila *Myo*, Aung Swa *Myo*, Kun Tai *Myo*, Taung Oo, Tayoketin *Myo*, Thabut *Myo*, Myoma, Khet Thin *Myo* and Nga Yant Tai[5].

Fifteen Lakes which were constructed at the same time with Myedu *Myo* were: Hton *Kan*, Nyan *Kan*, Kyei *Kan*, Kyarni *Kan*, *Kan* Gyi, Kair *Kan*, *Kan* Mauk, Kanbo, Kanma, Nagothin *Kan*, Sine *Kan*, Oukpho *Kan*, Tetkatho *Kan*, *Kan* Shay and etc[6].

Traditionally big cities had three moats. Myedu *Myo* also had three moats[7]. For the ruler of province, Governor (*Sawbwa*), Yaza Thinchan's home was also constructed[8]. The last one constructed with the same time with Myedu *Myo* was building fire step.

In recognizing the borders of Myedu, in the east was Ayeyarwaddy River, in the south was Kyauktaga, in the west was Chindwin River and in the north was Mogaung Nyaungphyubin. Between that area the king built over 2000 villages[9].

In the Bagan Period, Myedu was included in Nyan Tha *Taik*[10]. Myedu was 400. *Tapyu* Town in the Bagan Period[11].

By the situation of Myedu, it stood, as the exit and the entrance for the Mohnyin, Mogaung Shans. It stood as strategic points of northern Myanmar. A part from that, Myedu was home for royal soldiers. Myedu royal musketeers had fought the battles of Chinese Myanmar, Yodaya Myanmar, Kathe Myanmar, Mohnyin-Mogaung against the Shans and Anglo-Myanmar wars.

During the reign of Anawrahta, Myedu was governed by Shan chief HanBwa. Then Shan chief Han Bwa was assassinated by King Anawrahta. In 304 ME, the Chinese penetrated into Myedu. Myanmar repulsed them and repaired and extended the town[12].

Later Kings of the Anawrahta Dynasty indicate that the district was a part of the Bagan Kingdom from that time onwards until overrun by the Shans in 1298. Alaung Sithu is said to have visited Myedu. When he stayed on the hill known as the Myinkwataung, he built many pagodas including the Shwekugyi pagoda[13].

---

[1] Myedu Palmleaf (Kar, Reverse, line, 8-9)
[2] See Photo 7
[3] See Photo 8
[4] Myedu Palmleaf (Kar, Reverse, line, 1-3)
[5] Myedu Palmleaf (Kar, Reverse, line, 3-4)
[6] Myedu Palmleaf (Kar, Reverse, line, 4-5)
[7] Myedu Palmleaf (Kar, Reverse, line, 5-6)
[8] Myedu Palmleaf (Kar, Reverse, line, 6)
[9] Myedu Palmleaf (Kar, Reverse, line, 6)
[10] Dr Than Tun, *Myanmar Thamaing Shapontaw*, (Searching for Myanmar History), first Edition, 2003, Yonekyi chat sapay, P.122 (Henceforth; Than Tun, 2003)
[11] Toe Hla-1995, p.38
[12] A Williamson, ICS; Burma Gazetteer, Shwebo District, Vol.A, Yangon, Government Printing, 1924, Reprint, P396. (Hence forth Williamson, 1924).
[13] (a) Willianmson, 1924, P.13
(b) See Photo 9

After the collapse of the BaganEmpire, Sagaing was founded by Athin Khaya Saw Yun (1315-1327). During his reign, *Myauk Phet Myinne* (Northern Cavalry district region) was formed[1]. Myedu *Myo Thugyi* Nga Yan Naing was appointed as *Myin-gaung* (Captain of the Cavalry unit). There were twenty-four *Myinsis* (headman of the Cavalry) in Myedu Township[2].

Therefore, Myedu was in the Cavalry territory. The Cavalry units were very important for the Myanmar Kings. Apart from that Myedu was home for royal soldiers.

During the Innwa Period, Myedu was included in Northern *Taik*[3]. In the Sagaing-Pinya Periods, Mogaung *Sawbwa* San Long Hpa extended his domain down to Moksobo area. Myedu was governed by *Myosa* (Fief holder of a town) appointed by the Shan chiefs[4].

In the reign of King Thalun, Myedu was included in Shwe Ale Gyaung which lay between Mu river and Pyaung Thwe Chaung. It included all the lands in the west of Myedu[5].

Since the reign of King Thalun to the early Konbaung Period, Myedu was divided into two as upper area and lower area and each had to be ruled by one *Myothugyi*[6].

In the Myanmar monarchical days, Myanmar Kings fought various battles with the Shan Chiefs of Northern Mohnyin and Mogaung for control of Northern land. In the reign of Mingyi Swasawke (1367-1400), demarcation posts were erected to demarcate the realm of Myanmar King from that of Mohnyin *Sawbwa's* domain. Up to the year 1526, during a period of 155 years, there broke out ten wars between Myanmar and Shans implying that Myanmar and Shan fought each other once every fifteen years. In these wars, Mohnyin Shans reached Myedu in 1372 and 1392, and each time Myanmar capital had to send troops to defeat them[7]. During the Inwa King Mingyi Swasawke reign Myedu was repaired and constructed[8]. At that time, Myedu was reached under the Myanmar rule again. Mingyi Swasawke appointed That Shae Kyaw thin as *Myosa* at Myedu. But, in 1372 *Mohnyinsar* raided Myedu again. Mingyi Swasawke's son. Mingaung (1367-1414) penetrated the Shan territory and annexed up to Tagaung. Mingaung camped his troops at Myedu. In 1413, Mawdon, Mowke Shan *Sawbwas* attacked Myedu again and Einshe Min's troops resisted the Shans[9]. In AD 1499 Chinese King Utibwa had fought Mogaung, Monhyin through Myedu[10].

In 1502, Mohnyin *Sawbwa* Salone (Mohnyin Salone) attacked Myedu again from 1502, about 20 years, fightings occurred continuously in the surrounding at Myedu. Although Nayapati tried to gain back Myedu in 1511, it was not success. In AD 1523, Mohnyin Salone

---

[1] U Ka La, Mahayazawingyi (Great chronicle) Vols, Yangon, Hanthawady Printing Home, 1960, P335 (Henceforth; Ka La, 1960)
[2] Myedu Palmleaf (Ki- Reverse)
[3] Than Tun, 2003, P.122
[4] Willianson, 1924 P14
[5] Kyawshin, 2003, P.31
[6] Bandantta Kuthala, *Myedumyo Thamaing Tawgyi*, (History of Myedu *Myo*) Mandalay, Kuthan Young Wei Ye Press, 1933, first Edition, P48 (Henceforth; Kuthala, 1933)
[7] U Ba Mg (Professor) History Department, Myitkyina University Kachin Yetswe Thamaing (Chronological History of Kachin Land) (AD 556-1885) Vol. 1, 2002, P.ii
[8] Myedu Palmleaf (Ke, Reverse)
[9] *Hman Nan Yazawintawgyi* (Glass Palace Chronicle), Vol 3, Yangon, Myanmar Alin Thadin Sataik Press, 1993, February, Fourth Edition, P409 (Henceforth; Hman Nan, 1993)
[10] Hman Nan, 1993, P.91

had annexed Myedu and settled there[1]. Therefore after the downfall of Bagan, between 1225 to 1523, Myedu reached under the rule of Mohnin Shan for many years[2].

During the Taungoo Period, although Tabinshwehti could annex Innwa, he could not annex Myedu from the Shan. After Bayinmaung ascended the throne, he annexed Myedu. But between 1585 and 1590 Myedu was attacked by the Shan[3]. After the downfall of the second Myanmar Empire, Myedu was reached under the Shan influence again. During the 17th Century, Myedu was reached under the attack and rule of the Manipuris. During the reign of Mahadamayaza Dipati (1733-1752), Gwe Shan fortified at Male and attacked Myedu. Therefore Myedu faced with the attack of Gwe Shan after the Manipuris attacks[4].

In AD 1753 King Alaung Mintaya had given Myedu to his son who had conquered Innwa. When he acceded the throne in 1125 ME, he got white elephant from Magay *Myo,* he was called Hsinbyushin[5]. Myedu had been given as fiefs to Queens and Princess. They were King Singu's Queen Paduma Mahaythi[6], Yadana Maha Dewie (Younger daughter of King Badon)[7], Thiri Thusanda Mingala Dewi (Daughter of king Mindon)[8].

In the days of Myanmar Kings administrative regions were divided for easy execution. In AD 1765 in the reign of king Hsinbyushin, Myedu was included in the 13th Division of Thunapranta Division[9].

In AD 1817, during the reign of Badon, the whole Burma had been divided into twenty one Divisions and Myedu was also included in Thunanpranta Division[10]. In the reign of King Thibaw, Upper Myanmar was divided into ten Divisions. Myedu was included in the 9th Division of Yadanathinga[11].

During the reign of Myanmar kings, Myedu was governed by *Myowun*, *Myosa, Myingaung, Thanmhu* and *Thugyis*. In the later Konbaung Period, *Thin* Musketeer *Bos* had governed Myedu. By the 8 October 1877 settlement order, *Thin* Musketeer *Bo* and *Asu* had been offered fiefs at Myedu. Thin Musketeer *Thwe Thauk Kyee* was U Pho Myint[12].

In the early Period, Myedu royal Muskteers had fought the battles of Chinese Myanmar, Yodaya Myanmar, Kathe-Myanmar and Mohnyin-Mogaung against the Shans[13]. the later Konbaung Period, Myedu Muskteers and *Thwetauksu* had fought in the three Anglo-Myanmar Wars. Because of the failure in the first Anglo-Myanmar War (1824-26) Myanmar King extended *Thwetauksu* during 1829-1855. In 1854, there were 446 servicemen and totally 500 men consisted from Myedu at that military extension[14].

---

[1] Hman Nan, 1993, P.132
[2] Willianson, 1924, P.16
[3] Willianson, 1924, P.17
[4] Willianson, 1924, P.20
[5] Kyaw Shin, 2003, P.114
[6] U Maung Maung Tin, *Konbaungset Mahayazawingyi* (The Great Chronicle of Konbaung Dynasty) Vol.3, Yangon, Ledi Mandai Press, 1963, P.382 (Henceforth; Maung Maung Tin, 1963)
[7] Maung Maung Tin, 1963, P.395
[8] Maung Maung Tin, 1963, P.406
[9] U Tin; *Myanmar Min Okchok Pon Sardanhnin Bodaw Payaei Razathat Kaw thaw Ameik Pyan Tangyi* (Paper on administration of Myanmar Kings and Bodawpaya's code (or) File of Orders) Yangon, central Press, 1965, Vol III, P.82 (Henceforth; U Tin, 1965)
[10] U Tin, 1965, P.84
[11] Maung Maung Tin, 1963, P.632
[12] Toe Hla, 1995, P.43
[13] Hman Nan, 1993, P.409
[14] Toe Hla, 1995, P.83

The third Anglo-Myanmar War broke out in 1885 during the reign of King Thibaw (1878-1885). King Thibaw was faced with the threat of the English from the beginning of his ascending to the throne. So he prepared to protect these threats. He nominated *Thin* Musketeer *Bos* at Ngayane, Khawthanti and Myedu. On 29 August 1881, groups of (500) and (400) were formed and Musketeer Bo and Thwethaukkyee were appointed. Mg Tayoke was appointed as Myedu *Thin* Musketeer *Bo* and Mg Ponna was appointed as Myedu Western Column *Thwethaukkyee*[1].

In the later Konbaung Period, Myedu and surrounding regions stood as strongholds for the royal princes who wanted to get throne. They chose that areas because they assumed those lands as land of victory and a part form that Myedu was home for faithful royal soldiers. The princes who tried to get the throne from the base of Shwebo and Myedu strongholds were Tharawaddy, Mindon and Padain princes. When Tharawaddy Min (or) Konbaung Min's rebellion occurred on 24th February 1837, the officials of lower Myedu and Indaing Bo were the first to join Tharawaddy with their followers[2]. With the helps of Myedu and surrounding village headmen, Tharawaddy dethroned Bagyitaw in February 1837 and got the Amarapura throne. Tharrawaddy' son, Bagan Min was in his turn, deposed by Mindon Min. He too, in accordance with family precedent, made Shwebo his starting point. They already had a following in the towns and villages of the north including Madaya, Singu, Kyaukmyaung, Shwebo, Myedu, Dabayin, Pyinsala and Tantabin towns and a few of the officials, the Kyaukmyaung *Myook* for one were friendly also[3]. Bo Hlaing, the old Myedu *Wun* was sent to round up Tabayin, Pyinsala, Tantabin and Myedu and soon the majority of Shan *Sawbwas*, the *Myosa, Myooks, Wuns, Myingaungs*, *Myinsis* and *Thugyis* in the north acknowledged him[4]. On 18 February 1853, Mindon Min dethrone Bgan Min and ascended the Amarapura throne.

Myedu was to see yet one more rebellion, that of the Padainsa *Mintha* in 1866. The Padainsa was the son of *Einshe Min*, murdered by the Myingun prince in his unsuccessful palace revolt of that year. All Shwebo, Tabayin, Myedu and Pyinsala rose to join him and the Tabayin *Wun* took charge of a part of his army which set off via. Sheinmaga for the capital[5].

On their marching road, they were faced with king Mindon's troops and fought one another. But by the weakness of weapons from the Padain Prince's side, he was not successful. At the beginning, Myedu *Myosa* assisted the Padain Prince. But, later, they reached under Mindon Min.

Tabayin, Myedu, Pinsalanga-Myo, Ngayane and Kaw-Thandi were not required to furnish permanent troops in Mandalay after the Padainsa's rebellion, in which the *Ahmudans* of these districts joined. However, they were liable to be called upon to supply troops in time of war or when the king required them. Myedu men were found on garrison duty in the Shan States at the annexation[6].

In conclusion, Myedu had been famous since Bagan Period. It had been the main fortress in the north of Myanmar. It stood as the exist and entrance for the Mohnin Mogaung

[1] Toe Hla, 1995, P.87-88
[2] Willianson, 1924, P.35
[3] Willianson, 1924, P.37
[4] Willianson, 1924, P.37
[5] Willianson, 1924, P.38
[6] Willianson, 1924, P.168

Shan regions. It produced faithful and qualify soldiers and it had been birth place of warrior-heroes. It resisted internal and external enemies during the reign of Myanmar kings.

Conclusion

Myedu stood as strategic point of northern Myanmar. Myedu stood as the exit and entrance for the Mogaung-Mohnin Shan regions during the reign of Myanmar Kings. It was afortress town. Myedu was included in the *Myoukphet Myine* (Northern Cavalry district region). Myedu royal Muskteers had fought the battles of Chinese Myanmar, Yodaya Myanmar, Kathe-Myanmar and Monhyin Mogaung, Shans. Because of the military strength of Myedu, it became the recruiting ground for the rebellions of princes in the late Konbaung Period.

Acknowledgement

I would like to express my special thanks to Dr. Win Swe, Rector of Shwebo University, and Dr. Myo Myo, Pro-Rector of Shwebo University, for their kind permission to carry out this research.

Photo 1. Southern Town-Wall and Gate
Photo by Author 10-5-2020

Photo 2. Eastern Town-Wall
Photo by Author 10-5-2020

Photo 3. Western Town-Wall
Photo by Author 10-5-2020

Photo 4. Northern Town-Wall and moat
Photo by Author 10-5-2020

Photo 5. Myinbyushin abode
Photo by Author 10-5-2020

Photo 6. Saw Bilu abode
Photo by Author 10-5-2020

Photo 7. Kuni Pagoda
Photo by Author 10-5-2020

Photo 8. Kuphyu Pagoda
Photo by Author 10-5-2020

Photo 9. Shwekugyi Pagoda
Photo by Author 10-5-2020

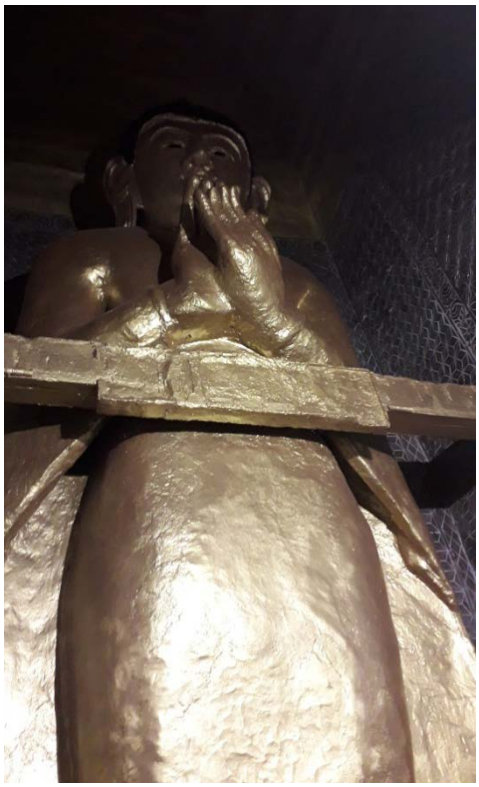


Photo 10. Shwekumyint Pagoda
Photo by Author 10-5-2020

Bibliography

1. History of Myedu "Palm leaf Manuscript, Wet-to village, Anauk-Kyaung Sayadaw U Thu Zana's Collection.
2. Ba Mg, U, (Professor), History. Department, Myitkyina University, *Kachin-Yetswethamaing* (Chronological History of Kachin land) (AD 556-1885) Vol.1, 2002.
3. *Hmannan Yazawin Tawgyi* (Glass Palace Chronicle), Vol.III, Yangon, Myanmar Alin Thadin Sataik Press, 1993, Fourth Edition.
4. Kala, U, *Mahayazawingyi* (Great Chronicle) Vol III, Yangon, Han thawady Printing House, 1960.
5. Kuthala, Bandantta; *Myedumyo Thamaingtawgyi* (History of Myedu Myo), Mandalay, Kuthan Young Wei Ye Press, 1988.
6. Kyaw Shin, Mg, *Myedu Myo* (Myedu Town), 1st Edition, Yangon Sapay-Beikman, 2003.
7. Maung Maung Tin, U, *Konbaungset Mahayazawingyi* (The Great Chronicle of Kongaung Dyansty) Vol III, Yangon, Ledi Mandai Press, 1963.
8. *Myanmar Sweson Kyan* (Myanmar Encyclo Encycelopaedia), Yangon, Sapay Beikman Press, 1964, first Edition.
9. Than Tun, Dr, *Myanmar Thamaing Shapontaw* (Searching for Myanmar History); first Edition, Yangon, Yomekyi Chat Sapay, 2003.
10. Tin, U; *Myanmar Min okchok Pon Sardanhnin Bodaw Payaei Raza that Kowthaw Ameik Pyan Tangyi* (Paper on administration of Myanmar Kings and Bodawpaya code (or) file of orders), Yangon, central Press, 1965.
11. Toe Hla, Dr, Chindwin Myitha Mu Ayar (The land of Chindwin Myitha Mu and Ayarwaddy), Yangon, Monywa offset Press, 1995.
12. Williamson, Mr.A.ICS, Burma Gazetteer, Shwebo District, Vol A, Yangon, Government Printing, 1924.

Administration of Shwebo Region in the Konbaung Period

Than Than Aye[1]

Abstract

In the administrative system of Konbaung Period, the king was a sovereign ruler with an absolute power. There were two systems of administration: *Ya-za-hta-ni Ôk-chôk-yei* (administration of royal city) and *A-wei-myo-ywa Ôk-chôk-yei* (administration of provinces). There were *Myo-wun* (governor of a town), *Myo-sa* ("eater" of a town), *Myo-thu-gyi* (head of township). *Thwe-thauk* (leader of a band of 50 men), *Shwe-hmu* (headman of gold producing tracts), *Than-hmu* (chief of iron workers) and *Thit-sei-hmu* (chief of tree gun workers) were also appointed. Shwebo Region was a cavalry administrative unit where a large number of brave horsemen appeared. The officers such as *Myin-gaung*, *Myin-si* and *Thwe-thauk* who were in charge of these cavalry areas were appointed by the king. These posts were the hereditary ones. Shwe-hnu was to rule gold workers and to present gold tax, was appointed by the king. Although *Shwe-hmu* was chosen in turn from anyone of the racial groups only the able person or the qualified group was given the right to rule. Gold, iron and resin were to presented as a tax to the King.

Key words : Administration, Judicial, tax

Introduction

In the reign of Mahadamayazadipati, Inwa royal city came under the Talaing on 1 March 1752. Meanwhile, U Aung Zeya, making Mok-hso-bo as a centre, strengthened his forces by means of organizing 46 villages. After collecting men and arms, he gradually extended his area. On 21 June 1753, he built 7 departments together with the royal palace. From that time onwards, a large number of towns and villages came under Alaungmintaya's control. The regions such as *Nga-so'* five villages in the north, Kawlin, Wuntho, Bánkyi 99 villages in the west, Kanni *Myo*, Badon *Myo*, Amyint *Myo*, Pakhangyi *Myo*, Myeidu *Myo*, Ngayanè *Myo*, Sipoktara *Myo* and Khawthandi came under Alaungmintaya's rule. As the country was reunified, Alaungmintaya ran the administration together with the military operations. In the reign of Alaungmintaya and Dabayin-min, Shwebo was a royal city. However, in the reign of successive kings, it was merely a key centre of administration. In the time of King Thibaw, Shwebo region was marked as *Na-wa-ma-hta-na* Yadanatheinga District consisting of nine towns or village tracts such as Yadanatheinga *Myo-wun-su-pa Myo-ywa*, Myeidu *Myo*, Kawlin *Myo*, Wuntho *Myo*, Ngayanè *Myo*, Khawthandi *Myo*, Pyinsala-nga *Myo*, *Shwe a shei gyaung* and *Shwe a le gyaung* villages.

Administration of the Shwebo Region in the Konbaung Period

In the administrative system of Konbaung Period, the king was a sovereign ruler with an absolute power. There were two systems of administration: *Ya-za-hta-ni Ôk-chôk-yei* (administration of royal city) and *A-wei-myo-ywa Ôk-chôk-yei* (administration of provinces). In the royal city administration, or the central administration there were five important administrative organs.[2] In the provincial administration, there were *Kha-yaing-wun* (governor of a district), *Myo-wun* (governor of a town), *Myo-sa* ("eater" of a town), *Myo-thu-gyi* (head of township) and *Ywa-thu-gyi* (village headman). The officers, equal in status to *Myo-thu-gyi*,

[1] Associate Professor, Dr, Department of History, Shwebo University.

[2] U Tin, *Myanmar-min Ôk-chôk-pôn Sar-dan* (Record on the Administration of Myanmar Kings), Vol.IV, Yangon, Government Press, *1976*, p.90 (Henceforth: Tin, *1976*)

such as *Myin-gaung* (captain of horse), *Myin-si* (cavalry officer), *Tan-gaung* (chief of an administrative unit), *Taing-gaung* (tax collector as well as village headman), *Thwe-thauk* (leader of a band of 50 men), *Shwe-hmu* (headman of gold producing tracts), *Ngwe-hmu* (officer of silver revenue), *Than-hmu* (chief of iron workers) and *Thit-sei-hmu* (chief of tree gun workers) were also appointed.[1]

Shwebo Region was a cavalry administrative unit where a large number of brave horsemen appeared. The officers such as *Myin-gaung*, *Myin-si* and *Thwe-thauk* who were in charge of these cavalry areas were appointed by the king. These posts were the hereditary ones. In the reign of Bandon *Min*, he formed *A-su-a-ngan*s (groups and divisions) concerned and scrutinized, the population and works. In this way, he attempted to know the condition of manpower or the number of people. In case of war, the groups concerned were responsible for sending or giving the necessary number of soldiers and aids for them. *Myin-gaung* and *Myin-si* had to manage the expense and expenditure and the living condition of the servicemen or soldiers served under them and their families. In case of war, they had to take military service and in time of peace they had to undertake cultivation by group.

In the 1783 *Sit-tan*[2], the condition of manpower of three villages in the war zone was mentioned as follows:

area	number of house	male + female = total
Paung-taung-ku	16	49 + 44 = 93
Pauk-taw	27	44 + 25 = 69
Sipoktara	50	147 + 79 = 226
Totals	93	240 + 148 = 388

The above mentioned table shows that the total population area 388 in 93 houses. *Myin-si-gyi* collected the list of followers and *Ywa-thu-gyi* took the list of *A-thi* (native non-serviceman), ala (person coming from the union of *a-thi* and kappa) and kappa (immigrant or alien non-serviceman). In doing so, although someone moved from his native village to other places and settled there, he was to be listed in the house list of the native group. According to the list collected by Nga Htwe Kywe[3] in 1783 who ruled the*thit-sei* six villages which produced tree gum or wood oil or resin, we may know the house list and the population moving to the other region.

It was mentioned as follows:

Village name	house in village	house in other village	total population
1. Taung-oo*Ywa*	10	56	233
2. Paka*Ywa*	13	61	263
3. Sithin*Ywa*	7	19	87
4. Khaung-nya*Ywa*	8	9	67
5. Leik-chan*Ywa*	4	0	11
6. Taung-houn*Ywa*	12	16	102
Addition	-	11	30
Totals	54	172	793

[1] Tin, *1976*, 105

[2] Ye Oo U Thaung, "*Let-hneit-set-mu*", Thaung *Sar-su* (Thaung Collection), p.3 (Henceforth: Thaung Collection)

[3] Thaung Collection, 4

By collecting the list of manpower systematically, the condition of enabling to take military service might be known and the administration could be run smoothly. The *Myo-wun* (governor of a town) was to administer *Myin-gaung* (captain of horse), *Myin-si* (cavalry officer) and *Shwe-thu-gyi* (headman of gold producing tracts). The town-governor was appointed by the king.

King Badon issued an *A-meint-daw* or royal decree on 12 February 1806[1] as follows:

> Let not lawless person and thief appear in north Mawton, Mawke, Pinchaing, Pintha, Intauktha... Intaing five villages and Naung-kauk ten villages ... let Yan-khwinThura be appointed as Wun giving 200 guns.
>
> Let Shwe-taungLetwè-Kyaw be appointed as Wun and administer Nga-yanè, Khaw-thandi, Sipok-tara, Htandabin and Nyaung-sin villages.

It is known that according to the 1783 *Sit-tan*, there was the appointment[2] of *Than-hmu* Thura-thara and *Than-hmu* Ye-khaung Deva-Kyaw-htin in Myeidu *Myo*. The words "*Tain-gaung* Nga-kauk"[3] and "*Tain-gaung* Nga-pu"[4] were also mentioned in these *Sit-tan*.

It was mentioned in the 1802 *Sit-tan* of Myeidu *Myo Auk-taik Thu-gyi* Nga War as follows:

"Let Mauk-te-ywa *Pyi-so* present 300 resin in a year and Nan-taun-yon *Pyi-so* 60 resin in a year".[5]

The term *Pyi-so* indicates the administration of the hereditary chief of town or village. *Pyi-so* was the chief who managed and administered the town. It seems that he was superior in status to *Thu-gyi*.[6]

The interrogation statement, dated 16 April 1763, and Khawthandi *Myo-thu-gyi* Nga Shan Pauk (45 year of age) and Nga San Aung (37 year of age) mentions as follows:

> If Nga-thit-sa passed away Nga-shwe-myat ruled, if ... Nga-bo-naung, if ... great-grandfather Nga-phyo-khaing, if ... grandfather Nga-myat-so, if... father Nga-pu, and if ... son Nga-shan-pauk ruled".
>
> "Nga-san-Aung also ruled *Myin-su* separately as his great-grandfather Nga-zei-tu and Nga-bo-naungwere brothers.[7]

These statements indicate that Khawthandi cavalry officers ruled their towns and villages traditionally and their succession was hereditary.

---

[1] Dr Yi Yi, "*Konbaung-khit Myo-ne Ôk-chôk-pôn*" (Provincial Administration of Konbaung Period), *Sarpeihnint Lu-hmu-yei Theit-pan Journal* (Union of Burma Journal of Literary and Social Sciences), Vol.I, No.2, Yangon, *1968*, p.380 (Henceforth: Yi Yi, *1968*)

[2] "*Myeidu Myo Tha-maing Pei-mu*" (Palm-leaf Manuscript on History of Myeidu Town), Kyaw Shin Sarsu (Kyaw Shin Collection) (Henceforth: Myeidu MS)

[3] *Tain-gaung* means Chief who had to levy tax and arrange or organize or administer the village. *Tain-gaung* is equal in status to *thu-gyi* or headman.

[4] Myeidu MS, Verso Kei

[5] Myeidu MS, Obverse (Recto) kei

[6] Yi Yi, *1968*,

[7] Khawthandi *Myo* 1763 *Sit-tan*, Dr Than Tun Collection

It cannot be said that the son and the grandson in the line of succession had the right to rule only when one ruler passed away. It is found that if the ruler was old and infirm or ill, he was to transfer his post. In doing so, the younger brother was entitled to the succession because the son, as an *A-hmu-dan-gyi*, could not undertake the post of *Myo-thu-gyi*.

It was mentioned in the 1765 *Sit-tan* of Sipoktara *Myo* as follows:

> My great grand-father ThamantaThetkayaza ruled Sipoktara. When he passed away his son Zeya Thamanta ruled. I, Thirithura, succeeded because Zeya Thamanta was old. If Thirithura did not take the *Myo-thu-gyi* post because he was an ahmu-dan-gyi I, son, Nga- myat-tho-oo administered.[1]

Thit-sei-hmu (chief of tree gun workers) administered those who lived in the resin producing region. He was the hereditary ruler. The following statement –

> Thugyi U Hpon ruled Taung-hon-ywa including in *Thit-sei* six villages in the reign of Badon-min-taya in 1783. Then, Maung-án, son, ruled in the reign of Myedaw Mintayagyi. Then, Maung-hmaung, son of *Thu-gyi* Maung-án, ruled in the reign of Shwebo-min-tayagyi in 1836".[2]

supports the fact of the hereditary succession and rule.

Shwe-hmu (headman of gold producing tracts), whose duty was to rule gold workers and to present gold tax, was appointed by the king. The villages including in the eastern gold producing tract were Maw-naing, Man-in, Nan-mar, Gaba, Maw-haing, Maw-teit, Maw-khwin, Gyo-taung, Khauk-sin, Set-tàw, Taung-htun, Malar, Si-nan, Ganama and Gananbwar. The villages including in the middle gold producing tract were Met-taung five villages. In-taing five villages, Naung-kauk ten villages, Kyun-hla-ywa, Sein-nan-ywa, Thit-sei six villages and Shwe-kyin thirteen villages.[3]

There were two gold producing tracts- *Shwe-a-shei-gyaung* (eastern gold producing tract) and *Shwe-a-le-gyaung* (middle gold producing tract). There was the difference in the type of administration between these two tracts. In the eastern gold producing region where the groups of Gadu, Ganan and Shan mingled and lived together, the hereditary succession, selecting or appointing, was not accepted. Only those person who was liked by the racial groups or by the villages which presented gold as a tax was elected and recognize as *Shwe-hmu* (headman of gold producing tracts). Although *Shwe-hmu* was chosen in turn from anyone of the racial groups only the able person or the qualified group was given the right to rule. On the other hand, the king appointed the person, who was put up or elected by them, with a *da-gyaungsar-chun* or one line royal appointment order written on palm-leaf, without removing him. Later, this system was practised only in the separate villages of Gadu and Ganan when the Shan was predominant.[4] In the other places, the hereditary rule continued to be practised. The *Shwe-hmu*s were those who had the right to contact directly with the sovereign.

The *Shwe-hmu*s of the middle gold producing tract ruled according to their hereditary rights of succession. The 1783 Mat-taung five villages *Sit-tan* states that

---

[1] Sipoktara *Myo*, 1765 *Sit-tan*, Dr Than Tun Collection

[2] *Ngwei Peimu* (Silver Palm leaf Manuscript), Line - 4, U Kyaw Shin Collection

[3] Maung Kyaw Shin, *Shwe-a-le-gyaung* (Middle Gold Producing Tract), Yangon, Sarpei Beikman Press House, *1996*, pp.49-50 (Henceforth: Kyaw Shin, *1996*)

[4] Gadù *Ôk-chôk-yei* (Administration of Gadu), Let-hneit-set-mu, Kyaw Shin *Sar-su* (U Kyaw Shin Collection), p.133 (Henceforth: Gadù *Ôk-chôk-yei*)

> "My great-grandfather Nga-e ruled Mat-taung five villages which presented the gold tax. When he passed away grandfather Nga-san-htun ruled. When he passed away father Nga-chit-htwe ruled ... Nga-e-paing ruled".[1]

This statement indicates the hereditary succession and rule. However, when Nga-e-paing passed away his son *Shwe-hmu* was unable to rule. So, *Kyei-htan-gyi*s[2] (royal tax collectors at the village level) of Mat-taung five villages ruled in turn. In relating to the change of administration, it was mentioned that

> When Shwe-hmu Nga-e-paing passed away Wet-pokmytei-tain Nga-aung-tha, not a blood relative, ruled. ... Kon-aing-thaNgaNaing, not a blood relative, ruled. ... Mat-taungAsou-tha Nang-that Thugyi Nga Aung Pan ruled. ...Kon-aing-tha Nga Hmounnot a blood relative, ruled . ... he entered the list into the 1802 royal treasury roll and ruled.[3]

This statement shows that though the king appointed *Shwe-hmu*s with one line royal appointment orders there was the rulers who administered without appointment orders.

Some *Shwe-hmu* sent report through *Kyi-wun* (officer of granaries) to *Hlut-taw* (Great Council of State or Supreme Court) informing that they wanted to rule according to the hereditary succession. In intaing five villages *Shwe-hmu* Nay-myo Thuwana Thinkhaya submitted and addressed to the king that he would always present the gold tax continue to rule as *Shwe-hmu*. Thus, the king passed *A-meint-daw* (royal decree or edict) with *da-gaungsar-chun* (one line royal appointment order) as follows:

> ... Lord or Water and Land, Master of the Great Chaddanta Elephant, Lord of the White Elephants, Lord of the Wondrous Setkyar Weapons, Lord of Life, His Righteous Majesty ... 6 February 1847, let Thuwana Thin-kya-ya continue to rule In-taing five villages with the post of *Shwe-hmu*.[4]

Together with this royal appointment order, he received the letters of *Hlut-taw wun-min* or minister, Atwinwun (Interior Minister or secretary or, privy councillor), *Kyi-wun* (Officer of Granaries) and Yenan-gyaung *Myo-sa* Thadomingyi Thet-taw-shei.

It is found that the post was transferred to the other one without ruling with hereditary succession. Because *Shwe-hmu*s were appointed by the king they had to submit stage by stage if the changes were needed.

Kyi-wun was informed that

> If Thugyi Nga-hpar-nyo of Kyiwun Wumsu Mawkhwin four villages passed away Nga-san-pwint, son of succession of office, could not succeed and perform, ... let Nga-kyun-eye perform and rule".[5]

---

[1] "*U Shwei Nú Parabaik*" (Folder Paper of U Shwe Nu), Kyaw Shin *Sar-su* (U Kyaw Shin Collection)
[2] *Kyèi-htàn-gyì* means royal tax collector at the village level
[3] "*Shwei-hmu Shin Aung Parabiak*" (Folded Paper of *Shwe-hmu* Shin Aung), Kyaw Shin Sarsu (U Kyaw Shin Collection)
[4] "*U Bo Chouki Sarchun*" (Appointment Order of U Bo Choke), Kyaw Shin *Sar-su* (Kyaw Shin Collection)
[5] "Wuntho *Sit-tan*", Than Tun Collection, pp.19-20 (Henceforth: Wuntho)

As a result of this, *Kyi-wun* had to submit the change of rank or office or position to the *Hlut-taw*. Together with the letter of *Kyi-wun*, the application of *Thu-gyi* went to the king. The king passed the appointment order. There *A-meint-daw* was reported and submitted by *Kyi-wun* to the *Hlut-taw*. Then the *Hlut-taw* had to submit the report on the change of list to the king. If the king showed permission the *Hlut-taw* passed the two line *Thu-gyi* appointment order. Then, the *Hlut-tawWun-gyi*s ordered and instructed the *A-twin-wun*s to make the change of list in *Shwe-taik-taw* or royal treasury. The record was written and listed through *Wun-dauk-taw-min* (next in rank and status to minister or assistant minister or officer who assisted the *Hlut-taw* ministers) and *Lu-lin-sa-yei* (young man or youth clerk). The person who was appointed had to submit the new list of *Sit-tan*. The transfer of the post was not easy as it went through stage by stage and step by step.

Together with one line *sar-chun* order of the king, the group of the *Hlut-taw* ministers passed the two line *sar-chun* order consisting of the facts and matters in relation with the duties of *Shwe-hmu*s, observance of the order of *Shwe-hmu* by the villagers, clearance of crimes, village community. It was mentioned in the letter of *Wun-min*s or ministers that

> Naung-kauk-kyi Village *A-si-yin Thu-gyi, Khaun-gyi* and *Kyei-htan-gyi* (royal tax collector at the village level) shall observe and perform the order of *Shwe-hmu* Nga-pyar. *Shwe-hmu* Nga-pyar ... must also observe the order concerned."[1]

With regard to the administration of towns and villages, areas of jurisdiction, areas of administration and the demarcation of the areas were mentioned in the 1783 written as follows:

> Kyun-hla *Shwe-hmu* ... one tain (1000 tar distance or 2 miles) in the east up to Mu back of other land, 500 *tar* (equal to 7 cubits) in the south-east up to Pyaung-thwe stream mouth back of Myeidu land,[2]

It is known that the area of jurisdiction and administration was marked by stream or creek from land and tree. In order to make the administration systematic, the demarcation was carried out in this way. It is also possible that it was done for *loke-myei* (land for working) and *nei-myei* (land for residing) and for preventing land disputes.

Shwe-hmu, equal in status to *Myo-thu-gyi*, received*A-si-a-nin* (conveyance or vehicle) and *A-saung-a-ywet* (insignia of office). Some *Shwe-hmu* obtained, together with *A-saung-a-yaung* or insignia of office,[3] two full-grown female elephants, and sometimes only one. Certain headman of gold producing tracts received a horse alone without getting elephant. Some *Shwe-hmu* had a right to reside in a house of seven chambers of second *du-yi* status, and some in a five chamber house of same status. These insignia and titles were conferred by the king. *Shwe-hmu* was mostly appointed by one line royal appointment order of the king, two line *Sar-chun-daw* order of the *Hlut-taw* ministers, *Kyi-wun*'s*sar-chun-daw*, *Shwe-wun*'s*sar-chun-daw* and *Na-khan-daw*'s *pyan-dan* (King's order promulgated by the *Hlut-taw* or modification).

Gold iron and resin were to the presented as a tax to the king. To do so, *Shwe-hmu* and *Than-hmu* had to levy the taxes on the native peoples. According to the 1802 Settaw–ywama *Sit-tan*,[4] we know that two *kyats* per house were to be presented as a gold tax. It was a

[1] "U Bo Pyan *Sarchun*" (Appointment Order of U Bo Pyan), Kyaw Shin *Sar-su* (U Kyaw Shin Collection)
[2] Kyaw Shin, *1996*, 194
[3] Wuntho, 17
[4] *Sett-taw Ywama Sit-tan* (*Sit-tan* of Set-taw Ywama), Tarpaw *Sayardaw Hmattan* (record of Tarpaw *Sayadaw*), Kyaw Shin Collection

custom to pay one *kyat* for *wun-sar* fees, two *mat* for *yei-sar* fees, one mat for *htein-sar* fees and one mu for *wun –kain* fees on gold tax ten.After imposing the tax on one house after another, the total gold revenues were presented to the king.

Shwe-hmu who had to present revenue at the most in the *Shwe-a-le-gyaung* tract was Shwekyin 13 villages *Shwe-hmu*. He had to present 1550 *kyat*s as a tax. Kòun-ain-ywa *Shwe-hmu* had to present 500 *kyat*s, Sein-nang-ywa *Shwe-hmu* 400 *kyat*s, and De-yòun six villages *Shwe-hmu* and Kyun-hla *Shwe-hmu* 300 *kyat*s respectively. *Shwe-hmu* who had to present the royal tax at the least was Wei-thaw-ywa *Shwe-hmu*.[1] He had to present 60 *kyat*s as a tax. There appeared land disputes in the villages of *Shwe-hmu*s. In-tauk-thar *Myo-thu-gyi* said that he owned Met-taung-ywa and Nghet-kya-ywa including in Kyun-hla Shwe-su-win Region. He frequently came to and imposed taxes or charges. Thus, there occurred quarrels about who should own the land. Regarding this event, King Mindon issued a royal order on 17 November 1854 as follows:

> In quarrel between In-thauk-thar *Myo-thu-gyi Myo-sa-yei* (Town Constable, Biliff, Inspector of Police) and Naung-kauk-ywa *Shwe-hmu*, let villages involving in litigation order and judge.[2]

It is found that *Shwe-hmu* won in these lawsuit.

For the disappearance of crimes on thieving and robbing in the kingdom, Alaungmintayagyi issued a royal edict as follows:

> If someone last the property from being stolen by the thief in towns and villages in every place, *Myo Ywa Thu-gyi* ... were to compensate the owner of property. If someone lost the property from being robbed by robbers in the intervals (intervening spaces) between the towns and between the villages, ... *Myo Ywa Thu-gyi*, near to the place where ... lost property, were to compensate the lost property".[3]

. King Badon issued an *A-meint-daw* that *Myo-wun*s concerned were to capture the thieves and robbers, to appoint *Ywa-thu-gyi*s to capture them unless they captured *Myo-wun*s and *Thu-gyi*s were to be judged or punished in accordance with criminal law. Regarding the case of thieving the two cows of Khawthandi *Myo-thu-gyi* Nga Thet Aye, enquiries and searches were made and the villagers of Sain-net-pyit were accused if thieving. Although *Thu-gyi*, owner of the cows, was called to face the case he failed to come. After over three months, he put forward the case again. *Myo-ôk-min* (officer of Town) judged in favour of Nga Thet Aye that the accused were to compensate price money for the cows to NgaThet Aye. It may be supposed that one-sided judgement was made without questioning thoroughly. In fact, it was the unjust and unfair settlement. The poor common peoples were in trouble due to the corruption and bribery of the provincial and local rulers or officers in hierarchy.[4]

---

[1] Ma Kyan, *Konbaung-khit A-khun-daw Yei-yar* (Revenue System in Konbaung Period), Yangon, Taw Win Myo Ma Press, 2009, p.60 (Henceforth: Kyan, *2009*)
[2] Kyaw Shin, *1996*, 319
[3] U (Maung Maung) Tin, *Konbaung-set Ma-ha Ya-za-win-daw-gyi* (Great Chronicle of Konbaung Dynasty), Vol.I, Yangon, Yar Phei Press, *2004*, p.84 (Henceforth: (Maung Maung) Tin, *2004a*)
[4] Thaung Collection, 256

Conclusion

In the reign of Alaungmintaya, he was unable to start collecting the *Sit-tan*s as he was busy with organizing and unifying the unstable country. During the reign of Myedu-min, he started to collect the *Sit-tan*s. Under King Badon, the two *Sit-tan*s were collected and investigated. The collection of *Sit-tan* aimed at knowing the extent and area of administrative land unit, the system of taxation and the hereditary ruling system. On 1 December 1783, Badon-min started to collect the *Sit-tan*s around the whole country. In doing so, he received the *Sit-tan* records from the provincial or local chiefs such as *Myin-gaung*, *Myin-si*, *Thu-gyi*, *Shwe-hmu*, *Ngwe-hmu*, *Than-hmu*, *Tan-gaung*, *Pyi-so* (hereditary chief of town or village) and *Thwe-thauk* (leader of a band of 50 men).

Acknowledgements

I would like to express my heartful thanks to Dr. Win Swe, Pro-Rector (Rector's duty), Pro-Rector Dr Myo Myo, Shwebo Unversity, for their encouragement to submit this paper. I would like to express special thanks to Dr Nu Nu, Professor and Head, Department of History, Shwebo University for her kindness and valuable suggestions and allowing me to carry out the present research.

References

Primary Sources

***Parabaik*s**

"*Parabaik of Kyun Hla Gain-chok Sayadawgyi U Tiloka*", Kyaw Shin Collection

Parabaik (folded paper), *Thamaing Htarma* (Department of History), *Mandalei Tetkathou* (University of Mandalay), Dr Than Tun Collection

"*Shweihm Ú Shin Aung Parabiak*" (Folded Paper of *Shwe-hmu* Shin Aung), Kyaw Shin Sarsu (U Kyaw Shin Collection)

"*U Bo Choke Parabaik*", Kyaw Shin Collection

"*U Shwei Nú Parabaik*" (Folder Paper of U Shwe Nu), Kyaw Shin *Sar-su* (U Kyaw Shin Collection)

Pei

Myedu MS, Observe Kei, Kyaw Shin Collection

Ngwei Peimu (Silver Palm leaf Manuscript), Line - 4, U Kyaw Shin Collection

Sarchun

"*U Bo Chouki Sarchun*" (Appointment Order of U Bo Choke), Kyaw Shin *Sar-su* (Kyaw Shin Collection)

"U Bo Pyan *Sarchun*" (Appointment Order of U Bo Pyan), Kyaw Shin *Sar-su* (U Kyaw Shin Collection)

***Sit-tan*s**

Khawthandi *Myo* 1763 *Sit-tan*, Dr Than Tun Collection

Naung-kauk Ten Villages *Sit-tan*s, Kyaw Shin Collection

SettawYwama Sit-tan (*Sit-tan* of Settaw Ywama), *Tarpaw Sayardaw Hmattan* (Record of Tarpaw *Sayadaw*), Kyaw Shin Collection

Sipoktara *Myo* 1765 *Sit-tan*, Dr Than Tun Collection

"Wuntho *Sit-tan*", Than Tun Collection

Unpublished Books

"*Ga-du Hmat-tan*" (Record on Gadu), Kyaw Shin Let-yei-mu (Han Written Script of Kyaw Shin), Kyaw Shin Collection

Gadù *Ôk-chôk-yei* (Administration of Gadu), Let-hneit-set-mu, Kyaw Shin *Sar-su* (U Kyaw Shin Collection)

Kyaw Shin, U, "*Shwe-a-shei-gyaung*", Let-hneit-set-mu, Kyaw Shin *Sar-su*

"*Myeidu Myo Tha-maing Pei-mu*" (Palm-leaf Manuscript on History of Myeidu Town), Kyaw Shin Sarsu (Kyaw Shin Collection)

Ye Oo U Thaung, "*Let-hneit-set-mu*", Thaung *Sar-su* (Thaung Collection)

----------, *Let-yei-mu Sar-su* (Hand written script collection)

Published Books in Myanmar

Kyan, M, *Konbaung-khit A-khun-dawyei-yar* (Revenue System in Kongbaung Period), Yangon, Taw Win Myo Ma Press, 2009

Kyaw Shin, Maung, *Shwe-a-le-gyaung* (Middle Gold Producing Tract), Yangon, Sarpei Beikman Press House, 1996

Kyaw Shin, *Myeidu Myo* (Myeidu Town), Yangon Bohou Press, 2003

Kyaw Shin, U, *Gadu*, Yangon, Sarpei Beikman Press House, 2000

(Maung Maung) Tin, U, *Konbaung-set Ma-ha Ya-za-win-daw-gyi* (Great Chronicle of Konbaung Dynasty), Volume.I, Yangon, Yar Phei Press, 2004

Shwe-bo Nidan (Introduction to Shwebo), *Myo-ne Sarpei-Loke-thar A-phwè* (Group of Township Writers), Yangon, Lout-ar Press, 1983

Tin, U, *Myanmar-mi Ôk-chôk-pônSar-dan* (Record on the Administration of Myanmar Kings), Volume.II, Yangon, Government Press, 1965

----------, *Myanmar-min Ôk-chôk-pônSar-dan* (Record on the Administration of Myanmar Kings), Volume.IV, Yangon, Government Press, 1976

----------, *Myanmar-min Ôk-chôk-pônSar-dan* (Record on the Administration of Myanmar Kings), Volume.V, Yangon, YinkyèihmÚ Beikman Department, 1983

Journals

Yi Yi, Dr, "*Konbaung-khit* Myo-ne Ok –chok-pon" (Provincial Administration of Konbaung Period), *Sarpeihnint Lu-hmu-yei Theit-pan Journal* (Union of Burma Journal of Literary and Social Sciences), Volum.1, No.2, Yangon, 1968

An Evaluation of Selected Doctrines on Chinese Traditional Thought

Lay Mi Aung[1]

Abstract

This paper attempts to present some significant doctrines such as self-cultivation, preservation of life, all-embracing love and reward and punishment. Chinese traditional thought gives on essential importance to the issue of individual character improvement. It is mostly concerned with actual daily life of men. The doctrines of Chinese thinkers are not the same to each other but their central aims are to develop ideal state and ideal society. By studying the doctrines of Chinese tradition, we can achieve the sense of moral, social and political responsibilities. The cultivation of citizen's moral character is the fundamental level for establishing a rational society and an essential level of human development. New politics and new social affairs have developed out of the old politics and old social affairs. Thus, this paper will contribute to emerge a new doctrine, a new culture and a new system from the old doctrines.

Key words: self-cultivation, preservation of life, all-embracing love, reward, punishment

Introduction

There are many significant doctrines in Chinese traditional thought. Among them, this paper exposes some doctrines such as self-cultivation, preservation of life, all-embracing love, and reward and punishment. These doctrines are not the same to each other but their central aims are to develop ideal state and ideal society. Chinese thought occurs in four periods; the ancient period (until 221BCE), the middle period (221BCE-960CE), the modern period (960-1900), and the contemporary period (from 1912). A great number of schools arise during the period of suffering and unrest in China. The hundred numbers of Schools has one thing in common, their primary concerns with man both as an individual and as a member of society. The most prominent schools are the Confucianists, the Taoists, the Mohists, the school of the Name, the Yin-Yang school and the Legalists. The ancient Chinese thinkers accept that the purpose of learning and cultivation is to better one-self and society. In fact, Chinese traditional thought mostly concerns with actual daily life of man.

Firstly, it presents that Confucian ethical doctrines are based on humanistic and social phenomena. Confucian mainly emphasizes on the social responsibilities of man. The Doctrine of self-cultivation plays a vital role in their hope for a better, more ethically focused society. Confucian desires a society governed by virtuous persons, who through personal and moral persuasion rather than law or punishment, will bring about the people welfare and social order. Again, it shows that to be useless, for Taoists, is the way to preserve one's life. The man who is skillful in preserving life much do not much evil, but neither must do much because he must live midway between good and evil. This is regarded as the doctrine of the preservation of life.

Then, it expresses that thought of Mo Tzu in Mohism promotes anti-war sentiments and universal love. He encourages men to practice all-embracing love. Because he accepts that the practice of "mutual all-embracingness" is right conduct and the practice of "discrimination" is wrong conduct. Finally, it explains that Han Fei Tzu, a legalist, utilizes reward and punishment as the "two handles" of government. He argues laws and

[1] Associate Professor, Dr, Department of Philosophy, Shwebo University

punishments can effectively prevent socially disruptive behavior. That is why, the best way that the government should practice to control the people is rewards and punishments.

Chinese traditional thought gives on essential importance to the issues of individual character improvement. The cultivation of citizen's moral character is the fundamental level for establishing a rational society and an essential human development. Traditional doctrines should be combined with the new realm of ethical values related to the philosophy of contemporary life.

The Doctrine of Self-cultivation in Confucian Thought

Confucius (551B.C), an upheld tradition, says that he is a transmitter but not an originator. While he transmits the traditional institutions and ideas, Confucius gives them interpretation derived from his own moral concepts. The first of his basic moral concepts is humanity (***ren***). Humanity is the moral character that developed in oneself and in one's relation with another. A man of humanity wants not only to establish his own character but to guide the character of others. To flourish personal and social morality, everyone needs to cultivate with humanity. For Confucius, any man may be a gentleman if his conducts are noble, unselfish, just and kind. To be a gentleman, it is not regarded depending on his birth, but on his moral cultivation.

Man's action should proceed from ***ren*** and be regulated by ***li*** as moral discipline. It is noted that everyone must not fail to cultivate his personal life. The concept of ***li*** as the greatest virtue should be applied in the social responsibilities that lead to the development of men and society. The idea of ***yi*** which means righteousness or dutifulness is also important concept in Confucian ethics. This concept leads to the unity of state and people. Confucian attitude is also to cultivate the man's behavior into family reverence. Everyone should be cultivated to develop a well-ordered society by guiding the rules of propriety and righteousness. Besides, being love one another will be prevented from the arising of all harmful results to develop a well-ordered of the state.

The concept of wisdom (***zhi***) is very important to man to know himself and the world. It is defined as memory, purpose, uprightness, straightness, honesty, justice. Man's most important knowledge is self-knowledge. Because self-knowledge will not deceive himself about the motives and his actions. The purpose of learning is to better self-knowledge and society. Wisdom involves not only learning, but also recognition of the way and ability to perceives situation accurately and make correct decisions. A man makes the right decisions based on wisdom. Without wisdom, it is not easy to build the development of human life and society. It can be said that wisdom is an essential part of self-cultivation. ***Ren*** and ***Zhi*** are like two wings, by supporting each other. Thus Confucius says that wisdom is to know men, but virtue is to love men. He also encourages men to think for themselves. It will be accepted that self-cultivation is achieved by practicing the doctrines of ***ren, li, yi, and zhi.***

Mencius (372-289 BC) is a disciple of Confucius's grandson. It is found that like Confucius, he also lives in a period of political struggle, moral chaos and intellectual conflicts. He desires that government depends upon good administration, underscoring the need of moral cultivation on the part of the ruling class. His thought is optimistically humanistic as he believes that human beings have inherent goodness. He accepts that all men were born with the same kind of nature. If they are guided by their innate feelings, then they will do what is good. All men in their original nature possess four good feelings which are

the four beginnings of the four great virtues of ***ren, li, yi*** and ***zhi.*** He also desires men to cultivate their original nature by practicing four great virtues. Concerning self-cultivation, Mencius presents as follows;

> "From the feeling of commiseration is essential to man, that the feeling of shame and dislike is essential to man, that the feeling of modesty and complaisance is essential to man, and that the feeling of approval and disapproval is essential to man. These feelings are the principle respectively of benevolence, righteousness, propriety and the knowledge of good and evil. Men have these four principles just as they have their four limbs"[1]

It is regarded that the original nature of man has four good feelings; the feeling of commiseration, the feeling of shame and dislike, the feeling of reverence and the sense of right and wrong. A person who lacks the feeling of commiseration, the feeling of reverence and the sense of right and wrong is not regarded as a man. These feelings are differentiating man from the beasts. Mencius guides ways in which man can preserve his original goodness. Man should first of all have to be good and to do good things. Men are naturally good but the environmental factors play large apart in the influence of his character. These virtues develop naturally from within as a tree grows by itself from the seed, or a flower from the bud.

Mencius accepts that morality is not inherent in human nature. He wants to maintain intrinsic goodness. All men are potentially perfectible, regardless of hereditary states. His assertion is that everyone can become a sage; and everyone is equal to everyone else. For him, people are the most important factor in government, and they have the right to revolt. For example, if a leader lacks the ethical qualities that a good leaders acts, the people have the moral right of revolution; if a sovereign does not act as he ideally ought to do, he morally ceases to be a sovereign. He regards man as a political animal. Man can develop the relationships only within state and society. The state is a moral institution and the head of the state should be a moral leader. It can be known that Mencius' political thought bases on the four feelings and the four beginnings of virtues. Because he says that only a sage can be a real king. One who cannot abide by humanity and follow by righteousness is to throw oneself away. Humanity is the peaceful abode of men and righteousness is straight path. Even if one cannot have both of them, he should give up life but choose righteousness.

The proper cultivation of emotional nature can be achieved only by the constant "accumulation of righteousness". It is recognized that one must always act morally because everything one does will react, for good or ill, on the development of one's own character. In brief, humanity is the characteristic of man; propriety is the correct position in which the world should ever be found, righteousness is the great path which men should ever be pursuing, and wisdom is knowledge of right and wrong.These virtues lead to man's spiritual and physical development as well as the harmonious and peaceful society.

Hsun Tzu (298-238 B.C) directly opposes to Mencius whose professes the original goodness of human nature. He holds that man by nature is evil because he seeks for gain and envious. He accepts a more extensive program which manifests practice and learning from external sources. Goodness for him is the result of coordinated social regulation. Especially, moral cultivation is in compliance with standards for behavior. According to Hsun Tzu, man must be transformed by teachers and laws and guided by ***li*** and ***yi***. His view on human nature agrees with Mencius that every man can become a sage if he chooses good and right.

He assumes that man is born without any beginning of goodness but has the beginning of evilness. Human nature should be cultured. If it is uncultured, it cannot be good. Man is born with inherent desire for profit and sensual pleasure.However, Hsun Tzu

[1] James Legge, *The Work of Mencius*, New York: Dover Publications, Inc, 1970, p.60

recognizes that man at the same time possesses intelligence, and that intelligence can make him to become good. It is noted that any man can become a sage because he is naturally intelligent. Every man needs to have a good social organization. Thus, in order to build a good social organization, men need to practice the rules of conduct and righteousness. Besides, in order to enjoy their lives, men need to co-operate and mutual support. For example, men need to be united in order to conquer other creature, that is, man's strength is not equal to that of ox; his running is not equal to that of the horse; however the ox and the horse are controlled by his intelligence. It is surely recognized that man can create a good social organization because he has intelligence but the others are unable. Concerning the cultivation of man's nature, Hsun Tzu argues as follows;

> "Someone may ask, "If man's nature is evil, whence come propriety and righteousness? I answer that all propriety and righteousness are result of the activity of sages and not originally produced from man's nature. The potter ponds the clay and makes the vessel. This being the case, the vessel is the product of the artisans' activity and not the original product of man's nature. The artisan hews a piece of wood and makes a vessel. This being the case, the vessel is the product of the artisans' activity and not the original product of man's nature."[2]

It is meant that propriety and righteousness are not native moral characteristics of man but the artificial efforts of sages. Man collects together his ideas and thoughts and becomes familiar with activities, facts and principles and produces propriety and righteousness and institutes laws and systems. Thus everyone should attempt to improve ***li*** and ***ren*** and hold up laws and regulations in his society. ***Li*** and ***ren***, laws and regulations are produced by acquiring training of the sage, not by man's original nature. By this way, man's original evil can exchange to virtue. It can be said that one cannot practice goodness unless he has a teacher to tell him how; his goodness depends on teachers and laws to become correct and achieve propriety and righteousness; without teachers and laws, man is unbalance and incorrect; at the same way, without propriety and righteousness, there will be rebellion, disordered, chaos and unstable condition. Besides, it is found that the selfish character of man results in strife and hatred creates negative consequences not only for society but for the selfish person himself.

By studying Confucians humanistic views, it is realized that self-cultivation is a real possibility for all humans; everyone should cultivate the root of humanity (***ren***) and extend this root to other social relationships; by cultivating the moral character, it is developed a harmonious family, organization, society and so on.; Confucians four great virtues are the necessity for the development of human character; their views on human nature are not the same but their central objective is to be a virtuous man; and to be a good man or a good citizen, he should be transformed by teachers and laws and by ***li*** and ***yi***; so self-cultivation is to be a virtuous man with the practice and learning from external sources. It can be said that self-cultivation looks like climbing a moral ladder.

The Doctrine of Preservation of Life in Taoist Thought

Ancient Taoists vision is regarded as an earlier way of thought before the date of Confucius. The term "***tao***" usually means a road or a way of action. Confucius regards "***tao***" as a philosophical concept, standing for the right way of action that is moral, social and political. But for the Taoists, "*tao*" is simple, formless, desire-less, without striving, supremely content. Thus the Taoists attempt to become one with nature. They accept that all

[2] Wing-Tsit Chan, *A Source Book in Chinese Philosophy*, New Jersey: Princeton University Press, 1969, p.51

artificial institutions and all striving are wrong. It does not mean that all strivings and all activities are wrong, but all straining is a mistake. It is expressed that the community which has neither poverty nor riches will always have the noblest principles. If there is no insolence or injustice in community, there will not be any contentions or envying.

Yang Chu is one of the earliest prominent Taoists. His dates are not clear but it assumes that he must have lived between the time of Mo-Tzu (C.479-C.381 B.C) and Mencius (C. 371-C.289 B.C). His fundamental doctrine is "Each one for himself" which means that though man might have profited the whole world by plucking out a single hair, he would not done it. Even for the great profit of the world, he would not exchange one hair of his shank. Because he is one who despises the things and values life. His second principle is "the despising of things and valuing of life". It means that our life is own possession and its benefit to us is very great. Reflection of his main idea can be found in the Lao-Tzu and Chaung-Tzu.

It may be regarded that the early Taoists are selfish. Yang Chu's egoism is tinged with Taoist thought. His principle of "each one for himself" is the positive aspect but the principle of "do not meddle with others" is the negative aspects. Concerning the preservation of life, he argues that a man who values his body in his action more than he does the world, may be given the world; he who loves himself more than he does the world, may be entrusted with the world. Again, if a man's action is so bad then society punishes him, it is not the way to preserve his life; if a man is so good then he obtains a fine reputation, it is not the way to preserve his life too. It can be deduced that to be useless is the way to preserve one's life. The man who is skillful in preserving life must not do much evil, but neither must he do much good. Thus he must live midway between good and evil. In such doing so, it is preservation of life. His doctrine of self-love and sensual enjoyment are influenced on Taoists view.

Concerning the doctrine of self-love, it argues that; if one love himself, he will love his family; if he loves his family, he will love his relative; if he loves his relative, he will love his nation and community; only if he does self-interest, he can serve good results of others; if he values his life, he will value other life; in this way, he can create a harmonious society on the basic of the doctrine of self-love. It may be regarded that the self-love is the preservation of self- life.

It may be assumed that Lao-Tzu lives in the 6^{th} century B.C and is contemporary with Confucius.According to him, Nature is all meant that happens in the universe. The spontaneity of thing is the absolute freedom from artificiality. Human is originally happy. But he suffers as a result of changes brought on by society. The best way to be happy is to undo the present artificial civilization and to live in tranquil communion with nature among forest and streams and hills. Every phenomenon contains its negative side in the process of evolution; life is followed by death, light by darkness, good by evil, justice by injustice and so on. A man may live true nature, and nature points him to happiness. But his artificial knowledge and desire may get the upper hand lead him unrighteous way.

According to Lao Tzu, people should have little knowledge. They have lost their own morality because they have too many desires and too much knowledge. Knowledge is enables people to know more about desires and guides to gain what the people want. In this way, with increasing knowledge people are no longer in a position to know how to be content and where to stop. But it is not possible that people should have little knowledge. Without knowledge they cannot avoid the faults that arise from desires. Only knowledge guides people to know how to be content, where to stop and what ought to do. Thus people should have much knowledge that controls the faults of people.It also founds that Lao Tzu's

doctrine of "***Wu Wei*** " (doing nothing), which means not "over doing" is also to rule the conduct of government as well as the personal life. For Confucians, only the sage king can rule the state; he should do many things for the people of the state; however the Taoists regard that the main task of sage king is not to do at all. For example; a man in the society has certain things which he ought to do; if he does "over doing" anything than what he ought to do, he will be far from success. The idea of "doing nothing" is the guiding principle of life. It is an important idea of Taoists and Lao Tzu.

After Lao Tzu, Chaung Tzu (C 369-C.286) is the third phase of Taoism. According to him, one is happy when one has a full and free practice of one's natural ability. There is death which is the end of all human activities. Fear of death is an anxiety about the sources of human unhappiness. Such fear and anxiety may be diminished if people have a proper understanding of the nature of things. People who understand the conditions of life do not seek to exercise what life cannot accomplish. For example; when a man tries too hard, he is certain not to succeed but he will fail. It may be seen that Taoists emphasize on the ideas that don't worry, do nothing and everything will be done. The man who has achieved absolute happiness is the perfect man, the spiritual man and the true sage. As the perfect man does nothing, the man should care nothing for worldly power, position or honours. Everyone should practice with his natural ability and such practice is preservation of life. Thus in order to achieve relative happiness, one simply follows what is natural in oneself.

The Doctrine of All-embracing Love in Mohist Thought

Mo-Tzu, the founder of Mohism, is the first opponent of Confucius. His dates are not clear and certain but probably he lived within the year 479-381 B.C. The principle of utility and the doctrine of all-embracing love is the most important aspect of Mo- Tzu.His famous doctrine is that everyone in the world should love everyone else equally and without discrimination. His teachings are intimately connected to the political, social and moral events of the time. His chief hope is to build an ideal society that depends on the principle of "loving one another" and "seeking one another's welfare". He encourages people to practice equal and universal love is to be a duty. Universal love means loving everyone, family members and strangers alike, equally. Men by nature do not love one another. Thus everyone in the world should love to each other equally and without discrimination. He makes a distinction between the principles of "discrimination" and "all-embracingness". The main task of the human-hearted man is to possess benefits for the world and to discard its calamities. Concerning the doctrine of all-embrcingness, Mo-Tzu pointes out as follows;

> "….one is as much for other states as for his own; one is as muchfor otherfamilies as for his own; one is as much for other person as for his own. Therefore, if the princes love one another, there will be no war. If the ministers love one another, there will be no riot. If men love one another, there will be no plunder….Consequently; there will be no harm in the world, for all men will love one another."[3]

It is meant that other people's countries as one's own and other people's families as one's own. For example; when the prince and minister do not love each other, they will not be kind and loyal; when individual do not love one another, they will be injure one another; when all the people in the world love one another, it can overcome the evil. Being love of father and son will be affectionate and filial. It is regarded that being universal love may be prevented from the arising of all the calamities, usurpation, hatred and animosity in the

[3] Chu Chai, *The Story of Chinese Philosophy*, New York: Washington Square Press, 1961, p.137

world. It is also found that one who loves others must also be loved by others; he who benefits others must also be benefited by others; he who hates others must also be hated by others; he who injures others must also be injured by others. Everyone has a moral obligation to promote benefits for the world and to remove harm from the world. The lack of love gives rise to the cause of harms such as mutual attacks among states, mutual usurpation among families and mutual injuries among individuals. Mo-Tzu desired to create ideal human society through the practice of all-embracing love.

It is also found that to practice the doctrine of all-embracing love is to obey the will of Heaven. If people practice with the will of Heaven, they will be rewarded but if they follow what Heaven dislikes, they will be punished. People are encouraged to do an altruistic concern for the welfare of all people. They should willingly act according to the will of Heaven that is Heaven wishes people to behave well and love each other. Besides, Mo-Tzu's the concept of utility is to advocate benefit and harms as standard for judging right and wrong, good and evil. It means what produces more good than evil is benefit, but more evil is harm; the most useful and beneficial to the people is right and valuable. It is noted that Mo-Tzu's view on religion is mainly the doctrine of all-embracing love. The latter Mohists also maintain that all human activities aim at obtaining benefit and avoiding harm. Concerning the essence of beneficialness, they give an answer that with the obtaining of which one is pleased and the harmful is that obtaining of which one is displeased. For example; if people desire to have happiness, they will do what the beneficial is; if they desire to avoid the harm, they will do what Haven wants. It may be accepted that to possess benefiting for all men is to embrace the greatest happiness of greatest number.

The Doctrine of Reward and Punishment in Legalist Thought

A school of thought which maintained that strict equal punishment is known as Legalist School or Legalism. This School is the most basic of all ancient Chinese Schools. Legalism is bitterly attacked especially Confucianism. It disagrees with the moral standards of the Confucian and religious sanction of Mohist in favor of power. Its aim is political control of the state and the population, a control to be achieved through an intensive set of laws, backed up by generous rewards and severe punishments. It looks to the present rather than the past, to changing circumstances rather than any prescribed condition. The Legalists advocate strong centralized government which should practice absolute power by the threat of the harsh punishments. They are concerned with establishing political order and administrative efficiency. Han Fei Tzu (ca.280-233 BCE), the synthesizer of Legalism, is the most important person of all legalists. He is a pupil of Hsun Tzu but he does not satisfy with Confucian political thought. He writes and composes a lengthy work bearing his name in fifty-five chapters. This book is a complete synthesis of the ideas of Shen Tao, Shen Pu-Hai and Shang Yang. His writings are indeed on practical guidance for ruler-ship.

According to Han Fei Tzu, one man's loss may be another man's gain; one's success may be completely based on other's failure. Naturally man aims for the increasing of his self-interest. He accepts that all men are originally egoistic. Here, it is found that his view on human nature is similar to that of his teacher, Hun Tzu. He does not deny that human character can transform into virtue from vice by training or cultivating, but it is very difficult and rarely successful. Concerning Confucian moral virtues, he argues that Confucius' moral example of humanity and righteousness is followed by only seventy people; the most people are submissive to power while few man can be influenced by the doctrine of humanity and righteousness; practicing Confucian moral virtues is impossible and impractical; thus a ruler

must devote himself not to moral teaching but to law because politic and morality are unrelated facts.

Han Fei Tzu views that human nature is to seek profit and to avoid harm. That is why, he points out that the best way of government is the method of reward and punishment. It is noted that this view is differ from that of Confucian that people should be govern by morality and ***li*** and not by law and punishment. Reward and punishment are utilized as the "two handles" of government. Rewards are good things which are the people all desires but punishments are evil things which are the people all dislike. Rewards are there for those who obey the law and punishments are to be imposed on those who violate orders. Power for him is the ruler on the higher level, that is, if the ruler has no power, then his state will be ruined, and if the ministers are without laws on the lower level, then they will become rebellious. A ruler not only should have power, law and order but also should cultivate to promote the moral virtues. His law and order should be contained both the method of rewards and punishments, and morality to develop a harmonious society.Indeed, the advice of scholars and the voice of people are very important to the rulers. Due to these reasons, it should be impossible the view of Han Fei Tzu that the ruler of the state does not listen to the advice of scholars.

Concerning his doctrine of reward and punishment, he argues as follows;

> "Now here is a young man of bad character. His parent rail at him but he does not reform; the neighbors scold him but he is unmoved; his teachers instruct him but he refuse to change his ways. Thus, although three fine influences are brought to bear on him - the love of parents, the efforts of the neighbors, the wisdom of his teachers -yet her remains unmoved and refuses to change so much as hair on his shin. But let the local magistrate send out the government solders to enforce the law and search for evil-doers and then he is filled with terror, reforms his conduct and changes hi ways. Thus love of parents is not to make children learn what is right, but must be backed up by the strict penalties of local officials; for people by nature grow proud on love, but they listen to authority."[4]

It means that the bad character of a young man cannot be changed by the factors such as the love of his parents, the efforts of the neighbors and the wisdom of his teachers. For these situations, it is necessary for young man to follow as a soldier obeys orders and commands. Only the laws can reform evils, bad character and ways of life. Thus, it can be said that the love of parents is not enough to train their children, but the children obey the laws of rewards and punishments.

To be a successful ruler, he needs to understand the people's likes and dislikes and manipulate them successfully to his advantage. He needs ability and knowledge to make laws of rewards and punishments and keep a watch on the conduct of the people. Rulership is a form of social control and that derives from understanding the people's mind. Thus, it may be said that rewards and punishments are indispensable in social order. Good behavior can be produced through a system of law that makes rewards and punishments.

Conclusion

In every society, there are many rules which are laid down for the performance of one's duties towards one's family, nation, employers, organization etc. Every person should always follow discipline strictly, performing perfectly all duties required of human beings.

[4] Jeeloo Liu, *An Introduction to Chinese Philosophy: From Philosophy to Chinese Buddhism*, New York: Blackwell Publishing, 2006, p.185

As man is a social being, he can build the freedom and the human race. His performances give rise to effects not only himself but also his family, society, state and so on. Thus, it is needed to act correct performances. To serve correct performances, it is needed to cultivate his personal life with morality or virtues. To cultivate his personal life, it is needed to listen to the teachings and advices of parents, teachers and wise. Thus, it agrees with Confucians view on self- cultivation. Because they view that man's moral character may be developed by experience and training. It is necessary to have self-cultivation which can upgrade social welfare in performing moral conducts or activities. It can be said that Confucians views on human nature are not the same but their central aim is to be the virtuous man. The bad character of man should be transformed by teachers and laws and guided by ***li*** and ***yi***. It may be regarded that self-cultivation is an essential performance to be a good man or good citizen in our society.

In contrast to Confucianism and Mohism, Taoism emerged as a form of individual preservation. A better way to conduct one's self is to live in isolation from the world. A man should follow what naturally happen and not meddle with it. Taoists accept that activity of man should not appreciate because institutions and civilizations that man makes are to go against nature. It may be assumed that the doctrine of Taoism full of anti-social, anti-knowledge and anti-civilization comments, that is, everyone in society does not communicate, or exchange good, with another. But it can be accepted that a man in society should not do "over doing" anything than what he ought to do becauseit will be far from success. Besides, being self-love and being self-value may be regarded as the preservation of life. For example, one who loves himself can preserve his life; one who values himself can preserve his life; if he does not love or value himself, then it will be harmful not only to himself but also to his family. Thus everyone needs natural ability that preserves his life.Individual preservation seems to be egoistic idea, but every person should practice the doctrine of preservation of life because self- preservation does not make harm to the others. Thus, preservation of life is a basic idea for our community.

Mo-Tzu advocates the doctrines that loving one another equally and benefiting one another mutually. These doctrines directly oppose to the Confucian conception of constructing a family based society. Concerning all-embracing love, Mencius also criticizes that Mo-Tzu's all-embracing love is a denial of the special relationship with the father and son in family. But his main purpose is to build ideal society and ideal state which is similar to that of Confucian. He assumes that ideal society and ideal state depend on the doctrine of all-embracing love. It is extremely impossible that being love to one another will be prevented from the arising of all harmful results to be a well-ordered of the state. Only practicing of all-embracing love cannot create ideal human society and remove causes of the harm from the world. As Mo-Tzu points out, it can be accepted that the root of all worldly trouble is because of people not loving one another. For example, if men in family do not love each other, there will be disordered; if they use only harsh punishment in family, they cannot have a moral sense or they cannot know what they should do. Thus,it may be said that the doctrine of all-embracing love is only a supporting factor to develop a good relationship and a good society.

It can be seen that Legalism also opposes the moral standard of Confucians and religious sanction of the Mohism. Its aim is especially political, social and economic control of the state and backed up by generous rewards and severe punishments. It stands for advocacy of strong centralized government. Legalist ideal state is centralized one sovereign, one regime, and one supreme law. Thus, the Legalists suggest that the government should hold absolute power by the threat of the harsh punishments. Han Fei Tzu argues that Mo-Tzu's all-embracing love is totally ineffective; that is why, only his doctrine of reward

and punishment would bring obedience, while love would bring spoilage. Besides, he also criticizes that Confucian model of moral politic, that is, the ruler's virtue and kindness are not sufficient to end social unrest. But it can be said that his law that constitutes a system of rewards and punishments cannot completely fulfill to be social order, political order, and family order. His political thought is being to establish absolute control for the ruler. It cannot be accepted that only law and punishment are necessary to ruler-ship; only using law and punishment as a means of social control is ultimately anti-moral; although the legalist doctrine for the state might bring about law and order, it fails to provide any foundation for the institution of democracy. In fact, both moral teachings and laws can be essential to ruler-ship because most people are taught to be good while the necessary few are restrained by law from committing evil things. Thus, it can be said that the doctrine of rewards and punishments is only a partial necessary instrument, but not absolute, for the rulers to control people.

Society changes with circumstances. When the circumstances change, institutions and morals should change with them. The new and the old differ from each other because their times are different. In fact, present new politics and new social affairs have developed out of the old politics and old social affairs and new culture and new ideas have also developed out of the old culture and old ideas. Thus, it should respect ancient Chinese traditional doctrines because some doctrines link with the current social practice.

Acknowledgements

I am grateful to Dr Saw Lynn, Professor and Head, Department of Philosophy, Shwebo University, for his valuable suggestion and encouragement to my work.

References

Chan, Wing-Tsit, (1969). ***A source Book in Chinese Philosophy***, Princeton: University Press.

Chu Chi, (1961). ***The Story of Chinese Philosophy***, New York: Washington Square Press.

Creel, H. G., (1964). ***Chines Thought From Confucius to Mao-Tse –tung***, New York: The Free Press.

Fung Yu-Lan, (1966). ***A Short History of Chinese Philosophy***, New York: the Free Press.

Ivanhoe, Philip. J and Bryan W. Van Norden, (2005) ***Reading In Classical Chinese Philosophy***, USA: Hackett Publishing Company Inc.

Jeeloo Liu, (2006). ***An Introduction to Chinese Philosophy: From Ancient Philosophy to Chinese Buddhism,*** New York: Blackwell Publishing.

Lai, Karyan. L., (2008). ***An Introduction to Chinese Philosophy***, New York: Cambridge University Press.

Norden, Bryan W. Van, (2011). ***Introduction to Classical Chinese Philosophy,*** New York: Hackett Publishing Company.

Wen Haiming, (2012). ***Chinese Philosophy***, New York: Cambridge University Press.

http//www.iub-edu/ p374/ analects of Confucius (eno2010) Pdf

A Study on the Perfection effort (*Uṭṭhānasampadā*) in the *Gotamīvagga, Aṭṭhākanipāta* of the *Aṅguttara Nikāya*

Than Ni[1] and Su Su Win[2]

Abstract

Sampadā means perfection or accomplishment. *Uṭṭhānasampadā* is defined as alertness or effort. Therefore, *Uṭṭhānasampadā* means perfect alertness or effort. In the world, people who are lazy to do things to earn a living, to live healthily, in businesses or in education will not achieve any progress. Only if they make effort and work hard, they will be successful in what they are doing. Therefore, this paper aims at the necessity of effort in order to have the benefits in this life and in the lives after death.

Key words: *sampadā, viriya, lokī, lokuttarā*

Introduction

Living beings act bodily (*kāyakamma*), verbally (*vacīkamma*) and mentally (*manokamma*), and they expect that their actions to produce what they desire for.

The Buddha taught some discourses on how living beings can have wholesome results as the result of their actions. He taught those discourses himself, and also encouraged his disciples to give guidance to all beings.

The Buddha told his disciples, "Monks, for the sake of many, in order for the protection of the world, for the sake of man and deities, go on journey. Any two of you should not go on the same direction. Monks, teach the Dhamma that is noble at the beginning, in the middle and at the end, that is meaningful in every word. Show the noble practice that is perfectly pure and noble. There are beings whose mind is not covered with massive defilement. They lose valuable aspect of their lives since they have never heard the Dhamma. They will be able to under the Dhamma if they have a chance to learn. I will go, too, to the grove of *Uruvela* in *SenāNigamana*." This instruction of the Buddha highlights the fact that the Buddha not only taught the Dhamma himself, but encouraged his disciples to do the same.[3]

The Buddha spent all his life as a Buddha, from the time of the enlightenment to the final demise, travelling and teaching the Dhamma day and night. He lived his life in the Dhamma. The teaching of the Buddha gives success in life and the taste of liberation from life to those who practice it.[4]

All the teachings of the Buddha have the essence of the liberation (*vimuttirasa*). However, these teachings are deeorated with the methods to mundane achievements and supra-mundane progresses. Some of the discourses are meant for the supra-mundane attainment while there are also some discourses that show guidelines to mundane success. Some discourses aim at giving guidance for a happy and successful life at present, and some other give guidelines for the lives after death. There are teachings that provide guidance for the present life and the lives after death, and also for both mundane and supra-mundane attainments. Among those many discourses, this paper focuses on *Ujjayasutta* in *Gotamīvagga*, *Dutiyapaṇṇāsaka*, *Aṭṭhakanipāta*, *Aṅguttaranikāya*, and study both the aspects

[1] Professor and Head, Dr, Department of Oriental Studies, Shwebo University
[2] Associate Professor, Dr, Department of Oriental Studies, Shwebo University
[3] Vi, 3, 27, 28.
[4] Dī, ṭṭha, 1, 16.

on mundane and supra-mundance achievements. Especially, the focus is placed on the fact that *uṭṭhānasampadā*, effort, is the most essential factor among the dhamma that leads one to the development of mundane and supra-mundane attainments.

Materials and Method

In this research, all of the data about the perfection effort were collected from libraries, together with descriptive method was used. The materials used for the purpose of the research are *pāli*, *Aṭṭhakathā* and Ganthantara Texts.

Findings

1. The text format

The teachings of the Buddha are grouped into five *Nikāyas – Dīghanikāya*, *Majjhimanikāya*, *Saṃyuttanikāya*, *Aṅguttaranikāya*, and *Khuddakanikāya*.[1] *Nikāya* literally means collection or place.[2] *Aṅguttara* means counting the numbers of the categories adding one each time. *Aṅguttaranikāya* means the collection of or the place of the dhamma the numbers of which increase one at each portion. Therefore, *Sīlakkhandhavagga Aṭṭhakathā* defines *Aṅguttaranikāya* that nine thousand five hundred and fifty-seven discourses beginning with *Cittapariyādāna Sutta* (discourse) the categories of which increase one at each portion of the discourses.[3]

Aṅguttaranikāya consists of eleven texts starting from *Ekakanipāta* and ending with *Ekādasakanipāta*. They are:

1. *Ekakanipāta*
2. *Dukanipāta*
3. *Tikanipātanipāta*
4. *Catukkanipāta*
5. *Pañcakanipāta*
6. *Chakkanipāta*
7. *Sattakanipāta*
8. *Aṭṭhakanipāta*
9. *Navakanipāta*
10. *Dasakanipāta*
11. *Ekādasakanipāta*

Aṅguttaranikāya is printed in three separate books in *Chaṭṭhasaṅgāyanā* version. The first book has four texts - from *Ekakanipāta* to *Catukkanipāta*. The second book has three texts - from *Pañcakanipāta* to *Sattakanipāta*. The third book has four texts - from *Aṭṭhakanipāta* to *Ekādasakanipāta*. *Ujjayasutta* is one of the discourses of *Aṭṭhakanipāta* in the third book.

---

[1] Dī, ṭṭha, 1, 23 [*Kathaṃ nikāya vasena pañcavidhaṃ*? *Sabbameva cetaṃ Dīganikāyo Majjhimanikāyo Saṃyuttanikāyo Aṅguttaranikāyo Khuddakanikāyo hoti pañcappabhedaṃ hoti*.]
[2] *Ibid* [*Samūhanivāsonikāyotivuccati*.]
[3] *Ibid*, 24.

Aṭṭhakanipāta consists of the following *vaggas* which the numbers of the discourses in those vaggas are mention along with.

1. *Mettāvagga* 10 discourses
2. *Mahāvagga* 10 discourses
3. *Gahapattivagga* 10 discourses
4. *Dānavagga* 10 discourses
5. *Uposathavagga* 10 discourses
6. *Gotamīvagga* 10 discourses
7. *Bhūmijālavagga* 10 discourses
8. *Yamakavagga* 10 discourses
9. *Sativagga* 10 discourses
10. *Sāmaññavagga* (There is no separate discourse here)
11. *Rāgapeyyāla* (There is no separate discourse here).

There are 11 *vaggas* altogether which consist of 90 discourses. *Sāmaññavagga* and *Rāgapeyyālavagga* do not have separate discourses, and therefore there are only 90 discourses in this *nipāta*.

In *Gotamīvagg* of *Ujjayasutta*, there are ten discourses:

1. *Gotamīsutta*
2. *Ovādasutta*
3. *Saṃkhittasutta*
4. *Dīghajāṇusutta*
5. *Ujjayasutta*
6. *Bhayasutta*
7. *Pathama Āhuneyyasutta*
8. *Dutiya Āhuneyyasutta*
9. *Pathama Puggalasutta* and
10. *Dutiya Puggalasutta*.

2. An outline on *Ujjayasutta*

Ujjayasutta of *Gotamīvagga* in *Aṭṭhakanipātapāḷi*, *Aṅguttaranikāya* begins with the phrase '*Athakho Ujjayo Brahmaṇo*....'. The place where the discourse was delivered is not mentioned. It is accustom in the formation of Pirṭaka that the place is not mentioned in a discourse if it is the same as the place where the previous discourse was taught and it has been mentioned there. In *Dīghajāṇusutta*, the discourse that comes just before *Ujjayasutta*, the place where the discourse was taught has been mentioned as '*Ekaṃ samayaṃ Bhagavā koliyesu viharati Kakkarapattaṃnāma Koliyānaṃ nigamo*'. It means, 'Once, the Buddha was dwelling at *Koliyanigamana* that was also known as *Kakkarapatta* in *Koliya* State'. This expression of the place suggests that *Ujjayasutta* was taught at the same place when he taught this discourse to *Ujjaya* the Brahmin.

Ujjaya Brahmin approached the Buddha, greeted him, took a seat himself at a suitable place. Then, he said to the Buddha, "Oh Venerable *Gotama*, we are willing to move to another place and settle down there. We are willing to go somewhere else. Please, guide us how to get desirable achievements in this very life and also in the lives after."[1] The Buddha taught *Ujjaya* Brahmin the Dhamma that can produce desirable attainments in this very life

[1] Aṅ, 1, 11 pa.vāsa [pravāsa] [p y v of + ṇ] (pa) moving to another place for good; depearting, ပါဠိ-မြန်မာ အဘိဓာန်၊ 647.

and the lives after. Among those Dhamma, the Buddha taught that *viriya* (effort) can bring about desirable results, and encouraged the Brahmin to use his effort well.

The Buddha taught the *Vijjaya* Brahmin the four benefits of four dhammas and the four not benefits of four dhamma for the mundane and supra-numdance.

The develop mundane is four kinds:

1. *Uṭṭhānasampadā* - perfect alternass or effort
2. *Ārakkhasampadā* - the perfection of protection
3. *Kalyāṇa mittasampadā* - having good friend and
4. *Sammājīvitā* - having righteous livelihood

The develop suparamundane is four kinds:

1. *Saddhāsampadā* - the perfection of faith
2. *Sīlasampadā* - the perfection of *sīla*
3. *Cāgasampadā* - the perfection of generosity and
4. *Paññāsampadā* - the perfection of *paññā*

The fail four dhammas are:

1. *Iddhidhutta* - too much sexual pleasure
2. *Surādhutta* - too much intoxication
3. *Akkhadhutta* - too much gambling and
4. *Pāpamitta* - having evil friends

Not fail the four dhammas are:

1. *Na iddhidhutta* - abstaining from sexual pleasure
2. *Na surādhutta* - abstaining from intoxication
3. *Na akkhadhutta* - abstaining from gambling and
4. *Na pāpamitta* - abstaining from evil friends

3. Perfection effort

Sampadā means perfectness or accomplishment.[1] *Uṭṭhāna* means alertness or making effort.[2] Therefore, *Uṭṭhānasampadā* means the perfectness of alertness, the perfectness of making effort, accomplishment through alertness, and accomplishment through effort. The Buddha taught, concerning with uṭṭhāna, as follows:

"In this world, a man from a good family earns his living by farming, trading, keeping cows, archery, being a royal servant or by any other skills. He is good at what he is doing. He is not lazy. He is wise enough to do those things himself or managing others to do them. This is called *uṭṭhānasampadā*, the perfectness of effort.[3]

---

[1] ပါဠိ-မြန်မာအဘိဓာန်၊ ၉၉၈။
[2] *Ibid*, 206.
[3] Aṅ, 3, 111.

The main points in this teaching are being good at what one is doing, not being lazy, and being able to think. Having skills and being able to think are the characters of wisdom while the opposite of laziness is effort. It can be noted here that wisdom is necessary in every actions leading to success. There is a big difference between the effort accompanied by wisdom and that is absent of wisdom. The effort accompanied by wisdom produces desirable results, but the other does not. Therefore, when he taught the nature of *uṭṭhānasampadā*, in order to show true *uṭṭhānasampadā*, the Buddha taught that it must be associated with wisdom that is skill and thinking carefully.

Effort is termed as *Viriya*. Here, *viriya* is braveness that is required when one performs actions. If one wishes to keep oneself healthy, one has to go for walks every day, eat regularly, empty the bowl regularly, take a bath at appropriate time, and take necessary medicines or nutrition, etc. One must not be lazy. Therefore, only those who have effort can keep themselves healthy.

Those who are lazy always find excuses in order not to face difficulties when they do businesses. Those who have effort work at appropriate time and get advantage in their businesses. In case of education, too, without *viriya*, one face failure while with *viriya*, one is successful. The Buddha himself fulfilled the perfection of viriya when he was fulfilling the *pārami* (perfections). When he became the Buddha, he did not rest; he spent all his time teaching and liberating beings. Every teaching of his suggests that to know is the first step and to work as one knows is the second step. He taught, "*Vāyametha puriso, na nibbindeyya paṇḍito*". It means, "Man should work hard; the wise should not be lazy". He also taught, "*Vīriyavato kiṃnāmana sijjhati*". It means, "There is nothing that can't be accomplished by one who has effort". Although the Buddha admired effort, he also warned that every endeavour must be accompanied by wisdom; it should not be blind acts.[1]

3.1 The four *viriya sampadāna*

The Buddha taught, in various ways, that effort can bring about advantages in this very life as well as in the lives after. *Abhidhamma* teaches this kind of *viriya* as *sampadāna* which means effort made properly.

This *sampadāna viriya* is of four kinds:

> *uppannānaṃ pāpakānaṃ pahānāya vāyamo*,
>
> the effort to discard evil states that have arisen,
>
> *anuppannānaṃ pāpakānaṃ anuppādāya vāyamo*,
> the effort to prevent the arising of unarisen evil states,[2]
> *anuppannānaṃ kusalānaṃ uppādāya vāyamo*,
>
> the effort to develop unarisen wholesome states,
>
> *uppannānaṃ kusalānaṃ bhiyyo bhāvāya vāyamo*
> the effort to augment arisen wholesome states.[3]

Those who possess these four kinds of *sampadā* will surely develop mundane and supra-mundane qualities. If one is lazy, one will fail everything. The Buddha described lazy people and also the danger of laziness as follows:

---

[1] Ko-kyint-abhidhamma (*Abhidhamma* in Daily Life), 134-149.
[2] Thin-gyo-bha-tha-tika (A Myanmar Sub-commentary on A Comprehensive Manual of Abhidhamma), 583-585.
[3] Thin-gyo-bha-tha-tika (A Myanmar Sub-commentary on A Comprehensive Manual of Abhidhamma), 583-585.

In this world, there are people who are lazy give excuses in order not to work. They say it's too cold, to hot, too late, too early, and they are too hungry or too full. They give unreasonable excuses so that they can avoid works. As a consequence, they will not get what they don't have, and also lose what they possess.[1]

Therefore, *viriya* is one of the necessary factors that produce benefits in this very life and also in the lives after. In this *Ujjayasutta*, when the Buddha taught what causes desirable benefits in this very life, he emphasizes viriya as *uṭṭhānasampadā*. If one can get desirable benefits in this very life, it is sure that one can also get them in the lives after. Therefore, *uṭṭhānasampadā* which is one of the sampadās is a reason to the attainment of mundane and supra-mundane benefits.

Conclusion

The Buddha taught the Dhamma for forty-five years. The Dhammam, his teachings, bring desirable benefits to those who use them in practice. The Dhamma can also remove suffering. The word 'Dhamma' is defined by Venerable Mahā Buddhaghosa as '*Bhavakantā rāutthāraṇena assāsadānena ca Dhammo*'. According to this definition, Dhamma saves beings from the painful journey of the circle of lives, provides comfort to them, and it is the refuge for them. This definition provides the meaning of the Dhamma sufficiently.

Every being wishes to be happy. They wish to live comfortably and have good communication with others wherever they are and whoever they meet. They want to be happy wherever they live, and have good relation with other people they meet. They want to have guidance that give them ways to attain mundane and supra-mundane benefits. *Ujjaya* Brahmin, before he took a trip, approached the Buddha in order to get some useful advice from the Buddha. This has become accustom of Myanmar people to approach the elders and monks in order to receive some useful advice from the latter before they took a trip.

As per request by *Ujjaya* Brahmin, the Buddha taught the Dhamma beginning with '*Uṭṭhānasampadā...*' that can produce desirable benefits in this very life and in the lives after death.

"In this world, a man from a good family earns his living by farming, trading, keeping cows, archery, being a royal servant or by any other skills. He is good at what he is doing. He is not lazy. He is wise enough to do those things himself or managing others to do them. This is called *uṭṭhānasampadā*, the perfectness of effort.

The main points in this teaching are being good at what one is doing, not being lazy, and being able to think. Having skills and being able to think are the characters of wisdom while the opposite of laziness is effort. It can be noted here that wisdom is necessary in every actions leading to success. There is a big difference between the effort accompanied by wisdom and that is absent of wisdom. The effort accompanied by wisdom produces desirable results, but the other does not. Therefore, when he taught the nature of *uṭṭhānasampadā*, in order to show true *uṭṭhānasampadā*, the Buddha taught that it must be associated with wisdom that is skill and thinking carefully.

In this world, there are people who are lazy and give excuses in order not to work. They say it's too cold, to hot, too late, too early, and they are too hungry or too full. They give

[1] Dī, 3, 149.

unreasonable excuses so that they can avoid works. As a consequence, they will not get what they don't have, and also lose what they possess.

The Buddha taught,

'*Viriyarambho bhikkkhve mahato attāya samvattati*'

'Monks, effort can bring a lot of benefits.'

The Buddha also taught, '*Vīriyārambho bhikkhave saddhammassa ṭhitiyā asammosāya anantarajānāya samvattati*.' It means, 'Monks, effort is to preserve the Dhamma of the Noble.'[1]

These teachings suggest that effort can bring benefits in this very life as well as in the life after. Perfect effort can bring both mundane and supra-mundane benefits to whoever possesses it.

Acknowledgement

I would like to express my special thanks to Rector Dr. Win Swe and Pro-Rector Dr. Myo Myo, Shwebo University, for their encourgements.

Reference

Pāḷi Text

Aṭṭhaka Navaka Dasaka Ekādasakanipāta Pāḷi, Department of Religious Affairs Press,Yangon, 1997.

Khuddaka Nikāya, Khuddakapāṭha Dhammapada UdānaItivuttaka Suttanipāta Pāḷi, Department of Religious Affairs Press,Yangon, 1997.

***Aṭṭhakathā* and *Ganthantara* texts**

Buddhaghosa, Mahāthera, Aṅguttara Aṭṭhakathā (Tatiyo Bhāgo). Department of Religious Affairs Press, Yangon, 2001.

Buddhaghosa, Mahāthera, Sīlakkhandhavagga Aṭṭhakathā. Department of Religious Affairs Press,Yangon, 1965.

ဟုတ်စိန်၊ ဦး၊ ပါဠိ–မြန်မာအဘိဓာန်၊ ဒေးလီးဂေဇက်စာပုံနှိပ်တိုက်(ပထမအကြိမ်)၊ ရန်ကုန်၊ ၁၉၇၅။

ဓနကာဘိဝံသ၊ အရှင်၊ သင်္ဂြိလ်ဘာသာဋီကာ၊ မြကျွန်းသာကုမ္ဗဏီလီမိတတ်၊ မိတ္တူ။ ရန်ကုန်၊ ၁၉၉၅။

[1]Aṅ, 1, 18.

Phytochemical Constituents, Antimicrobial Activities and Structural Elucidation of Pure Compound (PEN-2) from the Bark of *Derris Robusta* (DC.) Benth.

Poe Ei Nyo[1], Hnin Thanda Aung[2], Myint Myint Sein[3]

Abstract

The present study aims to investigate the phytochemical constituents, to test the antimicrobial activities and to isolate the secondary metabolites from the methanolic extract of the bark of *Derris robusta* (DC.) Benth. The antimicrobial activities of the crude extracts were determined by agar well diffusion method on six microorganisms. The separation of the chemical constituents was carried out by different chromatography techniques. Structural elucidation of pure compound, PEN-2, was done on the basis of spectral analysis using FT-IR, ^{1}H NMR, ^{13}C NMR, DEPT, DQF-COSY, HSQC, HMBC and DART-Mass Spectrometry. The structure of the pure compound, PEN-2, was elucidated as 3-(benzo[d][1,3]dioxol-5-yl)-5-hydroxy-7-methoxy-6-(3 methylbut-2-en-1-yl)4H chromen-4-one.

Key words: phytochemical, antimicrobial, secondary metabolites, *Derris robusta* (DC.) Benth.

Introduction

Natural products have pharmacological activity that can be useful in treating various kinds of diseases. These may act as active components not only for traditional medicine but also for modern medicines (Chintoju *et al*., 2015).

According to WHO, plants would be the best sources of obtaining a variety of drugs. About 80% of populations of the developed countries use traditional medicines that are derived from plants. A large number of plant infusion were indeed used to control different diseases and known to possess antimicrobial activity. It is believed that plant based drugs cause less or no side effect when compared with synthetic antibiotics (Sharief *et al*., 2014).

The genus *Derris* has received much attention from phytochemical viewpoint because of their plentiful production of flavonoids (Makungu, 2012). This plant is mainly found in India but also in Bangladesh, Myanmar, Thailand, Laos, Vietnam, and Indonesia (Paul *et al*., 2019). Extracts and metabolites from *Derris* species have been found to possess significant larvicidal, pesticidal, cytotoxic, antifungal, anti-inflammatory, antimicrobial, nitric oxide inhibitory, and cancer chemo preventive activities (Makungu, 2012).

The objective of this study was to carry out extraction, isolation of bioactive pure compound and structural identification of this compound from the bark of *Derris robusta* (DC.) Benth. In this paper, preliminary phytochemical investigation, antimicrobial activities, isolation and identification of pure compound, PEN-2, was described.

Botanical Description

Family	: Fabaceae
Botanical name	: *Derris robusta* (DC.) Benth.
Myanmar name	: Lwae

[1] Lecturer, D, Department of Chemistry, Shwebo University
[2] Associate Professor, Dr, Department of Chemistry, University of Mandalay
[3] Professor & Head (Rtd), Dr, Department of Chemistry, University of Mandalay

Parts of plant used : Stem bark
Peakfruiting season : May and June
Flowering period : April to june
Medicinal uses : anti–arthritis treatment, musculoskeletal pain, headaches, inflammation, rheumatism, insecticidal, antimicrobial

Figure 1 Stem bark, flowers and fruits of *Derris robusta* (DC.) Benth.

Materials and Method

Plant Material and Chemicals

The bark of *Derris robusta* (DC.) Benth. was collected from Matupi Township, Chin State in October, 2017. Firstly, the barks of sample were cleaned, then chopped into small pieces and allowed to become dry by exposure to air in the well ventilated room for about one month. These air dried pieces of sample were stored in a glass bottle with stopper and used throughout the experiment. Commercial grade reagents and solvents were purchased from Chemico Co.Ltd, Yangon. Column chromatography was carried out on silica gel (70-230) mesh. Analytical preparative thin layer chromatography was performed by using Kieselgel 60 (F_{254}, Merck). In thin layer chromatography, visualization was taken via UV lamp (Lambada-40, Perkin- Elmer Co, Japan) and iodine developing vapors. Crude and purified extracts were measured in Electrical Balance (Shimadzu, Japan).

Phytochemical Constituents of the Bark of *Derris robusta* (DC.) Benth.

Preliminary phytochemical screening on the extract of *Derris robusta* (DC.) Benth. was carried out by using standard methods.

Antimicrobial Activities of the Bark of *Derris robusta* (DC.) Benth.

Antimicrobial activities of the crude extracts of the bark of *Derris robusta* (DC.) Benth. on six microorganisms were determined by agar well diffusion methods with three solvent systems. The resulting data were shown in (Table 1).

Isolation of Pure Compound PEN-2

The air dried sample of *Derris robusta* (DC.) Benth. (1.00 kg) was grounded and percolated with methanol (4L) for about one month. Crude extract was filtered and evaporated under reduced pressure to afford methanolic crude extract. The methanolic crude extract was then extracted with ethyl acetate to give (50.42 g) of ethyl acetate extract. Then, (8.53 g) of ethyl acetate extract was separated on silica gel using the solvent system with various ratios such as n-hexane only, n-hexane: EtOAc (19:1 to 1:4) and EtOAc only. Totally (384) fractions were obtained. Each fraction was checked by TLC, iodine vapors and UV lamp. Fractions with similar chromatographic pattern were combined to yield (45) combined fractions.

The combined fraction (12) gave one spot on TLC in R_f value 0.41 with n-hexane: EtOAc (9:1) and pale yellow crystal of pure compound, PEN-2, (6.2 mg) was obtained. The yield percent of pure compound was found to be (0.07%) based on ethyl acetate extract (8.53 g). The structural elucidation of the pure compound, PEN-2, was determined by some spectroscopic methods such as FT-IR, ^{1}H NMR, ^{13}C NMR, DEPT, DQF-COSY, HSQC, HMBC and DART-Massspectral data respectively.

Results and Discussion

Phytochemical Constituents of the Bark of *Derris robusta* (DC.) Benth.

According to phytochemical investigation, the presence of chemical constituents such as alkaloids, tannins, saponins, flavonoids, terpenoids, glycosides, steroids, phenolic compounds and polyphenols were detected in the extract of *Derris robusta* (DC.) Benth. .

Antimicrobial Activities of the Bark of *Derris robusta* (DC.) Benth.

According to the results from (Table1), the crude methanolic extract of *Derris robusta* (DC.) Benth. showed medium activities on *Staphylococus aureus*, *Candida albicans*, and *E-coli* and low activity on *Bacillus subtilis*, *Pseudomonus aeruginosa* and *Bacillus pumilus*. Exception of medium sensitivity on *Pseudomonus aeruginosa*, the ethyl acetate extract responded low activity on all tested pathogens. The n-hexane extract revealed low sensitivity against five tested pathogens and no activity on *Pseudomonus aeruginosa*.

Table 1. The results of antimicrobial activities on the crude extracts of the bark of *Derris robusta* (DC.) Benth.

Sample	Solvent	Inhibition zone					
		1	2	3	4	5	6
Derris robusta (DC.) Benth.	n- hexane	13mm (+)	12mm (+)	-	13mm (+)	13mm (+)	14mm (+)
	EtOAc	12mm (+)	11mm (+)	17mm (++)	12mm (+)	11mm (+)	13mm (+)
	MeOH	14mm (+)	15mm (++)	12mm (+)	11mm (+)	15mm (++)	19mm (++)

Organisms	Agar well
(1) *Bacillus subtilis* (N.C.T.C-8236)	
(2) *Staphylococcus auerus* (N.C.P.C-6371)	10mm ~ 14mm (+)
(3) *Pseudomonas aeruginosa* (6749)	15mm ~ 19mm (++)
(4) *Bacillus pumilus* (N.C.I.B-8982)	20 mm above (+++)
(5) *Candida albicans*	
(6) *E-coli* (N.C.I.B-8134)	

Structural Elucidation of Pure Organic Compound PEN-2

The structural elucidation of pure compound, PEN-2, could be done by applying FT-IR,^{1}H NMR, splitting patterns and coupling constant (*J* values) of some prominent protons, ^{13}C NMR, DEPT, DQF-COSY, HSQC, HMBC and DART-Mass spectral data, respectively.

FT-IR Assignments of Pure Compound PEN-2

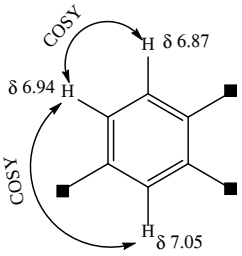
FT-IR spectrum of the pure compound, PEN-2, was described in (Figure 2). The resulting prominent functional groups contained in this pure compound, PEN-2, were tabulated in (Table 2).

Table 2 FT-IR Assignments of Pure Compound PEN-2

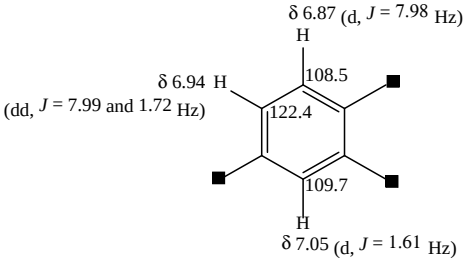
No.	Absorption band (cm^{-1})	Assignments
1.	3028.3	C-H stretching vibration of sp^2 hydrocarbon
2.	2978.4, 2909.2, 2887.0	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
3.	1652.3	C=O stretching vibration of carbonyl group
4.	1613.6, 1577.6, 1489	C=C ring skeleton stretching vibrations of aromatic ring
5.	1438.99	C-H in plane bending vibration of allylic hydrocarbon
6.	1370.1	C-H bending vibration of sp^3 hydrocarbon
7.	1248.6, 1220.9, 1173.4, 1120.5, 1034.7	C-O-C stretching vibrations of ether group
8.	933.5	C-H out of plane bending vibration of trans or *E* alkenic group
9.	819.1, 795.0	C-H out of plane bending vibrations of cis or *Z* alkenic group

According to this spectral data, the pure compound, PEN-2 consists of sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, aromatic ring, allylic hydrocarbon, ether group, trans or *E* and cis or *Z* alkenic groups respectively.

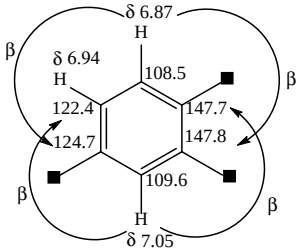
In DQF-COSY spectrum (Figure 6), the occurrence of medium graphic area between the two aromatic protons at (δ 6.94 and δ 6.87 ppm) and small graphic area between the two aromatic protons at (δ 6.94 and δ 7.05 ppm) implied the following tri-substituted benzene ring.



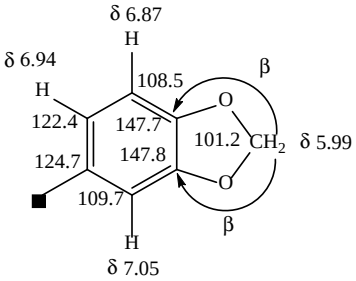
This fragment could be confirmed by the splitting patterns and coupling constants of these three aromatic protons at (δ 6.87 ppm, d, J = 7.98 Hz), (δ 6.94 ppm, dd, J = 7.99 and 1.72 Hz) and (δ 7.05 ppm, d, J = 1.61 Hz) in ^{1}H NMR spectrum, (Figure 3), as illustrated below. Furthermore, the HSQC spectrum (Figure 7), was supported ^{1}H-^{13}C direct correlation of the above aromatic protons with their respective aromatic carbons.



Moreover, according to HMBC spectrum (Figure 8), the observation of β^1H-^{13}C long range signals of the aromatic proton at (δ 6.87 ppm) with both sp^2 quaternary carbons at (δ 147.8 and δ 124.7 ppm) and the occurrence of β^1H-^{13}C long range signals of aromatic proton at (δ 7.05 ppm) with sp^2 quaternary carbon at (δ 147.7 ppm) and sp^2 methine carbon at (δ 122.4 ppm) produced the fragment.

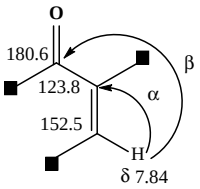


In addition, in HMBC spectrum (Figure 8), a singlet of two protons at (δ 5.99 ppm), suggesting a methylene dioxyl moiety had β^1H-^{13}C long range signals with two sp^2 quaternary carbons at (δ 147.8 and δ 147.7 ppm), affording the fragment (a).



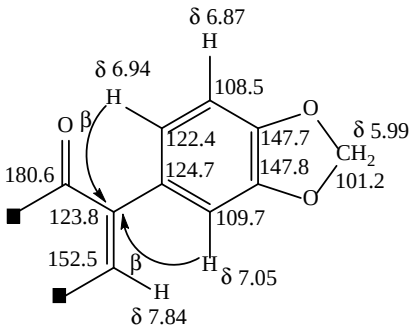
Fragment (a)

In HMBC spectrum (Figure 8), the sp^2 methine proton at (δ 7.84 ppm) had α and β ^{1}H-^{13}C long range couplings with sp^2 quaternary carbon at (δ 123.8 ppm) and carbonyl carbon at (δ 180.6 ppm) produced the fragment (b).



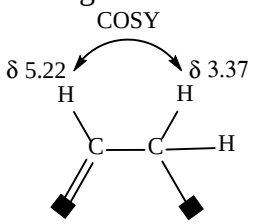
Fragment (b)

The fragment (a) and (b) could be connected by the existence of β ^{1}H-^{13}C long range coupling of sp^2 aromatic methine protons at (δ 6.94 and δ 7.05 ppm) with sp^2 quaternary carbon at (δ 123.8 ppm) in HMBC spectrum (Figure 8), leading to the fragment (c).

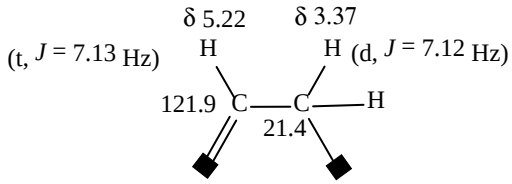


Fragment (c)

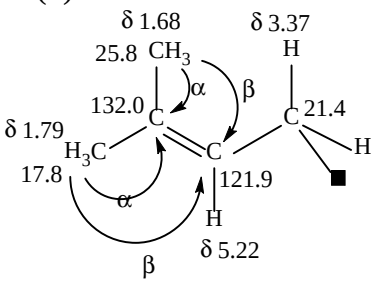
In DQF-COSY spectrum (Figure 6), two equivalent sp^3 methylene protons at (δ 3.37 ppm) were found to be correlated with another sp^2 methine proton at (δ 5.22 ppm) with medium graphic area affording the fragment.



This fragment could be confirmed by the splitting patterns and coupling constants of two equivalent sp^3 methylene protons at (δ 3.37 ppm, d, J = 7.12 Hz) and sp^2 methine proton at (δ 5.22 ppm, t, J = 7.13 Hz) in ^{1}H NMR spectrum, (Figure 3) and their corresponding ^{13}C NMR signals at (δ 121.9 and δ 21.4 ppm) in HSQC spectrum (Figure 7), producing the fragment.

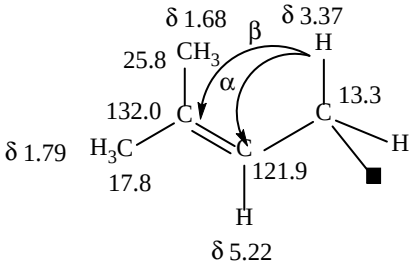


The appearance of α and β ^{1}H-^{13}C long range connections of two set of sp^3 methyl protons at (δ 1.68 and δ 1.79 ppm) with sp^2 quaternary carbon at (δ 132.0 ppm) and sp^2 methine carbon at (δ 121.9 ppm) in HMBC spectrum (Figure 8), leading to the fragment (d).

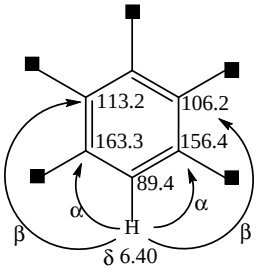


Fragment (d)

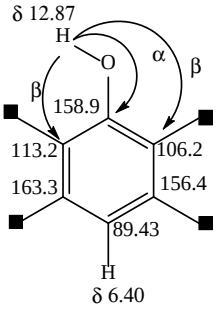
The fragment (d) could be confirmed by the occurrence of α and β ^{1}H-^{13}C long range signals of two equivalent sp^3 methylene protons at (δ 3.37 ppm) with sp^2 methine carbon at (δ 121.9 ppm) and sp^2 quaternary carbon at (δ 132.0 ppm) in HMBC spectrum (Figure 8).



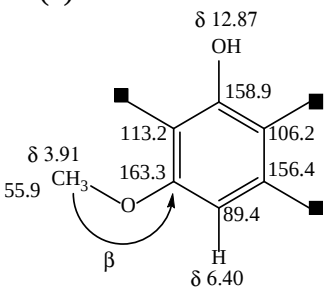
Moreover, according to HMBC spectrum (Figure 8), the singlet of sp^2 aromatic proton at (δ 6.40 ppm) had α^1H-^{13}C long range couplings with two sp^2 quaternary carbons at (δ 163.3 and δ 156.4 ppm) and β^1H-^{13}C long range couplings with two sp^2 quaternary carbons at (δ 106.2 and δ 113.2 ppm), resulting the fragment.



In addition, the singlet hydroxyl proton at (δ 12.87 ppm) had α^1H-^{13}C long range coupling with sp^2 quaternary carbon at (δ 158.9 ppm) and β^1H-^{13}C long range couplings with two sp^2 quaternary carbons at (δ 113.2 and δ 106.2 ppm) in HMBC spectrum (Figure 8), to produce the fragment.



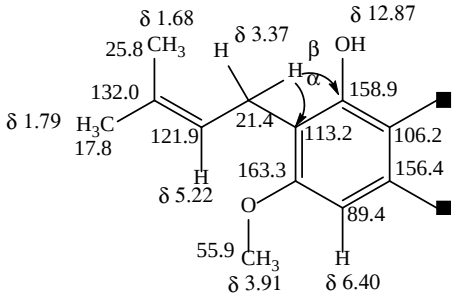
Furthermore, according to HMBC spectrum (Figure 8), the observation of β^1H-^{13}C long range signal of sp^3 methyl protons at (δ 3.91 ppm) with sp^2 quaternary carbon at (δ 163.3 ppm) afforded the fragment (e).



Fragment (e)

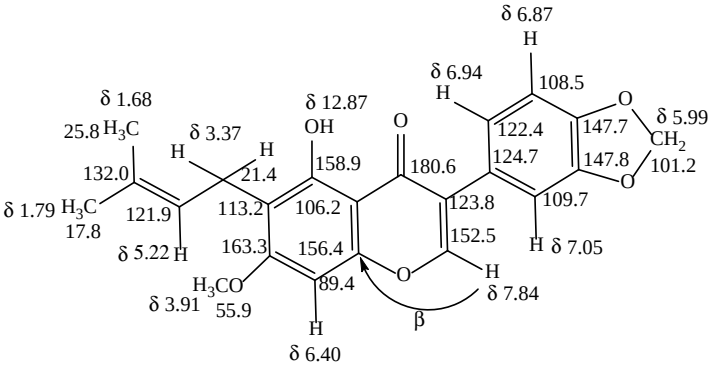
Fragment (d) and (e) could be connected by the observation of α and β^1H-^{13}C long range signals of two equivalent sp^3 methylene protons at (δ 3.37 ppm) with sp^2 aromatic

quaternary carbons at (δ 113.2 and δ 158.9 ppm) in HMBC spectrum (Figure 8), leading to the extended fragment (f).



Fragment (f)

The fragment (c) and (f) could be logically connected by an oxygen atom because of the down field chemical shift of sp^2 quaternary carbon at (δ 156.4 ppm) and sp^2 methine carbon at (δ 152.5 ppm), resulting the partial fragment (g). The partial fragment (g) could be assured by the existence of β^1H-^{13}C long range signal of sp^2 methine proton at (δ 7.84 ppm) with sp^2 quaternary carbon at (δ 156.4 ppm) in HMBC spectrum (Figure 8). Furthermore, the reliable chemical shift of sp^2 quaternary carbon at (δ 106.2 ppm) and the carbonyl carbon at (δ 180.6 ppm) could be logically connected to accomplish the complete structure of pure compound, PEN -2.



Fragment (g)

Structure of pure compound PEN-2

Molecular formula of (PEN-2) = $C_{22}H_{20}O_6$

Molecular Mass = 380.13

From DART-mass spectrum, molecular mass $[M + H]^+$ = 381.13.

Therefore, molecular mass of PEN-2 is agreed with the molecular mass given by DART-MS, (Figure 9).

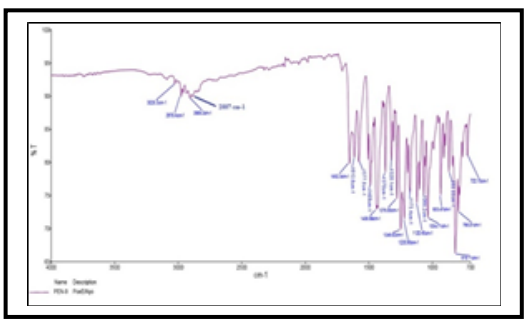


Figure 2 FT-IR Spectrum

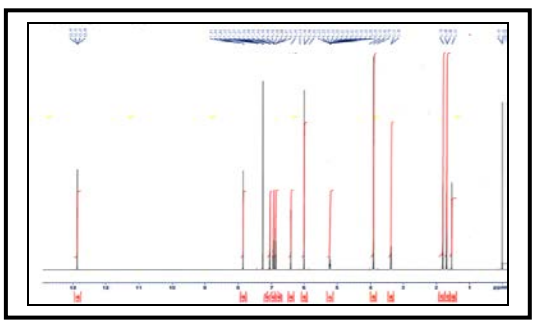


Figure 3 ^{1}H NMR Spectrum

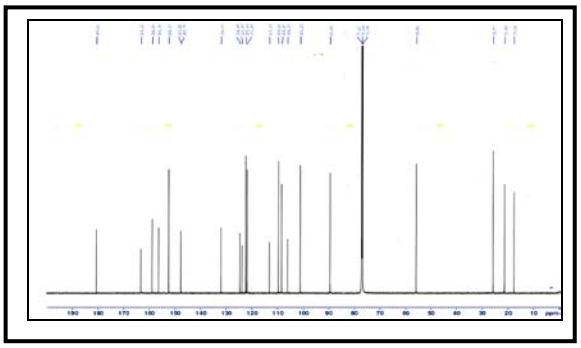


Figure 4 ^{13}C NMR Spectrum

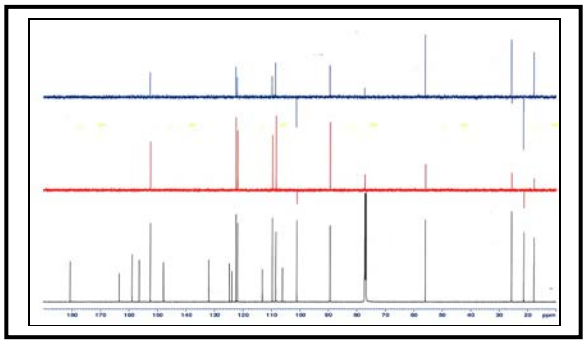


Figure 5 DEPT Spectrum

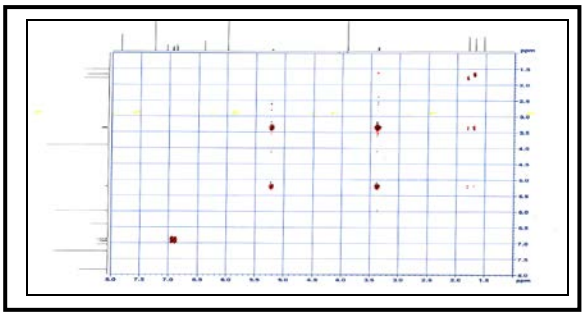


Figure 6 DQF-COSY Spectrum

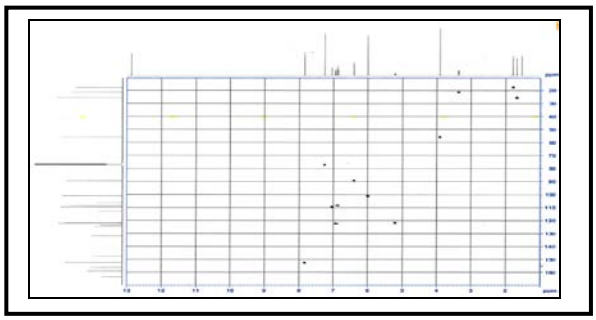


Figure 7 HSQC Spectrum

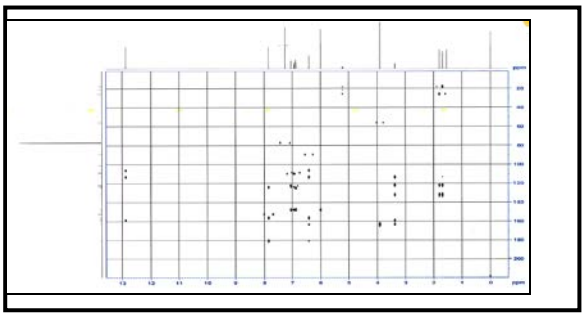


Figure 8 HMBC Spectrum

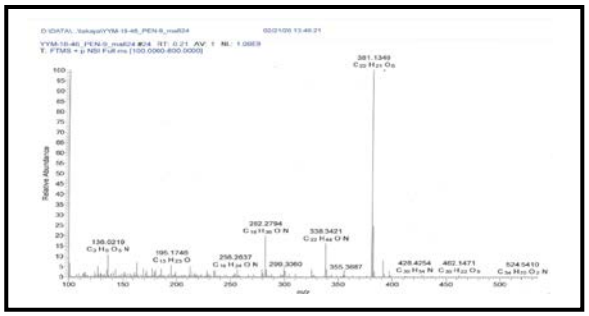
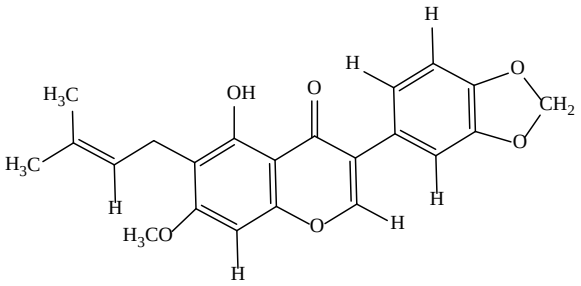


Figure 9 DART-Mass Spectrum

Conclusion

In this study, one of the Myanmar traditional plants, *Derris robusta* (DC.) Benth., was used for the investigation of phytochemicals, determination of antimicrobial activities and the isolation of bioactive constituents. Phytochemical analysis revealed that alkaloids, tannins, saponins, flavonoids, terpenoids, glycosides, steroids, phenolic compounds and polyphenols were present in the extracts of *Derris robusta* (DC.) Benth.. According to the results of antimicrobial activities, the crude methanolic extract showed medium activities on *Staphylococus aureus, Candida albicans,* and *E-coli* and low activity on other organisms. Exception of medium sensitivity on *Pseudomonus aeruginosa* the ethyl acetate extract responded low activity on all tested pathogens. The n-hexane extract revealed low sensitivity against five tested pathogens and no activity on *Pseudomonus aeruginosa*. According to FT-IR spectral data, sp^2 hydrocarbon, sp^3 hydrocarbon, aromatic ring, carbonyl group, allylic

hydrocarbon, ether group, *trans* or *E* and *cis* or *Z* alkenic groups was present in pure compound, PEN-2. The structure of the pure compound, PEN-2, was elucidated by means of spectroscopic analyses such as FT-IR, ^{1}H NMR, ^{13}C NMR, DEPT, DQF-COSY, HSQC, HMBC and DART-Mass Spectrometry. The structure of the pure compound, PEN-2, was shown below.



The IUPAC name of pure compound, PEN-2, is 3-(benzo[d][1,3]dioxol-5-yl)-5-hydroxy-7-methoxy-6-(3-methylbut-2-en-1-yl)-4H-chromen-4-one.

Acknowledgement

I would like to express my sincere thanks to Dr Win Swe, Pro-Rector (Rector's Duty), Dr Myo Myo, Pro-Rector and Dr Nyunt Nyunt Sein, Professor and Head, Department of Chemistry, Shwebo University, for their permission to do this research.

References

Chintoju, N.V., Konduru, P.S., Kathula, R.L. and Remella, R. (2015). "Importance of Natural Products in the Modern History". *Research and Reviews: Journal of Hospital and Clinical Pharmacy*, vol. 1 (1), January-March.

Sharief, N., Srinivasulu, A., Veni, P. S. and Rao, V. U.M. (2014). "Screening and Evaluation for antibacterial and antioxidant potentials in stem extract of *Derris trifoliate* L". *International Journal of Pharmaceutical Research and Bio-Science*, vol.3 (2), pp. 424-435.

Makungu, M., (2015). *Phytochemical Investigation of Three Leguminosae Plants for Larvicidal Activity Against Aedes Aegypti*. University of Nairobi, College of Biological and Physical Sciences, Department of Chemistry.

Paul, S.J.; Sumon, S.F.Z.M. and Hoque, Md.R. (2019). "Study on Pharmacological Activity Screening of *Derris robusta*." *Journal of Pharmacognosy and Phytochemistry*, vol.8 (4), pp.1170-1173.

Determination of Carbohydrate from *Ananas Comosus* (L.) Merr. (Pineapple)

San San Htay[1], San San Yee[2]

Abstract

In this research, the carbohydrate contents in *Ananascomosus* (L.) Merr. (pineapple) were determined. Pineapple juice was extracted from a pineapple fruit. Qualitative and quantitative analysis were carried out. The qualitative analysis was carried out by using Molisch's reagent, Fehling's reagent, Benedict's reagent, Barfoed's reagent, Rapid Furfural reagent and Iodine. The quantitative evaluation was also carried out by phenol-sulphuric acid method, using glucose, as standards.

Key words: carbohydrate, qualitative, quantitative, *Ananascomosus* (L.) Merr.

Introduction

In general, fresh fruits are healthy nutritious foods that are good sources of vitamins, mineral, phytochemicals and fiber. The pineapple is a tropical plant with an edible multiple fruit consisting of coalesced berries, also called pineapple and the most economically significant plant in the Bromeliaceae family (Grail, 1992).

The average pineapple weighs between 1 and 2 kg and with regard to its consumption and it consists of the pulp, shell and core. The pulp which is approximately 80% water is consumed not only in natural but also in multiple processed forms, including juice, jam, dehydrated, canned, or even alcoholic beverages, organic acid, and the enzyme bromelain, which is a protease that is involved in the composition of several medicines and is also used as a meat softener. The consumption of rapidly digestible carbohydrates leads to fast increases in blood glucose and insulin. Therefore, meals rich in carbohydrates result in a rapid elevation of blood glucose levels. Pineapple contains valuable nutrient components of simple sugar such as sucrose, glucose and fructose (Narine, 1999).

Although the nutritional composition of pineapple is well known, details of the composition of the pulp, shell and core are important. The pineapple from tropical America (Brazil and Paraguay) was initially domesticated by the Guarani Indians. Nowadays, it is cultivated in several countries where the weather conditions are favorable. The pineapple is considered the third most important tropical fruit produced in the world (Garil, 1992).

Botanical Description

Family name : Bromeliaceae
Botanical name : *Ananascomosus* (L.) Merr.
English name : Pineapple
Genus : Ananas
Myanmar name : Nanas
Medicinal uses : inflammation of spleen, venereal diseases, conjunctivitis and ring worm

[1] Lecturer, Dr, Chemistry Department, Shwebo University
[2] Lecturer, Dr, Chemistry Department, Shwebo University

Pineapple fruit

Pineapple on its parent plant

Materials and Methods

Sample Collection

The ripe *Ananascomosus* (L.) Merr (pineapple) fruits were collected from Sint In village, Lashio Twonship, Northern Shan State in Myanmar. The juice of pulp was used as a sample for the determination of carbohydrate content.

Qualitative Tests of Carbohydrate

The qualitative test of carbohydrate in the sample was determined by Molisch's test, Fehling's test, Barfoed's test, Benedict's test, Rapid Furfural test and Iodine test.

Total Carbohydrate Content of Pineapple

Carbohydrate of pineapple was determined by the phenol-sulphuric acid methods using 757 UV-vis spectrophotometer at Department of Chemistry, Lashio University.

To prepare the standard curve, 0.2, 0.4, 0.6, 0.8 and 1 mL of working standard glucose solution were transferred into a series of test tubes. Then, the volume of each test tube was made up to 1 mL with distilled water. Then, 1 mL of distilled water was set up for a blank solution.

1 mL of 5% phenol solution and 5 mL of 96% sulphuric acid were added to each test tube. Then, those test tubes were shaken, after 10 minutes shake, the all test tubes were placed in a water bath at 25˚-30˚C for 20 minutes. The test tubes containing standard glucose solution were gave rise colored product. The absorbance of blank solution and different concentration of glucose solution were measured at 490 nm by using UV spectrophotometer. Standard glucose calibration curve was constructed by plotting the absorbance against the different concentration of glucose.

The juice of pineapple fruit 100 mL was taken into a boiling tube. It was hydrolyzed with 5 mL of 2.5 N HCL for 3 hours in water bath and cool to room temperature. Then, it was neutralized with sodium carbonate until the effervescence and the volume was made up to 100 mL of distilled water and centrifuged it for 15 min. After that, the filtrate could be used as the sample solution. 0.1 mL of the sample solution was taken into the three separate test tubes. Then, the volume was made up to 1 mL with distilled water. To set a blank solution, 1 mL of distilled water was taken in a separate test tube. Then, 1 mL of phenol solution and 5 mL of H_2SO_4 were added into each tube and follow the same procedure as mentioned in the construction of standard calibration curve.

Results and Discussion

Qualitative Determination of Carbohydrates in Pineapple

Qualitative tests of carbohydrate were carried out from pineapple fruits. According to Molisch's test the violet color was appeared at the junction of two layers indicated the presence of carbohydrates. Reducing sugar is present by the tests of Fehling and Benedict was observed orange color and orange precipitate respectively. The observation of Barfoed's test and Rapid furfural test were indicated that monosaccharide (fructose) is present. The results are tabulated in (table 1) and (figure1).

Table 1 Results from Qualitative Test of Carbohydrates in Pineapple

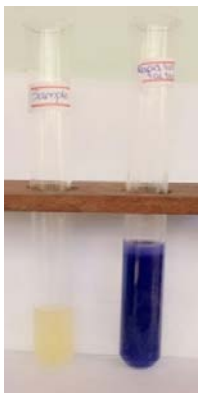
No.	Constituents	Reagent used	Observation	Remark
1	Molisch's test	α-naphthol 95% conc;H_2SO_4	Violet colour at the two layers	Carbohydrate is present
2	Fehling's test	Fehling's A + B	Orangecolour	Reducing sugar is present
3	Benedict's test	Benedict's solution	Orange precipitate	reducing sugar is present
4	Barfoed's test	Barfoed's reagent	Red precipitate	Monosaccharide is contained
5	Rapid furfural test	Conc: H_2SO_4	Violetcolour	Fructose is present
6	Iodine test	Iodine solution	-	Starch is absent

Molish's test

Benedit's test

Fehling's test

Barfoed'stest



Rapid Furfal test

Iodine's test

Figure 1 The results for qualitative test of carbohydrate in pineapple

Quantitative Determination of Total Carbohydrates

The amount of carbohydrates present in the sample solution could be calculated by using standard calibration curve. The results obtained were listed in (table 2) and (figure 2). According to these results, the amount of carbohydrate in pineapple is 0.28 g per 100mL of pineapple juice.

Table 2 Absorbance of Standard Glucose Solutions

No	Concentration of glucose (mg/mL)	Absorbance at 490nm
1	0.2	0.206
2	0.4	0.355
3	0.6	0.565
4	0.8	0.723
5	1.0	0.952

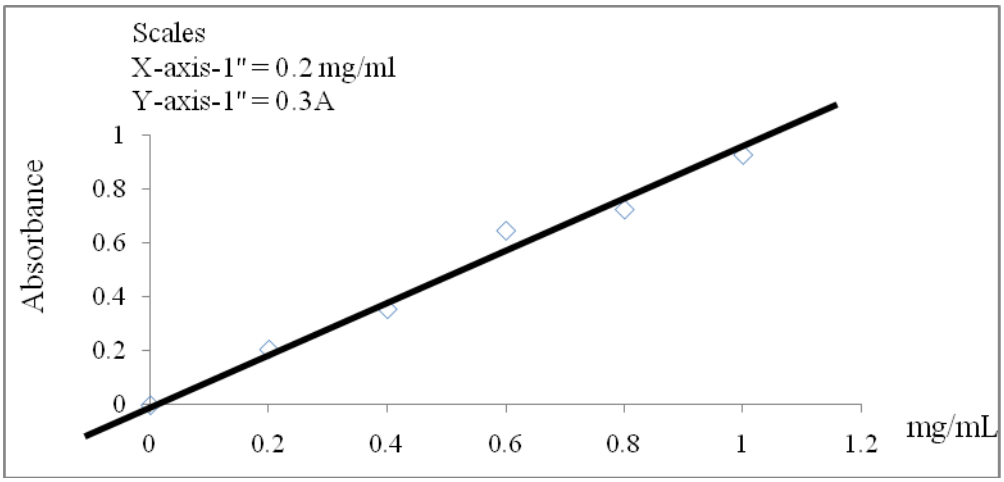


Figure 2 Standard calibration curve of glucose (wavelength 490 nm)

Table 3 Carbohydrate Content of Pineapple

No.	Sample solution (mL)	Absorbance (A)	Extent of glucose in 1 mL of sample solution (mg)	Total carbohydrate (g per 100mL)
1	0.1	2.501	2.80	0.28
2	0.1	2.495	2.75	0.28
3	0.1	2.497	2.79	0.28
			Mean	0.28

Conclusion

In this research, the qualitative and quantitative tests of carbohydrate in pineapple fruit was determined. According to the qualitative test, pineapple fruit contains carbohydrates as reducing sugar.

Moreover, the quantitative test of pineapple fruit was observed as 0.28g per 100mLof pineapple juice. Carbohydrates are common source of energy in living organisms. Therefore, pineapple fruit is suitable to eat every day for energy providing fruits.

Acknowledgement

I would like to express my deepest gratitude to my respectful Pro-Rector (Rector Duty), Dr Win Swe, and Pro-rector Dr Myo Myo, Shwebo University, for giving me a chance to write this research paper.

Also, I would like to give my special thanks to Professor Dr Nyunt Nyunt Sein, Professor and Head of Chemistry Department, Shwebo University, for her permission to present this paper.

References

Baker, K.F. and Collins, J.L. (1960). "Notes on the Distribution and Ecology of Ananas and Peseudananas in South America". Landon, *American Journal of Botany*, vol.2 (1)

Bruice, P.Y. (2001). "*Organic Chemistry*". New Jerntice, Simon & Schuster Company

Grail, D.S. and Hartel, R.W. (1992). "Kinetics of Butter Fat Crystallization". *America Journal of oil Chemists' Society*, vol.3 (2)

Manley, B.F.J. (1992). "*Multivariate Statistical Method's A Primer*". London, Chapman Hall

Narine, S.S. and Marangoni, A.G. (1999). "Relating Structure of Fat Crystal Networksto Mechanical Properties a Review". *Food Research International*, vol.5 (1), pp.125-140

Park, Y. and Subar, A.F. (2011). "Dietary Fiber Intake and Mortality in the Nih-Aarp Diet and Health Study". *Archives of Internal Medicine*, vol.2 (3), pp.234-242

Phytochemical Studies, Isolation of Chemical Constituents and Evaluation of the Antimicrobial Activities of *Uvariacordata* (Dun.) Wall.ex Alston.

San Thida Aung[1], Hnin Thanda Aung[2], Myint Myint Sein[3]

Abstract

This research deals with the investigation of phytochemical constituents, antimicrobial activities and as a new source of compounds from the bark of *Uvariacordata* (Dun.) Wall.ex Alston. The phytochemical screening by standard methods revealed that the bark of *Uvariacordata* contained tannin, saponin, flavonoid, terpenoid, glycoside, phenolic compound, polyphenol and reducing sugar. On antimicrobial screening of sample, methanol, n-hexane and ethyl acetate extracts were examined against seven microorganisms such as *Bacillus subtilis, Staphylococcus aureus, Pseudomonas fluorescens, Bacillus pumilus, Candida albicans, Escherichia coli* and *Agrobacterium tumefaciens* byagar well diffusion method. And then, five pure organic compounds (STDA-1 to STDA-5) were isolated from methanolic extract of the bark of *Uvariacordata* by applying advanced separation techniques such as thin layer, column and preparative thin layer chromatography. Moreover, the prominent functional groups containing in isolated compounds were determined by FT-IR spectroscopic method.

Key words: phytochemical, antimicrobial, preparative, spectroscopic, chromatography

Introduction

Medicinal plants are generally used in traditional medicine for the treatment of many aliments (Edoga *et al*., 2005). Medicinal plants contain bioactive organic compounds which produce definite physiological action on the human body. Medicinal plants are of great importance to the health of individual and communities (Mann., 1978).

Plants of the genus Uvaria, a member of the Annonaceae, have provided a fascinating array of secondary metabolities, several of which have shown interesting antibacterial, antifungal and antitumour activities (leboeuf *et al*., 1982; Waterman and Muhammad 1984; Nkunya *et al*., 1987).

In the present work, one Myanmar medical plant *Uvariacordata* (Dun.) Wall.ex Alston.; was selected due to its numerous medicinal properties. It is locally known as Me-tin-tar. According to the personal communication with traditional medicine practitioners, it is used to treat various types of cancer and tumor. It is widely distributed in eastern India, Sri Lanka, southern Burma (Myanmar), Indo-China, Thailand, Vietnam, Peninsular Malaysia, New Guinea; probably also elsewhere in Malesia (Trimen, Henry, 1843 -1896). In this work, preliminary phytochemical analysis, isolation of chemical constituents and antimicrobial activity evaluation were performed.

Materials and Methods

Sample Collection

Thebarks of *Uvaria cordata* were collected from Mahar Myaing forest, Kalawa Township, Sagaing Region. Firstly, the barks of sample were cleaned, then chopped into small pieces and allowed to air dry in the well ventilated room for about two weeks.

Materials

Commercial grade reagents and solvents purchased from Chemico Co.Ltd, Yangon, Myanmar, were used in this research.Column chromatography was carried out on silica gel

[1] Lecturer, Department of Chemistry, Shwebo University
[2] Associate Professor, Dr., Department of Chemistry, University of Mandalay
[3] Professor and Head (Rtd), Dr., Department of Chemistry, University of Mandalay

(70-230) mesh. Analytical preparative thin layer chromatography was performed by using Kieselgel 60 (F_{254}, Merck). Analytical TLC was performed on precoated silica gel 60 F_{254} plates (Merck, Darmstadt, Germany, Art. 5715). In thin layer chromatography, visualization was taken via UV lamp (Lambada-40, Perkin- Elmer Co, Japan) and iodine developing vapors.

Preliminary Phytochemical Screening of *Uvariacordata*

The phytochemical tests to detect tannin, saponin, flavonoid, terpenoid, glycoside, phenolic compound, polyphenol and reducing sugar were performed according to the standard procedures (Tiwari *et al*., 2011).

Antimicrobial Activities of Various Crude Extracts from the Stem Bark of *Uvariacordata*

The test microorganisms used for the antimicrobial activities screening were *Bacillus subtilis, Staphylococus aureus, Pseudomonus fluorescens, Bacillus pumilus, Candida albicans, Agrobacterium tumefaciens* and *Escherichia coli.* Antimicrobial activities of the stem bark of *Uvaria cordata* were tested for three different solvents systems by using agar well diffusion method in Department of Chemistry, Meiktila University.

Extraction and Partition of the Stem Bark of *Uvariacordata*

The air dried sample of the stem bark of *Uvaria cordata* (1Kg) was percolated with methanol (4 L) at room temperature for one month. Next, the percolated solution was filtered and evaporated to concentrate. The dried crude methanol extract of sample (60.0 g) was obtained. Then, it was partitioned into 27 fractions with the help of ethyl acetate, methanol and n-hexane by using column chromatography.

Isolation and Purification of Pure Compounds

60.0 g of methanolic crude extract was chromatographed by column using silica gel (70-230) mesh as adsorbent and n-hexane and ethyl acetate as eluents with various ratios from non-polar to polar (n-hexane only, hex : EtOAc = 9:1, 4:1, 1:1, 1:4, ethyl acetate only, EtOAc: Methanol 1:1, MeOH only). Totally 27 fractions were obtained.

The fraction -5 was rechromatographedby silica gel column chromatography using n-hexane and ethyl acetate (9:1, 4:1, 7:3) as eluents to give twenty sub-fractions (Fra-5-1 to Fra-5-20). And then, sub-fraction (5-2)was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (7:3) as eluents to give four sub-fractions (Fra-5-2-2 to 5-2-4). The sub-fraction (5-2-2) gave one spot on TLC in $R_f$value (0.15) with n-hexane: EtOAc (7:3) and yellow crystals of pure compound STDA-5 (19.8 mg) was obtained.

Then, the fraction -7 was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (9:1, 4:1, 7:3, 3:2) as eluents to afford nine sub-fractions (Fra-7-1 to Fra-7-9). And then, sub-fraction (7-5) was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (7:3) as eluents to give three sub-fractions (Fra-7-5-1 to 7-5-3). The sub-fraction (7-5-2) gave one spot on TLC in R_f value (0.27) with n-hexane : EtOAc (7:3), giving pale yellow crystals of pure compound STDA-4 (11.5 mg).

And then, the fraction -9 was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (7:3, 3:2, 1:1, 2:3) as eluents to afford ten sub-fractions (Fra-9-1 to Fra-9-10). And then, sub-fraction (9-4) was rechromatographed by

silica gel column chromatography using n-hexane and ethyl acetate (3:2) as eluents to give five sub-fractions (Fra-9-4-1 to 9-4-5). The sub-fraction (9-4-3) gave one spot on TLC in R_f value (0.17) with n-hexane : EtOAc (3:2), giving pale yellow crystals of pure compound STDA-3 (25.9 mg).

Besides that, the fraction -13 was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (1:1, 2:3, 3:7) as eluents to afford six sub-fractions (Fra-13-1 to Fra-13-6). And then, sub-fraction (13-3) was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (2:3) as eluents to give seven sub-fractions (Fra-13-3-1 to 13-3-7). The sub-fraction (13-3-4) gave one spot on TLC in R_f value (0.12) with n-hexane: EtOAc (2:3) giving pale yellow crystals of pure compound STDA-2 (51.4 mg).

Finally, the fraction -15 was rechromatographed by silica gel column chromatography using n-hexane and ethyl acetate (3:7) as eluents to afford seven sub-fractions (Fra-15-1 to Fra-15-7). And then, sub-fraction (15-2) was subjected to sephadex LH-20 using MeOH only as eluents to give nine sub- fractions (Fra-15-2-1 to 15-2-9). The sub-fraction (15-2-7) gave one spot on TLC in R_f value (0.26) with n-hexane : EtOAc (2:3), giving white amophorus crystals of pure compound STDA-1 (1.6 mg).

FT-IR Assignments of Pure Compounds

FT-IR spectra of pure compounds (STDA-1, STDA-2, STDA-3, STDA-4 and STDA-5) were measured at the Department of Chemistry, Monywa University and recorded on Perkin Elmer spectrum Version 10.4.00 within the range 400-4000cm^{-1} using KBr pellet.

Results and Discussion

The methanolic extract of *Uvariacordata* was fractionated by column chromatography over silica gel, followed by repeated column and preparative column chromatography to afford five pure compounds (STDA-1 to STDA-5).

Botanical Description

Family	:	Annonaceae
Botanical name	:	*Uvariacordata* (Dun.) Wall.ex Alston.
Myanmar name	:	Me-tin-tar
Parts of plant used	:	Bark

Figure 1 *Uvaria cordata* (Dun.) Wall.ex Alston., Plant

Preliminary Phytochemical Screening

The results for the phytochemical screening of the stem bark of *Uvaria cordata* by the standard procedures were shown in Table 1. According to preliminary phytochemical test, tannin, saponin, flavonoid, terpenoid, glycoside, phenolic compound, polyphenol and reducing sugar were found to be present in the selected sample.

Table 1 Preliminary Phytochemical Screening of the Bark of *Uvaria cordata*

No	Constituents	Observation	Results
1	Alkaloid	-	-
2	Tannin	Brown ppt.	+
3	Saponin	Formation of froth	+
4	Flavonoid	Yellow ppt.	+
5	Terpenoid	Reddish brown colour solution	+
6	Glycoside	Pale yellow ppt.	+
7	Steroid	-	-
8	Phenolic compound	Greenish bluecolor solution	+
9	Polyphenol	Bluish green color solution	+
10	Reducing sugar	Orange red ppt.	+

Antimicrobial Activities of the Bark of *Uvaria cordata*

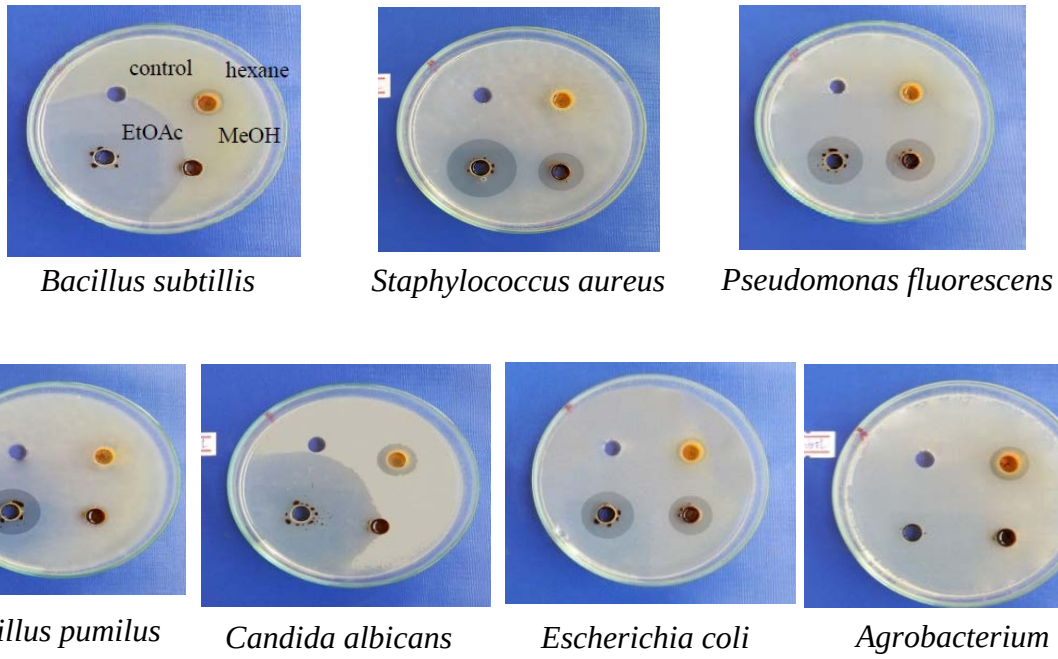
The antimicrobial activities of the stem bark of *Uvaria cordata* were tested in various solvent systems by using agar well diffusion method. The results were shown in Table 2 and Figure 2.

Table 2 Result of Antimicrobial Activities of the Stem Bark of *Uvaria cordata*

Sample	Solvent	Inhibition Zone (mm)						
		I	II	III	IV	V	VI	VII
Uvariacordata	n-hexane	-	18.77 (+++)	22.12 (+++)	-	-	20.43 (+++)	-
	EtOAc	58.45 (+++)	35.50 (+++)	32.32 (+++)	32.89 (+++)	58.66 (+++)	22.25 (+++)	-
	MeOH	11.86 (+)	-	11.08 (+)	-	17.74 (+++)	11.12 (+)	12.40 (++)

Agar Well – 10 mm
(+) ~ 8 mm – 12 mm
(++) ~ 13 mm – 17 mm
(+++) ~ 18 mm above

I = *Bacillus subtilis*
II = *Staphylococcus aureus*
III = *Pseudomonas fluorescens*
IV = *Bacillus pumilus*
V = *Candida albicans*
VI = *Escherichia coli*
VII = *Agrobacterium tumefaciens*



Bacillus subtillis *Staphylococcus aureus* *Pseudomonas fluorescens*

Bacillus pumilus *Candida albicans* *Escherichia coli* *Agrobacterium*

Figure 2 Antimicrobial activities of various crude extracts of *Uvaria cordata*

According to the results of antimicrobial activities, n-hexane extract showed high activities against *Escherichia coli, Pseudomonas fluorescens* and *Staphylococcus aureus* but no activity on *Agrobacterium tumefaciens, Bacillus pumilus, Bacillus subtillis* and *Candida albicans.* Ethyl acetate extract responded high activities on *Bacillus subtilis, Staphylococcus aureus, Pseudomonas fluorescens, Candida albicans, Bacillus pumilus* and *Escherichia coli* but no sensitively on *Agrobacterium tumefaciens.* Methanolic extract showed high activities against *Candida albicans,* medium activities against *Agrobacterium tumefaciens,* and low activities against *Bacillus subtilis, Escherichia coli* and *Pseudomonas fluorescens* but it did not exhibit activity against *Bacillus pumilus* and *Staphylococcus aureus.*

Isolation and Purification of Pure Compounds

Five pure compounds (STDA-1 – STDA-5) were isolated and purified from the bark of *Uvaria cordata*. The yield percent of pure compounds STDA-1, STDA-2, STDA-3, STDA-4 and STDA-5 were found to be 0.02%, 0.85%, 0.43%, 0.19% and 0.33% respectively based on MeOH crude extract (60.0 g).

FT-IR Assignments of Pure Unknown Compound, STDA- 1

The functional groups observed in FT-IR spectrum of pure compound, STDA-1 were tabulated in table 3. According to FT-IR spectrum (Figure 3), sp^3 hydrocarbon, carbonyl group and ether group were present in pure compound (STDA-1).

Table 3 FT-IR Assignments of Pure Compound, STDA-1

No	Absorption band (cm^{-1})	Assignments
1	2918.75, 2849.83	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
2	1708.80	C = O stretching vibration of carbonyl group
3	1463.10,1363.22	Symmetrical bending vibrations of sp^3 hydrocarbon
4	1267.83, 1186.00,1080.56	C-O-C stretching vibrations of ether group

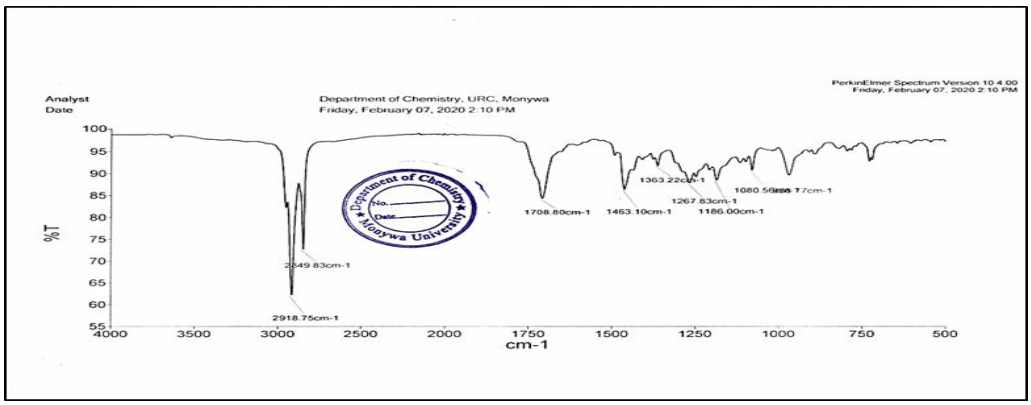


Figure 3 FT-IR Spectrum of Pure Compound, STDA- 1

FT-IR Assignments of Pure Unknown Compound, STDA-2

According to FT-IR spectrum (Figure 4), pure compound STDA- 2 should contain alcohol group, sp^2 hydrocarbon, sp^3 hydrocarbon, alkenic group, allylic hydrocarbon, ether functional group and trans or *E* and cis or *Z* alkenic groups respectively. The functional groups observed in FT-IR spectrum of pure compound, STDA-2 were tabulated in table 4.

Table 4 FT-IR Assignments of Pure Compound, STDA- 2

No	Absorption band (cm^{-1})	Assignments
1	3421	O-H stretching vibration of alcohol group
2	3025.49	C-H stretching vibrations of sp^2 hydrocarbon
3	2920.95, 2851.49	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
4	1719.87	C = O stretching vibration of carbonyl group
6	1452.39	CH bending vibration of sp^3 hydrocarbon
7	1376.68	OH bending vibration of alcohol group
8	1273.81	C-C-O stretching vibration of alcohol group
9	1178.14,1118.94, 1026.29	C-O-C stretching vibrations of ether group
10	970.92, 7111.98	C-H out of plane bending vibrations of trans or *E* and cis or *Z* alkenic group

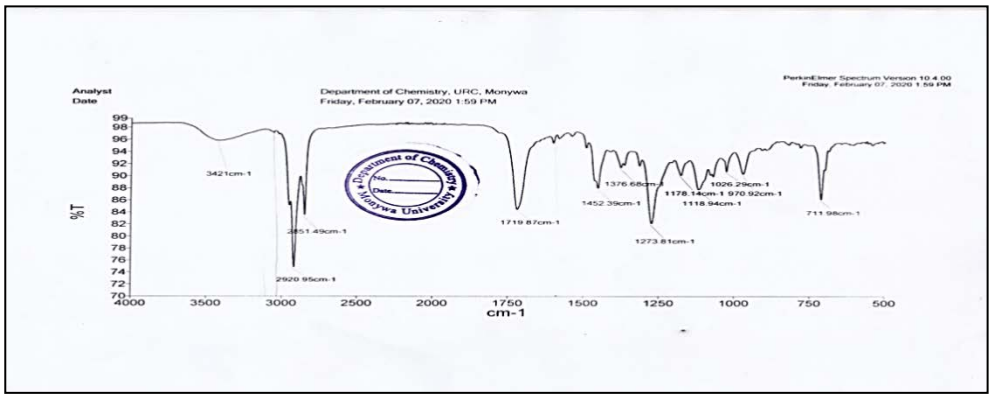


Figure 4 FT-IR Spectrum of Pure Compound, STDA- 2

FT-IR Assignments of Pure Unknown Compound, STDA-3

According to FT-IR spectrum (Figure 5), pure compound, STDA-3 should contain alcohol group, sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, alkenic group, ether functional group and trans or *E* and cis or *Z* alkenic groups respectively. The functional groups observed in FT-IR spectrum of pure compound, STDA-3 are tabulated in Table 5.

Table 5 FT-IR Assignments of Pure Compound, STDA-3

No	Absorption band (cm^{-1})	Assignments
1	3423.94	O-H stretching vibration of alcohol group
2	3028.85	C-H stretching vibration of sp^2 hydrocarbon
3	2918.56, 2850	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
4	1714.68	C=O stretching vibration of carbonyl group
5	1601.21	C=C stretching vibrations of alkenic group
6	1450.79	C-H bending vibrations of sp^3 hydrocarbon
7	1373.12	OH bending vibration of alcohol group
8	1269.54	C-C-O stretching vibration of alcohol group
9	1112.46,1069.44	C-O-C stretching vibration of ether group
10	973.45,806.07,702.34	C-H out of plane bending vibration of trans or *E* and cis or *Z* alkenic group

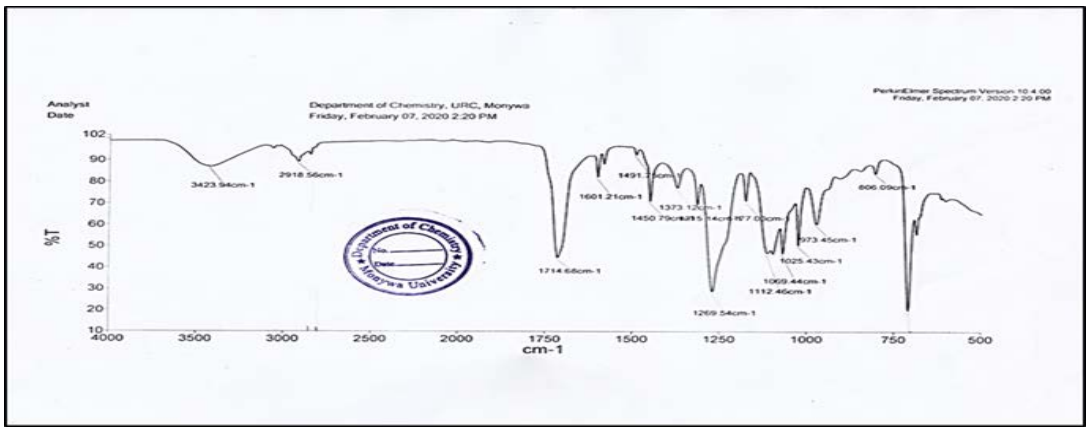


Figure 5 FT-IR Spectrum of Pure Compound, STDA- 3

FT-IR Assignments of Pure Unknown Compound, STDA-4

According to FT-IR spectrum, pure compound (Figure 6), STDA- 4 should contain alcohol group, sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, alkenic group, ether functional group and trans or *E* and cis or *Z* alkenic groups respectively. The functional groups observed in FT-IR spectrum of pure compound, STDA-4 were tabulated in Table 6.

Table 6 FT-IR Assignments of Pure Compound, STDA-4

No	Absorption band (cm^{-1})	Assignments
1	3443.05	O-H stretching vibration of alcohol group
2	3045	C-H stretching vibration of sp^2 hydrocarbon
3	2924.05, 2853.03	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
4	1715.64	C=O stretching vibration of carbonyl group
5	1601.07	C=C stretching vibration of alkenic group
6	1450.76	Symmetrical bending vibrations of sp^3 hydrocarbon
7	1373.22	O-H bending vibration of alcohol group
8	1266.80	C-C-O stretching vibration of alcohol group
9	1176.67, 1109.50	C-O-C stretching vibrations of ether group
10	968.33, 881.14, 715	C-H out of plane bending vibrations of trans or *E* and cis or *Z* alkenic group

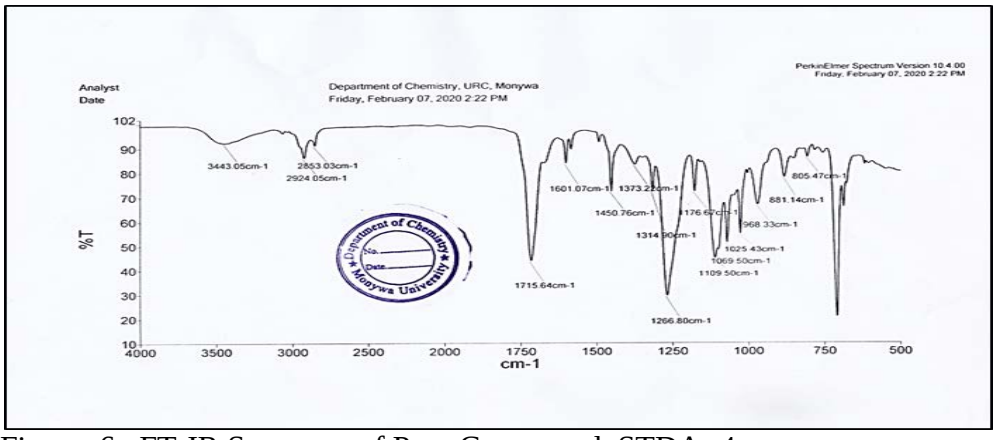


Figure 6 FT-IR Spectrum of Pure Compound, STDA- 4

FT-IR Assignments of Pure Unknown Compound, STDA-5

According to FT-IR spectrum (Figure 7), pure compound, STDA-5 should contain sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, alkenic group, ether functional group and trans or *E* and cis or *Z* alkenic groups respectively. The functional groups observed in FT-IR spectrum of pure compound, STDA-5 were tabulated in Table 7.

Table 7 FT-IR Assignments of Pure Compound, STDA-5

No	Absorption band (cm^{-1})	Assignments
1	3050	C-H stretching vibration of sp^2 hydrocarbon
3	2924.28, 2854.04	Asymmetric and symmetric C-H stretching vibrations of sp^3 hydrocarbon
4	1717.36	C=O stretching vibration carbonyl group
5	1601.22	C=C stretching vibration of alkenic group
6	1450.86, 1371.65, 1314.51	Symmetrical bending vibrations of sp^3 hydrocarbon
7	1268.41, 1227.40 1176.64, 1109.32	C-O-C stretching vibrations of ether group
8	968.02, 882.01, 715	C-H out of plane bending vibration of trans or *E* and cis or *Z* alkenic group

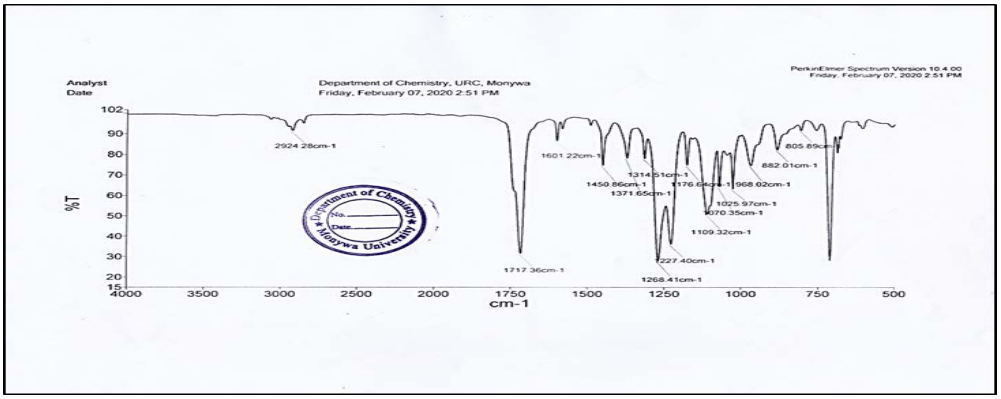


Figure 7 FT-IR Spectrum of Pure Compound, STDA- 5

Conclusion

One of Myanmar medicinal plants, *Uvaria cordata*has been widely used in various traditional medicines. The phytochemical analysis in this study revealed the presence of bioactive plant phytochemicals except alkaloid and steroid in *Uvaria cordata* which is believed to be the cause of their antimicrobial properties. According to the results of antimicrobial activities, n-hexane extract showed high activities against *Escherichia coli, Pseudomonas fluorescens and Staphylococcus aureus* but no activity on *Agrobacterium tumefaciens, Bacillus pumilus, Bacillus subtillis* and *Candida albicans.* Ethyl acetate extract responded high activities on *Bacillus subtilis, Staphylococcus aureus, Pseudomonas fluorescens, Candida albicans, Bacillus pumilus* and *Escherichia coli* but no sensitively on *Agrobacterium tumefaciens.* Methanolic extract showed highactivities against *Candida albicans,* medium activities against *Agrobacterium tumefaciens,* and low activities against *Bacillus subtilis, Escherichia coli* and *Pseudomonas fluorescens* but it did not exhibit activityagainst *Bacillus pumilus*and *Staphylococcus aureus.* The antimicrobial activities displayed by the ethyl acetate extract of *Uvaria cordata*are significant. Pure compounds (STDA-1 to STDA-5) were isolated and purified from the bark of *Uvaria cordata*, (Me-tin-tar) and their yield percentages were found to be 0.02%, 0.64%, 0.34%, 0.14% and 0.24% based on methanolic crude extract (60.0 g) respectively. The prominent functional groups in pure compound, STDA-1 were assigned by FT-IR spectra data. According to FT-IR spectrum, sp^3 hydrocarbon, carbonyl group and ether group were present in pure compound (STDA-1). According to FT-IR spectral data, alcohol group, sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, alkenic group, ether group and trans or *E* and cis or *Z* alkenic functional groups were present in STDA-2, STDA-3 and STDA-4. sp^2 hydrocarbon, sp^3 hydrocarbon, carbonyl group, alkenic group, ether and trans or *E* and cis or *Z* alkenic functional groups in pure compound, STDA-5 was assigned by FT-IR spectrum.

Acknowledgement

We are greatly indebted to Dr Win Swe, Pro-Rector (Rector's duty), Shwebo University, for his permission to do this research. We would like to express our sincere gratitude to Dr Nyunt Nyunt Sein, Professor and Head, Department of Chemistry for her permission to submit the paper.

References

Edoga, H.O. Okwu, D.E. and Mbaebie, B.O.(2005). "Phytochemicals constituents of some Nigerians medicinals plants" *Afr. J. Biotechnol*, vol. 4(7), pp. 685-688

Leboeuf, M.A. Cave, P. K. B. Mukherjee and R, Mukherjee. (1989). "The phytochemistry of the Annonaceae". *Phytochemistry*, vol.21, pp.2783-2813

Nkunya, M.H.H.H weenan, N.J.Koyi. L. THIJIS. and B, Zwanenburg. (1987). "Cyclohexene epoxides, (+)-pandoxide, (+)-beta-senepoxide and (-)-pipoxide from *Uvariapandensis"*. *Phytochem,* vol. 26, pp.783-785

Mann, J. (1978). “Secondary Metabolism”. *Oxford University press, London*, pp.154

Tiwari, P. Kumar, B.Kaur, M.Kaur, G. and Kaur, H.(2011). "Phytochemical Screening and Extraction: A Review", *Internationale Pharmaceutica Sciencia*, vol. 1(1), pp. 98-106

Trimen, Henry. (1843-1896); Alston, A.H.G., (Arthur Hugh Garfit); Hooker, Joseph Dalton, Sir, pp.1817-1911.

Waterman, P.G.and I. Muhammad. (1984). “Chemistry of Annonaceae. Structures of uvarindoles A-D, four new benzylatedindole alkaloids from *Uvariaangloensis”*.*J. Chem. Soc. Chem.Comm.* pp. 1280-1281

Synthesis and Characterization of Silver and Nickel Oxide Nanoparticles by Chemical Method

Myat Pan Wai[1], Ni Ni Pe[2] , Yi Yi Myint[3]

Abstract

In this research, Ag nanoparticles were prepared by using chemical synthesis. $AgNO_3$ was used as precursor, and reduced to colloidal silver nanoparticles by using tri-sodium citrate. NiO nanoparticles were synthesized by using sol-gel method. In this method, $NiCl_2.6H_2O$ and NaOH were used. The formation of silver and NiO nanoparticles were studied by EDXRF, XRD and FT-IR. The crystallite size and crystal structure of the silver and NiO nanoparticles were determined by XRD method.

Key words: nanoparticles, EDXRF, XRD, sol-gel

Introduction

The nano is a Greek word, which means small in size. It is used as the prefix for the billionth from the range 9 to 10 (Khalid, *et al.,* 2016). Nanostructures possess unique chemical and physical properties as compared to their corresponding bulk or isolated atoms and molecules. They possess unique properties due to increase relative area and quantum effects. Nanostructure are more useful because thermodynamic properties, mechanical properties, optical properties, electronic properties, magnetic properties and chemical properties can be significantly altered relative to their bulk counterparts.

Nanochemistry refers to the utilization of synthetic chemistry to make nanoscale building blocks of different sizes and shapes, composition and surface structures, charge and functionality. Nanomaterials were synthesized by various methods that includes, mechanical milling, lithography, chemical route and biological reduction methods which forms the green synthesis methods (Senthilkumar, *et al.,* 2015). Materials developed in the nanoscale range were applied in numerous fields such as solar energy conversion, catalysts, medicine and water treatment.

Silver nanoparticles are one of the metal nanoparticles which have varied and different properties when compared to other material (Khatoon, *et al.,* 2011). Currently most of the applications of silver nanoparticles are in antibacterial/ antifungal agents in biotechnology and bioengineering, textile engineering, water treatment, and silver-based consumer products (Rashid, *et al.,* 2013).

Nickel oxide (NiO) is an important transition metal oxide with cubic lattice structure. It has attracted increasing attention owing to potential use in a variety of applications such as: catalysis, battery cathodes, gas sensors, electrochromic films and magnetic materials (Kemary, *et al.,* 2013).

Materials and Methods

Materials

In this study, silver nitrate ($AgNO_3$), tri-sodium citrate dihydrate ($C_6H_5Na_3O_7.2H_2O$), nickel (II) chloride ($NiCl_2.6H_2O$), sodium hydroxide (NaOH), acetone, ethanol with high purity and distilled water were used.

[1] Assistant Lecturer, PhD Candidate, Department of Chemistry, Shwebo University
[2] Associate Professor, Dr., Department of Chemistry, University of Mandalay
[3] Professor and Head, Dr., Department of Chemistry, University of Mandalay

Preparation of Silver (Ag) Nanoparticles by Chemical Reduction Method

250 mL of 0.02 M $AgNO_3$ was transferred into a beaker. Then the solution was stirred for 2 hours at 85°C with 1000 rpm by using magnetic stirrer. To this solution 50 mL of 3% trisodium citrate was added drop by drop during stirring. During the process, solutions were mixed vigorously and heated until reddish yellow color changed. Then it was removed from the heating device and stirred until cooled to room temperature. After the formation of precipitate the whole mixture was washed with distilled water until to neutral pH. And then the precipitate was centrifuged at 6000 rpm for 15 minutes. Then the precipitate was washed again with acetone and dried in petridish. The resulting precipitate was calcinated at 500°C for 3 hours. After that, the grinded the resulting powder was weighed.

Preparation of Nickel Oxide (NiO) by Sol-gel Method

1.5 g of $NiCl_2.6H_2O$ was dissolved in 70 ml of absolute alcohol in a beaker. Then the solution was stirred for 2 hours at room temperature with 800 rpm by using magnetic stirrer. 0.5 g of NaOH was dissolved in 100 ml of absolute alcohol in another beaker. This solution was added in $NiCl_2.6H_2O$ solution dropwise. It was stirred for 3 hours at room temperature with 800 rpm. Light green colored gel was formed after two hours. The solution was allowed standing overnight. The clear supernatant liquid was decanted and washed the gel with distilled water until to neutral pH. And then the gel was washed with ethanol and centrifuged at 6000 rpm for 15 minutes. Then the precipitate was oven dried at 100°C for 2 hours. After then, fine green powder was calcinated at 300°C for 2 hours and ground. Then the resulting black colour powder was weighed.

Characterization Methods

Crystal structure and crystallite size of Silver ad Nickel Oxide (NiO) were characterized by XRD method.

EDXRF Analysis - Department of Chemistry, Monywa University
XRD Analysis - Department of Chemistry, University of Research Center,(YU)
FTIR Analysis - Department of Chemistry, University of Mandalay

Results and Discussion

The yield percent of Silver (Ag) and Nickel Oxide (NiO) nanoparticles were presented in Table 1.

Table 1 Yield (%) of Silver (Ag) and Nickel Oxide (NiO) Nanoparticles

No	Nanoparticles	Method	Calcined Temperature (ºC)	Yield (%)
1.	Ag	Chemical reduction	500	32.78
2.	NiO	Sol-gel	300	29.75

Some oxide forms and relative abundance (%) of prepared sample were shown in Table (2).

Table 2 Relative Abundance (%) of Silver Nanoparticles from EDXRF Spectrum

No.	Element	Relative Abundance (%)
1	Ag	89.458
2	Si	9.857
3	Fe	0.230
4	Ni	0.138
5	Cu	0.101
6	Mn	0.095
7	Cr	0.064
8	At	0.041
9	Se	0.017

From EDXRF data, the amount percent of Ag in silver nanoparticles was found to be 89.458% .

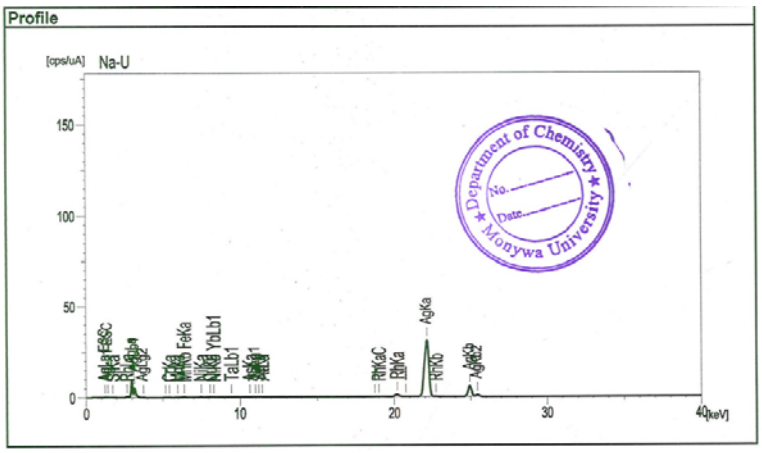


Figure 1 EDXRF Spectrum of Silver (Ag) Nanoparticles

Table 3 Relative Abundance (%) of NiO Nanoparticles from EDXRF Spectrum

No.	Metal Oxide	Relative Abundance (%)
1	NiO	99.871
2	Sm_2O_3	0.060
3	Fe_2O_3	0.047
4	NbO	0.023

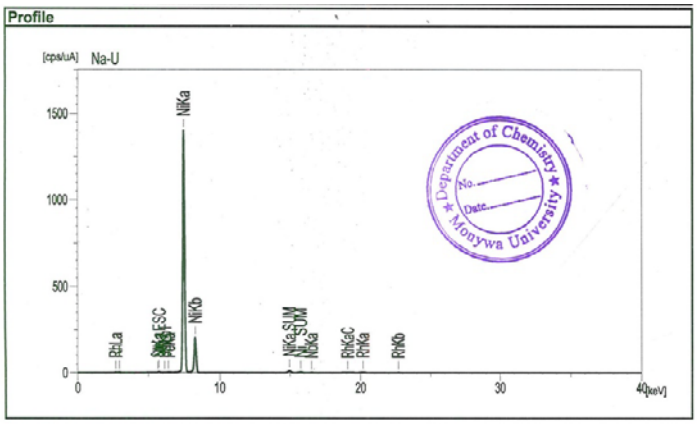


Figure 2 EDXRF Spectrum of Nickel Oxide (NiO) Nanoparticles

The crystal structure and crystallite size confirmation analysis were carried out by X-ray diffraction method. XRD patterns of silver and nickel oxide nanoparticles were shown in Figure 3 and 4. The crystallite size of the prepared silver and nickel oxide were calculated by using the Debye-Scherrer's equation (Scherrer, 1918), ($D=0.89\lambda/\beta Cos\theta$, where D is the particle diameter size, λ is the radiation wavelength and θ is the Bragg's angle). The results were shown in Table 4 and 5.

Table 4 Particle Size of Ag Nanoparticles

Peak No	Bragg angle (2θ)	Miller indices (h k l)	FWHM of peak (β) radians	Inter planar spacing d (nm)	Particle size, D (nm)
1	38.18636	(111)	0.00399	0.212	36.77
2	44.38366	(200)	0.00433	0.184	34.58
3	64.57404	(220)	0.00538	0.129	30.49

Table 5 Particle Size of NiO Nanoparticles

Peak No	**Bragg angle (2θ)**	**Miller indices (h k l)**	**FWHM of peak (β) radians**	**Inter planar spacing d (nm)**	**Particle size, D (nm)**
1	37.14222	(111)	0.03661	0.218	3.995
2	43.15392	(200)	0.03661	0.189	4.073
3	62.67496	(220)	0.03661	0.133	4.434

From the XRD result, the average particle size and interplanar spacing in (nm) of silver nanoparticles was found to be 33.92 nm and 0.175 nm and nickel oxide nanoparticles material was found to be 4.17 nm and 0.18 nm respectively.

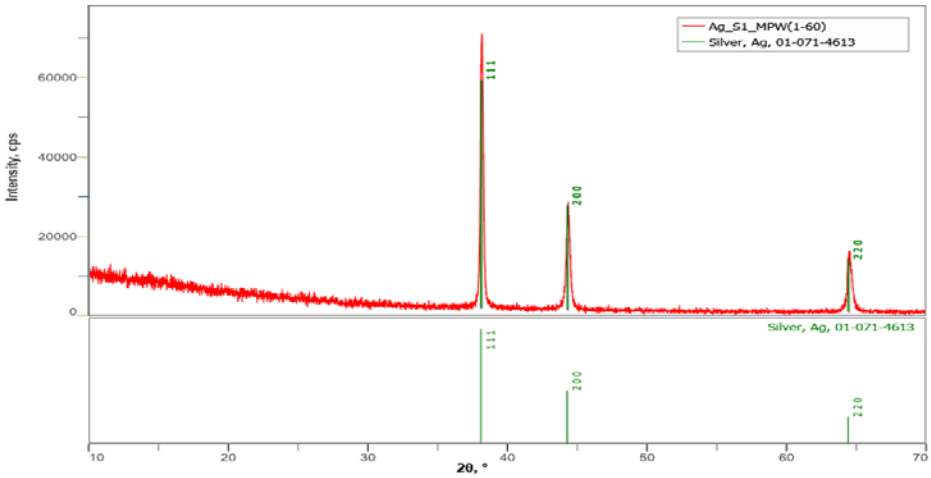


Figure 3 XRD Images of Silver Nanoparticle

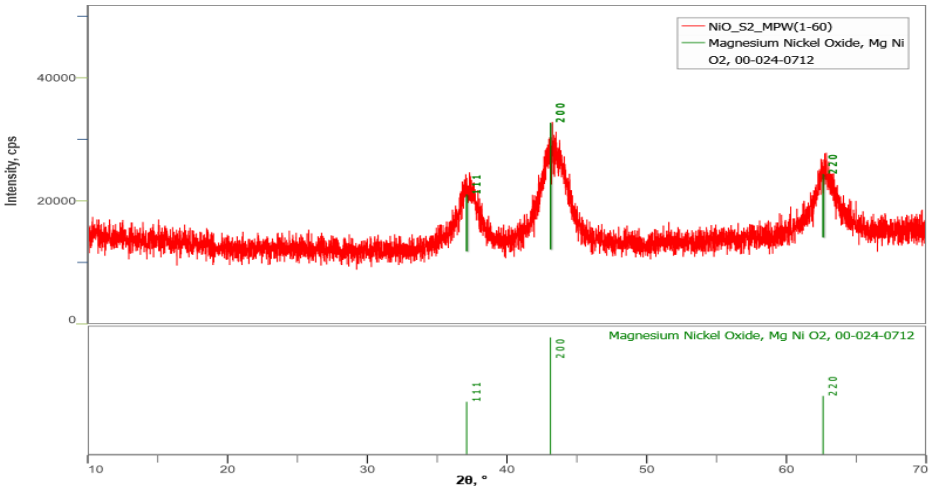


Figure 4 XRD Images of NiO Nanoparticles

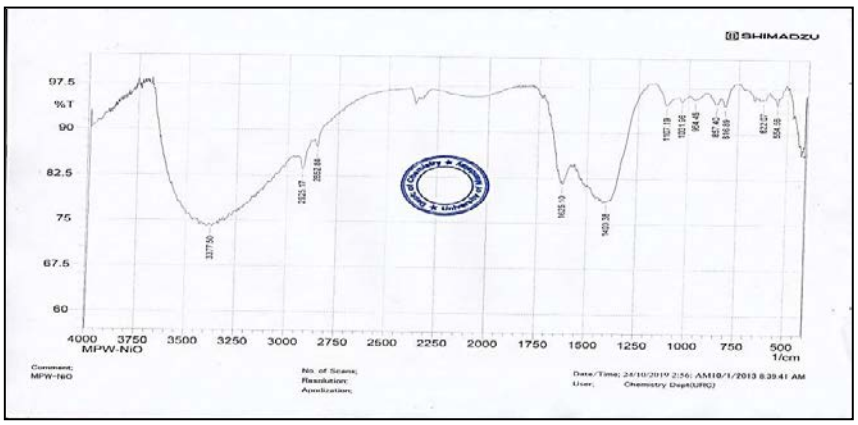


Figure 5 FT-IR Spectrum of NiO Nanoparticles

Fourier transform infrared spectrum of nickel oxide nanoparticles has been illustrated in Figure 5. In this spectrum, the peaks that presented to O–H stretching vibrations peak at 3377.50 cm^{-1}. The peaks of 622.07 cm^{-1} and 554.56 cm^{-1} belong to stretching vibrations of Ni-O bond.

Table 6 The Lattice Parameter for Silver Nanoparticles

Peak No	Bragg angle 2θ	$Sin^2\theta$	$\frac{\sin 2\theta}{\sin 2\theta \min}$	$3\times\frac{\sin 2\theta}{\sin 2\theta \min}$	$h^2+k^2+l^2$	hkl	a(A°)
1.	38.18636	0.1070	1	3	3	111	4.0786
2.	44.38366	0.1427	1.334	4.002	4	200	4.0787
3.	64.57404	0.2853	8.001	8.001	8	220	4.0787

Table 7 The Lattice Parameter for NiO Nanoparticles

Peak No	Bragg angle 2θ	$Sin^2\theta$	$\frac{\sin 2\theta}{\sin 2\theta \min}$	$3\times\frac{\sin 2\theta}{\sin 2\theta \min}$	$h^2+k^2+l^2$	hkl	a(A°)
1.	37.14222	0.10143	1	3	3	111	4.1892
2.	43.15392	0.13524	1.333	3.999	4	200	4.1892
3.	62.67496	0.27048	2.667	8.001	8	220	4.1891

Conclusion

In this research, the silver and nickel nanoparticles were synthesized by chemical reduction and sol-gel method. The prepared nanoparticles were characterized by sophisticated EDXRF, XRD and FT-IR techniques. The yield % of silver and nickel oxide nanoparticles were found to be 32.78% and 29.75%. From EDXRF datas, the amount percents of Ag in silver nanoparticles was found to be 89.458% and 99.871% of NiO was found in nickel oxide nanoparticles. According to FT-IR data, the O-H stretching vibration at 3377.50 cm^{-1} and the metal oxide (M-O) stretching vibrations of Ni-O at 622.07 cm^{-1} and 554.56 cm^{-1} were determined.

In XRD result, the average crystallite size and interplanar spacing of silver nanoparticles were found to be 33.92 nm and 0.175 nm and nickel oxide nanoparticles were found to be 4.17 nm and 0.18 nm respectively. The crystal structure of silver and nickel oxide nanoparticles were found to be face-center cubic because of $(h^2+ k^2 +l^2)$ which must be the even and odd integers with the series of 3,4,8,11,12,16,19,20, 24, 27, 32. The volume of unit cell for silver and nickel oxide nanoparticles were determined from the lattice parameters with the value of 67.852 $(A^{\bullet})^3$ and 73.518 $(A^{\bullet})^3$.

Acknowledgement

We would like to express our thanks to Dr Win Swe, Pro-Rector (Rector's duty), Shwebo University, and Dr Nyunt Nyunt Sein, Professor, Head of Department of Chemistry, Shwebo University, for their permission to do this research.

References

Kemary, M.E., Nagy, N. and Mehasseb. I.E. (2013). "Nickel Oxide Nanoparticles: Synthesis and Spectral Studies of Interactions with Glucose", *Material Science in Semiconductor Processing* vol. 16, pp.1747-1752

Khalid, Alaqad. and Saleh, T.A. (2016). "Gold and Silver Nanoparticles: Methods, Characterization Route and Applications towards Drugs", *Journal of Environmental & Analytical Toxicology*, vol.6 (4), pp. 2-10

Khatoon, U.T., Rao, K.V., Rao, J.V.R. and Aparna, Y. (2011). "Synthesis and Characterization of Silver Nanoparticles by Chemicals Reduction Method", *Journal of Materials Research* pp. 97-99

Rashid, M.U., Bhuiyan, K.H. and Quayum, M.E. (2013). "Synthesis of Silver Nano Particles (Ag-Nps) and their Uses for Quantitative Analysis of Vitamin C Tablets". *Dhaka Univ. J. Pharm.* vol. 12, pp. 29-33

Senthikumar, N., Raadha, SS. and Udayavani, S. (2015). "Synthesis and Characterization of Silver Nanoparticle by Chemical Route Method," *International Journal of Production Engineering* vol. 1, pp. 25-34

Study on the Transmission Coefficients for Double Rectangular Potential Barrier

Aye Than Kyae[1], Thida Win[2], Aye Aye Khaing[3]

Abstract

The propagation matrix method is used to calculate the transmission coefficients as a function of particle energy for double rectangular potential barrier with constant widths and different heights. We have found that the transmission resonance is not unity when the potential barriers used in this calculation are not symmetric. The exact position in energy of resonances depends upon both potential barrier width and energy. The unity peak transmission resonance is occurred when the symmetric double potential barriers are used in this calculation.

Introduction

The quantum mechanical objects can tunnel through classically impenetrable barriers. This barrier penetration effect has important applications in various branches of modern physics ranging from particle nuclear physics to semiconductor devices. For instance, radioactive decays and charge transport in electronic devices are typical examples of the tunneling effect. Resonant tunneling in semiconductor structures have attracted much interest for both fundamental research and applications in high speed electronics. In general, the tunneling problem consists of the propagation of a particle through a region where the particle's energy is smaller than the potential energy. Classically this region is forbidden to the particle where its kinetic energy will be negative. Quantum mechanically, however, since particle display wave features, the quantum waves can tunnel through the barrier.

The Propagation Matrix Method

The Propagation Matrix

A method is needed for finding solutions to be complicated potential structures for which analytic expressions are unmanageable. The transmission coefficient is calculated at the first potential step for a particle of energy E incident from the left. We then imagine the transmitted particle propagating to the next potential step, where it again has a probability of being transmitted or reflected. Associated with every potential step and free propagation region to the next potential step is a 2×2 matrix which carries wave function amplitude. The total one dimensional propagation probability for a potential consisting of a number of potential steps may be calculated by multiplying together each 2×2 matrix associated with transmission and reflection at each potential step. Therefore, the wave function coefficients for a particle traversing a one dimensional potential consisting of a number of such regions may be calculated by multiplying together the appropriate 2×2 matrices. We can solve for a particle moving in an arbitrary potential by dividing the potential into a number of potential energy steps. The following four basic parts are needed. We may use the propagation matrix method to calculate the probability of the electron emerging on the right-hand side of the

[1] Associate Professor, Dr., Department of Physics, Shwebo University
[2] Associate Professor, Dr., Department of Physics, Shwebo University
[3] Lecturer, Dr., Department of Physics, Shwebo University

barrier. The method is the best approached by dividing it into small, easy-to-understand, logical parts.

The Step Propagation Matrix

We calculate the propagation matrix $\mathbf{p}_{step}$ for transmission and reflection of the wave function representing a particle of energy *E* incident on a single potential step. The potential step we consider is at position x_{j+1} in Fig. (1).

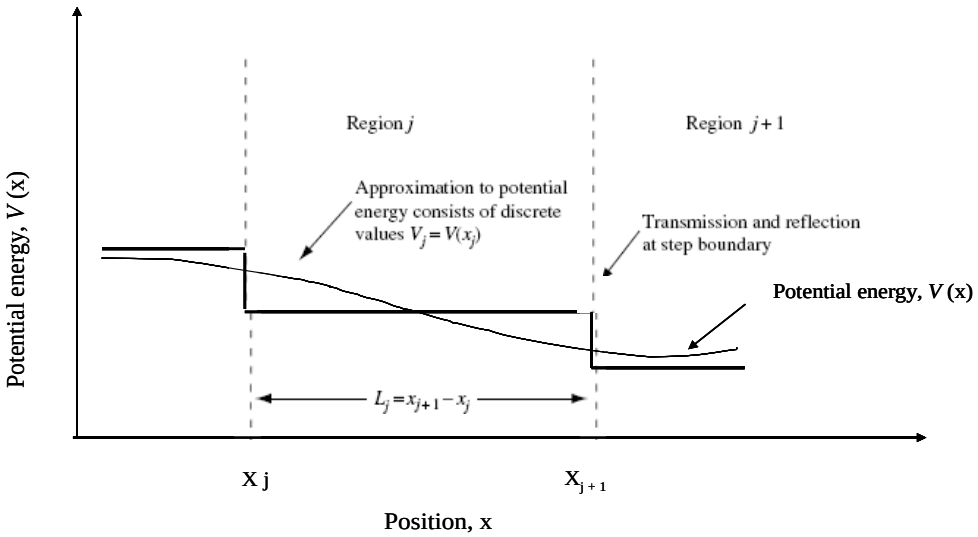


Fig. (1) Approximation of a smoothly varying one dimensional potential V(x) with a series of potential steps.

In this approach, the potential between position x_j and x_{j+1} in region j is approximated by a value V_j. Associated with the potential step at x_j and free propagation distance $L_j = x_{j+1} - x_j$ is a 2×2 matrix which carries all of the amplitude Fig.(2) shows detail of the potential step at position index j +1. The coefficients *A* and *C* correspond to waves traveling left to right in region j and j +1, respectively.

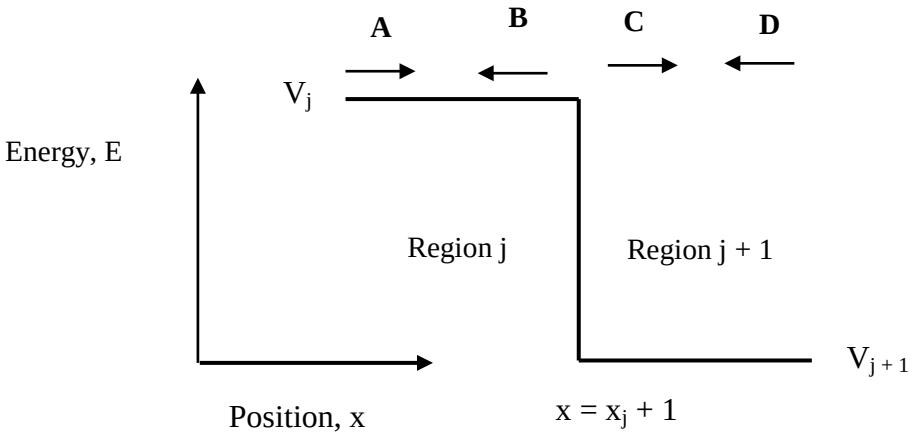


Fig. (2) A one dimensional potential step. In region j the potential energy is V_j and in region j+1 the potential energy is V_{j+1}.

The transition between region 1 and region 2 occurs at position x = x_{j+1}. The particle has wave vector $k_j = \frac{(2m\,(E - V_j))^{1/2}}{\hbar}$ in region j, and the wave functions, which are solutions to the Schrödinger equation in regions j and j+1, are

$$\psi_j = A_j e^{ik_j x} + B_j e^{-ik_j x} \tag{1}$$

$$\psi_{j+1} = C_{j+1} e^{ik_{j+1} x} + D_{j+1} e^{-ik_{j+1} x} \tag{2}$$

Following the convention we have adopted in this paper, *A* and *C* are coefficients for the wave function traveling left-to-right in regions j and j+1, respectively, and *B* and *D* are the corresponding right-to-left traveling-wave coefficients. The two wave functions given by Eq.(1) and (2) are related to each other by the constraint that ψ and dΨ/dx must be continuous. This means that at the potential step that occurs at the boundary between regions j and j+1 we require

$$\psi_j\Big|_{x = x_{j+1}} = \psi_{j+1}\Big|_{x = x_{j+1}} \tag{3}$$

and $$\frac{d\psi_j}{dx}\Big|_{x = x_{j+1}} = \frac{d\psi_{j+1}}{dx}\Big|_{x = x_{j+1}} \tag{4}$$

Substituting Eq.(1) and (2) into Eq.(3) and (4) gives two equations

$$A_j e^{ik_j x} + B_j e^{-ik_j x} = C_{j+1} e^{ik_{j+1} x} + D_{j+1} e^{-ik_{j+1} x} \tag{5}$$

$$A_j e^{ik_j x} - B_j e^{-ik_j x} = \frac{k_{j+1}}{k_j} C_{j+1} e^{ik_{j+1} x} - \frac{k_{j+1}}{k_j} D_{j+1} e^{-ik_{j+1} x} \tag{6}$$

By organizing into rows and columns the terms that contain left to right traveling waves of the form e^{ikx} and right-to-left traveling waves of the form e^{-ikx}, we may write Eq.(5) and (6) for a potential step at position $x_{j+1} = 0$ as a matrix equation:

$$\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} A_j \\ B_j \end{bmatrix} = \begin{bmatrix} 1 & \frac{1}{k_{j+1}} \\ \frac{k_{j+1}}{k_j} & -\frac{k_{j+1}}{k_j} \end{bmatrix} \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} \tag{7}$$

We would much prefer a simple equation of the type

$$\begin{bmatrix} A_j \\ B_j \end{bmatrix} = p_{j\,step} \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} \tag{8}$$

where $\mathbf{p}_{jstep}$ is the 2×2 matrix describing wave propagation at a potential step. To obtain this expression, we need to eliminate the 2×2 matrix on the left-hand side of Eq.(7). We simply use from basic linear algebra that the inverse of a 2×2 matrix $A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ is $A^{-1} = \frac{1}{|A|} \begin{bmatrix} a_{22} & -a_{12} \\ -a_{21} & a_{11} \end{bmatrix}$ where the determinant of A is given by $|A| = a_{11}\,a_{22} - a_{12}\,a_{21}$. Hence, the inverse of $\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$ is $\frac{-1}{2} \begin{bmatrix} -1 & -1 \\ -1 & 1 \end{bmatrix} = \frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$, so that we may write

$$\begin{bmatrix} A_j \\ B_j \end{bmatrix} = \frac{1}{2} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ \frac{k_{j+1}}{k_j} & -\frac{k_{j+1}}{k_j} \end{bmatrix} \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} = p_{step} \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} \tag{9}$$

where the step matrix is

$$p_{j\,step} = \frac{1}{2} \begin{bmatrix} 1+\frac{k_{j+1}}{k_j} & 1-\frac{k_{j+1}}{k_j} \\ 1-\frac{k_{j+1}}{k_j} & 1+\frac{k_{j+1}}{k_j} \end{bmatrix} \tag{10}$$

This is our result for the step potential that will be used later. We continue the development of the matrix method by considering the propagation between steps.

The Propagation between Steps

We calculate the propagation matrix $\mathbf{p}_{\text{free}}$ for propagation of the wave function between steps. The free propagation we consider is between positions x_j and x_{j+1} in Fig.(1). The distance of this free propagation is L_j. Propagation between potential steps separated by distance L_j carries phase information only so that $A_j e^{ik_j L_j} = C_{j+1}$ and $B_j e^{-ik_j L_j} = D_{j+1}$. This may be expressed in matrix form as

$$\begin{bmatrix} e^{i k_j L_j} & 0 \\ 0 & e^{-i k_j L_j} \end{bmatrix} \begin{bmatrix} A_j \\ B_j \end{bmatrix} = \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} \tag{11}$$

Or, alternatively, $$\begin{bmatrix} A_j \\ B_j \end{bmatrix} = P_{j\,free} \begin{bmatrix} C_{j+1} \\ D_{j+1} \end{bmatrix} \tag{12}$$

where $$p_{j\,free} = \begin{bmatrix} e^{-ik_j L_j} & 0 \\ 0 & e^{i k_j L_j} \end{bmatrix} \tag{13}$$

The Propagation Matrix $\mathbf{P}_j$ for the *j*-th Region

We calculate the propagation matrix for the j-th region in Fig.(1). This is achieved if we multiply $\mathbf{p}_{\text{step}}$ and $\mathbf{p}_{\text{free}}$ to obtain the propagation matrix $\mathbf{P}_j$ for the j-th region of the discretized potential. To find the combined effect of $\mathbf{p}_{\text{free}}$ and $\mathbf{p}_{\text{jstep}}$ we simply multiply the two matrices together. Hence, propagation across the complete j-th element consisting of a free propagation region and a step is

$$p_j = p_{jfree}\, p_{jstep} = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} \tag{14}$$

When we multiply out the matrices $\mathbf{p}_{\text{jfree}}$ $\mathbf{p}_{\text{jstep}}$ given by Eq.(13) and (10), respectively, it gives us the propagation matrix for the j-th region:

$$p_j = \frac{1}{2}\begin{bmatrix} \left(1+\frac{k_{j+1}}{k_j}\right)e^{-i\,k_j L_j} & \left(1-\frac{k_{j+1}}{k_j}\right)e^{-i\,k_j L_j} \\ \left(1-\frac{k_{j+1}}{k_j}\right)e^{i\,k_j L_j} & \left(1+\frac{k_{j+1}}{k_j}\right)e^{i\,k_j L_j} \end{bmatrix} \tag{15}$$

$$p_j = \begin{bmatrix} p_{11} & p_{12} \\ p_{12}^* & p_{11}^* \end{bmatrix} \tag{16}$$

Propagation through an Arbitrary Series of Step Potentials

We calculate the total propagation matrix ***P*** for the complete potential by multiplying together the propagation matrices for each region of the discretized potential. For the general case of *N* potential steps, we write down the propagation matrix for each region and multiply out to obtain the total propagation matrix,

$$P = p_1\ p_2 \ldots p_j \ldots p_N = \prod_{j=1}^{j=N} p_j \tag{17}$$

The total propagation matrix *P* satisfies continuity in Ψ and dΨ /dx between adjacent regions. Since the particle is introduced from the left, we know that $A = 1$, and if there is no reflection at the far right then $D = 0$. We may then rewrite

$$\begin{bmatrix} A \\ B \end{bmatrix} = \left(\prod_{j=1}^{j=N} p_j\right)\begin{bmatrix} C \\ D \end{bmatrix} = P \begin{bmatrix} C \\ D \end{bmatrix} \tag{18}$$

as

$$\begin{bmatrix} 1 \\ B \end{bmatrix} = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}\begin{bmatrix} C \\ 0 \end{bmatrix} \tag{19}$$

In this case, because $1 = p_{11} C$, the transmission probability $|C|^2$ is simply

$$|C|^2 = \left|\frac{1}{p_{11}}\right|^2 \tag{20}$$

Eq.(20) is a particularly simple result. We will make use of this when we calculate the transmission probability of a particle through an essentially arbitrary one-dimensional potential.

Transmission Probability for a Rectangular Potential Barrier

Fig. (3) is a sketch of the rectangular potential barrier we will consider. The thickness of the barrier is *L*. A particle of mass m incident from the left of energy *E* has wave vector k_1. In the barrier region, the wave vector is k_2.. The wave vector k_1 and k_2 are related through $k_1^2 = k_2^2 + 2\,m\,V_0/\hbar^2$.

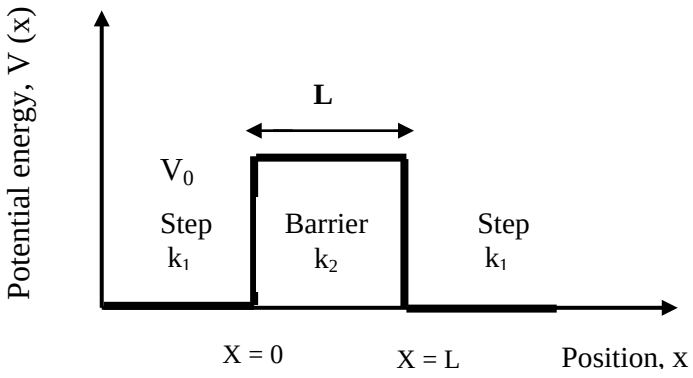


Fig. (3) The potential of a one dimensional rectangular barrier of energy $\mathbf{V_0}$.

A wavy particle incident on the barrier from the left with amplitude A sees a potential step-up in energy of V_0 at $x = 0$, a barrier propagation region of length L, and a potential step-down at $x = L$. A particle of energy E, mass m, and charge e has wave number k_1 outside the barrier and k_2 in the barrier region $0 < x < L$. We consider a particle impinging on a step change in potential between two regions in which the wave vector changes from k_1 to k_2 due to the potential step up shown in Fig. (3). The corresponding wave function changes from ψ_1 to ψ_2. Solutions of the Schroedinger equation for a step change in potential are

$$\Psi_1 = \frac{A}{\sqrt{k_1}} e^{i k_1 x} + \frac{B}{\sqrt{k_1}} e^{-i k_1 x} \tag{21}$$

$$\Psi_2 = \frac{C}{\sqrt{k_2}} e^{i k_2 x} + \frac{D}{\sqrt{k_2}} e^{-i k_2 x} \tag{22}$$

Applying the condition that the wave function is continuous at the potential step $\Psi_1\big|_{step} = \Psi_2\big|_{step}$ and that the derivative of the wave function is continuous $\left.\frac{d\Psi_1}{dx}\right|_{step} = \left.\frac{d\Psi_2}{dx}\right|_{step}$ gives

$$\frac{A}{\sqrt{k_1}} + \frac{B}{\sqrt{k_1}} = \frac{C}{\sqrt{k_2}} + \frac{D}{\sqrt{k_2}} \tag{23}$$

$$\frac{A}{\sqrt{k_1}} - \frac{B}{\sqrt{k_1}} = \frac{k_2}{k_1}\frac{C}{\sqrt{k_2}} - \frac{k_2}{k_1}\frac{D}{\sqrt{k_2}} \tag{24}$$

Rewritten in matrix form, these equations become

$$\frac{1}{\sqrt{k_1}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}\begin{bmatrix} A \\ B \end{bmatrix} = \frac{1}{\sqrt{k_2}}\begin{bmatrix} 1 & 1 \\ \frac{k_2}{k_1} & -\frac{k_2}{k_1} \end{bmatrix}\begin{bmatrix} C \\ D \end{bmatrix} \tag{25}$$

To eliminate the 2 × 2 matrix on the left-hand side of this equation, we must find and multiply by its inverse matrix. The determinant of the left-hand matrix is $(-1-1)/k_1 = -2/k_1$, so the inverse of the left-hand matrix is $\frac{k_1}{2\sqrt{k_1}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix}$. Hence, we may rewrite Eq. (25) as

$$\begin{bmatrix}A\\ B\end{bmatrix} = \frac{k_1}{2}\frac{1}{\sqrt{k_1}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix}\begin{bmatrix}1 & \frac{1}{k_2}\\ \frac{k_2}{k_1} & -\frac{k_2}{k_1}\end{bmatrix}\frac{1}{\sqrt{k_2}}\begin{bmatrix}C\\ D\end{bmatrix} = \frac{1}{2\sqrt{k_1 k_2}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix}\begin{bmatrix}k_1 & k_1\\ k_2 & -k_2\end{bmatrix}\begin{bmatrix}C\\ D\end{bmatrix}$$

Multiplying out the two square matrices gives the 2×2 matrix describing propagation at the step-up in potential

$$\begin{bmatrix}A\\ B\end{bmatrix} = \frac{1}{2\sqrt{k_1 k_2}}\begin{bmatrix}k_1+k_2 & k_1-k_2\\ k_1-k_2 & k_1+k_2\end{bmatrix}\begin{bmatrix}C\\ D\end{bmatrix} \tag{26}$$

Since the rectangular potential barrier consists of a step up and a step down, we can make use of this symmetry and immediately calculate the 2 × 2 matrix for the step down by simply interchanging k_1 and k_2. The total propagation matrix for the rectangular potential barrier of thickness L consists of the step-up 2 × 2 matrix multiplied by the propagation matrix from the barrier thickness L multiplied by the step-down matrix. Hence, our propagation matrix become

$$\mathrm{P} = \frac{1}{2\sqrt{k_1 k_2}}\begin{bmatrix}k_1+k_2 & k_1-k_2\\ k_1-k_2 & k_1+k_2\end{bmatrix}\begin{bmatrix}e^{-i\,k_2 L} & 0\\ 0 & e^{i\,k_2 L}\end{bmatrix}\frac{1}{2\sqrt{k_1 k_2}}\begin{bmatrix}k_2+k_1 & k_2-k_1\\ k_2-k_1 & k_2+k_1\end{bmatrix}$$

$$\mathrm{P} = \frac{1}{4k_1 k_2}\begin{bmatrix}(k_1+k_2)e^{-i\,k_2 L} & (k_1-k_2)e^{i\,k_2 L}\\ (k_1-k_2)e^{-i\,k_2 L} & (k_1+k_2)e^{i\,k_2 L}\end{bmatrix}\begin{bmatrix}k_2+k_1 & k_2-k_1\\ k_2-k_1 & k_2+k_1\end{bmatrix} \tag{27}$$

To find the matrix elements of P, we just multiply out the matrices in Eq.(27). The next step we want to take is to calculate the transmission probability for a particle incident on the barrier. We already know that the transmission of a particle incident from the left is given by $\left|\frac{1}{p_{11}}\right|^2$, so that we will be interested in obtaining p_{11} from Eq.(27)

$$p_{11} = \frac{(k_2+k_1)(k_1+k_2)e^{-ik_2 L} + (k_1-k_2)(k_2-k_1)e^{i\,k_2 L}}{4k_1 k_2} \tag{28}$$

$$p_{11} = \frac{(k_2^2+k_1^2)(e^{-ik_2 L} - e^{ik_2 L})}{4k_1 k_2} + \frac{2k_1 k_2(e^{-ik_2 L} + e^{i\,k_2 L})}{4k_1 k_2} \tag{29}$$

$$p_{11} = -\frac{1}{2}\frac{(k_2^2+k_1^2)(e^{ik_2 L} - e^{-ik_2 L})}{2k_1 k_2} + \frac{1}{2}(e^{-i\,k_2 L} + e^{ik_2 L}) \tag{30}$$

Results

We use the propagation matrix approach to calculate the transmission coefficient T of a double rectangular potential barrier with different heights. When solving Schroedinger equation, we obtain wave vectors k_1 and k_2 corresponding to the propagation in the potential barrier regions of 0 eV and V_0 respectively.

where $k_1 = \frac{\sqrt{2mE}}{\hbar}$ and $k_2 = \frac{\sqrt{2m(E-V_0)}}{\hbar}$

m is electron mass and *E* is energy of electron**.** Matrix technique in transmission calculations means that we express every region of barrier as a propagation matrix (P). In the present case we have a matrix for up front (p_u), then for propagation in barrier (p_b) and down front (p_d). where

$$p_u = \frac{1}{2\sqrt{k_1 k_2}}\begin{pmatrix} k_1+k_2 & k_1-k_2 \\ k_1-k_2 & k_1+k_2 \end{pmatrix}$$

$$p_b = \begin{pmatrix} e^{-ik_2L} & 0 \\ 0 & e^{ik_2L} \end{pmatrix}$$

$$p_d = \frac{1}{2\sqrt{k_1 k_2}}\begin{pmatrix} k_2+k_1 & k_2-k_1 \\ k_2-k_1 & k_2+k_1 \end{pmatrix}$$

The total propagation matrix of barrier can be obtained when the element matrices are multiplied together.

$$P = p_u \; p_b \; p_d \tag{31}$$

The transmission coefficient can be expressed $T = \frac{1}{|p_{11}|^2}$.

In order to find transmission coefficients of this double potential barriers, we use propagation matrix methods which is divided into four parts : up front (p_u), down front (p_d), propagation along the barrier region (p_b) and propagation along well region (p_w). Propagation matrix corresponding to entire barrier series was obtained, when the elements of it were multiplied together in sequential order. Thus

$$P = \prod_N p_u \; p_b \; p_d \; p_w \tag{32}$$

where N = total number of barriers

$$p_u = \frac{1}{2\sqrt{k_1 k_2}}\begin{pmatrix} k_1+k_2 & k_1-k_2 \\ k_1-k_2 & k_1+k_2 \end{pmatrix}$$

$$p_b = \begin{pmatrix} e^{-ik_2L} & 0 \\ 0 & e^{ik_2L} \end{pmatrix}$$

$$p_d = \frac{1}{2\sqrt{k_1 k_2}}\begin{pmatrix} k_2+k_1 & k_2-k_1 \\ k_2-k_1 & k_2+k_1 \end{pmatrix}$$

$$p_w = \begin{pmatrix} e^{-ik_1L} & 0 \\ 0 & e^{ik_1L} \end{pmatrix}$$

We apply the propagation matrix method to find the transmission coefficients of a particle in a one dimensional potential consisting of two rectangular potential barriers. We find the transmission resonances of a particle for the one dimensional double rectangular potential barrier with different heights and same barrier widths. We use the potential barrier widths 4 nm and the barrier-barrier separation is 3.5 nm.

Firstly, we calculate the transmission coefficients of a particle for the one dimensional double rectangular potential barrier with heights 0.5 eV and 1 eV. Secondly, we vary the barrier heights by using first potential barrier height 0.7 eV and the second potential barrier height 1.2 eV. Finally, we use the same barriers with barrier heights 0.7 eV and 1.2 eV. We plot particle transmission as a function of incident energy of a particle on a linear scale. To learn more about transmission resonances we plot this on a negative natural logarithmic scale. The results of this double potential barrier are shown in Fig. (4 a) to (7 b).

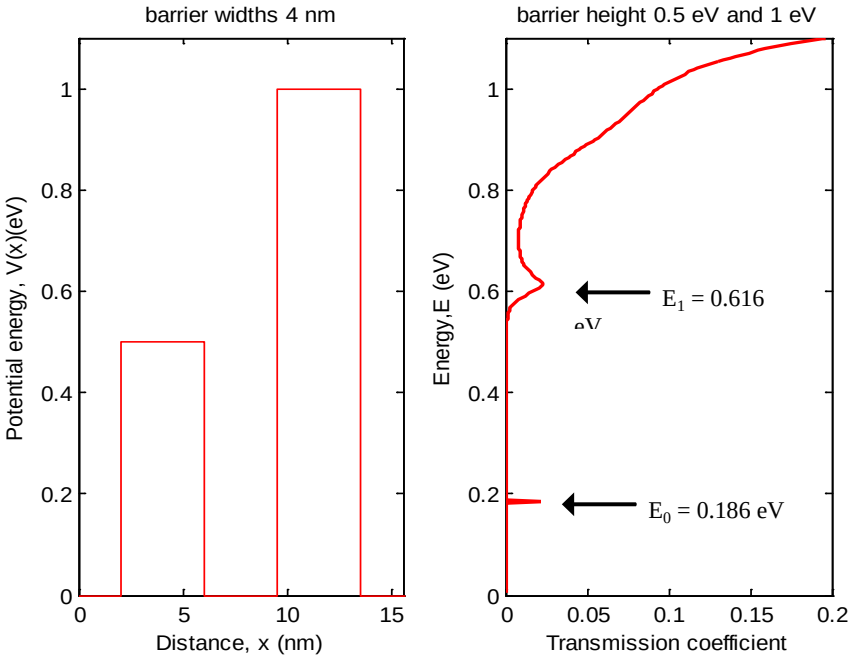


Fig. (4 a) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.5 eV and 1 eV.

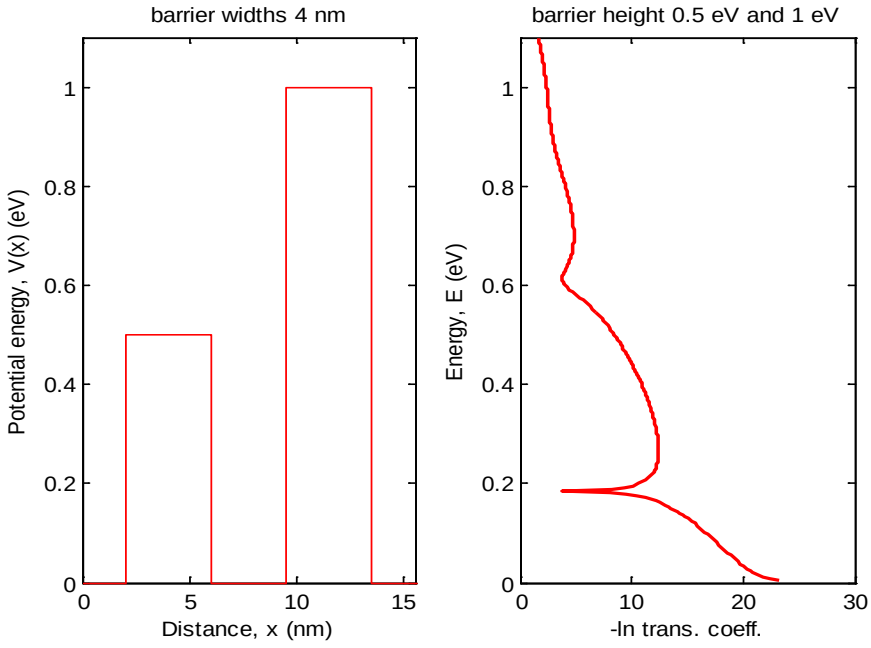


Fig. (4 b) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.5 eV and 1 eV.

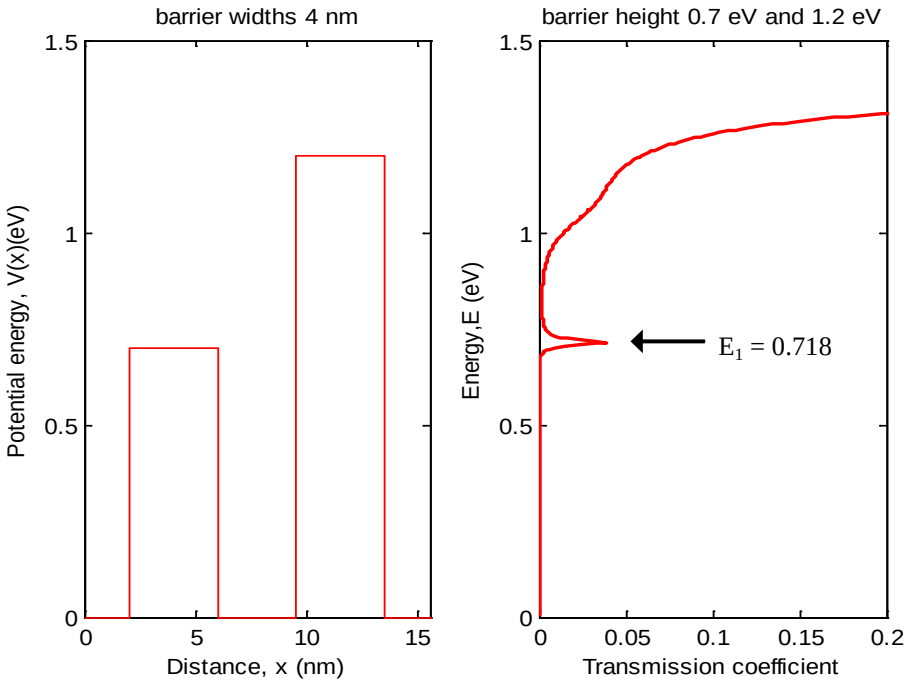


Fig. (5 a) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.7 eV and 1.2 eV.

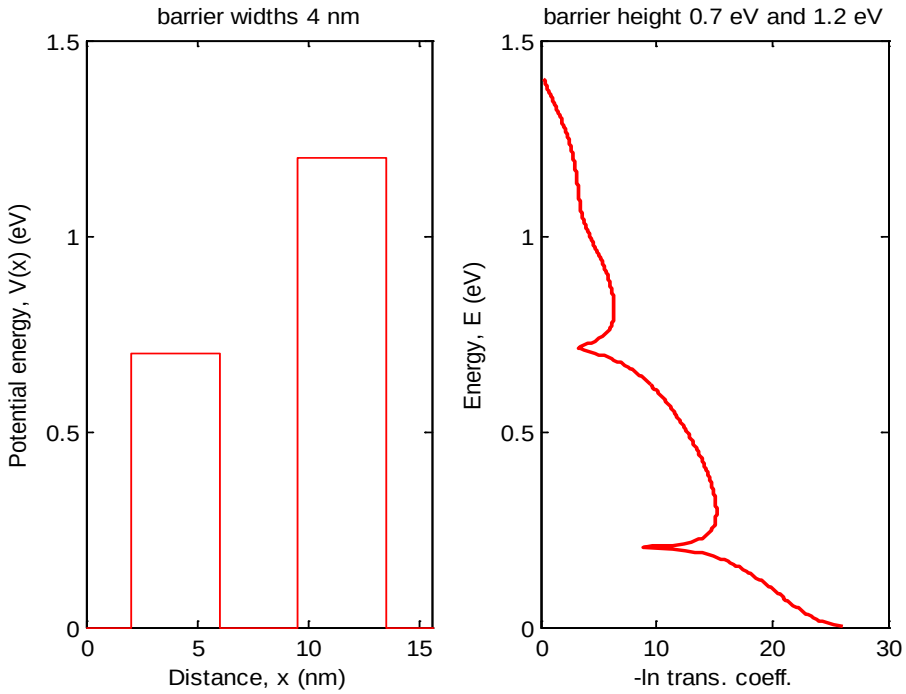


Fig. (5 b) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.7 eV and 1.2 eV.

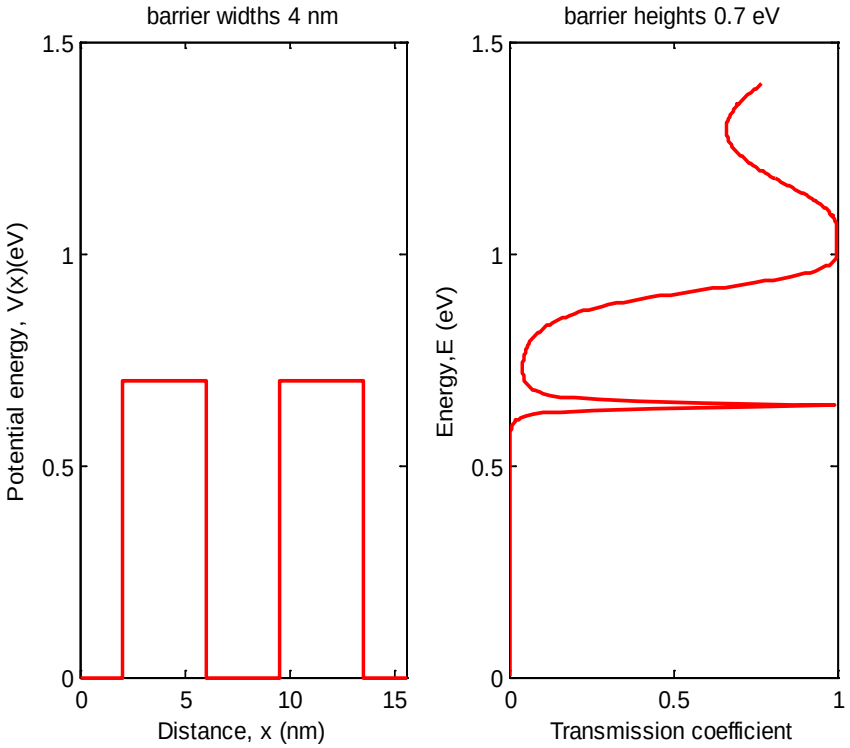


Fig. (6 a) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.7 eV.

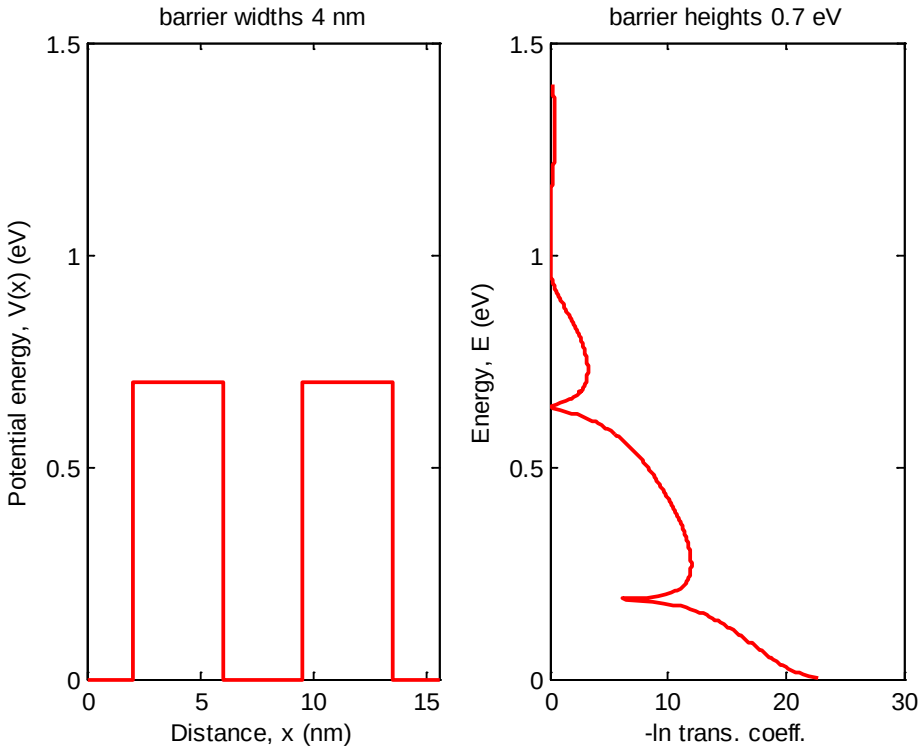


Fig. (6 b) The transmission coefficients for double potential barrier of widths 4 nm and heights 0.7 eV.

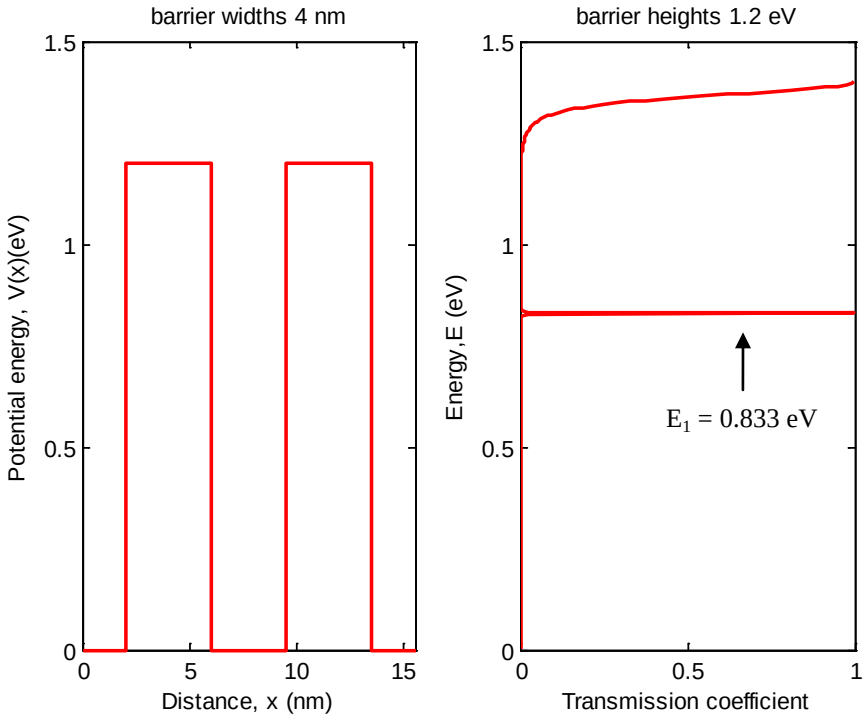


Fig. (7 a) The transmission coefficients for double potential barrier of widths 4 nm and heights 1.2 eV.

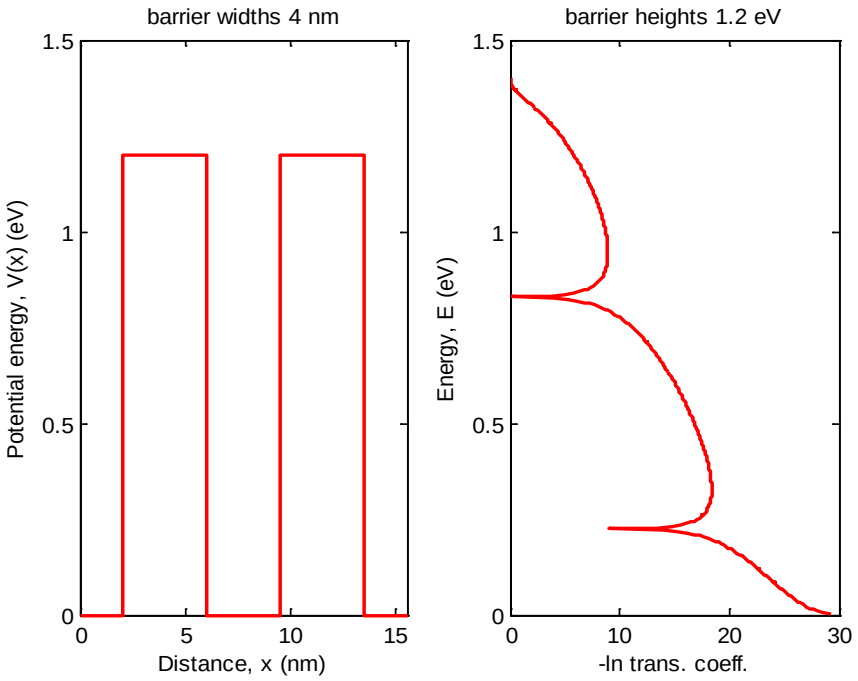


Fig. (7 b) The transmission coefficients for double potential barrier of widths 4 nm and heights 1.2 eV.

Discussion

We have found that there are two well-defined resonances in transmission at energy E_0 = 0.186 eV and E_1 = 0.616 eV in Fig. (4 a). The resonance at energy E_0 has a value less than either potential barrier energy and is quite narrow in energy. This suggest that for the particle with energy E_0 the resonance state is reasonably well localized by the two potential barriers. The E_1 = 0.616 eV resonance in this calculation occurs at an energy greater than the lower potential barrier energy. For this reason, the particle is not well localized by the two potential barriers, the resonance is broad in energy.

From the Fig. (4 a) to (5 b), we have seen that the transmission resonance is not unity because the potential barriers used in this calculation are not symmetric. The exact position in energy of resonances depends upon both potential barrier width and energy. When we used symmetric double rectangular potential barriers, we obtain the unity resonance transmission probability as shown in Fig. (6 a) and (6 b).

Conclusion

The transmission coefficient is a measure of the probability that the particle will be transmitted through the barrier. The ability of particle to penetrate the barrier when $E < V_0$ is a quantum mechanical result and is known as tunnel effect. In nuclear physics, there are nuclei that decay into an α particle and daughter nucleus. This α decay process can be explained by tunnel effect.

For particle energy $E < V_0$, no resonances occur and transmission is dominated by simple quantum mechanical tunneling through the rectangular potential barrier. Resonances with unity peak transmission probability were found for a particle of energy $E > V_0$ traversing a rectangular potential barrier of finite width and height V_0. To obtain unity transmission probability for particle energy $E < V_0$, a different type of potential must be considered.

It can be concluded that tunneling through symmetric double barrier structures can reach unity peak resonance. It can also be concluded that asymmetric barrier structures will be much harder to obtain unity peak resonance. Therefore, the concept of tunneling plays significant role in the design and development of nanoelectronic devices.

Acknowledgements

We would like to express our gratitude to Dr Win Swe, Rector and Dr Myo Myo, Pro-rector, Shwebo University for their encouragement to submit. We would like to give our deepest thanks to Dr Min Swe, Professor and Head of Department of Physics, Shwebo University, for his kind help and constant encouragement. We would like to express my thanks to Dr Khin Hnin Ei, Professor, Department of Physics, Shwebo University, for her advice and continuous encouragement.

References

Levi, A.F.J, (2006), *Applied Quantum Mechanics*, 2nd ed, Cambridge University Press.

Jain, Mahesh C, (2007), *Quantum Mechanics*, New Delhi, Prentice-Hall of India Private Ltd.

Zettili, N, (2001), Quantum Mechanics, England, John Wiley & Sons, Ltd.

Microcontroller Based 8x16 Dot Matrix Display

Nyi Nyi Tun[1], Su Su Win[2], Min Swe[3], Khin Hnin Ei[4]

Abstract

Microcontroller based 8x16 dot matrix display has been designed and constructed using PIC16F877A microcontroller, TD62783APG IC, two ULN2803A ICs, two 8x8 dot matrix LED displays, 7805 IC, two 7809 ICs, eight switches and other electronic components. There are six main parts in the constructed system. They are input unit, control unit, driver unit, output unit, +5 V regulated power supply and +9 V regulated power supply. PIC16F877A microcontroller was used as a control unit in the constructed circuit. TD62783APG IC and two ULN2803A ICs were used to drive the eight anode rows and sixteen cathode columns of the dot matrix display. +5 V regulated power supply was used for the control unit and +9 V regulated power supply was used for driver unit and display unit. Two 8x8 dot matrix LED displays were used to display the desired alphabets, digits and some waveforms in the constructed circuit.

Key words: PIC16F877A microcontroller, TD62783APG IC, ULN2803A IC

Introduction

An LED Matrix consists of an array of LEDs which are interconnected such that the positive terminal (anode) of each LED in the same column are connected together and the negative terminal(cathode) of each LED in the same row are connected together. This could be the other way around as well, with the positive terminals connected to the rows and the negative terminals connected to the columns.

This research work will provide how to drive and control a dot matrix LED display with a microcontroller. The display used is a commercially available PCB mount 8x8 dot matrix red LED display, with a total of 64 individual LEDs that are controlled by 16 control signals.

The Main Feature of the Constructed System

The constructed system consists of six main parts. They are input unit, control unit, driver unit, output unit and +5 V regulated power supply and +9 V regulated power supply. Eight switches were used in the input unit. PIC16F877A microcontroller was used as a control unit to control the whole constructed system. A TD62783APG IC and two ULN2803A ICs were used in the driver unit. Two 8x8 dot matrix displays were used as the output display unit. +5 V regulated power supply was used for the control unit. Two +9 V regulated power supplies were used in the constructed circuit. One was used for TD62783APG IC in the driver unit and the other was used for two ULN2803A ICs in the driver unit. The block diagram of the microcontroller based 8x16 dot matrix display is shown in Fig. (1).

[1] Lecturer, Dr, Department of Physics, Shwebo University
[2] Lecturer, Dr, Department of Physics, Mandalay University
[3] Professor (Head), Dr, Department of Physics, Shwebo University
[4] Professor, Dr, Department of Physics, Shwebo University

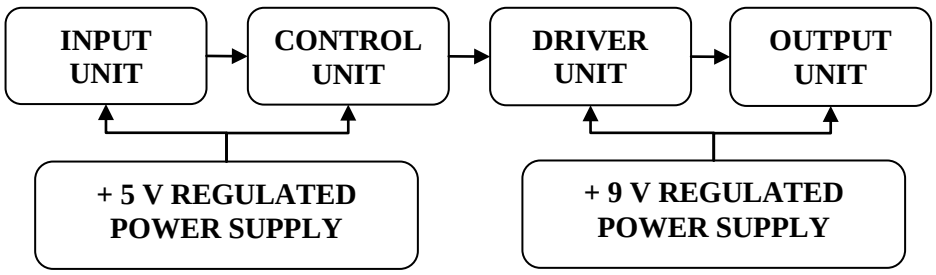


Fig. (1) Block diagram of microcontroller based 8x16 dot matrix display

Control Unit

Master clear input of PIC16F877A microcontroller was connected to +5 V via 10 K resistor. A 4 MHz crystal was connected between pin 13(OSC1) and pin 14(OSC2) of microcontroller. Pin 11 and pin 32 were connected to +5 V and pin 12 and pin 31 were connected to ground. A 22 pF capacitor was connected between ground and OSC1. Another 22 pF capacitor was also connected between ground and OSC2. There are five PORTs in this microcontroller. PORTB was used as the input of microcontroller. PORTA, PORTC, PORTD and PORTE were also used as the outputs of microcontroller in the constructed circuit.

RB0 to RB7 were connected to the ground with 10 K resistors. RB0 and RB7 were also connected to +5 V with SW1, SW2, SW3, SW4, SW5, SW6, SW7 and SW8 respectively. RC0 to RC7 of the microcontroller were connected to the input pins (1 to 8) of TD62783APG IC. RD0 to RD7 of the microcontroller were connected to the input pins (1 to 8) of ULN2803A IC1. RA0, RA1, RA2, RA3 and RA5 were connected to pins (1 to 5) of ULN2803A IC2. RE0 to RE2 were connected to pins (6 to 8) of ULN2803A IC2.

In the constructed circuit, PIC16F877A microcontroller was used as a main control device. The constructed main control device is as shown in Fig. (2). The program was written in Assembly Language.

Power Driver Circuit

Power driver circuit was constructed using TD62783APG IC and two ULN2803A ICs. The input pins (1 to 8) of TD62783APG IC were connected to RC0 to RC7 of the microcontroller. Pin 9 of this IC was connected to the +9 V. Pin 10 was connected to the ground. The output pins (18-11) were connected to the eight anode rows (A0-A7) of 8x8 dot matrix display respectively.

The input pins (1 to 8) of ULN2803A IC1 were connected to RD0 to RD7 of the microcontroller. Pin 10 of this IC was connected to the +9 V. Pin 9 of this IC was connected to the ground. The output pins (18-11) were connected to the eight cathode columns (K0-K7) of 8x8 dot matrix display respectively.

The input pins (1 to 5) of ULN2803A IC2 were connected to RA0, RA1, RA2, RA3 and RA5 of the microcontroller respectively. Pin 10 of this IC was connected to the +9 V. Pin 9 of this IC was connected to the ground. The output pins (18-14) were connected to the five cathode columns (K8-K12) of 8x8 dot matrix display respectively.

The input pins (6 to 8) of ULN2803A IC2 were connected to RE0 to RE3 of the microcontroller respectively. The output pins (13-11) were connected to the three cathode columns (K13-K15) of 8x8 dot matrix display respectively. The constructed power driver circuit is shown in Fig. (3).

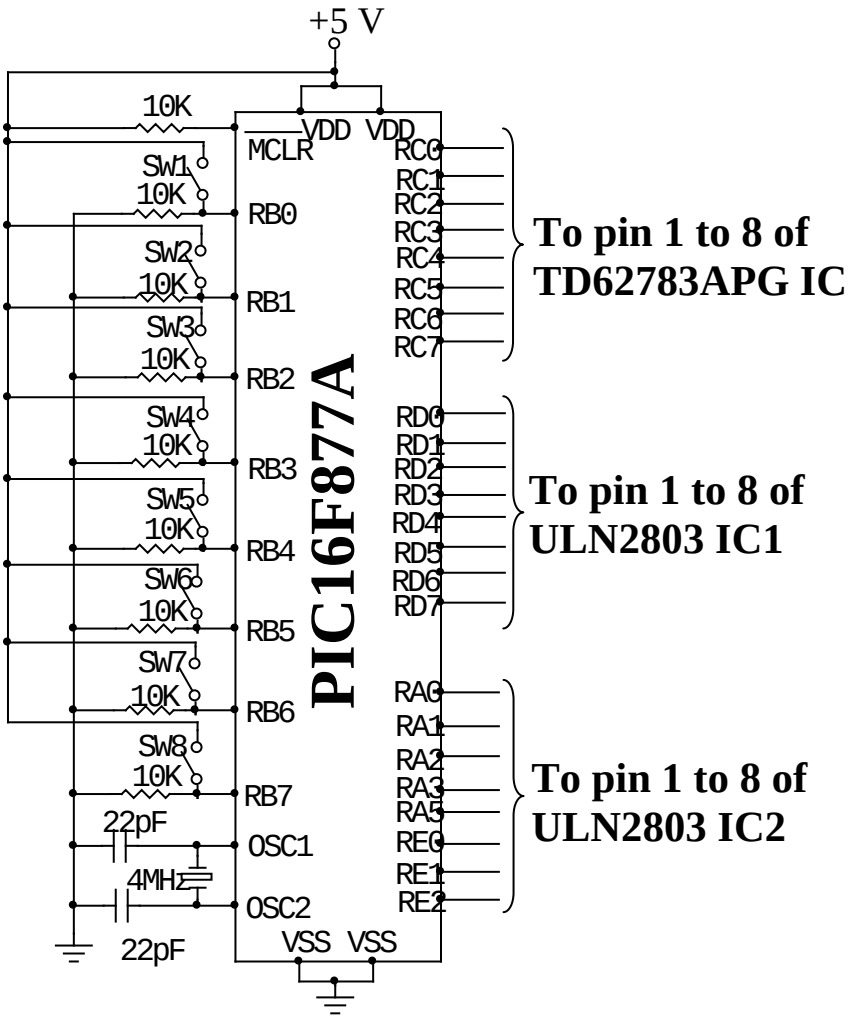


Fig. (2) Circuit diagram of constructed control unit

Output Unit Circuit

There are 128 red LEDs in the output unit. There are two 8x8 dot matrix LED displays in the output unit. There are eight anode rows and eight cathode columns in each 8x8 dot matrix LED display. The eight anode rows (A0-A7) of 8x8 dot matrix LED display 1 were connected to the eight anode rows (A0-A7) of 8x8 dot matrix LED display 2 respectively. Then the eight anode rows (A0-A7) of 8x16 dot matrix LED display were connected to the output pins (18-11) of TD62783APG IC respectively.

Eight cathode columns (K0-K7) of 8x16 dot matrix LED display were connected to the output pins (18-11) of ULN2803 IC1 respectively. Five cathode columns (K8-K12) of 8x16 dot matrix LED display were connected to the output pins (18-14) of ULN2803 IC2 respectively. Three cathode columns (K13-K15) of 8x16 dot matrix LED display were connected to the output pins (13-11) of ULN2803 IC2 respectively. The circuit of this unit is shown in Fig.(4).

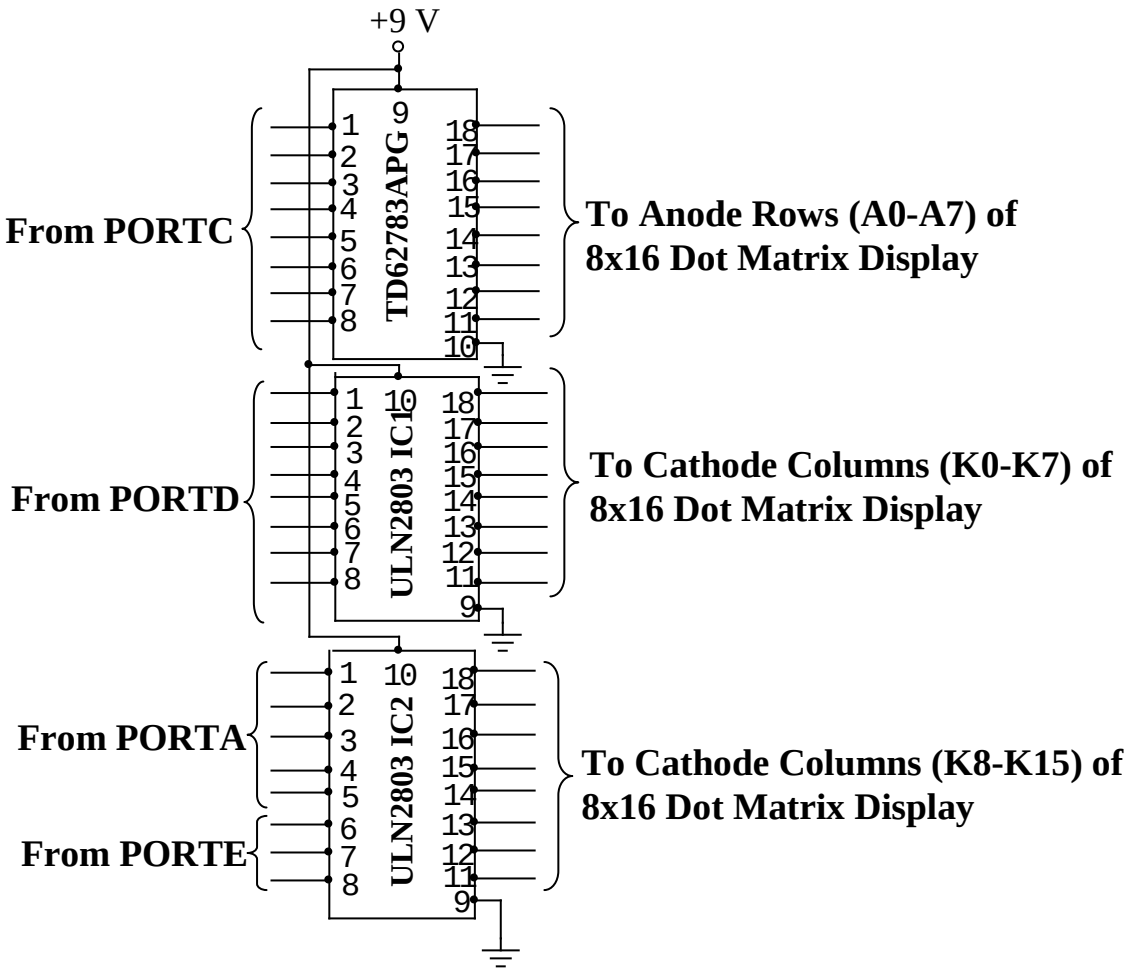


Fig. (3) Circuit diagram of constructed power driver circuit

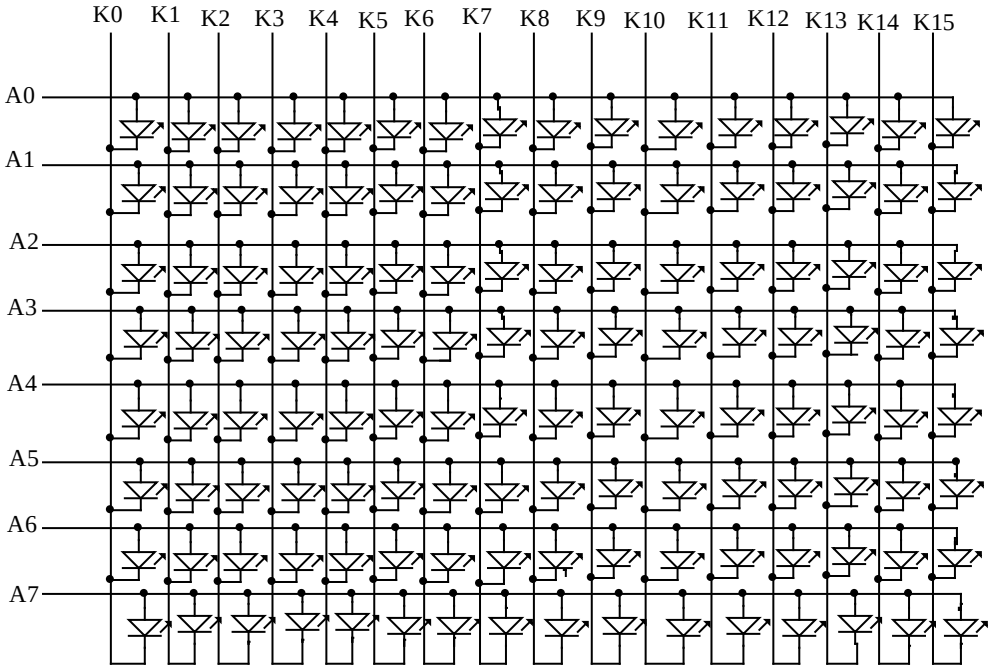


Fig. (4) Circuit diagram of the constructed output unit

Regulated Power Supply Circuit

+5 V regulated power supply and two +9 V regulated power supplies were used in the constructed system. The step-down transformer steps down high voltage AC main to low voltage AC. The secondary output of the step-down transformer was rectified by the bridge rectifier. Smoothing was performed by a 1000 µF electrolytic capacitor and a 0.1 µF Mylar capacitor.

The positive output voltage of the bridge rectifier was fed to pin 1 (input terminal) of LM7805 IC. Its pin 2 (common terminal) was connected to the ground. Its pin 3(output terminal) produced required +5 V DC for the control unit. The positive output voltage of the bridge rectifier was also fed to pin 1 (input terminal) of two LM7809 ICs. Their pin 2s (common terminal) were connected to the ground. Then the required +9 V DC were produced from the pin 3 (output terminal) of the two LM7809 ICs for the power driver unit. The constructed regulated power supply circuit is shown in Fig. (5).

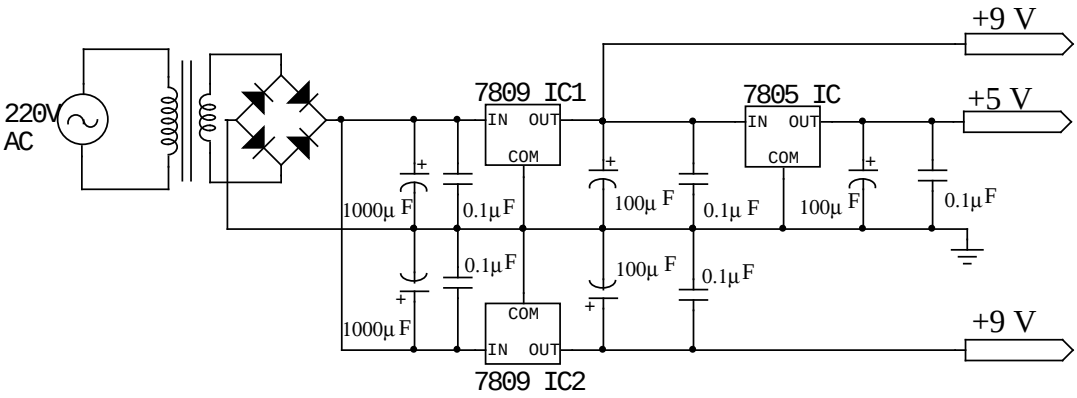


Fig. (5) Circuit diagram of the constructed regulated power supply circuit

Control Program

At the beginning of the control program, the variable and I/O ports are initialized. Firstly SW1 is checked. If the SW1 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the "**Square Wave**" is displayed on the 8x16 dot matrix LED display.

If SW1 is 0, the microcontroller checks SW2. If the SW2 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the "**Sine Wave**" is displayed on the 8x16 dot matrix LED display.

If SW2 is 0, the microcontroller checks SW3. If the SW3 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the "**Sawtooth Wave**" is displayed on the 8x16 dot matrix LED display.

If SW3 is 0, the microcontroller checks SW4. If the SW4 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the "**Rectangular Wave**" is displayed on the 8x16 dot matrix LED display.

If SW4 is 0, the microcontroller checks SW5. If the SW5 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the "**Triangle Wave**" is displayed on the 8x16 dot matrix LED display.

If SW5 is 0, the microcontroller checks SW6. If the SW6 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the word "**2018**" is displayed on the 8x16 dot matrix LED display.

If SW6 is 0, the microcontroller checks SW7. If the SW7 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the word "**PHYS**" is displayed on the 8x16 dot matrix LED display.

If SW7 is 0, the microcontroller checks SW8. If the SW8 is 1, the microcontroller produces the output signals for the 8x16 dot matrix LED display. Then, the Myanmar word "ဆရာ" is displayed on the 8x16 dot matrix LED display. Then, the program starts again to produce the output signals.

Microcontroller Based 8x16 Dot Matrix Display Circuit

When the power switch is turned on, the microcontroller checks the switch SW1 firstly. If the SW1 is 1, the microcontroller produces the respective output signals from PORTC, PORTD, PORTA and PORTE. These output signals are fed to the input pins (1-8) of the TD62783APG IC, the input pins (1-8) of ULN2803A IC1 and the input pins (1-8) of ULN2803A IC2 respectively.

Then TD62783APG IC and two ULN2803A ICs produce the amplified signals for the eight anode rows (A0-A7) and the sixteen cathode columns (K0-K15) respectively. After that the desired "**Square Wave**" is displayed on the 8x16 dot matrix LED display. If the SW1 is 0, the microcontroller checks SW2.

If the SW2 is 1, the microcontroller produces the respective output signals from PORTC, PORTD, PORTA and PORTE. These output signals are fed to the input pins (1-8) of the TD62783APG IC, the input pins (1-8) of ULN2803A IC1 and the input pins (1-8) of ULN2803A IC2 respectively.

Then TD62783APG IC and two ULN2803A ICs produce the amplified signals for the eight anode rows (A0-A7) and the sixteen cathode columns (K0-K15) respectively. After that the desired "**Sine Wave**" is displayed on the 8x16 dot matrix LED display. Similarly the microcontroller checks the other switches.

If SW2 is 0 and the SW3 is 1, the desired "**Sawtooth Wave**" is displayed on the 8x16 dot matrix LED display. If SW3 is 0 and SW4 is 1, the desired "**Rectangular Wave**" is displayed on the 8x16 dot matrix LED display. If SW4 is 0 and SW5 is 1, the desired "**Triangle Wave**" is displayed on the 8x16 dot matrix LED display. If SW5 is 0 and SW6 is 1, the word "**2018**" is displayed on the 8x16 dot matrix LED display. If SW6 is 0 and SW7 is 1, the word "**PHYS**" is displayed on the 8x16 dot matrix LED display. If SW7 is 0 and SW8 is 1, the Myanmar word "ဆရာ" is displayed on the 8x16 dot matrix LED display. Complete circuit diagram of the constructed microcontroller based 8x16 dot matrix display circuit is shown in Fig. (6).

Results

Microcontroller based 8x16 dot matrix display has been designed and constructed using PIC16F877A microcontroller, TD62783APG IC, two ULN2803A ICs, two 8x8 dot matrix LED displays, 7805 IC, two 7809 ICs, eight switches and other electronic components. PIC16F877A microcontroller was used as a control unit in the constructed circuit. TD62783APG IC and two ULN2803A ICs were used to drive the eight anode rows and sixteen cathode columns of the dot matrix display.

Two 8x8 dot matrix LED displays were used to display the desired alphabets, digits and waves in the constructed circuit. +5 V regulated power supply was used for the control unit. A +9 V regulated power supply was used for the TD62783APG IC in the driver unit. The other +9 V regulated power supply was used for two ULN2803 ICs in the driver unit.

Fig. (7) shows the internal circuit diagram of the constructed circuit. The photograph of the constructed system microcontroller based 8x16 dot matrix display is shown in Fig. (8). The photograph of the constructed system showing "**Square Wave**", "**Sine Wave**", "**Sawtooth Wave**", "**Rectangular Wave**", "**Triangle Wave**", "**2018**", "**PHYS**" and Myanmar word "ဆရာ" are shown in Fig. (9), Fig. (10), Fig. (11), Fig. (12), Fig. (13), Fig. (14), Fig. (15) and Fig. (16) respectively. Table (1) shows the calculated power and measured current value of some waves and words.

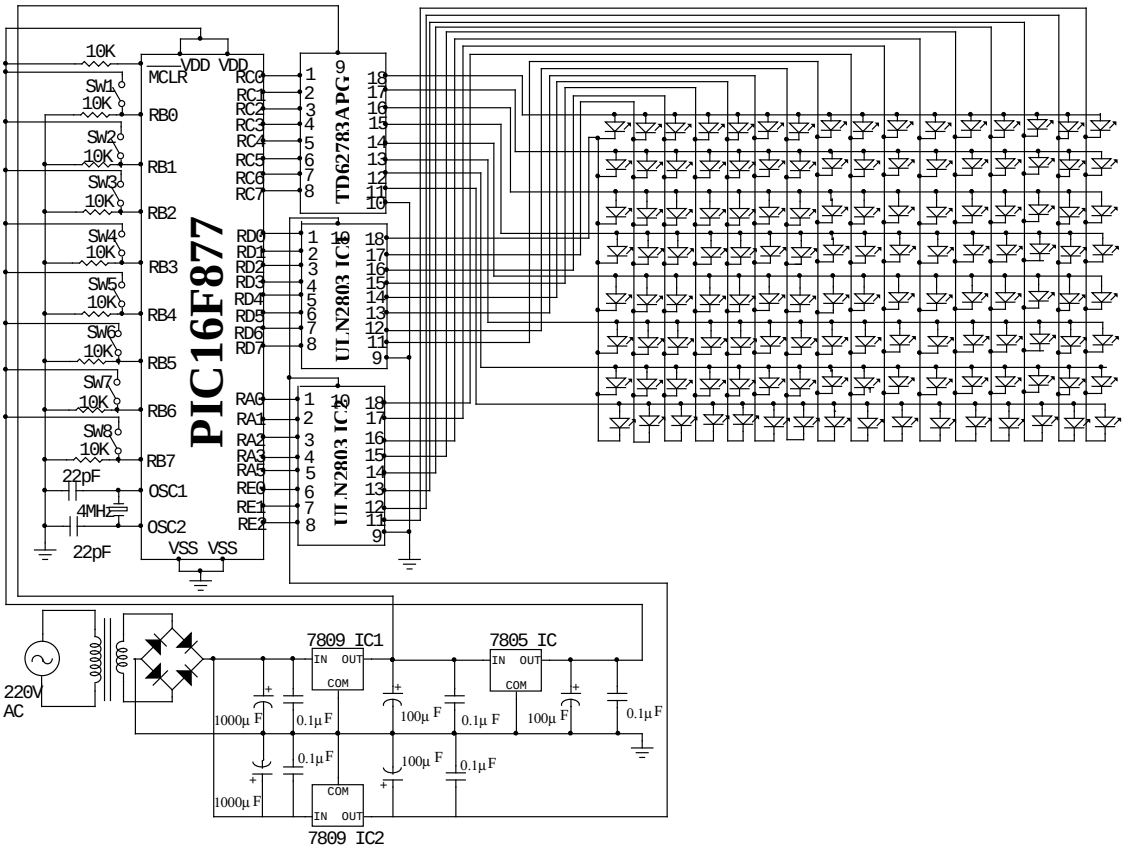


Fig. (6) Complete circuit diagram of the constructed microcontroller based 8x16 dot matrix display

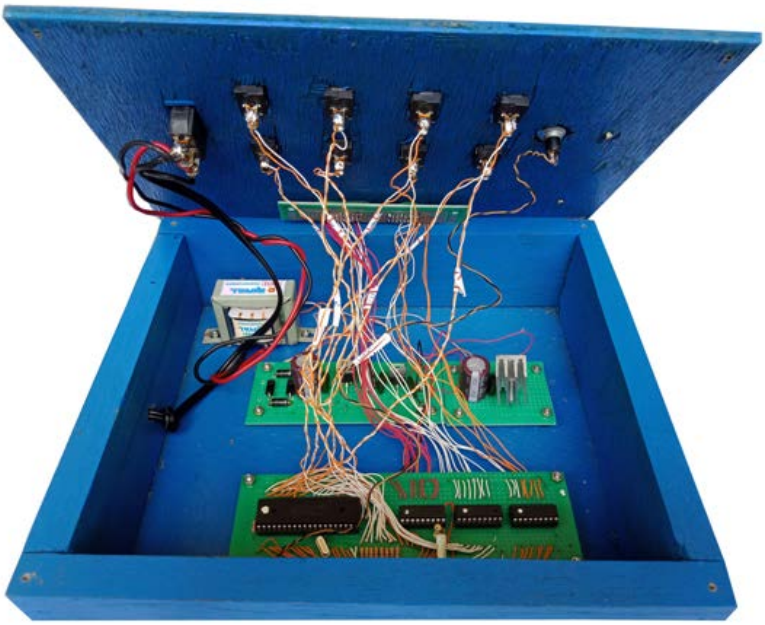


Fig. (7) The photograph of the internal circuit diagram of the constructed circuit

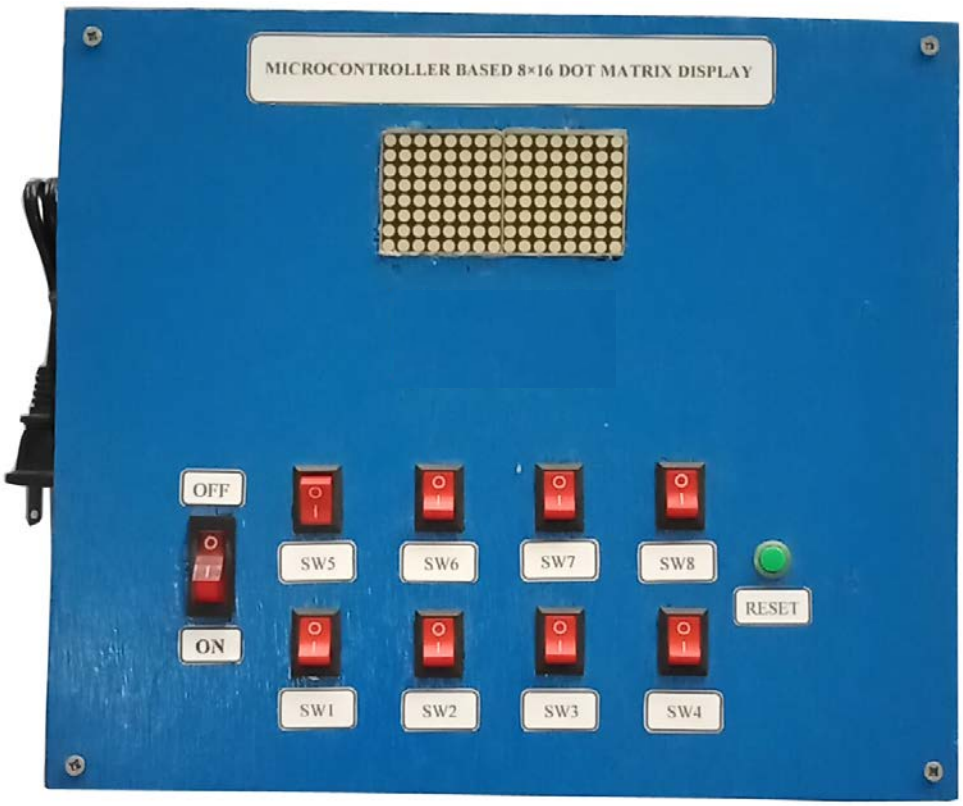


Fig. (8) Photograph of the constructed microcontroller based 8x16 dot matrix display

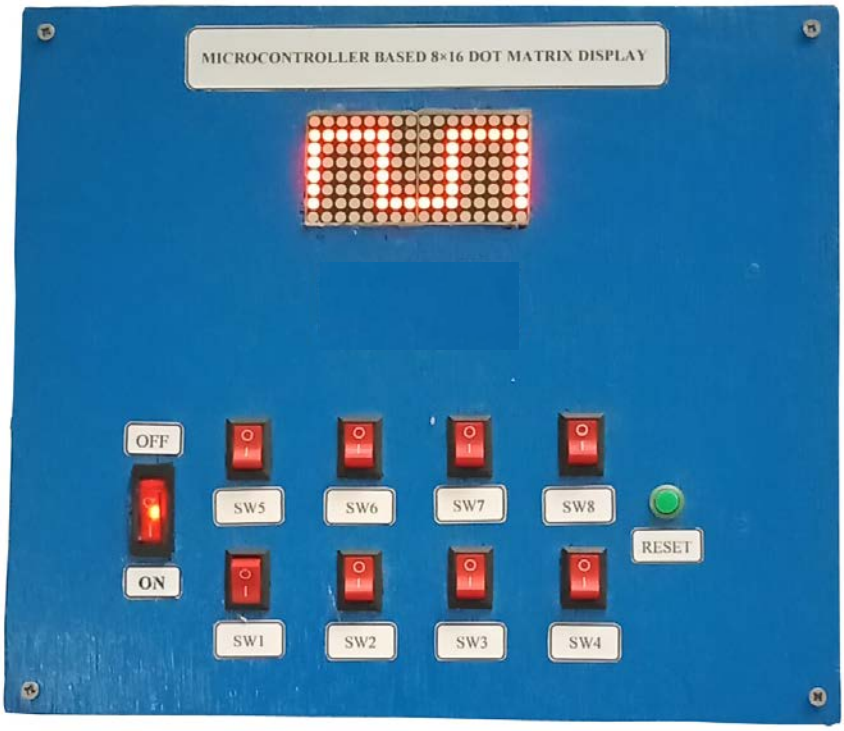


Fig. (9) Fig. (4.5) Photograph of the constructed system showing "**Square Wave**"

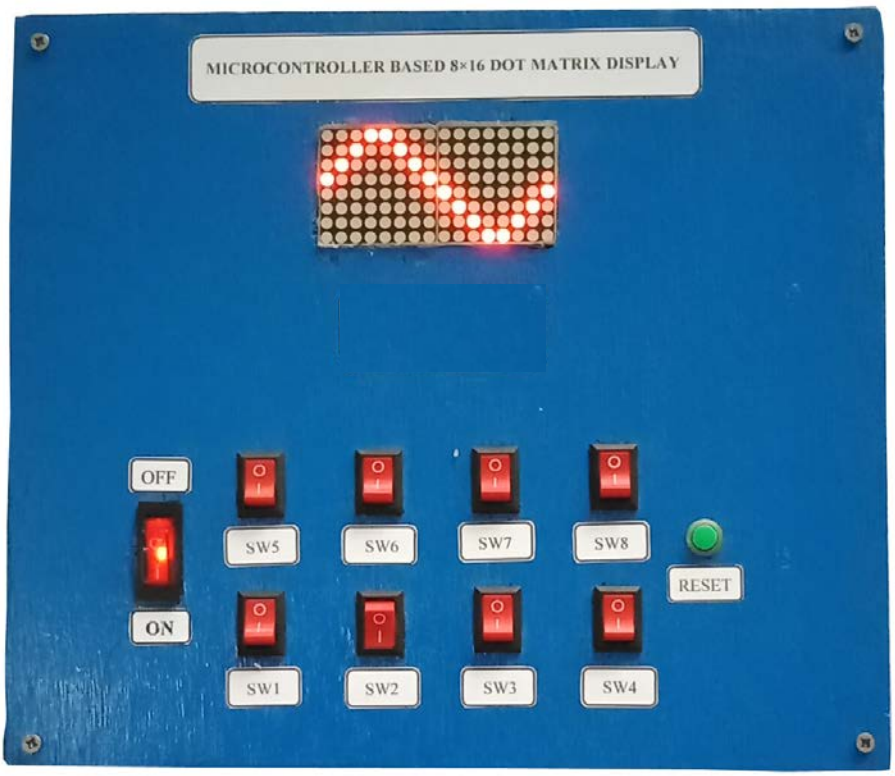


Fig. (10) Photograph of the constructed system showing **"Sine Wave"**

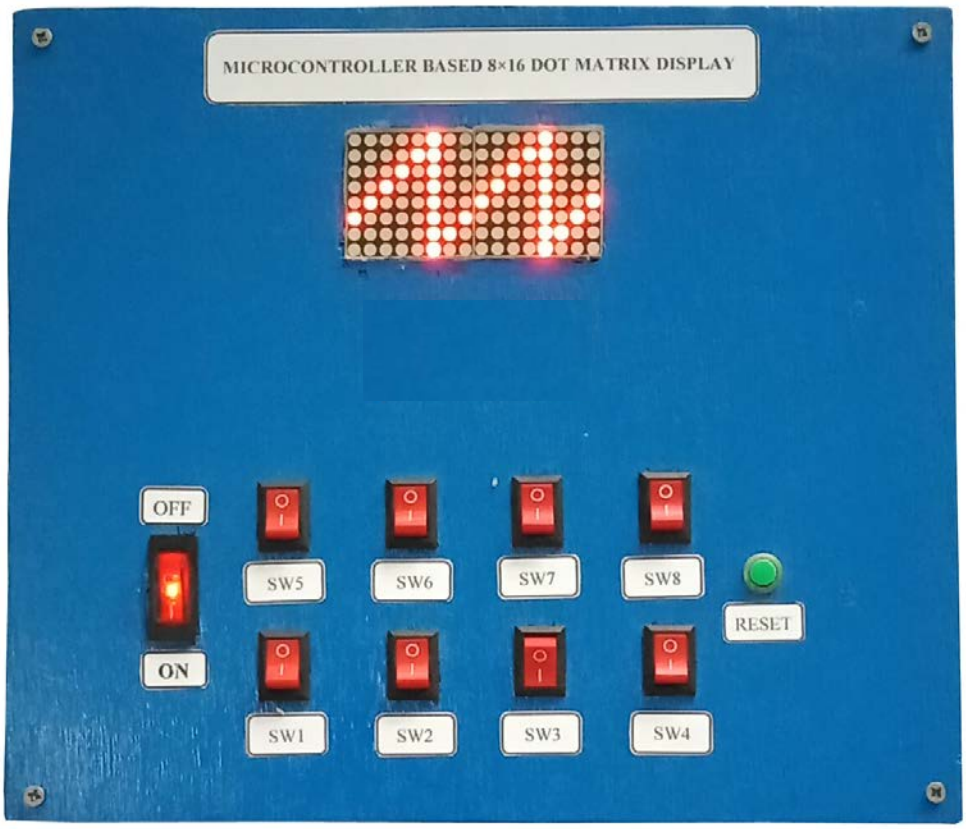


Fig. (11) Photograph of the constructed system showing **"Sawtooth Wave"**

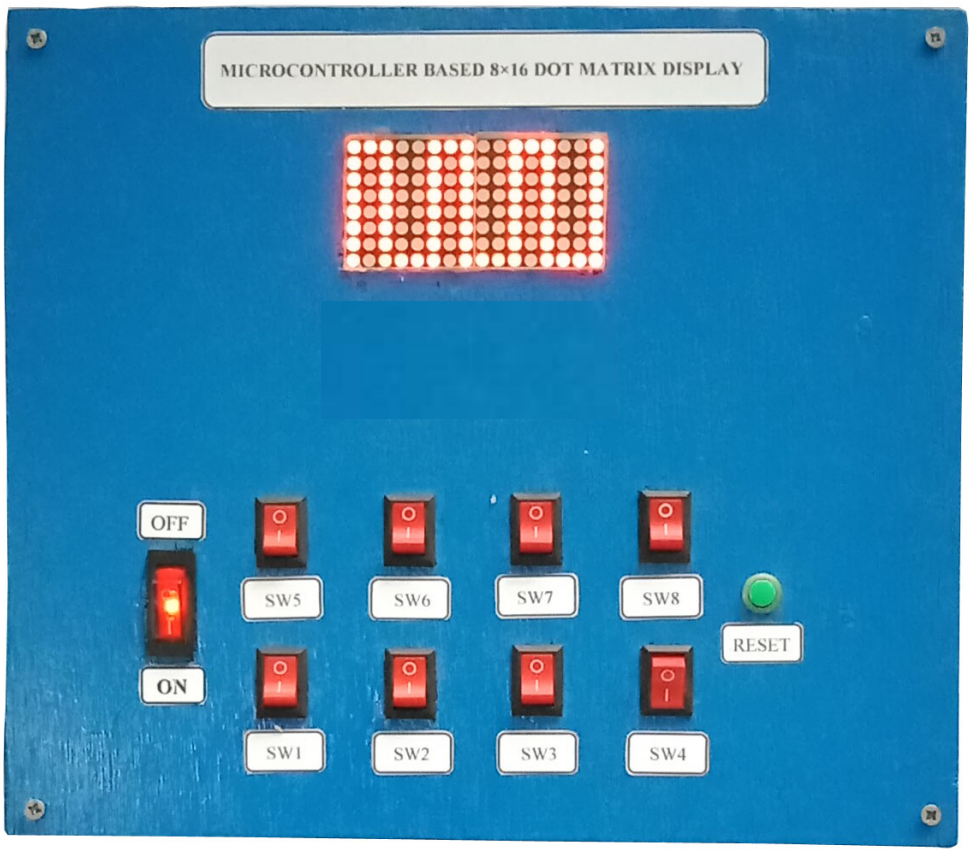


Fig. (12) Photograph of the constructed system showing **"Rectangular Wave"**

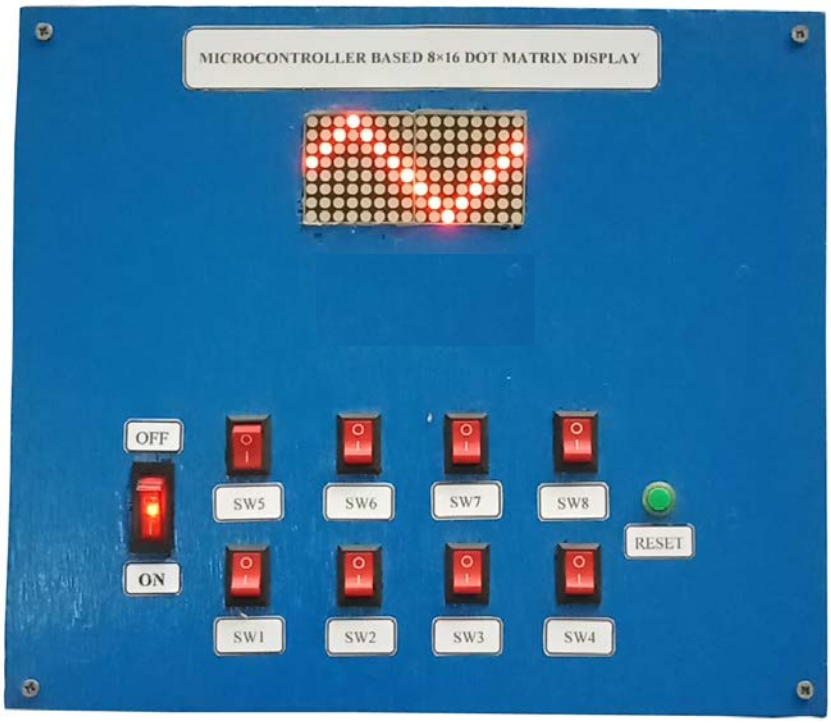


Fig. (13) Photograph of the constructed system showing **"Triangle Wave"**

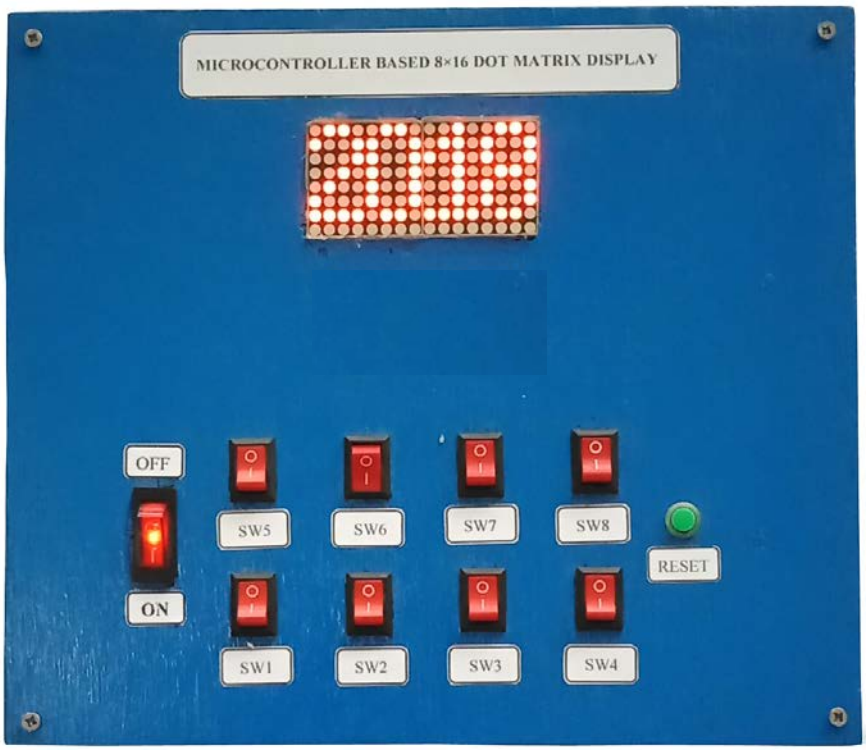


Fig. (14) Photograph of the constructed system showing the word **"2018"**

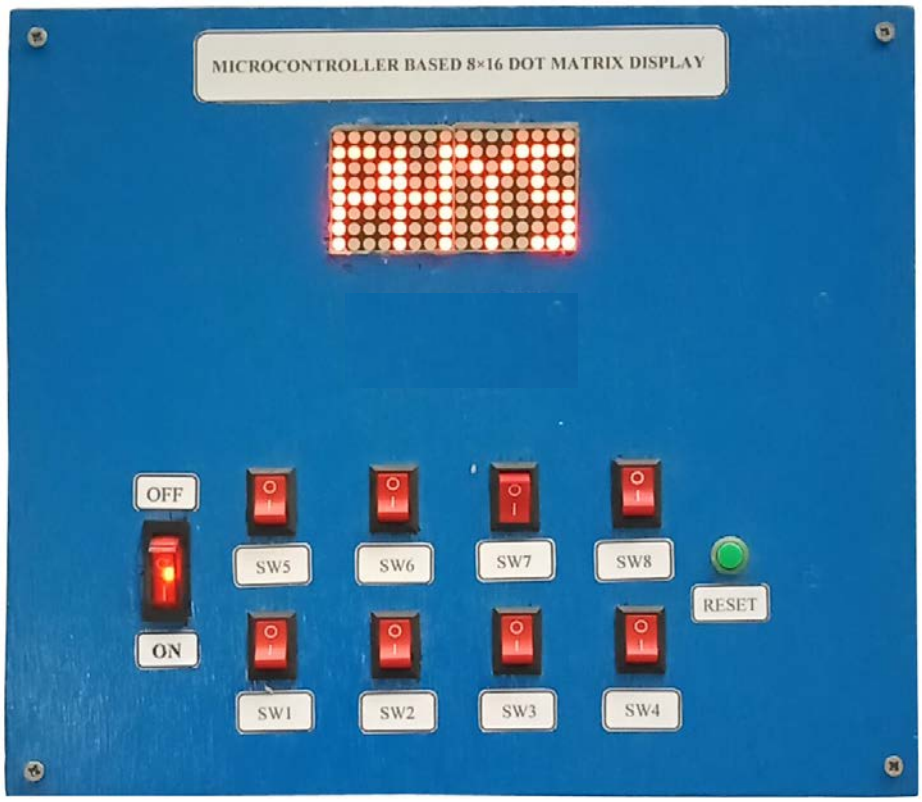


Fig. (15) Photograph of the constructed system showing the English word **"PHYS"**

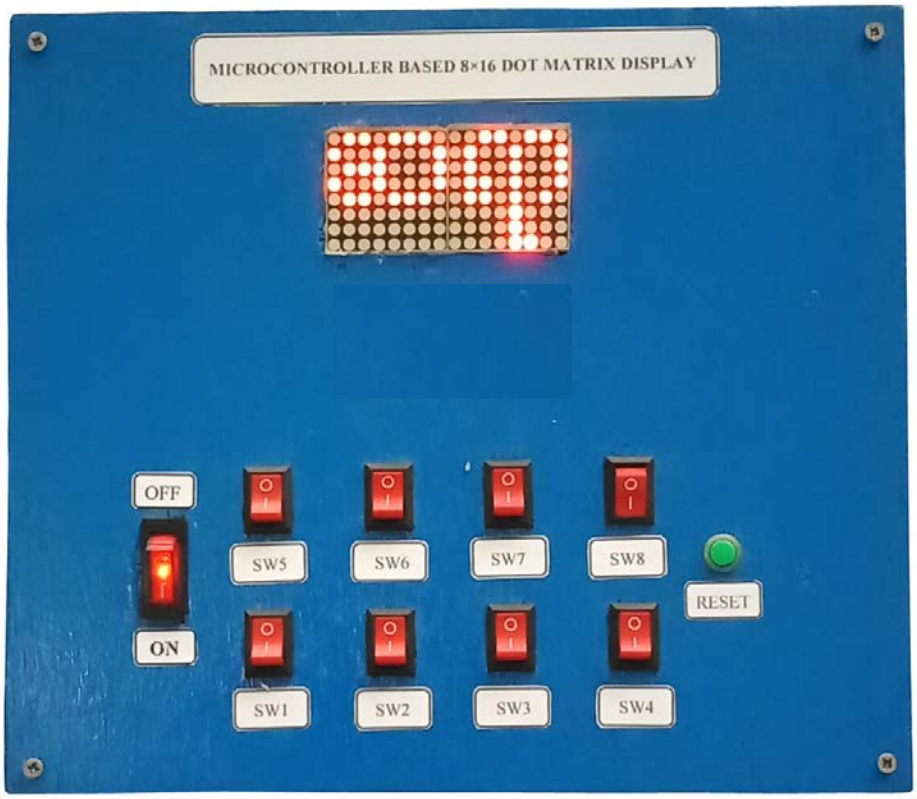


Fig. (16) Photograph of the constructed system showing the Myanmar word "ဆရာ"

Table (1) Calculated power and measured current value of some waves and words

Sr.No	Waves and Words	Measured Current (mA)	Calculated Power (mW)
1	Square Wave	126.3	1136.7
2	Sine Wave	130.7	1176.3
3	Sawtooth Wave	135.9	1223.1
4	Rectangular Wave	147.7	1329.3
5	Triangle Wave	135.2	1216.8
6	2018	134.7	1212.3
7	PHYS	135.1	1215.9
8	ဆရာ	139.6	1256.4

Discussion

When the power switch is turned on, the microcontroller checks the switch SW1 firstly. The microcontroller produces the respective output signals from PORTC, PORTD, PORTA and PORTE if the SW1 is 1. These output signals are fed to the input pins (1-8) of the TD62783APG IC and the input pins (1-8) of ULN2803A IC 1 and the input pins (1-8) of ULN2803A IC 2 respectively. Then these driver ICs produce the amplified signals for the eight anode rows (A0-A7) and the sixteen cathode columns (K0-K15) of the 8x16 dot matrix display respectively. After that the design of "**Square Wave**" is displayed on the 8x16 dot matrix LED display. Similarly the microcontroller checks the other switches and produces the respective output signals for the desired of waves and words.

Conclusion

In this research work, microcontroller based 8x16 dot matrix display has been designed and constructed. The constructed system can be displayed wave, English words and Myanmar words by modifying hardware and the control program. This constructed system is a useful framework for future researchers of electronics field.

Acknowledgements

The authors would like to thank Dr Win Swe, Rector, Shwebo University, for his encouragement. We are also grateful to Professor Dr Min Swe, Head of Department of Physics, Shwebo University and Professor Dr Khin Hnin Ei, Department of Physics, Shwebo University for their suggestions.

References

[1] Microcontroller Technology Inc., "PIC 16F87XA Data Sheet, Flash-based 8-bit CMOS Microcontroller with nano Watt technology", United State of America (2007).
[2] Toshiba Corporation,"TD62783APG/AFG Data Sheets", Malaysia (2006).
[3] Texas Instruments Corporation, "ULN2803A Data Sheet", United State of America (2014).
[4] National Semiconductor Corporation, "LM 78xx Data Sheet", United State of America (2006).

Determination of Radiation Protection of Concretes Made of Local Cements

Aye Aye Khaing[1], Khin Hnin Ei[2], Aye Than Kyae[3], San San Aye[4], Myat Thet Mon[5]

Abstract

A GM tube (GM-35, window type), Timer Scalar and Frequency Meter (ST-360), a radioactive source ^{60}Co and twenty-five concrete slabs are used in this research. Five brands of cement are mainly used for concrete samples and then the samples are prepared in this research. The concrete samples are made with mix ratio (1:3:6) and each ratio contains cement, sand, gravel and water for each type of brands. The samples are also made with the same area (5 x 5 cm^2) and different thickness (1to 5cm) for each type of brands. Therefore total samples are twenty-five and then these samples are used as the inspected objects in this research. All the results showed different values of linear attenuation coefficient and density according to the different brands of cement in the sample. This research paper is useful for experimental lab to the radiation protection.

Key words: cement, concrete, linear attenuation coefficient, radiation protection.

1. Introduction

Concrete is the most common building material used in construction and industry. It can be cast in any desired shape and fashion and is therefore applicable for most building purposes. Concrete does not decay and is resistant to wind, water, rodents and insects. It is a non-combustible material, making it fire resistant and able to withstand high temperatures. In the road sector, concrete is used for a number of purposes, including pavements, bridges, culverts, retaining walls and other structures. Concrete is a mixture of cement, water and aggregate. The aggregate consists of a mixture of various sizes of gravel and sand. When water is added to cement, a chemical reaction takes place causing the mix to harden. There are various grades of concrete available in the market based on these ratios. Some of them are: M10, M20, M30, M35, etc. "M" stands for "mix". Mix represents concrete with designated proportions of cement, sand and aggregate. And the number following “M” represents compressive strength of that concrete mix in N/mm^2 after 28 days. In this research, M10 (1: 3: 6) mix ratio is used.

1.1 Preparation of Samples and Experimental Apparatus

Five brands of cement are mainly used for concrete samples and then the samples are prepared in this research. The concrete samples are made with mix ratio (1:3:6) and each ratio contains cement, gravel, sand and water for each type of brands. The ingredients are thoroughly mixed which casted in the tin mass of rectangular shape (5 x 5 cm^2) area and (1 to 5 cm) thick for each type of brands. Therefore twenty five concrete slabs are prepared for this research. The following Table (1) shows the ingredients of sample.

In this research, A Geiger-Muller Tube (GM-35, window type), Timer, Scalar, and Frequency Meter (ST-360) and radioactive source (^{60}Co) have been used. The distance between the source and the detector is 11.5cm and the samples are placed 4.5 cm above the radioactive source.

[1] Lecturer, Dr., Department of Physics, Shwebo University
[2] Professor, Dr., Department of Physics, Shwebo University
[3] Associate Professor, Dr., Department of Physics, Shwebo University
[4] Lecturer, Dr., Department of Physics, Shwebo University
[5] Lecturer, Dr., Department of Physics, Shwebo University

1.2 Experimental Results and Discussion

A radioactive source ^{60}Co, Geiger - Muller tube (GM - 35) and twenty five concrete slabs are used in this research.^{60}Co gamma source and, Geiger - Muller tubes (GM – 35, window type) are placed 11.5 cm apart. First, 500V is set and the counting rates are recorded to determine the Geiger - Muller characteristic curve. The supply voltage is increased by 60V at a time to 1160V and the counting rates are recorded. The recorded data are shown in Table (2) and Fig.(4). From Fig.(4), starting voltage V_s=680, threshold voltage V_1= 690V, breakdown voltage V_2= 1040V, plateau length L = V_2-V_1= 350V and working voltage = V_1 + L/3 = 806V. Therefore working voltage of a GM counter is taken as 800V. Firstly, the background counting rates are recorded without gamma source at working voltage 800V. And then initial activity of the gamma source is determined. Finally, one of the samples is placed on the positioner that is situated between a gamma source (^{60}Co, 1μCi) and a GM tube that are 11.5cm apart. The sample is placed 4.5cm above the gamma source. These experimental results are shown in the following tables and figures.

Fig.(1) Concrete Samples (Top roll is AAA samples, second roll is Apache samples, third roll is Crown samples, fourth roll is Double Rhinos samples and fifth roll is Alpha sample).

Fig. (2) Radioactive Source ^{60}Co

Fig. (3) Demonstration of the Detection System

Table (1) Ingredients of Samples

Sr. No	Cement Brand	Thickness of Samples (cm)	No: of Slabs	Weight of Cements (g)	Weight of Sand (g)	Weight of Small Stone (g)	Mixed Proportion
1	AAA	1, 2, 3, 4, 5	5	100	300	600	1 : 3 : 6
2	APACHE	1, 2, 3, 4, 5	5	100	300	600	1 : 3 : 6
3	CROWN	1, 2, 3, 4, 5	5	100	300	600	1 : 3 : 6
4	DOUBLE RHINOS	1, 2, 3, 4, 5	5	100	300	600	1 : 3 : 6
5	ALPHA	1, 2, 3, 4, 5	5	100	300	600	1 : 3 : 6

Table (2) Data for Characteristic Curve of a GM counter

Sr.No	Applied voltage (V)	Counting rate (cpm)
1	500	0
2	560	0
3	620	0
4	680	221
5	740	234
6	800	252
7	860	255
8	920	260
9	980	272
10	1040	276
11	1100	288
12	1160	297

Table (3) Experimental Results for AAA Cement

Sr.No	Thickness of Sample (cm)	Counting Rate (cpm)	Background Counting Rate (cpm)	Net Counting Rate (cpm)
1	0	230	46	184
2	1	170	46	124
3	2	157	46	111
4	3	145	46	99
5	4	133	46	87
6	5	124	46	78

Table (4) Experimental Results for Apache Cement

Sr.No	Thickness of Sample (cm)	Counting Rate (cpm)	Background Counting Rate (cpm)	Net Counting Rate (cpm)
1	0	230	46	184
2	1	168	46	122
3	2	151	46	105
4	3	139	46	93
5	4	131	46	85
6	5	121	46	75

Table (5) Experimental Results for Crown Cement

Sr.No	Thickness of Sample (cm)	Counting Rate (cpm)	Background Counting Rate (cpm)	Net Counting Rate (cpm)
1	0	230	46	184
2	1	175	46	129
3	2	155	46	109
4	3	143	46	97
5	4	132	46	86
6	5	119	46	73

Table (6) Experimental Results for Double Rhinos Cement

Sr.No	Thickness of Sample (cm)	Counting Rate (cpm)	Background Counting Rate (cpm)	Net Counting Rate (cpm)
1	0	230	46	184
2	1	174	46	128
3	2	159	46	113
4	3	146	46	100
5	4	133	46	87
6	5	122	46	76

Table (7) Experimental Results for Alpha Cement

Sr.No	Thickness of Sample (cm)	Counting Rate (cpm)	Background Counting Rate (cpm)	Net Counting Rate (cpm)
1	0	230	46	184
2	1	168	46	122
3	2	155	46	109
4	3	143	46	97
5	4	131	46	85
6	5	125	46	79

Table (8) Different Values of Linear Attenuation Coefficient for Different cement

Sr.No	Cement Brand	Linear Attenuation Coefficient (μ)(cm^{-1})
1	AAA	0.156
2	Apache	0.163
3	Crown	0.17
4	Double Rhinos	0.163
5	Alpha	0.155

Table (9) Comparison of linear attenuation coefficient and density of the samples

Sr.No	Cement Brand	Linear Attenuation Coefficient (μ)(cm^{-1})	Density of Concrete (ρ)(kgm^{-3})
1	AAA	0.156	2110
2	Apache	0.163	2218
3	Crown	0.17	2400
4	Double Rhinos	0.163	2296
5	Alpha	0.155	2091

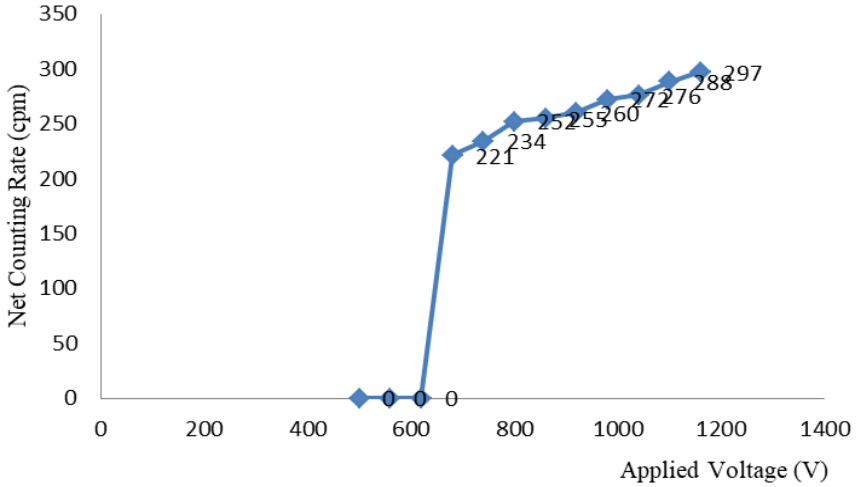


Fig. (4) Characteristic Curve of a GM Count

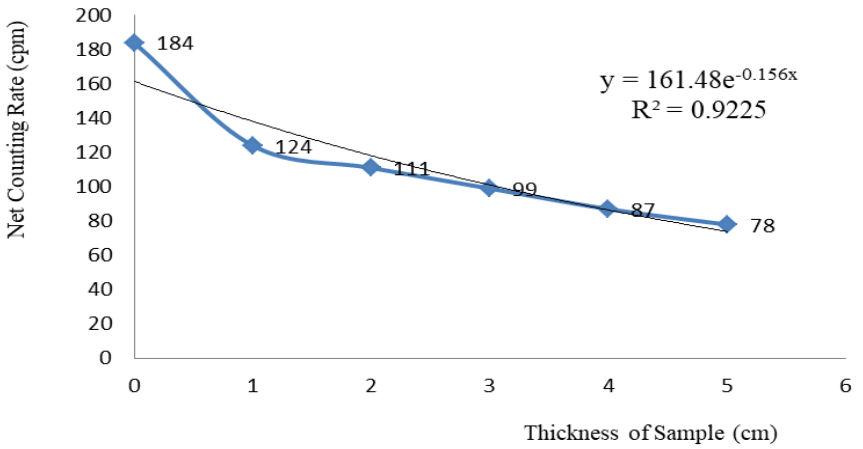


Fig. (5) Net Counting Rate vs Thickness of Sample for AAA cement

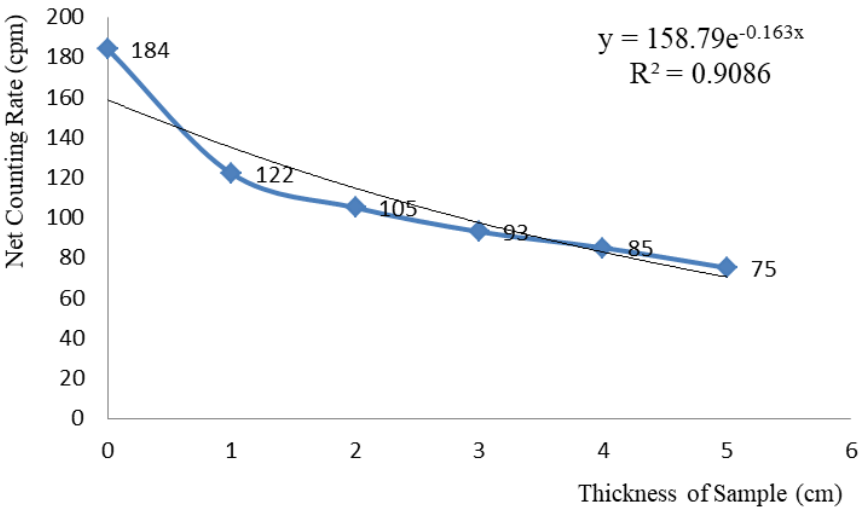


Fig. (6) Net Counting Rate vs Thickness of Sample for Apache cement

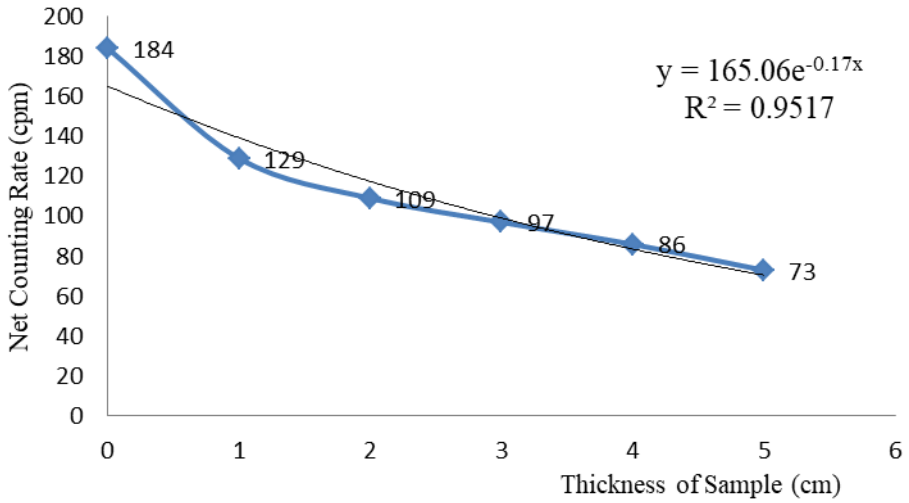


Fig.(7) Net Counting Rate vs Thickness of Sample for Crown cement

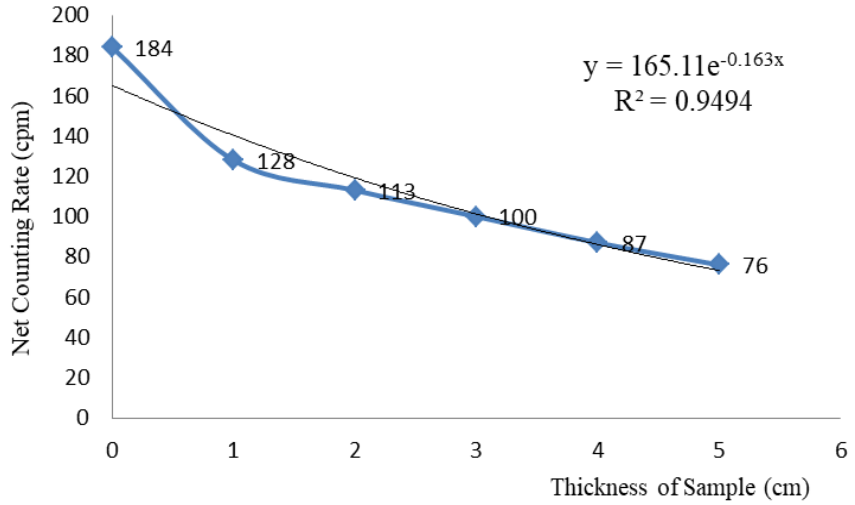


Fig. (8) Net Counting Rate vs Thickness of Sample for Double Rhinos cement

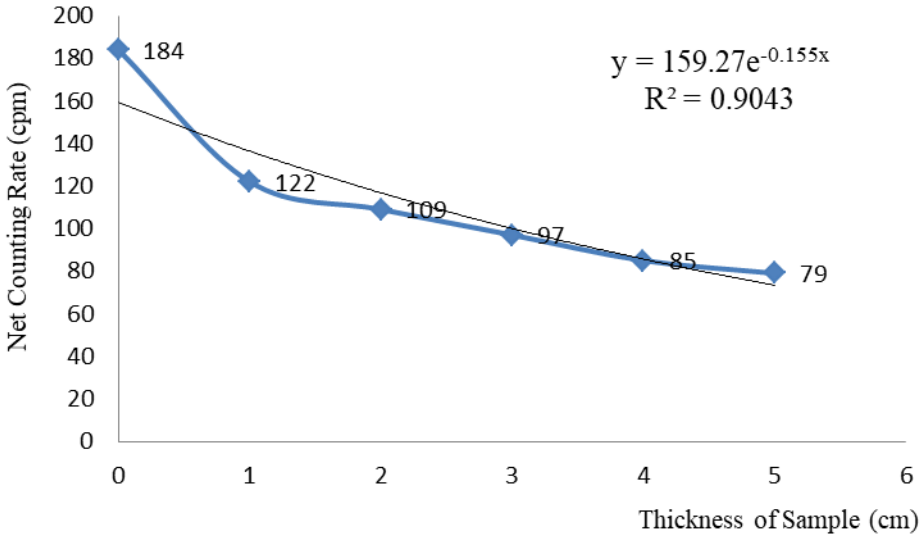


Fig. (9) Net Counting Rate vs Thickness of Sample for Alpha cement

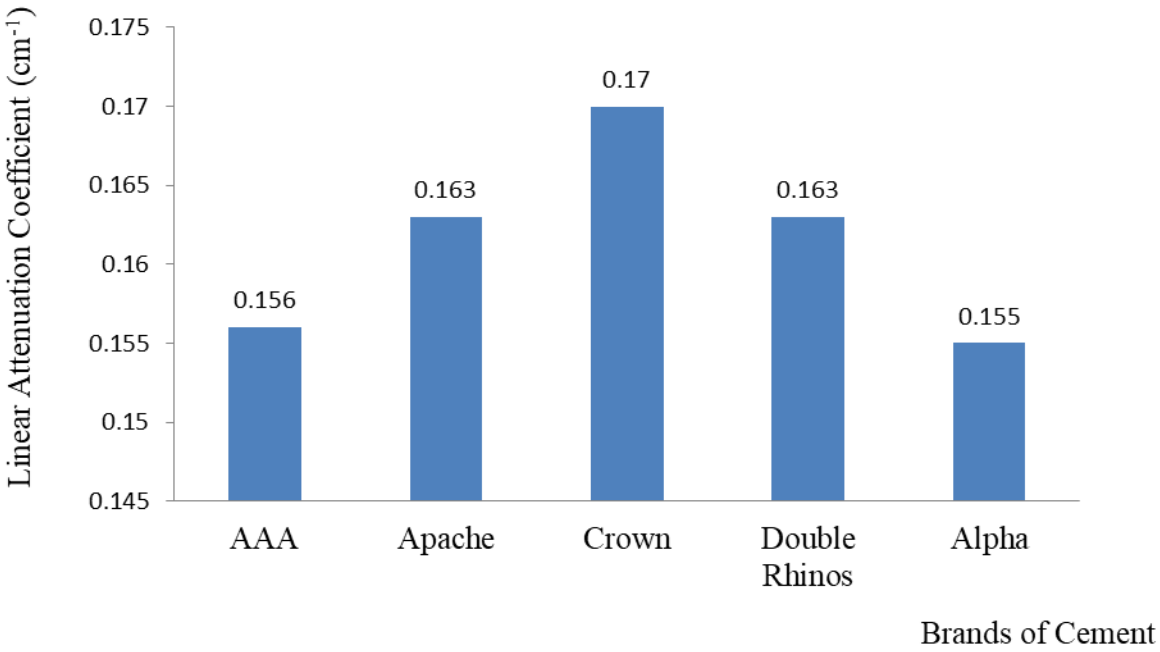


Fig (10) Linear Attenuation Coefficient vs Brands of Cement

Finding and Discussion

From Fig.(5) shows Net Counting Rate vs Thickness of sample for AAA cement. From this figure, the slope of the straight line gives the linear attenuation coefficient of the sample. The value of linear attenuation coefficient is 0.156cm^{-1}and R^2 value is 0.9225.

From Fig.(6) shows Net Counting Rate vs Thickness of sample for Apache cement From this figure, the slope of the straight line gives the linear attenuation coefficient of the sample. The linear attenuation coefficient is 0.163cm^{-1} and R^2 value is 0.9086.

From Fig.(7) shows Net Counting Rate vs Thickness of sample for Crown cement. From this figure, the slope of the straight line gives the linear attenuation coefficient of the sample. The linear attenuation coefficient is 0.17cm^{-1} and R^2 value is 0.9517.

From Fig.8 shows Net Counting Rate vs Thickness of sample for Double Rhinoceros cement. From this figure, the slope of the straight line gives the linear attenuation coefficient of the sample. The linear attenuation coefficient is 0.163cm^{-1} and R^2 value is 0.9494.

From Fig.(9) shows Net Counting Rate vs Thickness of sample for Alpha cement. From this figure, the slope of the straight line gives the linear attenuation coefficient of the sample. The linear attenuation coefficient is 0.155cm^{-1} and R^2 value is 0.9043.

Finally, Fig.(10) shows Linear Attenuation Coefficient vs Brands of Cement. It indicates that the range of linear attenuation coefficient is 0.155cm^{-1} to 0.17 cm^{-1}.

Conclusion

In this research five brands of cement are mainly used for concrete samples and then the samples are prepared. The samples have been prepared by the above method for this research. Twenty five concrete slabs are prepared for this research. In this research, a Geiger-Muller Tube (GM-35, window type), Timer Scalar and Frequency Meter (ST-360) and radioactive source (^{60}Co) have been used. The distance between the source and the detector is 11.5cm and the samples are placed 4.5 cm above of the radioactive source. First, background

counting rate (without radioactive source) and initial intensity of the radioactive source (without absorber) are determined. Finally, one of the samples is placed on the positioner that is situated between a gamma source (^{60}Co, 1μCi) and a GM tube. These experimental results are shown in the above tables and figures. From the above graphs, the slope of the straight line gives the linear attenuation coefficient of the sample. Finally, the values of linear attenuation coefficients and density of the concrete samples are compared. According to this research, the more the value of the linear attenuation coefficient, the more the the density of the sample. According to this research, this detection system depends on (i) the different weights of cement and (ii) thickness of the sample. The linear attenuation coefficient (μ) values are important in fundamental physics and many applied fields. Therefore the accurate linear attenuation coefficient values for X-rays and gamma-rays in several materials are essential for some fields such as nuclear and radiation physics, radiation dosimetry, biological, medical, agricultural, environmental and industrial. In this research, the value of linear attenuation coefficient of crown sample is the largest. Therefore Crown sample is more reliable for shielding material than others in this research. This research paper is useful for experimental lab to the radiation protection.

Acknowledgement

We wish to express our gratitude to Dr Win Swe, Rector, Shwebo University to allow to present this research. We are deeply grateful to Dr Min Swe, Professor and Head, Department of Physics, Shwebo University for his kind encouragements throughout the research.

References

[1] International Atomic Energy Agency, (2002). “Guidebook on Non-Destructive Testing of Concrete Structures”, VIENNA.

[2] Nicholas, T, (1995). “Measurement and Detection of Radiation”, Second Edition, Taylor and Francis, USA.

[3] William R.Leo, (1994). “Techniques for nuclear and particle physics experiments”, Second Revised Edition, Springer-Velar, Germany.

Purification of Some Water Samples from Shwebo University Campus by Using Solar Oven

Kyaw Kyaw Naing[1], Nwe Ni Kyaw[2], Khin Hnin Ei[3]

Abstract

This research is aimed to pure some water samples by using solar oven. In this research, some water samples from Shwebo University campus, Sagaing Region are purified and measured pH value before and after heating by using pH meter, solar energy and solar oven. Pure water from impure water is achieved by using direct and reflected solar radiation.

Key words; solar oven, solar radiation, pH meter.

Introduction

The drinking water's quality is very important. It is needed for the consumptions the cleanliness of water to set the fit healthiness of body. In many countries there is an important need for clean, pure drinking water. Often the water sources contain dissolved salts or harmful bacteria and therefore cannot be used for drinking. The ways of purified water are so many. Among them, we studied and researched one way of purified method by using solar energy. Solar energy can be used to remove effectively many impurities.

Solar Energy and Solar Radiation

Solar energy is the world's most abundant permanent source of energy. The amount of solar energy intercepted by the planet earth is MW. Of this amount, about 30 percent is reflected to space, 47 percent is converted to low-temperature heat and radiated to space, 23 percent power the evaporation precipitation cycle of the biosphere, and less than 0.5 percent is represented in the kinetic energy of the wind and wave and photosynthetic storage in plants. The solar energy that arrives at the surface of the earth is in two forms; direct radiation and diffuse radiation.

Geographical Location of Shwebo

The geographical location of Shwebo is favorable for solar energy use. Shwebo is situated in the dry zone and the larger city in Sagaing Region. It is situated between latitude 21º55´N and 22º18´N and longitude 95º4´E and 95º23´E. The total land area of ShweboTownship is 266.00 sq-miles, stretching 20 miles from north to south and 13 miles from east to west.

Materials and Methods

Experimental Work

The experimental work was to pure some samples water from Shwebo, Sagaing Region. This project was studied in the campus of Shwebo University. Water samples from

(1) Thapyaynyo hotel water sample

(2) Teachers char Mary water sample

(3) Eight Marge halls water sample

are collected from Shwebo University campus, Sagaing Region.

[1] Lecturer, Department of Physics, Shwebo University.
[2] Lecturer, Myanmar Institute of Information Technology (MIIT), Mandalay, Myanmar.
[3] Professor, Department of Physics, Shwebo University.

Operation of Solar Oven

This research work was used the constructed solar oven from Department of Physics, Shwebo and shown in figure (1). The experimental work was to know the pH values of some water samples. The position of our solar oven was adjusted in order that reflected solar radiation was to be incident on the cover plate, the receiver pots and inside the solar oven exactly. The principle is to use the heat from the sun by radiation trapping it inside the box with transparent glass plate. This heat is transferred by conduction through metal pots to the water contained in the pots. It is desirable to use reflectors to reflect solar rays toward the box, maintaining the heat. The position of solar oven was adjusted in one hour. In each time, the inner box temperature and surrounding temperature were recorded and tabulated from table (1) to table (3). The exposure time period was from 9 AM to 3 PM.

Measuring the pH Values

Before taking a pH measurement, the meter must be "calibrated". The probe is immersed in a solution that knows pH, such as pure water with a natural pH of 7.0. And then, the knobs on the box are used to adjust the displayed pH value of the known pH of the solution, thus calibrating the meter. To use pH meter, the water sample is placed in the cup and the glass probe at the end of the retractable arm is placed in the water. Inside the thin glass bulb at the end of the probe there are two electrodes that measure voltage. One electrode is immersed in a liquid that has a fixed acidity, or pH. The other electrode responds to the acidity of the water sample. A voltmeter in the probe measures the difference between the voltages of the two electrodes. The meter then translates the voltage difference into pH and displays it on the little screen on the main box.

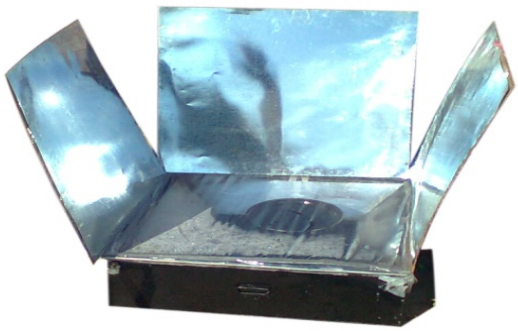


Figure (1) The photograph of constructed solar oven

Date	Time (hr:min)	Inner Box Temperature (°C)	Surrounding Temperature (°C)
10.8.2019	9:00	47	36
	10:00	56	37
	11:00	76	37
	12:00	89	38
	13:00	97	39
	14:00	90	36
	15:00	78	34

Table (1) The Measurement of Temperature for 1 Liter by Using of Solar Oven of Thapyaynyo hotel Water sample

Date	Time (hr:min)	Inner Box Temperature (°C)	Surrounding Temperature (°C)
11.8.2019	9:00	40	31
	10:00	55	33
	11:00	69	34
	12:00	72	35
	13:00	69	35
	14:00	57	34
	15:00	56	34

Table (2) The Measurement of Temperature for 1 Liter by Using of Solar Oven of Teachers char Mary water sample

Date	Time (hr:min)	Inner Box Temperature (°C)	Surrounding Temperature (°C)
12.8.2019	9:00	43	29
	10:00	48	31
	11:00	59	32
	12:00	69	35
	1:00	57	34
	2:00	48	32
	3:00	45	31

Table (3) The Measurement of Temperature for 1 Liter by Using of Solar Oven of Eight Marge halls Water sample

Results and Discussion

In this study we collected three samples water from Shwebo University campus, Sagaing Region and measured pH before and after solar heating by using solar energy. The measurement of pH values by using pH meter are shown in Table (4) through to Table (6) and Fig (2) through to Fig (4).

Heating	pH value
Before heating (at 9:00 am)	7.64
After heating (at 15:00 pm)	6.95

Table (4) The measurement of the pH values of Thapyaynyo hostel water sample

Heating	pH value
Before heating (at 9:00 am)	7.22
After heating (at 15:00 pm)	7.01

Table (5) The measurement of the pH values of Teachers char Mary water sample

Heating	pH value
Before heating (at 9:00 am)	7.46
After heating (at 15:00 pm)	7.06

Table (6) The measurement of the pH values of Eight Marge halls water sample

(a) (b)

Figure (2) The pH value of Thapyaynyo hotel water sample (a) before heating 9:0 Am and (b) after heating at 3:00 pm

(c) (d)

Figure (3) The pH value of Teachers char Mary water sample (c) before heating 9:0 Am and (d) after heating at 3:00 pm

(e) (f)

Figure (4) The pH value of Eight Marge halls water sample (e) before heating 9:0 Am and (f) after heating at 3:00 pm

Conclusion

In this research, the pH values of some lakes water by using solar heating method that obtained by solar oven. Most people who lived in Shwebo University, used these water in their campus. Therefore, they needed to know this water are purified or not. So, we analyzed the purification of some water.

The purification of pH value in 1 liter of Thapyaynyo hostel water sample before heating was 7.64. At heating after 7 hours the pH value of these water was 6.95. The purification of pH value in 1 liter of Teacher char Mary water sample before heating was 7.22. At heating after 7 hours the purification of pH value in these water samples was 7.06. The purification of pH value in 1 liter of eight marge hotel water sample before heating was 7.46. At heating after 7 hours the purification of pH value in eight marge halls water sample was 7.01. According to the results, at the higher temperature, the purification of pH value in water gradually decreases. As a result, the pH values of water were reduced after heating by using solar energy.

Acknowledgements

Firstly, we wish to express my deepest gratitude to Dr Min Swe, Professor and Head of Physics Department, Shwebo University for his encouragement and permission to this research. We are grateful to Dr Khin Hnin Ei, Professor, Department of Physics, Shwebo University for her helpful comments in compilation of this research.

References

1. Kreider, J.F, Kneith, F., **"Solar Heating and Cooling"**, Mc Graw-hill, Inc 1982.
2. Fisk, M.J, Anderson, H.C.W, **"Introduction to Solar Technology"**, Addison-Wesley Publishing Company, Inc. 1982.
3. Anderson E.E, **"Fundamentals of Solar Energy Conversion"**, Addison-Wesley Publishing Company, Inc. 1982.
4. H.P Garg, J.Prakash, **"Solar Energy Fundamentals and Application"**, Tata.MC Graw-Hill, Inc 1997.

Introduction to Plotting Rectangular and Polar Coordinates with Matlab

Cho Sandar[1], Zin Mar Tun[2]

Abstract

In this paper, firstly, we use two different coordinate systems such as rectangular and polar coordinate systems. And then, we explain the relationship between them. Finally, we plot the functions with 2-D and 3-D graphics by using Matlab.
Key words: rectangular coordinate system, polar coordinate system, Matlab.

Introduction

This paper describes rectangular and polar coordinate systems. We want to explain what they are and how to use them. Many different coordinate systems are used in Mathematics. Now, we introduced the connection of two coordinate systems. Finally, we derived how to apply polar coordinate by using Matlab.

1.1 Rectangular Coordinate System

The position of a point in a plane can be described using rectangular coordinates. In this system, we fix an origin, a point O, and then take two lines which are perpendicular to each other passing through O. These two lines are the axes. The x-axis is horizontal, and the y-axis is vertical. The position of any point P can be described by a unique ordered pair of numbers (x, y) in the plane. The first number in the ordered pair is the x-coordinate, which is the horizontal distance from O to the point. The second number is the y-coordinate, which is the vertical distance from O to the point.

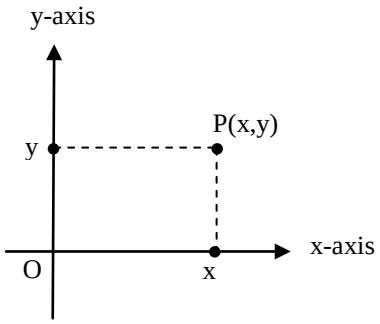


Figure 1 Point with coordinates (x,y)

1.2 Polar Coordinate System

Like the rectangular coordinate system, a point in polar coordinate consists of an ordered pair of numbers, (r,θ). The first coordinate is the distance of the point from the origin (or pole) O, and the second coordinate is the angle. The point we want to locate is the terminal point of this angle.

[1] Associate Professor, Dr., Department of Mathematics, Shwebo University
[2] Associate Professor, Dr., Department of Mathematics, Mandalay University of Distance Education

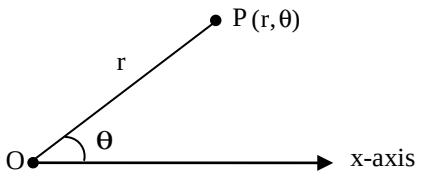


Figure 2 Point with coordinates (r, θ)

1.3 The Relationship between Rectangular and Polar Coordinates

We consider a point P with rectangular coordinates (x,y) and polar coordinates (r, θ). We shall identify the pole with the origin of rectangular coordinates, and the initial line with the x-axis.

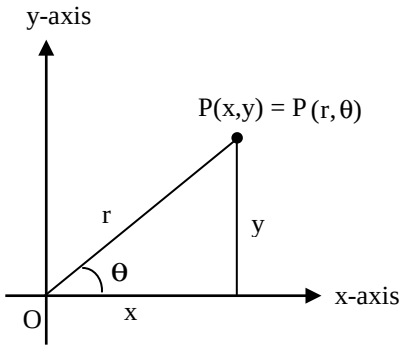


Figure 3 Rectangular and Polar coordinates

From the figure, we see that there are two pairs of equations that help us to convert from one system to another:

$$x = r\cos\theta, \quad y = r\sin\theta$$

to convert from polar coordinates to rectangular coordinates, and

$$r^2 = x^2 + y^2, \quad \tan\theta = y/x$$

to convert from rectangular coordinates to polar coordinates.

2. Plotting the Functions in Rectangular and Polar Coordinates

Matlab is a program for solving engineering and mathematical problems. Matlab works with essentially, a rectangular and polar coordinates. In this section, we described how to use some basic Matlab commands to plot the given functions. Then, we must first specify the data points at which the functions will be evaluated. We choose evenly spaced points.

2.1 Basic Commands for 2-D and 3-D Plots

Matlab provides a variety of functions for displaying data as 2-D or 3-D graphics. For 2-D graphic, the basic commands are:

plot (x, y, 'line style',…)
hold on
box off

We can add a title and labels for the axes with the commands; title, xlabel, ylabel. The text can be added to the graph by using the text command. We can control the scaling and appearance of plot axis with the axis function. To set scaling for the x- and y- axes on the current 2-D plot, use this command:

axis ([xmin xmax ymin ymax]).

Other commands for 2-D graphics are polar, bar, and stairs. For 3-D graphics, the most commonly used commands are:

plot (x, y, z, 'line style',…)

mesh (X,Y,Z)

Other commands available for 3-D graphics are image, cylinder, and sphere.

2.2 Examples

2.2.1 Example

(i) We plot $y = \sin(x) - 1$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol * for $\sin(x) - 1$.

```
x = linspace(0,2*pi);
y =(sin(x)-1);
plot (x,y,'r*') % contain red and stars dotted line
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(3,-0.6,'sin(x) - 1')
```

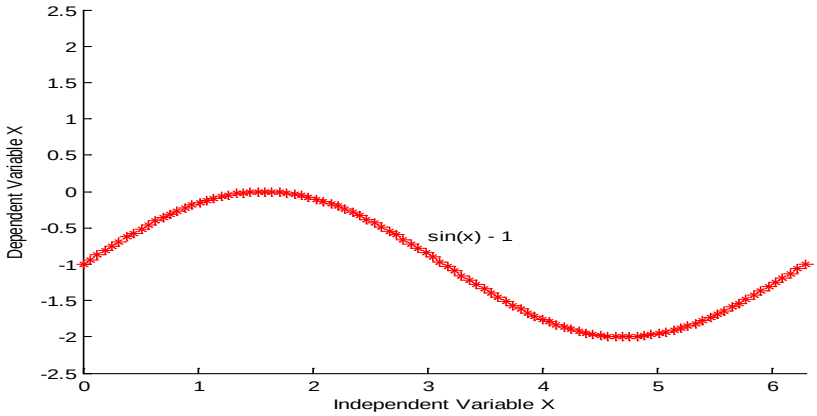


Figure 4

(ii) We plot $r = \sin(\theta) - 1$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = sin(theta)-1;
polar(theta,sin(theta)-1);
```

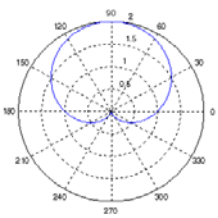


Figure 5

(iii) We plot $r = \sin(\theta) - 1$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(sin(theta)-1);
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

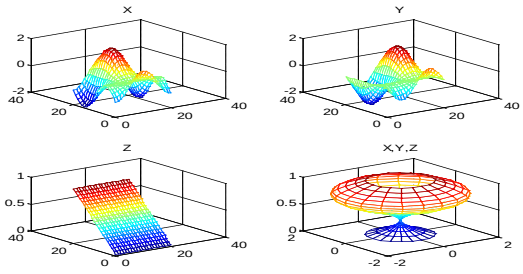


Figure 6

2.2.2 Example

(i) We plot $y = 1 - \sin(x)$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol o for $1 - \sin(x)$.

```
x = linspace(0,2*pi);
y =(1-sin(x));
plot (x,y,'ko') % contain black and o dotted line
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(3.3,1,'1 - sin(x)')
```

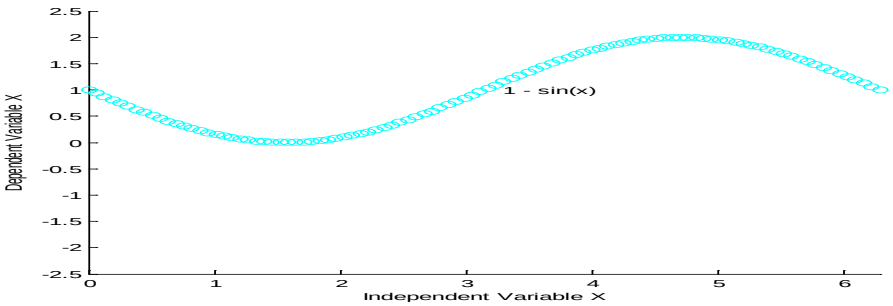


Figure 7

(ii) We plot $r = 1 - \sin(\theta)$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = 1-sin(theta);
polar(theta,1-sin(theta));
```

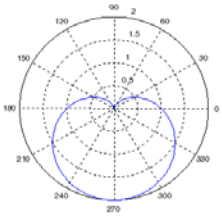


Figure 8

(iii) We plot $r = 1 - \sin(\theta)$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(1-sin(theta));
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

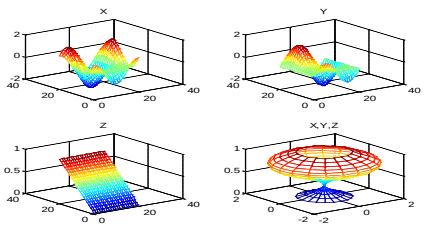


Figure 9

2.2.3 Example

(i) We plot $y = 1 + \sin(x)$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol - for $1 + \sin(x)$.

```
x = linspace(0,2*pi);
y =(1+sin(x));
plot (x,y,'hexagram') % contain blue
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(3.3,1,'1 + sin(x)')
```

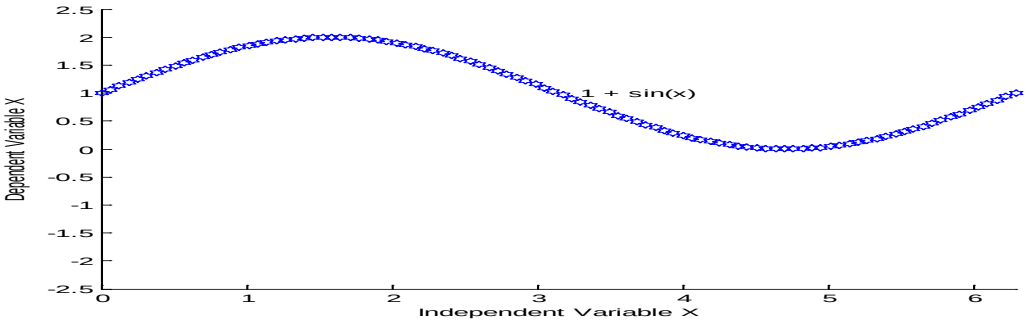


Figure 10

(ii) We plot $r = 1 + \sin(\theta)$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = 1+sin(theta);
polar(theta,1+sin(theta));
```

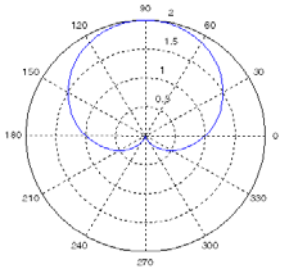


Figure 11

(iii) We plot $r = 1 + \sin(\theta)$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(1+sin(theta));
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

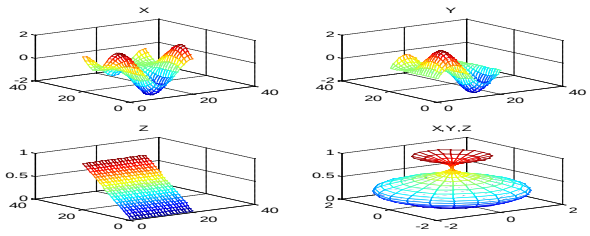


Figure 12

2.2.4 Example

(i) We plot $y = 1 - \cos(x)$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol pentagran for $1 - \cos(x)$.

```
x = linspace(0,2*pi);
y =(1-cos(x));
plot (x,y,'yp') % contain yellow and pentagram dotted line
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(3.3,1,'1 - cos(x)')
```

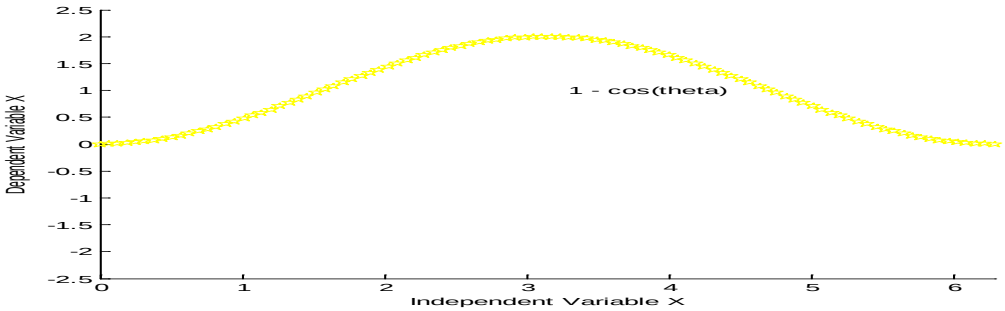


Figure 13

(ii) We plot $r = 1 - \cos(\theta)$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = 1-cos(theta);
polar(theta,1-cos(theta));
```

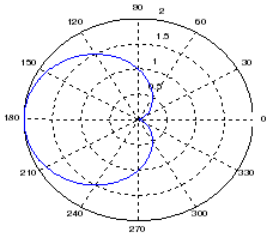


Figure 14

(iii) We plot $r = 1 - \cos(\theta)$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(1-cos(theta));
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

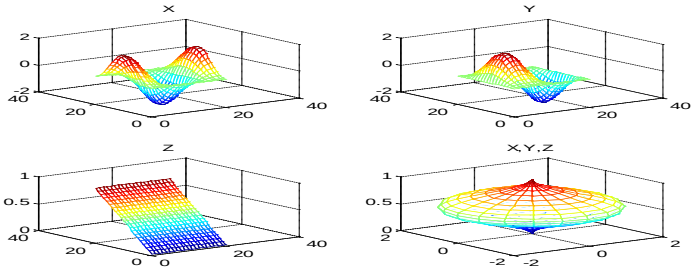


Figure 15

2.2.5 Example

(i) We plot $y = \cos(x) - 1$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol triangle up for $\cos(x) - 1$.

```
x = linspace(0,2*pi);

y =(cos(x)-1);
plot (x,y,'m^') % contain magenta and triangle up dotted line
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(1.9,-1,'cos(x)- 1')
```

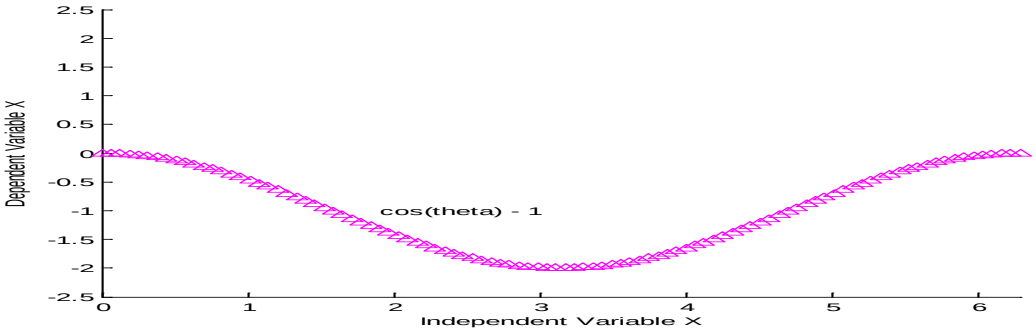


Figure 16

(ii) We plot $r = \cos(\theta) - 1$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = cos(theta)-1;
polar(theta,cos(theta)-1);
```

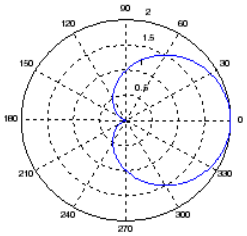


Figure 17

(iii) We plot $r = \cos(\theta) - 1$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(cos(theta)-1);
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

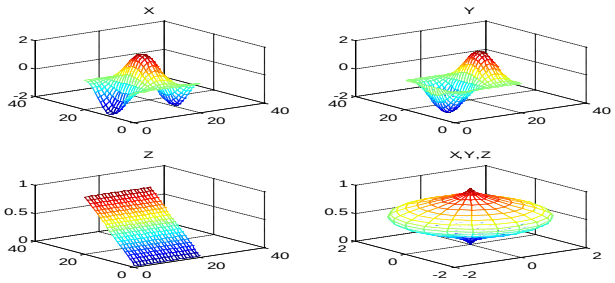


Figure 18

2.2.6 Example

(i) We plot $y = 1 + \cos(x)$ with $0 \le x \le 2\pi$ in rectangular coordinates. We use the symbol + for $1 + \cos(x)$.

```
x = linspace(0,2*pi);
y =(1+cos(x));
plot (x,y,'g+') % contain green and + dotted line
hold on
box off
xlabel('Independent Variable X')
ylabel('Dependent Variable X')
axis ([0 2*pi -2.5 2.5])% sets the axis 0 <= X <=2 pi,-2.5<= Y<= 2.5
text(3.3,1,'1 + cos(x)')
```

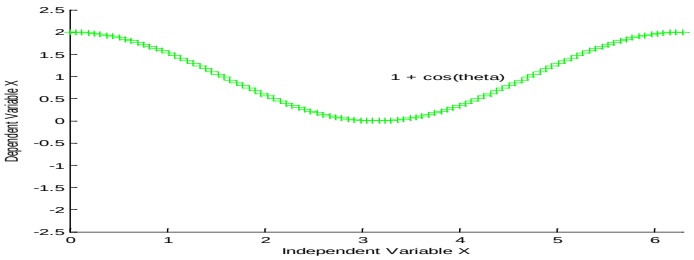


Figure 19

(ii) We plot $r = 1 + \cos(\theta)$ with $0 \le \theta \le 2\pi$ in polar coordinates.

```
theta = 0:0.01:2*pi;
r1 = 1+cos(theta);
polar(theta,1+cos(theta)
```

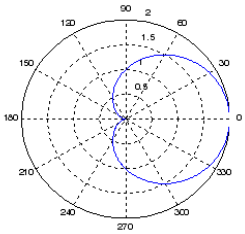


Figure 20

(iii) We plot $r = 1 + \cos(\theta)$ with $0 \le \theta \le 2\pi$ in 3-D.

```
theta = 0:pi/10:2*pi;
[X,Y,Z] = cylinder(1+cos(theta));
subplot(2,2,1); mesh(X); title('X');
subplot(2,2,2); mesh(Y); title('Y');
subplot(2,2,3); mesh(Z); title('Z');
subplot(2,2,4); mesh(X,Y,Z); title('X,Y,Z');
```

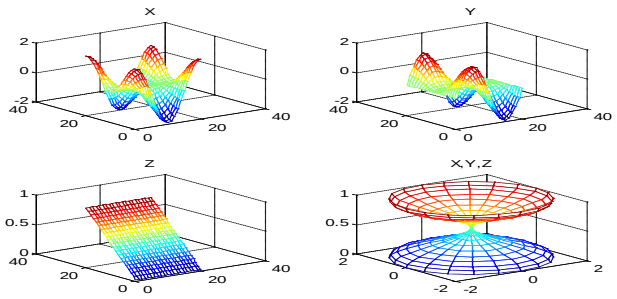


Figure 21

Conclusion

Polar coordinates are very useful in many real life applications where one moves from one point to another along an unimpeded vector, such as in the navigation of a plane, a ship, or a rocket. Moreover, Matlab has a lot more capability for graphing or plotting. Thus, we use Matlab to plot the functions in rectangular and polar coordinates. Finally, we illustrate some examples with Matlab commands.

Acknowledgements

My special thanks are due to Dr.Win Swe, Pro-rector (Rector's Duty), and Dr. Myo Myo, Pro-rector, Shwebo University, for their kind permission to conduct this research paper. Finally, I would like to express my sincere thanks to Professor Dr. Myint Myint Yi, Professor and Head of Department of Matematics, and Dr. Swe Aye, Professor, Department of Mathematics, Shwebo University, for their encouragement and valuable suggestions.

References

1. Alisa Favinger, 'The Polar Coordinate System', University of Nebraska- Lincoln, 2008.
2. Math Science Computing Center, "Introduction to Plotting with Matlab", University of Washington, 1996.
3. Tsishchanka, K., and Wood, E., "Polar Coordinates", Source URL, Saylor Orginazation, 2013.

Calculation of n-steps Transitions Probabilities with Matlab

Nyein Chan Kyaw[1]

Abstract

Some basic definitions of Markov chain are introduced. Then, one-step and n-steps transitions probabilities are studied. Finally, one-step to n-steps and n-steps to one-step of transition probabilities matrices are expressed with illustrated examples by using Matlab.

Key words: Stochastic process, Markov Chain, Transition probability matrix.

Introduction

Markov chains were introduced in 1906 by Andreyevich Markov (1856-1922) and were named in his honor.

A **stochastic process** $\{X_t, t \in T\}$ is a collection of random variables. The index t represents time and we refer X_t as the state of the stochastic process at time t. The set T is called the index set of the stochastic process. If $T = \{0,1,2,\ldots\}$, then the stochastic process is said to be **discrete time process**. If T is an interval of the real line, then the stochastic process is said to be a **continuous-time process**. The **state space** of a stochastic process is defined as the set of all possible values that the random variable X_t can assume.

Let $\{X_n, n = 0,1,2,\ldots\}$ be a discrete-time stochastic process. A stochastic process $\{X_n, n = 0,1,2,\ldots\}$ is called a **Markov chain** if

$$P\{X_{n+1} = j \mid X_n = i, X_{n-1} = i_{n-1}, \ldots, X_1 = i_1, X_0 = i_0\} = P_{ij} \quad (1)$$

for all states $i_0, i_1, \ldots, i_{n-1}, i, j$ and all $n \geq 0$. Equation (1) may be interpreted as stating that, for a Markov chain, the conditional distribution of any future state X_{n+1} given the past state $X_0, X_1, \ldots, X_{n-1}$, and the present state X_n, is independent of the past state and depends only on the present state.

One-step and n-steps transitions Probabilities

The value P_{ij} denotes the probability that the Markov chain whenever in state i, (the current state) move next (one unit of time later) into state j, is referred to as **one-step transition probability**.

Let P denote the matrix of one-step transition probabilities P_{ij}, so that

$$P = \begin{pmatrix} P_{00} & P_{01} & P_{02} & \cdots \\ P_{10} & P_{11} & P_{12} & \cdots \\ \vdots & & & \\ P_{i0} & P_{i1} & P_{i2} & \cdots \\ \vdots & \vdots & \vdots & \end{pmatrix}.$$

[1] Lecturer, Department of Mathematics, Shwebo University

This matrix is called **one-step transition probability matrix**.

Note that the transition probability matrix P for a Markov chain has the following properties;

(i) $P_{ij} \geq 0, i, j \geq 0$

(ii) $\sum_{j=0}^{\infty} P_{ij} = 1, i = 0, 1, 2, \ldots$

Property (i) is true since the entries in P are probabilities. Property (ii) is true since each row of P represents a possible starting state for the Markov chain and the entries are the individual probabilities for all possible outcomes for the experiment. Those probabilities must sum to one since the probability of the sample space is always one.

The **n-step transition probabilities** P_{ij}^{n} to be the probability that a process in state i will be in state j after n additional transitions. That is,

$$P_{ij}^{n} = P\left\{X_{n+m} = j \middle| X_{m} = i\right\}, \; n \geq 0, \; i, j \geq 0.$$

The **Chapman-Kolmogorov equations** provide a method for computing these n-step transition probabilities. These equations are

$$P_{ij}^{n+m} = \sum_{k=0}^{\infty} P_{ik}^{n} P_{kj}^{m} \text{ for all } n, m \geq 0, \text{ all i, j.} \qquad (2)$$

If $P^{(n)}$ denotes the matrix of n-step transition probabilities P_{ij}^{n}, then Equation (2) becomes

$$P^{(n+m)} = P^{(n)} \cdot P^{(m)}$$

where the dot represents matrix multiplication.

Hence, in particular,

$$P(2) = P(1 + 1) = P \cdot P = P2,$$
$$P(n) = P(n - 1 + 1) = Pn - 1 \cdot P1 = Pn.$$

That is, the **n-step transition matrix** may be obtained by the P(one-step transition matrix) by itself n-times.

Then, we can calculate the one-step transition probability and n-steps transition probabilities as following example.

Consider the six places of "The nine places of the victory land (Aung Myay)" in Shwebo such as Shwe-Tazar Pagoda, Shwe-Thein-Taw Pagoda, Shwe-Paw-Kyun Pagoda, Aung Myay Pagoda, Maw-Daw-Myin-Thar Pagoda and Shwebo Yadana Mingalar Palace. A tour bus visits these six places. The following figure shows the probability of visiting neighboring places (and outgoing properties sum to less than 1 it stays where it is with remaining probability).

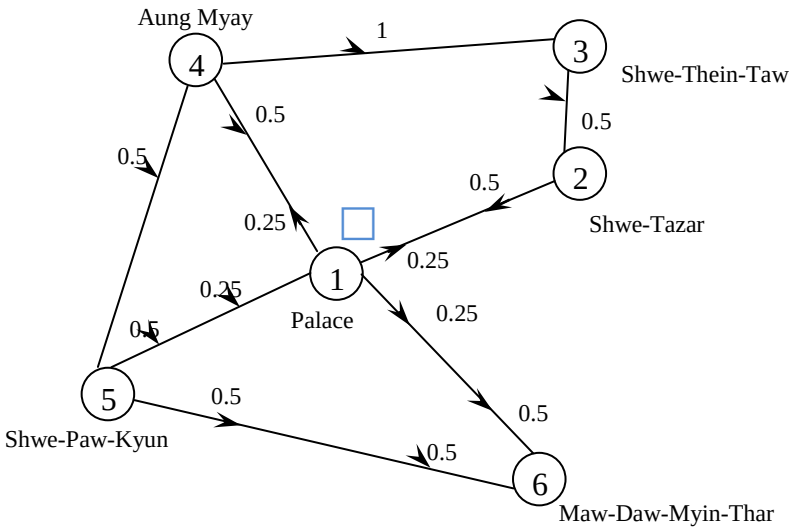


Figure (1)

The one-step transition probability matrix is

$$P = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \begin{pmatrix} 0 & 0.25 & 0 & 0.25 & 0.25 & 0.25 \\ 0.5 & 0 & 0.5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0.5 & 0 & 0 & 0 & 0.5 & 0 \\ 0.5 & 0 & 0 & 0 & 0 & 0.5 \\ 0.5 & 0 & 0 & 0 & 0.5 & 0 \end{pmatrix} \end{array}.$$

There are 6 “states” (places). In matrix P, the element $P_{45} = 0.5$ is the probability that the tour bus start in “Aung Myay Pagoda” and goes to “Shwe Paw Kyun”.

The two-steps transitions probability matrix is

$$P^{(2)} = P^2 = P \cdot P = \begin{pmatrix} 0.5 & 0 & 0.125 & 0 & 0.25 & 0.125 \\ 0 & 0.125 & 0 & 0.625 & 0.125 & 0.125 \\ 0.5 & 0 & 0 & 0 & 0.5 & 0 \\ 0.25 & 0.125 & 0 & 0.125 & 0.125 & 0.375 \\ 0.25 & 0.125 & 0 & 0.125 & 0.375 & 0.125 \\ 0.25 & 0.125 & 0 & 0.125 & 0.125 & 0.375 \end{pmatrix}.$$

The three-steps transition probability matrix is

$$P^{(3)} = P^3 = P^2 \cdot P = \begin{pmatrix} 0.1875 & 0.125 & 0 & 0.25 & 0.1875 & 0.25 \\ 0.5 & 0 & 0.0625 & 0 & 0.375 & 0.0625 \\ 0.25 & 0.125 & 0 & 0.125 & 0.125 & 0.375 \\ 0.375 & 0.0625 & 0.0625 & 0.0625 & 0.3125 & 0.125 \\ 0.375 & 0.0625 & 0.0625 & 0.0625 & 0.1875 & 0.25 \\ 0.375 & 0.0625 & 0.0625 & 0.0625 & 0.3125 & 0.125 \end{pmatrix}.$$

The four-steps transition probability matrix is

$$P^{(4)} = P^4 = P^3 \cdot P = \begin{pmatrix} 0.4063 & 0.0469 & 0.0625 & 0.0469 & 0.2969 & 0.1406 \\ 0.2188 & 0.125 & 0 & 0.1875 & 0.1563 & 0.3125 \\ 0.375 & 0.0625 & 0.0625 & 0.0625 & 0.3125 & 0.125 \\ 0.2813 & 0.0938 & 0.0313 & 0.1563 & 0.1875 & 0.25 \\ 0.2813 & 0.0938 & 0.0313 & 0.1563 & 0.25 & 0.1875 \\ 0.2813 & 0.0938 & 0.0313 & 0.1563 & 0.1875 & 0.25 \end{pmatrix}.$$

The five-steps transition probability matrix is

$$P^{(5)} = P^5 = P^4 \cdot P = \begin{pmatrix} 0.2656 & 0.1016 & 0.0234 & 0.1641 & 0.1953 & 0.25 \\ 0.3906 & 0.0547 & 0.0625 & 0.0547 & 0.3047 & 0.1328 \\ 0.2813 & 0.0938 & 0.0313 & 0.1563 & 0.1875 & 0.25 \\ 0.3438 & 0.0703 & 0.0469 & 0.1016 & 0.2734 & 0.1641 \\ 0.3438 & 0.0703 & 0.0469 & 0.1016 & 0.2422 & 0.1953 \\ 0.3438 & 0.0703 & 0.0469 & 0.1016 & 0.2734 & 0.1641 \end{pmatrix}.$$

The six-steps transition probability matrix is

$$P^{(6)} = P^6 = P^5 \cdot P = \begin{pmatrix} 0.3555 & 0.0664 & 0.0508 & 0.0898 & 0.2734 & 0.1641 \\ 0.2734 & 0.0977 & 0.0273 & 0.1602 & 0.1914 & 0.25 \\ 0.3438 & 0.0703 & 0.0469 & 0.1016 & 0.2734 & 0.1641 \\ 0.3047 & 0.0859 & 0.0352 & 0.1328 & 0.2188 & 0.2227 \\ 0.3047 & 0.0859 & 0.0352 & 0.1328 & 0.2344 & 0.207 \\ 0.3047 & 0.0859 & 0.0352 & 0.1328 & 0.2188 & 0.2227 \end{pmatrix}.$$

From the above result, the probability that the tour bus is still in “Shwebo Yadana Mingalar Palace” after 3 steps is $P_{11}^{(3)} = 0.1875$, after 6 steps is $P_{11}^{(6)} = 0.3555$. If we want to know the value of 1000 steps, we need many calculations.

Calculation by Matlab Programming

In this section, the methods of Matlab Programming for one-step and n-steps transition probabilities are expressed.

Example 1

To find the six-stepstransition probability, we recall the initial example of previous illustration.(See Figure (1))

```
>> P = [0 0.25 0 0.25 0.25 0.25; 0.5 0 0.5 0 0 0; 0 0 0 1 0 0; 0.5 0
   0 0 0.5 0;  0.5 0 0 0 0 0.5; 0.5 0 0 0 0.5 0];
   >> P^6
```

```
   ans =
   0.3555    0.0664    0.0508    0.0898    0.2734    0.1641
   0.2734    0.0977    0.0273    0.1602    0.1914    0.2500
   0.3438    0.0703    0.0469    0.1016    0.2734    0.1641
   0.3047    0.0859    0.0352    0.1328    0.2188    0.2227
   0.3047    0.0859    0.0352    0.1328    0.2344    0.2070
   0.3047    0.0859    0.0352    0.1328    0.2188    0.2227
```

So, we get the answer.

Example 2

On any given day, Gray is either cheerful (C), so-so (S), or glum (G). If he is cheerful today, then he will be C, S, or G tomorrow with respective probabilities 0.5, 0.4, 0.1. If he is feeling so-so today, then he will be C, S or G tomorrow with probabilities 0.3, 0.4, 0.3. If he is glum today, then he will be C, S or G tomorrow with probabilities 0.2, 0.3, 0.5. Now Gary is currently in a cheerful mood. Then, we consider the probability that he is not in a glum mood on any of the following three days.

By given conditions, we can get one-step transition probability matrix as follows.

$$\begin{pmatrix} 0.5 & 0.4 & 0.1 \\ 0.3 & 0.4 & 0.3 \\ 0.2 & 0.3 & 0.5 \end{pmatrix}.$$

But, to get the probability that he is not in a glum mood, we will consider as follows.

	C	S	G		column 1	column 2	column 3
C	0.5	0.4	0.1	row 1	C→C	C→S	C→G
S	0.3	0.4	0.3	row 2	S→C	S→S	S→G
G	0	0	1	row 3	G→C	G→S	G→G

```
   >> P = [0.5 0.4 0.1; 0.3 0.4 0.3; 0 0 1];
   >> A = P^3;
   >> p1 = 1 - A(1,3)

       p1 =

        0.585
```

Therefore, the probability that he is not in a glum mood is 0.585.

(Note that "p1" is the symbol of required answer. We can denote any alpherbet.)

Example 3

Customers in a certain city are continually switching the brand of a soap they buy. If a customer is now using brand *A*, the probability he will use brand *A* next week is 0.5, that he switches to brand *B* is 0.2, and that he switches to brand *C* is 0.3. If he now uses brand *B*, the probability he uses *B* next week is 0.6 and that he switches to brand *C* is 0.4. If he now uses brand*C*, the probability he uses *C* next week is 0.4, that he switches to brand *A* is 0.2 and to *B* is 0.4. Assume that the process is a Markov chain. Then, we will find the probability a customer now using brand *A* will be using brand *B* in two weeks and the probability a customer now using brand *A* will be using brand *B* in six weeks.

```
>> P = [0.5 0.2 0.3
       0 0.6 0.4
       0.2 0.4 0.4];
>>A = P^2;
>>B = P^6;
>>p1 = A(1,2)

 p1 =

0.3400

>> p2 = B(1,2)

p2 =

0.4563
```

Therefore, the probability a customer now using brand *A* will be using brand *B* in two weeks is 0.34 and the probability a customer now using brand *A* will be using brand *B* in six weeks is 0.4563.

We know that n-steps transition probabilities can get from one-step transition probability. Now, we will find one-step transition probability from n-steps transition probabilities.

Step 1 : Define (positive) transition probabilities between states i through j.
Step 2 : Add further assumptions bounding the transitions probabilities.
Step 3 : Define transition matrices.
Step 4: Construct for solubility equation.

Example 4

Suppose that the chance of rain tomorrow depends on previous weather conditions only through whether or not it is raining today and not on past weather conditions. Suppose also that if it rains today, then it will rain tomorrow with probability α; and if it does not rain today, then it will rain tomorrow with probability β in which the weather is considered as a two-state Markov chain. If the transition probability matrix that it will rain four days from today is

$$\begin{pmatrix} 0.5749 & 0.4251 \\ 0.570 & 0.4332 \end{pmatrix},$$

then we can find α and β.

So, $P^{(4)} = \begin{pmatrix} 0.5749 & 0.4251 \\ 0.570 & 0.4332 \end{pmatrix}$.

Let $P = \begin{pmatrix} \alpha & 1-\alpha \\ \beta & 1-\beta \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$.

```
>>syms a b c d positive;
>>assumeAlso ([a b c d]<1 & a + b == 1 & c + d == 1);
>> P = [a b; c d];
>> A = P^4;
>> B = [0.5749 0.4251; 0.5668 0.4332];
>> [sola, solb, solc, sold] = solve(A(1,1)== B(1,1), A(1,2)==
   B(1,2),A(2,1)== B(2,1),A(2, 2)== B(2,2))
sola =

       7/10
       31/70

solb =

       3/10
      39/70

solc =

      2/5
      26/35

sold =

      3/5
      9/35
```

unknown number	***solution I***	***solution II***
a	(7/10) = 0.7	(31/70) = 0.4429
b	(3/10) = 0.3	(39/70) = 0.5571
c	(2/5) = 0.4	(26/35) = 0.7429
d	(3/5) = 0.6	(9/35) = 0.2571

Therefore, $P = \begin{pmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{pmatrix}$ (or) $P = \begin{pmatrix} 0.4429 & 0.5571 \\ 0.7429 & 0.2571 \end{pmatrix}$.

Hence, $\alpha = 0.7$ and $\beta = 0.4$ (or) $\alpha = 0.4429$ and $\beta = 0.7429$.

This means that the solution of n-steps transition probability to one-step transition probability can have more than one solution. If we want to get only one solution, we must have some conditions. We can compare with Example 4 and the following Example 5.

Example 5

Suppose that the chance of rain tomorrow depends on previous weather conditions only through whether or not it is raining today and not on past weather conditions. Suppose also that if it rains today, then it will rain tomorrow with probability α; and if it does not rain today, then it will rain tomorrow with probability β in which the weather is considered as a two-state Markov chain; and **if it is rains today, the probability it will rain tomorrow is more than the probability it will not rain tomorrow**. If the transition probability matrix that it will rain four days from today is

$$\begin{pmatrix} 0.5749 & 0.4251 \\ 0.570 & 0.4332 \end{pmatrix},$$

Then, we can find α and β.

So, $P^{(4)} = \begin{pmatrix} 0.5749 & 0.4251 \\ 0.570 & 0.4332 \end{pmatrix}.$

Let $P = \begin{pmatrix} \alpha & 1-\alpha \\ \beta & 1-\beta \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}.$

If it ranis today, the probability it will rain tomorrow is more than the probability it will not rain tomorrow, therefore a > b.

```
>>syms a b c d positive;
>>assumeAlso ([a b c d]<1 & a + b == 1 & c + d == 1& a > b);
>> P = [a b; c d];
>> A = P^4;
>> B = [0.5749 0.4251; 0.5668 0.4332];
>> [sola, solb, solc, sold] = solve(A(1,1)== B(1,1), A(1,2)==
   B(1,2),A(2,1)== B(2,1),A(2, 2)== B(2,2))
```

```
sola =

      7/10

solb =

      3/10

solc =

      2/5

sold =

      3/5
```

Therefore $P = \begin{pmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{pmatrix}.$

Hence α = 0.7 and β = 0.4.

Conclusion

One-steps and n-steps transition probabilities are parts of the Markov chains. These can be applied many fields. Matlab means Matrix Laboratory. It can help us to get the solution quickly. If we know one-step transition, then we can find n-steps transition easily. Moreover, if we also know n-steps transition, we can find one-step transition. But, there may be many solutions for one-step. If we want to know exact solution, we will require sufficient conditions.

Acknowledgements

I would like to express my gratitude to **Dr Win Swe**, Rector, Shwebo University and **Dr Myo Myo**, Pro-Rector, Shwebo University for their permission to carry out the research and their encouragement. And then, I would like to thank Professor **Dr Myint Myint Yee**, Head of Department of Mathematics, Shwebo University, and Professor **Dr Swe Aye**, Department of Mathematics, Shwebo University, for their exhortation and helpful comments on this research.

References

[1] Attaway, S., (2009), "MATLAB, A Practical Approach", Elsevier, Inc., Canada.

[2] Ross, S.M., (2010), "Introduction to Probability Models", 10th Edition, Academic Press, New York.

[3] Ross, S.M., (1983), "Stochastic Process", John Wiley & Son Inc., New York.

[4] Weber, R., "Markov Chains", http://www.statslab.cam.ac.uk /~rrw1/markov/Mdraft1.pdf.

Hermite-Hadamard Inequality for Operator Convex Function

Saw Win[1]

Abstract

In this paper, firstly we express some basic concepts of Hermite-Hadamard Inequality. Finally, we calculate the main results which are refinements of some operator convex inequalities.

Key words:Hermite-Hadamard Inequality, Real-valued function, Operator Convex function.

1. Some Basic Concept of Hermite-Hadamard Inequality

The following classical inequality is well-known as the Hermite-Hadamard inequality in the literature:

$$f\left(\frac{a+b}{2}\right) \le \frac{1}{b-a}\int_a^b f(t)dt \le \frac{f(a)+f(b)}{2}, \tag{1}$$

where f is a convex function on an interval [a, b]. Both inequalities hold in the reversed direction if f is concave.

For any convex function defined on a segment [a, b], one can easily observe that (1) is equivalent to the following double inequality:

$$f\left(\frac{a+b}{2}\right) \le \int_0^1 f\left[(1-t)a+tb\right]dt \le \frac{f(a)+f(b)}{2}.$$

A real-valued continuous function f on an interval I is said to be **operator convex** if

$$f\left((1-\lambda)A+\lambda B\right) \le (1-\lambda)f(A)+\lambda f(B),$$

in the operator order, for all $\lambda \in [0,1]$ and for self-adjoint operators A and B on a Hilbert space H whose spectra are contained in I.

Theorem 1.1 Let $f: I \to \mathbb{R}$ be an operator convex function on the interval I. Then, for any self-adjoint operators A and B with spectra in I we have the inequality

$$f\left(\frac{A+B}{2}\right) \le \frac{1}{2}\left[f\left(\frac{3A+B}{4}\right)+f\left(\frac{A+3B}{4}\right)\right]$$

$$\le \int_0^1 f\left[(1-t)A+tB\right]dt$$

$$\le \frac{1}{2}\left[f\left(\frac{A+B}{2}\right)+\frac{f(A)+f(B)}{2}\right]$$

[1] Lecturer, Dr., Department of Mathematics, Shwebo University

$$\leq \frac{f(A)+f(B)}{2}. \tag{2}$$

Proof See[2].

Theorem 1.2 Let $f: I \to \mathbb{R}$ be an operator convex function on the interval I. Then, for any self-adjoint operators A and B with spectra in I and for any $\lambda \in [0,1]$, we have the inequality

$$f\left(\frac{A+B}{2}\right) \leq (1-\lambda) f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right] + \lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]$$

$$\leq \int_0^1 f\left[(1-t)A+tB\right]dt$$

$$\leq \frac{1}{2}\left[f\left((1-\lambda)A+\lambda B\right)+(1-\lambda)f(B)+\lambda f(A)\right]$$

$$\leq \frac{f(A)+f(B)}{2}. \tag{3}$$

Proof See[3].

Lemma 1.3 Let f be a real-valued function which is convex on the interval [a,b]. Then,

$$f\left(\frac{a+b}{2}\right) \leq \frac{1}{b-a}\int_a^b f(t)dt \leq \frac{1}{4}\left[f(a)+2f\left(\frac{a+b}{2}\right)+f(b)\right] \leq \frac{f(a)+f(b)}{2}. \tag{4}$$

Proof See[4].

Lemma 1.4 Let f be a real-valued function which is convex on the interval [a,b]. Then,

$$f\left(\frac{a+b}{2}\right) \leq \frac{1}{2}\left[f\left(\frac{3a+b}{4}\right)+f\left(\frac{a+3b}{4}\right)\right] \leq \frac{1}{b-a}\int_a^b f(t)dt \leq \frac{f(a)+f(b)}{2}.$$

(5)

Proof See[1].

2. Main Results

We present a refinement of the above Hermite-Hadamard inequalities (4) and (5) as follows.

Lemma 2.1 Let f be a real-valued function which is convex on the interval [a,b] and let n be a positive integer. Then,

$$f\left(\frac{a+b}{2}\right)\le\frac{1}{2}\left\{f\left[\frac{(2^n+1)a+(2^n-1)b}{2^{n+1}}\right]+f\left[\frac{(2^n-1)a+(2^n+1)b}{2^{n+1}}\right]\right\}$$

$$\le\frac{1}{b-a}\int_a^b f(t)dt\le\frac{1}{2(n+1)}\left[nf(a)+2f\left(\frac{a+b}{2}\right)+nf(b)\right]\le\frac{f(a)+f(b)}{2}.$$

Proof Since f is convex on [a, b], we have

$$f\left(\frac{a+b}{2}\right)\le\frac{f(a)+f(b)}{2}.$$

Thus,

$$\frac{1}{2(n+1)}\left[nf(a)+2f\left(\frac{a+b}{2}\right)+nf(b)\right]\le\frac{1}{2(n+1)}\left[nf(a)+f(a)+f(b)+nf(b)\right]$$

$$=\frac{f(a)+f(b)}{2}.$$

This completes the proof of the fourth inequality.

Using Hermite-Hadamard inequality, we have

$$f\left(\frac{a+b}{2}\right)=f\left[\frac{1}{2}.\frac{(2^n+1)a+(2^n-1)b}{2^{n+1}}+\frac{1}{2}.\frac{(2^n-1)a+(2^n+1)b}{2^{n+1}}\right]$$

$$=f\left[\frac{1}{2}.\frac{(2^n+1)a+(2^n-1)b+(2^n-1)a+(2^n+1)b}{2^{n+1}}\right]$$

$$\le\frac{1}{2}\left\{f\left[\frac{(2^n+1)a+(2^n-1)b}{2^{n+1}}\right]+f\left[\frac{(2^n-1)a+(2^n+1)b}{2^{n+1}}\right]\right\}.$$

This completes the proof of the first inequality.

To prove the second and the third inequalities, it is only needed to prove the following inequalities by Lemma 1.3 and Lemma1.4:

$$f\left[\frac{(2^n+1)a+(2^n-1)b}{2^{n+1}}\right]+f\left[\frac{(2^n-1)a+(2^n+1)b}{2^{n+1}}\right]\le f\left(\frac{3a+b}{4}\right)+f\left(\frac{a+3b}{4}\right)\qquad(6)$$

and

$$\frac{1}{2}\left[f(a)+2f\left(\frac{a+b}{2}\right)+f(b)\right]\le\frac{1}{n+1}\left[nf(a)+2f\left(\frac{a+b}{2}\right)+nf(b)\right].\qquad(7)$$

Next, we prove inequality (6) by induction. By Lemma 1.4, we have

$$f(a)+f(b)\ge f\left(\frac{3a+b}{4}\right)+f\left(\frac{a+3b}{4}\right).\qquad(8)$$

So, (6) holds trivially for the case n=1.

Now suppose the assertion (6) holds for the case n=k.

By the induction hypothesis and (8), we have

$$f\left(\frac{3a+b}{4}\right)+f\left(\frac{a+3b}{4}\right)\geq f\left[\frac{(2^k+1)a+(2^k-1)b}{2^{k+1}}\right]+f\left[\frac{(2^k-1)a+(2^k+1)b}{2^{k+1}}\right]$$

$$\geq f\left[\frac{3.\frac{(2^k+1)a+(2^k-1)b}{2^{k+1}}+\frac{(2^k-1)a+(2^k+1)b}{2^{k+1}}}{4}\right]+f\left[\frac{\frac{(2^k+1)a+(2^k-1)b}{2^{k+1}}+3.\frac{(2^k-1)a+(2^k+1)b}{2^{k+1}}}{4}\right]$$

$$=f\left[\frac{(2^{k+1}+1)a+(2^{k+1}-1)b}{2^{(k+1)+1}}\right]+f\left[\frac{(2^{k+1}-1)a+(2^{k+1}+1)b}{2^{(k+1)+1}}\right].$$

Hence,(6) holds for the case n=k+1.

Similarly, the inequality (7) holds by induction, so that the proof of Lemma 2.1 is complete.

Theorem 2.2 Let $f:I\to\mathbb{R}$ be an operator convex function on the interval I and let n be a positive integer. Then, for any self-adjoint operators A and B on a Hilbert space H with spectra in I, we have the inequality

$$f\left(\frac{A+B}{2}\right)\leq\frac{1}{2}\left\{f\left[\frac{(2^n+1)A+(2^n-1)B}{2^{n+1}}\right]+f\left[\frac{(2^n-1)A+(2^n+1)B}{2^{n+1}}\right]\right\}$$

$$\leq\int_0^1 f\left((1-t)A+tB\right)dt\leq\frac{1}{2(n+1)}\left[nf(A)+2f\left(\frac{A+B}{2}\right)+nf(B)\right]\leq\frac{f(A)+f(B)}{2}. \quad (9)$$

Proof Let $\chi\in H$ be a unit vector and two self-adjoint operators A and B with spectra in I. Define the real-valued function $\rho(t)=\left\langle f\left((1-t)A+tB\right)\chi,\chi\right\rangle$ on the interval [0,1].

Since f is an operator convex, then for any $t_1,t_2\in[0,1]$ and $\alpha,\beta\geq 0$ with $\alpha+\beta=1$, we have

$$\rho(\alpha t_1+\beta t_2)=\left\langle f\left((1-(\alpha t_1+\beta t_2))A+(\alpha t_1+\beta t_2)B\right)\chi,\chi\right\rangle$$

$$=\left\langle f\left(\alpha[(1-t_1)A+t_1B]+\beta[(1-t_2)A+t_2B]\right)\chi,\chi\right\rangle$$

$$\leq\alpha\left\langle f\left((1-t_1)A+t_1B\right)\chi,\chi\right\rangle+\beta\left\langle f\left((1-t_2)A+t_2B\right)\chi,\chi\right\rangle$$

$$=\alpha\rho(t_1)+\beta\rho(t_2).$$

So, $\rho(t)$ is a convex function on [0,1].

Applying Lemma 2.1 to the convex function $\rho(t)$ on [0,1], we have

$$\rho\left(\frac{1}{2}\right)\leq\frac{1}{2}\left[\rho\left(\frac{2^n-1}{2^{n+1}}\right)+\rho\left(\frac{2^n+1}{2^{n+1}}\right)\right]$$

$$\leq \int_0^1 \rho(t)dt \leq \frac{1}{2(n+1)}\left[n\rho(0)+2\rho\left(\frac{1}{2}\right)+n\rho(1)\right]$$
$$\leq \frac{\rho(0)+\rho(1)}{2}.$$

Hence,

$$\left\langle f\left(\frac{A+B}{2}\right)\chi,\chi\right\rangle \leq \frac{1}{2}\left\langle\left\{f\left[\frac{(2^n+1)A+(2^n-1)B}{2^{n+1}}\right]+f\left[\frac{(2^n-1)A+(2^n+1)B}{2^{n+1}}\right]\right\}\chi,\chi\right\rangle$$
$$\leq \int_0^1 \langle f((1-t)A+tB)\chi,\chi\rangle dt$$
$$\leq \frac{1}{2(n+1)}\left\langle\left[nf(A)+2f\left(\frac{A+B}{2}\right)+nf(B)\right]\chi,\chi\right\rangle$$
$$\leq \frac{1}{2}\langle[f(A)+f(B)]\chi,\chi\rangle. \tag{10}$$

Finally, by the continuity of the function f, we have

$$\int_0^1 \langle f((1-t)A+tB)\chi,\chi\rangle dt = \left\langle \int_0^1 f((1-t)A+tB)dt\chi,\chi\right\rangle \tag{11}$$

for any $\chi \in H, \|\chi\| = 1$ and any self-adjoint operators A and B with spectra in I.

Now (10) and (11) yield the whole inequalities (9) as desired.

Corollary 2.3 Under the assumption of Theorem2.2, if $n = 2$, then

$$f\left(\frac{A+B}{2}\right) \leq \frac{1}{2}\left[f\left(\frac{5A+3B}{8}\right)+f\left(\frac{3A+5B}{8}\right)\right]$$
$$\leq \int_0^1 f\left((1-t)A+tB\right)dt \leq \frac{1}{3}\left[f(A)+f\left(\frac{A+B}{2}\right)+f(B)\right] \leq \frac{f(A)+f(B)}{2}.$$

The following representation result is useful in the sequel.

Lemma 2.4 Let $f: I \to \mathbb{C}$ be a continuous function on the interval I and two self-adjoint operators A and B on a Hilbert space H with spectra in I. Then, for any $\lambda \in [0,1]$, we have the representation

$$\int_0^1 f((1-t)A+tB)dt = (1-\lambda)\int_0^1 f\left[(1-t)((1-\lambda)A+\lambda B)+tB\right]dt$$
$$+\lambda\int_0^1 f\left[(1-t)A+t((1-\lambda)A+\lambda B)\right]dt. \tag{12}$$

Proof See [3].

Theorem 2.5 Let $f : I \to \mathbb{R}$ be an operator convex function on the interval I and let n be a positive integer. Then, for any self-adjoint operators A and B on a Hilbert space H with spectra in I, we have the inequality

$$f\left(\frac{A+B}{2}\right) \le (1-\lambda) f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right] + \lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]$$

$$\le \frac{1-\lambda}{2}\left\{ f\left[\frac{(2^n+1)(1-\lambda)A+\left[(2^n+1)\lambda+(2^n-1)\right]B}{2^{n+1}}\right]\right.$$

$$\left. + f\left[\frac{(2^n-1)(1-\lambda)A+\left[(2^n-1)\lambda+(2^n+1)\right]B}{2^{n+1}}\right]\right\}$$

$$+\frac{\lambda}{2}\left\{ f\left[\frac{\left[(2^n-1)(1-\lambda)+(2^n+1)\right]A+(2^n-1)\lambda B}{2^{n+1}}\right]\right.$$

$$\left. + f\left[\frac{\left[(2^n+1)(1-\lambda)+(2^n-1)\right]A+(2^n+1)\lambda B}{2^{n+1}}\right]\right\}$$

$$\le \int_0^1 f\left((1-t)A+tB\right)dt \qquad (13)$$

$$\le \frac{1}{2(n+1)}\left\{\lambda n f(A)+(1-\lambda)n f(B)+n f\left[(1-\lambda)A+\lambda B\right]\right.$$

$$\left. +2(1-\lambda) f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]+2\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]\right\}$$

$$\le \frac{1}{2}\left\{ f\left[(1-\lambda)A+\lambda B\right]+(1-\lambda)f(B)+\lambda f(A)\right\} \le \frac{f(A)+f(B)}{2}.$$

Proof Using the Hermite-Hadamard inequality (9) we have

$$f\left(\frac{(1-\lambda)A+(1+\lambda)B}{2}\right)$$

$$= f\left(\frac{(1-\lambda)A+B+\lambda B}{2}\right)$$

$$\le \frac{1}{2}\left\{ f\left[\frac{(2^n+1)\left[(1-\lambda)A+\lambda B\right]+(2^n-1)B}{2^{n+1}}\right]+f\left[\frac{(2^n-1)\left[(1-\lambda)A+\lambda B\right]+(2^n+1)B}{2^{n+1}}\right]\right\}$$

$$\leq \int_0^1 f\left[(1-t)\{(1-\lambda)A+\lambda B\}+tB\right]dt \tag{14}$$

$$\leq \frac{1}{2(n+1)}\left[nf\left[(1-\lambda)A+\lambda B\right]+2f\left(\frac{(1-\lambda)A+\lambda B+B}{2}\right)+nf(B)\right]$$

$$\leq \frac{f\left((1-\lambda)A+\lambda B\right)+f(B)}{2}.$$

and

$$f\left(\frac{(2-\lambda)A+\lambda B}{2}\right)$$

$$= f\left(\frac{A+(1-\lambda)A+\lambda B}{2}\right)$$

$$\leq \frac{1}{2}\left\{f\left[\frac{(2^n+1)A+(2^n-1)\{(1-\lambda)A+\lambda B\}}{2^{n+1}}\right]+f\left[\frac{(2^n-1)A+(2^n+1)\{(1-\lambda)A+\lambda B\}}{2^{n+1}}\right]\right\}$$

$$\leq \int_0^1 f\left[(1-t)A+t\{(1-\lambda)A+\lambda B\}\right]dt \tag{15}$$

$$\leq \frac{1}{2(n+1)}\left[nf(A)+2f\left(\frac{A+(1-\lambda)A+\lambda B}{2}\right)+nf\left[(1-\lambda)A+\lambda B\right]\right]$$

$$\leq \frac{f(A)+f\left((1-\lambda)A+\lambda B\right)}{2}.$$

If we multiply inequality (14) by $1-\lambda$ and (15) by λ, add the obtained inequalities, and use representation (12), then we have

$$(1-\lambda)f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]+\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]$$

$$\leq \frac{1-\lambda}{2}\left\{f\left[\frac{(2^n+1)(1-\lambda)A+\left[(2^n+1)\lambda+(2^n-1)\right]B}{2^{n+1}}\right]\right.$$

$$\left.+f\left[\frac{(2^n-1)(1-\lambda)A+\left[(2^n-1)\lambda+(2^n+1)\right]B}{2^{n+1}}\right]\right\}$$

$$+\frac{\lambda}{2}\left\{f\left[\frac{\left[(2^n-1)(1-\lambda)+(2^n+1)\right]A+(2^n-1)\lambda B}{2^{n+1}}\right]\right.$$

$$\left.+f\left[\frac{\left[(2^n+1)(1-\lambda)+(2^n-1)\right]A+(2^n+1)\lambda B}{2^{n+1}}\right]\right\}$$

$$\leq \int_0^1 f\left((1-t)A+tB\right)dt$$

$$\leq \frac{1}{2(n+1)}\left\{\lambda n f(A)+(1-\lambda)n f(B)+n f\left[(1-\lambda)A+\lambda B\right]\right.$$

$$\left.+2(1-\lambda)f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]+2\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]\right\}$$

$$\leq (1-\lambda)\frac{f\left[(1-\lambda)A+\lambda B\right]+f(B)}{2}+\lambda\frac{f(A)+f\left[(1-\lambda)A+\lambda B\right]}{2},$$

which proves the inequality in (13) except the first and last inequalities.

By the operator convexity of f we have

$$(1-\lambda)f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]+\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]$$

$$\geq f\left[(1-\lambda)\frac{(1-\lambda)A+(1+\lambda)B}{2}+\lambda\frac{(2-\lambda)A+\lambda B}{2}\right]=f\left(\frac{A+B}{2}\right)$$

and

$$\frac{1}{2}\left\{f\left[(1-\lambda)A+\lambda B\right]+(1-\lambda)f(B)+\lambda f(A)\right\}$$

$$\leq \frac{1}{2}\left\{(1-\lambda)f(A)+\lambda f(B)+(1-\lambda)f(B)+\lambda f(A)\right\}=\frac{f(A)+f(B)}{2},$$

which proves the first and last inequality in (13). So, Theorem 2.5 is proved.

Remark 2.6 If we multiply $\int_0^1 f\left[(1-t)\left\{(1-\lambda)A+\lambda B\right\}+tB\right]dt$ by $1-\lambda$ and

$\int_0^1 f\left[(1-t)A+t\left\{(1-\lambda)A+\lambda B\right\}\right]dt$ by λ, then we obtain $\int_0^1 f\left((1-t)A+tB\right)dt.$

Proof For $\lambda=0$ and $\lambda=1$, the inequality is obvious.

Let $\lambda\in(0,1)$ observe that

$$\int_0^1 f\left[(1-t)\left\{\lambda B+(1-\lambda)A\right\}+tB\right]dt=\int_0^1 f\left[\left\{(1-t)\lambda+t\right\}B+(1-t)(1-\lambda)A\right]dt$$

and

$$\int_0^1 f\left[t\left\{\lambda B+(1-\lambda)A\right\}+(1-t)A\right]dt=\int_0^1 f\left[t\lambda B+(1-\lambda t)A\right]dt.$$

If we make the change of variable $u=(1-t)\lambda+t$, then we have $1-u=(1-t)(1-\lambda)$ and $du=(1-\lambda)dt.$

Then $\int_0^1 f\left[\{(1-t)\lambda+t\}B+(1-t)(1-\lambda)A\right]dt=\frac{1}{1-\lambda}\int_\lambda^1 f\left[uB+(1-u)A\right]du.$

If we make the change of variable $u=\lambda t$, then $du=\lambda dt$ and

$$\int_0^1 f\left[t\lambda B+(1-\lambda t)A\right]dt=\frac{1}{\lambda}\int_0^\lambda f\left[uB+(1-u)A\right]du.$$

Therefore,

$$(1-\lambda)\int_0^1 f\left[(1-t)\{(1-\lambda)A+\lambda B\}+tB\right]dt+\lambda\int_0^1 f\left[(1-t)A+t\{(1-\lambda)A+\lambda B\}\right]dt$$

$$=\int_\lambda^1 f[uB+(1-u)A]du+\int_0^\lambda f\left[uB+(1-u)A\right]du$$

$$=\int_0^1 f\left((1-u)A+uB\right)du.$$

By interchanging u and t, then we get

$$(1-\lambda)\int_0^1 f\left[(1-t)\{(1-\lambda)A+\lambda B\}+tB\right]dt+\lambda\int_0^1 f\left[(1-t)A+t\{(1-\lambda)A+\lambda B\}\right]dt$$

$$=\int_0^1 f\left((1-t)A+tB\right)dt.$$

Corollary 2.7 Under the assumptions of Theorem2.5, if $n=1,$ then

$$f\left(\frac{A+B}{2}\right)\le(1-\lambda)f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]+\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]$$

$$\le\frac{1-\lambda}{2}\left\{f\left[\frac{3(1-\lambda)A+(1+3\lambda)B}{4}\right]+f\left[\frac{(1-\lambda)A+(3+\lambda)B}{4}\right]\right\}$$

$$+\frac{\lambda}{2}\left\{f\left[\frac{(4-\lambda)A+\lambda B}{4}\right]+f\left[\frac{(4-3\lambda)A+3\lambda B}{4}\right]\right\}$$

$$\le\int_0^1 f\left[(1-t)A+tB\right]dt$$

$$\le\frac{1}{4}\left\{\lambda f(A)+(1-\lambda)f(B)+f\left[(1-\lambda)A+\lambda B\right]+2\lambda f\left[\frac{(2-\lambda)A+\lambda B}{2}\right]\right.$$

$$\left.+2(1-\lambda)f\left[\frac{(1-\lambda)A+(1+\lambda)B}{2}\right]\right\}$$

$$\leq \frac{1}{2}\left\{f\left[(1-\lambda)A+\lambda B\right]+(1-\lambda)f(B)+\lambda f(A)\right\} \leq \frac{f(A)+f(B)}{2}.$$

Conclusion

In this paper, we present several operator versions of the Hermite-Hadamard inequality for the operator convex function, which are refinements of some operator convex inequalities.

Acknowledgements

I would like to express my heartfelt gratitude to Rector **Dr Win Swe** and Pro-Rector **Dr Myo Myo**, Shwebo University for their permission to carry out the research and their encouragement. And then, I would like to thank **Dr Myint Myint Yee**, Professor and Head of Department of Mathematics and **Dr Swe Aye**, Professor, Department of Mathematics, Shwebo University, for their exhortation and helpful comments on this research.

References

[1] Burqan. A., (2016), "Improved Cauchy-Schwarz Norm Inequality for Operators", J.Math. Inequal., pp. 205-211.

[2] Dragomir, S. S., (2011), "Hermite-Hadamard Type Inequalities for Operator Convex Functions", Appl. Math. Comput., pp. 766-772.

[3] Dragomir, S. S., (2016), "Some Hermite-Hadamard Type Inequalities for Operator Convex Functions and Positive Maps", RGMIA Research Report Collection, pp.1-28.

[4] Feng. Y., (2012), "Refinements of the Heinz Inequalities", J.Inequal. Appl., pp.6-21.

Abundance of Bird Species in Southeastern Part of Chatthin Wildlife Sanctuary, Kanbalu Township, Sagaing Region

Myint Myint Pyone[1], Yu Yu Hnin[2], Htay Htay Win[3], Khin Maung Oo[4]

Abstract

The present study was carried out from December 2018 to July 2019. During the study period, total of 47 species belonging to 38 genera, 29 families under 11 orders of wildlife birds were recorded in southeastern part of Chatthin Wildlife Sanctuary. According the recorded data, the highest number of species was found during December and March whereas the lowest number of species was listed in July. The totals of 645 individuals were record at two sites in the study area. Hence, the highest number of 117 individuals was observed in December while the lowest number of 59 individuals was found in July. The number of 12 uncommon species, 17 common species and six very common species were recorded in Site I, the number of 18 uncommon species and 14 common species and five very common species were listed in Site II during the study period. Thus, Chatthin Wildlife sanctuary is one of the important areas in Myanmar for wildlife fauna including birds and more care for sustaining in this environ should be undertaken.

Key words: Wildlife bird, July, December

Introduction

Myanmar is one of the most biologically diverse regions in Asia (Wikramanyake *et al.*, 2001) and, unlike many other nations in South-east Asia, has been able to maintain large tracts of its natural habitats (Leimgruber *et al.*, 2003). In 1990, more than half of the remaining forests in mainland South-east Asia could be found in Myanmar (Dinerstein and Wikramanayake, 1993).

Chatthin is a secondary growth indaing forest with several seasonally flooded areas of open grassland and a seasonally large lake near the north-western edge of the WS. The W.S also includes three small villages and their associated farmland. The eastern, northern and western perimeter borders mainly rice paddies; the southern about secondary- growth forest. The indaing is deciduous dispterocarp forest dominated by the In; About two-thirds of the forest is low indaing with tree tops at 8-10 m, the remainder high indaing reaching 10-15m. In both, the canopy is open, 30-70%, and the forest floor has a mixture of shrubs and grass or mainly grass, never dense beneath the canopy. The shrub layer range from spare to moderate with a variety of other low shrubs and trees and In sprouting from root stocks (Zug *et al.*, 1998).

Avian fauna are also distributed in different area of world on the basis of using different habitat by different avian species its mean that different avian species are found in different area and not all avian species are exist in same area because every avian species use a different habitat from other species (Ahmad, 2011).

[1] Associate professor, Dr., Department of Zoology, Shwebo University
[2] Associate professor, Dr., Department of Zoology, Shwebo University
[3] Associate professor, Dr., Department of Zoology, Shwebo University
[4] Lecturer, Dr., Department of Zoology, Shwebo University

At present there are 38 designated and officially proposed protected areas, in Myanmar including 20 Wildlife Sanctuaries and Shwesettaw Wildlife Sanctuary happened to one among the established Wildlife Sanctuary and Chatthin Wildlife Sanctuary are now designated as priority sites for conservation investment in the Central Dry zone of Myanmar (Birdlife International, 2005).

The Chatthin Wildlife Sanctuary is one of 38 protected areas in Myanmar. In this area, the wild fauna is rich and wildlife flourishing in forests. The Sanctuary is also an important IBA but very few works has been done on avian fauna till date. Thus the site remains as a data deficient IBA .Hence, this area was selected as the following objectives:

- to identify bird species recorded in the study sites
- to study abundance of bird species in this area

Materials and Methods

Study area

Chatthin wildlife sanctuary is situated in the Kanbalu Township, Sagaing Region. Its geographical location is between Latitude 23º 34' 46" North and Longitude 95º 44' 26" East. The Chatthin Wildlife Sanctuary (CWS) covers an area of about 268.2 square kilometers.

Study sites and habitats

Total of two study sites were established such as young Indaing as study site I, and mixed deciduous as study site II. According to study site differences of habitats were recorded.

Study period

The present study was undertaken from December 2018 to July 2019.

Study method

Bird observations were made from 6:00 am to 10:00 am monthly. Binocular was used in the present survey to see birds from large distance easily and it is mostly used in wild life survey. The plumage, size, shape, posture, voice and behavior of birds were recorded. Photographs were taken to justify the species types which were difficult to identify. A few inconspicuous bird species were also identified based on their calls. Bird observations were recorded by slowly walking.

Point count method

Point count involved walking to and usually marking a particular spot and then recording all bird contacts for a pre-determined period before moving on to the next point. Five stations of point count were selected in each study site. At each point, ten minutes was stayed within 200m. Habitat data were recorded around each census station and investigate the presence or absence of individual bird species.

Analysis of data

Relative abundance is calculated as: Bisht *et al*. (2004)

$$\text{Relative abundance} = \frac{\text{Recorded number of individual of species}}{\text{Total number of individuals of all species}}$$

A relative abundance index of avian was determined. The abundance categories were: (1) <0.1, (2) 0.1,<0.05, (3) 0.05,> 0.05 . For each category, the following abundance score is given: 1 (uncommon), 2 (common), 3 (very common), respectively.

Identification

Bird identification follows Bird of Burma (Smythies, 2001), Bird of Myanmar (Kyaw Nyunt Lwin and Khin Ma Ma Thwin, 2003) and the Field Guide to the Birds of South-East Asia (Robson, 2007).

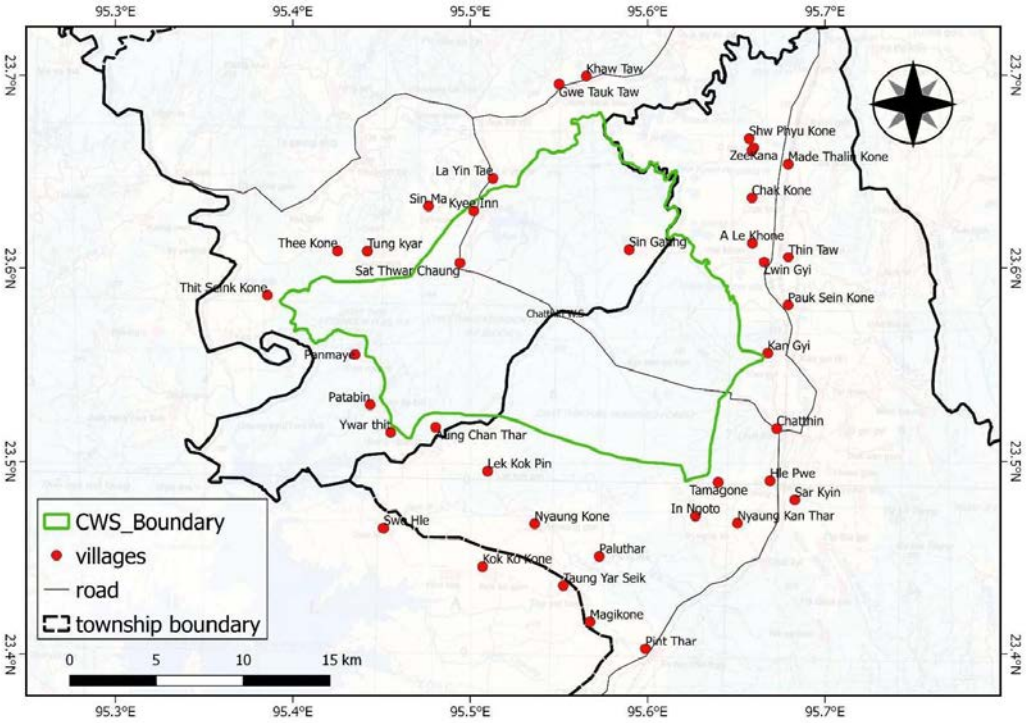


Figure 1. Map of the study area

(Source from Chatthin Wildlife Sanctuary)

Results and Discussion

The study area was chosen at Chattin Wildlife Sanctuary located in the southeastern part of Kanbalu Township, Sagaing region (Figure. 1). The study area was distinguished into two study sites. Each site was found to possess high structural plant diversity that provides different microhabitat for birds.

Thet Thet Tun (2010) observed a total of 105 species belonging to 74 genera, 25 families under 12 orders of birds were noted during the study period. She expressed species diversity of bird in Shwesettaw wildlife sanctuary, Magway Township, Magway Region.

In the present study, a total of 47 bird species confined to 38 genera, distributed among 29 families and 11orders were recorded during the study period from December 2018 to July 2019. Of these species, 21 species were confined to the only Order Passeriformes and remaining 26 species were non-passerine birds distributed among 11orders (Table. 1).

Among recorded data, the numbers of 25 species was noted in December, 18 species in January, 18 species in February, 25 species in March, 20 species in April, 20 species in May, 23 species in June and 16 species in July. Hence, the highest numbers of species was found during December and March whereas the lowest number of species was listed in July (Figure. 2, Table. 2).

Among the recorded data, the number of 12 uncommon species, 17 common species and six very common species were recorded in Site I, the number of 18 uncommon species and 14 common species and five very common species in Site II respectively (Figure. 4, Table. 4).

A total of 5211 individual of birds were detected from study sites, among which the highest number of bird species was recorded from mixed deciduous forest and indaing forest (Nay Myo Hlaing, 2016).

In present study, a total number of 645 individuals were listed in all study sites during the study period. The highest number of 396 individuals was observed in Site II while the lowest number of 249 individuals was noted in Site I (Figure. 3, Table. 3).

According to the recorded data, the highest number of 117 individuals was observed in December while the lowest number of 59 individuals was found in July.

During the study period, three woodpeckers were recorded from the young indang forest and hence appeared to be more compatible with the high canopied tree species this type of forest.

Since Chatthin wildlife sanctuary encompasses as vast area. Bird species might not occupy a place for long and because of their arboreal nature were free to move from one place to another as well so that observing a bird in a place was just a chance encounter.

There are all together 44 globally threatened birds species have recorded in Myanmar and a large proportion of these species are characteristics of forest ecosystems so major forest types support suitable places of globally threated species. Thus, Chatthin Wildlife Sanctuary is one of the important areas in Myanmar for wildlife fauna including birds and more care for sustaining in this environ should be undertaken.

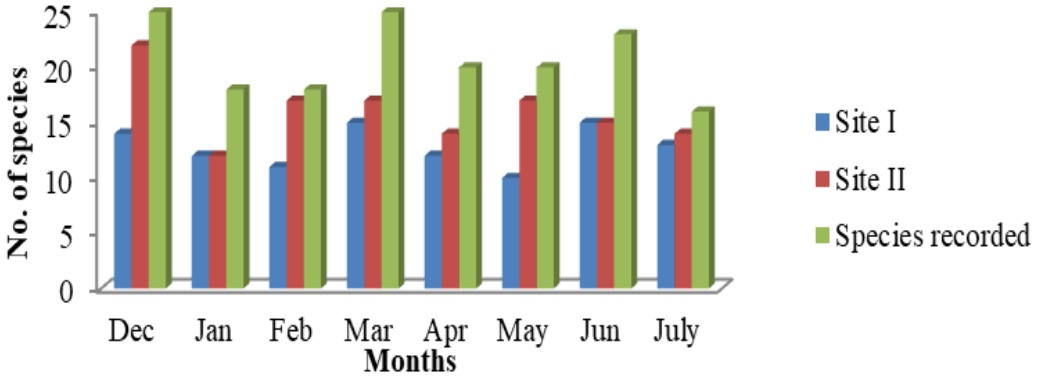


Figure 2. Number of species recorded in each month at the study sites

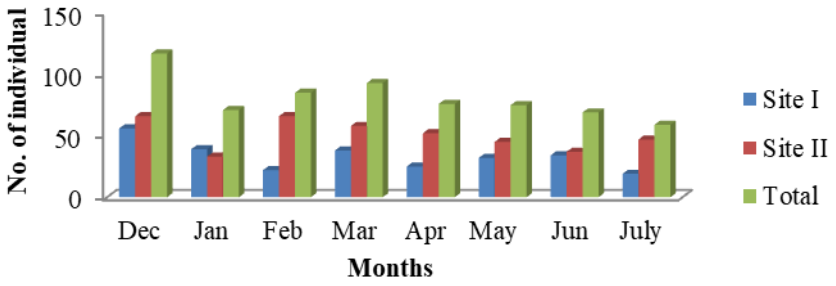


Figure 3. Recorded species of bird in the study sites

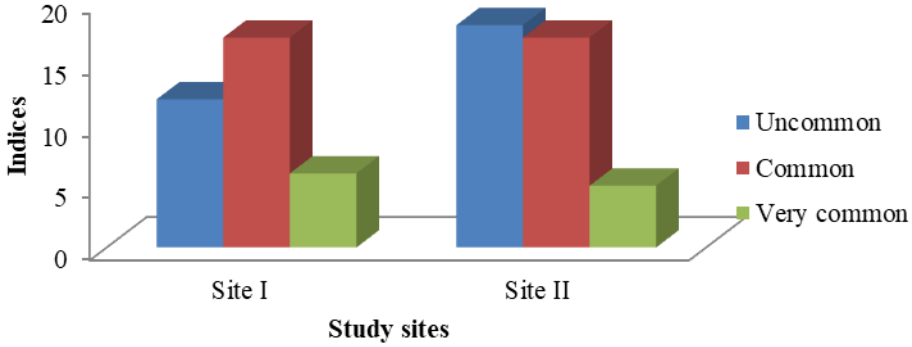


Figure 4. Relative abundance of species in each study sites

A. *Dendrocopos canicapillus*

B. *Dendrcopos mahrattensis*

C. *Dinopium javenense*

D. *Picus canus*

E. *Megalaima lineata*

F. *Psittacula eupatria*

Plate 1. Some recorded species in the study area

G. *Psittacula roseata*

H. *Psittacula alexandri*

I. *Alcedo atthis*

J. *Halcyon smyrnensis*

K. *Coracias benghaleness*

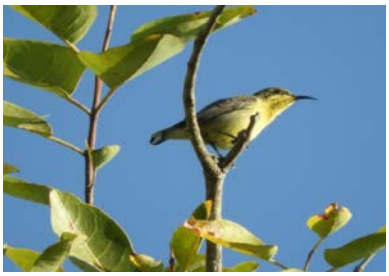
L. *Upupa epops*

M. *Streptopelia chinensis*

N. *Treron phoenicoptera*

O. *Sitta castanea*

P. *Dicaeum cruentatum*



Q.. *Nectarinia asiatica*

R. *Anthus hodgsoni*

S. *Polihierax insignis*

T. *Spizaetus cirrhatus*

U. *Accipiter badius*

Plate 1. Continued

V. *Spilornis cheela*

W. *Chloropsis aurifrons*

X. *Aegithina tiphia*

Y. *Coracina macei*

Z. *Tephrodonis pondiceriana*

A.A. *Pericrocotus cinnamomeus*

A.B.. *Pericrocotus flammeus*

A.C. *Pycnonotus blanfordi*

A.D. *Pycnonotus cafer*

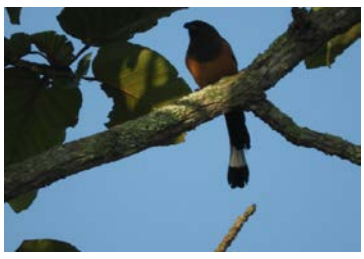
A.E.*Garrulax pectoralis*

A.F *Dicrurus macrocercus*

A.G *Dicrurus leucophaeus*

A.H. *Dicrurus paradiseus*

A.I. *Dicrurus hottentottus*



A.J. *Dendrocitta vagabunda*

Plate 1. Continued

A.K. *Rhipidura aureola*

A.L. *Ficedula parva*

A.M. *Hypothymis azurea*

A.N. *Oriolus chinensis*

A.O. *Oriolus xanthornus*

A.P. *Orthotomus sutorius*

A.Q. *Hirundo rustica*

A.R. *Hemiprocne coronata*

A.S. *Athene brama*

A.T. *Eudynamys scolopaceus*

A.U. *Vanellus indicus*

Plate 1. Continued

Table 1 Taxonomic status of recorded Wildlife bird species in the study area during the study period

Sr. No	Order	Family	Scientific name	Common name	Local name
1	Piciformes	Picidae	*Dendrocopos canicapillus*	Grey-capped pygmy woodpecker	Thit-tauk-hnget
2			*Dendrcopos mahrattensis*	Yellow-crowned woodpecker	Thit-tauk-hnget
3			*Dinopium javenense*	Common flameback	Thit-tauk-hnget
4			*Picus canus*	Grey-headed woodpecker	Thit-tauk-hnget
5		Megalaimidae	*Megalaima lineata*	Lineated barbet	hpo-gaung
6	Psittaciformes	Psittacidae	*Psittacula eupatria*	Alexandrine parakeet	kyet-taw
7			*Psittacula roseata*	Blossom-headed parakeet	kye-tama
8			*Psittacula alexandri*	Red-breasted parakeet	kalama-kyet-tu-ywe
9	Coraciiformes	Alcedinidae	*Alcedo atthis*	Common kingfisher	Bein-nyin
10			*Halcyon smyrnensis*	White-throated kingfisher	Bein-nyin
11		Coraciidae	*Coracias benghaleness*	Indian roller	hnget-hka
12		Upupidae	*Upupa epops*	Common hoopoe	Be-daung-bo
13	Columbiformes	Columbidae	*Streptopelia chinensis*	Spotted dove	Gyo-le-byauk
14			*Treron phoenicoptera*	Yellow-footed green pigeon	Bone-ma-ti
15	Caprimulgiformes	Sittidae	*Sitta castanea*	Chestnut-bellied nuthatch	Hnget-pya- chauk
16		Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed flowerpecker	
17		Nectariniidae	*Nectarinia asiatica*	Purple sunbird	Nan-pyi-soke
18		Motacillidae	*Anthus hodgsoni*	Olive-backed pipit	
19	Falconiformes	Falconidae	*Polihierax insignis*	white-rumped falcon	
20		Accipitridae	*Spizaetus cirrhatus*	Changeable hawk eagle	Gyo-thein
21			*Accipiter badius*	Shikra	Gyo-thein
22			*Spilornis cheela*	Crested serpent eagle	Lin-yone
23	Passeriformes	Irenidae	*Chloropsis aurifrons*	Golden-fronted leafbird	Hnget-sein
24			*Aegithina tiphia*	Commom iora	Shwe-pyisoe
25		Campephagidae	*Coracina macei*	Large-cuckooshrike	

Table 1. Continued

Sr.No	Order	Family	Scientific name	Common name	Local name
26			*Tephrodonis pondiceriana*	Common woodshrike	
27			*Pericrocotus cinnamomeus*	Small minivet	Hnget-mintha
28			*Pericrocotus flammeus*	Scarlet minivet	Hnget-mintha
29		Pycnonotidae	*Pycnonotus blanfordi*	Streak-eared bulbul	But-sa-mwe
30			*Pycnonotus cafer*	Red-vented bulbul	But-pin-pi
31		Turdoidinae	*Garrulax pectoralis*	Greater-necklaced laughingthrush	Wa-yaung-hnget
32		Dicruridae	*Dicrurus macrocercus*	Black drongo	Lin-mi-zwe
33			*Dicrurus leucophaeus*	Ashy drongo	Lin-mi-zwe
34	Passeriformes	Dicruridae	*Dicrurus paradiseus*	Greated racket-tailed drongo	Hnget-taw
35			*Dicrurus hottentottus*	Spangled drongo	Hnget-taw
36		Corvidae	*Dendrocitta vagabunda*	Rufoustreepie	Na-pha-gi
37		Rhipiduridae	*Rhipidura aureola*	White-browed fantail	Aung-sa
38		Muscicapidae	*Ficedula parva*	Red-throated flycatcher	
39		Monarchidae	*Hypothymis azurea*	black-naped monarch	Sa-me
40		Oriolidae	*Oriolus chinensis*	Black-naped oriole	Hnget-shwe-wa
41			*Oriolus xanthornus*	Black-hooded oriole	
42		Sylviidae	*Orthotomus sutorius*	Common tailorbird	
43		Hirundinidae	*Hirundo rustica*	Barn swallow	pyan-hlwa
44	Apodiformes	Hemiprocnidae	*Hemiprocne coronata*	Crested treeswift	pyan-hlwa
45	Strigiformes	Strigidae	*Athene brama*	Spotted owlet	zi-gwet
46	Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Asian koel	ok-aw
47	Charadriiformes	Charadriidae	*Vanellus indicus*	Red-wattled lawing	tit-ti-du

Table 2. Number of species in each study site during the study period

Sr.No	Month	Study sites		Species recorded
		Site I	Site II	
1	December	12	22	25
2	January	12	11	18
3	February	10	15	18
4	March	14	16	25
5	April	11	14	20
6	May	10	16	20
7	Jun	14	14	23
8	July	8	13	16

Table 3. Number of individual in each study site during the study period

Sr.No	Month	Study sites		
		Site I	Site II	Total
1	December	51	66	117
2	January	39	32	71
3	February	21	64	85
4	March	36	57	93
5	April	24	52	76
6	May	32	43	75
7	Jun	33	36	69
8	July	13	46	59
		249	396	645

Table 4. Relative abundance of species in each study site during the study period

Sr.No	Relative abundance indices	Study site	
		Site I	Site II
1	Uncommon	12	18
2	common	17	14
3	Very common	6	5
	Total	35	40

Conclusion

A total of 47 species belonged to 38 genera, 29 families under 11 orders of birds were noted during the study period. The highest number of 21 species was recorded in order Passeriformes while the lowest number one in order Psittaciformes, Apodiformes, Strigiformes, Cuculiformes and Charadriiformes. The highest number 25 species was counted in December and March while the lowest 16 species was noted in July. The total of 645 individuals was recorded at all sites in the study area. The highest number 117 was observed

in December while the lowest number 59 individuals in July The distribution and abundance of many bird species were determined by the composition of vegetation that formed a major element of their habitats. In the present study, it was revealed that local assemblages of bird species change in time as well as spatial and temporal.

Acknowledgements

I would like to express my heartful thanks to Dr Win Swe, Rector and Dr Myo Myo, Pro-Rector, Shwebo University for their encouragement to submit. Thanks are due to Dr Khin Than Htay, Professor (Head) and Dr Kyi Kyi Thaw Professor Department of Zoology for her permission and suggestions to work on this research.

References

Ahmad B. 2011. Habitat study of Alectoris chukar in distict Malakand. *B.Sc (Hons) Thesis*, Department of Forestry Shaheed Benazir Bhutto University Sheringal Dir, P.1-2.

Birdlife International. 2015 .The BirdLife checklist of the birds of the world, with conservation status and taxonomic sources.

Bisht, M.S., Kukreti, M. and Shantikhuson, 2004. Relative abundance and distribution of bird fauna of Garhwal Himalaya. *Eco.Env* & *Cons.*, 10(4): 251-460.

Dinerstein, E. &Wikramanayake, E. (1993) Beyond 'Hotspots': how to prioritize investments to conserve biodiversity in the Indo-Pacific region. *Conservation Biology* **7**: 53–65.

Kyaw Nyunt Lwin and Khin Ma MaThwin,2003. *Birds of Myanmar*. Swiftwinds Service Co.Ltd.Yangon, Myanmar.162. pp.

Leimgruber, P., Gagnon, J., Wemmer, C., Kelly, D., Songer, M.& Selig, E. (2003) Fragmentation of Asia's remaining wildlands: implications for Asian elephant conservation. *Animal Conservation* **6**: 347–359.

Nay Myo Hlaing, 2016. Avian community and their habitat use in the southern part of Alaungdaw Kathapa National Park. *Ph D Thesis*, Department of Zoology, University of Mandalay.

Robson, C., 2007. *A Field guide to the birds of Southeast Asia*. New Holland Publisher (UK) Ltd.

Smythies, B.E., 2001. *The Birds of Burma*. Oliver Boyd. Fourth edition. National History Publication (Borneo) 601pp.

Thet Thet Htun, 2010. Species diversity of birds in Shwesettaw Wildlife Sanctuary, Magway Region. *PhD Thesis*, Department of Zoology, University of Mandalay.

Wikramanayake, E., Dinerstein, E., Loucks,C., Olson,D., Morrison, J., Lamoreux, J., McKnight, M. & Hedao, P. (2001). *Terrestrial Ecoregions of Pacific:a Conservation Assessment.* Washington, DC, USA: Island Press.

George R. Zug, Htun Win, Thin Thin, Than Zaw Win, Win zaw Lhon, and Kyaw Kyaw (1998). Herpetofauna of the chathin wildlife Sanctuary, North-central Myanmar with Preliminary observation of Their Natural History. *Hamadryad* vol. 23, No. 2, pp.111-120

Assessment of some Microorganisms from Kyoe Kyar Dam, Shwebo Township, Sagaing Region

Htay Htay Win[1], Khin Hnin Thet[2], Myint Myint Pyone[3], Soe Soe[4], Yin Yin Seint[5]

Abstract

The research paper reported the composition of microorganisms found in water sample from Kyoe Kyar Dam and water quality. There were nine phyla, 15 classes, 18 orders, 23 families, 30 genera and 36 species of microorganisms in water sample and three groups of microorganisms were divided. In these phyla included phytoplankton, diatoms and zooplanktons groups. Among the three groups, the largest total genera percentage (%) were recorded 50.00% in zooplanktons group and 26.67% in phytoplanktons group and 23.33% in diatoms group during the study period. According to the results of the physical examination and chemical parameters were within the permissible limit as assigned by W.H.O. Standard except colour and turbidity. Thus, Kyoe Kyar Dam is recommended value for aquatic microorganisms and Dam environs. It may be concluded that Kyoe Kyar Dam can be assumed mesotrophic condition. The water quality in this dam is good condition. The results will provide a tool for biomonitoring aquatic status.

Key words: microorganisms, water quality, water quantity and Kyoe Kyar Dam.

Introduction

Microorganisms are found in the water of natural freshwater ponds, lakes, dam, streams, rivers and salt water. They can be observed blooming type under favorable conditions such as light, nutrients and environmental condition. Blooming microorganisms in the water give positive and negative effects of their environment and aquatic animals. Many researchers carried out the examining of microorganisms in lake for protection and management (Prok and Elleby, 2004).

Hans (1998) reported that phytoplankton and zooplankton are two of the common biological parameters collected because they form the base of the aquatic food web and influence other aspects of the lake including color and clarity of the water. Phytoplankton are widely present in freshwater environment, such as lakes and rivers where they are typically present as microorganisms-visible only with the aid of a light microscope. They have a major importance in the freshwater environment.

In an aquatic ecosystem, zooplanktons play a critical role not only for primary consumers but also serve as a source of higher organisms. Zooplanktons are useful indicator of future fisheries health because they are a food source of organisms at higher trophic levels. The biomass, abundance and diversity of zooplankton are used to determine the condition of aquatic environment (Davies *et al*., 2009).

Microorganisms in the water consist of protozoa, zooplanktons, cyanobacteria and microalgae and they coexist in the water. In aquatic environments such as ponds, lakes, rivers, innumerable living beings have their home (Carboni, 2009). Microorganisms are beneficial as well as harmful to aquatic organisms, domestic animals and human. Although

[1] Associate Professor, Dr, Department of Zoology, Shwebo University
[2] Associate Professor, Dr, Department of Zoology, Shwebo University
[3] Associate Professor, Dr, Department of Zoology, Shwebo University
[4] Lecturer, Dr, Department of Zoology, Shwebo University
[5] Lecturer, Dr, Department of Zoology, Shwebo University

microorganisms gave nutrient for aquatic animals and water body, excessive nutrients may turn the lake into eutrophic lake. Some eutrophic lake is harmful to aquatic animals and surface of water is nuisance and less gracious for resort people (Veronica, 2014).

Water quality is a term used to describe the chemical, biological, and physical characteristics of water. Water quality has become an important issue because of the increasing population size.

The water quality are pH, dissolved oxygen, biochemical oxygen demand, temperature, turbidity, conductivity, total alkalinity, total hardness, total dissolved solid and salinity.

The water stored dam is used for many purposes, such as for cattle to drink, domestic supplies, irrigation of crops, or driving turbines for electric power. In addition to all these functions, dam can also be used to grow fish.

Kyoe Kyar Dam is small earth filled dam in south east of Shwebo Township. This dam has a height of 6.1m, cover a length of around 1220 m, with actual storage capacity of water 289 acre feet. Kyoe Kyar Dam has been constructed at 1957-1958. In the flooded season, the water surface area is about 75 hectares. During the study period, the water depth ranges from 8.17 to 12.57 m.

The present study aims to investigate what kinds of microorganisms include Kyoe Kyar Dam, Shwebo Township. This research should be investigated to know whether microorganisms are relatively as beneficial or harmful to aquatic animals in this dam. Thus, it is under taken on the microorganisms in this dam according to the following objectives:

- to study and record the microorganisms found in Kyoe Kyar Dam,
- to understand the water quality in this dam,
- to know whether this dam is suitable for fish.

Materials and Methods

Study site and period

The study was undertaken at Kyoe Kyar Dam, Shwebo Township, Sagaing Region. It lies between N 22º 33′ 8.67″ and E 95º 49′ 1.39″. The area of the Dam is about 75 hectares (Plate.1). The study period was from June 2018 to June 2019.

Sample collections, Equipment and preparation methods

The water samples containing microorganisms were collected monthly from the study site of around Kyoe Kyar Dam of Shwebo Township.

Light microscope, beaker, micropipette and pointer were used. Firstly, each collected water sample of sterile plastic bottles was placed settable for sedimentation. Secondly, after sedimentation of these water samples, the supernatant and bottom water of each sterile plastic bottles were carefully put in beaker. Thirdly, after carefully stirring water sample in beaker, 0.1 ml (one drop of water) was collected with micropipette and placed on a glass slide and then covered by cover slip for the observation of microorganisms.

The taxonomic identification was made immediately after preparation of water sample. Carefully examined by counting the number of cells under light microscope (with the magnification of x100 and x400); at least 5 slides were observed.

Microorganisms were identified down to the genus and species level according to Desikachary (1959), Edmondson (1966) and Bellinger and Sigee (2010).

Water analysis

The analysis of water was made in the Laboratory of Water Supply and Sanitation Department, Mandalay City Development Committee (MCDC) for determination of physicochemical factors.

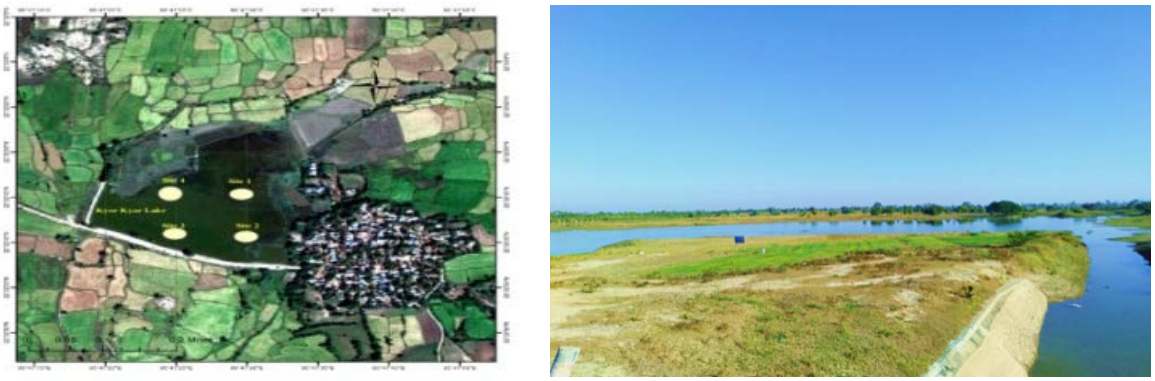


Plate.1. Kyoe Kyar Dam and Location map of Kyoe Kyar Dam (Source: Google earth, 2018)

Results

In the presents study, there were nine phyla, 15 classes, 18 orders, 23 families, 30 genera and 36 species of microorganisms were recorded in water sample of Kyoe Kyar Dam, Shwebo Township. Classification of microorganisms in water sample from Kyoe Kyar Dam, Shwebo Township was shown in Table 1 and microorganisms in water sample from this dam in terms of grouping by genera names was shown in Table 2.

There are three groups of microorganisms such as phytoplanktons, diatoms, and zooplanktons were divided and total classification of microorganisms under three groups was also shown in Fig. 1. Composition of microorganisms under three groups in terms of genera was also shown in Fig. 2. There are four genera of phylum Chlorophyta, (Plate 2), four species of two genera of Euglenophyta and two genera of Cyanophyta (Plate 2) and seven genera of Chrysophyta, (Plate 2), three genera of Protozoa, two genera of Amoebozoa and Ciliophora, (Plate 2), eight species of zooplankton under the phylum Rotifera and Arthropoda (Plate 2) were identified in this study site.

During the study period, pH values of water ranged between 7.1 and 8.1. Water temperature varied from 22º C to 34º C at the time of collection. Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) values recorded 5.68 mg/1 and 4.90 mg/1 respectively (Appendix).

Table 1. Classification of microorganisms in water sample from Kyoe Kyar Dam, Shwebo Township

Phylum	Class	Order	Family	Genus	Species
Chlorophyta	Chlorophyceae	Heterococcales	Centritractaceae	*Centritractus*	*C. dubius*
		Chlamydomonadales	*Haematococaceae*	*Haematococcus*	*Haematococcus* sp.
		Chlorococcales	Oocystaceae	*Tetraedron*	*T. trigonum*
					Tetraedron sp.
				Oocystis	*Oocystis* sp.
Euglenophyta	Euglenophyceae	Euglenales	Euglenaceae	*Trachellomonas*	*Trachellomonas* sp.
				Euglena	*E. acus*
					E. spirogyra
					E. oxyuris
					E. viridis
Cyanophyta	Cyanophyceae	Chroococcales	Chroococcaceae	*Microcystis*	*Microcystis* sp.
		Oscillatoriales	Oscillatoriaceae	*Oscillatoria*	*Oscillatoria* sp.
Chrysophyta	Bacillariophyceae	Bacillariales	Naviculaceae	*Neidium*	*Neidium* sp.
	Coscinodiscophyceae	Thalassiosirales	Thalassiosiraceae	*Thalassiosira*	*T. specules*
				Caloneis	*C. amphisbaena*
			Fragilariaceae	*Synedra*	*Synedra* sp.
			Ochromonadaceae	*Pinnularia*	*Pinnularia* sp.
			Nitzschiaceae	*Nitzschia*	*Nitzschia* sp.
		Tabellariales	Tabellariaceae	*Diatoma*	*Diatoma* sp.1

Table 1. Continued

Phylum	Class	Order	Family	Genus	Species
					Diatoma sp. 2
Protozoa	Rhizopoda	Actinophyridia		*Acanthocystis*	*Acanthocystis* sp.
	Sarcodina	Chrysomonodina		*Dinobryon*	*Dinobryon* sp.
	Filosa	Tricladida	Difflugiidae	*Difflugia*	*Difflugia* sp.
	Lobosea	Arcellinida	Crcellinidae	*Centropyxis*	*C.delicatula*
Amoebozoa	Tubulinea	Arcellinida	Arcellidae	*Arcella*	*Arcella* sp.
Ciliophora	Ciliata		Parameciidae	*Paramecium*	*P. caudatum*
	Spirotrichea	Peritrichida	Vorticellidae	*Vorticella*	*Vorticella* sp.
Rotifera	Monogononta	Ploima	Brachionidae	*Notholca*	*Notholca* sp. 1
					Notholca sp. 2
	Eurotatoria		Notommatidae	*Cephalodella*	*Cephalodella* sp.
			Mytilinidae	*Mytilina*	*Mytilina* sp.
		Floscullariaceae	Hexarthridae	*Hexarthra*	*Hexarthra* sp.
			Lecanidae	*Monostyla*	*M. bulla*
Arthropoda	Branchiopoda	Cladocera	Cyclopidae	*Macrocyclop*	*Macrocyclop* sp.
				Mesocyclops	*Mesocyclops* sp.
				Microcyclop	*Microcyclop* sp.

Table 2. Microorganisms in water sample from Kyoe Kyar Dam in terms of grouping by genera names

No	Genera names of groups		
	Phytoplanktons	Diatoms	Zooplanktons
1	*Centritractractus*	*Neidium*	*Acanthocystis*
2	*Haematococcus*	*Thalassiosira*	*Dinobryon*
3	*Tetraedron*	*Caloneis*	*Diffugia*
4	*Oocystis*	*Synedra*	*Centropyxis*
5	*Trachellomonas*	*Pinnularia*	*Arcella*
6	*Euglena*	*Nitzschia*	*Paramecium*
7	*Miccrocystis*	*Diatoma*	*Vorticella*
8	*Oscillatoria*		*Notholca*
9			*Cephalodella*
10			*Mytilina*
11			*Hexarthra*
12			*Monostyla*
13			*Macrocyclop*
14			*Mesocyclop*
15			*Microcyclop*
Total	8	7	15

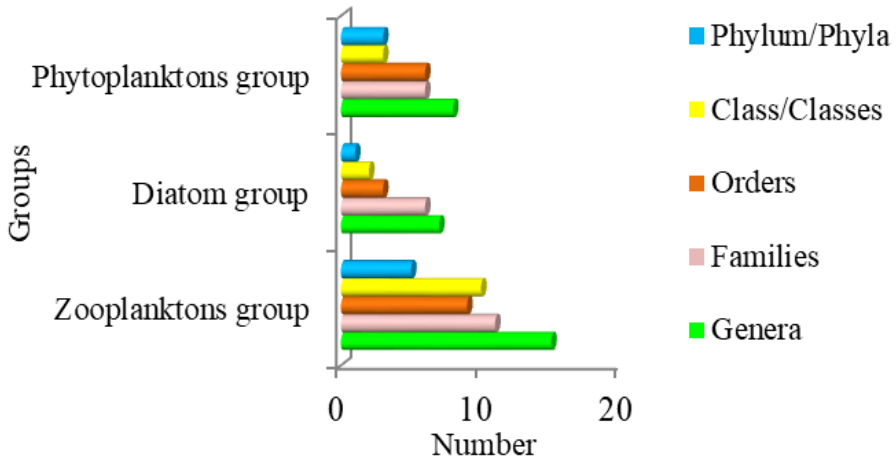


Fig. 1 Total classification of microorganisms under three groups

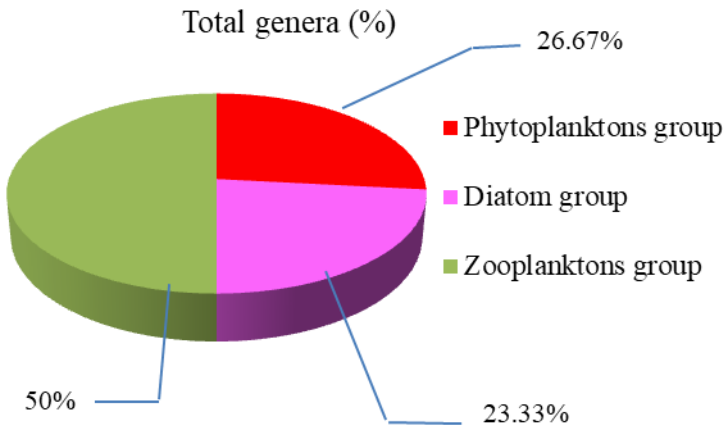
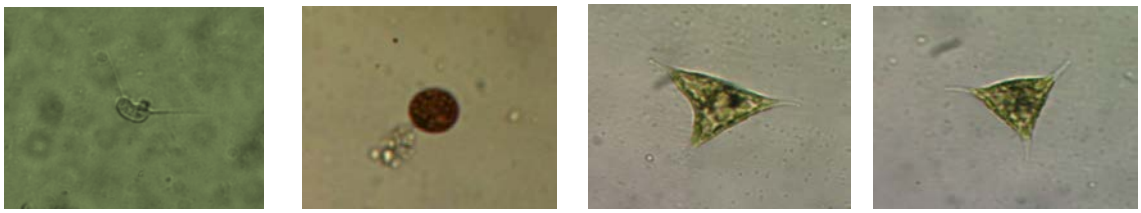
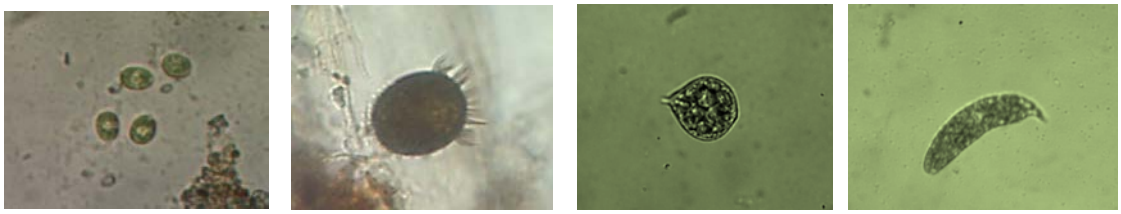


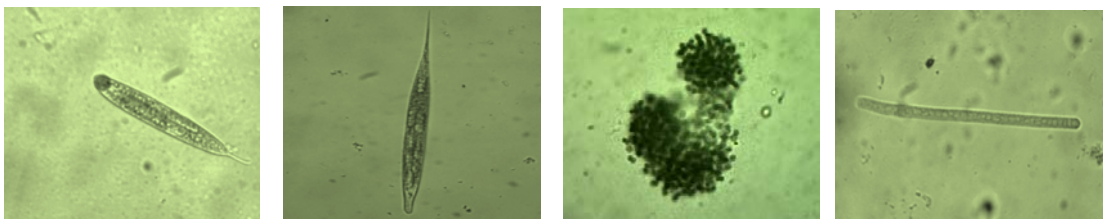
Fig. 2 Composition of microorganisms under three groups in terms of genera



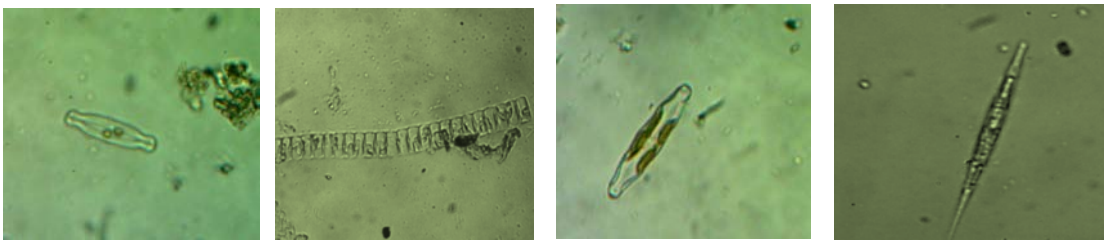
A. *Centritractus dubius* B. *Haematococcus* sp. C. *Tetraedron trigonum* D. *Tetraedron* sp.



E. *Oocystis* sp. F. *Trachellomonas* sp. G. *Euglena acus* H. *Euglena spirogya*

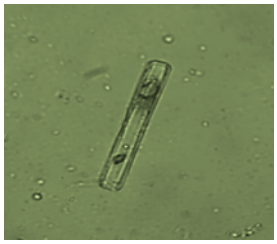


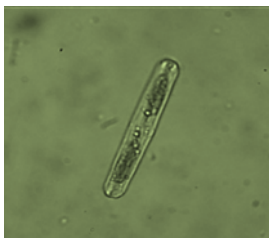
I. *Euglena viridis* J. *Euglena oxyuris* K. *Microcystis* sp. L. *Oscillatoria* sp.

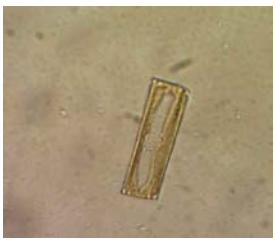


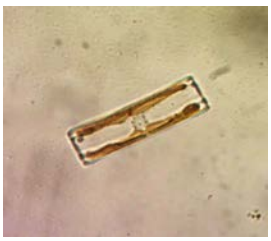
M. *Neidium sp.* N. *Thalassiosira* sp. O. *Caloneis amphisbaena* P. *Synedra* sp.

Plate 2 Microorganisms under phyla Chlorophyta, Cyanophyta, Euglenophyla and Chrysophyta in Kyoe Kyar Dam (x400)

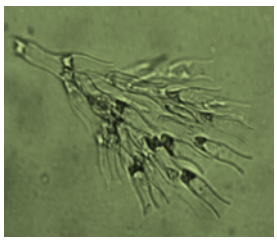

Q. *Pinnularia* sp.

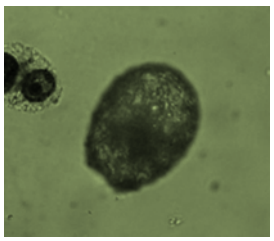

R. *Nitzzchia* sp.

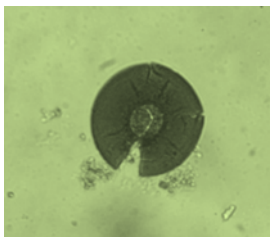

S. *Diatoma* sp. 1

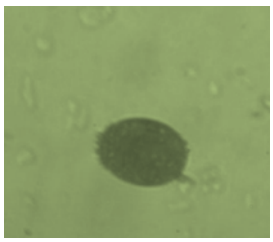

T. *Diatoma* sp.2

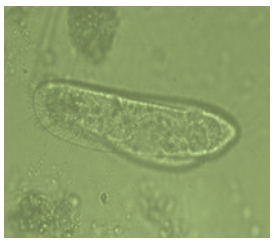

U. *Acanthocystis* sp.

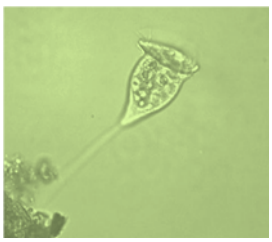

V. *Dinobryon* sp.


W. *Difflugia* sp.


X. *Centropyxis delicatula*


Y. *Arcella* sp.


Z. *Paramecium caudatum*

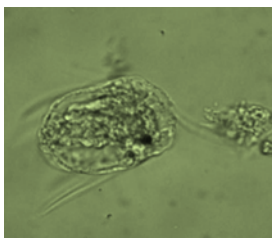

AA. *Vorticella* sp.

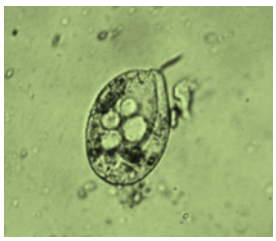

AB. *Notholca* sp.

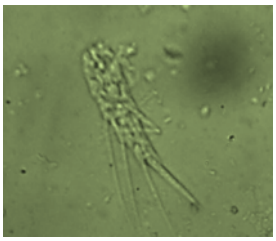

AC. *Notholca* sp

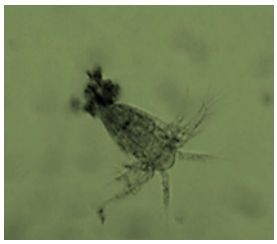

AD. *Cephalodella* sp.


AE. *Mytilina* sp.


AF. *Hexarthra* sp.


AG. *Monostyl abulla*


AH. *Macrocyclop* sp.


AI. *Microcyclop* sp.

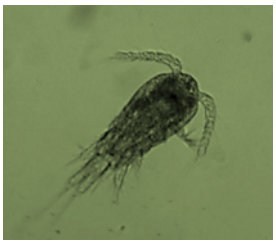

AJ. *Mesocyclop* sp.

Plate 2 Microorganisms under phyla Chrysophyta, Protozoa, Amoebozoa and Ciliophota in Kyoe Kyar Dam (x400)

Discussion

This research paper was investigated that assessment of microorganisms found in Kyoe Kyar Dam, Shwebo Township and the dominant species of microorganisms found in water sample were determined.

Three groups of microorganisms were found. They are phytoplankton's group (phyla Chlorophyta, Euglenophyta and Cyanophyta), diatoms group (phylum - Chrysophyta), and zooplanktons group (phyla Protozoa, Amoebozoa, Ciliophora, Rotifera and Arthropoda,). Among three groups, the largest total genera percentage 50.00% in zooplanktons group followed by 26.67% in phytoplankton group and 23.33% in diatoms group was also recorded. According to the results zooplanktons group was dominant genera in Kyoe Kyar Dam. The similar results are observed by Myat Khaing Myo (2015) who recorded zooplantons 77 species and 47 genera in Kyoe Kyar Dam.

The results of microorganism's composition were found nearly the same and significantly not different. In food chain, phytoplankton is eaten by herbivores (such as zooplankton) which will also be eaten by larger carnivores (fish and others) and etc. (Veronica *et al.* 2014).

There are altogether 30 genera in the water sample. The largest 15 genera (50.00%) recorded in zooplanktons group. It may be assumed that they are suspended in water and have the power of quickly locomotion or active swimmers. This result indicated that zooplanktons group may be more dominant species than the others in the water of Kyoe Kyar Dam. And then the results of highest genera are recorded. Therefore, it can be concluded that fertilized water body is suitable for fish species to live in Kyoe Kyar Dam. Das *et al*., 2012 reported that live foods include both phytoplanktonic as well as zooplanktonic organisms.

The second large eight genera (26.67%) were also recorded in phytoplankton groups. To date there are different kinds of phytoplankton used for the supplement of live fish food because of their excellent nutrient composition and digestibility. They have also high protein content which is abundant in nature. In addition, phytoplankton can affect the production of zooplankton and consequently the production of fish. Thus, the herbivores and omnivorous fish in this dam are ready to feed natural live food. Phytoplankton is the primary producer in the water, and it is also one of the life sources for all animals (Veronica, 2014). Euglenophyta association with increased level of dissolved organic; euglenoids have been used as environmental indicators of such conditions (Ghavzan *et al*., 2014). In the present study, two genera and four species of Euglenophyta were found in study site. This finding revealed the eutrophication condition. This result was agreed with Khin Myint Myint Tin (1992).

In addition, seven genera (23.33%) were recorded in diatoms group. This result indicated that the water quantity of Kyoe Kyar Dam is in oligotrophic condition. Phylum Cryophytes have traditionally been held to indicate oligotrophic conditions (Bellinger and Sigee, 2010). The results were agreed with Moe Kyi Han, 2010 and she reported that diatoms are a type of mainly aquatic photosynthetic algae. Diatoms group supports the supplement of live food for some fingerlings fish species that live in this dam (Carboni, 2009).

This research was investigated that assessment of microorganisms found in of Kyoe Kyar Dam, and the dominant species of microorganisms found in water sample were determined. The result indicated the water quality and quantity of this dam and whether these facts are suitable or not for resort people coming to Kyoe Kyar Dam.

Different kinds of species and wiggle in drops of water were observed from study site. Phytoplanktons are microscopic plants that live in all healthy aquatic systems including freshwater ponds and lakes (Conte and Cubbage, 2001).

Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) values recorded 5.68 mg/l and 4.90 mg/land respectively (Appendix).

During the study period, pH values of water ranged between 7.1 and 8.1. Water temperature varied from 22˚C to 34˚C at the time of collection.

Bera *et al*. (2014) reported that the life candle of aquatic organisms depend on dissolved oxygen (DO) which governs to the aquatic life fruitfully. Yeole and Patil (2005) reported a high pollution load may also decrease the DO value to a considerable level. In the present findings, DO concentrate 5.68 mg/L in Kyoe Kyar Dam. This DO value is within the permissible level.

Ezeanya *et al*., (2015), the permissible value of BOD in land water is 3mg/l and 20mg/L. In this studied dam, the recorded value of BOD is permissible value.

In this research, the physical examination of pH value in water sample is 7.1 - 8.1 and 7- 8.5 in W.H.O. Standard. The measurement of pH is to know acidity or alkalinity of water and the pH scale 7 is neutral. The result shows that pH value of water is suitable for aquatic microorganisms and Kyoe Kyar Dam environs. The colour (Units) of this dam water sample is > 50, and 5 in desirable W.H.O. Standard, but imperative is 50. The result shows that the colour of water is in imperative condition compared to W.H.O. Standard. The turbidity (N.T.U) of water sample in this dam is 126 and 5 in desirable and 25 in imperative in W.H.O. Standard. The result also shows more than imperative condition compared to W.H.O. Standard. The conductivity (micros/cm) is show as 561 from result examination.

The chemical analysis of Calcium as Ca is 21 and 75 in desirable and 200 in imperative in W.H.O. Standard. The total hardness ($CaCo_3$) is 80 and 100 in desirable and 150 in imperative in W.H.O. Standard. Magnesium as Mg is 6 and 30 in desirable and 150 in imperative in W.H.O. Standard. Chloride as CL is 25 and 200 in desirable and 600 in imperative in W.H.O. Standard. Total alkalinity is 180 and 200 in desirable and 500 in imperative in W.H.O. Standard. Total iron (Fe) is >0.2 and 0.1 in desirable and 1.0 in imperative in W.H.O. Standard. Manganese (Mn) is 0.03 and 0.05 in desirable and 0.5 in imperative in W.H.O. Standard. Sulphate (So_4) is <200 and 200 in desirable and 400 in imperative in W.H.O. Standard. The result values of all chemical analysis are within the acceptable range and permissible value.

The physicochemical parameters of freshwater are important to the population of microorganisms in the water. The present finding shows that physicochemical parameters of water are suitable for aquatic microorganisms except colour and turbidity.

The results of recorded microorganisms were different genera and number percentage of microorganisms may be assumed that the duration of research period, temperature and environmental conditions varied. This result depended on the content of microorganisms in collected water sample. It is possible that whether they may be scarcely present in dam or these microorganisms might not be seen under light microscope when examined. Nevertheless, many microorganism communities are altogether observed in this dam. The microorganisms serve as the base of the aquatic food web, providing an essential ecological function for all aquatic lives. They have high protein content which is abundant in nature of Myanmar.

Duigan *et al*. (2008) reported that mesotrophic lake is intermediate in most characteristics between oligotrophic and eutrophic stages. However, Kyoe Kyar Dam may be assumed as mesotrophic character.

Conclusion

The research paper concluded that three groups of microorganisms such as phytoplankton's, diatoms and zooplanktons were found in Kyoe Kyar Dam, Shwebo Township. The dominant group or genera of microorganisms found in water sample was zooplanktons, followed by phytoplanktons and diatoms groups. According to the results of the physical examination and chemical analysis, water of Kyoe Kyar Dam has permissible value for aquatic microorganisms. According to the results mentioned above, this dam can be assumed non-polluted still now and in mesotrophic condition. The water quality and quantity in this dam are in suitable conditions for resort people coming to Kyoe Kyar Dam, Shwebo Township. The results will provide a tool for biomonitoring of aquatic status and environmental health in natural aquatic ecosystem.

Acknowledgements

Our special thanks go to Dr Win Swe, Rector and Dr Myo Myo, Pro-rector, Shwebo University for given our a permission to undertake this research project. Our deepest thanks go to Dr Khin Than Htay Professor and Head and Dr Kyi Kyi Thaw, Professor, Department of Zoology, Shwebo University for hiring the apparatus to accomplish with regard to this research paper.

References

Bellinger, E.G. and Sigee, D.C., (2010), *Freshwater algae*: Identification and use as bioindicators. John Wiley & Sons, Ltd, United States of America.

Bera, A., Dutta, T.K., Patrra, B.C. and Sar, U.K., (2014), Physico-chemical profile of Kangsabati reservoir, west Bengal, India. *International Journal of Advanced Research*, 2(10):394-403.

Carboni, G., (2009), Small freshwater organisms. *The freshwater life*. Fun Science Gallery, Available from: http://www.funsci.com/fun3-en/protists/entrance.htm

Conte, F.S. and Cubbage, J.S., (2001), Phytoplankton and recreational ponds. *Western Regional Aquaculture Centre*.105: 1-5.

Das, P., Mandal, S.C., Bhagabati, S.K., Akhtar, M.S. and Singh, S.K., 2012. Important Live Food Organisms and Their Role in Aquaculture. *Frontiers in Aquaculture*, Narendra Publishing House.69–86.

Davies, T.W., Berry, D.L., Boyer, G.L. and Gobler, C.J., (2009), The effects of temperature and nutrients on the growth and dynamics of toxic and non-toxic strains of Microcystis during cyanobacteria blooms. *Harmful Algae*, 8, 715-725. *Journal homepage: www.elsevier.com/locate/hal*.

Desikachary, T.V., (1959), *Cyanophyta*. Indian Council of Agricultural Research New Delhi.

Duigan, C., Kobach, W. & Palmer, M. (2008), *Aquatic macrophyte classification, distribution and traits in British lakes.* Verh, Internat. Berein.Limnol, 30:477-481.

Edmondson, W.T., (1966), *Freshwater Biology*. John Wiley & Sons, Inc. United States of America.

El-Adly, A.A., El-Senousy, W.M., Samhan, F.A. and Mohamed M.B., (2008), Photothermal Efficiency of Gold Nanorods in Controlling Microorganisms in Water. *Journal of Applied Sciences Research.*4: (12) 1811-1816.

Ezeanya NC, Chukwuma GO, Nwaigwe RN and Egwuonwu C.L., (2015), *International Journal of Research in engineering and technology*, 4(3).

Ghavzan, N.J., Gunale, V.R, and Trivedy, R. K., (2006), *Limnological evaluation of an irban fresh water river with special reference to phytoplankton*, Pollute Res, 25 (2): 259-268.

Hans,W.P., (1998), *Growth and Reproductive Strategies of Freshwater Phytoplankton*. Growth and Reproductive Strategies of Freshwater Blue-Green Algae (Cyanobacteria). Cambridge University Press, Cambridge.

Khin Myint Myint Tin, (1992), Algal flora of Mandalay Moat. *MSc Thesis,* Department of Botany, University of Mandalay.

Moe Kyi Han, (2010), Study on length-weight and condition factor relationship of rohu, *Labeo rohita* (Hamiliton-Buchanan, 1822). *Departmental research.* Depatrment of Zoology, University of Taunggyi.

Myat Khaing Myo, (2015), Zooplankton variability under different environmental factors of Nampha In (Lake), Kachin State. *PhD Thesis*, Department of Zoology, University of Mandalay.

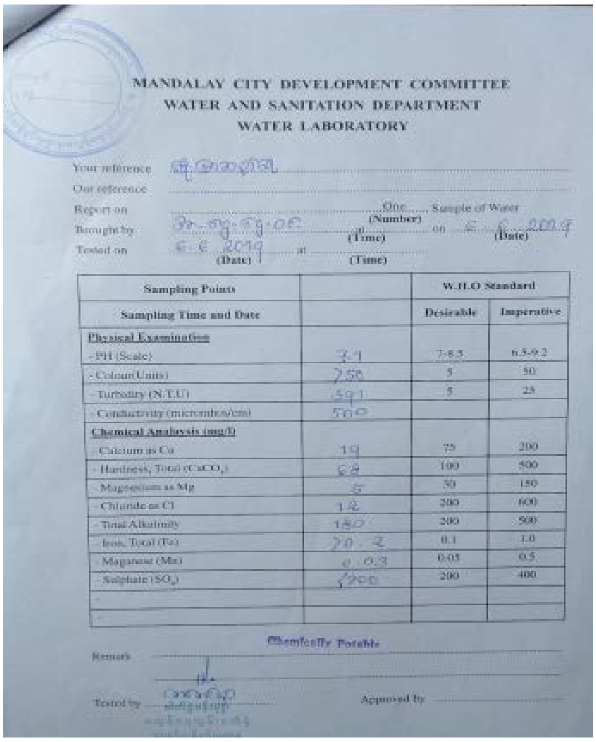
Prok, J. and Elleby, B., (2004), Lake Protection and Management. *Second Edition.*

Veronica, E., Leksono, A.S., Soemarno, Arfiati, D., (2014), Effect of water quality on phytoplankton abundance in Hampapamriver and fish pond of Batanjung village. *Journal of environmental Science, Toxicology and food technology* (IOSR-JESTFT), 8:1:1. 15-21.

World Health Organization (WHO), (2003), Guidelines for safe recreational water environments. Volume I, *Coastal and Fresh Water*. WHO, Geneva, Switzerland.

Yeole, S.M. and Patil, G.P., (2005), Physico-chemical status of Yedshilake in relation to water pollution. *J. Aqua, Biol*., 20(1):41-44.

Appendix



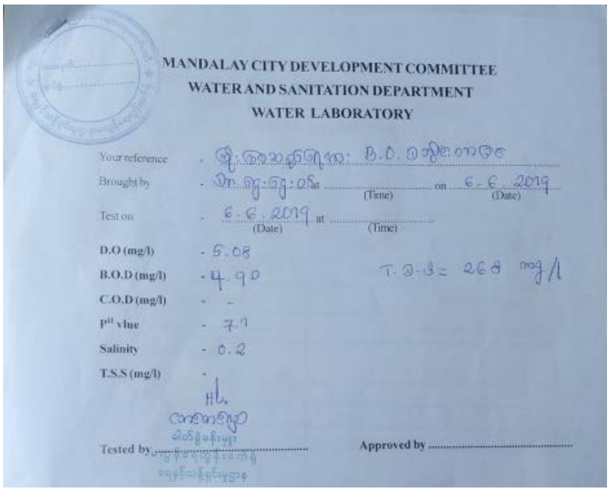
MANDALAY CITY DEVELOPMENT COMMITTEE
WATER AND SANITATION DEPARTMENT
WATER LABORATORY

Your reference
Our reference
Report on .... One (Number) ..... Sample of Water
Brought by .... at .... (Time) on 6.6.2019 (Date)
Tested on 6.6.2019 (Date) at .... (Time)

Sampling Points		W.H.O Standard	
Sampling Time and Date		Desirable	Imperative
Physical Examination			
- PH (Scale)	7.1	7-8.5	6.5-9.2
- Colour(Units)	250	5	50
- Turbidity (N.T.U)	591	5	25
- Conductivity (micromhos/cm)	500		
Chemical Analysis (mg/l)			
- Calcium as Ca	19	75	200
- Hardness, Total ($CaCO_3$)	68	100	500
- Magnesium as Mg	5	50	150
- Chloride as Cl	12	200	600
- Total Alkalinity	180	200	500
- Iron, Total (Fe)	>0.2	0.1	1.0
- Maganese (Mn)	<0.03	0.05	0.5
- Sulphate (SO_4)	<200	200	400
-			
-			

Remark: Chemically Potable

Tested by .... Approved by ....



MANDALAY CITY DEVELOPMENT COMMITTEE
WATER AND SANITATION DEPARTMENT
WATER LABORATORY

Your reference - .... B.O. ....
Brought by - .... at .... (Time) on 6.6.2019 (Date)
Test on - 6.6.2019 (Date) at .... (Time)

D.O (mg/l) - 5.08
B.O.D (mg/l) - 4.90
C.O.D (mg/l) - -
P[H] vlue - 7.7
Salinity - 0.2
T.S.S (mg/l) -

Tested by .... Approved by ....

Relative Abundance of Freshwater Fishes in Ayeyarwady River Segment between Ma Khauk Village and Shein Makar Village, Kyauk Myaung Township, Sagaing Region

Kyi Kyi Than[1], Khin Hnin Thet[2], Ko Lay[3], Kay Thi Khin[4], Bhwan Htam[5]

Abstract

A total number of 47 species of 36 genera distributed among 20 families and ten orders of freshwater fishes were recorded. During the study period, species composition was the highest in the order Cypriniformes (40.43 and the lowest (2.13%) each in Osteoglossiformes, Anguilliformes, Mugiliformes, Beloniformes and Tetraodontiformes. The highest number of species were recorded in September and October (47 species) and the lowest in February, March and April (28 species). Throughout the study period, total number of individual (596979) were recorded. *Gudusia variegata* was recorded as the highest total numbers of individuals (104780) and *Leiodon cutcutia*was recorded as the lowest number of individual (33) were observed. *Anguilla bengalensis*was collected only 35 numbers. Based on the relative abundance, six species are taken as very common, eigth species as common and 33 species as uncommon in study area.

Key words: Relative abundance; freshwater fish; Ayeyarwady River segment; Sagaing Region

Introduction

Myanmar encompasses a total of 8.2 million ha of permanent and seasonal water bodies and there were 29,000 ha of freshwater fish ponds and 115,687 ha of reservoirs. The inland waters are made up mainly of the interlocking of riverine and esturines systems of Ayeyawady (2,170 km long). The Ayeyawady River have higher species composition of fishes and productivity in Myanmar (Welcomme, 2001).

Fish is a very important source of the diet of the people of Myanmar. The fisheries sector plays a vital role in the culture and socio-economic life of Myanmar. Traditionally, Myanmar people prefer freshwater fish to marine fish. With the population of Myanmar 50 million in the year 2000 the per capita fish consumption was 21 kg/year. Myanmar has extensive water resources, both inland and marine. Inland fisheries production comes mostly from floodplains, the water surface of which covers some 6 million hectares during 4-5 months of the year (Inland Fishery in Myanmar, 2014).

Ayeyarwady River is an important natural shelter for many living things need to survive. It also supplies richly many habitats for aquatic flora and fauna in it and its environs. Ayeyarwady River supports to highly production of fisheries sectors resources. The people who live near the Ayeyarwady River depend on fishing for their food resources and earning

[1] Lecturer, Department of Zoology, Shwebo University
[2] Associate Professor, Dr., Department of Zoology, Shwebo University
[3] Lecturer, Department of Zoology, Shwebo University
[4] Lecturer, Department of Zoology, Shwebo University
[5] Lecturer, Department of Zoology, Shwebo University

intake. Today, the fisheries and related industries are rapidly developed and major foreign exchange is earned by them. Fish contains the highest protein per gram of all commonly meat. Perhaps, the prices of fishes are cheaper than meat. So many people can easily afford it and get a lot of protein diets.The study on occurrence of freshwater fish in Ayeyarwady Segment may be essential as one of the corner stone for conservation scheme of biological resources in Myanmar. Thus, the present study was carried out with the following objective:

- to identify record the fish species in study area
- to assess the monthly occurrence and abundance of fish species

Material and Methods

Study Area, Study Period, Collection, Preservation and Identification of Specimens

It was selected Ayeyarwady segment between Ma Khauk village and Shein Ma Karvillage. The studied area of Ayeyarwady River is about 46.19 km (28.7 miles) in length. The present study was undertaken from February, 2019 to January, 2020.

In this study, collection of specimen was made with the help of local fishermen. Fish sampling and landings survey were done at the first week and third week of in each month. Fish samples were collected (from four studysites) in Ayeyarwady segment at early morning and evening. At least five specimens of each species were preserved in 5-10% formalin based on their sizes for further analysis. Sample fishes at different species were randomly selected from the catches of different fishing gears in the River. The photographs of fresh specimens with natural colourations were taken by using digital camera. The local name of fishes was obtained after interviewed with the local fishermen and fish sellers.

Measurements were also taken on sample fishes to aid the identification process using keys provided by Day (1878), Lagler (1977), Talwar and Jhingran (1991), Jayaram (2013). Based on the recorded fish species, relative abundance of species were analyzed. as following;

Relative Abundance (Bisht *et al.*, 2004)

$$\text{Relative abundance} = \frac{\text{Number of individuals of each species}}{\text{Total number of individuals of all the observed species}}$$

The average relative abundance was categorized as:

Uncommon (uC) = having relative abundance less than 0.0100

Common (C) = having relative abundance of 0.0100 and above but less than 0.0500

Very common (vC) = having relative abundance of 0.0500 and above

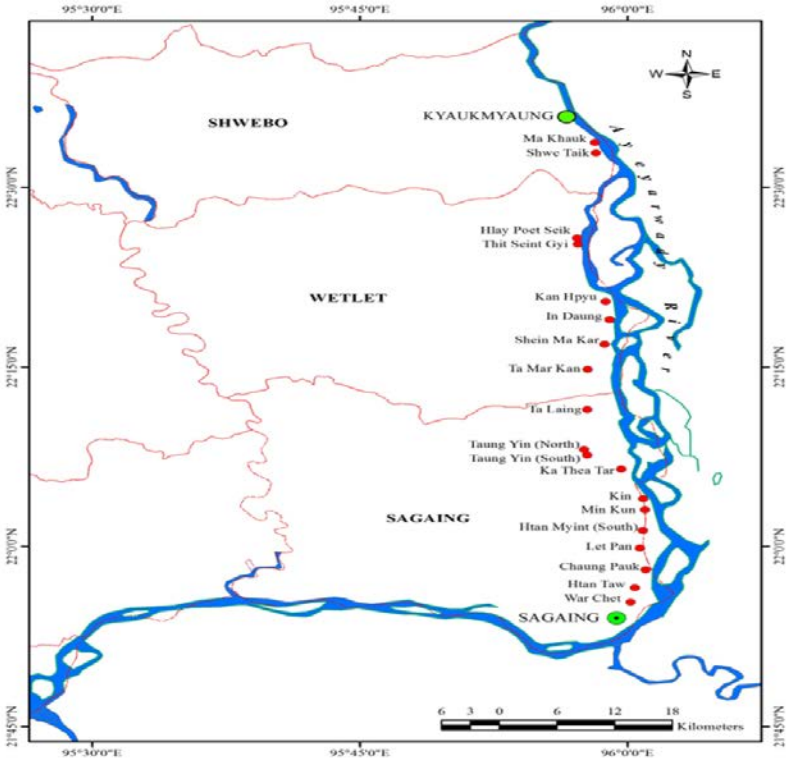


Fig. 1 Location of Study Sites

Results

A total number of 47 species of 36 genera distributed among 20 families and ten orders of freshwater fishes were recorded (Table 1).

Abundance and Relative abundance of the recorded Fish species in Different Sites

Of the recorded species, *Gudusia variegata* was found to be the most abundant. The total of number (104780) of fish caught; the relative abundance of *Gudusia variegata* (0.176) and followed by *Systomus sarana* (104000); relative abundance (0.174), *Salmophasia sardinella* (89550); relative abundance (0.15), *Puntius sophore* (76800); relative abundance (0.128), *Gudusia chapra* (72730); relative abundance (0.121), A*mblypharygodon atkinsonii* (67070); relative abundance (0.112), were recorded and these six species were very common (vC) (Table 2).

The total number of *Labeo angra* (4375); relative abundance (0.01), *Labeo bata* (19020); relative abundance (0.031), *Raiamus puntatus* (4510); relative abundance(0.01), *Osterobrama belangeri* (3550); relative abundance (0.01), *Mystus cavasius* (5300); relative abundance (0.01), *Mystus vittatus* (3990); relative abundance (0.010), *Wallago attu* (3045); relative abundance (0.01), and *Parambassis ranga* (11530); relative abundance (0.02), and these eight species were recorded as common species (C).

The remaining of 33 species were recorded as un common (uC) (Table 2).

Among the study sites, the highest total number of individual was recorded in Site II (226332, Kalama) and followed by Site I (136025, Ma Khauk). The lowest total number was found Site III (125052, Thit Seint Gyi) and followed by Site IV (109570, Shein Ma Kar).

Table 1. List of fish species recorded in the study area during the study period

Sr. No	Order	Family	Genus	Scientific Name	Common Name	Local Name
1	Osteoglossiformes	Notopteridae	*Notopterus*	*N. notopterus*	Bronze featherback	Nga Pyar/Nga phe
2	Clupeiformes	Clupeidae	*Gudusia*	*G. chapra*	Indian river shad	Nga la beat
3				*G. variegata*	Burmese river shad	Nga la beat baykyar
4	Anguilliformes	Anguillidae	*Anguilla*	*A. bengalensis*	Indian mottled eel	Nga ga lon/Nga mee taung
5	Cypriniformes	Cyprinidae	*Catla*	*C. catla*	Indian carp	Nga ohn don
6			*Cirrhinus*	*C. mrigala*	Mrigala	Nga gyin phyu
7			*Labeo*	*L. rohita*	Rohu	Nga myit chin
8				*L. calbasu*	Orange fin labeo	Nga net pyar
9				*L. stolizkae*	Moulmein labeo	Nga lai
10				*L. angra*	Angra labeo	Nga lu mei net
11				*L. bata*	Bata	Nga lu phyu
12			*Puntius*	*P. sophore*	Pool barb	Nga khone ma myi kyut
13			*Systomus*	*S. sarana*	Olive barb	Nga khone ma tote
14			*Salmophasia*	*S. sardinella*	Sardinella razorbelly minnow	Yin baung shay (or)Yin baung sa
15			*Amblypharyngodon*	*A. atkinsonii*	Burmese carplet	Nga pyet kyaw sein
16			*Raiamas*	*R. guttatus*	Burmese trout	Nga la war
17	Cypriniformes	Cyprinidae	*Barilius*	*B. gatensis*	River -carp baril	Nga mei war
18			*Osteobrama*	*O. belangeri*	Manipur osteobrama	Nga phan ma
19				*O. cunma*	Cunma osteobrama	Nga lay daunt
20		Cobitidae	*Acantopsis*	*A.choirorhynchos*	Horseface loach	Nga pyaw myit
21			*Lepidocephalichthys*	*L. berdmorei*	Burmese loach	Nga tha le doe
22		Botiidae	*Botia*	*B. berdmorei*	Blyth's loach	Nga sot kyar
23				*B. histrionica*	Burmese loach	Nga shwe yae
24	Siluriformes	Bagridae	*Mystus*	*M. cavasius*	Gangetic mystus	Nga zin yaing phyu

Table 1. Continued

Sr. No	Order	Family	Genus	Scientific Name	Common Name	Local Name
25				*M. vittatus*	Striped dwarf catfish	Nga zin yaing kyet chay
26				*M. leucophasis*	Sittaung mystus	Nga naut thwar
27			*Sperata*	*S. aor*	Long -whiskered catfish	Nga gaung
28			*Hemibagrus*	*H.peguensis*	Sittaung mystus	Nga ngeik
29		Schilbeidae	*Eutropiichthys*	*E. burmannicus*	Vacha	Nga myin oat phar
30				*E. vacha*	Batchwa vacha	Nga myin kun man
31			*Neotropius*	*N. artherinoides*	India potasi	Nga sa kar
32		Siluridae	*Ompok*	*O. bimaculatus*	Butter catfish	Nga nu than
33	Siluriformes	Siluridae	*Wallago*	*W. attu*	Boal	Nga batt
34		Sisoridae	*Gagata*	*G. dolichonema*	Gagata	Nga nan chung/Nga than chate
35			*Bagarius*	*B. bagarius*	Devil catfish	Nga moung ma
36	Mugiliformes	Mugilidae	*Rhinomugil*	*R. corsula*	Corsula mullet	Nga zin lone
37	Beloniformes	Belonidae	*Xenentodon*	*X. cancila*	Silver needle fish	Nga phaung yoe
38	Synbranchiformes	Mastacembelidae	*Macrognathus*	*M. aculeatus*	Lesser spiny eel	Nga mway htou
39				*M. zebrinus*	Zebra spiny eel	Nga mway kyar
40			*Mastacembelus*	*M. armatus*	Zig- zag eel	Nga mway na gar
41	Perciformes	Ambassidae	*Parambassis*	*P. ranga*	Indian glassy fish	Nga zin zat
42		Cichlidae	*Oreochromis*	*O.*sp.	Tilapia	Salapia
43		Gobiidae	*Glossogobius*	*G. giuris*	Tank goby	Naing lun nga
44		Anabantidae	*Anabas*	*A. testudineus*	Climbing perch	Nga pyay ma
45		Osphronemidae	*Trichopodus*	*T. pectoralis*	Snakeskin gourami	Japan nga
46		Channidae	*Channa*	*C. striata*	Striped snakehead	Nga yaunt phyu
47	Tetraodontiformes	Tetraodontidae	*Leiodon*	*L. cutcutia*	Ocellated pufferfish	Nga pu si (or) Nga pu si

Table 2. Abundance and relative abundance of fish species recorded in the study area during February, 2019 to January, 2020

No	Scientific Name	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total	RA	Status	PC%
1	*N. notopterus*	35	-	-	43	20	22	55	68	120	150	90	70	673	0.001	uC	0.1
2	*G. chapra*	-	-	-	-	-	-	19000	21730	32000	-	-	-	72730	0.121	vC	12
3	*G.variegata*	-	-	-	-	-	-	25410	36070	43300	-	-	-	104780	0.176	vC	18
4	*A.bengalensis*	-	-	-	-	-	5	3	10	15	2	-	-	35	0.000	uC	0.01
5	*C. catla*	20	15	10	26	35	25	35	55	44	22	18	15	323	0.001	uC	0.05
6	*C. mrigala*	-	-	22	-	18	-	32	48	58	32	25	15	250	0.000	uC	0.04
7	*L. rohita*	-	20	16	4	10	18	22	38	42	20	22	18	230	0.000	uC	0.04
8	*L. calbasu*	18	-	-	12	8	4	20	32	36	12	9	16	167	0.000	uC	0.03
9	*L. stoliczkae*	-	-	-	-	15	6	12	17	20	19	-	-	89	0.000	uC	0.01
10	*L.angra*	75	55	48	62	65	58	112	980	1120	800	420	580	4375	0.01	C	0.7
11	*L. bata*	85	78	42	65	120	80	250	1250	7500	3500	2530	3500	19020	0.031	C	3
12	*P. sophore*	2500	3600	4400	5300	3700	2300	3800	16200	18000	9500	3000	4500	76800	0.128	vC	13
13	*S. sarana*	1200	2800	1100	2900	5400	6600	7200	18800	25000	15000	9500	8500	104000	0.174	vC	17
14	*S. sardinella*	3500	4500	4800	5200	560	540	8500	1950	22000	18000	12000	8000	89550	0.150	vC	15
15	*A. atkisoni*	1500	2000	3500	3300	270	350	9500	11000	12000	9050	9000	5600	67070	0.112	vC	11
16	*R. puntatus*	350	220	450	200	180	-	-	650	850	550	600	460	4510	0.01	C	0.8
17	*B. gatensis*	280	320	120	80	75	-	-	325	450	550	220	180	2600	0.004	uC	0.4

Table 2. Contd.

Sr. No.	Scientific Name	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total	RA	Status	PC%
18	*O. belangeri*	250	220	100	110	90	80	350	560	680	760	200	150	3550	0.01	C	0.6
19	*O. cunma*	120	110	70	45	25	35	55	80	190	220	80	70	1100	0.002	uC	0.2
20	*A.choirorhynchus*	-	-	-	-	-	22	48	120	180	-	50	35	455	0.001	uC	0.08
21	*L. berdmori*	-	-	-	-	95	120	450	485	630	-	55	45	1880	0.003	uC	0.3
22	*B. berdmori*	-	-	-	150	280	250	350	420	650	530	170	50	2850	0.004	uC	0.5
23	*B. historionica*	-	-	-	130	170	200	280	320	450	250	180	120	2100	0.004	uC	0.4
24	*M. cavasius*	250	280	220	120	180	190	340	760	1210	1200	350	200	5300	0.01	C	1
25	*M. vittatus*	150	120	180	95	75	70	380	720	850	750	420	180	3990	0.01	C	0.7
26	*M. leucophasis*	30	50	-	45	25	50	90	125	150	170	-	-	735	0.001	uC	0.1
27	*S. aor*	35	-	-	50	30	22	45	120	180	110	-	-	592	0.001	uC	0.1
28	*H. peguensis*	-	-	-	20	18	12	38	115	20	-	-	-	223	0.000	uC	0.04
29	*E.varmanicus*	48	42	23	22	50	65	125	390	450	220	110	80	1625	0.003	uC	0.3
30	*E.vacha*	52	38	20	12	18	10	150	450	580	320	-	-	1650	0.003	uC	0.3
31	*N. atherionoides*	30	22	12	10	6	-	-	52	47	-	-	18	197	0.000	uC	0.03
32	*O. bimaculatus*	25	38	22	52	58	72	120	550	780	320	250	220	2507	0.004	uC	0.4
33	*W. attu*	55	35	25	30	58	32	280	720	760	840	120	90	3045	0.01	C	0.5
34	*G.olichonema*	-	-	-	22	16	12	55	67	78	25	-	-	275	0.000	uC	0.05

Table 2 Contd.

Sr. No.	Scientific Name	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total	RA	status	PC%
35	*B. bagarius*	-	25	22	-	10	8	45	55	70	65	-	-	300	0.001	uC	0.05
36	*R. corsula*	20	18	25	32	25	20	32	45	50	78	-	-	345	0.001	uC	0.06
37	*X. cancila*	-	-	-	20	45	35	50	68	80	32	-	-	330	0.001	uC	0.06
38	*M. aculeatus*	38	15	-	42	19	-	68	82	55	41	-	-	360	0.001	uC	0.06
39	*M. zebrinus*	-	22	35	60	35	27	56	100	82	39	52	-	499	0.001	uC	0.08
40	*M. armatus*	-	-	25	38	45	38	35	103	80	64	35	40	507	0.001	uC	0.08
41	*P. ranga*	650	820	800	750	780	350	580	1550	1700	1800	900	850	11530	0.02	C	2
42	*O. sp.*	80	60	55	62	78	65	120	350	550	780	85	90	2375	0.004	uC	0.4
43	*G. giuris*	60	45	32	50	72	23	38	120	250	-	-	-	690	0.001	uC	0.1
44	*A.testudineus*	20	18	16	12	10	32	30	90	110	60	22	20	440	0.001	uC	0.1
45	*T. pectoralis*	-	-	-	30	-	-	-	55	60	22	-	-	167	0.000	uC	0.03
46	*C. striata*	-	-	-	18	20	12	17	22	25	13	-	-	127	0.000	uC	0.02
47	*L. cutcutia*	-	-	-	1	1	1	3	8	10	9	-	-	33	0.000	uC	0.01
	Total individuals	11476	15586	16190	19210	12811	11861	78181	117929	173565	65925	40533	33712	596979			
	Total species	28	28	28	39	42	39	43	47	47	40	29	29	vC-6	C-8	uC	-33

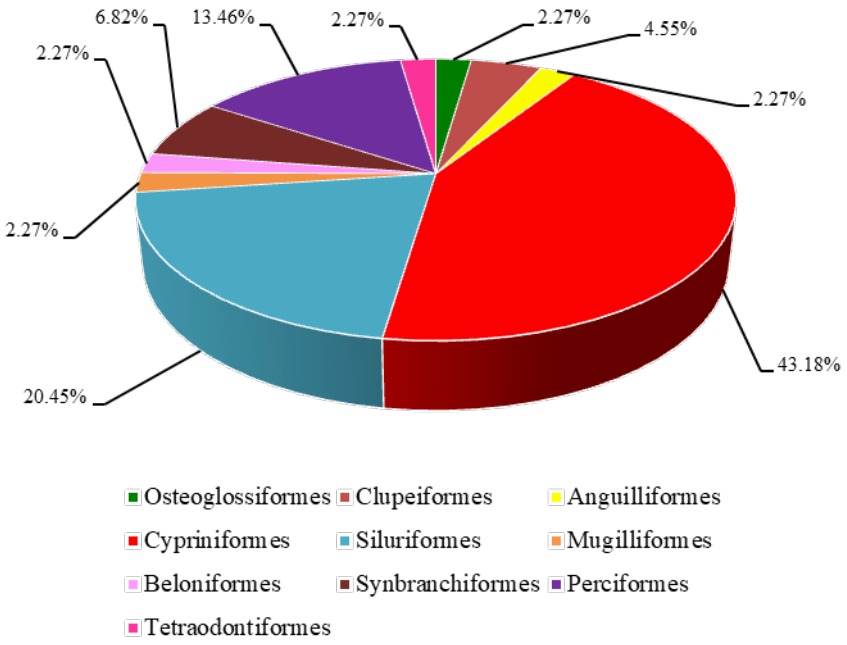


Fig. 2 Percentage representation of Species composition in different orders recorded from the study area

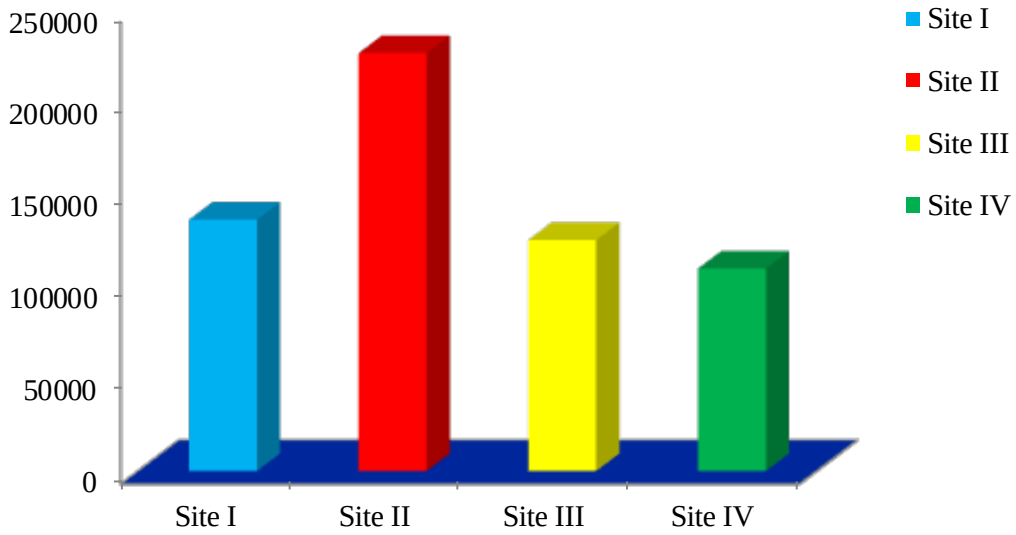


Fig. 3 Monthly abundance of fishes recorded from the study sites

A.*Notopterus notopterus*

B. *Gudsia chapra*

C.*G. variegata*

D.*Anguilla bengalensis*

E. *Catla catla*

F. *Cirrhinus. mrigala*

G. *Labeo rohita*

H.*L. calbasu*

I.*L. stolizkae*

J. *L. angra*

K. *L. bata*

L. *Puntius sophore*

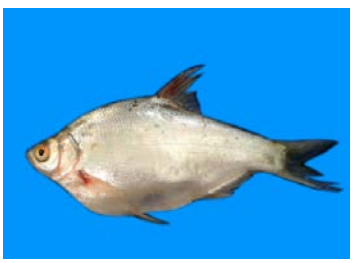
M. *Systomus sarana*

N.*Samophasia sardinella*

O.*Amblypharyngodon. atkinsonii*

P. *Raiamas guttatus*

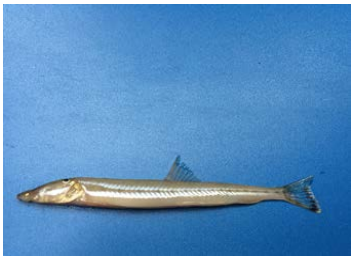
Q. *Barilius gatensis*

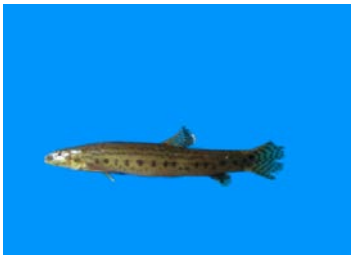


R. *Osteobrama belangeri*

Plate 1 Some recorded fish species in study periods


S. *O. cunma*


T. *Acantopsis choirorhynchos*

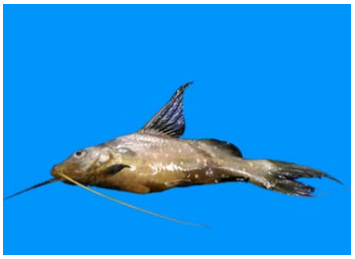

U. *Lepidocephalus. berdmorei*

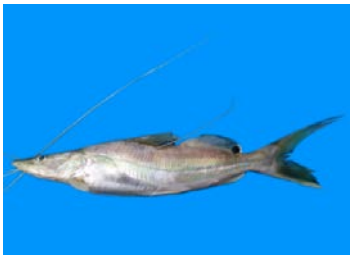

V. *Botia berdmorei*


W. *B. histrionica*

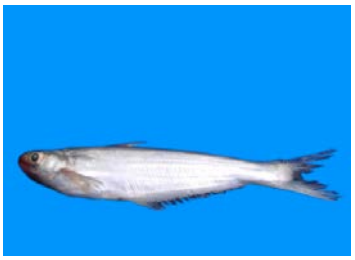

X.*Mystuscavasius*

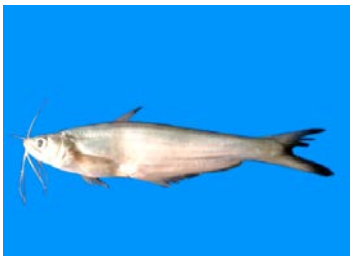

Y. *M. vittatus*


Z. *M. leucophasis*


AA. *Sperata aor*


AB. *Hemibargus peguensis*

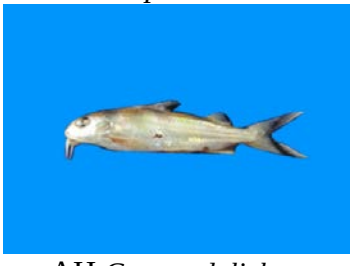

AC. *Eutropiichthys burmannicus*


AD.*E. vacha*


AE.*Neotropius. artherinoides*


AF. *Ompok bimaculatus*


AG. *Wallago attu*


AH.*Gagata dolichonema*


AI. *Bagarius bagarius*

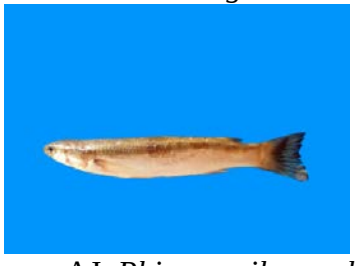
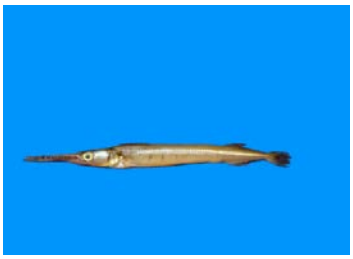

AJ. *Rhinomugil corsula*

Plate 1 Continued



AK. *Xenentodon cancila*

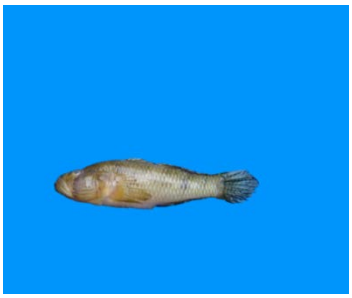
AL. *Macrognathus aculeatus*

AM. *M. zebrinus*

AN.*Mastacembelus armatus*

AO. *Parabamssis ranga*

AP.*Oreochromis* sp.



AQ. *Glossogobius giuris*

AR. *Anabas testudineus*

AS.*Trichopodus pectoralis*

AT. *Channa striata*

AU. *Leiodoncutcutia*

Plate 1 Continued

Discussion

In the present study, the most abundant family was Cyprinidae while Anguillidae, Belonidae and Tetraodontidae were the least abundant families. Of recorded species, the number individuals of species of *Gudusia variegata* was found to be the most abundance while the species of *Leiodon cutcutia* was recorded as the least number.

Of these recorded fish species, *G. chapra* (72730) and *G. variegata* (104780) were found in three months (August, September and October). Total numberof 33 of *L. cutcutia* species were found in seven months (May, June, July, August, September, October and November). 35 number of *Anguillabengalensis* was only recorded in five months (July, August, September, October and November).

The highest number of species were recorded in September andOctober (47 species, 10.7%) and the lowest in February, March and April (28 species, 6.4%) were observed during the study period. Throughout the study period, total numbers of individual (596979) were recorded. *Gudusiavariegata* was recorded as the highest total numbers of individuals (104780) and *L. cutcutia* was recorded as the lowest number of individual only 33 were observed.

Among four study sites, the highest total number of individual was recorded in Site II Kalama (226332) and followed by Site I Ma Khauk (136025). The lowest total number was found Site IV Shein Ma Kar (109570) and followed bySite III Thit Seint Gyi (125052).Thus the fish numbers of upper stream were found more abundance and species composition than downstream.

In the present study, according to Fish Base Consortium, 2015, three endemic species; *Gudusia variegata*, *Labeostolizkae*, *Mystus leucophasis* and two introduced species; *Oreochromis* sp. and *Trichopodus pectoralis* were observed in the study sites.

Among 47 species, 17 species were encountered in every month of the twelve months study period and also habour four endemic species, the study area need to be maintained substainable yield and this may be indicated favorable habitats for aquatic organisms.

Conclusion

The Ayeyarwady River supports diverse and abundant population of freshwater fishes.The flood plains of the Ayeyarwady River are highly productive and play an important role in the ecology of the river system. This characteristic could probably create suitable niches for a variety of fish species and subsequently higher fish abundance will be found in that habitat.According to the recorded data, it was thought that the species composition and abundance was partly dependent on factors of fluctuation of water level in River and livelihood of local people.

Acknowledgements

We are greatly indebted to Dr. Win Swe, Shwebo University for his kind permission to carry out this research work. Thanks are due to Dr Khin Than Htay, Professor, (Head) and Dr Kyi Kyi Thaw, Professor, Department of Zoology, Shwebo University for their permission and suggestion to work on this research. Lastly, thanks are due to Dr Thant Zin, Professor, (Head), Department of Zoology, Mandalay University for their supervision.

References

Bisht, M.S., Kukret, M. and Shanibhusan, 2004. Relative abundance and distribution of bird fauna of Garhwal Himalaya. *Eco Environment and Conservation*, 10(4): 451- 460

Day, F. 1889**.** *The Fauna of British India, including Ceylon and Burma* Fishes. Vol. I and II. Taylor and Franchs, London.

Fish Base Consortium, 2015. List of freshwater fishes for Myanmar. *Electronic document;* (http://www. fishbase.org/ListByLetter/common) Accessed 25.8.2017

Inland Fisheries in Myanmar, 2014**.** *Fishing gear in methods*. Electronic document; (http://www. Seafdec.org/ inland.fishing.gear) Accessed 24 February 2015.

Jayaram. K.C. 2013**.** *The freshwater fishes of the Indian Region*. Corrected 2nd Edition. Narendra Publishin house. Publisher and Distributor 1417, Kishan Dutt Street, Maliwara, Delhi (India).

Lagler, K. F. 1977**.** *Ichthyology*. (Fourth Edition) Toppon Co. Ltd., Japan, 545pp

Talwar P.K., and Jhingran A.G., 1991. *Inland Fishes of India and Adjacent Countries.* Vol. I and II. Oxford and IBH Publishing Co. PVT. LTD. Calcutta.

Welcomme, R.L. 2001. *Inland Fisheries*. Ecology and Management. Food and Agriculture Organization of the United Nations by Blackwell Science. Oxford.358pp.

Occurrence and Abundance of Fish Species from Mu River Segment Between Than-Payar-Chan Village and Ye-Kyi-Wa Village, Shwebo Township, Sagaing Region

Soe Soe[1], Kyi Kyi Than[2], Khin Maung Oo[3], Htay Htay Lin[4], Aye Su Mon[5]

Abstract

Investigation on occurrence and abundance of species composition were conducted from Mu River segment between Than-Payar-Chan village and Ye-Kyi-Wa village, Shwebo Township, Sagaing Region during December, 2018 to July, 2019. A total of 43 fish species belonging to 30 genera and distributed among 17 families and eight orders and 6170 individuals were recorded from the study area. It was indicated that the species composition of order Cypriniformes were dominate in the highest with 17 species (39.53%), followed by Siluriformes with 12 species (27.90%), Perciformes with seven species (16.27%) and Synbranchiformes with three species (6.97%) from the study area. The remaining four orders with only a single species and the composition was (2.32%) in the study period. Therefore, the most abundant fish species were recorded under family Cyprinidae with 14 species (32.55%) followed by Bagridae with seven species (16.27%), Cobitidae, Mastacembelidae and Channidae with three species (6.97%) and Siluridae with two species (4.65%) during the survey period. The remaining 11families with only a single species and composition was (2.32% each) from the study area.

Key words: Fish, species composition, occurrence and abundance

Introduction

Myanmar is rich in natural resources including diverse fish fauna. Fish and other aquatic resources are important to human livelihoods especially in many developing countries. In Myanmar, the fisheries sector is the fourth largest source of foreign exchange earnings after timber, mineral and rice (FAO/NACA, 1995).

Fish constitutes almost half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats; 21723 living species of fish have recorded out of 39900 species of vertebrates. Of these 8411 are freshwater species and 11650 are marine (Jayaram, 1999). Fish is high in protein and minerals such as Calcium and Selenium. Small fishes tend to be eaten whole and in some countries the bone of larger fish are also eaten, contributing, sometimes significantly, to Calcium supplies (Welcomme, 2001).Fish is a very important source of the diet of the people of Myanmar. The fisheries sector plays a vital role in the culture and socio-economic life of Myanmar (Inland Fishery in Myanmar, 2014).

Inland fisheries in Myanmar play an important role in food security and socioeconomic status of the people especially in rural areas and also in daily diet of the locals who traditionally prefer to consume freshwater fishes together with rice. Inland fisheries resources comprise rivers, estuaries lakes and brackish water pond, floodplain lagoons; major, minor village tanks (Aung Htay Oo, 2010).

[1] Lecturer, Dr, Department of Zoology, Shwebo University
[2] Lecturer, Department of Zoology, Shwebo University
[3] Lecturer, Dr, Department of Zoology, Shwebo University
[4] Lecturer, Dr, Department of Zoology, Shwebo University
[5] Lecturer, Dr, Department of Zoology, Shwebo University

Mu River is a river in upper central Myanmar, and a tributary of the country's chief river the Ayeyarwady. It supplies water for farmer to agricultural use. Most of the people who live near the Mu River depend on fish for their earning intake.

The study on occurrence of freshwater fish in Mu river segment may be essential as one of the corner stone for conservation scheme of biological resources in Myanmar. Thus, the present study was carried out with the following objectives:

- to investigate the species composition of the freshwater fish in study area
- to record the occurrence of fish species and
- to determine the monthly abundance of fish species in study area

Materials and Methods

Study Area

Mu River segment was selected between Than-Payar-Chan village and Ye-Kyi-Wa village located in Shwebo Township, Sagaing Region which lies between North latitude 22° 28′ and East longitude 96°33'00″. The study area was 4.827 km in length and 152.7 m in width. The depth of water level is about 7 m in the rainy season and 1.5 m in the hot season (Fig 1).

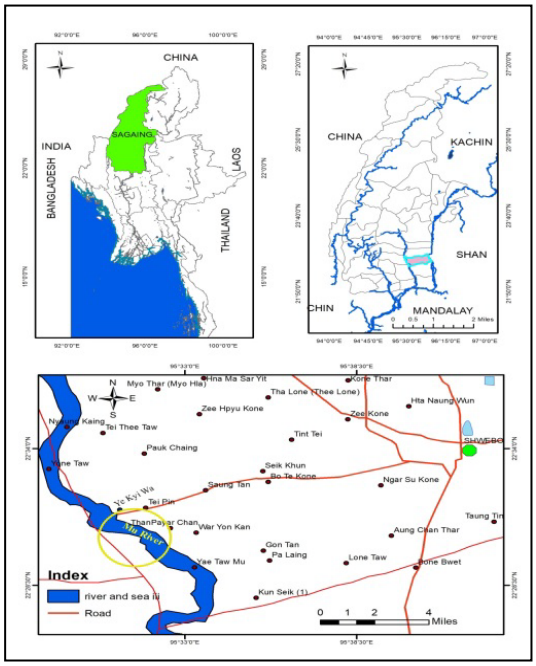


Fig 1 A map of study area of Mu River segment

Study Period

The study period lasted from December, 2018 to July, 2019.

Specimen collection and preservation

The specimens were collected twice per month throughout the study period. The collected specimens were examined and recorded soon after they were caught before the body color disappeared. Data of fishes were noted and color photographs taken. The local names were also noted down. Then they were preserved in 10% formalin for future study and identification.

Identification and classification

Identification of fishes species were made according to Day (1878), Jayaram (1981), Talwar and Jhingran (1991), Ferrais (1998). The classification of fishes was made according to Talwar and Jhingran (1991). Local names of the studied species were recorded according to local fishermen.

Data analysis

The data were analyzed as following **(**Bisht *et al*., 2004)

Species composition

Species composition was calculated as follow;

$$\text{Species composition} = \frac{\text{Total no. of species in particular family or order}}{\text{Total no. of species of all families or orders}} \times 100$$

Relative abundance

$$\text{Relative Abundance} = \frac{\text{Total number of individuals of the particular species}}{\text{Total no. of individuals of all species in a particular site}}$$

The average relative abundance;
(uC) = having relative abundance less than 0.0100
(C) = having relative abundance of 0.0100 and above but less than 0.0500
(vC) = having relative abundance of 0.0500 and above

Results

A total of 43 fish species belonging to 30 genera, 17 families and eight orders were recorded from Mu River segment between Than-Payar-Chan village and Ye-Kyi-Wa village during the study period.

Species composition, occurrence and relative abundance

A total of 43 species belonging to 30 genera and 17 families of eight orders were recorded from the study area of Mu River segment during the study period commencing from December, 2018 to July, 2019 (Table 1).

The recorded eight orders are Osteoglossiformes, Cypriniformes, Siluriformes, Mugiliformes, Cyprinodontiformes, Synbranchiformes, Perciformes and Tetraodontiformes. The most dominant order is Cypriniformes and confined to two families, represented by 12 genera and 17 species. The second dominant order is Siluriformes and confined to five families, 7 genera and 12 species, followed by order Perciformes and confined to 5 families, 5 genera and 7 species. The order Synbranchiformes and confined to one family, 2 genera and 3 species. The other four orders are represented by one family, one genera and one species (Fig 2 and Table 2).

During the study period, the highest number of 17 species was recorded from the order Cypriniformes amounting to (39.53%) in species composition, followed by the order Siluriformes with 12 species (27.90%) and perciformes with seven species (16.27%) respectively, while the order Synbranchiformes was represented by three species amounting (6.97%). The remaining four orders Osteoglossiformes, Mugiliformes, Cyprinodontiformes and Tetraodontiformes with a single species representative each and the species composition was only (2.32%) in (Fig 3 and Table 2).

With respect to the family, Cyprinidae was the riches species composition (32.55%), followed by Bagridae (16.27%) and the same position Cobitidae, Channidae and Mastacembelidae (6.97%) in each. Siluridae (4.65%) and Notopteridae, loricariidae, Schilbeidae, Sisoridae, Mugilidae, Belonidae, Ambassidae, Cichlidae, Gobiidae, Anabantidae, Tetraodontidae were the same position with one species in each (2.32 %) respectively (Fig 4 and Table 3).

During the study period, 28 species are uncommon (uC), 11 species common (C) and four species are very common (vC).

During the study period, the highest number of *Puntius sophores* (1468 individuals) was occurred. *Puntius sophores* showed the highest relative abundance 0.2379. The lowest number of *Labeo calbasu, Botia histrionica, Mastacembelus unicolor* and *Leiodon cutcutia* (one individuals each) was occurred and the lowest relative abundance 0.0001 (Table 4).

Table 1 List of fish species recorded from Mu River segment between Than-Payar-Chan village and Ye-Kyi-Wa village during December, 2018 to July, 2019

No.	Order	Family	Genus	Scientific name	Common name	Local name
1	Osteoglossiformes	Notopteridae	*Notopterus*	*N. notopterus*	Bronze feather back	Nga-phe
2	Cypriniformes	Cyprinidae	*Chagunius*	*C. chagunio*	Chaguni	Nga-hta-see
3			*Chela*	*C. laubuca*	Indian glass barb	Nga-maw-tawt
4			*Labeo*	*L. angra*	Angra labeo	Nga-lu-mie-net
5				*L. boga*	Boga labeo	Nga-lu-phyu
6				*L. calbasu*	Black rohu	Nga-net-pyar
7				*L. rohita*	Rohu	Nga-gyin-myet-san-ni
8			*Osteobrama*	*O. belangeri*	Manipur osteobrama	Nga-phan-ma
9				*O. cunma*	Cunma osteobrama	Nga-lay-daunt
10			*Puntius*	*P. gonionotus*	Thai-silver-barb	Thai-nga-khone-ma
11				*P. sophore*	Pool barb	Nga-khone-ma-myi-kyut
12			*Systomus*	*S. sarana*	Olive barb	Nga-khone-ma-toke
13			*Salmophasia*	*S. sardinella*	Sardinella razorbelly minnow	Nga-yin-baung-zar
14			*Amblypharyngodon*	*A. atkinsonii*	Carplet	Nga-byet
15			*Raiamas*	*R. guttatus*	Burmese trout	Nga-la-war
16		Cobitidae	*Acantopsis*	*A. choirorhynchos*	Banana fish	Nga-pyaw-myit
17			*Lepidocephalichthys*	*L. berdmorei*	Loach	Nga-tha-la-doh
18			*Botia*	*B. histrionica*	Burmese loach	Nga-shwe-yae
19	Siluriformes	Bagridae	*Mystus*	*M. bleekeri*	Day's mystus	Nga-zin-yaing-war
20				*M. cavasius*	Gangetic mystus	Nga-zin-yaing-phyu
21				*M. gulio*	Long whiskered catfish	Nga-yway
22				*M. leucophasis*	Sittaung mystus	Nga-nauk-thwar
23				*M. menoda*	Menoda catfish	Nga-ngike
24				*M. pulcher*	Pulcher mystus	Nga-zin-yaing-kyet-chay
25			*Sperata*	*S. aor*	Long whiskered catfish	Nga-gaung

Table 1 Continued

No	Order	Family	Genus	Scientific name	Common name	Local name
26	Siluriformes	Loricariidae	*Hypostomus*	*H. plecostomus*	Suckmouth catfish	Nga-soke-khwet
27		Schilbidae	*Eutropiichthys*	*E. vacha*	Batchwa vacha	Nga-myin-kum-man
28		Siluridae	*Ompok*	*O. bimaculatus*	Indian butter catfish	Nga-nu-than
29			*Wallago*	*W. attu*	Boal	Nga-but
30		Sisoridae	*Gagata*	*G. cenia*	Indian gagata	Nga-nan-kyaung
31	Mugiliformes	Mugilidae	*Rhinomugil*	*R. corsula*	Corsula mullet	Nga-zin-lone
32	Cyprinodontiformes	Belonidae	*Xenentodon*	*X. cancila*	Freshwater-gar-fish	Nga-phaung-yoe
33	Synbranchiformes	Mastacembelidae	*Macrognathus*	*M. aral*	One striped spiny eel	Nga-mway-ni
34			*Mastacembelus*	*M. armatus*	Spiny eel	Nga-mway-na-gar
35				*M. unicolor*	Spot eel	Nga-mway-byauk-ma
36	Perciformes	Ambassidae	*Parambassis*	*P. ranga*	Indian glassy fish	Nga-zin-zat
37		Cichlidae	*Oreochromis*	*Oreochromis* sp.	Talapia	Salapia
38		Gobiidae	*Glossogobius*	*G. giuris*	Tank goby	Nylon-nga
39		Anabantidae	*Anabas*	*A. testudineus*	Climbing perch	Nga-byay-ma
40		Channidae	*Channa*	*C. orientalis*	Asiatic snake head	Nga-yant-gaung-to
41				*C. punctatus*	Spotted snake head	Nga-yant-pa-naw
42				*C. striata*	Striped snake head	Nga-yant-gaung-shay
43	Tetraodontiformes	Tetraodontidae	*Leiodon*	*L. cutcutia*	Ocellated puffer fish	Nga-pu-si

Table 2 Percentage of species composition in different orders from the study area

No.	Order	Number of species	Percentage (%)
1	Osteoglossiformes	1	2.32
2	Cypriniformes	17	39.53
3	Siluriformes	12	27.90
4	Mugiliformes	1	2.32
5	Cyprinodontiformes	1	2.32
6	Synbranchiformes	3	6.97
7	Perciformes	7	16.27
8	Tetraodontiformes	1	2.32
	Total	43	100

Table 3 Percentage of species composition in different families from the study area

No.	Family	Number of species	Percentage (%)
1	Notopteridae	1	2.32
2	Cyprinidae	14	32.55
3	Cobitidae	3	6.97
4	Bagridae	7	16.27
5	Loricariidae	1	2.32
6	Schilbeidae	1	2.32
7	Siluridae	2	4.65
8	Sisoridae	1	2.32
9	Mugilidae	1	2.32
10	Belonidae	1	2.32
11	Mastacembelidae	3	6.97
12	Ambassidae	1	2.32
13	Cichlidae	1	2.32
14	Gobiidae	1	2.32
15	Anabantidae	1	2.32
16	Channidae	3	6.97
17	Tetraodontidae	1	2.32
	Total	43	100

Table 4 Monthly relative abundance of fish species in Mu River segment between Than-Payar-Chan village and Yay-Kyi-Wa village during December, 2018 to July, 2019

No.	Species name	Dec	Jan	Feb	Mar	Apr	May	June	July	Total	Relative abundance	Status
1	*Notopterus notopterus*	5	3	3	3	1	2	1	4	22	0.0035	uC
2	*Chagunius chagunio*	1	0	0	0	5	5	15	100	126	0.0204	C
3	*Chela laubuca*	0	0	0	110	300	0	0	0	410	0.0665	vC
4	*Labeo angra*	11	25	0	0	0	5	0	0	41	0.0066	uC
5	*Labeo boga*	10	0	0	0	0	0	0	0	10	0.0016	uC
6	*Labeo calbasu*	1	0	0	0	0	0	0	0	1	0.0001	uC
7	*Labeo rohita*	2	0	1	0	1	0	0	0	4	0.0006	uC
8	*Osteobrama belangeri*	1	0	0	0	11	7	3	5	27	0.0043	uC
9	*Osteobrama cunma*	26	9	88	22	11	3	2	3	164	0.0266	C
10	*Puntius gonionotus*	3	5	0	0	0	0	13	0	21	0.0034	uC
11	*Puntius sophore*	201	129	201	450	253	150	50	34	1468	0.2379	vC
12	*Systomus sarana*	1	40	0	3	14	12	3	6	79	0.0128	C
13	*Salmophasia sardinella*	0	70	0	2	16	1	350	820	1259	0.2042	vC
14	*Amblypharyngodon atkinsonii*	100	850	0	30	0	168	0	0	1148	0.1861	vC
15	*Raiamas guttaus*	24	32	1	2	12	5	2	20	98	0.0159	C
16	*Acantopsis choirorhynchos*	2	0	0	0	0	0	6	17	25	0.0040	uC
17	*Lepidocephalichthys berdmorei*	0	0	3	2	15	2	9	5	36	0.0058	uC
18	*Botia histrionica*	0	1	0	0	0	0	0	0	1	0.0001	uC
19	*Mystus bleekeri*	1	1	10	4	20	4	2	17	59	0.0096	uC
20	*Mystus cavasius*	0	10	4	1	8	0	0	0	23	0.0037	uC
21	*Mystus gulio*	1	2	1	0	0	0	0	0	4	0.0006	uC
22	*Mystus leucophasis*	3	1	0	1	0	0	0	0	5	0.0008	uC
23	*Mystus menoda*	1	1	0	1	0	0	0	0	3	0.0004	uC
24	*Mystus pulcher*	50	0	0	7	8	0	4	0	69	0.0112	C
25	*Sperata aor*	1	1	0	0	0	0	0	0	2	0.0003	uC

Table 4 Continued

No.	Species name	Dec	Jan	Feb	Mar	Apr	May	June	July	Total	Relative abundance	Status
26	*Hypostomus plecostomus*	5	3	0	0	5	0	0	0	13	0.0021	uC
27	*Eutropiichthys vacha*	0	5	0	0	0	0	0	0	5	0.0008	uC
28	*Ompok bimaculatus*	1	0	0	5	1	4	2	2	15	0.0024	uC
29	*Wallago attu*	1	0	2	0	0	0	0	0	3	0.0004	uC
30	*Gagata cenia*	1	90	0	0	0	0	60	26	177	0.0287	C
31	*Rhinomugil corsula*	68	0	0	0	2	2	0	0	72	0.0117	C
32	*Xenentodon cancila*	0	2	3	0	3	3	1	0	12	0.0019	uC
33	*Macrognathus aral*	0	0	0	2	9	0	0	0	11	0.0018	uC
34	*Mastacembelus armatus*	4	20	14	0	6	6	7	0	57	0.0092	uC
35	*Mastacembelus unicolor*	0	1	0	0	0	0	0	0	1	0.0001	uC
36	*Parambassis ranga*	0	103	0	25	2	1	37	20	188	0.0305	C
37	*Oreochromis* sp.	53	93	9	11	0	8	40	8	222	0.0360	C
38	*Glossogobius giuris*	1	31	7	11	1	6	60	4	121	0.0196	C
39	*Anabas testudineus*	0	20	2	0	2	0	0	0	24	0.0039	uC
40	*Channa orientalis*	2	14	23	48	11	3	2	5	108	0.0175	C
41	*Channa punctatus*	0	10	8	5	4	1	0	1	29	0.0047	uC
42	*Channa striata*	0	2	1	0	2	0	0	1	6	0.0009	uC
43	*Leiodon cutcutia*	0	1	0	0	0	0	0	0	1	0.0001	uC
	Total no of individuals	581	1575	381	745	723	398	669	1098	6170		
	Total no of species	29	30	18	21	26	21	21	19			

(uC) = Uncommon

(C) = Common

(vC) = Very common

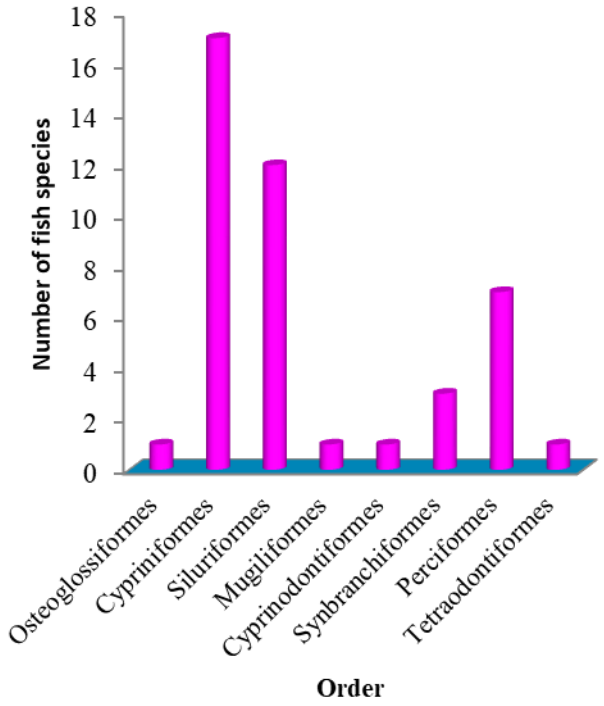


Fig. 2 Number of recorded fish species in Mu River segment

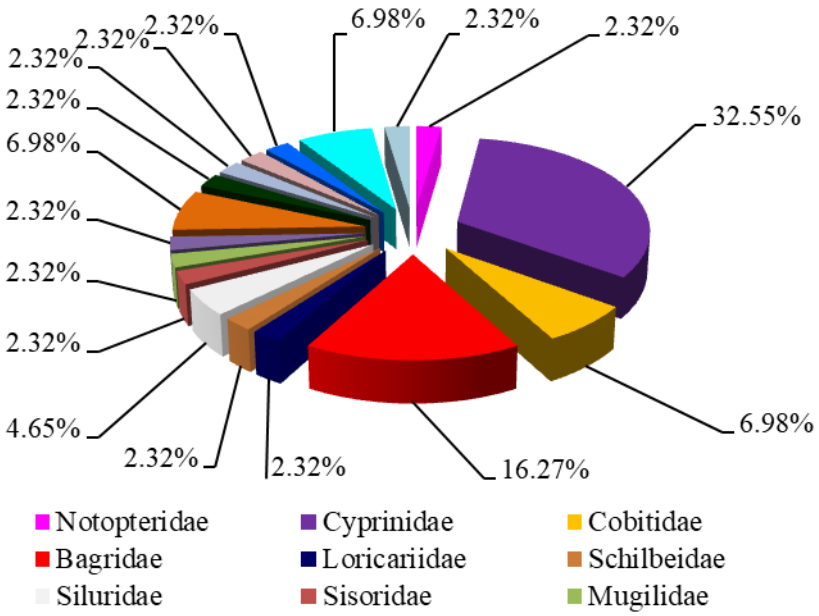
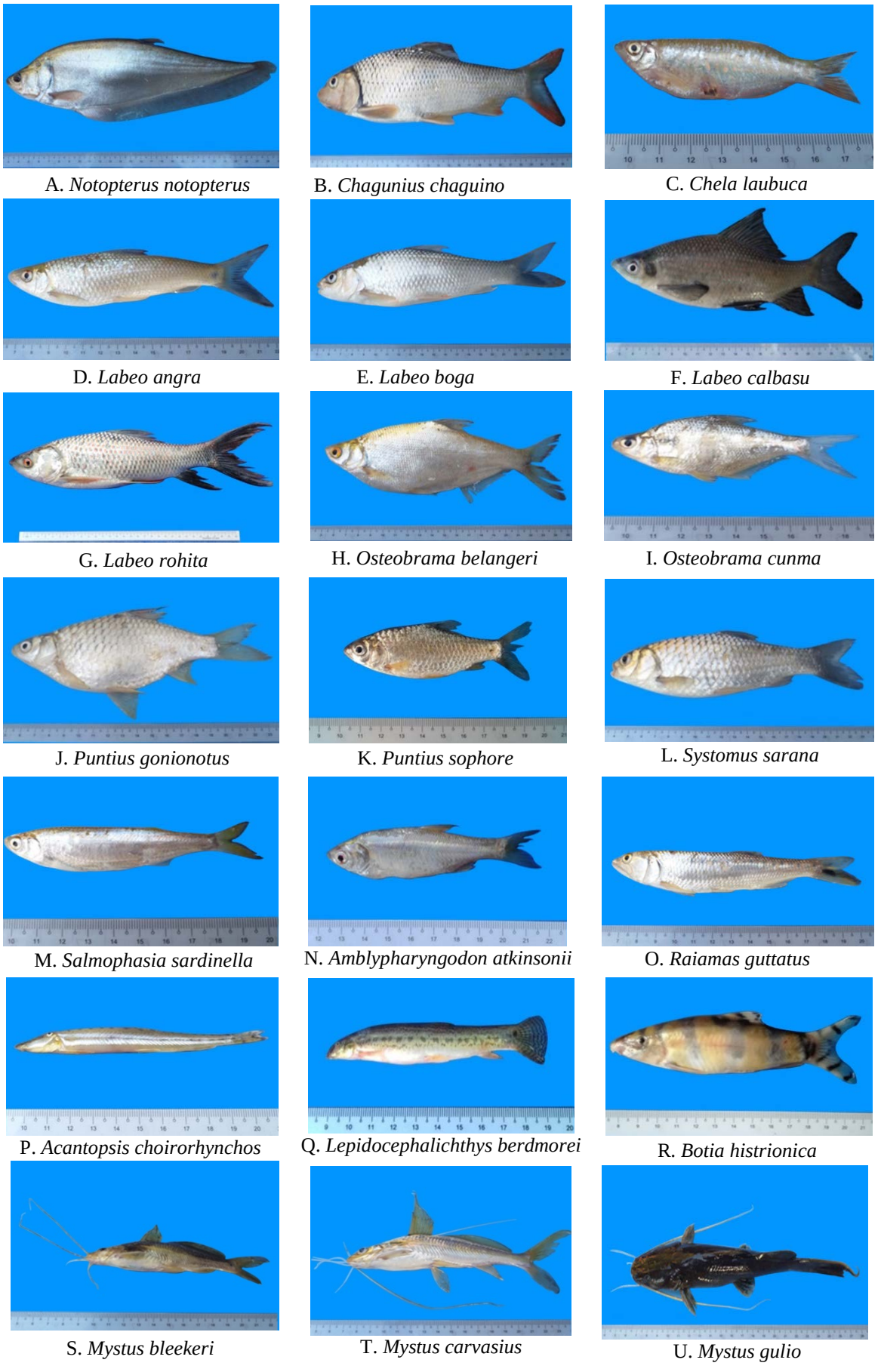


Fig. 4 Species composition (percentage) of recorded fish species in different families during the study period



A. *Notopterus notopterus* B. *Chagunius chaguino* C. *Chela laubuca*

D. *Labeo angra* E. *Labeo boga* F. *Labeo calbasu*

G. *Labeo rohita* H. *Osteobrama belangeri* I. *Osteobrama cunma*

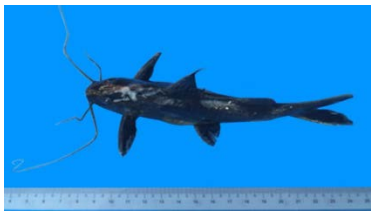
J. *Puntius gonionotus* K. *Puntius sophore* L. *Systomus sarana*

M. *Salmophasia sardinella* N. *Amblypharyngodon atkinsonii* O. *Raiamas guttatus*

P. *Acantopsis choirorhynchos* Q. *Lepidocephalichthys berdmorei* R. *Botia histrionica*

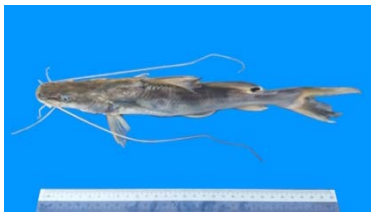
S. *Mystus bleekeri* T. *Mystus carvasius* U. *Mystus gulio*

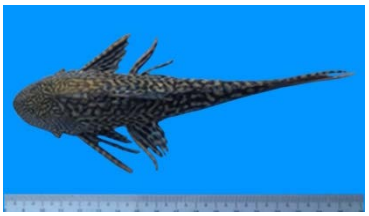
Plate 1 Recorded fish species from the study area


V. *Mystus leucophasis*

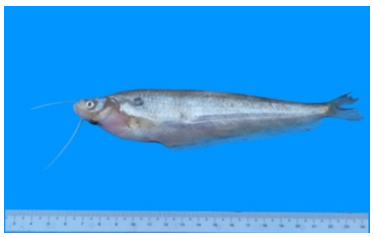

W. *Mystus menoda*

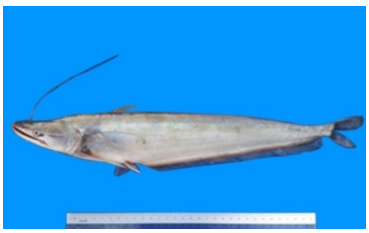

X. *Mystus pulcher*

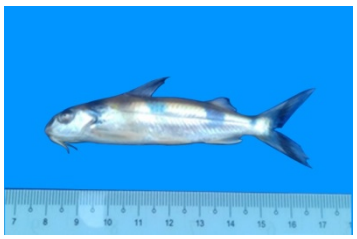

Y. *Sperata aor*

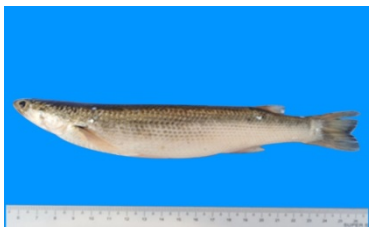

Z. *Hypostomus plecostomus*

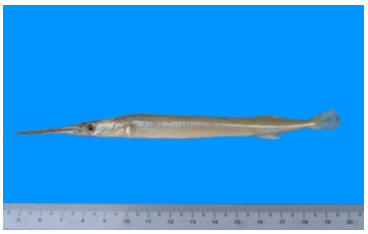

AA. *Eutropiichthys vacha*

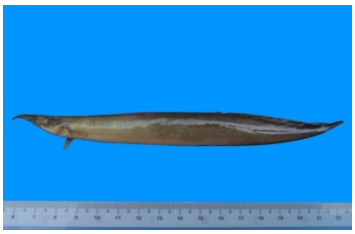

BB. *Ompok bimaculatus*


CC. *Wallago attu*

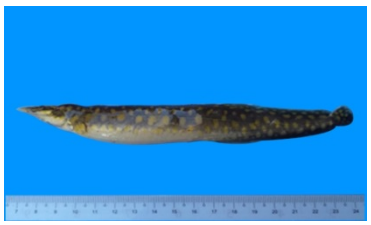

DD. *Gagata cenia*

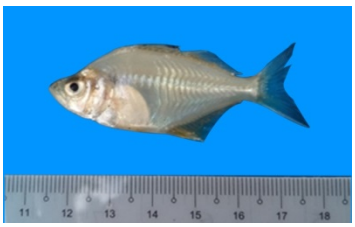

EE. *Rhinomugil corsula*


FF. *Xenentodon cancila*


GG. *Macrognathus aral*


HH. *Mastacembelus armatus*

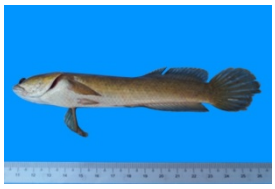

II. *Mastacembelus unicolor*


JJ. *Parambassis ranga*


KK. *Oreochromis* sp.


LL. *Glossogobius giuris*


MM. *Anabas testudineus*


NN. *Channa orientalis*


OO. *Channa punctatus*


PP. *Channa striata*


QQ. *Leiodon cutcutia*

Plate 1 Continued

Discussion

Some fish fauna in Mu River segment was conducted based on species composition and abundance during December, 2018 to July, 2019.

Based on the monthly data, the percentage species composition of recorded fish species were found to be the highest 39.53% with 17 species under the order Cypriniformes, followed by 27.90% with 12 species in Siluriformes, 16.27% with 7 species in Perciformes, 6.97% with 3 species in Synbranchiformes and 2.32% with only one species in each of the remaining four orders, Osteoglossiformes, Mugiliformes, Cyprinodontiformes and Tetraodontiformes during the study period. The order Cypriniformes was dominant in study area. This is not surprising since, Cypriniformes is the dominant group among the different orders of fish.

Cypriniformes was the largest of all fish orders (Day, 1889 and Talwar and Jhingran, 1991). Similarly in this study, the order Cypriniformes was the largest of all fish orders.

The species composition of Cypriniformes is higher than those of remaining orders, this finding agrees with the Lagler *et al*. (1970) and Nelson (1984) reported that the order Cypriniformes was the largest order of the freshwater fishes group. Similarly, by local workers, Pyone Pyone Hla (2009) and San San (2010) also reported that the species composition was the highest in the order Cypriniformes in their respective study area of central Myanmar.

Das and Sharma (2012) reported the order Cypriniformes, Siluriformes and Perciformes were most abundant in all the seasons in riverine habitats. The observed finding is agreement with that of Kullander *et al.,* (2004), they described that the order Siluriformes is one of the largest orders with ten families. In the present study, the order was Cypriniformes (39.53%), Siluriformes (27.90%) and Perciformes (16.27%) in each.

According to collected data, the species composition of fish species showed that the family Cyprinidae (32.55% and 14 species) was the most dominant groups, followed by families Bagridae (16.27% and 7 species), Cobitidae, Mastacembelidae and Channidae (6.97% and 3 species each), Siluridae (4.65% and 2 species) and the remaining families each with 2.32% respectively during the study period.

Nyanti (1995) and Leh (2000) reported that approximately 66% and 46 % respectively of the fish collections in Sarawak were from the Cyprinidae family. The freshwater fish faunas of East and South East Asia are dominated by cyprinids (Rainboth, 1991). Similarly 32.55% Cyprinidae were dominant among the fish fauna in the study area.

Based on monthly occurrence and abundance data, the highest number of species (30) and individuals (1575) were recorded in cold month (January) during the study period. The lowest individuals of (381) and species number (18) were recorded in hot month (February). Htay Htay Sein (2010), Ni Ni Aye (2013) and Aye Su Mon (2016) reported that the highest individuals were observed in cold season. The present study agrees with the findings of above mentioned authors.

With respect to the individual species, *Puntius sophores* was the dominant species and occurred throughout study period. During the study period, it was recorded (1468) in total of (6170) individuals. It was assumed that *Puntius sophores* has high productivity in study area.

Conclusion

Knowledge of available resources and the biological characters of species serve the baseline information for further studies on resource conservation and maintenance. Based on the average relative abundance, 28 species are uncommon (uC), 11 species common (C) and four species very common (vC) during the study period. The present work will provide future strategies for development and fish conservation.

Acknowledgements

I would like to express we appreciation to Dr Win Swe, Rector, Shwebo University and Dr Myo Myo, Pro-Rector, Shwebo University for their interest in my research work and constant encouragement. Thank are also due to Dr Khin Than Htay, Professor and Head, Department of Zoology, Shwebo University and Dr Kyi Kyi Thaw, Professor, Department of Zoology, Shwebo University, for their invaluable advice, suggestions in we research paper.

References

Aye Su Mon, 2016. Diversity and Relative Abundance of Fish Fauna in Khule In (Lake), Singu Township, Mandalay Region, *PhD Dissertation*. Department of Zoology, Mandalay University.

Bisht, M. S., Kukreti, M. and Shanti Bhuson, 2004. Relative abundance and distribution of bird fauna of Garhwal Himalaya. *Eco. Env & Cons.*, 10(4): 451 460.

Day, F., 1878. *The fishes of Indian being a Natural History of the Fishes Known to Inhabit the sea and Freshwater of India, Burma and Ceylon*; vol I and II. Today and Tomorrow's Book Agency, New Delhi. 776 pp.

FAO, 2003. *Myanmar Aquaculture and Inland Fisheries*. Food and Agriculture Organization of the United Nations and Network of Aquaculture Centre in Asia-Pacific. *RAP* Publication 2003/18. Bangkok. 60pp.

Ferraris, C.J., 1998. *Identification Guided to the Commercial Inland Fishes of Myanmar*, FAO, T/C.P/MYA/ 4553.57pp.

Ferraris, C.J. and M.C.C. Pinna, 1999. Higher-level names for Catfishes (Actinopterygii: Ostariophysi: Siluriformes). Proc. Calif. Acad. Sci., 51: 1-17.

Hossain, M.M., Islam, M.A., Ridgway, S. and T. Matsuishi, 2006. Mangament of inland open water fisheries resources of Bangladesh: issues and options. *Fisheries Reserch*, 77 (3): 275-284.

Htay Htay Sein, 2010. Diversity of fish fauna in Lay-Ein-Su-Let-Kyar In (Lake) in Myingyan Township, Mandalay Division. *PhD Dissertation*, Zoology Department, Mandalay University.

Jayaram, K.C., 1981. *The Freshwater Fishes of India, Pakistan, Bangladesh, Burma and Srilanka,* Zoological Survey of India. Calcutta. 475 pp.

Jayaram, K.C., 1999. *The freshwater fishes of the Indian Region.* Narendra Publishing House, Delhi. 551pp.

Jayaram, K.C., 2013. *The freshwater fishes of the Indian Region*, 2nd Edition, Narendra Published, India.

Lagler, K.F., Bardach, J.E. and R.R. Miller, 1962. *Ichthyology, study of fishes*, (first edition). Toppon Co. Ltd., Japan. 545pp.

Nelson, J.S., 1994. *Fishes of the world*, 3rd ed. Wiley, New York, 600 pp.

Ni Ni Aye, 2013. Species diversity and seasonal occurrence of fish fauna at Sunye In (Lake), Sintkaing Township. *PhD Dissertation*, Department of Zoology, University of Mandalay.

Pyone Pyone Hla, 2009. Fish fauna and their Relative Abundance in Kyee In (Lake). *PhD Dissertation*, Department of Zoology, University of Mandalay.

Rahman, A.K.A., 1992. *Wetlands and Fisheries*. Freshwater Wetlands in Bangladesh. IUCN, The World Conservation Union, Dhaka. Pp, 47-62.

San San, 2010. Seasonal abundance and commercial importance of some fishes from Inhlya In (Lake) in Singaing Township, Mandalay division. *PhD Dissertation*, Department of Zoology, University of Mandalay.

Talwar, P.K. and A.G. Jhingran, 1991. *Inland of fishes and adjacent countries.* Vol I, II Oxford and IBH publishing Co Pvt. Ltd, New Delhi, India.541pp.

Townsend, C.R., 1989. The patch dynamics concept of stream community ecology. *Journal of the North American Benthological Society*, 8:36-50.

Welcomme, R.L., 2009. *Fisheries and Aquaculture.* Vol III. Freshwater Fish: Harvest Technology.

Nesting, Nest Characteristics and Clutch Size of Some Waterbirds in Shwebo Environs

Zaw Myo Win[1], Kyi Kyi Than[2], Soe Soe[3], Htay Htay Lin[4], Swe Swe Thant[5]

Abstract

A total of ten nesting waterbird species and 65 nests were observed from three different study sites. Two nest types were observed namely, cup nest and platform nest made by waterbird. Most nesting of waterbird species were found in June and least in April. Clutch size of most waterbird was five, the largest clutch size was seven and three was least clutch size.

Key words: nesting, nest characteristics, clutch size and waterbirds

Introduction

A bird nest is the spot in which a bird lays and incubates its eggs and raises its young. Nest are primarily used for breeding, they may also be reused in non- breeding season for roosting. In most species, the female does most or all the nest construction, though the male often helps. In some polygamous species, however, the male does most or all the nest building (Campbell and Lack, 1985).

Many species of bird conceal their nests to protect them from predators. Some species may choose nest sites that are inaccessible of built the nest so as to deter predators (Rudolph *et al*., 1990).

There is great diversity in the types of nests that birds build and where they are placed, each suited to particular habitat or reproductive requirements. Nests are made of various kinds of organic materials including twigs, grass lichens, and leaves among others (Hansell, 2007).

The cup nest is smoothly hemispherical inside, with a deep depression to house the eggs. Most are made of pliable materials including grasses- though a small number are made of mud or saliva. Many passerine and a few non-passerines, including some hummingbirds and some swifts, build this type of nest (Heenan *et al.*, 2011).

Platform nests are relatively flat nests that may be located on the ground, in a tree, or on the tops of rooted vegetation or debris in shallow water. Depending on the species, these nests can be on the ground or elevated (Hyde and Kenneth, 2004).

Nest size depends on nest site, and choice of a nest hole as a breeding site may constrain the size of nests. Nests are often larger than the builder(s) themselves and sometimes considerably so, as shown by ants, termites, and some birds such as raptors (Hansell, 2007*).*

Although Shwebo Township is located in the Central Dry Zone of Myanmar, and has many different habitat types for birds including both terrestrial and aquatic birds. Since it has bushes, swamps with tall grass, lakes, paddy field, plains, median and tall trees, forested area, Shwebo environs was chosen as the study area for the present study with the following objectives:

[1] Assistant Lecturer, Dr., Department of Zoology, Shwebo University
[2] Lecturer, Department of Zoology, Shwebo University
[3] Lecturer, Dr., Department of Zoology, Shwebo University
[4] Lecturer, Dr., Department of Zoology, Shwebo University
[5] Lecturer, Department of Zoology, Shwebo University

- to evaluate the nest characteristics of some nesting bids species
- to assess the clutch size and egg characteristics of respective species

Materials and Methods

Study Area

Shwebo Township is located in the upper Central Dry Zone of Myanmar. It is situated between 22˚34´56.445˝and 26˚ 39´ 46˝ N and between 93˚ 47´ 27.673˝and96˚ 52´27.673˝E. Three different study sites were allocated to observe and record the status of bird species in Shwebo Environs.

Fig. 1 Location map of Study area (Source Google earth)

Study period

The present work was conducted from April, 2016 to March, 2017.

Nest Searching and Watching

Nest searching was conducted from April, 2016 to March, 2017. Nests were located by following individual birds carrying nesting materials or food to the nest, vocalizations from the nest sites and by active searching in thickets. During the breeding season sites were visited daily or as required. Nests were checked with binoculars (Nicula, 5×7) a distance of 6-10 m usually once every two to four days from the time they were found. Nests could be observed safely from thus distance without flushing the attending adult.

Nest Site and Nest Characteristics

Nest diameter, nest depth, nest height above the ground surface and water surface, nest materials and number of nests were also recorded according to Pettingill (1985), Nair

(2012) and Soni *et al*. (2004). Nest-tree species were also classified according to Handley and Chit Ko Ko (1987). Nest sighted dates were also recorded.

Egg Characteristics and Clutch Size

The breadth and width, description of egg were measured to the nearest 0.01 cm using caliper. Clutch size was recorded.

Identification and Classification of species

Identification of species was followed according to Smythies (2001) and Robson (2015).

Results

Recorded number of Nesting Birds and Nests

A total of ten nesting bird species were confined to nine genera, five families and four orders are aquatic birds and 65 nests were observed from three different study sites in Shwebo environs during the study periods from April, 2016 to March, 2017 (Table 1 and Table 4).

Two nest types were observed namely, cup nest and platform nest. Among them, cup nest was built by aquatic birds of *Amaurornis phoenicurus, Porzana fusca, Gallicrex cinerea* and *Plegadis facinellus, Phalacroocrax niger, Ixobrynchus sinensis, I. cinnamomeus, Ardeola bacchus, Bubulcus coromandus, Egretta garzetta* constructed Platform nest. Various materials were used to build a nest by various species of birds (Table 2 and Plate 1).

Among the recorded species, the maximum nest height recorded was *Plegadis facinellus* (mean nest height 23.68 ± 3.51 m) and *Ixobrynchus cinnamomeus* (mean nest height 1.5± 0.41 m) was the lowest (Table 4).

A total of ten nesting species recorded, the eggs colour and description varied depending upon a species (Table 5 and Plate 1).

The clutch sizes of recorded species range from three to seven according to species. The egg length and egg breadth of *Plegadis facinellus* (Glossy Ibis) was 4.98 ± 0.12 m and 3.38 ± 0.10 m is the longest and 2.93±0.00 m and 2.01 ± 0.00 m of *Porzana fusca* (Ruddy Breasted Crake) is shorted (Table 5).

Nesting of waterbirds was found the highest in June (nine species) and one species in Aprilas least in present study periods (Table 3).

Table 1. General description of nesting bird's species of three study sites during April, 2016 to March, 2017

Sr. No.	Order	Family	Scientific Name	Common Name	Vernacular Name
1.	Pelecaniformes	Therskiornithidae	*Plegadis facinellus**	Glossy Ibis	Kha-yu-soak
2.		Ardeidae	*Ixobrychus sinensis**	Yellow Bittern	Chyone-toe-byaing
3.			*I.cinnamomeus**	Cinnamon Bittern	Sat Bying
4.			*Ardeola bacchus**	Chinese Pond Heron	Byaing-auk
5.			*Bubulcus coromandus**	Eastern Cattle Egret	Kywe-kyaung-byaing
6.			*Egretta garzetta**	Little Egret	Wai-tha-li-byaing
7.	Suliformes	Phalacrocoracidae	*Phalacrocorax niger**	Little Comorant	Tin Gyi
8.	Gruiformes	Rallidae	*Amaurornis phoenicurus**	White-breasted Waterhen	Ye-kyat-yin-phyu
9.			*Porzana fusca**	Ruddy Breasted Crake	Ye-ngon
10.	Charaniformes	Charanidae	*Gallicrex cinerea**	Water Cock	Baung-dok

* = Waterbird species

Table 2. Nest diameters, nest depth, nest materials and nest pattern of recorded nests during April, 2016 to March, 2017

Sr. No.	Species	Nest Diameter (cm) Mean ± SD	Nest Depth (cm) Mean ± SD	Nesting Materials	Nest Pattern
1.	*Plegadis facinellus**	26.00 ± 2.5	8.75 ± 0.75	Dead Stick and dried leaves	Platform
2.	*Ixobrynchus sinensis**	10.68 ± 0.65	6.2 ± 0.27	Leaves of *Cyperus tegetum* (Wet-La)	Platform
3.	*I.cinnamomeus**	12.98 ± 0.63	0.98 ± 0.15	Stalk of *Oriza sativa sp*.	Platform
4.	*Ardeola bacchus**	12.03 ± 1.49	1.36 ± 0.43	Dead Stick	Platform
5.	*Bubulcus coromandus**	11.09 ± 1.36	1.22 ± 0.76	Dead Stick	Platform
6.	*Egretta garzetta**	12.03 ± 1.49	1.36 ± 0.43	Dead Stick	Platform
7.	*Phalacrocorax niger**	16.23 ± 0.27	15.1 ± 0.40	Dead Stick and dried leaves	Platform
8.	*Amaurorni sphoenicurus**	19.13 ± 1.11	7.90 ± 0.85	Stalk and Leaves of grass	Cup
9.	*Porzana fusca**	15.00 ± 0.00	5.00 ± 0.00	Stalk and Leaves of *Oriza sativa sp*.	Cup
10.	*Gallicrex cinerea**	17.67 ± 3.24	4.56 ± 0.45	Leaves of Grass, Stalk of *Oriza sativa sp*.	Cup

* = Waterbird species

Table 3. Monthly number of nesting species recorded in three study sites during April, 2016 to March, 2017

Sr. No.	Species	April	May;	June	July	Aug;	Sep;	Oct;	Nov;	Dec;	Jan;	Feb;	Mar;
1.	*Plegadis facinellus**	-	-	+	-	-	-	-	-	-	-	-	-
2.	*Ixobrynchus sinensis**	-	-	-	+	+	-	-	-	-	-	-	-
3.	*I. cinnamomeus**	-	-	+	+	-	-	-	-	-	-	-	-
4.	*Ardeola bacchus**	+	+	+	-	-	-	-	-	-	-	-	-
5.	*Bubulcus coromandus**	-	+	+	+	-	-	-	-	-	-	-	-
6.	*Egretta garzetta**	-	-	+	+	+	-	-	-	-	-	-	-
7.	*Phalacrocoracx niger**	-	+	+	-	-	-	-	-	-	-	-	-
8.	*Amaurornis phoenicurus**	-	-	+	-	-	-	-	-	-	-	-	-
9.	*Porzana fusca**	-	-	+	-	-	-	-	-	-	-	-	-
10.	*Gallicrex cinerea**	-	+	+	+	-	-	-	-	-	-	-	-
Total number species		1	3	9	4	2	0	0	0	0	0	0	0

*=Waterbird, + = Present, - = Absent

Table 4. Nest number, nest site and nest height of the nest encountered during April, 2016 to March, 2017

Sr. No.	Species	No. of Nest	Nest Site	Nest Height (M) Mean ± SD
1.	*Plegadis facinellus**	8	*Tamarindus indica* (Magyi)	23.68 ± 3.51
2.	*Ixobrynchus sinensis**	5	*Cyperus tegetum* (Wet-La), *Oriza sativa sp*. (Paddy Plants)	2.10 ± 0.94
3.	*I.cinnamomeus**	5	*Cyperus tegetum* (Wet-La), *Oriza sativa sp.* (Paddy Plants)	1.5± 0.41
4.	*Ardeola bacchus**	6	*Albizia labbek* (Koke -Ko) and *Tamarindus indica* (Magyi)	13.67 ± 4.50
5.	*Bubulcus coromandus**	7	*Albizia labbek* (Koke -Ko) and *Tamarindus indica* (Magyi)	15.54 ± 0.99
6.	*Egretta garzetta**	5	*Albizia labbek* (Koke -Ko) and *Tamarindus indica* (Magyi)	15.72 ± 0.67
7.	*Phalacrocoracx niger**	6	*Tamarindus indica* (Magyi)	25.12 ± 0.51
8.	*Amaurornis phoenicurus**	3	*Sacchanum spontaneum* (Kaing- grass) and *Carex pandanophylla* (Myet-mont- nyin)	2.5 ± 0.40
9.	*Porzana fusca**	1	*Oriza sativa sp*. (Paddy Plants)	1.7± 0.00
10.	*Gallicrex cinerea**	9	*Oriza sativa sp*. (Paddy Plants)	1.67 ± 0.37
	Total number of nest	65		

*= Waterbird

Table 5. Egg Characteristics and clutch size of recorded nest during April, 2016 to March, 2017

Sr. No.	Species	Egg Length (cm) Mean ± SD	Egg Breadth (cm) Mean ± SD	Egg Colour	Clutch Size Mean ± SD
1.	*Plegadis facinellus**	4.98 ± 0.12	3.38 ± 0.10	Deep blue	5 ± 0.00
2.	*Ixobrynchus sinensis**	3.04 ± 0.02	2.14 ± 0.01	White	3.5 ± 0.70
3.	*I. cinnamomeus**	3.63 ± 0.00	2.48 ± 0.30	White to milky	4 ± 0.00
4.	*Ardeola bacchus**	3.71 ± 0.34	2.78 ± 0.14	Greenish blue	4.5 ± 0.70
5.	*Bubulcus coromandus**	4.17 ± 0.08	3.41 ± 0.01	Whitish, tinged blue or green	4.0 ± 1.41
6.	*Egretta garzetta**	4.29 ± 0.04	3.19 ± 0.04	Pale blue green	4.0 ± 1.41
7.	*Phalacrocoracx niger**	4.35 ± 0.05	2.55 ± 0.15	Pale bluish-green	5 ± 0.00
8.	*Amaurornis phoenicurus**	3.21 ± 0.32	2.62 ± 0.14	Pink with brown spot	5 ± 0.00
9.	*Porzana fusca**	2.93±0.00	2.01 ± 0.00	Whitish to pinkish cream	7 ± 0.00
10.	*Gallicrex cinerea**	3.99 ± 0.35	2.74 ± 0.27	Reddish with brown spot	5.0 ± 1.0

*= Waterbird

A. *Plegadis facinellus*

B. *Ixobrynchus sinensis*

C. *I. cinnamomeus*

D. *Ardeola bacchus*

E. *Bubulcus coromandus*

F. *Egretta garzetta*

Plate 1 Nests of recorded species with eggs and nestlings

G. *Phalacrocoracx niger*

H. *Amaurornis phoenicurus*

I. *Porzana fusca*

J. *Gallicrex cinerea*

Plate 1 Continued

Discussion

In the present study, a total of ten nesting waterbirds build two nest types of cup and platform shaped. Among these, the most common nest type encountered was platform type. Platform nests used by most waterbirds were built mostly in aquatic environment, out of which reached from most predators. Moreover, living in a colony also afforded protection. Nest pattern may perhaps important for the breeding success and bird populations.

The type of nest constructed by birds is thought to be a factor affecting clutch size in birds, with clutch sizes being larger in relatively secure nests than in more vulnerable nests (Lack, 1968).

In the present study, a total of ten nesting species recorded, the eggs colour are pure white, greenish blue to blue and deep blue, varying background colour painted with reddish to brown spots, whitish background colour tinged with blue or green.

Traditionally avian egg colouration has been explained as a result of natural selection to reduce predation (Underwood and Sealy 2002).

In present study, a total of ten recorded nesting species, the egg length is from 2.01 ± 0.00 m to 2.93 ± 0.00 m and egg breadth is 3.14 ± 0.01 m to 4.29 ± 0.04 m.

The size of the eggs is related to the size of the parent, so small eggs will belong to small birds and large eggs to larger birds (Paul Baicich and Colin Harrison, 2012).

The number of eggs varies from four to seven depending upon the species in the present study.

Clutch size also varies within species, depending on age of the female, latitude, time of year, temperature, feeding conditions, and etcetera. In many single-brooded species there is a decline in clutch size with progressive time of laying (layging date) (Klomp, 1970).

Nest of waterbird species were occurred from April to August in present study periods. The remaining months were not occurred.

Jones, *et al*., (1976) showed that some nests were found in each month of the year but nearly 80 percent of the nests were found during a period of five month (March to July) and the greatest reproductive activity occurred in April, May and June. So, it may be assumed that many water bird species bred from April to August in a year.

Conclusion

According to the results, the present study area is favorable for successful reproduction and foraging of avifauna because it have bushes, swamps with tall grass, lakes, paddy field, plains, median and tall trees, forested area. Therefore, conservation efforts need to focus not only on protection of nesting birds with their nests, but also large-scale preservation of adjacent foraging habitats.

Acknowledgement

We are very grateful to Dr Win Swe and Dr Myo Myo, Pro-rectors, Shwebo University for their encouragement. We would like to thank Dr Khin Than Htay, Professor and Head, Department of Zoology, Dr Kyi Kyi Thaw, Professor, Department of Zoology for her rendering suggestions.

References

Campbell, Bruce; Lack and Elizabeth., 1985. A Dictionary of Birds, Carlton, England: T and A D Poyser, *ISBN 0-85661-039-9*.

Handley, H.G. and Chit Ko Ko., 1987. *List of Trees, Shrubs, Herbs and principal climber of Burma*. Supdt. Govt. Printing and Staty. Rangoo, Myanmar, 590pp

Hansell, M., 2007. *Bird Nests and Construction Behaviour*, Cambridge University Press, *ISBN 0-521-01764-5.*

Heenan, Caragh; Seymour, R., 2011. *"Structural support, not insulation, is the primary driver for avian cup-shaped nest design"*, Proceedings of the Royal Society B, *278 (1720): 2924–2929.*

Hyde and Kenneth., 2004. *Zoology: An Inside View of Animals, Dubuque, IA: Kendall Hunt, p. 474,* ISBN 0-7575-0997-5.

Johnson, A., 2016. What hatched here? How to identify eggshells. *Bird Egg Identification.*

Jones, P. J., & P. Ward.1976. The level of reserve protein as the proximate factor controlling the timing of breeding and clutch size in the Red-billed Quelea, Queleaquelea. *Ibis* 118: 547-574.

Klomp, H., 1970. The determination of clutch-size in birds: a review. *Ardea*, 58: 1-124.

Nair, M.V., Pardhan, S.M. and Pardhan, A.K., 2012. *A photographic Field Guide of Common Nesting Birds of Odisha*. *Odisha (India) Wildlife Organisation.*

Paul, B. and Harrison, C., 2012. *Nests, Eggs, and Nestlings of North American Birds.*

Pettingill, O.S.Jr., 1985. *Ornithology in laboratory and field.* Academic Press, London.

Robson., 2015. *Birds of South-East Asia.Thailand, Penisular Malaysia, Singapore, Vitenam, Cambodia, Laos and Myanmar*. New Holland Publishers (UK) Ltd. Third edition.

Rudolph, D. C., Kyle, H. and Conner, R. N., 1990."*Red-cockaded woodpeckersvs. Rat Snakes: The effectiveness of the resin barrier*" (PDF), Wilson Bull., 102(l): 14–22nt.

Smythies, B.E., 2001. *The Bird Burma*. Oliver and Boyd. Fourth edition Natural History Publication (Borneo).

Soni, V.V., Sharma, P., Davae, S.M., Bahalodia, K. and Vijayakumar., 2004. Nesting ecology of some terrestrial birds in Rajkot city city (Gujarat). *Journal of current Bioscience 2(1).*

Underwood, T.J. and Sealy, S. G., 2002. Adaptive significance of egg colouration. In: Deeming DC (ed). *Avian incubation, behaviour, environment and evolution*. Oxford University Press, Oxford, pp 280–298.

Meiotic Behaviour of *Tamarindus indica* L.

Khaing Khaing Myint[1], Nilar[2], Khin Zarli Tun[3]

Abstract

In the study on meiotic behaviour of *Tamarindus indica* L., it was showed that mean number of univalent chromosomes per cell was (1.27 ± 0.68) and bivalent chromosomes per cell was (11.72 ± 0.32). Laggard and bridge chromosomes were no more than (0.17 ± 0.10). Therefore, normal pollen fertility was greater than abnormal pollen sterility. Investigation of chromosomes behavior during meiosis is essential for understanding the genetic stability of a species.

Key words: *Tamarindus indica* L, chromosomes behavior, genetic stability.

Introduction

Tamarindus indica L. is indigenous to the drier savanas of tropical Africa, but it certainly naturalized long ago in tropical Asia. Tamarind is now cultivated in all tropical countries, on a plantation scale in India, and it is economically important all over South-East Asia. (Verheij & Coronel, 1992)

It has many uses. The green fruits and flowers may be used for souring soupy dishes of fish and meat. The fruits of sour types are made into juice, jam, syrup and candy. Tamarind seeds are also edible after soaking in water and boiling to remove the seed-coat. Flour from the seed may be made into cake and bread. The seed oil which resembles linseed oil and is suitable for making paint and varnish. (Verheij & Coronel, 1992)

The bark is astringent and tonic and its ash may be given internally as a digestive. Incorporated into lotions or poultices, the bark may be used to relieve sores, ulcers, boils and rashes. It may also be administered as a decotion against asthma and amenorrhea and as a febrifuge. Young leaves may be used in fomentation for rhumatism, applied to sores and wounds, or administered as a poultice for inflammation of joints to reduce swelling and relieve pain. A sweetened decoction of leaves is good against cough and fever. Filtered hot juice of young leaves and poultice of the flowers are used for conjunctivitis. The pulp may be used as an acid refrigerant, a mild laxative and also to treat scurvy. Powdered seeds may be given to cure dysentery and diarrhoea. (Verheij & Coronel, 1992)

Tamarind grows well over a wide range of soil and climatic conditions. It is found in places with sandy to clay soils, at low to medium altitudes, where rainfall is evenly distributed or where the dry season is long and very pronounced. It is a multipurpose tree. Hence, it is necessary to clarify the cytogenetic behaviour of this species. The aim of this study is to provide more information on the meiotic of *Tamarindus indica* L. which is a useful genetic stability of a species and beneficial for further research concern with the *Tamarindus.*

[1] Associate Professor, Dr., Department of Botany, Shwebo University
[2] Demonstrator, Department of Botany, Sagaing University
[3] Demonstrator, Department of Botany, Sagaing University

Materials and Methods

Material

Tamarindus indica L. was used in the present study and it was collected from Monywa.

Methods

(1) Collection of young flowers buds for PMCs study

As soon as young flowers bud were collected from collection site, they were fixed in the Carnoy's solution. After that the samples were transferred to 70% ethanol for long utilization.

(2) Slide preparation and cytological analysis

Meiotic chromosome divisions of pollen mother cells of this species was investigated by the Giemsa squash technique according to Beeks (1955).

The anthers were taken off from young flowers buds and placed on the glass slide, and them a drop of Giemsa stain was added on the anthers. After that the undesired materials were again removed from the glass slide and the samples were coverd withthin glass cover slip. The anthers were crushed by using pencil eraser. Then a drop of acetic acid was added and press with uniform thumb pressure to obtain well spread slide. In this way the slide was ready to observe the PMCs characters under the microscope. Fifty cells from each species were examined for metaphase, anaphase, telophase, sporeterod study and hundred pollen grains for pollen study.

(3) Photomicrograph

Chromosone pairing at metaphase I stage, chromosome movement at anaphase I stage chromosome and nucleus forming condition at telophase I stage, metaphase II, anaphase II, telophase II stage, normal spore tetrad, spore tetrad with micronuclei, normal pollen and abnormal pollen with clear images were taking photograph.

Results

Scientific name - *Tamarindus indica* L.
English name - Tamarind
Myanmar name - Magyi
Family - Fabaceae
Chromosome number - 2n = 24

Morphological Characters

Deciduous large tree; bark rough, fissured, grayish-brown. Leaves alternate, stipulate, petiolate, peripinnate compound. Infloresence lateral and terminal reacemes. Flowers bisexual, zygomorphic, perigynous; sepals 4, aposepalous; petal 5; apopetalous; 2 anteriar petals reduced to white scales. Stamens 7, 3 fertile and 4 staminodes, monadelphous. Ovary monocarpellary, semi inferior, marginal placentation. Fruits indehiscence legume. Seeds compress, dark brown with thick pulp.

Chromosome Characters

Metaphase I

In the univalent chromosome characters of *Tamarindus indica*, the total analyzed cells number were 50 and it was found that (1.27 ± 0.68) mean univalent per cell. The total bivalent mean number per cell was (11.72 ± 0.32) (Table 1, Fig.1.B).

Anaphase I and Telophase I study

For the occurrence of anaphase I cell with laggard chromosome was (0.15±0.2) and bridge chromosome (0.11 ± 0.06). Telephase I cell with lagard chromosome was 0.17 ± 0.10. In bridge chromosome was (0.13 ± 0.07) (Table 1, Fig. 1, C & D).

Metaphase II, Anaphase II and Telophase II

Normal chromosome pairing was found in these stages. No laggard and bridge chromosomes were observed (Table 1, Fig 1. E; Fig. 2, A & B).

Spore tetrad

50 total cell number was analyzed in spore tetrad characters. It was showed that 2.28 ± 2.11 mean number micronuclei per spore tetrad (Table 1, Fig. 2, C).

Pollen study

When studied pollen grains characters, 100 pollen grains were accounted. It was found that 80% normal pollen and 20% abnormal pollen (Table 1, Fig. 2, D).

Table 1. Mean value in Metaphase, Anaphase, Telophase, Spore tetrad and Pollen characters of *Tamarindus indica* L.

No.	Characters	Mean	S.E
1.	Univalent	1.27	0.68
2.	Bivalent	11.72	0.32
3.	Anaphase I Laggard	0.15	0.02
4.	Anaphase I Bridge	0.11	0.06
5.	Telophase I Laggard	0.17	0.10
6.	Telophase I Bridge	0.13	0.07
7.	Tetrad Micronuclei	2.28	2.11
8.	Normal Pollen	80%	
9.	Abnormal Pollen	20%	

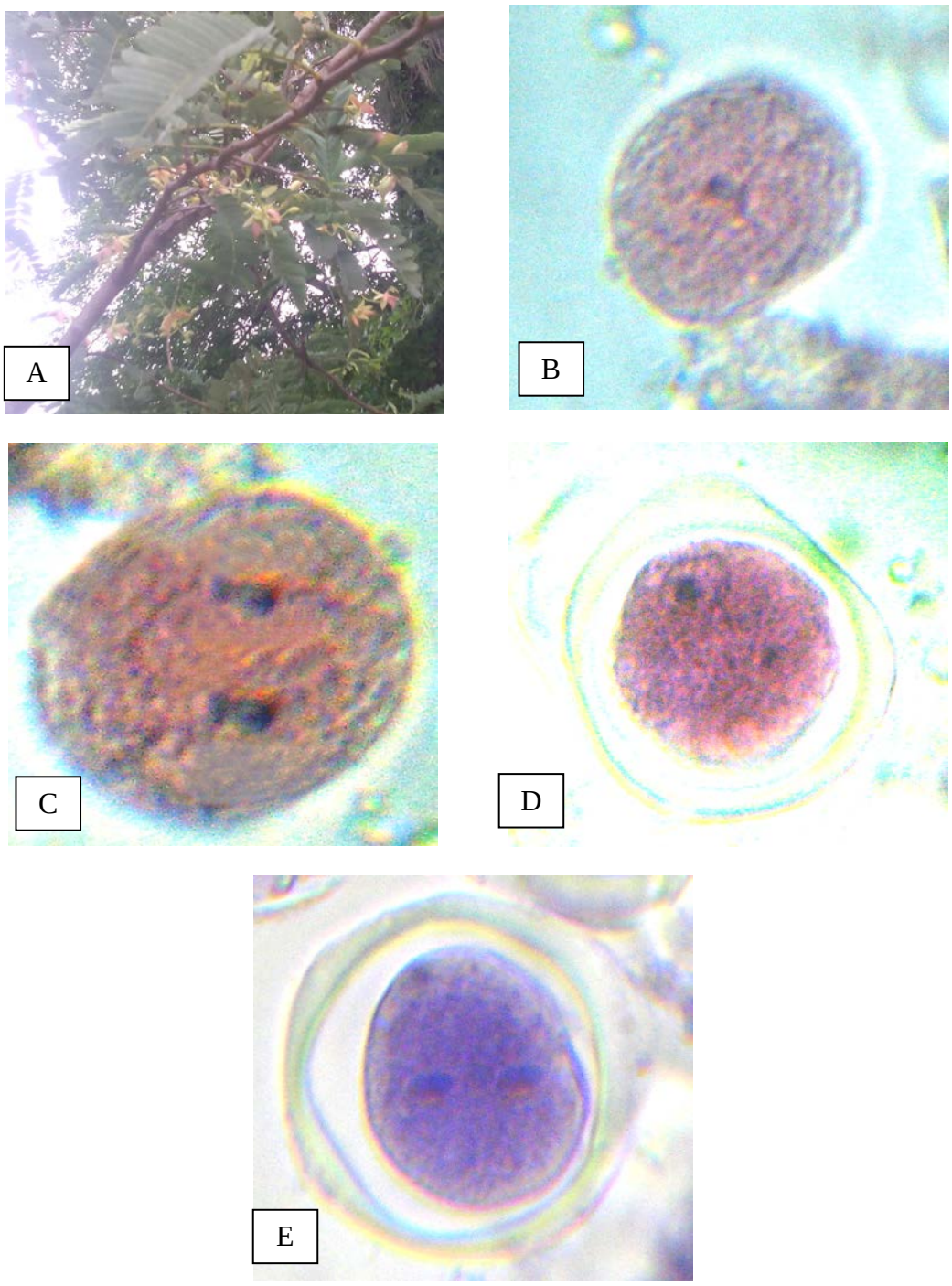


Figure 1. A. Flowering branch of *Tamarindus indica* L.
B. Metaphase I of *Tamarindus indica* L.
C. Anaphase I of *Tamarindus indica* L.
D. Telophase I of *Tamarindus indica* L.
E. Metphase II of *Tamarindus indica* L.

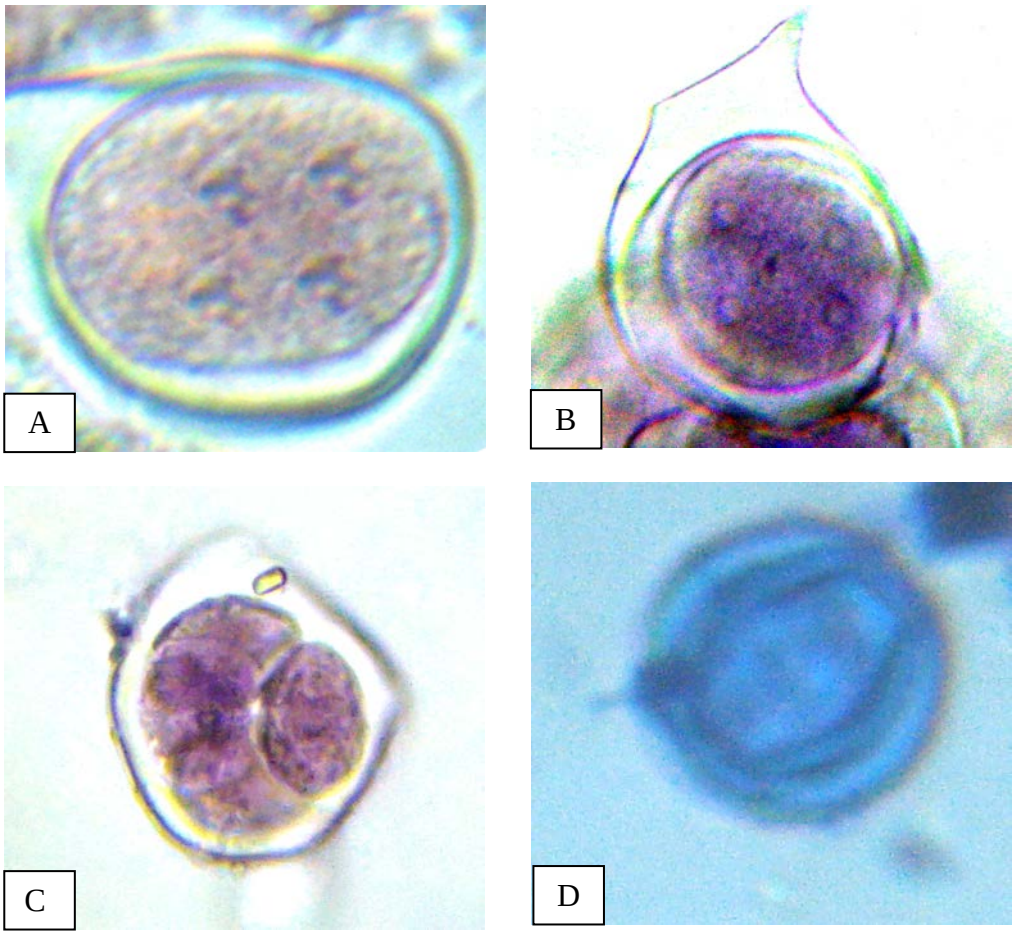


Figure 2. A. Anaphase II of *Tamarindus indica* L.
B. Telophase II of *Tamarindus indica* L.
C. Spore tetrad of *Tamarindus indica* L.
D. Normal pollen of *Tamarindus indica* L.

Discussion and Conclusion

The meiosis consists of two consecutive cell division (meiosis I and meiosis II), without DNA synthesis between them. The meiosis I is a specialized division whose purpose is to generate a haploid gamete with reduced number of chromosomes, allowing the exchange of genetic material. The meiosis II is alike to a mitotic division but the results are four haploid cells forming microspore tetrads (Harrison et al, 2010). The correct chromosome behaviour during meiosis protects the structural integrity of the genome and the right segregation to daughter cells during the cell division (Pawlowaki *et al*., 2010).

In the present meiotic study of *Tamarindus india*, mean number of univalent chromosome per cell was 1.27 ± 0.68. These univalent failed to organize at the equatorial region at metaphase I. Precocious migration of univalents to the poles is a very common abnormality among plants.

Chiasmata are responsible for the maintenance for bivalent, which permit normal chromosome segregation. In the present study of total bivalent number was 11.72 ± 0.32. According to kuwada (1919), the cytological data of plants indicated that cells with highest total bivalent number produced more fertile pollen.

Unorientation and scattering of chromosomes may be due to either their inhibition of spindle formation or destruction of spindle fibre formed. The behaviour of these and of the laggard and bridge chromosome is characteristic in that they generally lead to micronucleus formation (kodura, 1981, kumar, 2002). In the present study, the formation of laggard and bridge chromosome at anaphase I and telophase I were less than 0.15 (Table 1).

After this stage, the cells proceeded to undergo meiosis II, the lagging chromosomes observed at anaphase I were able to catch up with the other chromosomes and formed the daughter nuclei in spore tetrad stage. In the present study of spore tetrad with daughter nuclei were (2.28).

Darlington (1965) proposed that yield of plants can be assumed from its meiosis characters, especially from the study of their fertility and sterility of pollen. In the present study of fertility and sterility pollen were (80%) and (20%) present. These results may be given to basic information for further research of *Tamarindus indica* L.

Acknowledgements

First and Foremost, I would like to express my sincere gratitude to Dr. Win Swe (Rector's duty) and Dr. Myo Myo, Pro-Recors, Shwebo University, for their permission and encouragement for this research. I would like to express my sincere gratitude to Dr. Khin Hnin Yee, Professor and Head, Department of Botany, Shwebo University, for the permission to use various department facilities during the study period. I am grateful to Dr. Nilar, Professor, Department of Botany, Shwebo University, for her kind suggestions and invaluable advice for this research.

References

Beeks, R.M., (1955). Improvement in the squash technique or plant chromosomes. EI Aliso 3, 131-134.

Darlington, C.D. (1965) Meiosis in diploid. In "Cytology" J. and A. Chruchill ltd. 89-119.

Herrison, J, Alvey. E, and Henderson. L. (2010). Meiosis in Flowering Plants and Other Green Organisms Journel of Experimental Botany, 61, 2863-2875.

Kodura PRk, Rao MK. 1981. Cytogenetics of synaptic mutants in higher plants. Theor Appl Genet 59: 197-214.

Kumar G., Single. 2002. V. EMS induced chromosomal stickines in Hordeum vulgare L. The Nucleus 45: 139-142.

Pawlowaki. W. (2010). Chromosome Organization and Dynamics in Plants. Plant Biology. 1, 640-645.

Verheij and R.E Coronel (1992) Plant Resource of South-East Asia. No 2. Edible fruits and nuts Bagor, Indonesia.

Taxonomic Study On Some Bamboo Species in Momeik District, Northern Shan State

San San Wai[1], Khin Hnin Yee[2], Thandar Myat Mon[3]

Abstract

Taxonomic characteristics of some bamboo species of Momeik District, Northern Shan State were studied from July 2017 to July 2018. The total of 5 species of 4 genera belonging to subtribes Bambosinae and Arundinariinae were collected and identified. The description of the collected species was presented with relevant photographs. An artificial key to the species were also constructed.
Key words: Taxonomy, Bamboo species, Momeik District

Introduction

Bamboo is a woody grass and perennial evergreens belonging to the family Poaceae. 1000 species belonging to 80 genera are worldwide distributed.In South-East-Asia, 20 genera and about 200 species are found (Drarsfield & Widjaja, 1995). In Myanmar, 18 genera and about 100 species are found (Hundley & Chit Ko Ko, 1987). Kress *et al*., (2003) recorded that 17 genera and 92 species are found in Myanmar. Bamboo is one of the natural resources of the tropics, and because of its wide distribution, availability, rapid growth, easy handling and desirable properties, has been used widely in the daily life of the local community as a sustainable resource (Dransfield & Widjaja, 1995). Bamboo is utilized for various purposes depending upon its properties. It plays an important role in the daily life of people; for house construction, agricultural tools and implements, as food material etc. Besides a convenient source of cellulose for paper manufacture and rayon, it supports a number of traditional cottage industries. Bamboo crafts are used in making baskets, mats and ladders containers, pipes, fencing, umbrellas, tool handles, bow and arrows, fans, toys, spoons, tooth picks and many other products of household use with bamboo that was abundantly available in nearby forests. People eat young bamboo shoots by boiling them in water until they are soft and cook them mixed with meat and other vegetables. The ten major species used in upper part of Myanmar (Rawat and Khanduri, 2001). Therefore, the present research focuses on bamboo species found in Momeik District in Northern Shan State. The objective of this study was to identify and document information of bamboo plants used by local people and to give the valuable information of the bamboo grow in Momeik District.

Materials and Methods

The present study, was carried out at Momeik district, Northern Shan State. The district has a total geographical area of 2680.09 square kilometer and the study area lies betwneen N latitude 22º 53’ and 23º 26’ E longitude 96º 09’ and 97º 05’. The elevation of Momeik District is 244.0 m above the sea level. Taxonomic identification of the collected specimens were identified by the culms, culm sheaths , branching types , eye buds and leaves, referring to the books of Flora of British India, Hooker (1897), Dassanayake (1994), Stapleton (1994) and Wong (1995). An artificial key has been also constructed based on the description of individual species occured in the study area. The morphological characters of all the collected species were stated with color photographs.

[1] Lecturer, Dr Department of Botany, Shwebo University
[2] Professor and Head, Dr, Department of Botany, Shwebo University
[3] Lecturer, Dr, Department of Botany, Monywa University

Results

In the present study a total of 5 species of 4 genera belonging to subtribes Bambusinae and Arundinariinae were recorded. The lists of the collected species were shown in Table 1.

Table 1. List of the Collected Species

Family	Subfamily	Tribe	Subtribe	No.	Scientific name
Poaceae	Bambusoideae	Bambuseae	Arundinariinae	1.	*Arundo donax* L.
			Bambusinae	2.	*Bambusa vulgaris* Schroder. ex. Wed
				3.	*Bambusa wamin* E.G. Camus
				4.	*Dendrocalamus giganteus* Wallich ex Munro
				5.	*Thyrsostachys siamensis* Gamble.

1. ***Arundo donax*** L. Sp. Pl. 1: 81. 1753. (Figure 1)

Local name : Kyuwa, Alokyu
English name : Giant reed
Flowering period : Unknown

Deciduous, a tall perennial reed, rhizome knotty, about 6 m height; culms very stout, erect, 15.0-30.0 cm long, hollow, unbranches or with bamboo like clusters of slender branches from the nodes, 1.0-2.0 mm in diameter, not swollen; internodes 15.0-45.0 cm long, light green, glabrous, smooth, white waxy when young, white ring present; culm sheaths thin, cylindrical, 5.0-7.0 cm long, 1.0-2.0 cm wide, smooth, pale yellow-colored, glabrous; blade narrowly lanceolate 25.0-30.0 cm long, pendulous or erect with auricle, acuminate at the apex, pale yellow colored, without bristles; ligules short, about 0.5-1.0 mm long; leaves alternate, 1 grouped; leaf-blade linear-lanceolate 30.0-50.0 cm by 2.5-5.0 cm, gray-green and a hairy tuft at the base, margins scabrous, tapering to a slender filiform apex; petioles sheathing with auricles, 5.0-6.0 mm long, green, with long bristles; ligules 1.0-2.0 mm long.

2. . ***Bambusa vulgaris*** Schrader ex. JC. Wendland Collect. Pl. 2: 26, t. 47. 1810. (Figure 2)

Bambusa thouarsii Kunth (1822)
Bambusa surinamensis Ruprecht, Scric, 6, Vol: 5: 44. 1839.

Local name : Shwe wa
English name : Common bamboo; Golden bamboo
Flowering period : Unknown

Every green, not closely tufted, sympodial, unarmed, about 21 m high culms strong, cylindrical, erect, slightly zigzag, hollow; white ring absent , branching form the lower nodes, 15.0-20.0 m long, 4.0-10.0 cm in diameter, nodes thickened, swollen, oblique, aerial roots at the basal ones; internodes 20.0-42.0 cm long, glabrous, bright yellow with dark green streaked, appressed hairs to glabrous, smooth, white, waxy when young; culm sheaths

broadly triangular, 15.0-20.0 cm long, 10.0-17.0 cm wide, smooth, straw colored, appressed black hairs; blade broadly triangular, 35.0-50.0 cm long, erect with auricles, acuminate at the tip, glabrous on the smooth back, appressed dark brown hairs, the inner surface strongly ribbed with dense; ligules about 1.0-3.0 mm long, slightly serrated; auricles 1.0-2.0 cm long, long bristle along the edges. Leaves 6 to 9 grouped at the end of a branch; petioles sheathing with auricles, 5.0-6.0 mm long, green, with long bristles; leaf blade linear-lanceolate, 5.0-30.0 cm by 1.0-4.5 cm, green and glabrous, with a rounded to cuneate base and acuminate at the tip, the edge smooth; ligules a truncate rim 0.4-1.0 mm long, glabrous on the adaxial surface, puberulent on the abaxial surface; auricles small rounded lobes, eciliate.

3. *Bambusa wamin* E.G. Camus. (Figure 3)

B. vulgaris f. waminii. T.H. Wen, J. Bamoo Res. 4(2) (1985) 16.

Local name : Wamin
English name : Buddha's Belly Bamboo
Flowering period : Unknown

Every green bamboo with not closely tufted, sympodial rhizome, about 6.0 m high; culms erect only slightly out arched, 3.0-5.0 m long, shining and perfectly glabrous; culm buds short and tough, closed at the front; nodes swollen, oblique; internodes short, hollow, cylindrical but basally inflated., 5.0-6.0 cm long, dark green, glabrous, smooth with white ring below the nodes; culm sheaths broadly triangular, 5.0-23.0 cm long, 10.0-15.0 cm wide, smooth, straw-colored, appressed black hairs; blades broadly triangular, 1.0-6.5 cm long, erect with auricles, acuminate at the apex, straw colored, appressed hairy on both surface; auricles 1.0-1.5 cm long, long bristle along the edges; ligules 2.0-3.0 mm long, slightly serrate. Leaves 3 to 5 grouped at the end of a branch; petioles sheathing with auricles, 2.0-3.0 mm long, green, with long bristles; leaf blades lanceolate, 7.0-2.7 cm by 1.5-3.5 cm, green and glabrous, obtuse at the base, acuminate at the apex; ligules 1.0-1.5 mm long, green, glabrous.

4. *Dendrocalamus giganteus* Wallich ex Munro Trans Linn Soc. 26:150. 1868. (Figure 4)

Bambusa giganteus Hook.f., Fl. Br. Ind. 7: 406. 1897.

Local name : Wabogyi
English name : Giant bamboo
Flowering period : Unknown

Evergreen, densely tufted, sympodial, the giant bamboo about 30 m height, culms wide, pale thin wax with arching tip, 30.0-35.0 m long, 20.0-30.0 cm in diameter, hallow; nodes not swollen; internode 20.0-50.0 cm long, dark green, glabrous, covered with a white waxy layer when young, white ring below the nodes; culm sheaths caducous, thickly leathery, broadly ovate-lanceolate, 20.0-50.0 cm long, 25.0-50.0 cm wide, whitish to grayish green when young turning pale brown with age, with dark brown hairs on the back; blades reflexed, ovate-lanceolate, 10.0-30.0 cm long, with auricles without bristle, acuminate at the apex, pale brown colour ; ligules 6.0-12.0 mm long, serrulate.Leaves 3 to 12 grouped at the end of a branch; petioles sheathing with auricles, 4.0-5.0 mm long, green, without bristles; blades oblong-lanceolate, 20.0-30.0 cm by 3.0-6.0 cm, green, glabrous above, slightly rough beneath; ligules 1.0-3.0 mm long, truncate; auricles inconspicuous lines or ridges.

5. *Thyrsostachys siamensis* Gamble Ann. Roy. Bot. Gard. Calcutta 7.59. 1896. (Figure 5)

Thyrsostachys regia (Munro). Bennet (1988).

Local name : Tiyowa

English name : Monastery bamboo, Umbrella-handled bamboo
Flowering period : Unknown

Deciduous, densely tufted, sympodial rhizomes, about 15 m heigh; culms erect with arching tips, branching towards the top only, 7.0-13.0 m long, 2.0-6.0 cm in diameter; nodes not swollen; internodes 15.0-28.0 cm long, hollow, dark green, glabrous, bearing a white ring; culm sheaths persistent, thin, with short, pale appressed hairs on outside, 16.0-17.5 cm long, 11.0-15.0 cm wide near the base, straw coloured ; blade snarrowly lanceolate, acute at apex, 6.0-10.0 cm long, erect, pubescent adaxially, ligules very short, about 0.5-1.0 mm wide, fine-hairy on the edge; auricles none. Leaves 4 to 8 groups at the end of branch; petioles sheathing with auricles, 2.0-3.0 mm long, pale green; leaf blades narrow, linear, 5.0-12.0 cm by 0.5-1.1 cm wide, green, glabrous, ligules a subentire inconspicuous rim, very short, entire, 0.2 mm long, entire, ciliate; auricles absent.

Discussion and Conclusion

The present study deals with a taxonomic study on some bamboo growing in Momeik District. Altogether 5 species belonging to 4 genera of two subtribes, Arundinariinae and Bambusinae have been identified. Among them, one species belonging to one genus is the Subtribe Arundinariinae and 4 species belonging to 3 genera are under the subtribes Bambusinae. To identify bamboo species, the most important parts of the habit are culms, culm sheaths, leaves and leaf sheaths. The rhizome type of bamboo species *Arundo donax* L. is knotty. The rest 4 species, *Bambusa vulgaris* Schrader ex.Wed, *Bambusa wamin* E.G.Camus, *Dendrocalamus giganteus* Wallich ex Munro and *Thyrsostachys siamensis* Gamble are sympodial.

In the study area, *Bambusa wamin* E.G. Camus and *Bambusa vulgaris* Schrader ex. Wed pocess swollen nodes, *Arundo donax* L., *Dendrocalamus giganteus* Wallich ex Munro and *Thyrsostachys siamensis* Gamble do not pocess swollen nodes. The internodes of *Bambusa wamin* E.G. Camus is shorter than the rest four species. The culm sheaths colour of *Arundo donax* L. is pale yellow and *Dendrocalamus giganteus* Wallich ex Munro is pale brown. The culm sheaths of *Bambusa vulgaris* Schrader ex. Wed, *Bambusa wamin* E.G. Camus and *Thyrsostachys siamensis* Gamble are straw-coloured .

The shape of culm sheaths is broadly triangular in *Bambusa vulgaris* Schrader ex. Wed and *Bambusa wamin* E.G. Camus. The culm sheaths are cylindrical in *Arundo donax* L.,broadly ovate – lanceolate in *Denderocalamus giganteus*, narrowly lanceolate in *Thyrsostachys siamensis* Gamble.

Bambusa vulgaris Schrader ex. Wed, *Bambusa wamin* E.G. Camus and *Dendrocalamus giganteus* Wallich ex Munro possess the long ligules and the rest 2 species possess the short ligules. The auricles is absent in *Thyrsostachys siamensis* Gamble. In the rest 3 species, auricles are found. The ligules of leaves are short in *Thyrsostachys siamensis* Gamble and *Dendrocalamus giganteus* Wallich ex Munro. In the rest 3 species ligules of leaves are long.

In Myanmar, bamboo grows in most regions, near the roadside, in the home garden, in the village and in the forest. The realization of bamboo is the most potential important in non-timber resources .The large woody culms are used for building houses, bridges and water pipes and for manufacturing furniture. The young shoots were edible. It is hoped that this research will be useful for persons belonging to various works of society. Therefore, the taxonomic study on some species of bamboo helps to know the plant resources in Momeik District. It is hoped that this paper will give some information for further studies in various ways.

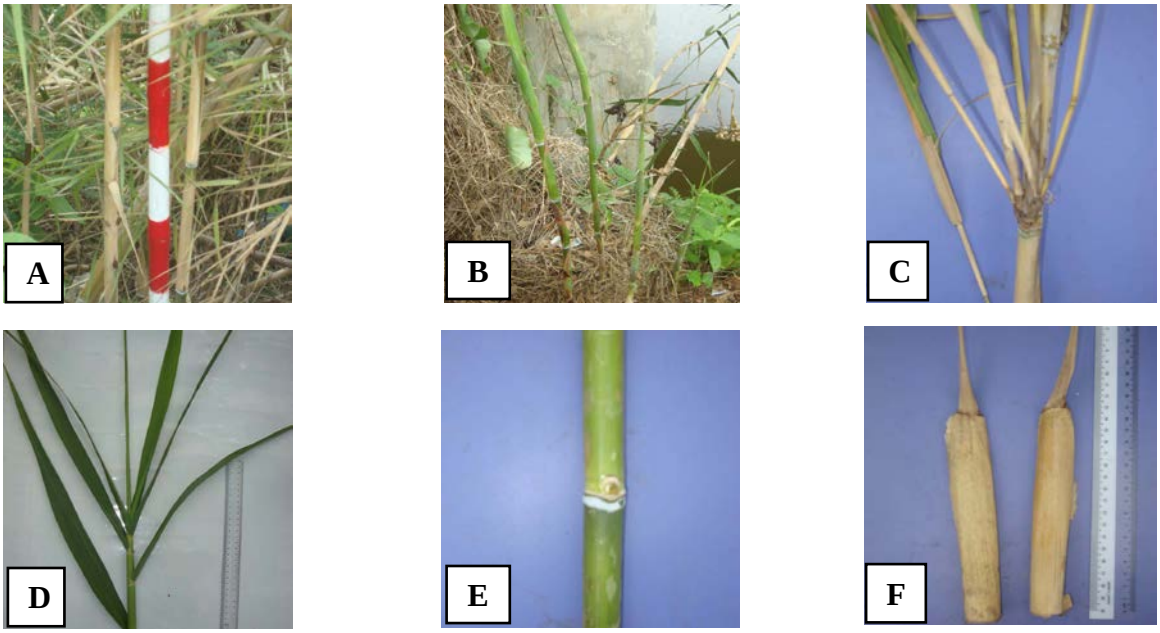


Figure 1. ***Arundo donax*** L.

A. Habit B. Young shoot
C. Branching type D. Leaves
E. Eye / Bud F. Culm sheath

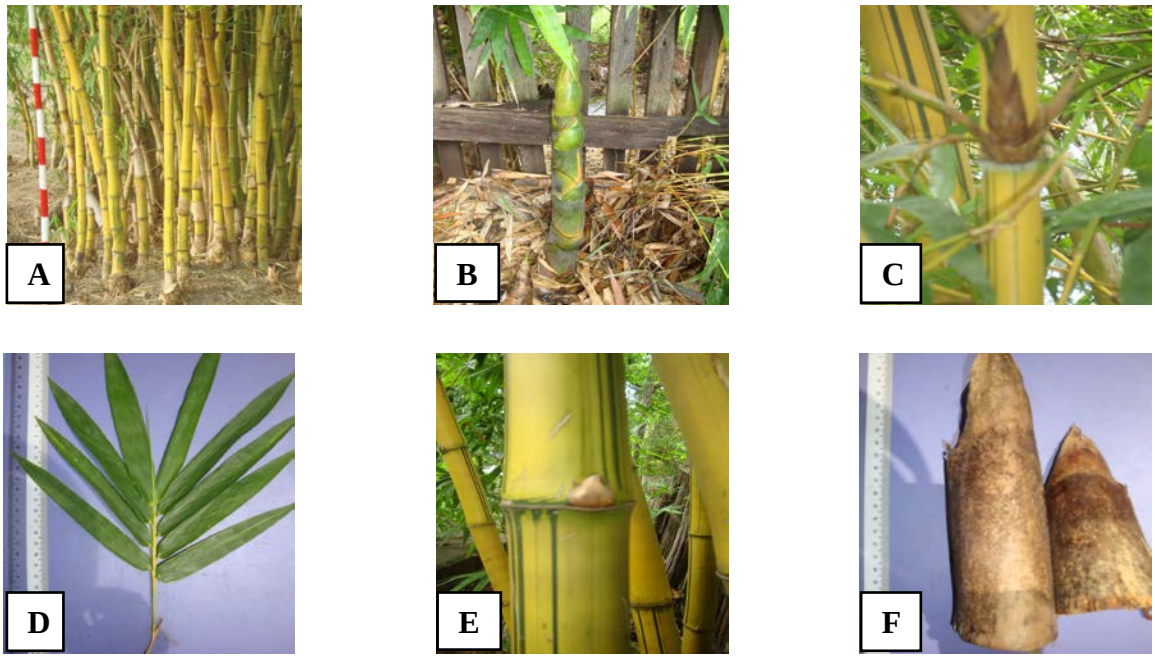


Figure 2. ***Bambusa vulgaris*** Schrader ex. Wed.

A. Habit B. Young shoot
C. Branching type D. Leaves
E. Eye / Bud F. Culm sheath

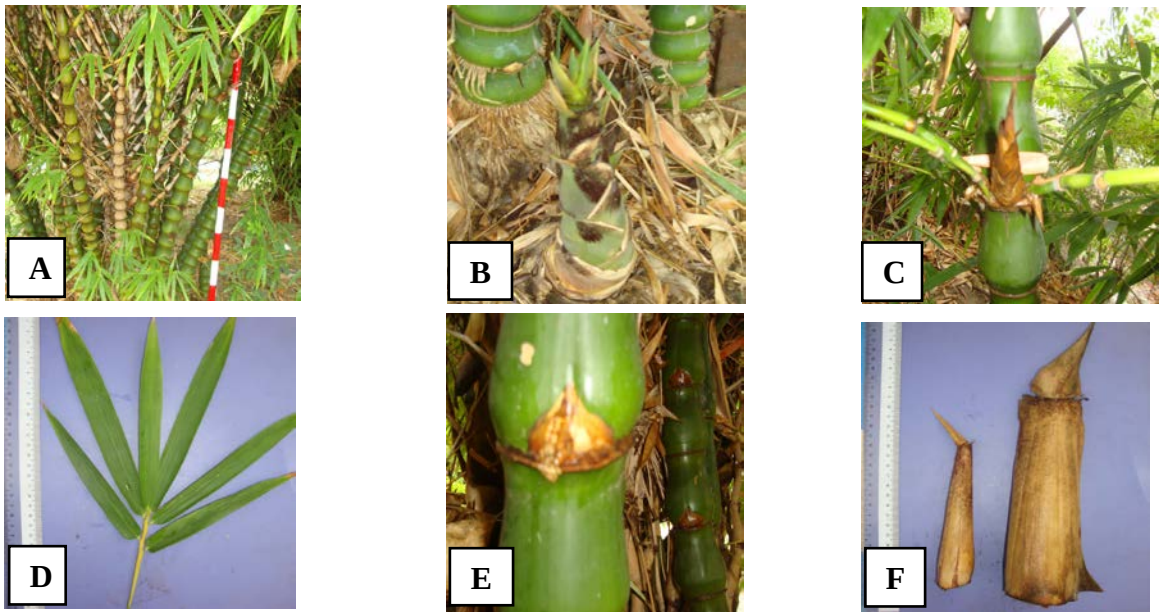


Figure 3. ***Bambusa wamin*** E.G. Camus.

A. Habit B. Young shoot
C. Branching type D. Leaves
E. Eye / Bud F. Culm sheath

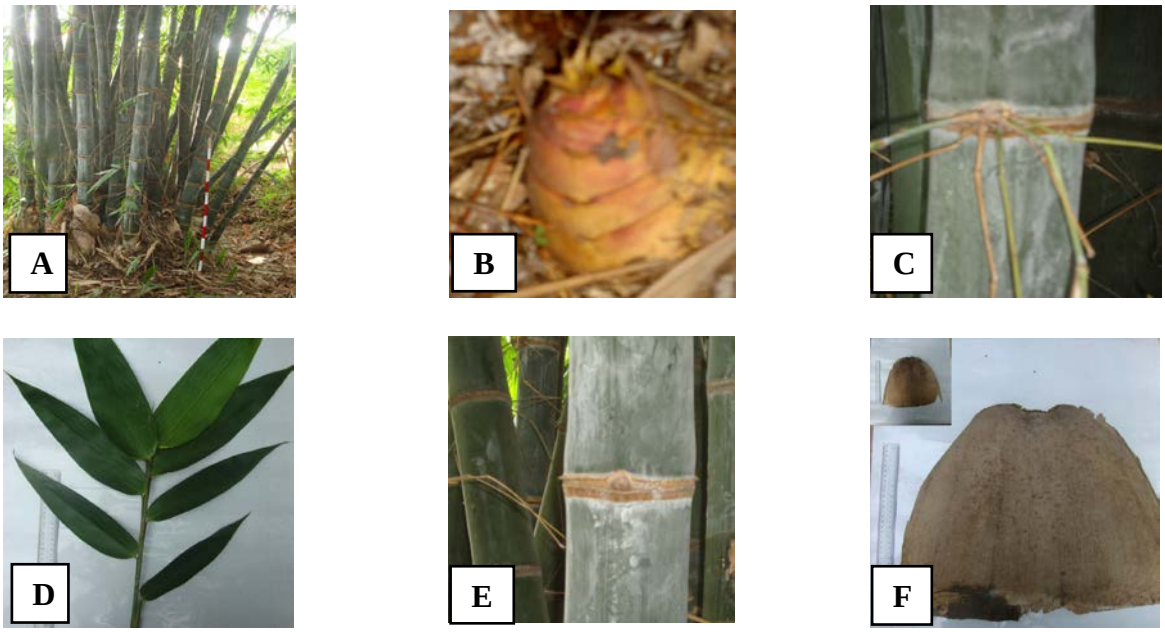


Figure 4. ***Dendrocalamus giganteus*** Wallich ex Munro

A. Habit B. Young shoot
C. Branching type D. Leaves
E. Eye / Bud F. Culm sheath

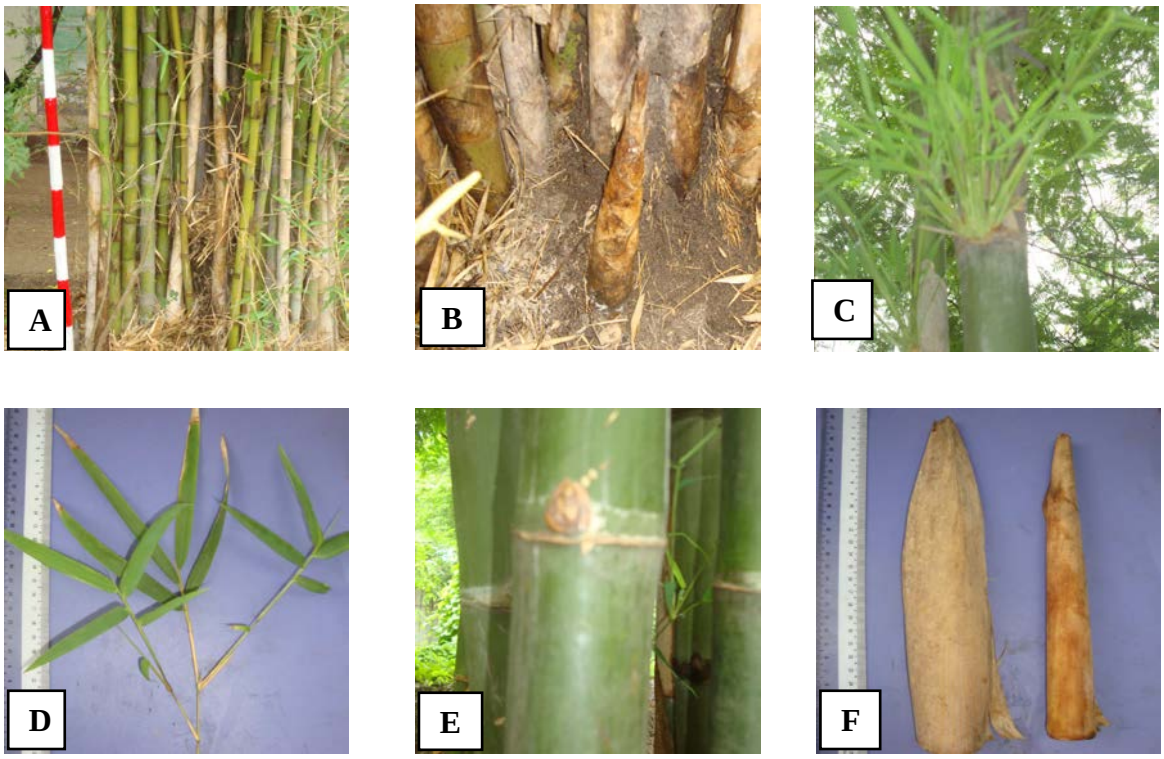


Figure 5. ***Thyrsostachys siamensis*** Gamble.

A. Habit B. Young shoot
C. Branching type D. Leaves
E. Eye / Bud F. Culm sheath

An Artificial Key to the Species

1. Reed deciduous; rhizome Knotty---------- 1. *Arundo donax*
1. Bamboos evergreen; rhizome sympodial---------- 2
   2. Culms with swoolen nodes ---------- 3
   2. Culms without swollen nodes ---------- 4
3. Culms with white ring; leaves 3 to 5 grouped---------- 3. *Bambusa wamin*
3. Culms without white ring; leaves 6 to 9 grouped---------- 2. *Bambusa vulgaris*
   4. Every green; culm -sheaths -caducous, -thickly, longer -than 20.0cm, bigger than 25.0 cm---------- 4. *Dendrocalamus giganteus*
   4. .Deciduous; -culm -sheaths- persistent, thin, -shorter -than 16.0 cm, smaller than -15.0 cm---------- 5. *Thyrsostachys siamensis*

Acknowledgements

We would like to express our special thanks to Pro-rector (Rector's duty) Dr Win Swe, Shwebo University, and Dr. Myo Myo, Pro-Rector, Shwebo University, for their permission to conduct this research. We would also be grateful to Dr. Khin Hinn Yee, Professor and Head, Department of Botany, Shwebo University, and Dr Nilar, Professor, Department of Botany, Shwebo University, for providing all the research facilities and helpful opinions concerning this work. We are very thankful to Dr. Soe Myint Aye, Director Deputy-General, Department of Higher Education, Nay Pyi Taw, for his guidance and invaluable suggestions.

References

Backer, C.A & R.C. Brink. 1968. Flora of Java, 3: 496-641 N.V.P. Noordholf Groningen.
Dassanayake, M.D. 1994. A revised handbook to the flora of ceylon, Vol. 3.
Dransfield, S. 1981. The genus *Dinochloa* (Gramineae-Bambusoideae) in sabah. kew. bull., 36: 613-633.
Hooker, J.D. 1897. The flora of British India. Vol. 7. Reeve and Co. Ltd. England.

Hundley, H.G & Chit Ko Ko, 1987. List of trees, shrubs, herbs and principal climbers etc. recorded from Burma. P. 299-324. supdt.Govt. Printing and stationary, Burma.

Kress, J., W.R. A. Defilipps, E. Farr & Yin Yin Kyi. 2003. A checklist of the trees, shrubs, herbs and climbers of Myanmar.

Nwe Nwe Hninn. 2007. Morphology, Anatomy and Chemical Analysis on four bamboo species for various utilization, PhD Dissertation, Department of Botany, University of Mandalay.

Nanko, H., B. Allan & H. Dave. 2005. The world of Market Pulp. Appleton, WI, USA: WOMP, LLC. p-256. ISBNO-615.13013-5.

Puri, H.S. 2003. Rasayana ayurvedic herbs for longevity and rejuvenation London: Taylor 2. Francis. pp. 71-73. ISBN 0203216563.

Stapleton, C. 1994. Royal Botanic Garden Edimburgh, Royal Botanic Gardens Kew, Nepal.

Thomas, R. 1979. A commentary on the Bamboos (Poaceae : Bambusoideae). Biotropica 11(3): 161-172.

Wong, K.M. 1995. The Morphology, Anatomy, Biology and Classification of Peninsular Malaysian Bamboos. University of Malaya Botanical Monograph No. 1. University of Mala

Antifungal Activity of *Bacillus* sp. Against Anthracnose Disease of Greengram

Thandar Myat Mon[1], Khin Hnin Yee[2], Zaw Lwin Oo[3]

Abstract

Antifungal effect on pathogenic microorganisms that causes the antharcnose diseases of greengram was studied by using *Bacillus* sp. isolated from leaves of *Catharanthus roseus* (L.) G. Don. This experiment was conducted at the Microbiology Laboratory, Department of Botany, Monywa University. The isolation of endophytic bacteria was conducted by using AB medium. The identification of isolated bacteria was confirmed as *Bacillus* species by the studies of morphological character and biochemical tests. Pathogenic fungi were isolated from the infected leaves of greengram. The resulting strain was designated as *Colletotrichum* sp. The assay for antifungal was performed on Potato Dextrose Agar (PDA) medium by dual culture method. The result of percent growth inhibition over control was presented in this investigation. Although the isolated *Bacillus* bacteria possess the positive effect on anthracnose disease of greengram, the antifungal inhibition occurred on *Colletotrichum* sp. strain.

Key words: Antifungal properties, dual culture method, *Colletotrichum* sp.

Introduction

The crop suffers from several fungal diseases and among them, anthracnose caused by *Colletotrichum* spp is one of the serious disease observed regularly in greengram growing areas of Maharashtra. Symptoms are most visible on leaves and ripe fruits at first, anthracnose generally appears on leaves as small and irregular yellow, brown, dark brown or black spots. The spots can expand and merge to cover the whole affected area (Kulkarni, 2009).

Fungus produces definite spots on leaves, which are initially brown, later turning grey or dirty grey with narrow reddish brown margin bearing fructification on both the surfaces (Kavyashree, 2014). Greengram is attacked by several pathogens, including fungi, bacteria and viruses (Quebral and Cagampang, 1970). On an average 14% of the total loss in crop yield is due to plant diseases and more than 50% plant diseases are caused by fungi leading to huge economic loss (Agrios, 2005).

Greengram, *Vigna radiata* (L.) Wilczek, an ancient and well known leguminous crop of Asia, commonly called as mung bean is an important pulse crop of India (Veena, 2012). Greengram has nutritional, medicinal as well as ecological importance. It is a source of easily digestible proteins (20-26 %), besides containing 1.3 % fat, 60.4 % carbohydrates and negligible flatulence-causing factors (Malik, 1994).

Catharanthus roseus (L.) G. Don is an important medicinal plant of family Apocynaceae. *Catharanthus roseus* (L.) G. Don is a herbaceous plant traditionally used in medicine to cure diabetes and blood pressure. It is cultivated mainly for its alkaloids, which are having anticancer activities (Jaleel *et al*., 2009). *Catharanthus roseus* (L.) G. Don also possesses good antibacterial, antifungal, anti-oxidant, anti-diabetic and antiviral potential (Nisar *et al*., 2016). In addition, decoctions of the plant leaves have been used for maladies

[1] Lecturer, Dr, Department of Botany, Shwebo University
[2] Professor and Head, Dr, Department of Botany, Shwebo University
[3] Associate Professor, Dr, Department of Botany, Kyaing Tong University

ranging from ocular inflammation, diabetes, hemorrhage to treating insect stings and cancers (Siddiqui *et al*., 2010).

The *Bacillus* genus is a heterogeneous group of Gram-positive, facultative anaerobic, endospore-forming bacteria and ubiquitous in nature. Colony morphology and size are very variable between and within species. *Bacillus* cells may occur singly and in pairs, in chains and as filaments. The rod-shaped cells of *Bacillus* species are usually round-ended, cell diameters range from 0.4 to 1.8 µm and lengths from 0.9 to 10.0 µm. After 24–48 hr incubation, colonial sizes of mesophilic strains typically range from 1 to 5 mm; color commonly ranges from buff or creamy-gray to off-white (Graumann, 2007).

Colletotrichum sp. is one of the most important phytopathogens worldwide causing the economically important disease anthracnose in a wide range of hosts (Bailey and Jeger, 1992). The average seed yield loss of 40.18% and stalk yield loss of 46.90% was noticed due to anthracnose of greengram (Kulkarni, 2009). *Colletotrichum* sp. produced dark grey colonies and formed typically cylindrical conidia with rounded ends. The other colonies were white to orange in color. On the reverse side, the centre was dark orange to pink (Silvaa *et al.*, 2017). *Colletotrichum* spp. is characterized by conidiophores simple, elongate and conidia hyaline, 1-celled, ovoid or oblong. These characters were observed in present results of strain (Barnett, 1955).

The investigation on antifungal effect of Bacillus sp. isolated from leaves of *Catharanthus roseus* (L.) G. Don is still needed. The objectives of the present study are to investigate the antifungal effect of endophytic bacteria, *Bacillus* sp. isolated from leaves of *Catharanthus roseus* (L.) G. Don, to describe the anthracnose disease of green gram, to study their macroscopical and microscopical characters of pathogenic fungi and to determine antifungal activity of *Bacillus* sp. against anthracnose diseases of greengram.

Materials and Method

Isolation of *Bacillus* sp.

The leaves samples of *Catharanthus roseus* (L.) G. Don were collected from Monywa University. Isolation of endophytes from leaves was done as soon as possible after the samples were brought to the Microbiology laboratory of Department of Botany, Monywa University. In the isolation of *Bacillus* sp., AB medium were used as the basal culture media according to Atlas, 1993. The composation of AB medium was shown in Table 1.

The leaves samples were washed in running tap water to remove adhered epiphytes and soil debris. After proper washing, the leave samples were surface sterilized by step-wise washing in 99% ethanol for 1 min, rinsed in sterile water for 1 min, then immersed in a 5% solution of sodium hypochlorite for 5 min, followed by three rinses (one min each) in sterile distilled water. Each leaf was cut into small pieces. Then, the leaf pieces were washed three times at one minute in each time in sterilized distilled water. The leaf pieces were placed on sterile filter paper to remove excess water. The pieces were transferred on the AB medium, Petridishes by using the sterilized transfer needle. Petridishes were incubated at 28°C for 2 to 5 days. Single colonies growing out of the inoculated fragments were selected based on morphology characteristics and appearance. Pure culture was established and then subsequently sub cultured on AB slant for further study. Effectiveness of surface sterilization was tested by the method of Schulz *et al*., (1993).

Table 1. Composition of AB medium (Atlas, 1993)

	Constituents	Amounts
1	Peptone	0.5g
2	Sucrose	2.0g
3	Agar	2.0g
4	Distilled Water	100ml

After autoclaving, nystain was added into the medium to control fungal growth.

Isolation Method for Fungal Diseases of Greengram

The anthracnose diseases of greengram were washed in running tap water for 10 minute. The infected leaves were cut into about 1cm pieces were cleared by running tap water. Then, the smaller pieces were dried on the sterilized paper for 2 minute. The disease infected parts were fixed with double-faced sticky tape inside the lid of a petridish. The lid of the petridish was placed on Potato Dextrose Agar medium (Phuakjaiphaeo and Kunasakdakul, 2015) as shown in Table 2.

Table 2. Preparation of Potato Dextrose Agar (PDA) medium

	Constituents	Amounts
1	Potato Dextrose Agar (PDA)	3.9 g
2	Distilled water	100 ml
3	pH	6.5

After autoclaving chloramphenicol (0.1g) was added to the medium.

Antifungal activity of Antagonistic bacteria

The bacterial antagonists were tested against *Colletotrichum* sp. PDA was prepared, autoclaved and after cooling, 20 ml was poured in each petridishes. After solidification, the respective bacterial bioagents were streaked on PDA plates. Four streaks were drawn on petridishes, in a square pattern. Each streak was drawn 3cm away from the center of the plate. After streaking, mycelial discs of 6mm were taken from the margin of 5 days old cultures, were inoculated in the center of PDA petridishes, separately. Each treatment was replicated thrice. The petridishes having targeted fungal Pathogens served as control. The petridishes were subsequently incubated at 37 ± 1˚C, till the complete growth was observed in control plates. Colony diameter of the targeted fungal pathogens in treated plates was recorded and Percent growth inhibition over control was calculated according to the formula (Vincent, 1927).

$$I = \frac{R_1 - R_2}{R_1} \times 100$$

Where, I = per cent inhibition of mycelia growth.

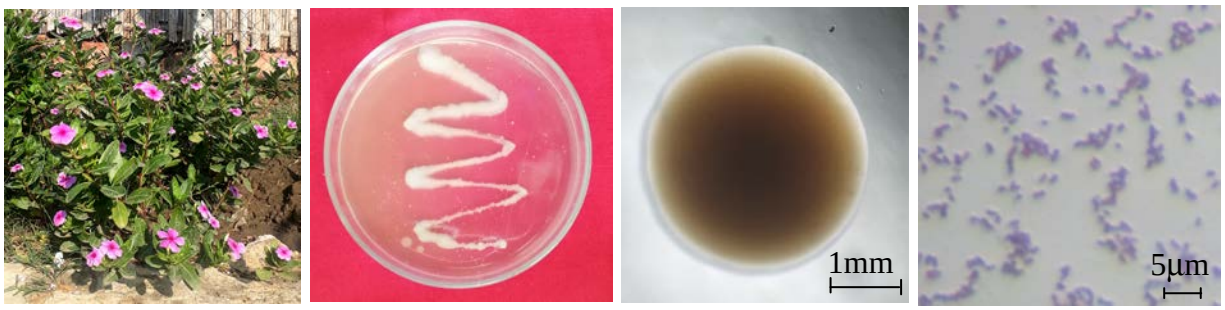
R_1 = Mycelial growth in control.

R_2 = Mycelial growth in treatment.

Results

Morphological character of isolated *Bacillus* sp. on AB medium

The colony and cell morphology of *Bacillus* sp. showed fast growing, off- white color, abundant growth, circular, smooth, margin entire, convex and viscid, diameter of 1.0 – 3.0 mm on AB medium. Cells were rod- shaped; 0.4– 1.0 × 1.5– 3.0 µm, gram positive as showed in figure 1.



(a) (b) (c) (d)

Figure 1. A. Habit of *Catharanthus roseus* (L.) G. Don plant
B. Culture of *Bacillus* sp. by streaks methods
C. Colony character of *Bacillus* sp.
D. Cell morphology of *Bacillus* sp.

Biochemical characteristics of *Bacillus* sp.

Various tests revealed it to be gram positive rods, aerobic, motility, nitrate reduction test, starch hydrolysis test and catalase test. The results of biochemical tests were presented in Table 3.

Table 3. Biochemical Test for *Bacillus* sp.

No	Reaction	Response	Result
1	Gram staining	Purple color	Positive
2	Motility test	Diffuse growth spreading from the line of inoculation	Positive
3	Nitrate reduction	Color changes from clear to red	Positive
4	Starch hydrolysis	Clear zone is formed around the growth zone	Positive
5	Catalase test	Production of free oxygen gas bubbles	Positive

Observation of pathogenic fungi

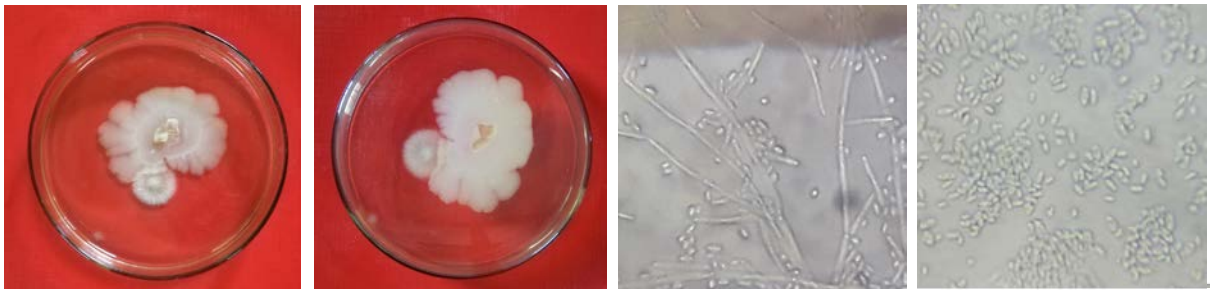
The pathogenic fungi were isolated from leaves diseases. Symptoms of anthracnose disease of greengram; well-defined spots often bound by veins and yellow border develop, the centers of which may turn grey to black, it appearing about 5 to 6 weeks after planting, depending upon the weather condition mostly temperature and humidity. Under favorable environmental conditions, severe leaf spotting and defoliation occurs at the time of flowering and pod formation as shown in figure 2.

(a) (b) (c) (d)

Figure 2. A. Infected plant of greengram
B. Inflorescences of greengram
C. Symptom on the upper surface of leaf
D. Symptom on the lower surface of leaf

Characters of pathogenic fungi

Macroscopical character was white creamy colony on potato dextrose agar medium (PDA) at 25°C and pH 6.5 -7.0 after 3 - 7 days. The color of the colony was white creamy. Reverse colony was white color, cotton like colony. In microscopical characters, hyphae were septate. Conidiophores were hyaline, simple, and cylindrical. Conidia were hyaline, cylindrical, 8-15× 4-6 µm in diameter. According to these macroscopical and microscopical characters, the fungus was *Colletotrichum* sp. as shown in figure 3.



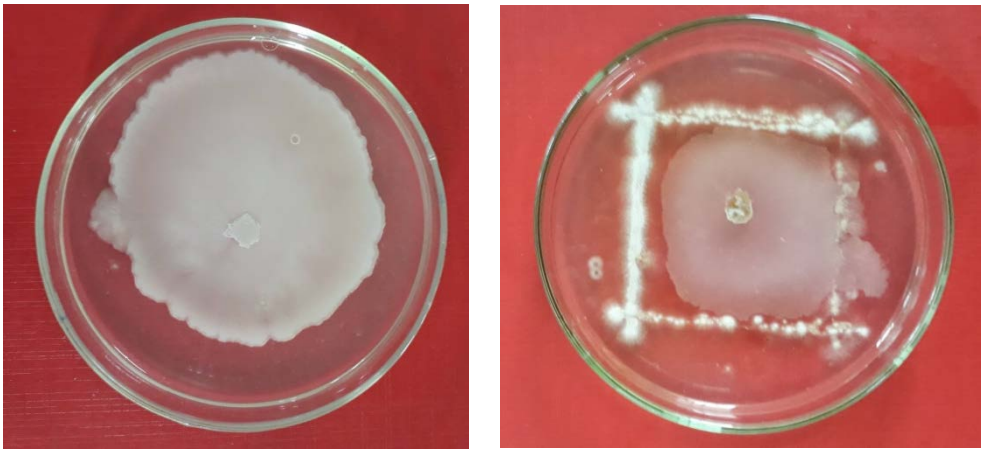
(a) (b) (c) (d)

Figure 3. A. Surface colony characters of *Colletotrichum* sp. on PDA medium (4 days)
B. Reverse colony characters of *Colletotrichum* sp.
C. Hyphae of *Colletotrichum* sp.
D. Conidia of *Colletotrichum* sp. spores character

Antifungal activity of *Bacillus* sp. on pathogenic fungi

The antagonistic effect of bacterial isolates was screened by dual culture method. The bacterial cultures of *Bacillus* sp. were tested against *Colletotrichum* sp. After a week of incubation, the growth of targeted fungal pathogens towards and away from the bacterial isolate was recorded. The percent inhibition of mycelial growth over control was presented in tabulated.

The bacterial isolates of *Bacillus* sp. significantly inhibited the mycelia growth of tested fungi. The inhibition of mycelial growth was recorded in *Colletotrichum* sp. showed average inhibition of 30.76 %. The strain of *Bacillus* sp. exhibited inhibition of *Colletotrichum* sp. as shown in and Figure 4.



(a) (b)

Figure 4. Inhibitory effects of *Bacilluss* sp. strain after dual cultures for 6 days on PDA medium

A. Untreated control of fungus mycelium of *Colletotrichum* sp.

B. Fungus mycelium in test inoculated of *Colletotrichum* sp.

Discussion and Conclusion

The present research deals with the isolation, identification of microorganism and study of antifungal effect of endophytic bacteria, *Bacillu*s sp. The endophytic bacteria were isolated from leaves of *Catharanthus roseus* (L.) G. Don, and examined the antagonistic effect on pathogenic fungi which caused anthracnose diseases of greengram.

In the present investigation, bacteria strain *Bacillus* sp. was isolated from *Catharanthus roseus* (L) G. Don by using AB medium. The colony and cell morphology of *Bacillus* sp. showed fast growing, off- white color, abundant growth, circular, smooth, margin entire, convex and viscid, diameter of 1.0 – 3.0 mm on AB medium. Cells were generally rod-shaped; 0.4 – 1.0 × 1.5 – 3.0 µm, gram positive. These general characters were also similar to the Graumann (2007).

Graumann (2007) described the morphology and physiology of the bacterium, rod-shaped cells of *Bacillus* species are usually round-ended, cell diameters range from 0.4 to 1.8 µm and lengths from 0.9 to 10.0 µm. The colonies of other species vary from moist and glossy through granular to wrinkled; shapes vary from round to irregular, sometimes spreading, with entire through undulate or crenate to fimbriate edges. After 24–48 hr incubation, colonial sizes of mesophilic strains typically range from 1 to 5 mm; color commonly ranges from buff or creamy-gray to off-white.

Biochemical characteristics of the selected tests were analyzed. Aerobic, motility, nitrate reduction test, starch hydrolysis test and catalase were found to be positive. According to the result, the one strain of bacteria character was confirmed as genus *Bacillus* sp. by referring to by Graumann (2007) and Rajashekhar *et al*., (2017).

Symptoms on leaves have been variously described by workers from time to time. Kavyashree (2014) reported that fungus produces definite spots on leaves, which are initially brown, later turning grey or dirty grey with narrow reddish brown margin bearing fructification on both the surfaces.

Barnett (1955) described that *Colletotrichum* spp. is characterized by conidiophores simple, elongate and conidia hyaline, 1-celled, ovoid or oblong. These characters were observed in present results of strain. The character of the strain was confirmed as *Colletotrichum* sp.

As a result of the present observation, macroscopical character was white creamy colony on potato dextrose agar medium at 25°C and pH 6.5-7.0 after 3-7 days. The color of the colony was white creamy, cotton like colony. Reverse colony was white color. In microscopical character, hyphae were septate. Conidiophores were hyaline, simple, and cylindrical. Conidia were hyaline, cylindrical, 8-15 × 4-6 µm in diameter. According to these macroscopical and microscopical characters, the fungus was *Colletotrichum* sp. So, the fungus was confirmed as *Colletotrichum* sp. according to report of Barnett, (1955) and Silva *et al*., (2017).

In conclusion, the present work revealed the characters of *Bacillus* species, pathogenic fungi, and the level of inhibition rate on pathogenic fungi and deformation of pathogenic fungi structure by using endophytic bacteria, *Bacillus* sp. The research work also showed the antagonistic effect on anthracnose disease of green gram caused by *Colletotrichum* sp. From the grower's point of view, the treatment which gives maximum is more important than a mere control of the disease. Plant growth promoting microbes is one of the important mechanisms for plant growth promotion and disease suppression. Thus, the necessity to obtain high quality yield, the concern for the environment and the human safety, the possibility to reduce and control the environmental pollution, the request to safeguard that impose reduction of chemical treatments, all that should induce the farmers to choose biological interventions. According to the present research, it is concluded that *Bacillus* sp. is the best biocontrol agent against anthracnose disease of greengram.

Acknowledgements

We would like to thank Pro-rector (Rector's duty) Dr Win Swe and Pro-rector Dr Myo Myo, Shwebo University, for giving us a chance to do this research. We would like to express our heartfelt gratitude to Dr Khin Hnin Yee, Professor and Head, Dr Nilar, Professor, Department of Botany, Shwebo University, for their invaluable kindness and precious guidelines to complete this research. We are also thankful to Dr Tin Tin Nyunt, Professor and Head, Department of Botany, Monywa University, and Dr Zaw Lwin Oo, Associate Professor, Department of Botany, Kyaing Tong University, for their valuable advice, suggestions and careful help to finish this research.

References

Adsule, R N., Kadam, S. S. and Salunkhe, D. K. 1986. Chemistry and technology of greengram (*Vigna radiata* [L.] Wilczek). *Critical Review of Food Science and Nutrition* **25**: 73-105.

Agrios, G. N. 2005. Plant Pathology. V Edition, Elsevier Academic Press, California, USA. pp. 922. Significance of plant Diseases in plant pathogen. pp. 25-37.

Atlas, R. M. 1993. Microbiological Media. Boca Raton Ann Arbor, London Tokyo.

Bailey, J. A and M. J. Jeger. 1992. *Colletotrichum:* Biology, Pathology and Control. Common wealth Mycological Institute.

Barnett, H. L. 1955. Illustrated genera of imperfect fungi. Department of Plant Pathology, Bacteriology and Entomology west Virginia University Morgantown, West Virginia.

Granum, P. E. 2007. *Bacillus cereus*. Food Microbiology, Fundamentals and Frontiers. 3rd Ed (Doyle MP & Beuchat LR, eds), pp. 445–455. Washington, DC: ASM Press.

Jaleel, C. A., R. Gopi and R. Paneerselvam, 2009. Alterations in non-enzymatic antioxidant components of *Catharanthus roseus* exposed to paclobutrazol, gibberellic acid and *Pseudomonas fluorescens*. Plant Omics J., 2: 30-40.

Kavyashree, M. C. 2014. Studies on fungal foliar disease of of gerrn gram, *Vigna radiata* (L.) Wilczek, University of Agricultural Sciences and Technology of Kashmir Division of Plant Pathology, Shalimar Campus Srinagar.

Kulkarni, S. A. 2009. Epidemiology and integrated manangement of anthranose of green gram. M.Sc. (Agri.) Thesis submitted to USA.

Malik, B. A. 1994. Grain Legumes. In: *Crop Production*. M. S. Nazir (ed.), National Book Foundation, Islamabad. p. 301.

Nisar, A., A. S. Mamat and A.S. Aslam. 2016. An update review on *Catharanthus roseus*. Phytochemical and Pharmacological Analysis. Indian Research Journal of Pharmacy and Science. India.

Phuakjaiphaeo, C. and K. Kunasakdakul. 2015. Isolation of Screening for Inhibitory Activity on *Alternaria brassicicola* of Endophytic Actinomycetes from *Centella asiatica* (L.) Urban. Department of Entomology and Plant Pathology, Faculty of Agriculture. Chiang Mai University. Thailand.

Quebral, F. C. and I. C. Cagampang. 1970. Influence of Cercospora leaf spot control on yield of mung bean. Agriculture at Los Banos, 10: 7–12

Rajashekhar, M., Shahanaz and V. K. Kalia. 2017. Biochemical and molecular characterization of *Bacillus* spp. isolated from insects. Journal of Entomology and Zoology Studies 2017; 5(5): 581-588

Schulz, B., U. Wanke and S. Draeger. 1993. Endophytes from herbaceous and shrubs: effectiveness of surface sterilization methods. Mycol. Res. 97:1447-1450.

Silvaa, D. D. De., P. K. Adesb., P. W. Crousac and P. W. J. Taylora. .2017. *Colletotrichum* species associated with chili anthracnose in Australia Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Vic., 3010, Australia.

Veena. 2012. Investigation on leaf spot of gren gram caused by *Cercospora canescens* Ellis and Martin, Department of Plant Pathology College of Agriculture, University of Agricultural Sciences, Dharwad.

Vincent, J. M. 1927. Distortion of fungal hyphae in presence of certain inhibitors. *Nature*, 59, pp. 850. 1927.0

Geochemical Studies of Chromitites in Ultramafic rocks of Mu Wall Luo Area, Tiddim Township, Chin State, Myanmar

Tun Tun Min[1], Tint Swe Myint[2], Shwe Soe[3], Immanuel[4]

Abstract

Mu Wall Luo Area is situated about 32 km (20 miles) north of Kalay. The study area is dominated by harzburgite with minor dunite (Late Jurassic–Early Cretaceous) containing segregated chromite deposits. Five chromitites occurred in the Mu Wall Luo ultramafic rock unit. Chromitite constitute the chromite as dominant minerals showing medium to coarse-grained cumulate texture. Among the chromite grains, the interstitital silicate of olivine, orthopyroxene and plagioclase are found. X-ray diffraction (XRD) of chromitites of the Mu Wall Luo Area shows pattern of magnesiochromite ($MgCr_2O_4$). Chromitite composition is characterized by Cr_2O_3 ranges from 28.50 to 32.20 wt.%, Al_2O_3 from 31.40 to 25.40 wt.%, MgO 24.70 to 21.50 wt.%, and FeO ranges from 5.05 to 4.43 wt.%. The maximum Fe_2O_3 content is 2.41 wt% and TiO_2 is always below 0.17 wt%, as typical for podiform chromitites and ophiolitic chromitites. The TiO_2 vs. Cr_2O_3 diagram, Mg#[Mg/(Mg+Fe^{2+})] versus Cr#[Cr/(Cr+Al)] and TiO_2 vs. Fe^{2+}/Mg diagram indicate that most of the chromitite samples located in the field of podiform chromitite. Chromitites of the study area exhibit an affinity to be in the high Al-rich chromitites which might have formed initial liquid after lower degree of partial melting. The high-Al chromitites are typically hosted in less depleted Cpx-bearing harzburgites. In the trivalent ion plot (Cr-Al-Fe^{3+}) and Al_2O_3 vs Cr_2O_3 of chromitite compositions show their mantle origin. On the basis of $TiO_2$and Al_2O_3 diagram, chromitites of the Mu Wall Luo Area are clustered in the supra-subduction zone (SSZ) field. Chromite deposits form as a result of melt-rock interaction.

Key words: cumulate texture, magnesiochromite, podiform chromitite, supra-subduction zone, melt-rock interaction

Introduction

Mu Wall Luo Area is situated at the eastern flank of the Northern Chin Hills, 32 km (20 miles) north of Kalay. The area is bounded by N latitude 23˚ 33' 30" and 23˚ 38"and E longitude 94˚ 00' 30" and 94˚ 05' 30". It lies in UTM map sheet No.2394-02. It extends about 5 miles (8 kilometers) from north to south and 6 miles (9 kilometers) from east to west. So, it covers about 30 square miles (72 square kilometers) of surface area. It is easily accessible by car in all season due to nearing of the Kalay-Tamu car road. The location map of the study area is shown in Figure (1). The study area is fairly rugged mountainous region. The contact of the ultramafic body to the surrounding flysch sediments are marked by approximately N-S trending fault zones. Aerial photographs of the western part of Mu Wall Luo Area show a layer-like feature with a steep dip to the west. The study area is bordered at the east by the Tui Mi Lui Chaung and at the west by Chin Chaung. The drainage pattern of the study area is coarse dendritic to subdendritic pattern. Tui Mi Lui Chaung flow as meandering system.

[1] Associate Professor, Dr., Department of Geology, Shwebo University
[2] Associate Professor, Dr., Department of Geology, Kalay University
[3] Lecturer, Department of Geology, Yadanabon University
[4] M.Sc (student), Geology, Kalay University

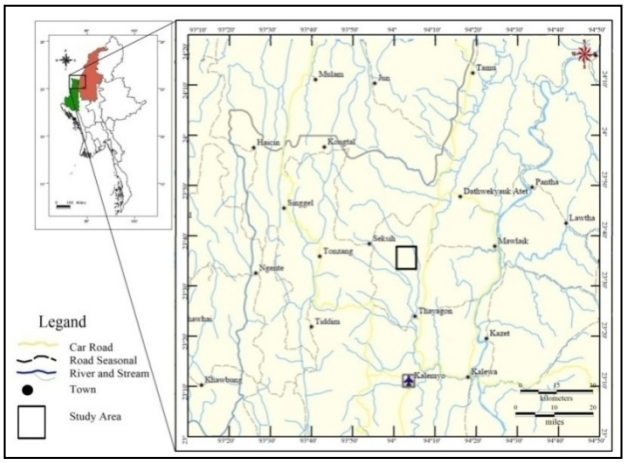


Fig. (1) Location map of the study area.

Regional Geologic Setting

The Indoburman Ranges are morphologically divided into four parts: in the south there is the Rakhine Yoma, followed to the north by the Chin Hills, which are really mountains, reaching up as high as Mt. Victoria. Further to the north the Naga Hills follow, with Sarameti Peak towering over the mountain ranges. In the north, the Naga Hills give way to the E-W trending Patkoi Ranges. The regional geologic setting of the study area is shown in Fig. (2). The study area lies prominently on the eastern flank of the northern Chin Hills.

The Chin Hills are composed of a metamorphic basement overlain by the Triassic Pane Chaung Group turbidites and Cretaceous shales and limestones. Older age of Pane Chaung Group was assumed to be thrust westwards onto the Upper Cretaceous Falam Mudstone-Micrite Formation. The metamorphic basement is composed of low-grade mica and chlorite Kanpetlet schists and higher grade amphibolite facies chlorite-epidote-garnet-bearing rocks of the Yazagyo and Khwekha Metamorphics (United Nations, 1979). The schists were originally considered to be part of pre-Mesozoic basement (Brunnschweiler, 1966) and were later reinterpreted as Triassic (Mitchell *et al.*, 2010: in Sevastjanova *et al.*, 2015).

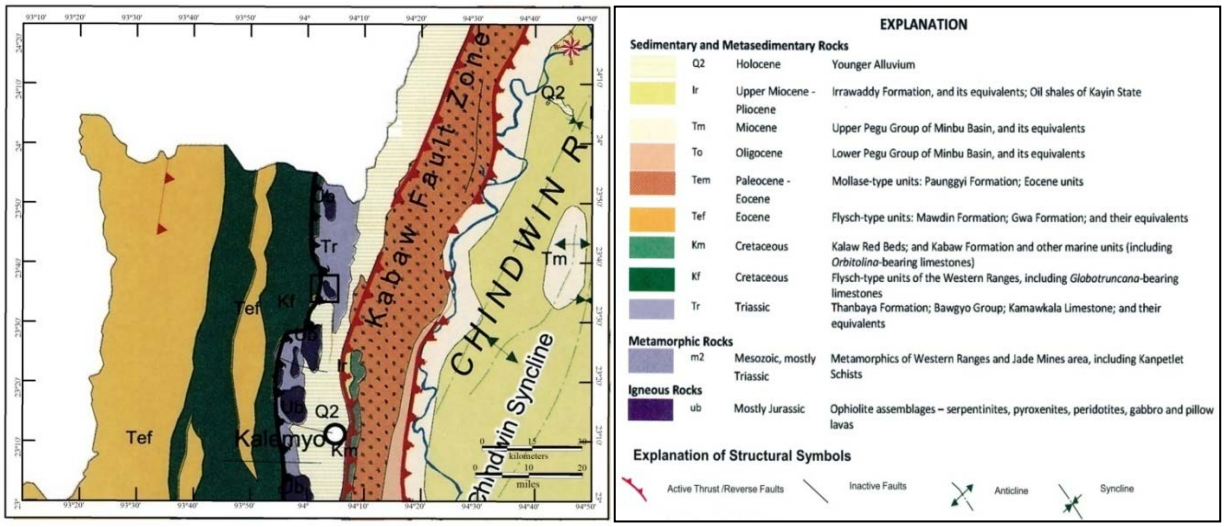


Fig. (2) Regional geologic setting of the study area and its environs. (Source: MGS 2014)

Purpose of Study

Investigation is carried out for the following purposes:

1. to describe the distribution of chromitite occurrences of the Mu Wall Luo Area,
2. to study the texture and petrography of chromitites of the study area,
3. to investigate the mineralogical and geochemistry of chromitites of the research area,
4. to recognize origin of chromitites on the basis of field occurrences and laboratory investigation.

Method of Study

Five representative chromitite samples collected from the study area have been selected and analyzed by the reflected light ore microscope, X-ray fluorescenes (XRF) and X-ray diffraction (XRD) analyses. These analyses are carried out on powdered pellets at Mandalay University Research Center and Department of Research and Innovation (Naypyidaw).

General Geology

Rock Units Distribution

The study area consists of an ophiolitic rock sequence which comprises mantle peridotite overlain by crustal ultramafic cumulates. The mantle section is mainly ultramafic tectonites and is dominated by harzburgite/serpentinized harzburgite with minor dunite/ serpentinized dunite containing segregated chromite deposits. Ultramafic cumulates are composed of repeated successions of pyroxenite. Serpentinites have been found along the contact to the flysch sediments in the west and east. Some sporadic exposures of plagiogranite were observed in the study area. Gabbro, diabase, and plagiogranite cannot be mapped for their restricted area extent. The geological map of the study area is shown in Fig. (3), and stratigraphic sequence of the study area is shown in Table (1).

Table (1) Stratigraphic sequence of the study area

Rock Units	Age
Sedimentary Rocks	
Alluvium	Holocene
Pane Chaung Group	Middle-Upper Triassic
Igneous Rocks	
Ultramafic Rocks (including serpentinites)	Late Jurassic - Early Cretaceous
Basic Rocks (diabase and gabbro) Plagiogranite	?Late Jurassic

Chromitites

Five chromitite occurrences are known in the Mu Wall Luo ultramafic unit (Fig.3). The chromite mineralization is concentrated along the southeastern part of the study area. Most commonly the chromitite is of massive type (Fig.4A).Chromitites are a significant feature of the harzburgite/serpentinized harzburgite because they are widely dispersed through the unit (Fig.4B). The host rock of the other chromitite is usually dunite.

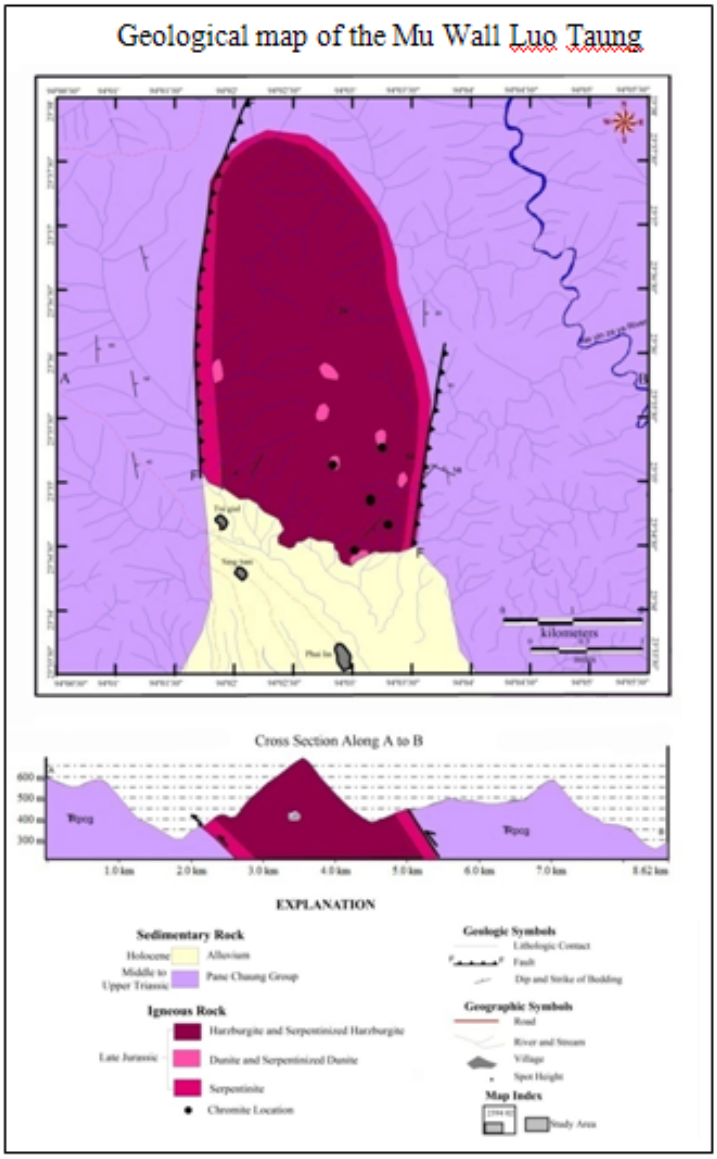


Fig. (3) Geological map of the study area.

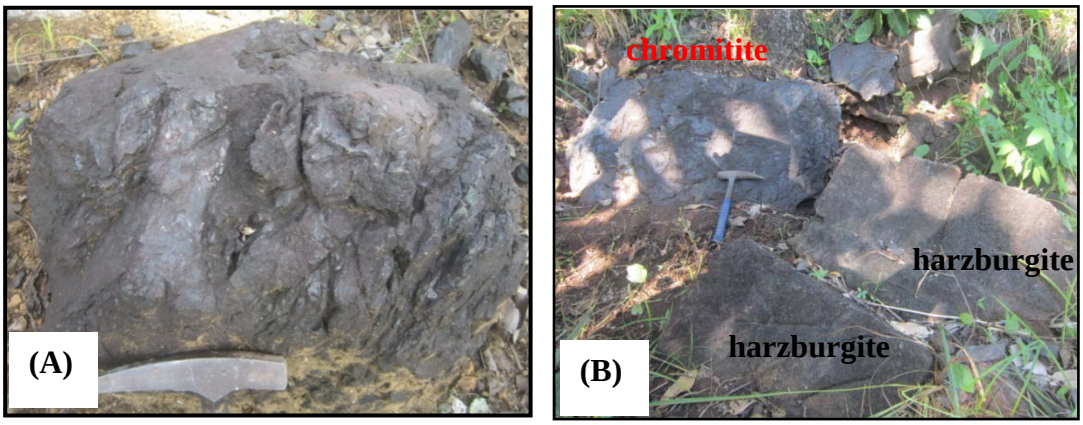


Fig. (4) **(A)** Massive chromitite. **(B)** Field photograph of massive chromitite enveloped harzburgite in ultramafic body of the study area (Loc: N 23° 35' 15.7" and E 94° 03' 15.1").

Ore Microscopy of Chromitite

Chromitite samples are polished to study under reflected light ore microscope. The chromitite is showing black to dark grayish, with a brownish black and sub-metallic to dull. Chromitite constitutes the chromite as dominant minerals showing medium to coarse-grained cumulate texture. Among the chromite grains, the interstitital silicate of olivine, orthopyroxene and plagioclase are found. The chromites are found as subhedral to euhedral crystal (Fig.5A), cream color, irregular cracks, corrosion affects and it sometime showed cataclastic texture (Fig.5B). Individual chromite grains are mostly 0.3 mm in diameter. Some of the chromites have thin magnetite rims.

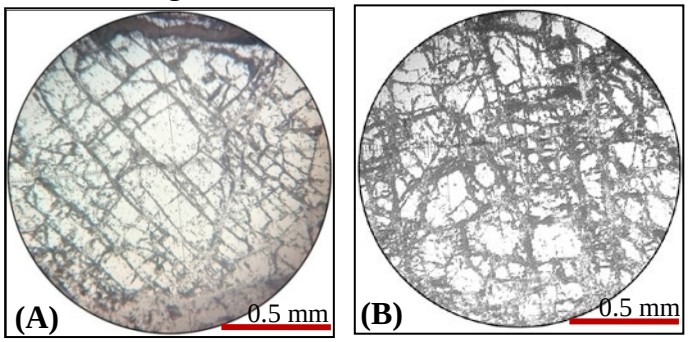


Fig. (5) (A) Euhedral chromite found in the chromitite showing the cleavage and irregular cracks. (B) Cataclastic texture (under reflected light,4x).

Results

Geochemistry of Chromitites

X-ray powder diffraction (XRD) of chromitite of the Mu Wall Luo Area shows patterns of magnesiochromite ($MgCr_2O_4$) (Fig. 6A). Representative X-ray fluorescenes (XRF) analyses of chromitite were listed in (Table 1). Chromitite composition is characterized by Cr_2O_3 ranging from 28.50 to 32.20 wt.%, Al_2O_3 from 31.40 to 25.40 wt.%, MgO 24.70 to 21.50 wt.%, and FeO ranges from 5.05 to 4.43 wt.%. In the Cr# vs. Mg# diagram (Dick and Bullen 1984) (Fig. 6B), most of the chromitites are plotted in the magnesiochromite affinity.

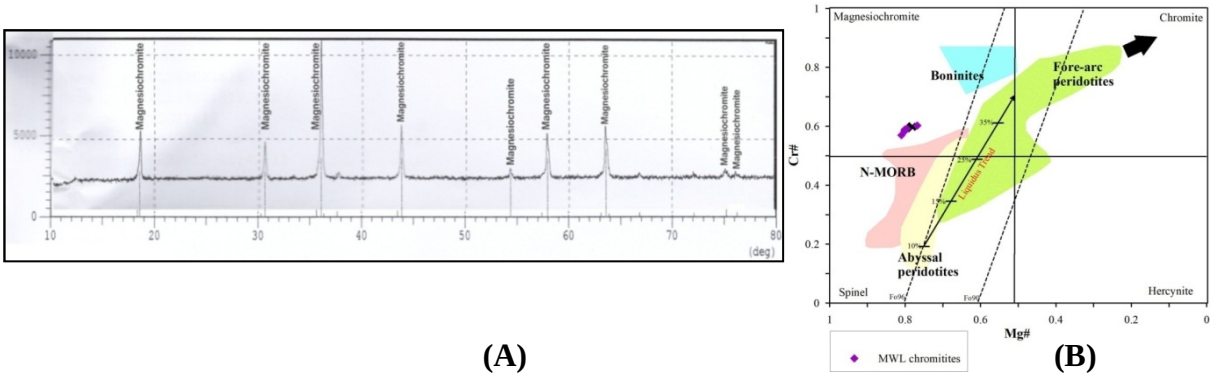


Fig. (6) **(A)** X-ray diffractograms of chromitite from the study area. **(B)** Chromitites from the Mu Wall Luo Area plotted on the Cr# [Cr/(Cr + Al)] versus Mg# [Mg/(Mg + Fe^{2+})] diagram. Fields are collected from Dick and Bullen, 1984.

Al_2O_3 contents of chromitites show a positive correlation with Cr_2O_3 (Fig. 7A). In the chromitites, Al_2O_3 contents of chromitites are negatively correlated with MgO (Fig. 7C), whereas Cr_2O_3 contents are negatively correlated (Fig. 7D). Chromitites have relatively uniform Cr_2O_3 and Al_2O_3 contents, and are variable MgO and FeO.

The compositional characteristics of the study area chromitites, i.e. Cr, Al, Mg, Fe^{3+} and Ti concentrations, are in accordance with those from typical podiform chromitites hosted in the mantle section of ophiolites.

The TiO_2 vs. Cr_2O_3 diagram indicate that most of the chromitite samples located in the field of podiform chromitite (Fig.8). The maximum Fe_2O_3 content is 2.41 wt% and TiO_2 is always below 0.17 wt%, as typical for podiform chromitites and ophiolitic chromitites. The low TiO_2 contents of studied samples (0.13-0.17wt%) also indicate its characteristics as podiform chromitites. In stratiform chromitites, TiO_2 content is higher than 0.3 wt%. This is related to the nature of primary magma which has been generated from depleted source. Ti is strongly partitioned into liquid during partial melting of the upper mantle (Mirza, T.A, 2008).

Table 1. The result of XRF analysis of chromitites in Mu Wall Luo Area.

ore	chromitites				
Samp: No.	1	2	3	4	5
SiO_2	5.31	11.5	12.8	14.3	10.4
TiO_2	0.17	0.14	0.14	0.13	0.15
Al_2O_3	31.40	27.00	26.10	25.40	27.50
Fe_2O_3	2.11	2.26	2.25	2.26	2.41
FeO	4.43	4.74	4.72	4.74	5.05
Cr_2O_3	32.10	29.20	28.80	28.50	32.20
MgO	24.30	24.70	24.50	23.80	21.50
CaO	0.03	0.35	0.54	0.81	0.41
Na_2O	0.00	0.00	0.00	0.00	0.30
K_2O	0.07	0.06	0.06	0.00	0.06
NiO	0.07	0.06	0.05	0.05	0.07
V_2O_5	0.09	0.08	0.06	0.07	0.09
Co_2O_3	0.02	0.01	0.00	0.02	0.02
ZnO	0.02	0.02	0.02	0.02	0.02
Yb_2O_3	0.00	0.03	0.00	0.03	0.00
Total	100.12	100.15	100.04	100.14	100.18
Si	2.50	5.40	6.00	6.70	4.90
Mg	14.76	14.90	14.77	14.35	12.97
Al	8.31	7.15	6.91	6.72	7.28
Cr	11.00	9.99	9.85	9.75	11.00
Ti	0.10	0.10	0.10	0.10	0.10
Ni	0.13	0.20	0.14	0.11	0.11
$Mg/(Mg+Fe^{2+})$	0.75	0.78	0.78	0.77	0.74
Cr/(Cr+Al)	0.57	0.58	0.59	0.59	0.60

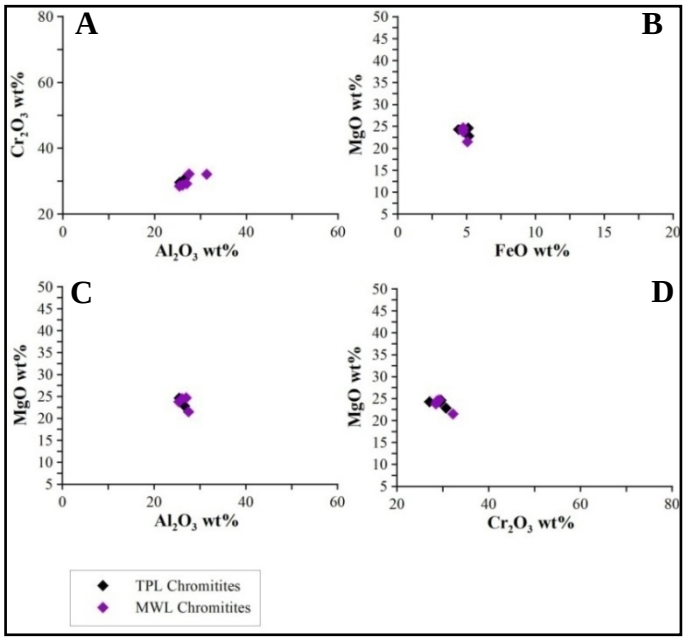


Fig. (7) (A-D) Interelemental relationships of chromitites from Mu Wall Luo Area.

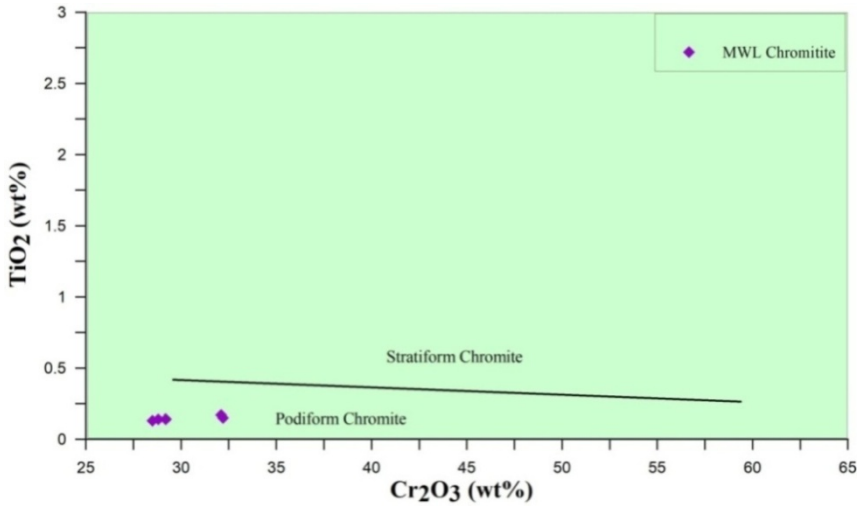


Fig. (8) Chemical composition of chromitites is compared with stratiform and podiform chromitites on TiO_2 wt% vs Cr_2O_3 wt% diagram. Fields are collected from Musallam *et al*. (1981) and Arai *et al*. (2004) (in Mirza, T.A, 2008).

In the diagram Mg#[Mg/(Mg+Fe^{2+})] versus Cr#[Cr/(Cr+Al)], the composition of these chromitites clearly plots within the field of podiform (ophiolite) chromitites (Fig. 9). The Cr# [100Cr/(Cr+Al)] ratio ranges from 57 to 60 and the Mg# [100Mg/(Mg+Fe^{2+})] lies between 74 and 78. Nickel content (0.05-0.07 wt %) of chromitites in ophiolites are similar to those of chromitites in typical podiform chromite deposits (Ahmed, 1984). In the discriminant diagrams Cr# vs. TiO_2 (Barnes and Roeder, 2001), chromitites from the Mu Wall Luo Area are plotted in the ophiolitic chromitites (Fig. 10).

In the TiO_2 vs. Fe^{2+}/Mg diagram (Fig.11), chromitites are situated at the podiform chromitite field. The chromitites have a low Fe/Mg ratio indicating low Fe/Mg ratio of the magma from which they have crystallized. Fe-Mg exchange temperatures (Ballhaus *et al*., 1991) of chromite from massive chromitite and olivine from coexisting silicate mantle dunite or harzburgite are between 915 and 1200°C, which suggest magmatic origin of chromite.

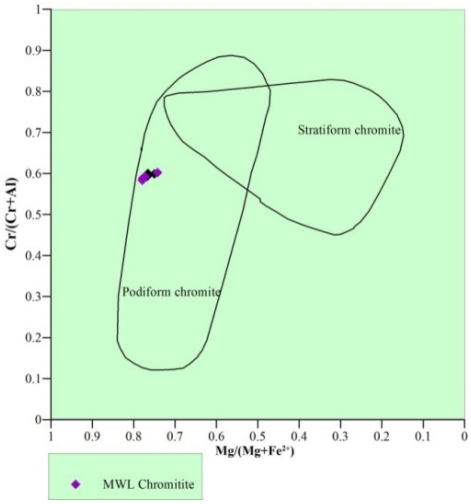


Fig. (9) Chromitites are plotted on the Cr# [Cr/Cr+Al] versus Mg# [Mg/Mg+ Fe^{2+}] diagram. Compositional fields of podiform and stratiform chromitites are collected from Leblanc and Nicolas (1992) and Irvine (1967) (in Mirza, T.A, 2008), respectively.

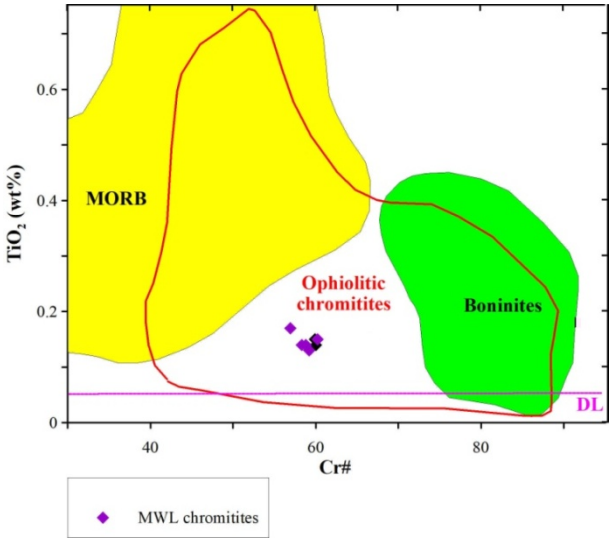


Fig. (10) Composition of chromitites from the study area are plotted on the TiO_2 (wt%) vs. Cr# diagram. Compositional fields are from Barnes and Roeder (2001).

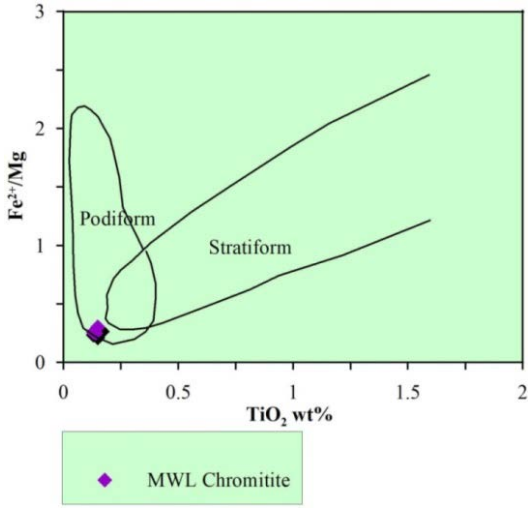
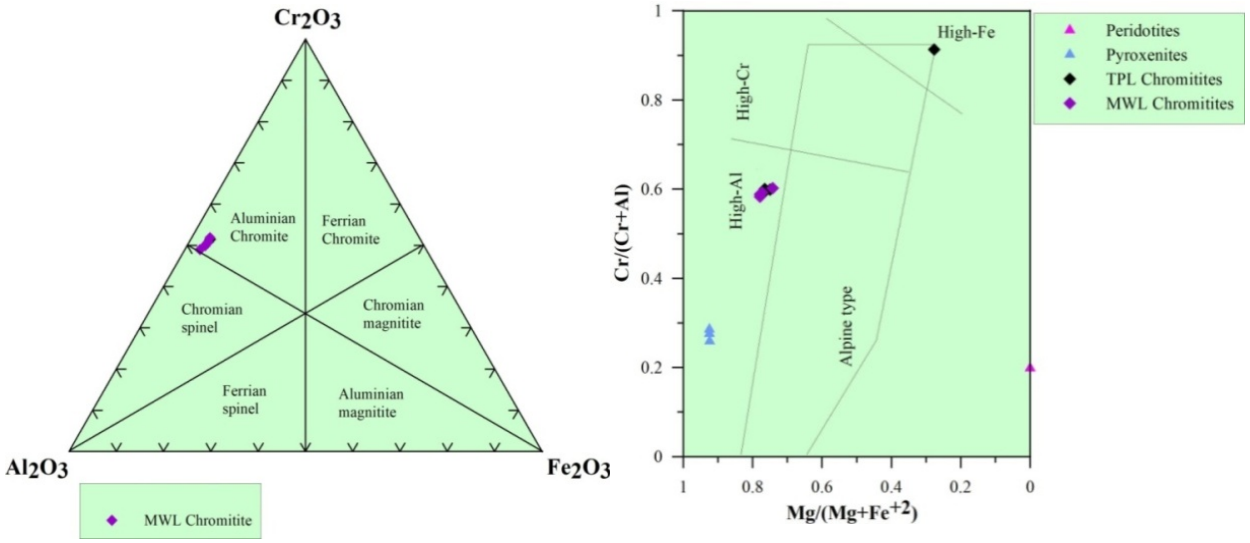


Fig. (11) Chromitites of the studied area are plotted in the TiO_2 vs. Fe^{2+}/Mg podiform and stratiform chromitite diagram (Mirza, T.A, 2008).

The analyses of chromitites are plotted on the ternary diagram of Cr_2O_3-Al_2O_3-Fe_2O_3 by Steven (1944) (Fig.12A). Five analyses of chromitites exhibit an affinity to be in the aluminian chromite field. The chromitite samples have a high Al-rich chromitites (Cr#< 0.6), which might have formed initial liquid after lower degree of partial melting.

The Cr# value (Cr# = [Cr/(Cr+Al+Fe^{3+})]) of chromitite is frequently used to constrain the conditions and determine the mantle peridotite source and the degree of partial melting (Bonatti & Michael, 1989). Podiform chromitite compositions range in the field of high- Al, high-Cr and high-Fe. In the plot of Cr# versus Mg#, chromitites are plotted in the field of high-Al chromian (Fig.12B). It has Cr_2O_3 and Al_2O_3 contents of 28.50 to 32.20 wt.% and 31.40 to 25.40 wt.%, respectively and is best described as Al-rich chromite (Table1; Fig.12A). The high-Al chromitites are typically hosted in less depleted Cpx-bearing harzburgites or lherzolites.



(A) **(B)**

Fig. (12) **(A)** Cr_2O_3-Al_2O_3-Fe_2O_3 diagrams for chromitite in Mu Wall Luo Area (Steven, 1944). **(B)** Plot of Cr# [Cr/Cr+Al] versus Mg# [Mg/Mg+ Fe^{2+}] for chromitite of the study area. The Alpine-type field and other fields are Mirza, T.A, 2008.

Origin of Chromitites

The chemical compositions of chromitite are plotted on various diagrams to examine their origin of the chromitite of the present study. The trivalent ion plot (Cr-Al- Fe^{3+}) and Al_2O_3 vs Cr_2O_3 of chromitite compositions show their mantle origin (Fig. 13A & 13B).

Kamenetsky *et al*. (2001) have compiled a database of TiO_2 and Al_2O_3 compositions of chromitite and have identified fields with varying degrees of overlap that can be used to distinguish six different tectonic settings. The TiO_2 and Al_2O_3 contents of chromitite from genetically- related peridotite, dunite and chromitite samples aids the interpretation of the tectonic setting in which they formed. Kamenetsky *et al*. (2001) showed that the TiO_2 and Al_2O_3 content of chromitite are controlled by the parental melt.

On the basis of these parameters, chromitites of the Mu Wall Luo Area are clustered in the supra-subduction zone (SSZ) peridotite field (Fig. 14).

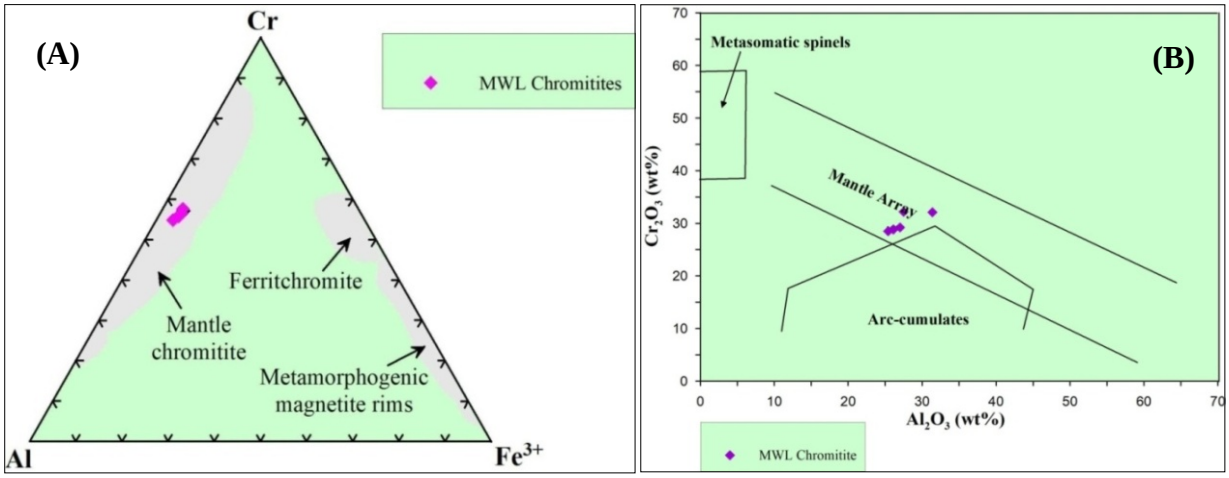


Fig. (13) **(A)** Trivalent ion plot (Cr-Al-Fe^{+3}) of chromitite compositions. Mantle chromitite, Ferritchromite and metamorphogenic magnetite field (Arai and Yurimoto, 1994) are shown for comparison. **(B)** Al_2O_3 versus Cr_2O_3 plot of the chromitite of the present study. Fields are collected from Franz and Wirth (2000).

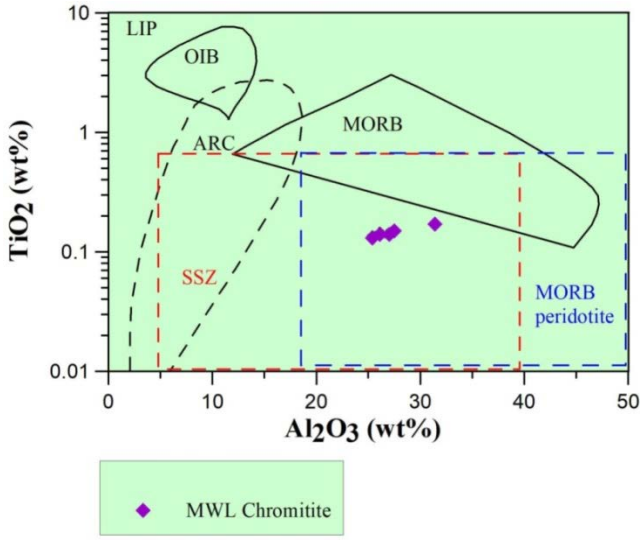


Fig. (14) Plot of TiO_2 versus Al_2O_3 in chromitite from Mu Wall Luo ophiolite complex. Fields are collected from Kamenetsky *et al*. (2001). SSZ; Supra-subduction zone; LIP, large igneous province; MORB, mid-ocean ridge basalt; OIB, ocean island basalt. ARC = arc related volcanic rocks.

There are three origins of podiform chromitites:

i) podiform chromitites may represent part of the residuum after extensive extraction of melt from their mantle host, based on their association with the residual mantle rocks such as dunite and harzburgite,

ii) podiform chromitites have been interpreted as a cumulate filling of a magma conduit inside the residual mantle, and

iii) it has been stressed that such deposits form as a result of melt-rock or melt-melt interaction (i.e. “magma-mingling”). The presence of water in the melt is thought to be necessary for the crystallization of chromium spinel (Edwards *et al*., 2000).

Conclusion

Based on geochemical characteristics of the studied chromitite in Mu Wall Luo Area, Tiddim Township, Chin State, the following main conclusions are summarized:

- Five chromitites are occurred in the Mu Wall Luo ultramafic rocks.
- X-ray diffraction (XRD) of chromitites of the study area show patterns of magnesiochromite ($MgCr_2O_4$)
- The TiO_2 vs. Cr_2O_3 diagram, Mg#[Mg/(Mg+Fe^{2+})] versus Cr#[Cr/(Cr+Al)] and TiO_2 vs. Fe^{2+}/Mg diagram indicate that most of the chromitite samples located in the field of podiform chromitite.
- Chromitites of the study area exhibited in the aluminian chromite affinity. The chromitite samples have a high Al-rich chromitites which might have formed initial liquid after lower degree of partial melting.
- The high-Al chromitites are typically hosted in less depleted Cpx-bearing harzburgites or lherzolites.
- The trivalent ion plot (Cr-Al- Fe^{3+}) and Al_2O_3 vs Cr_2O_3 of chromitite compositions show their mantle origin.
- Chromitites of the Mu Wall Luo Area are formed in the supra-subduction zone (SSZ).
- Chromitites form as a result of melt-rock or melt-melt interaction. The presence of water in the melt is thought to be necessary for the crystallization of chromium spinel (Edwards *et al*., 2000).

Acknowledgements

We express our thanks to Dr.Win Swe (Rector, Shwebo University) and Dr.Myo Myo, (Pro-rector, Shwebo University) for their kind permission and encouragement to carry out our research work. We are so grateful to Professor Dr. Khin Khin Lin, Head of Department of Geology, Shwebo University, for her invaluable suggestion and constructive comment. We would like to express our thanks to Dr. Zaw Win, Professor, Department of Geology, Shwebo University for his close supervisions and invaluable encouragements throughout this work.

References

Ahmed, Z. (1984). "Stratigraphic and textural variations in the chromitic competition of the ophiolitic Sakhakot-Qila complex, Pakistan". *Economic Geology.*Vol.79, 1334-1359.

Arai, S, and Yurimoto, H. (1994). "Podiform chromitites of the Tari-Misaka ultramafic comples, southwest Japan, as mantle-melt interaction products". *Economic Geology.*Vol.89,pp.1279-1288.

Ballhaus, C., Berry, R.F., Green, D.H. (1991). "High pressure experimental calibration on the olivine-orthopyroxene-spinel oxygen geobarometer: implications for the oxidation state of the upper mantle". *Contributions to Mineralogy and Petrology*, 107, 27-40.

Barnes, S.J., Roeder, P.L. (2001). The range of spinel compositions in terrestrial mafic and ultramafic rocks. *J. Petrol.* 42, 2279–2302.

Bonatti, E., and Michael, P.J. (1989)."Mantle peridotites from continental rifts to ocean basins to subduction zones". *Earth planet Sci. Lett.*, Vol.91, pp.297- 311.

Dick, H.J.B. and Bullen, T. (1984). Chromium spinel as a petrogenetic indicator in abyssal and alpine-type peridotites and spatially associated lavas. *Contributions to Mineralogy and Petrology*, 86, 54–76.

Edwards, S.J., Pearce, J.A., Freeman, J. (2000). "New insights concerning the influence of water during the formation of podiform chromite". In: Dilek, Y., Moores, E.M., Elthon, D., Nicolas, A. (eds.). Ophiolites and oceanic crust: new insights from field studies and the ocean drilling program: Boulder, Colorado. *Geological Society of America Special Paper*, 349, 139-147.

Franz, L. and Wirth, R. (2000). "Spinel inclusions in olivine of peridotite xenoliths from TUBAF seamount (Bismark Archipelago/Papua New Guinea) : evidence for thermal and tectonic evolution of the oceanic lithospheric". *Contrib Mineral. Petrol., v.140*, pp.283-295.

Kamenetsky, V.S., Crawford, A.J., Meffre, S. (2001). "Factors controlling chemistry of magmatic spinel: an empirical study of associated olivine, Cr-spinel and melt inclusions from primitive rocks". *Journal of Petrology*, 42, 655-671.

Mirza, T.A. (2008). "Petrogenesis of the Mawat ophiolite complex and the associated chromitite, Kurdistan Region, NE Iraq". Ph.D. Thesis.

Myanmar Geosciences Society, (2014). Geological map of Myanmar (1: 2,250,000).

Sevastjanova, I., Hall, R., Rittner, M., Saw Mu Tha Lay Paw, Tin Tin Naing, Alderton,D.H., and Comfort, G. (2015). "Myanmar and Asia united, Australia left behind long ago". *Gondwana Research*, p 1-17.

Steven, R.E.(1944)."Composition of some chromites of western Hemisphere Am".*Mineral,Jour*.Vol. 26, pp. 1-34.

U. N. (1979). "Geology and Exploration Geochemistry of part of the Northern and Southern Chin Hills and Arakan Yoma, Western Burma", *Techincal Report. 4*, New York.

Sedimentary Facies And Depositional Environments of Moza Formation of Nat Sone Hmaw Area, Pyawbwe Township, Mandalay Region

Khin Thet Zun[1]

Abstract

The Nat Sone Hmaw Area is situated about 27 km northwest of Pyawbwe Township, Mandalay Region, lying one the northern part of Pegu Yoma. The lithologic units of the study area are mainly composed of Miocene clastic sedimentary rock. They are Taungtalone Sandstone, Moza Formation and Khabo Sandstone. The Upper Pegu Group (mainly Miocene) of the study area belongs to (11) lithofacies on the basis of the associated primary sedimentary structures, faunal contents, biogenic structure, bed sets and bed-based types. These facies associations were (1) Point-bar Facies (2) Sand bar Facies (3) Mixed-flat Facies (4) Upper sand flat Facies (5) Shoal Facies. Herringbone-cross laminated and parallel to rippled-cross laminated sandstone units are deposited in tidal bars of the upper part of an estuarine channel. Rippled-laminated sandstone and shale intercalated units are interpreted as the deposits of the middle-upper part of the point bars in the tide-dominated estuarine environment. These facies association suggest depositional environment of Moza Formation is tide-dominated estuary environment on an estuarine point bar in the upper part and central part of the tide-dominated estuary system.

Key words: formation, lithofacies, facies association, depositional environment

Introduction

The Nat Sone Hmaw Area is situated about 27 km north west of Pyawbwe Township in Mandalay Region. It is located between the latitudes 20º32' N and 20º40' N and between the longitudes 95º47' E and 95º55'E, referring to UTM topographic map 2095-14 (84-P/14). The location map of the study area is shown in figure 1.

Regional geologic setting

The research area is situated in the Central Cenozoic Belt of Myanmar. This belt is **re**latively a low-lying province between the Eastern Highlands to the east and the Western Ranges to the west. The area forming a segment of the northern part of the Pegu Yoma. The regional trend of the strata of the study area is NNW-SSE. The study area lies in the Bago Yoma Uplift which is a prominent morphological and geological unit in Myanmar. The Bago Yoma is about 400 miles long and 40 miles wide striking generally NNW-SSE between the Ayeyarwady and Sittaung valleys. The research area is situated at the eastern margin of northern Bago Yoma. The region to the east of the study area is composed of the Tertiary mollassic sediments. Further to the east, the rugged terrain of the granites and other intrusives with undifferentiated metamorphics (mainly schist and gneiss of “Mogoke Belt) are exposed (Searle and Haq, 1964). In the western part, the Upper Pegu Group of Miocene age and Irrawaddy Formation (Late Miocene-Pliocene) are observed.

[1] Lecturer, Department of Geology, Shwebo University

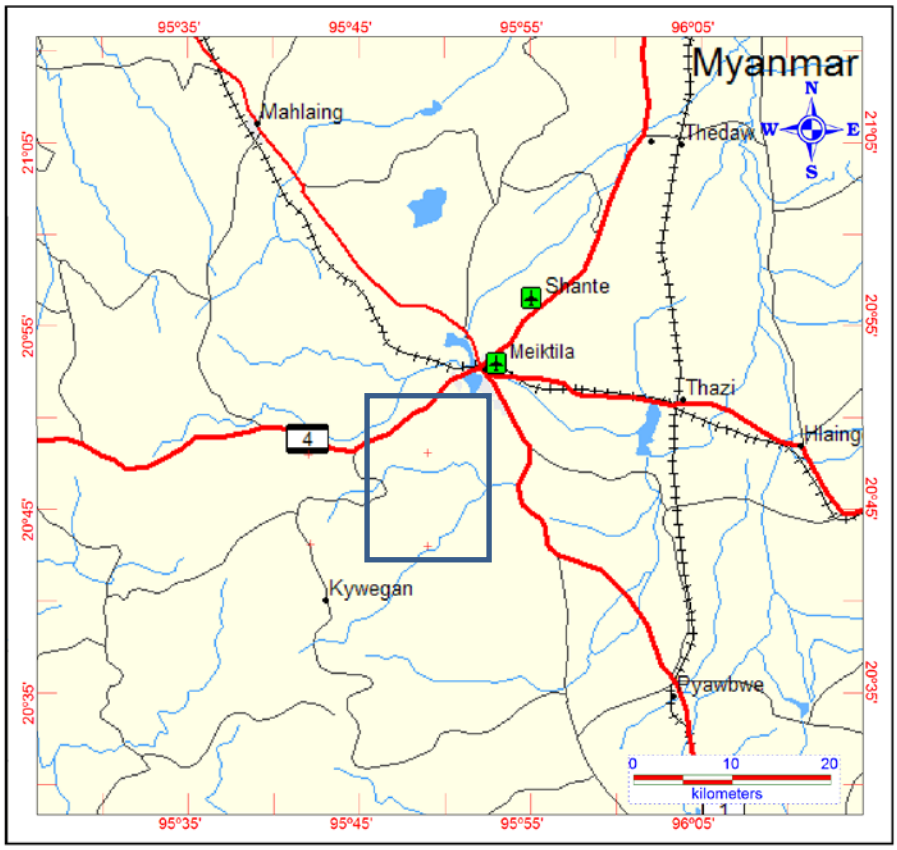


Figure (1) Location map of the study area

Sedimentary Facies Analysis

The lithologic units of the study area are mainly composed of Miocene clastic sedimentary rock. They are Taungtalone Sandstone, Moza Formation and Khabo Sandstone. Among them, I intend to investigate the facies analysis of the Moza Formation. The Moza Formation is composed of buff to reddish brown, thin- to medium-bedded, micaceous sandstone and bluish grey shales interbedded with hard calcareous sandstone bands, intraformational mud pebble conglomerate and fossiliferous sandstone bands. The sedimentary structures such as lunate ripple, small scale cross lamination, climbing ripple lamination, sole-marking and convolute lamination are common. For the specific study of sedimentary rocks the criteria (lithology, texture, beds, sedimentary structures, fossil content and paleocurrent data) are considered after Tucker (2001). The author adopted the degree of sorting of grains based on Compton (1962), bed thickness scales based on Ingram (1954), and grain size descriptions based on Wentworth's scales Fig (13).

Facies A: Trough cross-stratified sandstone

It occurs as grouped trough-shaped cross-bedding sets measuring up to 1-3 m in vertical section and individual sets ranges from 0.3 to 1 m. Its lower contact is sharp and gradational. It is assigned to have deposited in an upper flow regime (Reineck and Singh, 1980).

Facies B: Planar cross-stratified sandstone

This facies occurs in group with planar shaped cross-bedding sets measuring up to 1-2 m in vertical section or solitary sets up to 0.7 m thick, 1.3 m being common. They are generally tangential and dipping at low angle in the tidal flat and estuarine deposits.

Facies C: Horizontal laminated sandstone

This facies is developed in fine to medium grained sandstone and it is characterized by the presence of horizontal laminations. The contact is either flat or slightly concave. This facies is also widely distributed in the study area. It may be interpreted to have been formed in lower and upper flow regimes (Reineck and Singh, 1980).

Facies D: Ripple - laminated sandstone and/or siltstone

They are well developed in packet up to 1 m thick. This facies shows horizontal and cross lamination with sand-filled burrows. They consist of alternating very thin beds of fine sand, shale and clay. They belong to lower flow regime (Reineck and Singh, 1980) and may be assigned to have been deposited in offshore, channel shoal, tidal flat and estuarine environments.

Facies E: Thick-bedded sandstone with lenticular bedding

In this facies, the ripples or sandstones lenses are discontinuous and isolated both in vertical and horizontal directions. The origin of this facies requires conditions of current or wave action depositing sand, alternation with slack water conditions when mud is deposited. Therefore, this facies is interpreted to be a subtidal zone (Reineck and Singh, 1980).

Facies F: Medium- to thick-bedded sandstone-mudstone interbeds with wavy bedding

In this facies, mud and sandy layers alternate and form continuous layers. The genesis of this facies requires conditions where the deposition and preservation of both sand and mud are possible (Reineck and Singh, 1980). This facies may be assigned to have deposited in environmental such as shoreface, tidal flat and tidal channel environments.

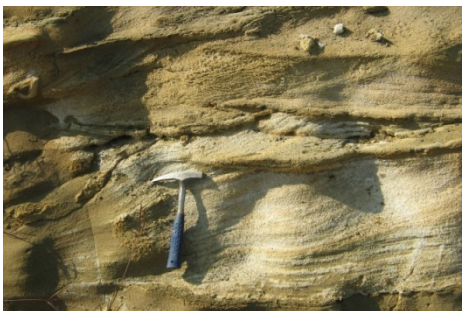


Fig.2. Facies **A**; Trough cross-stratified sandstone

Fig.3.Facies **B:** Planar cross-stratified sandstone

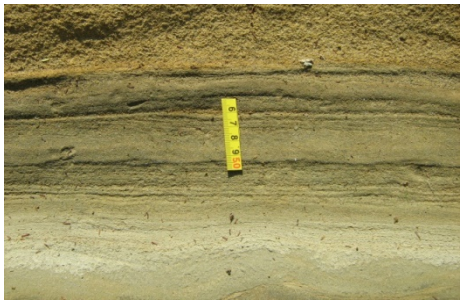


Fig.4. Facies **C:** Horizontal laminated sandstone

Fig.5. Facies **D**: Small- scale ripple cross-laminated sandstone and / or siltstone

Fig.6. Facies **E**: Thin-to medium-bedded sandstone with lenticular bedding

Fig.7. Faices **F:** Medium- to thick-bedded sandstone-mudstone interbeds with wavy bed

Fig.8. Facies **G:** Medium- to thick-bedded sandstone with convolute bedding

Fig.9. Facies **H:** Sand- silt and/ or mud interbeds

Facies G: Medium to thick bedded sandstone with convolute bedding

This facies shows marked crumpling or complicated folding of the lamina of a rather well defined fine sand or silty fine sand. Generally convolutions show more or less sharp crests alternating with rather broad troughs (Reineck and Singh, 1980). This facies may be interpreted to have been formed in the delta front environment.

Facies H: Thin to medium bedded sand-silt and / or mud interbeds

In this facies, thin- to medium-bedded sand-silt and/ mud are interbedded with different thickness. It is composed of alternating thin layers of somewhat different composition texture and color. It is known as thinly interlayer bedding (rhythmites). Thickness of individual laminae is usually less than 3 or 4 mm. These rhythmic repetitions are regular changes in the transport or production of material and these regular changes can be of short duration such as tidal changes (Reineck and Singh, 1980).

Facies I: Massive or crudely bedded sandstone

It occurs as a group measuring up to decimeter and solitary bed up to centimeter. The contact is commonly regular. This facies is widely distributed throughout the area. Massive sandstone are generally interpreted to have been formed in channel environment by many authors such as Reineck and Singh, 1980; Reading, 1996; etc.

Facies J: Thick bedded to massive sandstone with mud pebble

This facies is mainly composed of fine-to medium-grained, thick-bedded to massive sandstone with mud clasts or pebbles. The contact is commonly sharp and erosional.

Sometimes these mud pebbles are parallel to the bed. This facies may also be interpreted to have been deposited in mud flat and mixed flat environments (Reading, 1996).

Facies K: Laminated or massive clay or mudstone

This facies is characterized by fine grained sediments mainly clay and silty clay. They are commonly bluish grey to greenish grey in color. They are usually friable and massive but sometimes show layering as thin beds. The contact is commonly sharp and non-erosional. This facies may also be interpreted to have been deposited in mud flat and mixed flat environments (Reading, 1996).

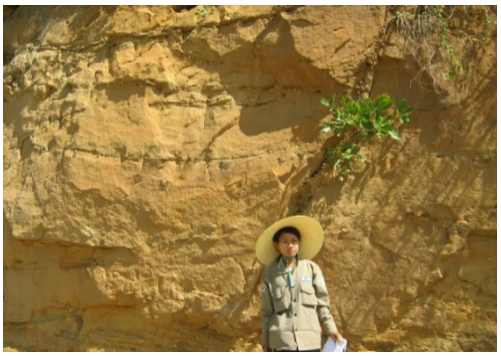


Fig.10. Massive or crudely bedded sandstone (Facies **I**) in the Moza Formation

Fig.11. Thick-bedded to massive sandstone with mud pebble (Facies **J**) in the Moza Formation

Fig.12. Laminated or massive clay or mudstone (Facies K) in the Moza Formation

Facies Association

In Moza Formation, five major lithofacies associations are distinguished on the basis of the associated primary sedimentary structures, faunal contents, biogenic structure, bed sets and bed based types. They consist of

1. Tidal Channels Association (Point- bar Facies)
2. Tidal Sand-bar Association (Sand-bar Facies)
3. Tidal-flat Association (Mixed-flat)
4. Upper Sand-flat Association and
5. Shelf Mud Association (Shoal Facies)

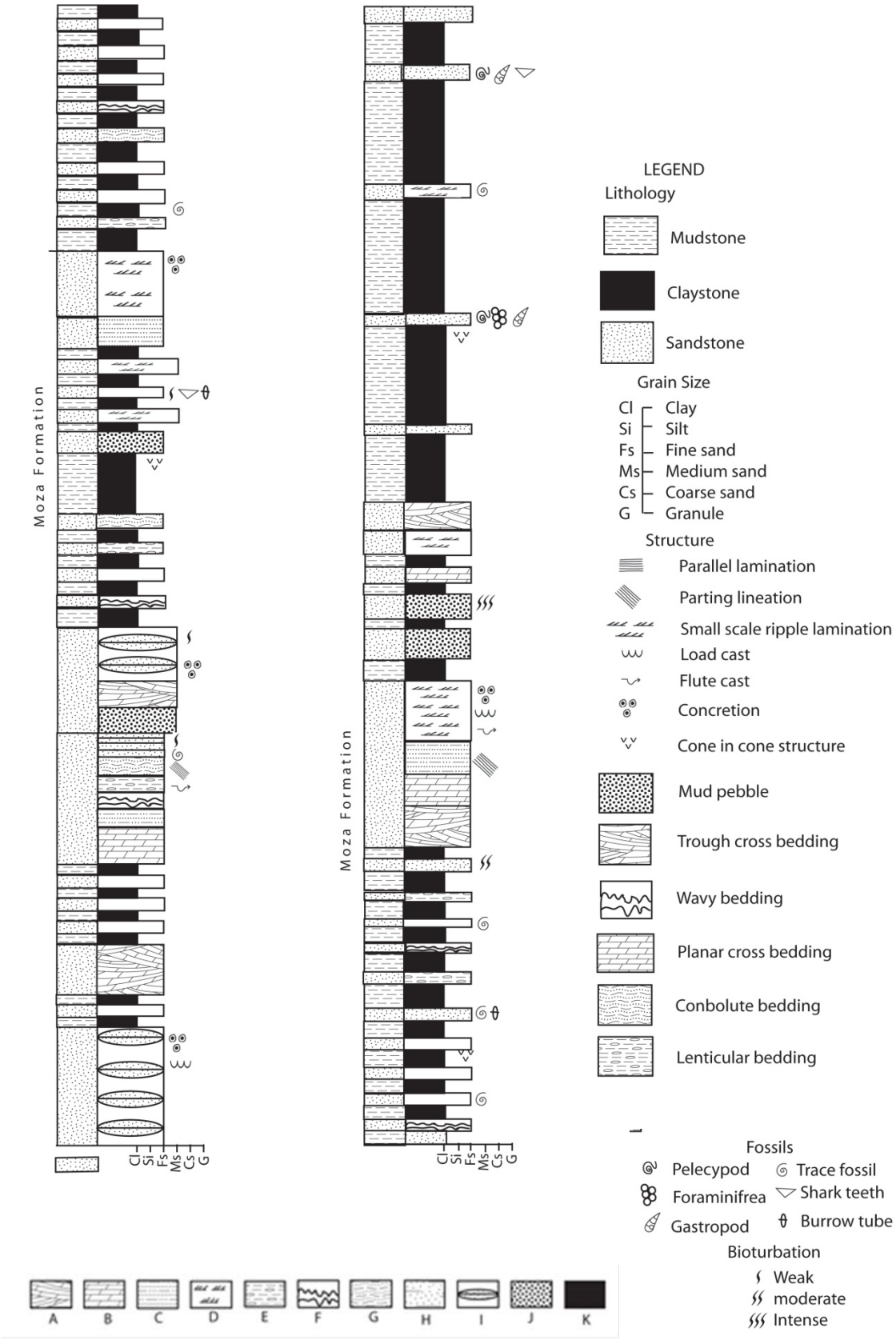


Fig (13) Detailed sedimentological log of the Moza Formation

1. Tidal Channels Association (Point bar Facies)

Tidal channel association is represented by facies (D) and (J). This facies contains medium to thick bedded, trough cross bedded sandstones with intraformational mud pebbles, ripple laminated fining to thinning upward sandstone and shale units. Ripple mark, parallel lamination and mud drape are present in the upward-thinning and fining sequence of the upper horizon. Small scale scour-and fills are locally found at the base of the bed. This facies mainly overlies the sand bar facies and underlies the shoal facies.

2. Tidal Sand-bar Association (Sand bar Facies)

This facies association is represented by facies (A), (B) (C), (D), (F) and (G). The sandstones are interbedded with shale or siltstone. These sandstones are well sorted, gray to whitish grey and grade upward into wavy to parallely laminated sandstone with bedding truncations. The upper part of the facies is mainly composed of cross strastification and ripple laminations. This facies is underlain by the Sand Sheet Facies and Mixed-flat (Tidal-flat) Facies and overlain by the Point-bar Facies.

3. Tidal-flat Association (Mixed-flat)

Tidal flat association is combination of facies (C), (E), (F), (G) and (K). This facies association is mainly composed of thinly interlayered sand-shale bedding. There are four main types of sedimentary structure in interlayered and sand-mud sequence. Flaser, lenticular, streaked mud lamination and horizontal lamination are occasionally association with plant remains. Current-rippled beds and intraformational mud clasts are also present. This unit is underlain by the sand bar and upper sand flat facies and overlain by shoal facies.

4. Upper Sand-flat Association

This facies association is represented by facies (B), (I) and (J). It is made up almost entirely of buff colour to yellowish brown sandstone. Trough to low angle cross lamination is present in thick bedded units, where as some show massive bedding characters with bioturbations. Ichonofaunal assemblages are characterized by *Ophiomorpha* and *Skolithos* ichnospecies. Sometime, nodules are present along the bedding planes. This facies is underlain by the estuary point-bar facies and is overlain by the Mixed-flat facies.

5. Shelf Mud Association (Shoal Facies)

This facies association is a combination of facies (A), (B), (D), and (H). It mainly comprises thin to medium bedded, gray to greenish gray siltstone and dark grey shale with hard sandstone bands with abundant fossil debris and few mud clasts. Allochems consist mainly of medium to coarse grained and moderately sorted skeletal remains of echinoids, mollusks, etc. The upper bedding surface shows hard ground characters and the lower part is sandy more than the upper part. This facies is overlain by estuarine Point-bar facies and Mixed-flat facies.

Conclusion

The environmental interpretation of the Moza Formation was done on the basic of primary sedimentary structure, texture, and geometry of facies analysis. All facies associations are interpreted as representing an estuarine point bar in the upper and central parts of the tide dominated estuary system. Herringbone-cross laminated and parallel to rippled-cross laminated sandstone units are deposited in tidal bars of the upper part of an estuarine channel (Allen,1963). Rippled-laminated sandstone and shale intercalated units are interpreted as the deposits of the middle-upper part of the point bars in the tide-dominated estuarine environment (Kyi Khin *et al.,* 1991). Sedimentary features that indicate deposition

by tractional currents include cross-stratifications, current ripples and wavy bounding surface bedding planes (Reineck and Singh, 1980; Reading, 1996). In regions with a substantial tidal range, a sand flat often passes upwards into a mud flat tidal environment. Furthermore, lenticular bedded sand and clay indicate the mixed flat environment. Parallel laminated fine sand is interpreted as the sand flat of the upper flow regime in an intertidal environment. Formation show at least five facies association representing deposition on tidal Channels Association, Tidal Sand-bar Association, Tidal flat Association, Upper Sand-flat Association and Shelf Mud Association. These facies association suggests depositional environment of Moza Formation is tide dominated estuary environment on an estuarine point bar in the upper part and central part of the tide dominated estuary system.

Acknowledgements

I would like to thank to Dr. Win Swe, Rector of Shwe Bo University, Dr. Myo Myo, Pro-rector of Shwe Bo University, and Dr. Khin Khin Lin, Professor and Head of the department of Geology, Shwe Bo University for their kind permission to carry out this work. I sincerely express my gratitude to Dr. Zaw Win, Professor of Geology Department, Shwe Bo University for his advice and suggestion. Finally, I would like to express many thanks are due to all people who gave me helps throughout this study.

References

Allen, J. R. L., 1963. *The Classification of cross-stratified units and notes on their origin; sedimentology*, vol. 2 pp.

Kyi Khin, 1991. *Sedimentology of Yamethin West Area, Yamethin Township, Mandalay Division.*

Kyi Khin and Myitta, 1999. Marine transgression and regression in Miocene sequences of northern Pegu (Bago) Yoma, Central Myanmar. *Journal of Asian Earth Sciences*, vol.17, pp 369-393.

Maung Maung, 1978. *Stratigraphy and sedimentation of the Myotha-Ngazun Area*, M.Sc. Thesis, Mandalay Art and Science University.

Maung Maung, 1994. *Petrology of Shwezettaw-Kyauk-O-Ngape area, Ngape-Minbu Township, Magway*. M.Sc Thesis (unpub).

Miall, A.D., 1984. *Principles of Sedimentary Basin Analysis*: New York, Springer, Verlag.

Nichols, G.J., 2009. *Sedimentology and Stratigraphy* (2nd ed): John Wile & Sons, New York.

Potter, P.F., 1959. *Facies model conference* science. Prentice-Hall Inc, New Jersey.

Reading, H.G., 1996. *Sedimentary Environment*: Processes, Facies and Stratigraphy (3rd ed): Oxford, Black well Sci. Publications.

Reineck, H.E and Singh, I.B., 1980. *Depositional Sedimentary Environment*: Springer- Verlag, New Yourk.

Searle, D. L and Haq, B. T., 1964. The Mogok Belt of Burma and its Relationship to the Himalayan Orogeny 22nd, Inter, Ged Congr, India.

Tucker, M.E., 1996. *Sedimentary Rocks in the field* (2nd ed). John Wiley and Sons, Chictester, New Yourk., Brisban. Tosono. Singapore.

Tucker, M.E., 2001. *Sedimentary Petrology* (3rd ed). Blackwell Science Ltd., UK.

Thant Zaw Moe, 2017, Sedimentology of the Neogene Sequences exposed in Myothit-Taungnyo Area, Magway-Mandalay Regions., Unpublished Ph. D Thesis, Univeristy of Mandalay.

An Account of Field, Petrographic Characteristics and Tectonic Setting of Gabbroic Rocks and Serpentinized Peridotite in Pwint Phyu Area, Mogaung Township, Kachin State

Chit San Aung[1]

Abstract

The ophiolite sequences of Northern Myanmar, as a part of ophiolite sequence, represent both, mantle section and crustal section. The crustal part of the ophiolite sequences, compose of a layered series (cumulate peridotites and gabbros). This paper aims to overview of petrographic character and physical features of the gabbroic rocks and serpentinized peridotite. The gabbros comprise olivine gabbro, normal gabbro, gabbronorite, and uralitized gabbros. Gabbros in this area compose mainly of pyroxene, plagioclase, and minor amounts of amphibole and biotite, olivine and other accessory minerals. Serpentinized peridotites contain olivine, pyroxene, serpentine, anthophyllite , brucite and other opaque minerals. Petrographic characters may indicate that they are formed in subduction-related tectonic setting.

Key words: Ophiolite sequences, mantle section, petrographic character, olivine gabbro, serpentinized peridotites

Introduction

The study area, Pwint Phyu village, lies on the Namyin valley, the southern part of Mogaung Township, Myitkyina, Kachin State of northern Myanmar. The study area is covered about 100 km^2 and represents a part of ophiolite sequence. This area may be generated by Sagaing fault, right-lateral transform faulting. In the study area, the dominant metamorphic rock types are pelitic to psammatic schists, some igneous units and sedimentary units. The igneous rocks- olivine gabbro, serpentinized peridotite and komatiite are main units in this area. This paper is only concentrated on the gabbroic rocks and serpentinized-peridotites in southeastern part of research area.

General geology

The studied area lies north of the Mogaung Township, between latitudes N 25º 02' - 25º 13' and longitudes E 96º 31' - 96º 45' and covers southernmost part of the 92-C12 and northeastern part of the 92-D9 of one inch to one mile topographic maps. The rocks of study area consist chiefly of Katha metamorphic rocks and ultramafic rocks. The ophiolitic rocks are found either as mountainous blocks or as fragments .The metamorphic serpentinized-peridotites are encountered as fragmental blocks in the southeastern part. Gabbroic rocks are also exposed as separate mountainous blocks in the southern part of the area. Primary rhythmic layering is well searched, where plagioclase-rich bands alternate with the pyroxene-rich bands. The gabbroic rocks in the area form rugged mountains and rest in a tectonic contact against the underlying mantle sequence. The gabbros comprise olivine gabbro normal gabbro and gabbro-norite. Serpentinized peridotite is exposed at the eastern part of the Pwintpyu village in the study area. It is light to dark green color, fibrous and soft nature. The location map and satellite image map of the study area are shown in figures (1) A and B.

[1] Lecturer, Geology Department, University of Shwebo

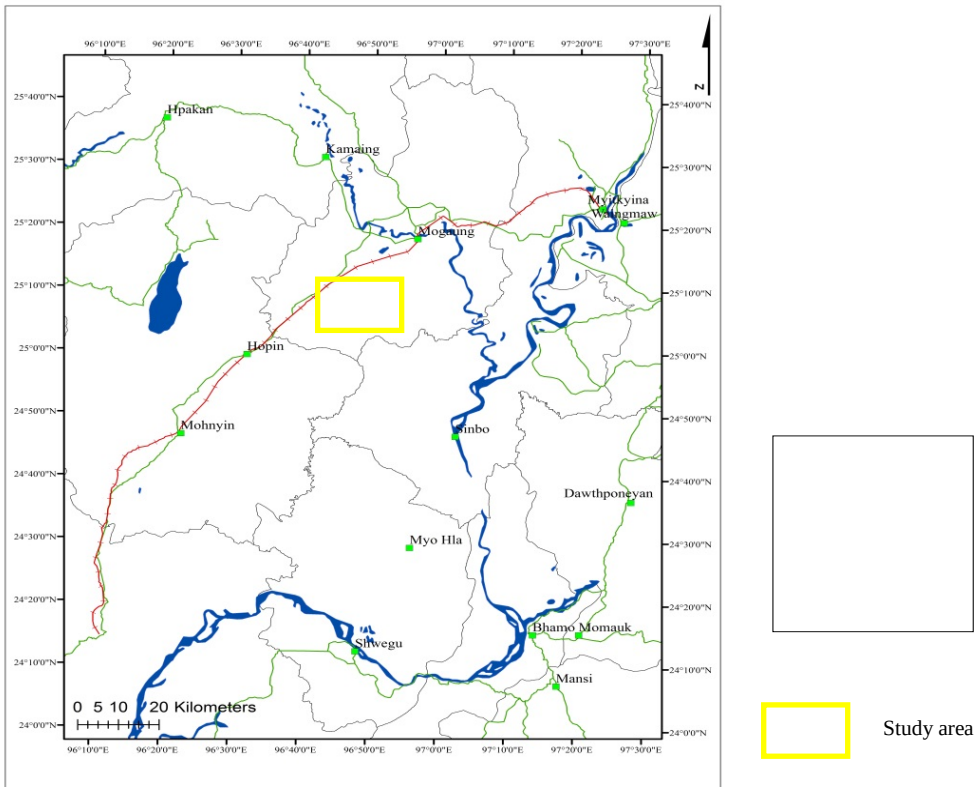


Fig. (1). A. Location map of Pwint Phyu area

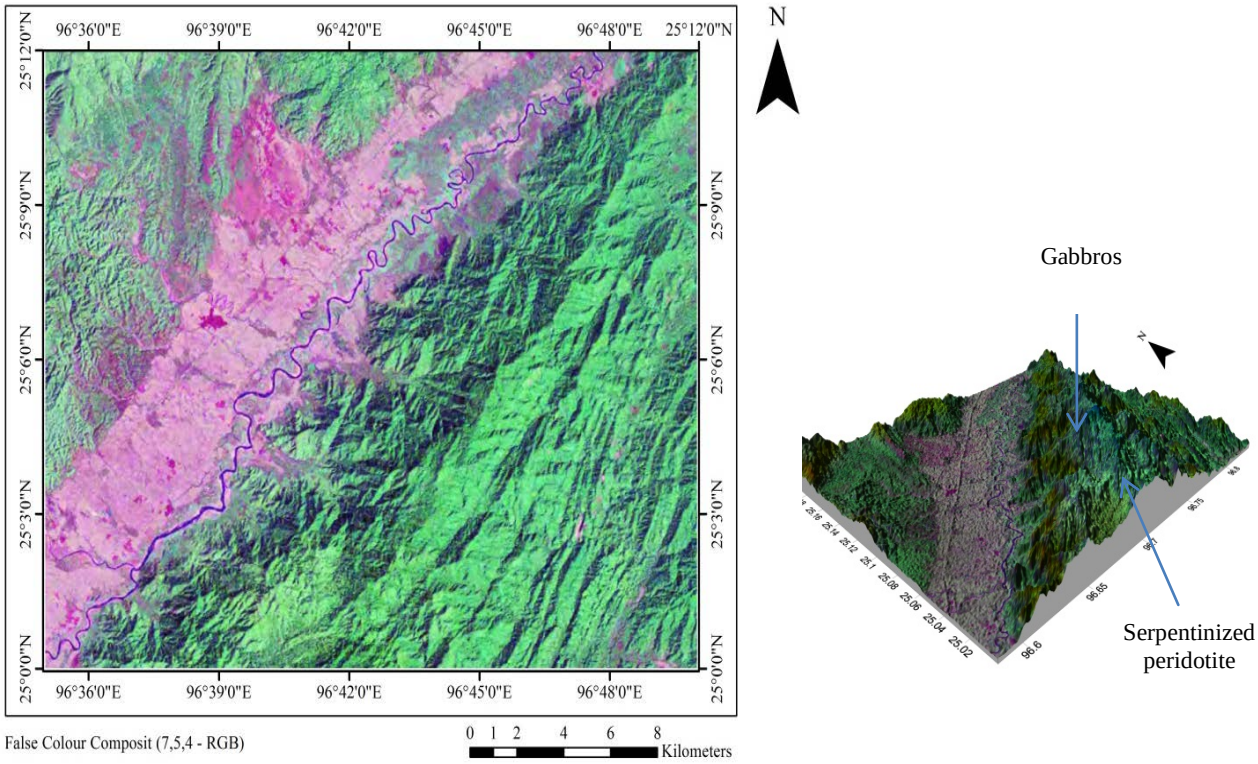


Fig. (1). B. DEM image and 3D image of the area and its environs

Regional Geologic Setting

Geologically, Myanmar has been traditionally divided into three major tectonic units (Searle et al., 2007), the Indian plate to the west, the West Burma Block, and the Shan Plateau that lies east of the Sagaing fault (Fig. 2a). The east dipping Andaman subduction zone that continues on shore along the western margin of the Indo-Burma Range (IBR) accretionary prism marks the presently active Indian plate boundary. The Shan Plateau is a part of the Sibumasu Block, and is bordered to the west by the Mogok metamorphic belt (MMB). The West Burma Block lies to the east of the 1200 km long dextral Sagaing fault on which the Burma plate is moving northwards relative to Asia at about 18 mm/yr (Maurin et al., 2010). Discontinuous ophiolite massifs are widely distributed in Myanmar and they have been traditionally classified into the Western Belt and the Eastern Belt (Mitchell, 1993). The Western Belt roughly follows the trend of the eastern Indo-Burma Range, and crops out best in the Chin Hills. Previous geochronological studies have reported Jurassic ages (e.g., 166–176Ma) for the Myitkyina ophiolite in the Eastern Belt (Liu et al., 2016a; Yang et al., 2012). Similar Late Jurassic (i.e., middle-upper Tithonian) ages have also been constrained for radiolarian cherts in the Myitkyina ophiolite (Maung et al., 2014). The Myitkyina ophiolite crops out in the Tagaung-Myitkyina belt and is characterized by a big massif of mantle peridotites (Fig. 2b), which is heavily covered by sediments and vegetation, and only exposed in some quarries (Fig. 2a). Mafic plutonic rocks (e.g., gabbro) were found in the field, whereas red radiolarian cherts and pillow basalts are locally preserved. Mantle peridotites of the Myitkyina ophiolite mainly consist of harzburgites, with minor lherzolites/dunites that are locally exposed (Hla Htay, 2004).

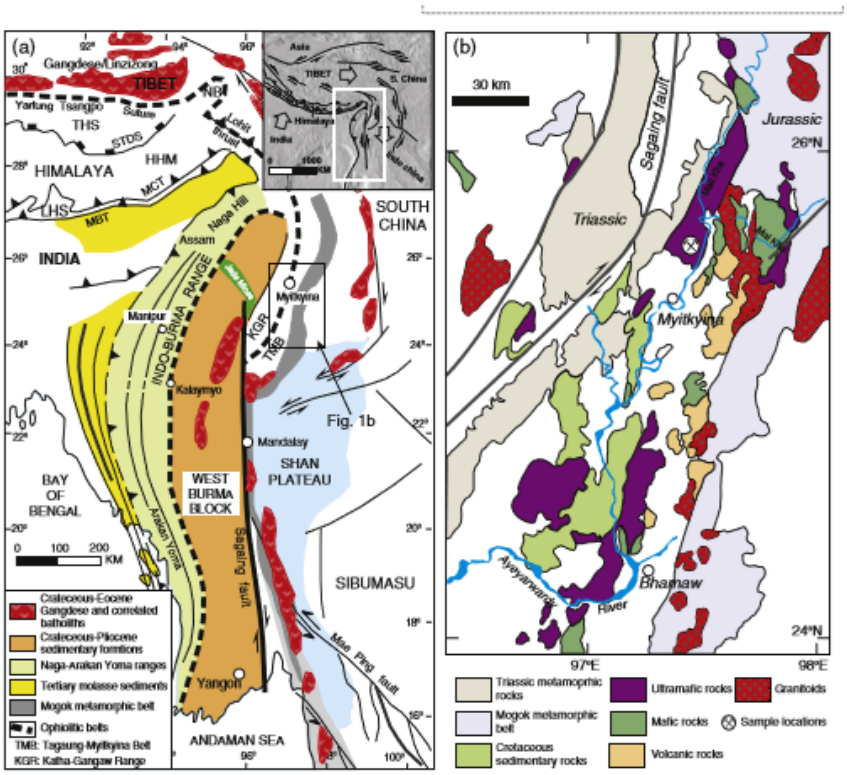


Fig. (2). Sketch geological maps of Myanmar (a) and the Myitkyina ophiolite (b). (Modified after Liu et al. (2016b).)

The study area is located within the northern part of the Central Cenozoic Belt. Regionally, most part of northern Myanmar is mainly composed of basic and ultrabasic igneous rocks, volcanic rocks, sedimentary and metamorphic rocks. The northern part of the study area, is well known Jade Mines area, consisting of phyllites, kyanite schist and garnet-mica schist intruded by sill-like bodies of serpentinite, peridotite and chlorite bearing dunite (Noetling 1893, Clegg, 1941). Further west beyond these, it is surrounded by Wuntho massif and Central Volcanic Line. Wuntho massif is constituted by submarine basalt and Hb-andesites that pass into dacite (Mitchell et al, 1986). The Sagaing fault, right lateral strike fault, passes through the central part of the study area. The southern part is covered by Pleistocene gravels, Irrawaddy formation, Male formation, Tagaung Taung ultrabasics, Mayathein Metamorphics, Katha Metamorphics, Ngapyawdaw Chaung formation and Tonnge basalt and alluvium in Figure (2).

Aims and objectives

The aims of this investigation are to highlight the detailed field and to study their mechanical, physical and petrographical properties, to help engineers to get a better knowledge of gabbroid rocks. Another objective of this study is to identify the general tectonic setting of the gabbroic rocks and serpentinized peridotite of the area.

Method of study

Both field and laboratory methods are used for present research. In the field, one inch topographic maps 92-C12 is used as base map. These maps index enlarged to a scale of two inches to one mile. GPS instrument and Bruton Compass are used extensively in the field, for measuring specific locality, foliation, joints, bearings, dip and strike, etc. But the various kinds of previous literatures written by many authors and the former geological map are studied. Representative samples are collected from the outcrops to study petrography analysis. More than 20 thin sections are cut from representative samples collected from the individual rock types. And then, thin sections are studied and examined each mineral under petrographic microscopes.

Field and Petrographic Characteristics

Petrographic characteristics of the studied rocks are used in the interpretation of origin and genesis of the area. Classification of the mafic rocks in the studied area follows the nomenclature system, as recommended by the IUGS Subcommission on the Systematics of Igneous Rocks. In the study area, the dominant metamorphic rock types are pelitic to psammatic schists, some igneous units and sedimentary units. Samples are collected from distinctive lithologic units covering the whole area. Most of ultramafic units are gabbroic rocks and serpentinized peridotite. The gabbroic rocks are made up primarily of four minerals: olivine (Ol.), clinopyroxene (Cpx.), orthopyroxene (Opx.) and plagioclase (Pl.), with substantial amount of hornblende (Hb). Their petrographic characteristics are studied by referencing the petrology of igneous and metamorphic rocks (Best, 1986 and Hyndman, 1985). Petrographic observation is made from over 100 thin sections. Among these, common lithologic units are determined after detailed microscopic studies. The gabbroic rocks in the studied area can be divided into the following types depending on the lithology of the mantle-crust transition zone and crustal sequences (Tokhi M. E et al., 2016).

a. Olivine gabbro

Megascopic study

Olivine gabbro is cropped out at the southern part of Pingyaing village in the study area. It shows light grey color on the weathered surface and dark color on the fresh surface. This type of rock has a uniform texture and is dominated by the coarse-grained olivine crystals. It is very hard and compact. Conspicuous olivine crystals are found in hand specimen of this rock units (GPS: N 25º 5' 46" – E 96º 38 21").

Microscopic study

Olivine gabbros form one of the most common rock types in the layered gabbroic sequence of the study area. It consists mainly of plagioclase and olivine, while pyroxene represents less than 10% of the volume. The rock shows coarse-to very coarse-grained hypidiomorphic granular texture. It contains pyroxene, plagioclase, and minor amounts of amounts of amphibole and biotite, olivine and other accessory minerals. The pyroxene content is mostly clinopyroxene, generally augite, but small amount of orthopyroxene may also be presented.

Green-colored olivine occurs as euhedral to subhedral grains betwen XN. It is colorless to pale green in thin sections under PPL. It also shows moderately pale green pleochroism.. Some of elongated olivine crystals display parallel extinction. The crystals show retardation, distinctive fracturing, lack of cleavage, and alteration of serpentine minerals.

Cracked-plagioclase shows euhedral to subhedral grains with tapering twin lamellae under PPL because of incipient deformation and has undulatory extinction. Plagioclase with albite twins shows as first order interference yellow colored minerals with low relief under PPL. Some of the plagioclase grains are cloudy because of alteration. Plagioclase grains are commonly homogeneous and rarely show signs of compositional zoning.

Clinopyroxene oikocryst especially augite with ophitic texture shows colorless under PPL and pale green to pale brown colors under XN .It displays second-ordered interference color and higher birefringence. It is moderate to high relief and inclined extinction. In some slices, clinopyroxene exhibits herringbone patterns, and alters to serpentine and chlorite.

b. Gabbro-norite

Megascopic study

This unit is mainly cropped out at Payitaung, southern part of Pingyaing village and eastern part of Zawgyi Taung . It shows dark grey color on the weathered surface and light grey color on the fresh surface. Sometimes show reddish brown color on the weathered surface (GPS:N 25º 03' 37.6" - 25º 41' 07.1").

Microscopic study

This rock is mainly composed of plagioclase, diopside and subordinate clinopyroxene and olivine. Plagioclase is an intercumulus phase found as subhedral to anhedral crystals, partly saussuritized and shows traces of deformational lamellae.

Clinopyroxenes are partly altered to tremolite and chlorite. Relict olivine occurs in granular masses and sub-rounded grains ranging from, 1 mm to 3 mm in size. The grain size varies from medium-grained to coarse-grained; fine-grained varieties are rare. They show poikilitic texture and wavy extinction due to deformation. The olivine crystals show moderate

and second order interference between XN. It also gives colorless under PPL. Frequently, serpentine is found along the cracks in olivine. Translation lamellae appear in olivine of some section. Small olivine grain is enclosed in it.

Subhedral plagioclase shows polysynthetic twinning. Plagioclase shows as first order interference yellow to brown colored minerals with low relief under PPL. Some of the plagioclase grains are cloudy because of alteration. Graphite grains are scaly masses and show a flaky or platy crystal form, of both regular and irregular habits.

Orthopyroxene is nearly rectangular crystals in this unit and sometimes shows irregular in shape. It is colorless to pale green in under PPL with weakly pleochroic and first order yellow or red color between XN. In some sections, pyroxene performs as groundmass for spinifex olivine crystals. In some section, tremolite shows the fibrous aggregate of yellowish brown colored crystals in it. Subhedral basal sections of colourless to pale green tremolite with moderate relief can be found in some sections of gabbro-norite under PPL.

c. Normal Gabbro

Megascopic study

The rock shows medium-coarse-grained foliated schistose texture. Weathered color is dark and fresh color is light grey in color. The mineral compositions are plagioclase and clinopyroxene with minor amphibole and olivine. In this unit, clinopyroxene is more abundant than others and forms subhedral prismatic grains or irregular grains plagioclase. This unit crops out at the southern part of the area (GPS: N 25º 05' 46" – E 96º 32' 21").

Microscopic study

This unit is medium to coarse-grained and usually characterized by equigranular textures. It mainly consists of plagioclase and clinopyroxene with minor amphibole and olivine. Clinopyroxene is more abundant and forms subhedral prismatic grains or irregular grains intergrown with plagioclase. The main accessory minerals are magnetite, apatite and epidote.

Plagioclase is euhedral to anhedral porphyroblast grains of colorless under PPL. It displays first order yellow interference color between XN. Saussauritization occurs along the grain boundaries of plagioclase. Quartz occurs as clear anhedral grains and also found as inclusions in this feldspar.

Characteristically, clinopyroxenes especially in diopside are darkish green to black-colored anhedral grains between XN. It displays fairly high relief and upper second order interference colors. Polysynthetic twinning can be occurred. In some section, it is sometimes more or less altered to tremolite.

Amphibole is a medium to coarse euhedral to subhedral grains and shows deep green and brown colors between XN. It sometimes shows pink color and moderate relief under PPL. Most of the amphibole shows various shades of pleochroic color especially in blue or brown with second order of orange interference colors between XN. Simple twinning and two sets of cleavage can be observed in thin sections of this unit.

Olivine crystal is a wide variety of habitats, from equant solid polyhedral outlines and shows yellow to yellowish-brown color between XN and colorless under PPL. The olivine displays as skeletal crystals with high relief between XN and under PPL. Olivine exhibits second order interference color and shows various pleochroic colors.

Serpentinized peridotite

Megascopic study

The rock is exposed at the eastern part of the Pwintpyu village in the study area. It is light to dark green color, fibrous and soft nature. It contains mostly of serpentine minerals (chrysotile, antogorite and asbestos) and relict olivine and pyroxene minerals (GPS: N 25º 10' 19.38" – E 96º 43' 2.85").

Microscopic study

It is medium to coarse grained, holocrystalline and has hypidiomorphic granular texture. It consists of olivine, pyroxene, serpentine minerals, anthophyllite , brucite and other opaque minerals.

Olivine occurs in granular masses and sub-rounded grains ranging from, 1 mm to 3 mm in size. The grain size varies from medium-grained to coarse-grained; fine-grained varieties are rare. They show wavy extinction due to deformation. It shows moderate and second order interference between XN. It also gives colorless under PPL. Translation lamellae appear in olivine of some section. Small olivine grain is enclosed in it. Serpentine minerals are found as yellow-green colored flaky minerals.

Serpentine occurs along the olivine cracks and displays vein and mesh structure. The serpentine shows colorless and low relief under PPL. It sometimes shows wavy extinction and displays various interference colors such as blue, green and yellow. Serpentines are probably antigorite.

Anthophyllite is bladed aggregates of unterminated prismatic crystals. It is also commonly lamellar or brous, asbestiform. The mineral grains show variegated colors especially gray, brownish gray, yellowish brown, green, emerald-green; in thin section, colorless to pale green or yellow between XN. Most of the antophyllite crystals show colorless and moderate relief under PPL. They usually show low to moderate interference colors under PPL. They are fibrolite some sections and occur in altered hazgburgite.

Brucite is typically flattened tabular crystals showing lamellar and fibrous aggregates and foliated masses. It displays moderate relief and color under PPL. Magnetite is opaque and occurs as accessory minerals.

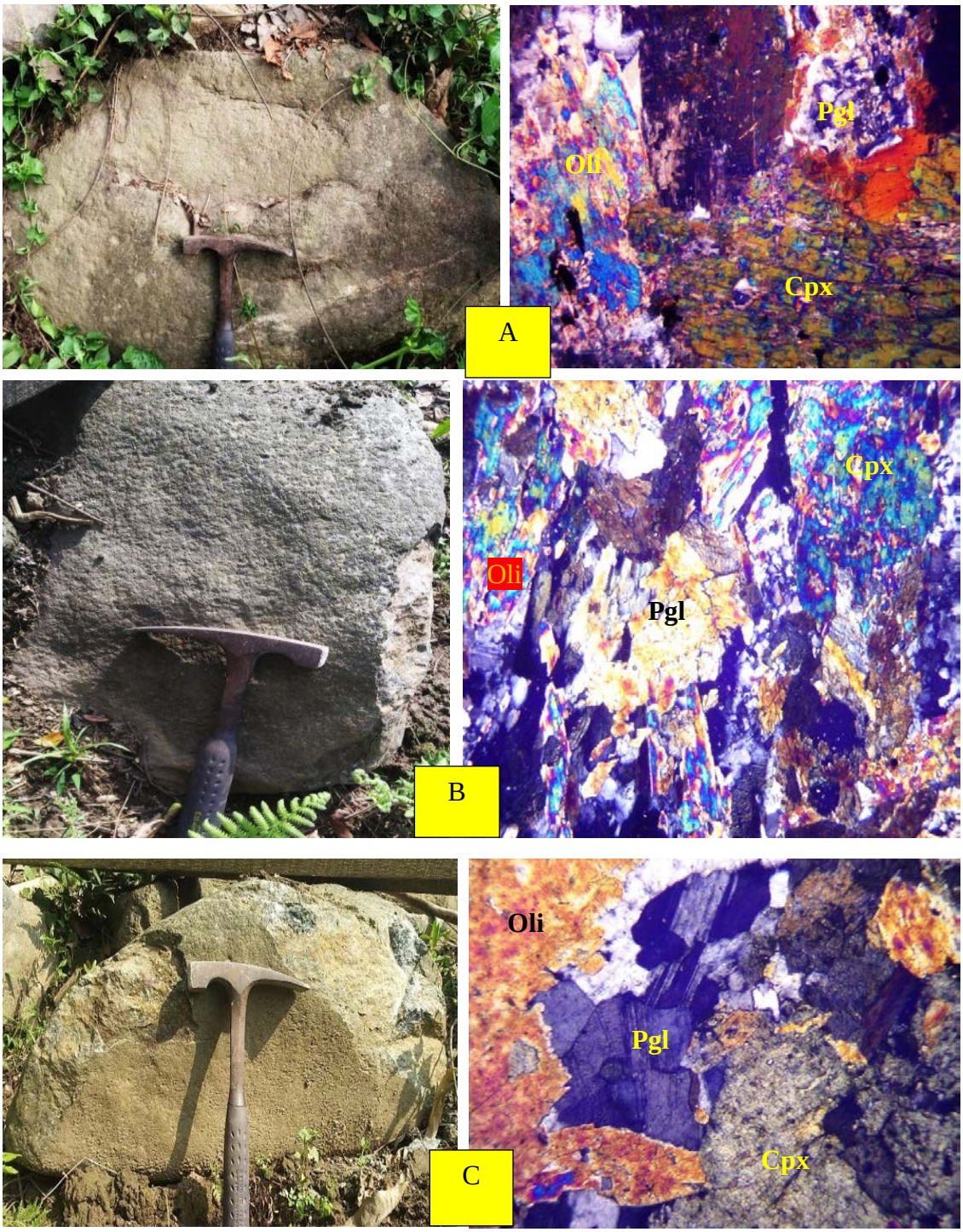


Fig.(3). Photographs showing the outcrop nature and petrographic characteristics of gabbroic rocks (A) Example of olivine gabbro (B) Example of gabbro-norite and (C) Example of normal gaabbro rock (Pgl=plagioclase, Cpx=clinopyroxene, Opx=orthopyroxene, Oli=olivine)

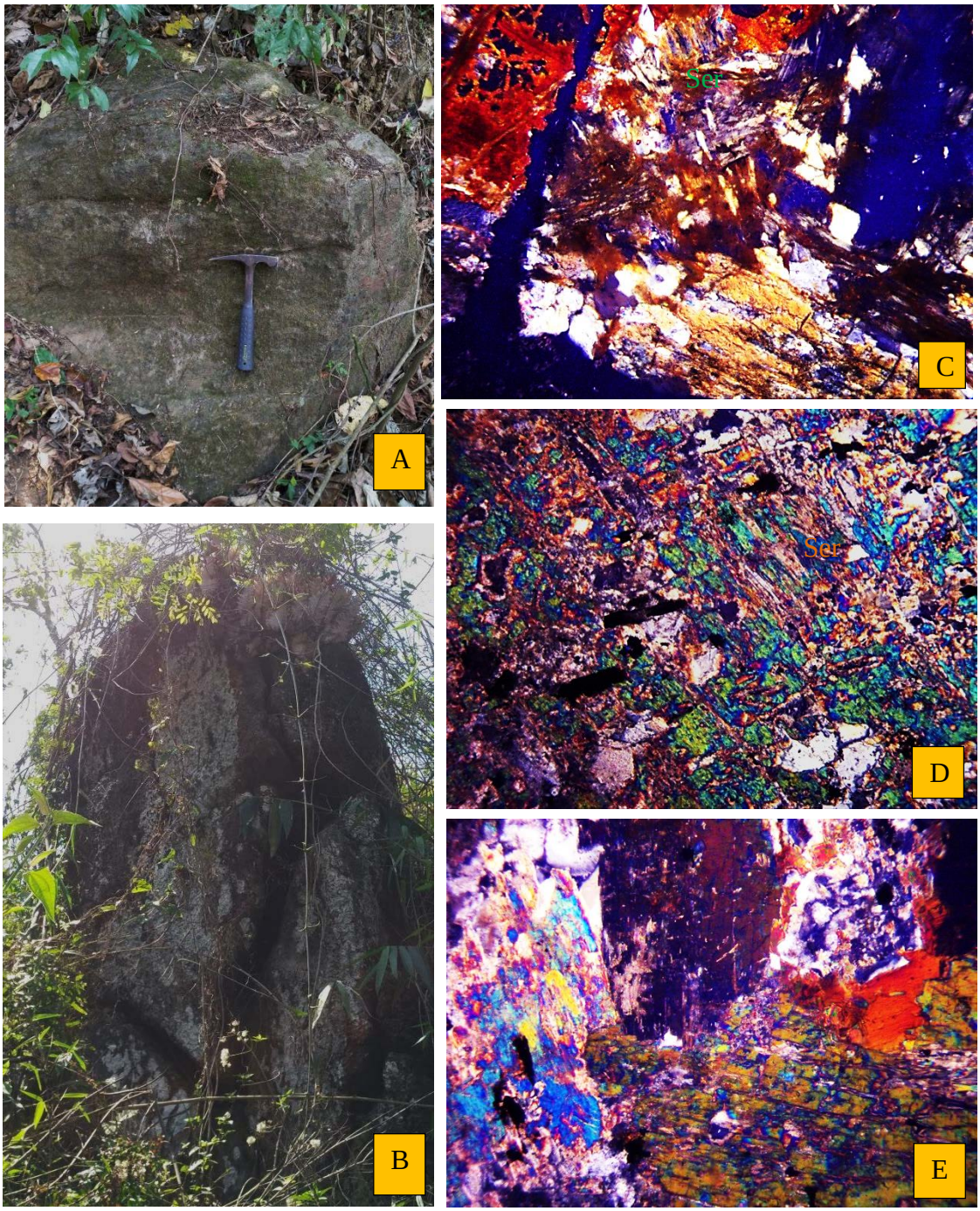


Fig.(4). Photographs showing the outcrop nature and microscopic views of mineral assemblages of serpentine+olivine+anthophyllite+ other accessory minerals in serpentinized peridotites (Ser=serpentine, Oli=olivine, Ant=anthophyllite)

Result, Discussion and Conclusion

The southernmost part of the Kumon Range, separated by the Sagaing-Namyin fault from the Katha-Gangaw Range, was studied by Aung Win (2008). He observed the eclogite unit in biotite zone of pelitic schist. He described the temperature-pressure condition for the formation of eclogite is P-2.3 GPa at T-493°C in peak-pressure stage of eclogite facies

The northern part of the Katha-Gangaw Range has been studied by Nyan Win (2008). He confirmed that kyanite-garnet schist associated with metapelites of Katha-Gangaw Range

has undergone high P/T (~ 1.9 GPa/ 750°C) metamorphism. However, the peak conditions of the Kanpetlet schist in Indo-Myanmar ranges are around 0.8-0.9 GPa and 450°C (Soequet and Pubellier (2002) and the garnet clinopyroxinite of Tagaung-Myitkyina Belt is 1.1 GPa and 630-650°C (Aung Kyaw Thin, 2006). On the basis of the above considerations, the Katha-Gangaw Range including the study area has experienced high P/T condition. With the exception of lack of Cretaceous Limestone, the metamorphic rocks exposed at the present study area are partly similar to that of Ngapyawdaw Chaung Formation. Therefore, the Katha Metamorphics exposed at Gangaw Range may be considered as primarily metamorphosed from the pelitic and psammitic rocks with metabasic rock of Jurassic to Early Cretaceous age.

According to the structural and lithological features, the metamorphic rocks of the study area are similar to those of the Katha-Kumon range. Radiometric dating are performed on metamorphic rocks, using $^{39}Ar/^{40}Ar$ methods for muscovite and biotite, in Katha and Kumon Ranges, and the results indicate that the metamorphism took place in 37 to 32 Ma, Late Eocene to Early Oligocene (G. I. A. C, 1999) and (Myo Min, 2007). Gabbros in this area include olivine gabbro, norite gabbro and normal gabbro. All three minerals; olivine, pyroxenes and plagioclases (ol + pyx + pgl) are involved in the fractionation process. This type of mineralization is typical of decompression setting over a subduction zone. Serpentinized peridotite in the study area belonging to Myitkyina peridotites are more refractory and have experienced hydrous melting, which might originate from SSZ setting. SSZ-type peridotites in Kalaymyo and Myitkyina ophiolites supports that they have experienced complicated evolution in different tectonic settings. They also might be justaposed with SSZ peridotites during collision of a spreading center with a subduction zone (Liu. et.al 2016b.).

Previous studies on Hf-Nd isotopes of abyssal peridotites and oceanic xenoliths have demonstrated the existence of such mantle domains (i.e., with extremely radiogenic Hf isotopes) in the asthenosphere (Bizimis et al., 2007; Stracke et al., 2011). Both petrological and geochemical data suggest that the gabbroic intrusions within the mantle peridotites of the Myitkyina ophiolite are crystallized from hydrous melts. The Sr-Nd-Hf isotopes indicate that the hydrous melts were derived from the mantle wedge that was metasomatized by a subducted sediment component. Therefore, the Myitkyina gabbros are generated in a supra-subduction zone setting. This suggests that the Myitkyina ophiolite is originated in a supra-subduction zone (SSZ) setting rather than a mid-ocean ridge (MOR) setting. Such a conclusion is consistent with previous studies on both basalts and peridotites of the Myitkyina ophiolite (Liu et al., 2016a; Yang et al., 2012).

According to previous authors, most of the gabbroic rock and serpentinized peridotites in the study area may be a typical of tectonic setting over a supra-subduction zone (SSZ). Although the present study area and its environs have many research related to economic aspects, detailed petrologic data have not been yet. Therefore, the study area is deserved to detailed studies about the petrographic views which can create the data for the evolution of northern Myanmar.

Acknowledgements

I am deeply indebted to Dr Win Swe, Rector, University of Shwebo, for his kind permission and giving the opportunity to conduct this research work. I wish to express my sincere gratitude to Dr Khin Khin Lin, Professor, Head of Geology Department, Shwebo University, for her constructive comment and guidance. Finally, I would like to express many thanks to all my teachers, Department of Geology, Shwebo University, for their advice, comment and suggestion.

References

Aung Kyaw Thin, 2006. Petrogenetic Study on Igneous and Metamorphic Rocks of the Tagaung-Twinnge Area, Thabeikkyin Township, Unpublished. PhD Dissertation, Dept.of Geol. Mandalay University. 125p.

Aung Win, 2008. Petrogenetic Studies of Metamorphic Rocks in Mogaung Area, Mogaung and Phakant Townships, Myitkyina District, Kachin State: Implication for Tectonic Setting. Unpublished. PhD Dissertation, Dept. Geol. Mandalay University. 183p.

Best, M.G., 1986. Igneous and Metamorphic Petrology.CBS publisher and Distributors, New Delhi, India. 620p.

Bizimis, M.,et al., 2007. Ancient recycled mantle lithosphere in the Hawaiian plume: osmium-hafnium isotopic evidence from peridotite mantle xenoliths. *Earth and Planetary Science Letters* 257, 259–273.

Clegg, E.L.G., 1941. The Cretaceous and associated rocks of Burma. *Mem.of the Geol. Surv. India*. V.74. pp. 1-101.

Chuan-Zhou Liu. et.al, 2016. Petrology and Geochemistry of Mantle Peridotites from the Kalaymyo and Myitkyina Ophiolites (Myanmar*): Implications for Tectonic Settings .Special Issue of the 2nd International Conference on Computational and Experimental Science and Engineering (ICCESEN 2015*) Vol.130, No.1, pp. 17-22.

G.I.A.C, 1999. and Myo Min, 2007. The Tectonics of Myanmar: *Final Report of G.I.A.C Project*. 1996-1999. 156p

Hyndman, D.W., 1985. Petrology of Igneous and Metamorphic rocks.2nd ed. Mc. Graw Hill, Inc, New York. 335

Htay, H, 2004. Geology of Inkhaingbum and Myitsone Area, Myitkyina Township, Kachin St*ate*. p. 20.

Liu, C.Z., etal.,2016a. Tethyan suturing in Southeast Asia: zircon U-Pb and Hf-O isotopic constraints from Myanmar ophiolites. Geology 44, 311–314.

Liu, C.Z., et al., 2016b. Petrology and geochemistry of mantle peridotites from the Kalaymyo and Myitkyina ophiolites (Myanmar): implications for tectonic settings. Lithos 264, 495–508.

Mitchell, et.al, 1986. Ophiolite a detachment related to syn-collision thrusting: *Journal of Geodynamics*, V. 5, pp. 257-274.

Mitchell, A.H.G., 1993. Cretaceous-Cenozoic tectonic events in the western Myanmar (Burma) Assam region. *Journal of the Geological Society* 150, 1089–1102

Maurin, T., et al., 2010. First global positioning system results in northern Myanmar: constant and localized slip rate along the Sagaing Fault. Geology 38, 591–594

Maung, M., et al ., 2014. Latest Jurassic radiolarian fauna from the Chinghkran area, Myitkyina Township, Kachin State, northern Myanmar. In: Swe, Win, et al. (Eds.), *Regional Congress on Mineral and Energy Resources of Southeast Asia. GEOSEA 13. GEOSEA*, Yangon, pp. 38–39.

Noetling, F., 1893.Notes on the occurrence of jadeite in Upper Burma.*Geol. Surv. India Rec.*, v.26, 26-31.

Nyan Win, 2008. Petrogenetic study of the metamorphic rocks in Mohnyin-Namma-Hopin Area, Mohnyin District, Kachin State.Unpublished.PhD Dissertation, Dept. Geol. Mandalay University. 133p.

Ningam .N and Phani. P.R.C. (2019) An Account of Field and Petrographic Characteristics of Granitic Rocks of Cherlapally Area, Nalgonda District, Telangana. *International Journal of Trend in Scientific Research and Development (IJTSRD)* vol.3 Issue 5, August 2019. pp.222-224

Soequet, A. and M. Pubellier (2002). Cenozoic deformation in Western Yunnan (China- Myanmar border). *Jour. of Jour Asian Earth Sciences* 24. pp 495-515

Searle et al.,2007. Tectonic evolution of the Mogok metamorphic belt, Burma (Myanmar) constrained by U-Th-Pb dating of metamorphic and magmatic rocks. Tectonics 26:TC3014. http://dx.doi.org/10.1029/2006TC002083

Stracke, A.,et al., 2011. Abyssal Peridotite Hf Isotopes Identify Extreme Mantle Depletion. *Earth And Planetary Science Letters* 308, 359–368.

Tokhi M. E et al**.,** 2016**.**Geochemical Characters of the Gabbroic Rocks in Ophiolite Sequences of North Hatta Area, United Arab Emirates. *Special issue of the 2nd International Conference on Computational and Experimental Science and Engineering (ICCESEN 2015)* V-230(2016).pp. 17-22

Yang, J.S et al., 2012. Discovery of a Jurassic SSZ ophiolite in the Myitkyina region of Myanmar. *Acta Petrologica Sinica* 28, 1710–1730 (in Chinese with English abstract).

Petrographic Study of the Sitha Formation exposed in the Ngwetaung-Taunggyun Area, Patheingyi and Pyin Oo Lwin Townships

Thwe War Lin[1]

Abstract

The Ngwetaung-Taunggyun area is situated at about 12 miles (19.31 km) east of Mandalay and about 11 miles (17.70 km) south and south west of Pyin Oo Lwin. The Paleozoic stratigraphic units, from lower to upper, are as follows; Ngwetaung Group: Si-baing Orthoquartzite (Late Cambrian), Taunggyun Sandstone (Early Ordovician) and Sitha Formation(Middle Ordovician). Sitha Formation is mainly composed of thick-bedded to massive, bluish-grey limestone with irregular silt partings and pathches with burrow structures. The stratigraphic contact between Sitha Formation and Taunggyun Sandstone is conformable. Petrographically, Sitha Formation is can be divided into ooidal grainstone, bioclastic pelloidal mudstone, pelloidal mudstone, bioclastic wackestone-packstone, bioturbated wackestone- packstone, and sparitized mudstone-wackestone. Sitha Formation indicates the warm, shallow slightly agitated marine environment.

Key words: Sitha Formation, ooidal grainstone, bioclastic pelloidal mudstone, shallow marine environment

Introduction

The study area is situated at about 12 miles (19.31 km) east of Mandalay and about 11 miles (17.70 km) south and southwest of Pyin Oo Lwin. The area is located in Patheingyi and Pyin Oo Lwin Townships. It lies between latitudes 21° 56′ 24′′ N to 22° 00′ N and longitudes 96° 15′ 45′′ E to 96° 21′ 30′′ E. It is represented by one-inch topographic map of 93- C/5. It can be easily accessible by car throughout the year. This area extends about 3.54 miles (5.69 km) from north to south and 6.2 miles (10 km) from east to west. It covers a surface of about 21.95 square mile (57 square kilometer). The location map of the study area is shown in Fig (1). The study area lies mainly in the western marginal zone of the Shan Plateau. The Paleozoic rocks are widely distributed in the present area. The regional topographic trends run generally parallel to the regional strike of the various formations. In the northern part, the plain west of Si-baing chaung is made up of Plateau Limestone which is faulted against the Ordovician limestone on the west and Si-baing Orthoquartzite of Ngwetaung Group on the east. Elsewhere, the line of junction between the two is gradational. To the east, just east of Sin-hnin chaung, the boundary between the two units of Naungkangyi Group is a faulted one. The Linle-Taungnyo Taung in the central part is composed mainly of the Sitha limestone, and it is faulted against the Taunggyun Sandstone on the west in some places. To the south of Sedaw chaung, the Zebingyi Syncline formed within the Plateau Limestone and the continuations of Pyintha Anticline formed within the Nyaungbaw Formation are noticeable. In this part, some stratigraphic units apparently pinch out. The Dattaw or Sedaw chaung forms a deep gorge, and it most probably is a fault stream, with canyon-like walls on both sides. The most widely distributed rock sequences mainly consist of Paleozoic carbonate and clastic rocks that generally decreases in age from west to east. The contacts between the rock sequences are gradational, conformable or tectonic. Contact between Zebingyi Formation and the Maymyo Dolomite Formation is unconformable.

[1] Lecturer, Dr., Department of Geology, Shwebo University, thwewarlin@gmail.com

Material and Methods

The UTM topographic map 1:50000 and satellite images are used in the preliminary field mapping and field data are plotted on the topographic map. The traverses were taken along the stream courses, cart tracts and motor-roads where good exposures of rocks were observed. The stratigraphic succession of different rock units was established on the basis of lithologic characters, faunal contents and stratigraphic positions in the sequence. Stratigraphic thickness of various formations were measured either by direct taping or by compass and taping or pacing method as described by Compton (1962). By using methods described in Wilson, 1975, the carbonate facies and depositional environments of the area will be studied.

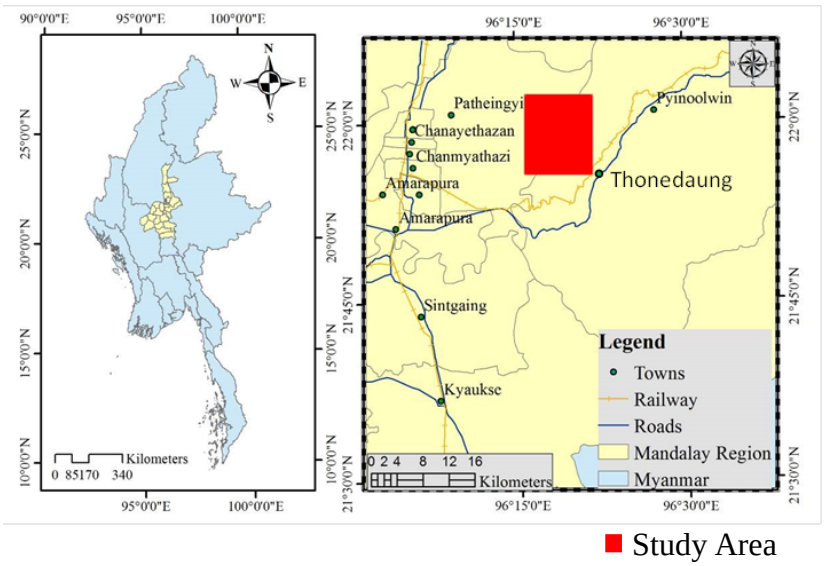


Fig (1) Location map of the Study Area

Stratigraphy

The present area encompasses a small portion of the Northern Shan State. The Paleozoic rocks are well exposed in the study area. The strata are ranging in age from Late Cambrian to Middle Ordovician. On the basic of lithologic characteristics, faunal content and stratigraphic relation, the stratigraphic succession of the Ngwetaung-Taunggyun area is divided into Si-baing Orthoquartzite (Late Cambrian), Taunggyun Sandstone (Late Cambrian to Early Ordovician) and Sitha Formation (Middle Ordovician).The author specialized the study of Sitha Formation. It is mainly composed of thick-bedded to massive, bluish-grey limestone with irregular silt partings and pathches with burrow structures Fig. 2(A), (B) and (C). Yellow, buff and purplish brown silt patches are also commonly visible on weathered surface. The lower part of the Sitha Formation is characterized by medium to fine grained, dark grey on weathered surface and light grey to grey on freshed surface. Oolitic limestone is also occurred in the lower part of this unit. In the upper part, dark grey, thin to medium-bedded limestone interbedded with laminate limestone occur in Linele Taung. Thin bedded limestones are also present. Locally, buff-colored siltstones occur in the upper part of this unit. In this portion, barities are occurred thick bedded to massive, dark grey limestone with irregular silt partings. Especially, it is exposed in West of Natsin Taung, Sethit Taung, and Hill peak of Aungmyaezabu Monastery (Barities quarry). The vein width is ranging from 2" to 7' 6". Cepelopods also occur in medium to thick bedded, dark grey silt patches Limestone Fig.2 (D) and (E). Sitha Formation is widely exposed in eastern part of study area. This formation is conformably overlain by Taunggyun Sandstone. Sitha Formaiton can be correlated with Wunbye Formation (Myint Lwin Thein, 1973) of Shan State (south) in Pindaya Range.

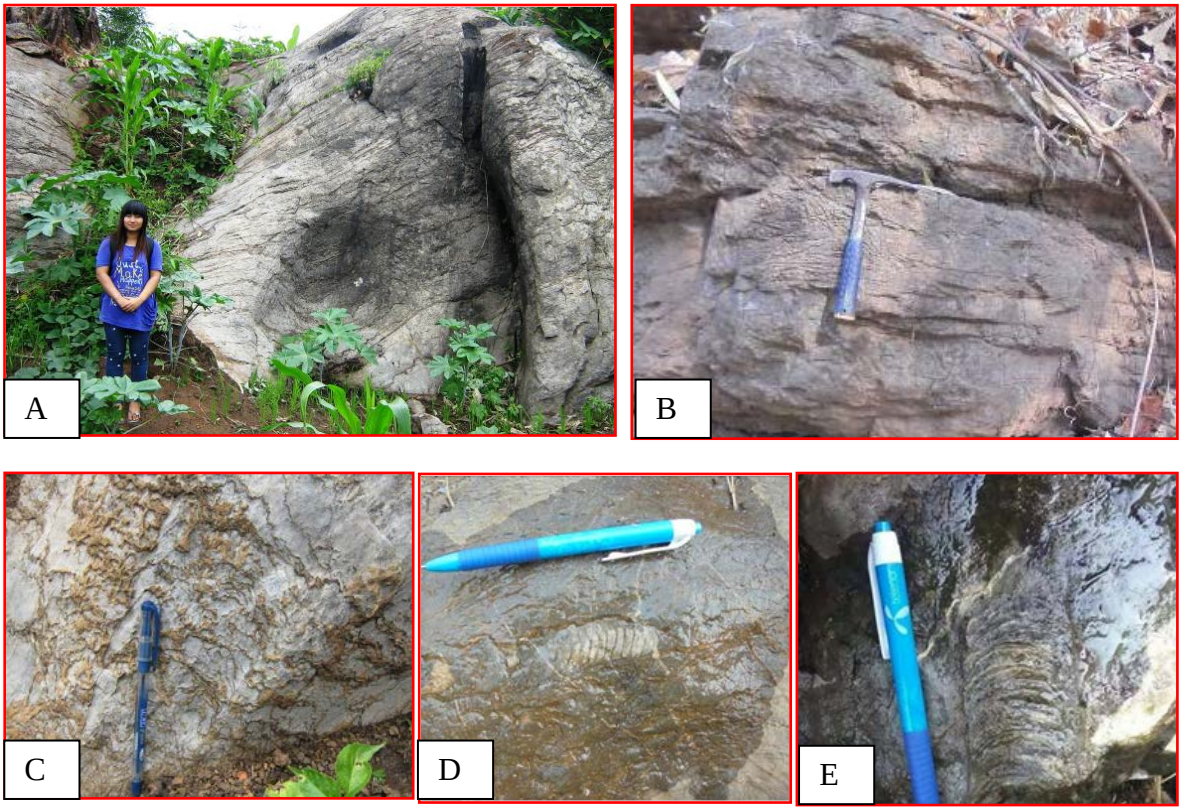


Fig (2) (A) Massive Limestone with stylolite seams (Sitha Formation). (B) Medium to thick bedded, dark grey limestone of Sitha Formation. (C) Complex structure of solution seams indicated the polygenetic diagenesis processes of late burial stage in Sitha Formation. Cepelopods occur in medium to thick bedded, dark grey silt patches Limestone, (D) and (E) *Orthoceras* sp.

Petrography

The study area is lithologically composed of Paleozoic sediments of the western marginal zone of the Shan Plateau. Petrographic analysis of carbonate rocks can reveal a great deal of information about the environment in which the sediment was deposited. Therefore, this petrographic study will give more accurate information on tectonic environment of the source terrain during deposition of sediment. To study the petrography of the Ngwetaung-Taunggyun area, at least 30 samples are systematically collected from Sitha Formation. The classification of limestone by Dunham's (1962) classification use to classify the limestone of the study area. Petrographically, Sitha Formation is can be divided into ooidal grainstone, bioclastic pelloidal mudstone, pelloidal mudstone, bioclastic wackestone-packstone, bioturbated wackestone- packstone, and sparitized mudstone-wackestone.

Sitha Formation

Megascopic study

Sitha Formation is mainly composed of thick-bedded to massive, bluish-grey limestone with irregular silt partings and patches with burrow structures. Yellow, buff and purplish brown silt patches are also commonly visible on weathered surface. These limestones are medium to fine grained, dark grey on weathered surface and light grey to grey on freshed surface. Silt patches and worm burrow tubes appear in the grey argillaceous limestone.

Microscopic study

Sitha Formation is composed essentially of ooids and crystalline limestone in the lower part of the formation. The main constituents are micrite 55 %, ooids 20 %, sparite 20 % and others 5 %. In the Sitha Formation, Seven types of rocks are classified on the basis of content of allochems, authochems and texture of grain (Table 1).

Ooidal Grainstone

This limestone is mainly composed of non-skeletal grains: ooid 50%, pellet 5%, bioclast 10%, sparite 30 % and micrite 5%. Micrite is minor constituent of this rock. Ooids is ranging in size from 0.5 mm to 1mm. The ooids are rounded or elliptical or spherical. Most ooid occur radial and concentric coating. The nuclei of ooids are bioclast, carbonate particles and some are enclose micritic encrustation as well. Ooids are well sorted to moderately sorted and characterized by an internal radial texture. The bioclastic grains comprise 10% of the rock. The bioclast grains are especially brachiopod shells fragment and echinoderm plates, which commonly show subangular to subrounded plates. Worm burrow tubes are also encountered in the micrite. Brachiopod shell's fragments are replaced by calcite also occur in this rock. Pellet occurs in this rock amounting to 10 % of total volume. Pellets can be seen to consist of ovoid to ellipsoidal aggregate of silt and clay sized carbonate particles. The size of pellet is ranging from 0.1 mm to 1mm. Sparry calcite consists of 30 % of total rock volume. Sparry calcite occurs as crystalline mosaic resulting from passive precipitation in voids and intergranular spaces (Fig.3 A). Micrite commonly observed as equigranular microcrystalline carbonate grains in 5% of rock volume(Fig.3 B). Because of more than 30 % grains, minor amount of micrite, and mainly of ooidal grains. This rock is named as ooidal grainstone. (Dunham, 1962)

Environment

Ooids are formed in saline water under agitated conditions along shore or in shallow places where waves break. Basing on the observed petrographic analysis and ooids formation may be reasonably pointed out that, it could be deposited in shoal environment getting agitated water conditions, probably tidal bar.

Bioclastic Pelloidal Mudstone

This rock is mainly composed of 35 % micrite, 15 % bioclasts, 35 % pelloid, 10 % sparite, 3 % dolomite and 2 % of quartz silt. Micrite commonly observed as equant microcrystalline carbonate grains. Pelloids occur as elliptical to subrounded outlines with lack of internal structures. Main components of pelloids are argillaceous materials. In thin section, the pelloids show translucent to dark tint and their long axes arrange parallel to sub-parallel to the bedding plane. The size of pelloids ranges between 0.1 mm to 0.2 mm. Sparite 10 % and dolomite 3 % also constituted as a minor component. Sparite replaced the original component of bioclasts and small vein lets. Quartz silt contains 2% of the total rock volume(Fig.3 C). These are subangular to surrounded grains having size ranges from 0.02 mm to 0.1 mm. Bioclasts possibly, brachiopods, trilobites, microbialites also composed as the minor component of this type. They all are randomly orientated in the lime-mud.

Table (1) Summary on the Petrographic Criteria on the Classified Petrographic Units of Sitha Formation

Sr. No	Petrographic Name	Megascopic Feature	Microscopic study		Interpretation of Depositional Environment
			Constituent minerals	Salient features	
1	Ooidal Grainstone	Medium to thick bedded, oolitic limestone	Ooid, pellet, bioclast, Sparry calcite, others	Ooids with concentric and radial structure	Sand shoal environment
2	Bioclastic Pelloidal Mudstone	Thin to medium bedded, light grey limestone and shale intercalation	Bioclasts, pelloid, micrite, a few dolomite,quartz	Pelloids and fossil fragments	Shallow to deep marine environment
3	Pelloidal Mudstone	Medium bedded grey limestone	Pellet, micrite, no fossil fragments	Pellet with no internal structures	Subtidal to supratidal environment
4	Bioclastic Wackestone-Packstone	Fossiliferous argillaceous limestone, medium bedded	Bioclast, encrusting algae, lime-mud, sparry calcite	Bioclasts embedded in the micrite	Low energy deep shelf margin environment
5	Bioturbated Wackestone-Packstone	Grey to dark grey burrow limestone, thin to medium bedded	Burrow tubes, microspar, a few fossil fragment	Burrow structures mainly horizontal burrow	Shelf lagoon environment
6	Stylolitic Mudstone	Fine grained limestone, thin bedded	Stylolite, lime-mud , micrite, iron, fine silt	Stylolite seams marked by iron residue	Deep shelf margin environment
7	Sparitized Mudstone-Wackestone	Medium to thick bedded grey limestone with calcite veins	Micrite, sparry calcite vein and stylolite seams	Lime-mud, neospars	Deep shelf margin to deep marine

Environment

Pellets are common in the shallow marine tidal and subtidal shelf carbonates, but are also abundant in deep water carbonate (Flugel, 2010). It is correlated with the "Restricted circulation belt" of Wilson, 1975. Generally, pellets indicated the low energy, shallow marine environment (Myint Thein, 1985).

Pelloidal Mudstone

The main building blocks of this rock type are pelloid 40 % and micrite 60 %. No fossil formed in this rock. Pellet with no internal structures are ranging in size from 0.01 mm to 0.1mm. Mostly are elliptical to sub-rounded shape with no central nucleus. The accurate origins of these pelloids are not clearly known as yet. In the present study area, all pellets are almost equal sizes, diameters are less than 0.1 mm and slightly orientation of pellets show thinly laminated fabric (Fig.3 D). These fabrics are closely resembled with the characterized features for algal peloids (Flugal, 2010). Larger axles of those pellet show parallel laminated structure. It is also assumed as the original laminations of algal mat. Myint Thein, 1985 also stated that same pelloids with laminated structures are formed by encrustation and decomposition of algae.

Environment

The high content of micrite indicated that it deposition probably took place under relatively quiet water environment. According to Purdy (1965), pellets can be deposited under subtidal to supratidal environment. Abundantly composed laminated pelloids also indicated the low energy, less-agitated water environment (Wilson, 1975).

Bioclastic Wackestone- Packstone

This rocks composed mainly of bioclasts (cystoids, bryozoans and? foraminifera) 40 %, encrusting algae (highly argillaceous) 10 %, lime mud (microcrystalline ooze) 40 % and spary calcite (10%). It is composed mainly of bioclastic grains (> 10%) and lime mud. It is mud supported, original components not bounded together during deposition. Cystoid plates now composed of calcite with single crystal extinction are observed as distinct feature. Microbialites (encrusting algae) constituted as diagnostic fabric (Fig.3 E). The abundance of bioclasts with no preferred orientation, large amount of lime-mud, and irregular patches of algal materials show the distinct fabric of this unit.

Environment

The abundance of bioclasts with very random orientation indicated the rapid sedimentation on very low energy environment (Heckel, 1972). Large amount of lime mud associated with organic debris also accumulated in the low energy, restricted circulation belt. (Wilson, 1975)

Bioturbated Wackestone- Packstone

It is mainly composed of argillite filled burrow tubes 45% and microspars 40%. Burrow tubes formed by microorganisms show slight orientation. These burrows are filled with argillites. Fossil fragments may constitute about 10 to 15% of the total volume. They are sponges and crinoid ossicles. Length of burrow tubes are ranging from 0.5 mm to 1mm and the average diameters are about 0.01 mm to 0.3mm (Fig. 3 F).

Environment

These burrow filled argillites indicate the less agitation and moderately deep-water condition. Because of the presentation of microbial (algal mat), and burrow structure, it is also correlated with the shelf lagoon open circulation belts" (Belt 7) of Wilson, 1975.

Stylolite Mudstone (micrite)

It is composed essentially of lime mud (micrite) 95% and iron (hematite; siderite) 5% lime mud contain particles of clay and fine silt 5% of total rock volume. Stylolite seams marked by in soluble iron residue are encountered in the micrites(Fig.3 G). Those seam resulting from the later diagenetic stage due to pressure solution.

Environment

Abundance of lime mud reflects the low energy environment. Stylolite seams formed by pressure dissolution in semi-lithified carbonate rocks indicate the moderate to deep shelf margin (Wilson, 1975).

Sparitized Mudstone-Wackestone

Megascopic study

This type is composed mainly of medium to thick bedded, grey to dark grey, limestone with distinct solution features such as solution furrows, pits and sinks holes. Fossil are rare to absent in the exposure. Calcite veins passing through the bedding planes are rarely seen. Jointing rather common on outcrop and dip joints and oblique joints are very common.

Microscopic study

The most prominent lithology of this unit is fine-grained limestone. It is composed mainly of micrite 50%, sparry calcite 45% and iron 5%. Calcite veins constitute the neospars (authigenic calcite) with distinct compromise boundaries and rhombohedral cleavage (gride planes) Fig. 3(H). Stylolite seams show extreme curvatures (tight crenulation) and marked by insoluble residue possibly magnetite and hematite.

Environment

Lime-mud with stylolite seams indicates the slightly low energy and moderately deep marine possibly deep shelf margin. Calcite veins with neomorphic spar probably formed by diagenetic processes of early phase (Wilson, 1975 and Tucker, 2003).

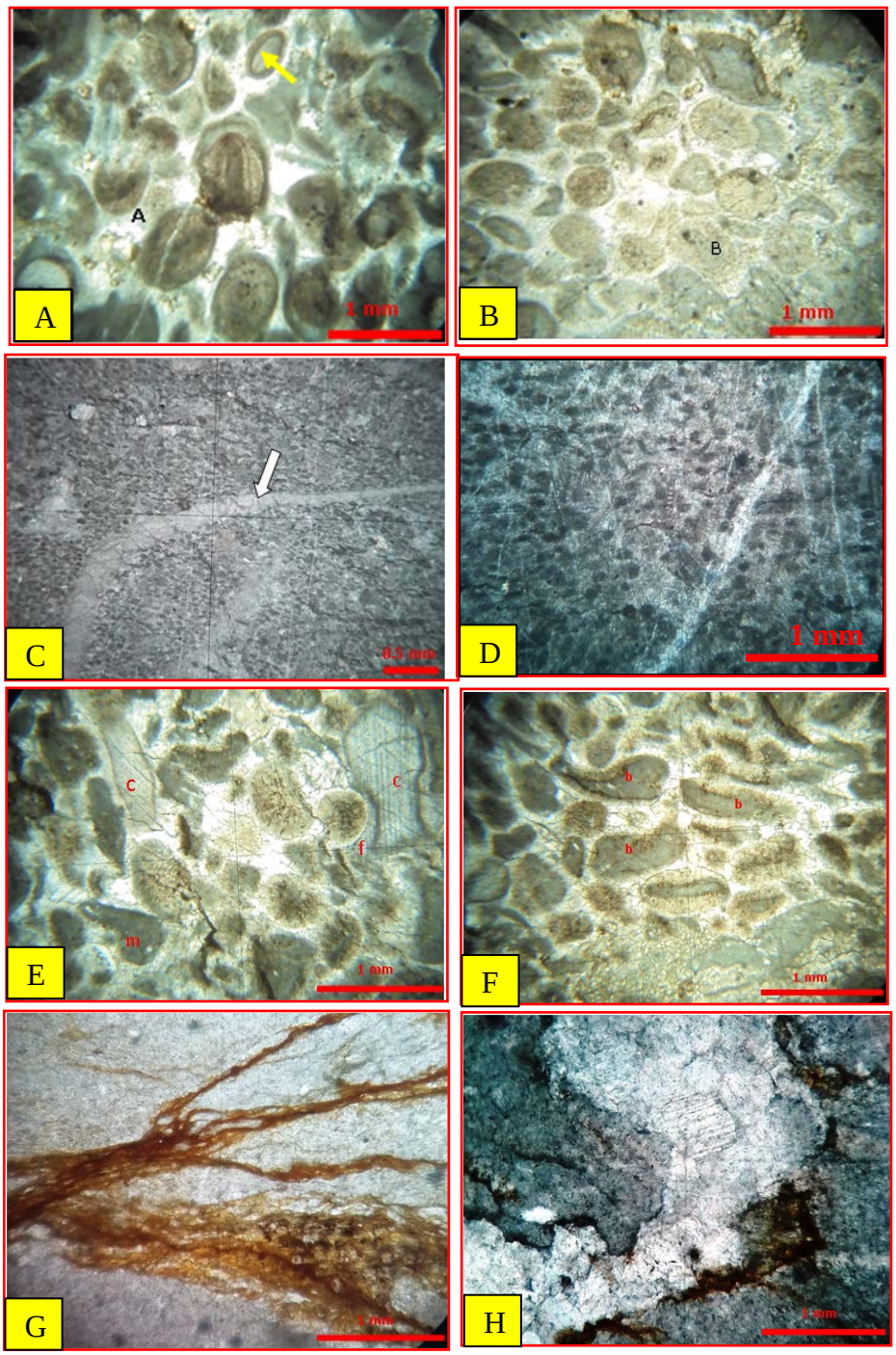


Fig (3) (A) Photomicrograph showing Ooidal grainstone; ooidal grains with both concentric and radial structures with outer shell (cortex) coated by iron residue (arrow). Intergranular spaces between ooids are filled with sparite (A) and micrite (B) noted (under XN). (C) Bioclastic pelloidal mudstone; pellets embedded in the micrite. Sparite (Arrow) filled bioclasts are also noted (under XN). (D) Equant pelloids with slight-orientation formed the laminated structures observed in the "Pelloidal Mudstone" (under XN). (E) Photomicrograph showing bioclasts: cystoids plate (c); microbialites (m) and? foraminifera (f) in the Bioclastic Wackestone-Packstone (under XN).(F) Bioturbated wackestone- packstone; slightly oriented burrow tubes (b) in lime mud (under XN).(G) Photomicrograph showing stylolite seams in the lime mud (under XN). (H) Sparitized mudstone-wackestone; Calcite vein now replaced by neospars with compromised boundaries, distinct twin planes are also noted (under XN)

Result and Discussions

The study area mainly lies in the western marginal zone of the Shan Plateau. The Paleozoic rocks were widely distributed in the present area. Sitha Formation is mainly composed of thick-bedded to massive, bluish-grey limestone with irregular silt partings and pathches with burrow structures. Petrographically, Sitha Formation can be divided into ooidal grainstone, bioclastic pelloidal mudstone, pelloidal mudstone, bioclastic wackestone-packstone, bioturbated wackestone- packstone, and sparitized mudstone-wackestone. In conclusion, above the factors and petrography, Sitha Formation indicates the warm, shallow slightly agitated marine environment Fig (4).

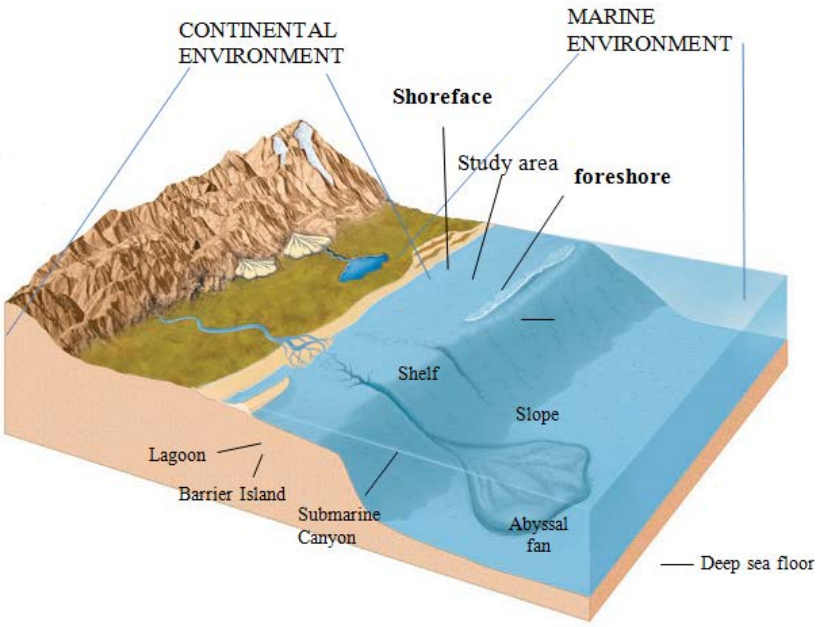


Fig (4) Proposed depositional model of the present study area (Reneick and Singh, 1980)

Acknowledgements

I would like to express my special thanks to Dr. Khin Khin Lin, Professor and Head, Department of Geology, Shwebo University, for her interest, encouragement and valuable advice. I am deeply grateful to Dr. Zaw Win, Professor, Department of Geology, Shwebo University, for his careful perusal of the manuscript and invaluable suggestions. Special thanks are also due to the teaching staffs, Geology Department, Shwebo University, for their help and suggestions.

References

Compton, R.R. (1962) *Manual of Field Geology*. Wiley, Landon

Dunham, R.J., 1962. Classification of carbonate rocks according to depositional texture, *in* Ham, W.E., ed., p. 108-121, Symposium classification of carbonate rocks: *Am. Assoc. Petroleum Geologists Memoir* 1, 279p.

Flugel, E., 2010. *Microfacies of Carbonate Rocks, 2nd Edition*, Springer-London, 984p

Heckel, P.H., 1972. Recognition of Ancient Sedimentary Environments: *SEPM Spec.*Pub. No.16, P. 226-286

Hla Myint, 1984: Geology of the Ngwetaung-Taunggyun Area, Patheingyi and PyinOoLwin Townships; (Unpublished) *M.Sc Thesis*, Geol. Dept., Mandalay University. 106pp.

Myint Lwin Thein, 1973. The Lower Paleozoic stratigraphy of western part of the southern Shan State, Burma.*Bulletin of the Geological Society of Malaysia*, 6: 143-163.

Myint Thein, 1985, Calcium-Carbonate Particles: their origin and significance, *Unpublished*, Lecture Note, Geol. Dept., M.U

Purdy, E.G.,1965. Recent Calcium Carbonate Facies of the Great Bahama Bank; 1, *Petrography and Reaction Group*. J.Geol., v.71, No.3, P, 334-335

Renieck, H.E., and Singh, I.B., 1980: *Depositional Sedimentary Environment*: Springer-Berlag, New York., P. 257-337

Tucker, M. E., 2003. *Sedimentary Rocks in the Field*; The geology field guide series. Wiley and Sons Ltd, England, 228p.

Wilson, J.L., 1975. *Carbonate facies in geologic history*: New York, Springer-Verlag, 471p.

Content

Content