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Editorial Board

ကနန်းလူမျိုးတို့၏ယဉ်ကျေးမှု

မျိုးမျိုး[၁]

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် ကနန်းလူမျိုးတို့၏ ယဉ်ကျေးမှုဓလေ့ထုံးစံများကို လေ့လာထားသည့် စာတမ်းဖြစ်ပါသည်။ ကနန်းလူမျိုးတို့ ဆင်းသက်လာပုံနှင့် ပတ်သက်၍ ပညာရှင်တို့၏ အယူအဆများ၊ ဒေသခံတို့၏အယူအဆများ၊ ပါးစပ်ရာဇဝင်များလေ့လာတင်ပြထားပါသည်။ ထိုပြင် ယဉ်ကျေးမှု၊ ကိုးကွယ်ယုံကြည်မှု၊ ဝတ်စားဆင်ယင်မှု၊ မင်္ဂလာပွဲကျင်းပပုံနှင့် ရှင်ပြုပွဲကျင်းပပုံ ဓလေ့ ထုံးစံများကို လေ့လာတင်ပြထားပါသည်။

နိဒါန်း

ဤစာတမ်းတွင်ကနန်းလူမျိုးတို့၏ယဉ်ကျေးမှုဓလေ့ထုံးစံများကို လေ့လာတင်ပြထားပါသည်။ ကနန်းလူမျိုးများသည် ဗန်းမောက်မြို့နယ် မူးမြစ်ဖျား ဒေသတွင် တစ်စုတစ်စည်းတည်း နေထိုင်ကြ ပါသည်။ စာတမ်းပြုစုသူသည် အချက်အလက်များ ရရှိရန်အတွက် ကနန်းဒေသသို့သွားရောက်ကာ ကွင်းဆင်းလေ့လာခဲ့ပါသည်။ ကနန်းဒေသ ဟော်ယောကျေးရွာမှဦးထွန်းဝေ၏ အကူအညီဖြင့် ကနန်း ကျေးရွာပေါင်း (၂၄)ရွာသို့ ရောက်ရှိခဲ့ပါသည်။ ကနန်းလူမျိုးများနှင့် တွေ့ဆုံကာ အချက်အလက်များ ကောက်ယူခဲ့ပါသည်။ စာတမ်းတွင် ကနန်းလူမျိုးတို့ ဆင်းသက်လာပုံအကျဉ်းနှင့် ကိုးကွယ်ယုံကြည်မှု ဓလေ့ထုံးစံများ အကြောင်းကို လေ့လာတင်ပြထားပါသည်။

၁။ ကနန်းလူမျိုးတို့ နေထိုင်ရာဒေသနှင့်လူဦးရေ

ကနန်းလူမျိုးတို့သည် ဗန်းမောက်မြို့မှာ အနောက်ဘက် မိုင်(၄၀)အကွာနှင့် ပင်လယ်ဘူးမြို့မှ မြောက်ဘက်(၂၆)မိုင်အကွာ မူးမြစ်ဖျားဒေသ၌နေထိုင်ကြသည်။ တစ်နည်းအားဖြင့် ကနန်းဒေသသည် မြောက်လတ္တီတွဒ် ၉၅° ၂၀' မှ ၉၅° ၃၀' အထိ အရှေ့လောင်ဂျီတွဒ် ၂၄°၂' မှ ၂၄°၂၉'အထိ အတွင်းတွင် တည်ရှိပါသည်။ **“ကနန်းအစ ရွှေကျောင်းက၊ ကနန်းအဆုံး လယ်ပိတုံး”** ဟူသောဆိုရိုး စကားအရ ကနန်းလူမျိုးတို့နေထိုင်ရာဒေသသည် မြောက်ဘက်စွန်းရှိ ရွှေကျောင်းရွာမှ အစပြု၍ တောင်ဘက် အစွန်းဆုံး လယ်ပိတုံးရွာအထိရှိသည်။ ကနန်း ရွှေအစုဝင် နယ်မြေသည် မြောက်မှတောင် အထိ (၁၆)မိုင် ခန့်ရှည်လျား၍ အရှေ့မှအနောက်အထိ (၁၀)မိုင်ခန့်ရှည်လျားပြီး ဧရိယာစတုရန်း မိုင်(၁၃၄)မိုင် ကျယ်ဝန်းပါသည်။

၂။ ကနန်းလူမျိုးသမိုင်းကြောင်းအကျဉ်း

ကနန်းလူမျိုးတို့ မြန်မာပြည်အတွင်းသို ပျံ့နှံ့ဝင်ရောက်လာပုံကို အတိအကျပြောရန် ခက်ခဲပါသည်။ သို့သော် ပညာရှင်တို့၏အယူအဆ၊ ဒေသခံတို့၏အစဉ်အလာမှတ်သားချက်၊ တူးဖော်တွေ့ရှိသမျှ ရှေးဟောင်းသုတေသနမှတ်တမ်းများ၊ ဒေသခံတို့၏ မြေပြင်တွေ့လေ့လာ မှတ်သားချက်များကို အခြေခံ၍သာ ကနန်းလူမျိုးများ ပျံ့နှံ့ရာလမ်းကြောင်းကိုမှန်းဆနိုင်ပါသည်။

> **မြန်မာနိုင်ငံတွင် ပြောဆိုသုံးစွဲနေကြသော ဘာသာစကားများ၏ အရင်းအမြစ်ကို လေ့လာကြည့်မယ်ဆိုပါက တိဗက်တရုတ်မျိုးရိုးနှင့် ဩစထရစ် ခေါ် တောင်ပိုင်း မျိုးရိုးဟူ၍ ဘာသာစကားမျိုးရိုးနှစ်ခုမှ ဆင်းသက်လာသည်ကိုတွေ့ရသည်[၂]**

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[၁] ခုတိယပါမောက္ခချုပ်၊ ဒေါက်တာ၊ ရွှေဘိုတက္ကသိုလ်။

[၂] ဖေမောင်တင်၊ ၁၉၆၆၊ ၁၈။

သို့ဖြစ်၍လည်း မြန်မာနိုင်ငံရှိ တိုင်းရင်းသား ဘာသာစကားအများစုမှာ မျိုးနွယ်တူ ဘာသာစကားများမှ ဆင်းသက်လာကြောင်း ဘာသာလောကကျမ်းတွင်ခွဲခြမ်း ဖော်ပြထားပါသည်။ ကနန်းဘာသာစကားသည် တိဗက်တရုတ်မျိုးနွယ်၊ တိဗက်မြန်မာအုပ်စုဝင်ဘာသာစကားဖြစ်သည်။

> တိဗက်မြန်မာအုပ်စုသည် မြန်မာနိုင်ငံအတွင်းသို့ဝင်ရောက်လာသောအခါ အရှေ့၊ အလယ်၊ အနောက်အရပ်များသို့ (၃) မျိုးကွဲကာ ပျံ့နှံ့သွားပြီး အလယ်ပိုင်းသို့ ခွဲထွက်လာသော တိဗက်မြန်မာအစုတွင်
>
> (က) မြန်မာအုပ်စု
>
> (ခ) မရု+အဇီ အစုခွဲ
>
> (ဂ) ကတူး–ကနန်း အစုခွဲ
>
> (ဃ) ဓနု+ တောင်ရိုးအုပ်စုခွဲ
>
> (င) ရခိုင်အုပ်စုခွဲ
>
> (စ) အင်းသားအုပ်စုခွဲ
>
> (ဆ) ထားဝယ်အုပ်စုခွဲ
>
> (ဇ) ယောတောင်သားအုပ်စုခွဲ[၁]နှင့် အခြားလူမျိုးစုများပါဝင်ကြောင်း

ဦးမင်းနိုင်က တို့ တိုင်းရင်းသားပြည်ထောင်စုဘွားစာအုပ်တွင် ဖော်ပြထားပါသည်။

ဆရာကြီး ဦးဖေမောင်တင်လည်း ကနန်းလူမျိုးနှင့် ပတ်သက်၍

> **ပုဂံမြန်မာတို့က နိမ်နင်းအုပ်စိုးခြင်း မပြုမှီ တကောင်း၌ မြို့တည်ပြီးလျှင် အထက်ချင်းတွင်း၊ မူးနှင့်ဧရာဝတီတောင်ကြားများတွင် နေထိုင်ဘူးသော ကနန်းနှင့် (မိမိတို့ကို အဆက်ဟုခေါ်သော) ကန္တူး[၂]**

ဟူ၍ ဆက်(ဝါ) သက်အစုတွင် ပါဝင်ကြောင်းတင်ပြထားပါသည်။

ဒေါက်တာသန်းထွန်းက ကနန်းလူမျိုးတို့ ဆင်းသက်လာပုံနှင့် ပတ်သက်၍

> **ကနန်းလူမျိုးတို့မှာလည်း ကတူးလူမျိုးကဲ့သို့ပင် သက်အုပ်စုတွင် ပါဝင်ပြီး မွန်ဂိုလီးယားကုန်းပြင်မြင့်မှဆင်းသက်လာပြီး မြန်မာနိုင်ငံအတွင်းသို့ မြောက်ပိုင်းမှ ဝင်သူများ ဖြစ်ပါသည်[၃]**

ဟူ၍ လည်းကောင်း

> **ကတူးကနန်းတို့သည် တိဗက်မြန်မာမျိုးဆက်ဝင် သက်လူမျိုးအုပ်စုတွင်ပါဝင်ပြီး ကသာခရိုင် အတွင်း၌ နေထိုင်ကြပါသည်။ သက်၊ ကတူး၊ ပျူ၊ ကရင်တို့ကား ဗမာထက် စော၍ မြန်မာနိုင်ငံအတွင်း ရောက်ရှိလာသူများဖြစ်သည်[၄]**

ဟူ၍လည်းကောင်း ယူဆပါသည်။

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[၁] မင်းနိုင်၊ ၁၉၇၂၊ ၂။
[၂] ဖေမောင်တင်၊ ၁၉၆၆၊ ၁၅။
[၃] သန်းထွန်း၊ ၂၀၀၂၊ ၄၈။
[၄] သန်းထွန်း၊ ၂၀၀၂၊ ၄၈။

သမိုင်းဆရာကြီး ဗိုလ်မှူးဘရှင်ကမူ

> **ရှေးဦးပျူတို့သည် အရှေ့မြောက်ဆီမှဝင်လာ၍ ၁ရာစု အေဒီလောက်တွင် ယခုဗိဿနိုးဟုတွင်နေခဲ့သော သိရသမျှရှေးအကျဆုံးမြို့ကြီးကို တည်ထောင်ခဲ့ကြသူများဖြစ်ကြသည်။ ကသာခရိုင်ရှိ ယခုကတူးကနန်း တိုင်းရင်းသားတို့၏ ရှေးဘိုးဘေးကြီးများ ဖြစ်ကြသည်။**[၁]

ဟုဖော်ပြထားသည်ကိုတွေ့ရသည်

ဆာဂျော့စကော့က

> **ကနန်းလူမျိုးသည် ကတူးလူမျိုး၏အဆက်ဖြစ်ပြီး သက်အုပ်စုဝင်ဖြစ်သည်။ နရပတိစည်သူမင်းသည် ကနန်းဒေသသို့ ခရီးလှည့်လည်စဉ်က ကနန်းလူမျိုးတို့သည် ကြီးကျယ်ခမ်းနားစွာ ကြိုဆိုကြသည်။ ကနန်းလူမျိုးများ ဦးစွာနေထိုင်သော ရွာကို ကနန်းမရွာဟု အမည်ပေးခဲ့သည်။ နောက်မှရောက်လာသော ကနန်းလူမျိုးများ နေထိုင်ရာရွာများကိုမူ ကနန်းပွားရွာဟုခေါ်သည်။ ကနန်းမရွာနှင့် ကနန်းပွားရွာများကို ရွှေမှူးများအုပ်ချုပ်သည်**[၂]

ဟုဖော်ပြထားသည်။

အလန်ဝီလျံကမူ–

> **ကတူးဘာသာစကားသည် သက်ကဆင်းသက်လာပြီး ကနန်းဘာသာစကားကိုမူ ကတူးဘာသာစကားနှင့် ဆင်းသက်ရာလမ်းကြောင်းတူသည်**[၃]

ဟု ယူဆထားသည်။

ကနန်းလူမျိုးဒေသခံတို့၏အစဉ်အလာမှတ်သားချက်မှာမူ ကနန်းလူမျိုးတို့ မူလအစမှာ ဗိဿနိုးမင်းသမီးနှင့် ဗိဿနိုးမြို့တွင် အခြေခံသည်။ ဗိဿနိုးမင်းသမီးအား ဒွတ္တပေါင်မင်းကြီး တိုက်ခိုက်လာ၍ မြို့ပါပျက်သဖြင့် မြို့သူမြို့သားများသည် ချင်းတွင်းမြစ်ကို ဆန်တက်ခဲ့ကြသည်။ မဟာမြိုင်တောတစ်နေရာတွင် မုန်းစတိတ်မြို့ကိုတည်ထောင်ကြသည်။ မုန်းစတိတ်မြို့ပျက်၍ မိုးကောင်းသို့ပြောင်းရွှေ့သွားကြရာ ကနန်းဒေသလိတ်စောရွာနေရာတွင် ချင်းလေးမုံတို့ မိသားစု ကျန်ရစ်ခဲ့သည်။ မိုးကောင်းဘက်သို့သွားသူတို့က ကျန်ရစ်သူချင်းလေးမုံတို့ကိုပြန်ခေါ်ရန် သူလုံနှင့် သူကပ်ညီနောင်တို့ကို တာဝန်ပေးသည်။ သူလုံသူကပ်ညီနောင်နှင့် ချင်းလေးမုံတို့ ညီအမသင့်မြတ်ကြပြီး လိတ်စောရွာတွင် ဆက်လက်နေထိုင်ရာမှ ကနန်းလူမျိုးများ ပေါက်ဖွားလာသည်ဟူ၍ ဖြစ်သည်။

ထို့ပြင် အစဉ်အလာမှတ်သားချက်နောက်တစ်မျိုးမှာမူ ကတူး၊ ကနန်းနှင့် ကချင်တို့သည် ညီအကို သုံးဦးဖြစ်ပြီး နေထိုင်ရာ အရပ်ဒေသကွဲပြားသွားရာမှ လူမျိုးကွဲ ဘာသာစကား ကွဲဖြစ်သွားခြင်းပင်ဖြစ်သည်။ ကချင်လူမျိုးတို့၏အိမ်တွင် ညီငယ်များဖြစ်သည့် ကတူး၊ကနန်းတို့ လိုက်လာလျှင် နေထိုင်ရန်အခန်းတစ်ခန်းပို့ဖွဲ့လေ့ရှိသည် ဟူ၍ဖြစ်ပါသည်။

ကနန်းရှေးဟောင်းသမိုင်းပုံပြင်များ၌ ကနန်းဟူသည် ချင်းလူမျိုးဝင်ဖြစ်သည်ဟုဆိုသည်။ ကနန်းလူမျိုးအသက်ကြီးသူများကမူ ကနန်းဟူသည် မြန်မာပြည်မြေပြန့်တွင် ကြွင်းကျန်ရစ်သော

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[၁] ဘရှင်၊ ၁၉၉၈၊ ၁၁၄။

[၂] George Scott, 1900,569-575.

[၃] Allan Williams, 1971, 41.

ချင်းကြွင်းချင်းကျန်များဖြစ်သည်ဟုဆိုကြသည်။ ချင်းတို့သည် မဟာမြိုင်မှ မုံးစပတ်၊ မုံးစပတ်မှ ကနန်းဒေသ လိတ်စောသို့ ပြောင်းလာသည်ဟုဆိုကြသည်။ ထို့ပြင် ကနန်းဒေသတွင် ချင်းလူမျိုးတို့၏ အသုံးအဆောင်များဖြစ်ကြသော လက်စွပ်၊လက်ကောက်၊ နားတောင်းစသော အဆင်တန်ဆာများနှင့် ချင်းအိုး၊ ချင်းဖိုခနောက် အစရှိသော အသုံးအဆောင်ပစ္စည်းများကို တူးဖော်ရရှိခဲ့ကြသည်။ ထို့ကြောင့် ကနန်းဒေသတွင် ပထမအခြေစိုက်နေထိုင်သူတို့မှာ ချင်းလူမျိုးများဖြစ်လိမ့်မည်ဟု ခန့်မှန်းကြပါသည်။

ကနန်းဒေသသို့ ဒုတိယဝင်ရောက်လာသူတို့မှာ ထူးယဉ်(ထူးရင်)လူမျိုးများဖြစ်သည်။

ထူးယဉ်တို့သည် ပုဂံခေတ်ဦးခန့်ကပင် ယခုလိတ်စောခေါ်ကျေးရွာနှင့် ယင်း၏အနီးဝန်းကျင်ဒေသတွင် အခြေစိုက်ခဲ့ဟန်ရှိသည်။ ထူးယဉ်တို့သည် ကွန်းကတူးနှင့် ယဉ်ကျေးမှုချင်း ဖလှယ်ကြသည်။ ကနန်းဒေသသို့ တတိယဝင်လာသူတို့မှာ သက်လူမျိုး အနွယ်ဖွား ထမန်လူမျိုးများ ဖြစ်သည်။ ထူးယဉ်၊ ကွန်းကတူးနှင့် ထမန်လူမျိုးများ ကနန်းဒေသတွင် နေထိုင်ခဲ့ကြသည်။

မြန်မာသက္ကရာဇ် ၁၁၇၆ခု သီတင်းကျွတ်လဆန်း (၆) ရက်နေ့တွင် ရေးကူးထားသော ကနန်းသမိုင်းစာပေမူတွင်လည်း–

> **ကနန်းလူမျိုးခေါ်တွင်ပုံနှင့်ပတ်သက်၍ နရပတိစည်သူမင်းကြီးသည် ဖောင်စကြာနှင့် နိုင်ငံအနှံ့လှည့်လည်တော်မူခဲ့စဉ် မူးမြစ်ဖျား မူးချောင်းနှင့် မေတ္တာချောင်းတို့ပေါင်းစုံရာ (ယခင်လိတ်စောရွာ)အနီးတွင် ခေတ္တရပ်တန့်တော်မူခဲ့သည်။ မင်းကြီးသည် လိတ်စောရွာနှင့် ယင်း၏ဝန်းကျင်ရှိ မေတ္တာချောင်းကမ်းတစ်လျှောက်တွင် ဝန်းဝိုင်းသော မဏ္ဍပ်ကြီးများသဏ္ဌာန်နေအိမ်များ ဆောက်လုပ်နေထိုင်သော လူမျိုးများ၏ အမည်ကို ဟူးရားဖြူး ဟူးရားညိုတို့အား မေးမြန်းတော်မူခဲ့သည်။ ဟူးရားဖြူး ဟူးရားညိုတို့က ရှမ်းဘာသာဖြင့် ကနား(မဏ္ဍပ်)များ ဆောက်လုပ်နေထိုင်ကြသည်ကို အစွဲပြု၍ ကန္နားလူမျိုးဟု မင်းကြီးအား လျှောက်တင်ကြသည်။ ထိုအချိန်မှစ၍ ကနားလူမျိုးဟု ပြောင်းလဲခေါ်ဝေါ်လာသည်**[၁]

ဟုဆိုပါသည်။

အထက်ပါ ပညာရှင်တို့၏ အယူအဆနှင့် ဒေသခံတို့၏ ပြောဆိုချက်များအရ ကနန်း လူမျိုးသည် ချင်း၊ ထူးယဉ်နှင့် တမံလူမျိုးတို့ သွေးနှောရာမှ ပေါက်ဖွားလာသည်ဟု ထင်မြင်မိပါသည်။ ကနန်းဘာသာစကားသည်လည်း တိဗက်တရုတ်မျိုးခွဲ၊ တိဗက်မြန်မာအုပ်စု၊ သက်အုပ်စု ဝင်ဖြစ်မည်ဟုမှန်းဆရပါသည်။ ထို့ကြောင့် ကနန်းဘာသာစကားသည် မြန်မာနိုင်ငံတွင်းရှိ တိုင်းရင်းသား လူမျိုးများ၏ ဘာသာစကားနှင့် မျိုးနွယ်တူမှ ဆင်းသက်လာသည် ဟုဆိုနိုင်ပါသည်။

၃။ ကနန်းလူမျိုးတို့၏ ကိုးကွယ်ယုံကြည်မှု

ကနန်းဒေသတွင် ကနန်းဖိုရွာနှင့် ကနန်းမရွာဟူ၍ နှစ်ရွာရှိကြောင်းသိရပါသည်။ ကနန်းမ ရွာမှာ လိတ်စောရွာဖြစ်ပြီး ကနန်းဖိုရွာမှာ ထပ်မံတိုးပွားလာသောရွာများကို ဆိုလိုပါသည်။

ကနန်းလူမျိုးတို့သည် ဗုဒ္ဓဘာသာဝင်များဖြစ်ကြသည်။ဘုရားစေတီပုထိုးများလည်း တည်ထားကိုးကွယ်ခဲ့ကြသည်။ ကနန်းဒေသလိတ်စောရွာတွင် မင်းတုန်းမင်းလက်ထက်ကတည်းက ဆောက်လုပ်

[၁] နုနု၊ ၁၉၉၁။

ထားသော ရွှေကျောင်းကြီးကို ယခုတိုင်တွေ့မြင်နိုင်ပါသည်။ ကနန်းရွာတချို့တွင် ကြီးကျယ်ခမ်းနားသော ဘုန်းကြီးကျောင်းများကို ယခုတိုင် တွေ့နိုင်ပါသည်။

ကနန်းလူမျိုးတို့သည် မိရိုးဖလာနတ် ကိုးကွယ်ယုံကြည်မှုလည်းရှိကြသည်။ မြန်မာလူမျိုး ကဲ့သို့ တောစောင့်နတ်၊ တောင်စောင့်နတ်၊ ပုန်းမကျိနတ်တို့ကို ပူဇော်ပသမှုရှိပါသည်။ ကနန်းလူမျိုးနှင့်သက်ဆိုင်သော နတ်များလည်း ကိုးကွယ်ကြသည်။ မုဆိုးနတ်ခေါ် ဖီဟော်နတ်၊ ဆူမုံနှင့် ဆူကပ်နတ်တို့ကို ပူဇော်ပသကြသည်။

ဆူမုံနှင့်ဆူကပ်နတ်နှစ်ပါးပူဇော်ပသသော အချိန်မှာ နယုန်လမှ တန်ဆောင်မုန်းလအတွင်း ဖြစ်သည်။ တစ်နည်းအားဖြင့် လယ်စိုက်ချိန်နှင့် ကောက်စောစပါးပေါ်ချိန် ဖြစ်သည်။ ရှေးယခင် ကမူ ကျွဲပေါင်ကြီး တစ်ကောင်ကိုသတ်၍ အဆိုပါ နတ်နှစ်ပါးကို ပူဇော်ပသလေ့ ရှိသည်။ ယခုအခါမှာမူ ဆူမုံနှင့် ဆူကပ်နတ်နှစ်ပါးတို့သည် သောတပန်ဘဝသို့ ကူးပြောင်းခဲ့ကြကြောင်း ထိုနတ်နှစ်ပါးက အိမ်မက်ပေးသဖြင့် ကျွဲကိုသတ်၍ ပူဇော်ပသခြင်းကို မပြု လုပ်ကြတော့ပေ။ သို့သော် ယင်းနတ်တို့ကို အလိုအလျောက်သေသော ကျွဲသား (သို့မဟုတ်) ပုံသကူ ကျွဲသားနှင့် ပူဇော်နိုင်သည်ဟု ဒေသခံတို့က ပြောကြားကြသည်။

ဖီဟော်နတ်အား ပူဇော်ပသရာတွင်မူ ကိုယ်တိုင်သော်လည်းကောင်း မုဆိုးများကိုမှာကြား၍ သော်လည်းကောင်း ချေကိုရွာကြရသည်။ ချေရလျှင် တစ်ကောင်လုံး၏ အသားကို ဖီဟော်နတ်စင်ရှေ့တွင် မြေအိုးများနှင့် ချက်ပြုတ်ရသည်။ ဖီဟော်နတ်ပူဇော်မည်ဟု သတင်းစကား ရရှိသူတိုင်း ထမင်းထုပ်ကိုယ်စီဖြင့် နတ်စင်သို့လာရသည်။ ချေသားဟင်းချက်ပြီးသောအခါ လိုအပ် သလို နတ်အား ပူဇော်ပသပြီးနောက် ဟင်းအိုးကို ဖိုခွင်ပေါ် အနေအထားအတိုင်းထားပြီး ချေသားဟင်းကို လုယက်စားသောက်ရသည်။ ဖိုခွင်ပေါ်မှ ဟင်းအိုးကွဲပြီးလျှင် ဟင်းရည်ဖြင့် မီးငြိမ်းသွားသည်အထိ လုယက်စားသောက်ကြရသည်ဟုဆိုသည်။

၄။ ကနန်းလူမျိုးတို့၏ ဓလေ့ထုံးစံ

ကနန်းလူမျိုးတို့သည် အိမ်တစ်အိမ်တွင် အိမ်ထောင်စုပေါင်း(၁၀)စုခန့် နေထိုင်ကြပြီး ဝိုင်းလုပ် ဝိုင်းစားစနစ် ကျင့်သုံးသည်။ သားသမီးများ အိမ်ထောင်ကျသော်လည်း အိမ်ခွဲလေ့မရှိဘဲ မိဘအိမ်မှာပင် တစ်အိမ်တည်း အတူနေလေ့ရှိသည်။ အိမ်ဆောက်ရာတွင် မဏ္ဍပ်နှင့်တူသော အိမ်ကြီးများ ဆောက်လုပ်နေထိုင်လေ့ရှိသည်။ အိမ်ဆောက်ပုံမှာ ဝိုင်းဝန်းသော ပုံသဏ္ဌာန်ရှိ၍ ကျီးအက်(အဖီ)များ ချထားသည်။ အိမ်ကြီးမှာဝင်ပေါက်တစ်ခုသာရှိ၍ ပြတင်းပေါက်ထားလေ့မရှိပါ။ ခေါင်တိုင်ကို အထွတ်အမြတ်ထားပြီး မိဘအတွက် ခေါင်တိုင်ခန်းတစ်ခန်းထားရှိသည်။ အခြားအိပ်ခန်းများ ဖွဲ့စည်းခြင်းမရှိပါ။ အိမ်ဆောက်ရာတွင် သံကိုအသုံးအပြုဘဲ ထုပ်စွပ်လျောက်စွပ်၍ ကြိမ်နွယ်ဖြင့် ချည်နှောင်ထားပါသည်။ သက်ကယ်ကို အစီးလိုက်မိုးကာခြင်းဖြင့် တစ်ကြိမ်မိုးထားလျှင် အနှစ်သုံးဆယ်ခန့်ခံပါသည်။ အိမ်၏အောက်တွင် မောင်းဆုံ၊စပါးကျီ၊ထင်းပုံ၊လူနေကွပ်ပျစ်ထားလေ့ရှိသည်။ အိမ်ထောင်စုတစ်စု တိုးလာတိုင်း ရှိရင်းအိမ်ကိုချဲ့သည့်သဘောဖြင့် ကျီးအက်(အဖီ)ကို ဆက်လက်ချကြသည်။ အိမ်မှာကြီး၍ ကျယ်ပြန့်လာပြီး အဖီကျီးအက်ပတ်လည်ချထားသဖြင့် မဏ္ဍပ်သဖွယ် ဖြစ်လာသည်။

ကနန်းလူမျိုးတို့၏ ဝတ်စားဆင်ယင်ပုံမှာ မြန်မာဆန်သည်။ ကနန်းအမျိုးသားဝတ်စုံမှာ တောင်ရှည်ပုဆိုး တိုက်ပုံအင်္ကျီရင်ဖုံးနှင့် ခေါင်းပေါင်းပေါင်းရသည်။ ကနန်းအမျိုးသမီး ဝတ်စုံမှာမူ လုံချည်မဲ၊ အင်္ကျီရင်ဖုံးလက်ရှည်အညိုနှင့် ခေါင်းပေါင်း ပေါင်းရသည်။ အပျိုမဖြစ်သေးသော မိန်းကလေးငယ်များသည် ဆံရစ်ဝိုင်းများထားကြောင်းတွေ့ရသည်။ ကနန်းလူမျိုးတို့၏ ဝတ်စားဆင်ယင်မှုနှင့် ပတ်သက်၍ ဆာဂျော့စကော့က–

ကနန်းလူမျိုးတို့၏ ဝတ်စားဆင်ယင်ပုံသည် မြန်မာဆန်သည်[၁]

ဟုဆိုထားသည်။

ကနန်းဒေသတွင် ယခင်က ရွှေမှူးသူကြီးများခန့်၍ အုပ်ချုပ်ပြီး ယခုခေတ်တွင် ကျေးရွာဥက္ကဋ္ဌများခန့်၍ အုပ်ချုပ်ကြောင်းတွေ့ရသည်။ ကနန်းလူမျိုးတို့၏ လူမှုဆက်ဆံရေး ပုံစံသည် စုပေါင်းဆောင်ရွက်မှုကို အခြေခံသည်။ အိမ်ဆောက်ရာတွင်ဖြစ်စေ၊ လယ်စိုက်ရာတွင်ဖြစ်စေ၊ သာရေးနာရေးကိစ္စများတွင်ဖြစ်စေ စုပေါင်းဆောင်ရွက်ကြသည်။ အပျိုလူပျိုဆက်ဆံရေးတွင် လူပျိုခေါင်းမှာ အရေးပါဆုံးပုဂ္ဂိုလ်ဖြစ်သည်။ လူပျိုများကို လူပျိုခေါင်းက အုပ်ချုပ်ရသည်။ လူပျိုခေါင်းရွေးချယ်ရာတွင်လည်း လူငယ်ပိုင်းမှ အများသဘောတူသူကိုသာ ရွေးကောက်တင်မြှောက် ရသည်။ လူပျိုခေါင်းက မောင်းသုံးချက်တီးပါက အပျိုများကိုခေါ်ခြင်း၊ မောင်းငါးချက်တီးပါက လူပျိုများကို ခေါ်ယူခြင်းဖြစ်သည်။ ကနန်းလူမျိုးတို့၏ လက်ထပ်ပွဲဓလေ့တွင် မင်္ဂလာငယ်နှင့် မင်္ဂလာကြီးဟူ၍ နှစ်မျိုးရှိသည်။ မင်္ဂလာငယ်မှာ သတို့သမီးဖက်မှခွဲခန့်(ဦးဆောင်)သော မိရာဖရာကွမ်းဖိုးပေး ဆောင်ခြင်းဖြစ်သည်။ ပေးဆောင်ပြီးပါက အကြင်လင်မယားအဖြစ် ပေါင်းသင်းနိုင်သည်။ မင်္ဂလာကြီးဆောင်ရာတွင် သတို့သားဖက်မှ ရှေ့ဆောင်လူကြီးများ၊ လူပျိုရံအပျိုရံများ၊ ကန်တော့ပွဲ၊ ကွမ်းဆေး၊ လက်ဖက်လက်ဆောင်များ၊ အုန်းငှက်ပျောပွဲများ၊ သပြေပန်း၊ မြေဇာမြက်ဖျာနှစ်ချပ်၊ ဆန်၊ မိရာဖရာ ငွေကြေး၊ လူပျိုရံအပျိုရံတွက် ငွေကြေးတို့ယူဆောင်၍ သတို့သမီးအိမ်သွားကာ အကျေးအမွေးများနှင့် ဧည့်ခံခြင်းဖြစ်သည်။ မင်္ဂလာပွဲနှင့်ပတ်သက်၍ ကနန်းလူမျိုးတို့၏ ဓလေ့မှာ (၁)သတို့သမီးအိမ်သို့လာရာတွင် လူဦးရေ 'မ'ဂဏန်းဖြစ်ရ၍ ပြန်သည့်အခါ 'စုံ'ဂဏန်း ဖြစ်စေခြင်း၊ (၂) သတို့သားဘက်မှ ယူဆောင်လာသော ဖျာနှစ်ချပ်ရွက်သူမှာ မိစုံဖစုံရှိသော မိန်းကလေးဖြစ်ရခြင်း၊ (၃) ဧည့်ခံကျွေးမွေးရာတွင် ပန်းကန်ခွက်ယောက်မကွဲစေရခြင်း၊ (၄)ထင်းခွေရေခပ်မှအစ ပွဲပြီးဖျာသိမ်းသည်အထိ လူပျိုခေါင်းဦးစီးသော အပျိုလူပျိုအဖွဲ့မှ တာဝန်ယူလုပ်ကိုင်ရခြင်း၊ (၅) တစ်ရွာတည်းသားချင်း မင်္ဂလာဆောင်ပါက သတို့သမီးဖက်မှဖိတ်ထားသော ဧည့်သည်များကို သတို့သမီးအိမ်တွင် ဧည့်ခံကျွေးမွေး၍ သတို့သားဖက်မှလည်း ထိုနည်းတူပြုကာ လက်ဖွဲ့ငွေသီးခြားစီ ခွဲယူခြင်းများ ဖြစ်ပါသည်။

ကနန်းလူမျိုးတို့သည် ရှင်ပြုပွဲမင်္ဂလာကို ရှေးမူမပျက်ဆောင်ရွက်လေ့ရှိသည်။ နွေဦးပေါက်လျှင် ကျေးရွာများတွင်စုပေါင်း၍ ရှင်ပြုပွဲများပြုလုပ်လေ့ရှိပါသည်။

ကနန်းရှင်ပြုအလှူမဏ္ဍပ်သည် အလျားငါးတောင်စီရှိ အခန်းပေါင်း (၁၄)ခန်းစီပါပြီး မိုးလုံ လေလုံဆောက်ကြသည်။ အလှူမဏ္ဍပ်မှာ ခမ်းနားကြီးကျယ်လှသည်။ အလှူပွဲတွင်လည်း လူပျိုအပျိုအဖွဲ့ကပင် တာဝန်ယူဆောင်ရွက်ကြသည်။ ကနန်းအလှူပွဲသည် မြန်မာလူမျိုးများကဲ့သို့ပင် ရှင်လောင်းလှည့်သော အလေ့အထရှိသည်။ အလှူရှင်၏ ဆွေမျိုးသားချင်းတို့သည် အလှူနေ့အတိုင်မီ (၁၀)ရက်

[၁] George Scott, 1900,570.

ခန့်က အစပြု၍ ဆန်၊ လက်ဖက်ကျည်၊ အုန်း၊ ငှက်ပျောနှင့်ငွေများ လာပို့ကြသည်။ သူငယ်ချင်း အပေါင်းအသင်းတို့ကလည်း အလှူပွဲမတိုင်မီ (၃)ရက်ခန့်အလိုကပင် လက်ဖက်ကျည်၊ အုန်း၊ ငှက်ပျောနှင့်ငွေများကို ပဒေသာပင်သီး၍ တီးမှုတ်ကခုန်ပြီး ရှင်မိရှင်ဖအိမ် သို့လာရောက် ထောက်ပံ့ကြသည်။ ထိုသို့ပြုလုပ်သောပွဲကို သဟာယသင်္ဘာပွဲဟုခေါ်သည်။ ရှင်လောင်းယူပွဲ၊ ပေါက်ပေါက်ထိုးပွဲများလည်း ပြုလုပ်သည်။ အလှူကြီးနေ့တွင် မဏ္ဍပ်အတွင်းရှိ ဧည့်ပရိတ်သတ်များကို ကျွေးမွေးဧည့်ခံကြသည်။

ရှင်ပြုအလှူပွဲတိုင်းပင် "ရှင်ပြုပွဲကြီးမှူးရေးအဖွဲ့" ကို စနစ်တကျ ဖွဲ့စည်းထားလေ့ရှိသည်။ ကနန်းရှင်ပြုပွဲတွင် ကနန်းလူမျိုးတို့၏ စနစ်ကျမှု စေတနာသဒ္ဓါတရား ထက်သန်မှုတို့ကို တွေ့ရသည်။ ကနန်းလူမျိုးတို့၏ ဓလေ့ထုံးစံတွင်မြန်မာနှင့်တူသော ဓလေ့ထုံးစံများရှိသကဲ့သို့ မတူသော ဓလေ့ထုံးစံများလည်း တွေ့ရသည်။ ဗုဒ္ဓဘာသာကို သက်ဝင်ယုံကြည်မှု၊ စေတနာသဒ္ဓါ တရား ထက်သန်မှုတို့ကို တွေ့ရသည်။

ခြုံငုံသုံးသပ်ချက်

ပညာရှင်တို့၏အယူအဆနှင့် ဒေသခံများ၏ ပြောဆိုချက်များအရကနန်းလူမျိုးများသည် ချင်း၊ ထူးယဉ်နှင့်ထမံလူမျိုးတို့ သွေးနှောရာမှ ပေါက်ဖွားလာသည်ဟု ယူဆမိပါသည်။ ကနန်းဖိုရွာနှင့် ကနန်း မရွာဟူ၍ နှစ်မျိုးရှိကြောင်းသိရသည်။ ကနန်းမရွာမှာ လိပ်စောရွာဖြစ်ပြီး ကနန်းဖိုရွာမှာ ထပ်မံတိုးပွားလာသောရွာများကို ဆိုလိုကြောင်းသိရသည်။

ကနန်းလူမျိုးများသည် ဗုဒ္ဓဘာသာကို ကိုးကွယ်ကြသည်။ ဘုရား၊ စေတီ၊ ပုထိုးများ တည်ထား ကိုးကွယ်ခဲ့ကြသည်။ ကနန်းရွာတချို့တွင် ကြီးကျယ်ခမ်းနားသော ဘုန်းကြီးကျောင်းများ တွေ့နိုင်ပါသည်။ မိရိုးဖလာ နတ်ကိုးကွယ်ယုံကြည်မှုလည်းရှိသည်။ မြန်မာလူမျိုးများကဲ့သို့ တောစောင့်နတ်၊ တောင်စောင့်နတ်၊ ပုန်းမကျိနတ်များ ပူဇော်ပသကြောင်းတွေ့ရသည်။ ကနန်းဒေသရှိ မုဆိုးနတ်ခေါ် ဖီဟော်နတ်၊ ဆူမုံနှင့် ဆူကပ်နတ်တို့ကို ပူဇော်ပသကြောင်းသိရသည်။

ကနန်းလူမျိုးတို့၏ ဓလေ့ထုံးစံမှာ အိမ်တစ်အိမ်တွင် အိမ်ထောင်စုပေါင်း (၁၀)စုခန့် စုပေါင်းနေထိုင်ကြပြီး ဝိုင်းလုပ်ဝိုင်းစားစနစ်ကျင့်သုံးကြသည်။ သားသမီးများ အိမ်ထောင်ကျ သော်လည်း မိဘအိမ်တွင် စုပေါင်းနေကြသည်။ ကနန်းလူမျိုးတို့ ဝတ်စားပုံမှာ မြန်မာဆန်သည်။ ကနန်းဒေသတွင် ယခင်က ရွှေမှူးများအုပ်ချုပ်ပြီး ယခုကျေးရွာဥက္ကဋ္ဌများခန့်၍ အုပ်ချုပ်ကြောင်း တွေ့ရသည်။ မင်္ဂလာဆောင်ရာတွင် မင်္ဂလာငယ်နှင့် မင်္ဂလာကြီးဟူ၍ နှစ်မျိုးရှိသည်။ မင်္ဂလာငယ် သည် သတို့သမီးဘက်က စီမံသော မိရာဖရာကွမ်းဖိုးပေးဆောင်ခြင်းဖြစ်သည်။ မင်္ဂလာကြီးသည် သတို့သား ဘက်ကဦးဆောင်ကာ အကျွေးအမွေးဖြင့် ဧည့်ခံခြင်းဖြစ်သည်။ ကနန်းလူမျိုးတို့သည် ရှင်ပြုပွဲကို ရှေးမူမပျက် ဆောင်ရွက်လျက်ရှိသည်။ နွေဦးပေါက်လျှင် ကျေးရွာများစုပေါင်း၍ ရှင်ပြုပွဲ များပြုလုပ်လေ့ရှိပါသည်။ ကြီးကျယ်ခမ်းနားသော မဏ္ဍပ်ကြီးများဆောက်လုပ်ကာ "ရှင်ပြုပွဲကြီးမှူးရေးအဖွဲ့" ကဦးဆောင်၍ ကျွေးမွေးကာ ရှင်ပြုပွဲ ကျင်းပကြောင်း တွေ့ရသည်။

နိဂုံး

ကနန်းလူမျိုးတို့၏ ယဉ်ကျေးမှုဓလေ့ထုံးစံများသည် မြန်မာနှင့်တူသည့် အချက်များ များ၍ မတူသည့်အချက်များလည်းတွေ့ရသည်။ လမ်းပန်း ဆက်သွယ်ရေး ကောင်းမွန်လာပါက ကနန်းလူမျိုးများသည် မြန်မာနှင့်ရောပြီးယဉ်ကျေးမှုများ တဖြည်းဖြည်းပြောင်းလဲသွားနိုင်ပါသည်။ ထို့ကြောင့် ဤစာတမ်းတွင် ကနန်းလူမျိုးတို့၏ယဉ်ကျေးမှုကို လေ့လာမှတ်တမ်းတင်ရခြင်းဖြစ်ပါသည်။

ကျမ်းကိုးစာရင်း

ကျော်ရှင်း၊ ဦး။ (၁၉၈၉)။ ကနန်းအလှ။ ရန်ကုန်။ စာပေဗိမာန်ပုံနှိပ်တိုက်

နုနု၊ မ။ (၁၉၉၁)။ ကတူးကနန်းသမိုင်း။ မန္တလေးတက္ကသိုလ်။ မဟာဝိဇ္ဇာကျမ်း။

ဖေမောင်တင်၊ ဦး။ (၁၉၆၆)။ ဘာသာလောကကျမ်း။ ရန်ကုန်။ စာပေဗိမာန်ပုံနှိပ်တိုက်

ဘရှင်၊ ဗိုလ်မှူး။ (၁၉၈၈)။ အနော်ရထာအရင်ကမြန်မာနိုင်ငံ။တတိယအကြိမ်၊ ရန်ကုန်၊ ဦးမြတ်ကျော်စာလုပ်ငန်းပုံနှိပ်တိုက်။

သန်းထွန်း၊ ဒေါက်တာ။ (၂၀၀၂)။ ခေတ်ဟောင်းမြန်မာရာဇဝင်။ (တတိယအကြိမ်)၊ ရန်ကုန်။ အင်းဝစာအုပ်တိုက်။

အကိုစော ။ (၁၉၇၅)။ လေ့လာမိသမျှကတူးကနန်ဒေသ၊ ရန်ကုန်စာပေဗိမာန်၊ ပုံနှိပ်တိုက်။

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သီသီစန်း[၁]

စာတမ်းအကျဉ်း

ဤစာတမ်းသည် အင်းဝခေတ်ပျို့များမှ ပြည်ဘွဲ့.မြို့.ဘွဲ့.များကို လေ့လာတင်ပြထား သောစာတမ်းဖြစ်ပါသည်။ အင်းဝခေတ် ပျို့(၂၁)စောင်ရှိသည်အနက် ပျို့(၁၂) စောင် ကို အခြေခံ၍ လေ့လာတင်ပြထားခြင်း ဖြစ်သည်။ သာယာသော တိုင်းပြည်၊ သာယာသောမြို့၏ အင်္ဂါရုပ်များကို သိရှိစေရန်နှင့် သာယာစည်ကားလှသော အင်းဝမြို့ကြီးကို ပြန်ပြောင်း အမှတ်ရစေရန် ရည်ရွယ်၍ တင်ပြထားခြင်းဖြစ်ပါသည်။ ထိုသို့.တင်ပြထားသည့် အတွက် အမျိုးဂုဏ်ဇာတိဂုဏ်ကို ထက်သန်လာ စေပါသည်။

နိဒါန်း

မြန်မာစာပေတွင် အင်းဝခေတ်ကို ပျို့ခေတ်ဟု မှတ်တမ်းတင်ကြပါသည်။ ပျို့စာဆိုများသည် သာသနာတော်၏အသက်ဖြစ်သော ကျမ်းဂန် ဒေသနာများကို ဆည်းပူးလေ့လာပြီး ဇာတကဝတ္ထု တို့ကို အခြေခံ၍ ပျို့ကဗျာများ ရေးဖွဲ့.ခဲ့ကြသည်။ ဇာတကဝတ္ထုကို အခြေခံသဖြင့် နောက်ခံ ဝန်းကျင်မှာ ပျို့၏ကျောရိုးဇာတ်လမ်းဖြစ်ပျက်ရာ ဗာရာဏသီပြည်၊ သာဝတ္ထိပြည်၊ ရာဇဂြိဟ်ပြည်၊ ကပိလဝတ်ပြည်၊အမရဝတီပြည်၊မိတ္ထီလာပြည်တို့ဖြစ်သည်။ ပျို့စာဆိုတို့.သည် ထိုပြည်များကို ဖွဲ့ရာတွင် မိမိတို့ ကြုံတွေ့ခံစားနေရသော အင်းဝပြည်ကြီး၏ သွင်ပြင်လက္ခဏာများနှင့်ထင်ဟပ် ရေးဖွဲ့ကြပါသည်။ ဤသို့ဖြင့် အင်းဝခေတ်ပျို့များတွင် စာဆိုတို့.ကျင်လည်ရာ အင်းဝပြည်ကြီးကို ထင်ဟပ်သော ပြည်ဘွဲ့မြို့ဘွဲ့များကို တွေ့ရပါသည်။

အင်းဝခေတ်ပျို့များမှ ပြည်ဘွဲ့.မြို့.ဘွဲ့.များ

အင်းဝခေတ်တွင် ပျို့(၂၁)စောင် ပေါ်ထွန်းခဲ့သည်။ အင်းဝခေတ်ပျို့များမှ ပြည်ဘွဲ့.မြို့ဘွဲ့ များကို လေ့လာတင်ပြရာတွင် ဂါထာခြောက်ဆယ်ပျို့၊ ဆုတောင်းခန်းပျို့၊ နေမိ ငရဲခန်းပျို့၊ နေမိဘုံခန်းပျို့၊ ပါရမီတော်ခန်းပျို့၊ ပြာဋိဟာခန်းပျို့၊ ဘူရိဒတ်လက်ံကြီး၊ ရွှေဟင်္သာမင်းပျို့၊ လောကသာရပျို့၊ သုဝဏ္ဏသျှံမြားပစ် ခန်းပျို့၊ သုဝဏ္ဏသျှံသူဌေးခန်းပျို့၊ သံဝရပျို့တို့ကို လေ့လာ တင်ပြပါမည်။ ထိုသို့.လေ့လာတင်ပြရာတွင် မြို့အင်္ဂါရုပ် များနှင့်ပြည့်စုံပုံ၊ မြို့တန်ဆာများနှင့် ပြည့်စုံပုံ၊ စိုက်ပျိုးရေးဖြစ်ထွန်း၍ စပါးဆန်ရေပေါများပုံ၊ ဥယျာဉ်ခြံမြေများနှင့် တင့်တယ်ပုံ၊ ပြည်တွင်းပြည်ပ ကူးသန်းရောင်းဝယ်ရေး ပွင့်လန်းပုံ၊ ပွဲလမ်းသဘင် များဖြင့် စည်ကား သာယာပုံဟူ၍ ခွဲခြားတင်ပြပါမည်။

၁။ မြို့အင်္ဂါရုပ်များနှင့် ပြည့်စုံပုံ

အင်းဝခေတ်ပျို့များတွင် ပြည်ဘွဲ့.မြို့.ဘွဲ့များကို ရေးဖွဲ့ရာ၌ မြို့အင်္ဂါ(၇)ပါးနှင့် ပြည့်စုံကြောင်း ရေးဖွဲ့ထားသည်ကို တွေ့ရပါသည်။ မြို့အင်္ဂါ(၇)ပါးထဲတွင် ပြည့်ရှင်မင်းသည် တစ်ပါး အပါအဝင်ဖြစ်ပါသည်။ တိုင်းပြည်တစ်ပြည်၊ မြို့တစ်မြို့၏ လူနေစည်ကားမှု၊ သာယာလှပမှုသည် အုပ်ချုပ်သူမင်းနှင့်လည်း သက်ဆိုင်ပါသည်။ အုပ်ချုပ်သောပြည့်ရှင်မင်းသည် မင်းကျင့်တရားနှင့်အညီ အုပ်ချုပ်ရမည်။ ရှေးအစဉ်အလာကိုလည်း ထိန်းသိမ်း ရမည်။ ပြည်သူပြည်သား တို့၏အမွေအနှစ် မစားသော၊ သမာသမတ်ကျသော၊ ကြောင်းကျိုးဆင်ခြင်တတ်သော၊ ဘုန်းကြီးသော၊ ပြည်သူတို့ ချစ်ကြောက်ရိုသေသော ဝိသေသထူးရှိသည့် မင်းကောင်း မင်းမြတ်ဖြစ်ရမည်။ ထိုသို့သော မင်းကောင်းမင်းမြတ်ရှိပုံကို ရှင်တေဇောသာရ၏ ရွှေဟင်္သာ မင်းပျို့တွင်

“ထိုသည့်မင်းကား၊ စောင့်ခြင်းတရား၊ ဆယ်ပါးမကွာ၊ လေးဖြာဝတ္ထု၊

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[၁] တွဖက်ပါမောက္ခ၊ဒေါက်တာ၊မြန်မာစာဌာန၊ ရွှေဘိုတက္ကသိုလ်။

သဂြိုဟ်မှူလည်း၊တစ်ခုမကျန်၊ ပြည့်စုံဟန်ဖြင့်၊ မင်းမွန်ရှေးဆက်၊
ကျင့်တိုင်းပက်၍၊ မပျက်စည်ကွင်း၊ မပြင်းတုတ်ခွန်၊ မလွန်အသစ်
မွေနှစ်မစား၊ သူနှစ်ပါး၏၊ အပါးချိန်တွင်၊ ဖြစ်ပေကျင်၍၊ လေး
လျင်မရှိ အညီညွတ်လျက်၊ အသိဆုံးဖြတ်၊ ဓမ္မသတ်လည်း၊ တတ်စွ
ထိုမင်း၊မပင်းလိုရာ၊ မျက်နှာမကြည်၊ အလည်တည့်၏"[3]

ဟုရေးဖွဲ့ထားသည်။

တစ်ဖန် ပြည်တစ်ပြည်၊ မြို့တစ်မြို့သာယာစေရန် မြို့အင်္ဂါဖြစ်သော အမတ်ပညာရှိ၊ ဆေး သမား၊ အဆွေခင်ပွန်းကောင်းများလည်းရှိရမည်။ ကန်တော်မင်းကျောင်းဆရာတော်၏ လောကသာရ ပျို့တွင်

" ဆေးသမားနှင့်၊ ဟူးရားမကွာ၊ တတ်လိမ္မာသား
ရေးရာပွန်းတီး၊ မတ်ကြီးကြံတက်၊ တုံးသက်တိုင်ပင်
မြော်မြင်ကျိုးကြောင်း၊ ခင်ပွန်းကောင်းလည်း
တိမ်းစောင်းယိမ်းမပ်၊ စောင်မကွပ်လျက်"[4] ဟူ၍ ရေးဖွဲ့ထားသည်ကို တွေ့ရသည်။ တိုင်းပြည်သည် စည်ပင်တိုးတက်အောင် အကြံဉာဏ်ပေးနိုင်သော အတိုင်ပင်ခံအမတ်များ၊ ပြည်သူ ပြည်သားများ ကျန်းမာရေးစောင့်ရှောက်မှုအတွက် ဆေးဆရာများ၊ လုပ်ငန်းများ အောင်မြင်ရန် ဘေးရန်ကင်းဝေး အောင်ပြုပေးနိုင်သော ဗေဒင်ဆရာများ၊ မိတ်ကောင်း ဆွေကောင်းများနှင့် ရှိသင့်သည်။ သို့မှသာ မင်းနှင့် ပြည်သူပြည်သားများသည် ကျန်းမာကြံ့ခိုင်ပြီး အသိဉာဏ် ဖွံ့ဖြိုးသောသူ များဖြစ်လာကာ တိုင်းပြည်ကို တိုးတက်အောင်၊ အေးချမ်းသာယာအောင် ဆောင်ရွက်နိုင်ပေ လိမ့်မည်။

ထို့ပြင် ပြည့်အင်္ဂါတစ်ပါးဖြစ်သည့် စစ်လက်နက်အင်အား တောင့်တင်းပြည့်စုံပုံကိုလည်း ရှင်တေဇောသာရ၏ ရွှေဟသ်ာမင်းပျို့၊ ဗာရာဏသီပြည်ဘွဲ့တွင်

" လှံစည်းကျူရုံ၊ အပုံကာလွှား၊ အပြားပြားလျှင်
မြို့နားဝန်းကျင်၊ သိပ်နှက်တင်လျက်"[2]

ဟုလည်းကောင်း ရှင်အဂ္ဂသမာဓိ၏သုဝဏ္ဏသျှံသူဌေးခန်းပျို့ သာဝတ္ထိပြည်ဘွဲ့တွင်

" ချည့်နှောင်ပေါပည်း၊လှံစည်းအဲမောင်း၊ ကတောင်းလွှားကာ၊
တန်ဆာမိန်ညို၊ မောက်တိုမောက်လူ၊ ပည်းထူချပ်သေး
ပါလည်းကွေးက၊ စွေးစွေးမရှား၊ မြို့နားအသိပ်"[5]

ဟုလည်းကောင်းရေးဖွဲ့ထားပါသည်။ အဖျက်ရန်ချေမှုန်းနိုင်ရန် စစ်လက်နက်အင်အား တောင့်တင်း ပြည့်စုံရမည်။ ကာကွယ်ရေးသတိရှိရမည်။ သို့မှသာ ပြည်သူပြည်သားတို့၏ အသက်အိုးအိမ်စည်းစိမ် များကို လုံခြုံစွာကာကွယ်နိုင်မည်ဖြစ်သည်။

အင်းဝခေတ်ပျို့များတွင် ပျို့စာဆိုတို့သည် မိမိတို့နောက်ခံထားသောပြည်၊ မြို့တို့ကို ဖွဲ့ဆို ရာတွင် ပြည်အင်္ဂါ၊ မြို့အင်္ဂါများ ထည့်သွင်းဖွဲ့ဆိုကြပါသည်။ ထိုသို့ဖွဲ့ဆိုရာတွင် မင်းကျင့်တရား နှင့်အညီ အုပ်ချုပ်သောမင်းကောင်းမင်းမြတ်ရှိပုံ၊ အမတ်ပညာရှိ၊ ဆေးသမား၊ ဗေဒင်ဆရာ၊ မိတ်ကောင်းဆွေကောင်းများရှိပုံ၊ စစ်လက်နက်အင်အားတောင့်တင်းခိုင်မာပုံများကို အဓိကထား ထည့်သွင်း ဖွဲ့စပ်ထားကြောင်း သိရပါသည်။

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[3] တေဇောသာရ၊ ရှင်၊ မ – ၁၃၂၄၊ ၈။
[4] ကန်တော်မင်းကျောင်းဆရာတော်၊ ၁၉၃၀ ၊ ၃၇။
[5] တေဇောသာရ၊ ရှင်၊မ–၁၃၂၄၊ ၇။
[6] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၄၀ ၊ ၄။

၂။ မြို့တန်ဆာများနှင့် ပြည့်စုံပုံ

တိုင်းပြည်တစ်ပြည်၊ မြို့တစ်မြို့ လုံခြုံမှုအတွက် မြို့တန်ဆာ(၇)ပါးနှင့် ပြည့်စုံရမည်။ အင်းဝခေတ် ပျို့များတွင် ပျို့စာဆိုတို့သည် မိမိတို့ပျို့များ၏ မိမိတို့နောက်ခံထားသော ပြည်၊ မြို့များ၏ မြို့တန်ဆာများကို ထည့်သွင်းဖွဲ့ဆိုကြပါသည်။ ကန်တော်မင်းကျောင်းဆရာတော်၏ လောကသာရ ပျို့တွင် ကျုံး၊မြောင်း၊ ရဲလောင်း၊ ရင်တား၊ တန်ဆောင်းနှင့် တင့်တယ်ပုံ၊ စစ်လက်နက် အင်အား ပြည့်စုံပုံကို

“ ရန်သူကြောက်ဖွယ်၊ နက်ဝှမ်းကျယ်သား၊ ပင်လယ်ကျုံးမြောင်း
ရေနေကောင်းလျက်၊ ရဲလောင်းရင်တား၊ တံခါးထူရိုက်
ကြံ့ခိုင်မြို့ကို၊တစ်သိန်းဖြိုလည်း၊ မဖြိုနိုင်မှု၊
ကြီးကျယ်ထုနှင့်၊ မျက်ရှုလှတင့်၊ တန်ဆောင်းဆင့်၍
သွယ်မြင့်ပြုဆောင်၊ မြားမြောင်လက်နက်၊ မြို့ထက်ပတ်
လျှောက်၊ စစ်တဲဆောက်၍၊ ရင်လျှောက်ပတ်ကုံး၊သူရဲဖုံးက
စသည်မကျန်၊ တံခွန်လောက်လွှဲ၊ စူးရဲကစ၊ အနေကျလျှင် ”[၁]

ဟုလည်းကောင်း၊ ရှင်အဂ္ဂသမာဓိ၏သုဝဏ္ဏသျှံသူဌေးခန်းပျို့တွင် သာဝတ္ထိပြည်၏ကျုံး၊ ရဲလောင်း၊ ရင်တား၊တံခါးနှင့် စစ်လက်နက်၊ စစ်သည်ရဲမက်များ ပြည့်စုံပုံကို

“ခပ်သိမ်းကြီယာ၊ မြို့ဖွယ်ရာလည်း၊ လိမ္မာပြုပြင်
ကျုံးမြေထွင်၍၊ မြင်းဆင်ဖြင့်ပဲ၊ သူရဲမဆုံ၊ ကြာ၊
သော်အုံမျှ၊ စေးရွံ့ခက်ထူ၊ ရန်သူခရှောင်၊မာန်အောင်
ခင်းကျင်း၊ အိုင်အင်းကန်ချောင်း၊ တန့်ဆည်မောင်းလျက်
ရဲလောင်းအမြောင်၊ ကျည်းချောင်တံခါး၊ ဝန်းလျားပတ်ကုံး
ကျုံးကားသုံးတန်၊ ရင်တားသန်၏၊ နက်ဖြန်သံဘက်
ရန်သူထွက်၍၊စစ်မက်မြူစယ်၊ ပြုချင်ဘွယ်သို့၊
ရေးကျယ်တတ်ပွန်၊ သစ်တန်ခွန်လည်း၊ ရန်၏အတား၊
တိုင်ဆော့လွှားလျက်၊ လေးမြားမီးဘေက်၊ ထန်းလျှော့
လက်တင်၊ စီရင်သင့်အပ်၊ ဆင်ကပ်လေးလွဲ၊တုံးမောင်းဆွဲလျက်
သူရဲပစ်ထိုး၊ ပြအိုးပြဆောင်၊ အယောင်ယောင်တည့် ”[၂]

ဟုလည်းကောင်း ရေးဖွဲ့ထားပါသည်။ တံခါး၊ ကျုံး၊ သူရဲခိုရဲ၊ သူရဲဖုံး၊ လက်နက်၊ဗိုလ်ပါရဲမက်၊ တံခါးမှူး၊ တံခါးစောင့်၊ မြို့ရိုး၊ တံတိုင်းဟူသော မြို့တန်ဆာများနှင့်ပြည့်စုံကြောင်း၊ ခိုင်ခံ့အောင် တည်ဆောက်ထားကြောင်း ဖွဲ့ဆိုထားပါသည်။ မြို့တန်ဆာများနှင့် ခိုင်ခန့်အောင် တည်ဆောက်ထားသည့်အတွက် ရန်သူများ အလွယ်တကူ မချဉ်းကပ်နိုင်ပေ။ ချဉ်းကပ်လာလျှင်လည်း ချက်ချင်းသိ၍ ကာကွယ်နိုင်အောင် စီမံထားခြင်းဖြစ်သည်။

၃။ စိုက်ပျိုးရေးဖြစ်ထွန်း၍ စပါးဆန်ရေပေါများပုံ

မြန်မာနိုင်ငံသည် လယ်ယာစိုက်ပျိုးရေးကို အဓိကထားလုပ်ကိုင်သော နိုင်ငံဖြစ်သည်။ ဆန်ရေစပါးသည် လူတို့၏ အသက်သွေးကြောဖြစ်သည်။ ဆန်ရေစပါးပေါများရန် မိုးလေဝသ မှန်ကန်ရမည်။ လယ်ယာချောင်းမြောင်း ကောင်းမွန်ရမည်။ အင်းဝခေတ်ပျို့များတွင် မိုးလေဝသ မှန်ကန်၍ ဆန်ရေစပါးပေါများကာ စိုက်ပျိုးရေးဖြစ်ထွန်းပုံကို ဖွဲ့ဆိုထားပါသည်။ ရှင်တေဇောသာရ၏ ရွှေဟင်္သာမင်းပျို့တွင် ဗာရာဏသီပြည်ရှိ လယ်ယာကန်ချောင်း၊ မြောင်းကြီး မြောင်းငယ်တို့တွင်

[၁] ကန်တော်မင်းကျောင်းဆရာတော်၊ ၁၉၃၀၊ ၃၆။
[၂] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၄၀ ၊ ၄။

ရေများ ပြည့်လျှံနေပါသည်။ ရေကာတာများ တည်ဆောက်ထားပါသည်။ ထို့ကြောင့် ရေစီးရေလာ ကောင်းပါသည်။ မိုးလည်း ကောင်းမွန်မှန်ကန်သဖြင့် သီးညှပ်၊ သီးထပ် စိုက်ပျိုးနိုင်ပါသည်။ သီးနှံ အထွက်ကောင်း၍ ကျီအပြည့်သို့ လှောင်ထားနိုင်ပုံကို–

“ လယ်ယာကန်ချောင်း၊ မြောင်းလည်းရေဝင်၊ အုန်းအင်းဖြင့်လျက်
ကောက်လျင်ကောက်ကြီး၊ သုံးသီးမုရင်း၊ ခူနှင်းမောင်းသွန်း၊
လုပ်ငန်းဆောင်တာ၊ ရေကာပင်းတား၊ တံတားရေပြွန်၊ မိုးကောင်း
မှန်၍၊ စိုက်လုန်ကောက်ပင်၊ ပျိုးတိုင်းရှင်၏၊ ဝန်းကျင်ရွှေယ်၊
စိမ်းစိမ်းဆွယ်လျှင်၊ ပေါယယ်လုပ်ဆောင်၊ ရေမိုးအောင်၍၊
မခေါင်မရှား၊သီးမှည့်များလျက်၊ စပါးကျီပြည့်၊”[၁]

ဟူ၍ ဖွဲ့ဆိုထားပါသည်။ ထို့အတူ သုဝဏ္ဏသျှဲ မြားပစ်ခန်းပျို့တွင် ဗာရာဏသီပြည်၏ လယ်ယာကန် ချောင်းကောင်း၍ စပါးဆန်ပေါများပုံကို

“ လယ်ယာကန်ချောင်း၊ စီးသည့်မြောင်းနှင့်၊ မောင်းကားလက်လွတ်၊
ရေရှင်လွတ်၍၊ပြတ်တိမဖြစ်၊တစ်နှစ်သုံးသီး၊ကောက်ကြီးမုရင်း၊
ကျီကြွသွင်းလျက်၊မွတ်ခြင်းမထင်”[၂]

ဟုလည်းကောင်း၊ ဘူရိဒတ်လင်္ကာကြီးတွင် ဗာရာဏသီပြည်၏ ရေစီးရေလာကောင်းသော ချောင်း၊ မြောင်းများနှင့် မိုးလေဝသမှန်ကန်သောကြောင့် ရှားပါးမရှိပုံကို

“ လယ်ယာကန်ချောင်း၊ စီးသည့်မြောင်းနှင့်၊ မိုးကောင်းစာဂုန်
နှစ်တိုင်းမှန်၍၊ ရံဖန်ထိုလှ၊ကာလကျီးကျူး၊ မရှားဘူးတည့်”[၃]

ဟုလည်းကောင်း၊ သံဝရပျို့တွင် ဗာရာဏသီပြည်သည် မြေလွတ်၊ မြေရိုင်းမကျန်အောင် စိုက်ပျိုး နိုင်ပုံ၊ သိုလှောင်ရန်သယ်ယူသည့် စပါးလှည်းများ၊ များပြားလှသဖြင့် လှည်းလမ်းကြောင်း တစ်လျှောက် ဖုန်မှုန့်တထောင်းထောင်း၊ နွားငေါက်သံ တည်ညံဖြစ်နေပုံကို–

“ ချောင်းရိုးချောင်းမြောင်း၊ စောင်းထောင်ဘီလာ၊ တောင်ယာကုန်း
ကျင်း၊ မျိုးမြင်းခွက်ထဲ၊ ကြဲကာမျှလျှင်၊စားရသည်ချည်း၊ ခွန်နက်ပည်း၏ ”[၄]
“ စပါးအိမ်မှာ၊ သွင်းမည့်ခါလည်း၊ မဟာသကဋ္ဌ၊ လှည်းမကတ်တင်
ကျွန်နွားနှင်သော်၊ ကောင်းကင်ခြောင်းခြောင်း၊ မြေမှုန့်ထောင်းမျှ
ဆော်မောင်းသံသည်း၊ ထိန့်ထိန့်ကြည်း၏ ”[၅]

ဟူ၍ ဖွဲ့ဆိုထားပါသည်။ စိုက်ပျိုးရေးအတွက် သဘာဝကိုသာ အားမပြုဘဲ လုံ့လဝီရိယဖြင့် တီထွင် ကြံဆကြိုးပမ်းလုပ်ဆောင်ကြသဖြင့် လယ်ယာမြေဖြစ်ထွန်းကာ ချမ်းသာကြွယ်ဝနေပုံကို အားကျဖွယ် ဖော်ညွှန်းထားပါသည်။

၄။ ဥယျာဉ်ခြံမြေများနှင့် တင့်တယ်ပုံ

ဥယျာဉ်ခြံမြေများနှင့်တင့်တယ်ခြင်းသည် လူများ၏ စိတ်ကိုရွှင်လန်းစေပါသည်။ ဤသည်ကို သိသော အင်းဝခေတ်စာဆိုများသည် မိမိတို့ရေးစပ်သောပျို့များတွင် ဥယျာဉ်ခြံသာယာပုံ များကို ထည့်သွင်း ဖွဲ့စပ်ကြပါသည်။ အင်းဝခေတ်သုဝဏ္ဏသျှဲသူဌေးခန်းပျို့တွင် သာဝတ္ထိပြည်ရှိ ဥယျာဉ်ခြံ များတွင် အသီးမျိုးပေါင်းစုံလင် သီးနေကြပုံကို–

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[၁] တေဇောသာရ၊ ရှင်၊ မ–၁၃၂၄၊ ၅။
[၂] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၁၀ ၊၇၉။
[၃] ရဋ္ဌသာရ၊ ရှင်မဟာ၊ ၁၉၆၄၊၃၂။
[၄] ယင်း၊၁၉၇၃၊၁၆၉။
[၅] ယင်း၊၁၉၇၃၊၁၆၉။

“ သစ်ပင်အပေါင်း၊သီးစကောင်းသား၊ သအောင်းသတွတ်၊
ချဉ်ဖြတ်လျှင်းလျော၊ မင်းပေါသစ်တို၊ သရိုရမ်း
စင်ဖြမ်းချဉ်မျိုး၊ ကနစိုးက၊ ကြိုးလျှင်သွယ်သို့
ယိုးယယ်မလွှကာ၊ တည်လိမ်မာနှင့်၊ သမ္ဘရာတခြား၊ စောင်းလျား
ချဉ်သင်း၊ ရှောက်မြည်ရှင်းကား၊ ဖျားရင်းညွှတ်ညွှတ်၊ ဆွတ်လည်းအလို ”[၁]

ဟုလည်းကောင်း၊ နေမိဘုံခန်းပျို့တွင် သောဏဒိန်ဘုံနတ်ပြည်၊ နတ်ဥယျာဉ်၏ သီးမျိုးစုံနှင့် သာယာပုံကို–

“ နတ်ဥယျာဉ်လည်း၊ အချဉ်အချို၊ သစ်တိုသစ်နီ၊ သတိသတောင်း
ဝှေးဖအောင်းတည့်၊ သင်းပေါင်းသမီး၊ အိမ်ဇီးမန်ကျည်း၊
တောင်တလည်းနှင့်၊ စရည်းရှစ်ရှား၊ သဖန်းခါးက၊ စောင်းလျား
ကမွှလာ၊ ထောက်ရှာတည်သီး၊ ညီးရရီးလျှင် ”[၂]

ဟုလည်းကောင်း၊ ဂါထာခြောက်ဆယ်ပျို့တွင် ကပိလဝတ်ပြည်သွားလမ်းခရီး၌ သီးမျိုးစုံ သီးနေကြပုံကို–

“ ပြည့်စင်ခံသီး၊လုံးကြီးရင်ခတ်၊ သတွတ်ဖအောင်း၊ သင်းပေါင်း
ဖက်အုပ်၊ လက်ခုပ်မအူ၊ မှန်ကူပိတ်ချင်း၊ အင်ကြင်းဆင်းဝါ
မာလကာသစ်တက်၊ စုံကွမ်းရွက်နှင့် ပျားယက်မတူ
ကြံဖြူအတိ၊ပေါက်ဘိပေါယယ် ”[၃]

ဟုလည်းကောင်း ဖွဲ့ဆိုထားပါသည်။ မြေပြင်အနှံ့ ချိုချဉ်ဖန်ခါး ရသာထူးပြားသော သီးပင်များ ညွှတ်နေအောင်သီးနေပုံ၊ ပဒေသာပင်မှ ဆွတ်ချူနိုင်သကဲ့သို့ သီးမျိုးစုံ သီးနေကြပုံကို သိမြင်လာစေပါသည်။

ထို့ပြင် အေးမြကြည်လင်သော ရေကန်တွင် ကြာငါးမျိုးနှင့်တင့်တယ်ပုံ၊ ကျေးငှက် သာရကာတို့ ပျော်မြူးနေကြပုံကို သုဝဏ္ဏသျှံမြားပစ်ခန်းပျို့တွင်

“ ရေကန်ကြည်လည်း၊ငါးမည်ကြာပေါင်း၊ ကြိုင်ကြိုင်လှောင်း၍
သောင်းသောင်းကျေးငှက်၊ သံမြည်တွန်ကျော်၊ ဖိုမခေါ်လျက်
မျှော်လေအရာ ပျော်ဘွယ်သာလျှင် ”[၄]

ဟုလည်းကောင်း၊ ဆုတောင်းခန်းပျို့တွင် အမရဝတီပြည်၏ ဥယျာဉ်ခြံအတွင်း ရေကန်တွင် ကြာငါးမျိုးနှင့် တင့်တယ်ပုံ၊ ကျေးငှက်တို့ဘာသာ သဘာဝအသံများဖြင့် မြည်ကျူးကာ ပျော်မြူးနေကြပုံကို

“ ရွှဖွယ်သာနီး၊ ရေလုံးမွှေး၏၊ ခြေခြေသာယာ၊ အေးပျံ့လာသား၊
ကြိုးကြာသံမြက်၊ စက္ကဝါက်နှင့်၊ ရေကြက်ဝမ်းဘဲ၊ ဟသ်ဝဲလျက်၊
မကွဲထွန်ထူး၊ ဖော်ပြိုင်မြူး၏ ”[၅]

ဟုလည်းကောင်း၊ သုဝဏ္ဏသျှံသူဌေးခန်းပျို့တွင် သာဝတ္ထိပြည်ရှိ ရေကန်ကို–

“ ကန်အစုတ်လည်း၊ကုမုဒ္ဒရာ၊ကြာတိပွမ်းပွမ်း၊ ကျေးငှက်မြွမ်းမျှ ”[၆]

ဟုလည်းကောင်း ရေးဖွဲ့ထားပါသည်။ ရေကန်ကို ထည့်သွင်းဖွဲ့စပ်ထားသည့်အတွက် မြင်ရသူ တို့၏ စိတ်နှလုံးဝယ် အေးမြလန်းဆန်းစေပါသည်။ ဥယျာဉ်သည် လူတို့၏ စိတ်အပန်းဖြေစရာ နေရာဖြစ်

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[၁] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၄၀၊ ၂။
[၂] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၇၆၊ ၁၇။
[၃] အုန်းညို၊ ရှင်၊၁၉၆၅၊ ၃၀။
[၄] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၁၀၊ ၇၉။
[၅] သီလဝံသ၊ ရှင်မဟာ၊၁၉၆၉၊ ၇။
[၆] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၄၀၊ ၃။

သည်။ ထို့ကြောင့် အင်းဝခေတ်စာဆိုတို့သည် ပြည်သူပြည်သားများ စိတ်နှလုံး ချမ်းမြေ့မှုရစေရန် မိမိတို့ရေးစပ်သောပျို့များတွင် သာယာသော ဥယျာဉ်များအကြောင်း ကိုထည့်သွင်း ဖွဲ့စပ်ထားသည်ဟု ဆိုနိုင်ပါသည်။

၅။ ပြည်တွင်းပြည်ပကူးသန်းရောင်းဝယ်ရေးပွင့်လန်းပုံ

တိုင်းပြည်တစ်ပြည် မြို့တစ်မြို့၏ စည်ကားသာယာမှုသည် ကူးသန်းရောင်းဝယ်ရေး ကောင်းမွန်ခြင်း ဖြစ်သည်။ ပျို့စာဆိုများသည် မိမိတို့ဖွဲ့သောပျို့များတွင် ဒေသနောက်ခံအဖြစ် ထားသော ပြည်၊ မြို့တို့၏ စည်ကားသာယာပုံကို ကုန်သွယ်မှုကောင်းပုံဖြင့် ဖွဲ့ပြထားသည်။ ဆုတောင်းခန်းပျို့တွင် အမရဝတီပြည်၏ စည်ကားသာယာပုံကို ကုန်သွယ်မှုဖြစ်ထွန်းပုံနှင့် ဖွဲ့ပြ ထားသည်။ အမရဝတီပြည်ကြီးသည် ကုန်ပစ္စည်းပေါများသည်။ အရောင်းအဝယ် ဖြစ်ထွန်းသည့် အတွက် အပြည်ပြည်နှင့် ဆက်သွယ်မှုရှိသည်။ အမရဝတီပြည်သို့ ကုန်သွယ်မှုအဖြစ် မရောက်လာသော ပြည်ဟူ၍ မရှိကြောင်းကို ဆုတောင်းခန်းပျို့တွင်

“ ရှင်သားရောင်းဝယ်၊ ကုန်စယ်မခေါင်၊ ပြည်ကုန်အောင်မှ
လေ့ထောင်လေ့မ၊ အပုံကျလျက်၊ ကုံငဖွေးဖွေး၊
ဗိုလ်တိဝေးသား၊ အိမ်ဈေးသဘင်၊ မွမ်းဖြင်ဤသို့
ရှုဖွယ်မြို့လျှင်၊ မချို့မတဲ့၊ ရှစ်ရပ်ပြို့၏ ”[၁]

ဟု လေ့ကြီးလေ့ငယ်များနှင့် ရောင်းဝယ်နေကြကြောင်း ရေးဖွဲ့ထားသည်။

ထို့အတူ ရွှေဟင်္သာမင်းပျို့တွင် ဗာရာဏသီပြည်သို့ အရပ်ရှစ်မျက်နှာ ပြည်တွင်းပြည်ပမှ လာသူလာ၊ သွားသူသွား ရောင်းဝယ်ဖောက်ကားကြပုံကို

“ ထိုသည်ပြည်ကား၊ ဝန်လည်ကြေညာ၊ ရှစ်မျက်နှာမှ၊ အလားအလာ
အသွားအရောက်၊ ပြန်ဖောက်ရောင်းဝယ်၊ ကုန်စည်ပေါပြည်း
ကြည်းကားဝန်တင်၊ ရေတွင်ကားလေ၊ အထွေထွေလျှင် ”[၂]

ဟု ကြည်းကြောင်းတွင် ဝန်တင်လှည်းများဖြင့်လည်းကောင်း၊ ရေကြောင်းတွင် လှေများဖြင့် လည်းကောင်း ရောင်းဝယ်ဖောက်ကားကြကြောင်း ရေးဖွဲ့ထားပါသည်။

တစ်ဖန်ဘူရိဒတ်လင်္ကာကြီးတွင် ဗာရာဏသီပြည်၏ ကူးသန်းရောင်းဝယ်မှုကို–

“ ရပ်ထူးမြေခြား၊ ပြည်တစ်ပါးမှ
ဖောက်ကားရောင်းဝယ်၊
တုံ့လှယ်ခေါက်တင်၊
ကုန်စယ်ရှင်၏ ”[၃]

ဟူ၍ ရေးဖွဲ့ထားသည်။ ပြည်တွင်းသာမက ပြည်ပနိုင်ငံများပါ ရောင်းဝယ်ကြပုံကို မြင်သာစေပါသည်။

ထို့အတူ သံဝရပျို့တွင်လည်း

“ ကုန်သည်တို့လည်း၊ စင်စို့ရွှက်စပ်၊ အထပ်ထပ်လျှင်၊ ပြည်နှပ်မှီခို
ရောက်လာဟို၏၊ ထိုပြည်ရပ်သား၊ ထိုလူများကို၊ ပိုင်ကားနိုပ်စက်
နိုင်ထက်ကြီးမြင့်၊ မကျင့်စေရ၊ နေဆုံးမလျက်၊ အာဏာစက်ကြောင့်
ဥည့်ဒုက်တစ်အုပ်၊ပြင်းဟုပ်မဝံ၊ အညှံမချောင်း၊ ဘေးမဲ့ကြောင်းလျှင် ”[၄]

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[၁] သီလဝံသ၊ ရှင်မဟာ ၁၉၆၉၊ ၆။

[၂] တောသာရျှရှင်၊ မ–၁၃၂၄၊ ၅။

[၃] ရဋ္ဌသာရ၊ ရှင်မဟာ၊ ၁၉၆၄၊ ၃၂။

[၄] ရဋ္ဌသာရ၊ ရှင်မဟာ၊၁၉၇၃၊ ၇။

ဟူ၍ ဗာရာဏသီပြည်သို့ မှီခိုအားထားရန် ရောက်လာကြသော ကုန်သည်တို့ကို အနိုင်အထက် မပြုကြစေရန် အကာအကွယ်ပေးထားကြောင်း၊ အရှင်သခင်၏ ဘုန်းတော်ကြောင့် သူခိုးဓားပြရန်မှ ကင်းဝေး၍ ကုန်းလမ်း၊ ရေလမ်း လုံခြုံစိတ်ချရကြောင်းကို ရေးဖွဲ့ထားပါသည်။တိုင်းပြည် အေးချမ်းလုံခြုံမှု ကုန်သွယ်မှု ပြုနိုင်သည့် သဘောကို သိရပါသည်။

၆။ ပွဲလမ်းသဘင်များဖြင့် စည်ကားသာယာပုံ

တိုင်းပြည်တစ်ပြည်တွင် ရန်အပေါင်းကင်းငြိမ်းမှ အေးချမ်းသာယာမည်။ ထိုသို့ အေးချမ်း သာယာမှသာ ပွဲလမ်းသဘင်များ ကျင်းပနိုင်မည်ဖြစ်သည်။ အင်းဝခေတ်ပျိုများတွင် တိုင်းပြည် အေးချမ်းသာယာမှုကို ပွဲလမ်းသဘင်များနှင့် စည်ကားသာယာပုံဖြင့် ချိန်ထိုးရေးဖွဲ့ထား ပါသည်။ ရွှေဟင်္သာမင်းပျိုတွင် ဗာရာဏသီပြည်သည် ကာကွယ်ရေးတောင့်တင်းသဖြင့် စစ်မက် ငြိမ်းချမ်း သည်။ တိုင်းပြည်အေးချမ်းသာယာသဖြင့် အစာရေစာပေါများသည်။ ပြည်သူပြည်သားတို့ စိတ်ချမ်းသာ ကိုယ်ချမ်းသာရှိကြသည်။ ထို့ကြောင့် ပွဲလမ်းသဘင်များဖြင့် ခြိမ့်ခြိမ့်သဲသဲ စည်ကား နေသည်ကို–

“ အိမ်ခြေပြည့်နှက်၊အုတ်ကျက်ဗိုလ်သံ၊ မဆိတ်ညံတည့်
ပွဲခံသဘင်၊ နတ်ရပ်သွင်သို့၊ ပဉ္စင်ငါးမည်၊ ပတ်စည်စောင်းငြင်း
သီချင်းစည်းဆုပ်၊ လက်ခုပ်လင်းကွင်း၊ သံညှင်းသံအိုင်၊
သံဖြိုင်တီးမှုတ်၊ သောက်ထုတ်သေစာ၊ မင်္ဂလာခမ်းနား
ပြုသည်များ၏ ”[၁]

ဟူ၍ ပွဲလမ်းသဘင်များမှ တီးမှုတ်သံများကို ကြားယောင်လာအောင်၊ စားပွဲသောက်ပွဲ ဧည့်ခံပွဲများ ဆင်နွဲနေသည်ကို မြင်ယောင်လာအောင် ပျော်ရွှင်ကြည်နူးဖွယ်ဖြစ်အောင် ရေးဖွဲ့ထားပါသည်။

ထို့အတူ သံဝရပျို့တွင်

“ ဉာဉ်ခါဉာဉ်ခါ၊ ကြည့်ချေရာကား၊လသာပကြိုက်၊ စောင်းငြင်း
လိုက်၍၊ ဧရိုက်ခြည်းခြည်း၊ ဖြည်းဖြည်းညင်းညင်း၊ သာချင်း
ရတု၊ ပျော်မှုတသီး၊ ရုပ်ကြီးရုပ်ငယ်၊ မီးဝယ်ကြည့်ပွဲ
အုံ့အဲမနိုင်၊ အဆိုင်ဆိုင်လျှင်၊ အဲတိုင်အခွံ၊ အံထောက်သံနှင့်၊
ခုန်ပျံတန်းတက်၊ ရေခွက်ခြေထား၊ လှုပ်ရှားမယို၊ သန်ကို
ကြွားကြွား၊ ပြေးလွှားကြွက်လျှောက်၊ မိုးမြှောက်ရင့်ပြန်
လှင်ကန်တောင်ရေး၊ မှာပြေးမှာဝန်း၊မှားသွန်းဟန်ပြ၊
ကာကွင်းသီ၊ ရှုအီနာဖွယ်၊ နတ်ပြည်ဆွယ်၏၊ မြို့လယ်
မြို့နား၊ မြို့တွင်းသားတို့၊ အများဗိုလ်လှိုင်း၊ တရိုင်းရိုင်း
သည်။ နေ့တိုင်းသဘင် ကချေတည်း”[၂]

ဟု ရေးဖွဲ့ထားသည်။ ဗာရာဏသီပြည်တွင် လသာသောညအခါများ၌ တေးဂီတဖျော်ဖြေမှုများ၊ ရုပ်သေးစင်၊ ရုပ်ကြီးစင် စသည့် ကြည့်ချင်ပွဲများ၊ ကျွမ်းဘားပြပွဲ၊ ကိုယ်ခံပညာစွမ်းရည်ပြပွဲ များဖြင့် သီဆိုတီးမှုတ်ကပြဖြေဖျော်နေကြသည်မှာ ကြည့်ရှုနားဆင်၍ မငြီးနိုင်အောင်ဖြစ်ကြောင်း ရေးဖွဲ့ထား ပါသည်။ ပျော်ပွဲရွှင်ပွဲများဖြင့် စည်ကားပုံကို မြင်လာစေပါသည်။

ထိုသို့ ပျော်ပွဲရွှင်ပွဲများနှင့် ပျော်ရွှင်စရာကောင်းသကဲ့သို့ ဘာသာရေးပွဲတော်များနှင့်လည်း ကြည်နူးစရာကောင်းပုံကို သုဝဏ္ဏသျှဲသူဌေးခန်းပျို့တွင်

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[၁] တေဇောသာရ၊ ရှင်၊မ–၁၃၂၄၊ ၇။

[၂] ရဋ္ဌသာရ၊ ရှင်မဟာ၊ ၁၉၇၃၊ ၅။

“ ဖိုလ်မက်ရှာမှီး၊ ကြံစည်သီးသား၊ သက်ကြီးမိဘ၊
လှူဒါနနှင့်၊တလလေးခါ၊ တရားနာ၏ ”[၁]

ဟု ရေးဖွဲ့ထားသည်။ ဗာရာဏသီပြည်တွင် တစ်လ၊ သီတင်းလေးပတ် ဥပုသ်နေ့များ၌ သက်ကြီး ဝါကြီးများကို ပူဇော်ကန်တော့ကြသည်။ တရားတော်များ နာကြားကြသည်။ ကုသိုလ်ဒါန ပြုကြကြောင်းကို ရေးဖွဲ့ထားပါသည်။ ဘာသာတရားကို ရိုသေကိုင်းရှိုင်းမှု၊ သက်ကြီးမိဘများကို ဂါရဝထားမှုများကို သိရပါသည်။

ဤသို့ပျော်ပွဲရွှင်ပွဲ၊ ဘာသာရေးပွဲများ ကျင်းပသကဲ့သို့ ရိုးရာယုံကြည်မှုပွဲတော်များ ကျင်းပကြောင်းကိုလည်း တွေ့ရသည်။ ဆုတောင်းခန်းပျို့တွင် အမရဝတီပြည်ရှိ ပြည်သူပြည်သားများသည် ဗိဿနိုးနတ်၊ ရက္ခစိုးနတ်များ အစဉ်အလာမပျက်ပူဇော်ပသကြပုံကို

“ ရှေးသူဟောင်းတို့၊အပေါင်းညီညာ၊ ရိုသေရာဟု
ဒိဋ္ဌာနုဂတိ၊ မှတ်မိသမျှ၊ အဓိကလျှင်၊ ရက္ခတောစိုး
ဗိဿနိုးကို၊ ရှိခိုးတုံ့ဝပ်၊ ရေစင်သပ်လျက် ”[၂]

ဟုလည်းကောင်း၊ ပါရမီတော်ခန်းပျို့တွင်

“အောင်မြိုင်ချမ်းသာ၊ မင်္ဂလာလူဝယ်၊ ပုဗ္ဗကြယ်သို့ ” [၃]

ဟုလည်းကောင်း၊ နေမိဠဝဲခန်းပျို့တွင်

“အကြင်လူဝယ်၊ ပုဗ္ဗကြယ်ကို ၊ ကိုးကွယ်ပူဇော်ကြွယ်မူခေါ်သို့ ”[၄]

ဟုလည်းကောင်း ၊ ပြာဠိဟာခန်းပျို့တွင်

“ ပုဗ္ဗကြယ်လည်း၊ လယ်ဝယ်ကပင်၊ စာရင်ထင်၍ မြဲပင်စောင့်ရှောက် ” [၅]

ဟူ၍ လည်းကောင်းရေးဖွဲ့ထားသည်။ ရိုးရာဓလေ့ကို လောကီပျော်ရွှင်ပွဲတစ်ခုအနေဖြင့် ကျင်းပကြောင်း တွေ့ရသည်။ မိရိုးဖလာ ရိုးရာယုံကြည်မှုဓလေ့ထုံးစံများကို လက်ခံကျင့်သုံးနေသည်ဟုဆိုရပေမည်။ အင်းဝခေတ်ပျို့များတွင် ပွဲလမ်းသဘင်ကျင်းပမှုကို ကြည့်လျှင် ပျော်ပွဲရွှင်ပွဲများ၊ ဘာသာ ရေးပွဲများ၊ ရိုးရာယုံကြည်မှုပွဲတော်များ ကျင်းပကြောင်း သိရပါသည်။

ခြုံငုံသုံးသပ်ချက်

အင်းဝခေတ်ပျို့များသည် များသောအားဖြင့် ဘုရားဟောဇာတက အခြေခံ၍ ရေးဖွဲ့ သောကြောင့် ဇာတကလာ မြို့၊ ပြည် များကို နောက်ခံထား၍ ရေးဖွဲ့ကြသည်။ အများဆုံး နောက်ခံထားသော ပြည်မှာ ဗာရာဏသီပြည်ဖြစ်သည်။ ရွှေဟင်္သာမင်းပျို့၊ သုဝဏ္ဏသျှံသူဌေးခန်းပျို့၊ သုဝဏ္ဏသျှံ မြားပစ်ခန်းပျို့၊ ဆုတောင်းခန်းပျို့၊ သံဝရပျို့၊ ဘူရိဒတ်လက်ံကြီးတို့တွင် ပြည်ဘွဲ့မြို့ဘွဲ့ များကို မြို့အင်္ဂါ ၊ မြို့တန်ဆာများဖြင့် ပြည့်စုံစွာ ခမ်းခမ်းနားနား ဖွဲ့ဆိုထားပါသည်။ နတ်ပြည်ကို ဖွဲ့ဆိုသော နေမိဘုံခန်းပျို့တွင် နတ်ဘုံသာမက၊ ဥယျာဉ်၊ ရေကန်တို့ကိုပါထည့်သွင်း၍ ခမ်းနားစွာ ဖွဲ့ဆို ထားပါသည်။ တစ်ဖန်ဇာတ်လမ်းမဲ့ပျို့ဖြစ်သော လောကသာရပျို့တွင် ကန်တော်မင်းကျောင်း ဆရာတော်သည် မြို့ပြဆိုင်ရာ လမ်းညွှန်မှုပြုခဲ့သည်။ ဤလမ်းညွှန်မှုမှာပင် မိမိဖြစ်စေချင်သည့် ခမ်းနားသော မြို့အသွင်ကို ထည့်သွင်းကာ ဖွဲ့စပ်ထားပါသည်။

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[၁] အဂ္ဂသမာဓိ၊ ရှင်၊၁၉၄၀၊ ၇။
[၂] သီလဝံသ၊ ရှင်မဟာ ၊ ၁၉၆၉၊ ၁၆။
[၃] သီလဝံသ၊ ရှင်မဟာ ၊ ၁၉၆၅၊ ၇။
[၄] အဂ္ဂသမာဓိ၊ ရှင်၊ ၁၉၅၃၊ ၄၉။
[၅] တောဓောသာရ၊ ရှင်၊မ–၁၂၉၁၊ ၈၅။

နိဂုံး

ပျို့စာဆိုများသည် ပျို့များကိုရေးဖွဲ့ကြချိန်တွင် အင်းဝခေတ် ကောင်းစားစဉ်ကာလကိုလည်း ကြုံတွေ့ခဲ့ရမည်။ ဂငယ်သုံးခု ဥသျှစ်ထုကာလကိုလည်း ကြုံတွေ့ခဲ့ရပေမည်။ ထို့ကြောင့် မိမိတို့ ပျို့များတွင် ပြည်ဘွဲ့မြို့ဘွဲ့များကို ရေးဖွဲ့ရာ၌ သာယာစည်ကားလှသော အင်းဝမြို့ကြီးကို ပြန်ပြောင်း အမှတ်ရတမ်းတ၍ ခမ်းနားစွာ ဖန်တီးခြင်းလည်းရှိမည်။ လက်ရှိအခြေအနေကို မြင်တွေ့ရ၍ အပြောက် အမွမ်းခြယ်သည်လည်းရှိမည်။ မည်သို့ပင်ဖြစ်စေ အင်းဝခေတ်ပျို့များတွင် ပါဝင်သော ပြည်ဘွဲ့မြို့ဘွဲ့. များသည် အင်းဝပြည်ကြီးကို ရည်ညွှန်းနေသည်ဟု ဆိုချင်ပါသည်။

ကျမ်းကိုးစာရင်း

- *ကန်တော်မင်းကျောင်းဆရာတော်။လောကသာရပျို့*။ရန်ကုန်၊စာပေဗိမာန်ပုံနှိပ်တိုက်။
- *တေဇောသာရ*၊ရှင်။မ–၁၂၉၁။*ပြာဠိဟာခန်းပျို့*၊ ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။
- *တေဇောသာရ*၊ ရှင်။မ–၁၃၂၄။ *ရွှေဟင်္သာမင်းပျို့*၊မန္တလေး၊ မြဇော်ပုံနှိပ်တိုက်။
- *ရဋ္ဌသာရ*၊ *ရှင်မဟာ။ ၁၉၆၄။ဘူရိဒတ်လင်္ကာကြီး*၊ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။
- *ရဋ္ဌသာရ*၊*ရှင်မဟာ*။*၁၉၇၃*။*သံဝရပျို့*၊ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။
- *သီလဝံသ*၊*ရှင်မဟာ*။*၁၉၆၅*။*ပါရမီတော်ခန်းပျို့*၊ ရန်ကုန်၊ နိုင်ငံတော်ဗုဒ္ဓသာသနာအဖွဲ့ပုံနှိပ်တိုက်။
- *သီလဝံသ*၊*ရှင်မဟာ*။ *၁၉၆၉*။ ဆုတောင်းခန်းပျို့၊ ရန်ကုန်၊နိုင်ငံတော်ဗုဒ္ဓသာသနာအဖွဲ့ပုံနှိပ်တိုက်။
- အဂ္ဂသမာဓိ၊ရှင်။၁၉၅၃။ *နေမိဝဏ္ဏခန်းပျို့*။ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်
- အဂ္ဂသမာဓိ၊ရှင်။၁၉၇၆။ *နေမိဘုံခန်းပျို့*။ရန်ကုန်၊ မြန်မာနိုင်ငံဗုဒ္ဓဘာသာအဖွဲ့ပုံနှိပ်တိုက်။
- အဂ္ဂသမာဓိ၊ရှင်။၁၉၄၀။သုဝဏ္ဏသျှံသူဌေးခန်းပျို့။ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။
- အဂ္ဂသမာဓိ၊ရှင်။၁၉၁၀။*သုဝဏ္ဏသျှံမြားပစ်ခန်းပျို့*။ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။
- အုန်းညို၊ရှင်။*၁၉၆၅*။*ဂါထာခြောက်ဆယ်ပျို့*။ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။

မြန်မာဘာသာစကား၏ တိုးတက်ပြောင်းလဲပုံအစဉ်ကို သမိုင်းဘာသာဗေဒနည်းဖြင့် လေ့လာခြင်း

မိုးမိုးကျော်[၁]

စာတမ်းအကျဉ်း

ဤသုတေသနစာတမ်းသည် မြန်မာဘာသာစကား၏ တိုးတက်ပြောင်းလဲပုံအစဉ်ကို သမိုင်း ဘာသာဗေဒနည်းဖြင့် လေ့လာထားခြင်းဖြစ်ပါသည်။ ရည်ရွယ်ချက်မှာ ဘာသာစကားများသည် အချိန်အလိုက်နေရာဒေသအလိုက် ပြောင်းလဲတတ်သည့်သဘောနှင့် ပြောင်းလဲရာ တွင်အသံပြောင်းမှု (အသံထွက်ပြောင်းမှု)၊ အဓိပ္ပာယ်ပြောင်းမှု၊ သဒ္ဒါပြောင်းမှုဟူသော အဓိကပြောင်းလဲမှု(၃)မျိုးကို တင်ပြလိုခြင်း ဖြစ်ပါသည်။ ထိုသို့တင်ပြရာတွင် ပုဂံခေတ်မှ မျက်မှောက်ခေတ်အထိ သုံးနှုန်းခဲ့သော မြန်မာဘာသာစကားတို့ကို ဘာသာဗေဒ အခြေခံကဏ္ဍ(၃)ခုမှ သမိုင်းဘာသာဗေဒနည်းဖြင့် လေ့လာတင်ပြသွား မည်ဖြစ်ပါသည်။ ဤသို့လေ့လာခြင်းဖြင့် မြန်မာဘာသာ စကားများ၏ ခေတ်စဉ်အလိုက် ပြောင်းလဲပုံသဘောကို သိရှိနိုင်မည်ဖြစ်ပါသည်။

နိဒါန်း

လူတစ်ဦးနှင့်တစ်ဦး ဆက်သွယ်ရာတွင် ဘာသာစကားသည် အကောင်းဆုံးနှင့်အထိရောက်ဆုံး၊ အထက်မြက်ဆုံးဖြစ်ပါသည်။ ဘာသာစကားကိုအခြေခံ၍ လူ့ယဉ်ကျေးမှုကို ထိန်းသိမ်းပေးနိုင်သည့်အပြင် တိုးတက်အောင်လည်း စွမ်းဆောင်နိုင်ပါသည်။ ထို့ပြင် ဘာသာစကားသည် ပြောင်းလဲ တတ်သည့်သဘောလည်း ရှိပါသည်။ ထို့ကြောင့် ဤသုတေသန စာတမ်းတွင်ပုဂံခေတ်မှ မျက်မှောက်ခေတ်အထိ တစ်ခေတ်မှတစ်ခေတ်သို့ ဘာသာစကား၏ စကားသံများ၊ စကားလုံးအဓိပ္ပာယ်များ၊ စကားလုံးဖွဲ့ထုံးများ ပြောင်းလဲပုံကို လေ့လာတင်ပြ သွားမည်ဖြစ်ပါသည်။

မြန်မာဘာသာစကား၏ တိုးတက်ပြောင်းလဲပုံအစဉ်ကို သမိုင်းဘာသာဗေဒနည်းဖြင့် လေ့လာခြင်း

၂၀ရာစုမတိုင်မီအထိ ဘာသာစကားကို သမရိုးကျအစဉ်အလာနည်းအတိုင်း လေ့လာခဲ့ကြ သည်။ ၂၀ရာစုဝန်းကျင်တွင် ဘာသာဗေဒပညာရှင်များက ဘာသာစကားကို သိပ္ပံနည်းကျကျ သရုပ်ဖော်ရာ၌ အပြောဘာသာစကား (Spoken Language) သို့မဟုတ် အရေးဘာသာစကား (Written Language) တို့တွင် ရှိသောအချက်အလက်များ ယထာဘူတကျကျ လျော်ကန်သင့်မြတ်သော နည်းစနစ်များကိုသီအိုရီများ နှင့်စိစစ်၍ဖွင့်ဆိုခဲ့ကြသည်။

ဘာသာစကားကိုဘာသာဗေဒပညာရှင်များက

A system of arbitrary vocal symbols

စနစ်တကျဖွဲ့စည်းထားသောစိတ်ကူးစိတ်သန်းသက်သက်မျှသာဖြစ်သည့်စကား သံသင်္ကေတများ[၂]

ဟုဆိုထားပါသည်။ ထို့ကြောင့်ဘာသာစကားသည်စနစ်တကျဖွဲ့စည်းထားခြင်း၊ စိတ်ကူးစိတ်သန်းဖြင့် တီထွင်ထားခြင်း၊ ထိုတီထွင်ချက်တို့သည် စကားသံသင်္ကေတတို့ဖြစ်ခြင်း ဟူသော သဘောတို့ကို တွေ့ရပါသည်။

ဘာသာဗေဒတွင်အခြေခံကဏ္ဍ(၃)ခုရှိပါသည်။ ၎င်းတို့မှာ

(၁) သရုပ်ဖော်ဘာသာဗေဒ (Descriptive Linguistics)

(၂) သမိုင်းဘာသာဗေဒ (Historical Linguistics)

(၃) အနှိုင်းဘာသာဗေဒ (Comparative Linguistics)

တို့ဖြစ်ပါသည်။

သရုပ်ဖော်ဘာသာဗေဒသည် သတ်မှတ်ပိုင်းခြားထားသည့် အချိန်ကာလအတွင်းရှိဘာသာ စကားများကို ဘာသာဗေဒနည်းဖြင့် သရုပ်ဖော်စိစစ်ဖော်ထုတ်ခြင်းဖြစ်သည်။

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[၁] တွဲဖက်ပါမောက္ခ၊ဒေါက်တာ၊ မြန်မာစာဌာန၊ ရွှေဘိုတက္ကသိုလ်။

[၂] မြန်မာစာဌာန၊ ၁၉၉၇၊ ၁၆။

သမိုင်းဘာသာဗေဒသည်ဘာသာစကားများ တစ်ခေတ်မှတစ်ခေတ် မည်သို့မည်ပုံ ပြောင်းလဲသည်ကို လေ့လာခြင်းဖြစ်သည်။

အနှိုင်းဘာသာဗေဒသည်မျိုးတူဘာသာစကားနှင့်မျိုးမတူဘာသာစကားတို့ကိုဘာသာစကားနှစ်ခုသို့မဟုတ် ဘာသာစကားအများကိုနှိုင်းယှဉ်လေ့လာခြင်းဖြစ်ပါသည်။

ဘာသာစကားသည်အချိန်အလိုက်၊ နေရာအလိုက်ပြောင်းလဲတတ်သည့်သဘောရှိပါသည်။ သစ်ပင်၊ တိရစ္ဆာန်စသည်တို့၏ အဆင့်ဆင့်ပြောင်းလဲမှုသည် နှစ်ပေါင်းသန်းချီကြာမှ ထင်ရှားတတ်သော်လည်း ဘာသာစကားပြောင်းလဲမှုသည်နှစ်ပေါင်းတစ်ထောင်၊ တစ်ရာအတွင်း၌ ထင်ရှားတတ်သည်ကို တွေ့ရပါသည်။ ထိုသို့ပြောင်းလဲရာတွင်အဓိကပြောင်းလဲမှု(၃)မျိုးတွေ့နိုင်ပါသည်။ ယင်း တို့မှာ

(၁) အသံပြောင်းမှု/အသံထွက်ပြောင်းမှု

(၂) အဓိပ္ပာယ်ပြောင်းမှု

(၃) သဒ္ဒါပြောင်းမှု[၁]

တို့ဖြစ်ပါသည်။

(၁) အသံပြောင်းမှု/အသံထွက်ပြောင်းမှု

အသံပြောင်းမှုသည်အသံထွက်ပြောင်းလဲမှုပင်ဖြစ်ပါသည်။ အသံထွက်သည်အချိန် ကာလကို လိုက်၍ တရွေ့ရွေ့ပြောင်းလဲတတ်သည့်သဘောရှိပါသည်။ ထိုသို့ပြောင်းလဲမှုကြောင့်စကားသံတို့၏ မူလအသံပုံသဏ္ဌာန်အသစ်အဖြစ် ဖြစ်ပေါ်လာပါသည်။

မျက်မှောက်ခေတ်တွင် “ချီ”ဟူသောအသုံးကိုပုဂံခေတ်က “ခ်ိ”ဟု သုံးထားကြောင်း တွေ့ရပါ သည်။ သာဓက–

စာရိယ်သကာစခ်ိပုဉီတေ[၂]

ဖုန်သည်အသင်္ချာမင်ပန်ရကာပျံခ်ိသာလေပုကံရောက်၏[၃]

ပုဂံရောက်ရကာဖုန်သည်အသင်္ချာပျံခ်ိသာကျွောန်ရသတေ။[၄]

ထို့အတူပင်းယခေတ်တွင်လည်း ဤကဲ့သို့သုံးစွဲကြောင်း တွေ့ရပါသည်။သာဓက–

ခ်ိပင်ပါသသူကာ အကွ္လိုဝ် ထပ်တူရစိယ်သတေ။[၅]

ဤကောင်းမှုကိုခ်ိပင်ပါသသူကာငါနှင့်အတူရစပါစေသတေ။[၆]

အင်းဝခေတ်တွင်မူ “ခ်ိ”အစား “ခိ”ဟူ၍ ရေးထုံးပြောင်းလဲသုံးစွဲနေကြောင်း တွေ့ရသည်။

သာဓက–

တြာဖျာဆင့်ဖွသို့ဝင်သည် မွှောက်ဘက်ပြည်ကိုဝ်ရလတ်သောခါ ကွ္ယ်ဩက်စခိ တိုဝ် တန္ခိုဝ်သမွှေကိုဝ်[၇]

ငကျွောင်နှိုက်မွှေ ၁၀၀၀ ကိုဝ် ခိပင်သာသူလျှင်[၈]

တောင်ငူခေတ်တွင်မျက်မှောက်ခေတ်၌သုံးစွဲနေသည့် “ချီ”အသုံးကိုသုံးနှုန်းနေပြီဖြစ်ကြောင်း တွေ့ရပါသည်။ သာဓက–

ဟုတ်တည်ဟူ၍ စစ်ချီလေပိုဝ်[၉]

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[၁] ထွန်းမြင့်၊ဦး၊ ၁၉၉၅၊ ၂၀။

[၂] ဇမောင်၊ဦး၊ ၁၉၅၈၊ ၁၀၉။

[၃] –ယင်း–၊ ၁၁၃။

[၄] –ယင်း–။

[၅] ငြိမ်းမောင်၊ဦး၊ ၁၉၈၃၊ ၃၂၀။

[၆] –ယင်း–၊ ၃၄၇။

[၇] –ယင်း–၊ ၁၈၄။

[၈] –ယင်း–၊ ၂၁၄။

[၉] ငြိမ်းမောင်၊ဦး၊ ၁၉၉၈၊ ၁၃၃။

ငါကဲသို့ဝ်သာသနာငါထောင်ကိုချီပင်အသူကာငါနှင့်အမျှရစေသော[၁]

ထို့ကြောင့်မျက်မှောက်ခေတ် "ချီ"အသုံးကိုပုဂံခေတ်၊ ပင်းယခေတ်တို့တွင် "ခီ"ဟု သုံးနှုန်း သော်လည်း အင်းဝခေတ်တွင်မူ "ခိ"ဟု ပြောင်းလဲသုံးနှုန်းနေကြောင်း တောင်ငူခေတ်မှစတင်ကာ ယနေ့ခေတ်သုံး "ချိ"ဟူသောအသုံးသို့သုံးနှုန်းခဲ့ကြောင်း တွေ့ရပါသည်။ "ခီ" မှ "ခိ"၊ "ခိ" မှ "ချိ"ဟူ၍ အသံပြောင်းလဲမှု သဘောကိုသိမြင်လာပါသည်။

တစ်ဖန်မျက်မှောက်ခေတ်၌ "သော"ဟူသောအသုံးကိုပုဂံခေတ်က "သ"ဟူသော အသံထွက်ဖြင့် သုံးစွဲ နေကြောင်း တွေ့ရပါသည်။သာဓက–

ဖျက်ဆီသသုန္ဒိက်ရောက်စေသတေ။[၂]
ဤယ်ငါလွတ်သကျွန်ကိုဖျက်ဆီသသူကာအဝီစိယ်ကာ
အထက်အယင်ကာသြက်ဖွစ်စိယ်[၃]

ပင်းယခေတ်တွင်လည်း"သ"အသုံးကိုပင်အသုံးပြုနေဆဲဖြစ်ကြောင်း တွေ့ရပါသည်။ သာဓက–

ငါအလူဇထိပါသသူကာအပ္ပစ်ယှစ်ပါတန်ဆဲပါအပဲလေလာပါစေသတည်။[၄]
ဤလူလက်ထက်လေချဲသာဟူသည်အတည်ဟိရုယ်သာသနာကိုဝ် ခီပင်ပါရသ
ကိုဝ်ဖွစ်စိယ်ကုန်သတေ။[၅]

အင်းဝခေတ်တွင်မူ "သ" အသုံးသာမက "သာ" နှင့် "သော" ကိုပါသုံးနေပြီဖြစ်ကြောင်း တွေ့ရပါ သည်။သာဓက–

မဟာဓမ္မရာဇာဓိပတိမည်တော်ဟိသမင်း[၆]
အစည်တစိုက်မကွာကြသော ကြာစကာတိုဝ် ကိုဝ်မှတ်တော်မူလျက်
အဆက်ဆက်
သာသသီရာတွင်မကွာမကွေအဆွေစင်စစ်သမီတော်ချစ်နှင်နှင်ဖြစ်စေချင်သာဆု
တောင်ပတ္ထနာတော် ဟိသာအာဖြင်[၇]
ရွှေဖြင်ပြုသော၊ ငွေနေရာလှ်ခင်သော၊ ရတနာပိမုန်ထက်နေသောဆန်ကြဲသော
ပုဆိုလဲ့ဝတ်သော၊ဆန်ကြဲသောပန်လှ်ပန်သော[၈]

အထက်ပါသာဓကတို့ကိုကြည့်ခြင်းအားဖြင့် ပုဂံခေတ်၊ ပင်းယခေတ်တို့တွင် "သော"အစား "သ"ကို သုံးကြောင်း တွေ့ရပါသည်။ အင်းဝခေတ်တွင် "သ"အသုံးနည်း၍ ယင်းအစား "သာ"နှင့် "သော"ကို ပြောဆိုသုံးစွဲနေပြီဖြစ်ပါသည်။ "သာ" အသုံးမှာကျောက်စာ တွင်ကာရန်ကို လိုက်၍ သုံး ခြင်းဖြစ် ဟန်တူပါသည်။ အင်းဝခေတ်တွင် မျက်မှောက်ခေတ်သုံး "သော"အသုံးကိုမူအများဆုံး သုံးနေ ပြီဖြစ်ပေသည်။ ဤသို့ဖြင့် "သ"မှ "သာ"၊"သော" သို့ပြောင်းလဲလာသောမြန်မာဘာသာစကား၏ အသံပြောင်းလဲမှုတစ်ရပ်ကိုတွေ့ရပါသည်။

ထို့ပြင်မျက်မှောက်ခေတ်၌ "ချိန်"ဟူသောအသုံးကိုပုဂံခေတ်က "ခိန်"ဟု သုံးခဲ့ကြောင်း လေ့လာ တွေ့ရှိရပါသည်။ သာဓက–

ငယ် ၅၀ ဆာယ်လေခိန်အံ့။[၉]
အပေါင်ကျွန် ၁၁ ယောက်၊ အဖိုဝ်ငယ် ၃၃၀ ခိန်ပိယ်စအ်။[၁၀]

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[၁] –ယင်း–၊ ၁၃၄။
[၂] စမောင်ဦး၊ ၁၉၅၈၊ ၅၅။
[၃] –ယင်း–၊ ၁၂၁။
[၄] ငြိမ်းမောင်ဦး၊ ၁၉၉၈၊ ၃၄။
[၅] –ယင်း–၊ ၄၅။
[၆] –ယင်း–၊ ၉၂။
[၇] ငြိမ်းမောင်ဦး၊ ၁၉၉၈၊ ၉၃။
[၈] –ယင်း–၊ ၁၀၃။
[၉] စမောင်ဦး၊ ၁၉၅၈၊ ၁၂၉။
[၁၀] –ယင်း–၊ ၇၀။

ပင်းယခေတ်တွင် “ခိန်” ဟူသောအသုံးကိုသက္ကရာဇ် ၆၈၇ ခုနှစ်တွင် ရေးထိုးသောငွေနှစ်ဘုရား ကျောက်စာ၌သာ

ငယ်ခိန်သောသံပျင်ရန် ကောင်ဖိုဝ် ၁ ကွပ်။[၁]

ဟုသုံးထားသည်ကိုတွေ့ရပါသည်။ ပင်းယခေတ်ထိုး အခြားကျောက်စာတို့တွင်

သံပျင်ကလန် ၇ ယောက်ကိုဝ် ငယ် ၃၀။[၂]

တ်စိန္ဒိယ် ၁၅၀ အဖိုဝ်ကာ ငယ် ၄၀၀။[၃]

မဟာကဿပယ် သန္ဓိယ် ၄၀၀ သဖိုဝ်ငယ် ၆၀၀။[၄]

ဟူ၍ “ခိန်” အသုံးမပါဘဲ ရေးသားခဲ့ကြသည်ကိုတွေ့ရပါသည်။

ဤသည်ကိုကြည့်ခြင်းဖြင့်မြန်မာဘာသာစကား၏
အသံထွက်တို့သည်အချိန်ကာလကိုလိုက်၍ပြောင်းလဲသည်သာမကအသုံးနည်းသွားခြင်း၊
ကွယ်ပျောက်သွားခြင်းတို့လည်း ရှိကြောင်း တွေ့ရပါသည်။
တစ်ဖန်မျက်မှောက်ခေတ်တွင် “ရှိ”ဟူသောအသုံးကိုပုဂံခေတ်တွင် “ဟိ”ဟု သုံးခဲ့ကြောင်း တွေ့ရပါသည်။ သာဓက–

ကွေ်ာင်ပြောက်ဟိသောကျွန် ၁၅ ယောက်။[၅]

သွီင် ကုလာပါကိုဝ်လှုသကာ ကြည်စင်နှိုက်ဟိသောဥယန်တရပ် ၅ ပဲဟိ။[၆]

ပင်းယခေတ်တွင်လည်း “ဟိ”အသုံးကိုတွေ့ရပါသည်။ သာဓက–

လောဟကုမ္ဘီဝေတ္တရဏီစသော ငရဲမျာစွာဟိ၏[၇]

ပုရွာသင်ပုတ်လဲသန်လေဟိ၏ လောဟူရကာ။[၈]

အင်းဝခေတ်တွင်လည်း “ဟိ”ကိုပင်ဆက်လက်သုံးစွဲနေသည်ကိုတွေ့ရပါသည်။ သာဓက–

ဝံပဲငယ်မြေထန်ပေါက်ငယ်လေညည်ဟိ၏။ မင်ကျည်စောက်ပယ်သုံမ်တွင်ဟိ၏။
ကြက်မျာ ဝယ်လေ ပယ်ဟိစအ်[၉]

“ဟိ”အသုံးသည်ညောင်ရမ်းခေတ်တိုင်သုံးနှုန်းနေသည်ကိုတွေ့နိုင်ပါသည်။သာဓက–

ကွန္ဒနီလာအဆင်ဟိသဝ်ချဝ်မွတ်ပြေပြစ်သဝ် ကြီလှုစွသဝ် အလျာအနံ်ဟိသဝ်။[၁၀]

ထို့ကြောင့် “ဟိ”အသုံးကိုလေ့လာကြည့်လျှင် ပုဂံခေတ်မှညောင်ရမ်းခေတ်တိုင်အောင် ပြောဆိုသုံးနှုန်းနေသည်ကိုတွေ့ရပါသည်။ ခေတ်ကာလကြာရှည်သည် အထိသုံးစွဲနေသော အသံထွက်တစ်ခုအဖြစ်သိရှိနိုင်ပါသည်။

ဤသို့ဖြင့်အသံပြောင်းမှု/ အသံထွက်ပြောင်းမှုတို့ကို လေ့လာကြည့်လျှင်မြန်မာစကားသံတို့သည်အချိန်ကာလကိုလိုက်၍ပြောင်းလဲသွားကြောင်း တွေ့နိုင်ပါသည်။ “ခိ” မှ “ချိ”၊ “သ”မှ “သော”၊ “ခိန်” မှ “ချိန်” သို့ပြောင်းလဲလာသောအသံထွက်တို့သည်တစ်ခေတ်မှတစ်ခေတ်ပြောင်းသည်နှင့်အမျှ ၄င်းအသံထွက်တို့သည်လည်း ပြောင်းလဲခဲ့ပါသည်။ “ဟိ” စကားသံမှာမူခေတ်ကာလ ကြာမြင့်စွာမပြောင်းလဲဘဲသုံးနှုန်း ပြောဆိုနေသောစကားသံတစ်ခုအဖြစ်သိမှတ်ရပါသည်။ မည်သို့ပင်ဖြစ်စေ

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[၁] ငြိမ်းမောင်ဦး၊ ၁၉၈၃၊ ၃၀၄။
[၂]–ယင်း–၊ ၂၅၇။
[၃]–ယင်း–၊ ၂၆၈။
[၄] ငြိမ်းမောင်ဦး၊ ၁၉၈၃၊ ၂၆၉။
[၅]–ယင်း–၊ ၃၇။
[၆]–ယင်း–၊ ၃၈။
[၇]–ယင်း–၊ ၂၅၃။
[၈]–ယင်း–၊ ၂၉၅။
[၉] ငြိမ်းမောင်ဦး၊ ၁၉၉၈၊ ၄၂။
[၁၀]–ယင်း–၊ ၁၄၃။

မြန်မာစကားသံတို့သည် အချိန်ကာလကိုလိုက်၍ ပြောင်းလဲတတ်သောသဘောရှိကြောင်း သိရှိမှတ်သားရပါသည်။

မြန်မာဘာသာစကားရှိ စကားသံတို့သည် အချိန်ကာလကိုလိုက်၍ ပြောင်းလဲတတ်သကဲ့သို့ ခေတ်တစ်ခေတ်အတွင်းမှာပင်ပြောင်းလဲသုံးနှုန်းနေကြောင်း တွေ့ရပါသည်။ သာဓက–

'ကိုကြီး' ကို 'ကွီး'
'ညီလေး' ကို 'ညေး'
'ညီမလေး' ကို 'ညလေး'
'ကလေး' ကို 'ခေး'
'မမ' ကို 'မတ်မတ်'
'သမီး' ကို 'မွီး'

ဟူ၍ပြောဆိုရေးသားခြင်းမျိုးဖြစ်ပါသည်။

(၂) အဓိပ္ပာယ်ပြောင်းမှု

အဓိပ္ပာယ်ပြောင်းမှုဆိုသည်မှာအချိန်ကာလကို လိုက်၍စကားလုံးတို့၏ အဓိပ္ပာယ်ပြောင်းသွားခြင်းမျိုးဖြစ်ပါသည်။

မျက်မှောက်ခေတ်တွင် "ညံ"၏ အဓိပ္ပာယ်သည်အသံများ "ဆူညံသည်"ဟူသော အဓိပ္ပာယ်ရှိကြောင်း တွေ့ရပါသည်။သာဓက–

အောင်မောင်းတဒူဒူနဲ့၊ ညံ့ဆူဆူအောင်သံကြွေး ရဲသွေးကပွား[၁]

ကုန်းဘောင်ခေတ်တွင် "ညံ့"၏ အဓိပ္ပာယ်ကို

တောကြီးဆိတ်ညံ့၊ ဆီးကျဲကျဲတည့်[၂]

ဟုလည်းကောင်း၊

ဆိတ်ညံ့စွာသော၌တောအရပ်၌အကျွန်ုပ်၏ သားငယ်သမီးငယ်တို့ကိုခြေသို့၊
ဆင်၊ ကျား သားရဲတို့စားလေကုန်သလော[၃]

ဟုလည်းကောင်း တွေ့ရပါသည်။တိတ်ဆိတ်သည်၊ ငြိမ်သက်သည်ဟူသော အနက်အဓိပ္ပာယ်ဖြင့် သုံးထားခြင်းဖြစ်သည်။ မျက်မှောက်ခေတ်တွင် သုံးသောအဓိပ္ပာယ်နှင့် ကုန်းဘောင်ခေတ်တွင် သုံးသော အဓိပ္ပာယ်တို့မှာဆန့်ကျင်ဘက်အနက်ဖြင့်ပြောင်းလဲသွားသည်ကိုတွေ့ရပါသည်။

ထို့ပြင်အဓိပ္ပာယ်ပြောင်းလဲမှုနှင့်ပတ်သက်၍ဆရာကြီး ဦးထွန်းမြင့်၏ ဖော်ပြချက်တွင် ပုဂံခေတ်က **"သူငယ်တော်"၏ အဓိပ္ပာယ်မှာ"မင်းညီမင်းသားများနှင့်အတူ ကစားရသည့်ကစားဖော်ကစား ဖက်"**[၄] ဟူ၍ဖြစ်သည်။ ကုန်းဘောင်ခေတ်တွင်မူ **"နန်းတွင်းရှိအညစ်အကြေးတို့ကို သုတ်သင်သန့်စင် ပေးရသူ"**[၅] ဟူသော အနက်ရှိကြောင်း ဖော်ပြထားသည်။

တစ်ဖန် "ဝမ်းပျက်"ဟူသောအသုံးကိုညောင်ရမ်းခေတ်တွင် **"မင်းကြီးလည်း သတို့သမီးကို မြင်တော်မူသော်ဘုန်းမဆုံးသည်ဖြစ်၍နားကျယ်နှင့် ဝမ်းပျက်လိလိဟု မိန့်တော်မူသည်"**[၆] ဟူ၍ တွေ့ရပါသည်။ ဤတွင် "ဝမ်းပျက်"ဟူသော အသုံးမှာ "စိတ်ကုန်၊ စိတ်ပျက်"ဟူသော အဓိပ္ပာယ်ဖြင့် သုံးစွဲထားသည်ကိုတွေ့

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[၁] မြန်မာစာဌာန၊ ၁၉၈၈၊ ၃၈။
[၂] မြန်မာစာဌာန၊ ၁၉၈၅၊ ၁၉။
[၃] ဩဘာသဦး(မင်းပူး)၊ ၁၉၆၄၊ ၂၃။
[၄] ထွန်းမြင့်ဦး၊ ၁၉၉၅၊ ၂၁။
[၅] –ယင်း–။
[၆] ကုလားဦး၊ ၂၀၀၆၊ ၂၀၈။

ရပါသည်။ မျက်မှောက်ခေတ်တွင်မူ "ဝမ်းပျက်"ဟူသောအသုံးမှာ "ကျင်ကြီးစွန့်ရာတွင် ပုံမှန်ထက်ပိုမို လွန်ကဲသည်" ဟူသောအဓိပ္ပာယ်ဖြင့်သုံးစွဲနေကြောင်း တွေ့ရပါသည်။

စကားလုံးတို့၏ အဓိပ္ပာယ်ပြောင်းလဲမှုသည် တစ်ခေတ်မှတစ်ခေတ်သို့ ကူးပြောင်းမှသာ ပြောင်းလဲသည် မဟုတ်ပေ။ မျက်မှောက်ခေတ်တစ်ခေတ်တည်းမှာပင်အဓိပ္ပာယ်များ ပြောင်းလဲလေ့ရှိသည်ကိုလည်း တွေ့ရပါသည်။ သာဓက–

'ကောင်းသည်၊ နှစ်သက်သည်၊ချောသည်၊ လှသည်' ကို 'မိုက်တယ်၊ လန်းတယ်၊ လန်ထွက်နေတာပဲ'
'စိတ်ဝင်စားမိသည်၊ ချစ်သည်၊ ကြိုက်သည်' ကို 'ကြွေပြီ၊ ကြွေနေပြီ'
'အဆင်မပြေဖြစ်အောင်စကားဖြင့်ကျီစယ်နောက်ပြောင်သည်' ကို 'ဂျင်းထည့်'
'ငွေကြေးပေါများသည်' ကို 'ရေလျှံ'
'ငွေကြေးမရှိဖြစ်သည်' ကို 'ရေခန်း'
'ငွေတစ်သိန်း၊ နှစ်သိန်း' ကို 'တစ်ပုံး၊ နှစ်ပုံး'
'ငွေတစ်သောင်း၊ နှစ်သောင်း' ကို 'တစ်ပုလင်း၊ နှစ်ပုလင်း'
'နေရာတကာ ဝင်ရောက်စွက်ဖက်သူ' ကို 'ငပွကြီး၊ ပွကြီး'
'မျက်နှာထားခပ်တည်တည်နေသည်၊ မာကျောသည်' ကို 'ခပ်ချေချေ'
'စိတ်ထဲတွင်မကျေမနပ်ဖြစ်သည်' ကို 'တင်းတယ်'
'သူတစ်ပါး ထိခိုက်နစ်နာအောင်ပြုမူပြောဆိုသည်' ကို 'ဖဲ့'

ဟူ၍ပြောဆိုသုံးနှုန်းနေသည်ကိုတွေ့ရပါသည်။

အထက်ပါသာဓကတို့ကို ကြည့်ခြင်းဖြင့်စကားလုံးတို့၏ အဓိပ္ပာယ်သည်ခေတ်ကာလကိုလိုက်၍ ပြောင်းလဲသည်သာမက ခေတ်တစ်ခေတ်တည်းအတွင်းမှာပင် ပြောင်းလဲလေ့ရှိသည်ကို တွေ့ရပါသည်။ မျက်မှောက်ခေတ်တစ်ခေတ်တည်းတွင် ပြောင်းလဲရာ၌စကားလုံးတို့၏ ပင်ကိုအဓိပ္ပာယ် အပြင် အဓိပ္ပာယ်အသစ်ကိုပါထည့်သွင်းပြောင်းလဲ၍ပြောဆိုသုံးနှုန်းနေသည်ကိုတွေ့ရပါသည်။

(၃) သဒ္ဒါပြောင်းမှု

သဒ္ဒါပြောင်းမှုဆိုသည်မှာစကားလုံး၊ ပုဒ်၊ ဝါကျခွဲ၊ ဝါကျဟူ၍ သဒ္ဒါဖွဲ့စည်းမှု အဆင့်ဆင့် တွင်ရှိသော သဒ္ဒါစည်းကမ်းများ ပြောင်းလဲမှုကိုဆိုလိုပါသည်။

"သော"ဟူသော ဝိဘတ်သည် ပုဂံခေတ်ကနာမ်အထူးပြု၊ ကြိယာအထူးပြု၊ ဝိဘတ်အနေဖြင့် အသုံးပြုခဲ့သည်ကိုတွေ့ရပါသည်။ သာဓက–

ထိုဝ်မင်ကြီကာအရပ်လိယ်မျက်နှာရှိက်အာရိုက်ရန်ခပွင်<u>သော</u>နိုင်ငံစွာ<u>သော</u>ဖွစ်၏။[၁]
သစ်မထီကွောင်နှိုက်ပုရာတြာသဃ်ာရတနာသုံပါ အာလှူ<u>သော</u>[၂]
ဤမြ<u>သော</u>ငါကျွန်ုငါလယ်ခပ်သိမ်းကာ ငါကွောင်တဝ် နှိုက်ဟိ<u>သော</u>ပုရာ တရာ သဃ်ာရတနာသုံပါ<u>သော</u> ကိုဝ်လျှင် ငါလှူသတေ။[၃]

မျက်မှောက်ခေတ်တွင်မူ "သော" ကို နာမ်အထူးပြုဝိဘတ်၊ နာမဝိသေသန ပုဒ်ပြောင်းပစ္စည်းအဖြစ် သာသုံးသည်ကိုတွေ့ရပါသည်။

ထို့ပြင်မျက်မှောက်ခေတ်၌ "၍"ကို ကြိယာဝိဘတ်အဖြစ် သုံးသော်လည်း ပုဂံခေတ်တွင်မူ နာမ်ဝိဘတ် အဖြစ်လည်း သုံးကြောင်း တွေ့ရပါသည်။ သာဓက–

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[၁] ဓမောင်ဦး၊ ၁၉၅၈၊ ၁၄၃။
[၂] ငြိမ်းမောင်ဦး၊ ၁၉၈၃၊ ၆၇။
[၃] ငြိမ်းမောင်ဦး၊ ၁၉၈၃၊ ၇၂။

လည်ရှယ်မျှပ်ရှယ် ထွန်နှင်ထွန်သော[၁]
လက်တန်တောင်ရှယ်ဖြတ်သော[၂]
ခြိုယ်ပုဆစ်ရှယ်ဖြတ်သော[၃]

ဟု ရေးသားထားသည်ကိုတွေ့ရပါသည်။ မျက်မှောက်ခေတ်တွင်မူ "၍"ကို နာမ်ဝိဘတ်အဖြစ် အသုံးပြုခြင်း မရှိတော့ပေ။

သဒ္ဒါပြောင်းမှုကိုလေ့လာကြည့်လျှင်ပုဒ်မှ ဝါကျခွဲ၊ ဝါကျမှ ဝါကျဖွဲ့ပုံအဆင့်တို့တွင် ပြောင်းလဲခြင်း မရှိဘဲစကားလုံးအဆင့်နှင့် စကားလုံးမှ ပုဒ်ဖွဲ့ပုံအဆင့်၌သာ ပြောင်းလဲသည်ကိုတွေ့ ရပါသည်။

ခြုံငုံသုံးသပ်ချက်

မြန်မာဘာသာစကားတို့၏ တိုးတက်ပြောင်းလဲပုံကို သမိုင်းဘာသာဗေဒနည်းဖြင့် လေ့လာ ရာတွင် ဘာသာစကား၏ ပြောင်းလဲမှု(၃)ခုဖြင့်တင်ပြထားခြင်းဖြစ်ပါသည်။ ယင်းတို့အနက် အသံ ပြောင်းမှုနှင့် အဓိပ္ပာယ်ပြောင်းမှုတို့သည် အချိန်ကိုလိုက်၍တစ်ခေတ်မှ တစ်ခေတ်သို့ ပြောင်းသည့် နည်းတူ မျက်မှောက်ခေတ်ကာလတစ်ခုတည်းအတွင်းမှာပင် ပြောင်းလဲမှု ရှိသည်ကိုတွေ့ရပါသည်။ မျက်မှောက်ခေတ်အတွင်း ပြောင်းလဲမှုတို့မှာခေတ်ကာလလူငယ်များ၏ တီထွင်ပြောဆို သုံးစွဲမှုတို့ကြောင့် ပြောင်းလဲသွားသောစကားလုံးများပင်ဖြစ်ပါသည်။ စိတ်ကူးစိတ်သန်းအခြေအနေတို့ကို အခြေခံပြီး တီထွင်ကြံဆဖန်တီး၍ ပြောဆိုသုံးနှုန်းခြင်းဖြင့် စကားသံများပြောင်းလဲခြင်းတို့ဖြစ် ပေါ်လာပါသည်။ စကားလုံးတို့၏ အနက်အဓိပ္ပာယ်တွင်မူလ အဓိပ္ပာယ်သာမက အဓိပ္ပာယ်အသစ် များပါတိုးပွားလာကြောင်း တွေ့ရပါသည်။ ဘာသာစကား ပြောင်းလဲမှု(၃)ခု အနက်အသံ ပြောင်းမှုနှင့် အဓိပ္ပာယ်ပြောင်းမှုမှာအများဆုံးနှင့်အမြန်ဆုံးပြောင်းလဲ၍ သဒ္ဒါပြောင်းမှုမှာအနည်းဆုံးနှင့်အနှေးဆုံး ပြောင်းလဲမှုဖြစ်သည်ကို တွေ့ရပါသည်။

နိဂုံး

ဤသုတေသနစာတမ်းသည် မြန်မာဘာသာစကား၏ တိုးတက်ပြောင်းလဲပုံကို သမိုင်းဘာသာ ဗေဒနည်းဖြင့်လေ့လာတင်ပြထားသည့်စာတမ်း ဖြစ်ပါသည်။ ထိုသို့လေ့လာရာတွင် ပုဂံခေတ်မှမျက်မှောက် ခေတ်တိုင်အောင် ပြောင်းလဲမှုရှိသော ဘာသာစကားတို့ကို ခေတ်စဉ်အလိုက် လေ့လာထားခြင်းဖြစ်ပါသည်။ မြန်မာဘာသာစကားသည်အချိန်၊ နေရာတို့ကိုလိုက်၍ပြောင်းလဲတတ်သည်ဖြစ်ရာဘာသာစကားတို့၏ ပြောင်းလဲမှု အစဉ်ကို လေ့လာမှုသည် မည်သည့်အခါမျှ ဆုံးခန်းတိုင်မည် မဟုတ်ပေ။ ထို့ကြောင့်ဤစာတမ်းတွင်မြန်မာဘာသာစကား၏ တိုးတက်ပြောင်းလဲမှု သဘောကိုသိမြင်စေလိုသည့်အတွက် အကျဉ်းမျှသာ လေ့လာတင်ပြထားခြင်းဖြစ်ပါသည်။

ကျမ်းကိုးစာရင်း

ကုလား၊ ဦး။ (၂၀၀၆)။ ***မဟာရာဇဝင်ကြီး၊ပထမအုပ်***(ပဉ္စမအကြိမ်)။ ရန်ကုန်၊ ရာပြည့်စာအုပ်တိုက်။

ငြိမ်းမောင်၊ဦး(ဖတ်ရှုရေးသားစီစဉ်သူ)။(၁၉၈၃)။***ရွှေဟောင်းမြန်မာကျောက်စာများ၊တတိယတွဲ***။ရန်ကုန်၊ပုံနှိပ်ရေးနှင့်စာအုပ်ထုတ်ဝေရေးလုပ်ငန်းကော်ပိုရေးရှင်း။

ငြိမ်းမောင်၊ဦး(ဖတ်ရှုရေးသားစီစဉ်သူ)။(၁၉၉၈)။***ရွှေဟောင်းမြန်မာကျောက်စာများ၊ စတုတ္ထတွဲ***။ ရန်ကုန်၊ ယဉ်ကျေးမှုဝန်ကြီးဌာန ရွှေဟောင်းသုတေသန ဦးစီးဌာန။

ငြိမ်းမောင်၊ဦး(ဖတ်ရှုရေးသားစီစဉ်သူ)။(၁၉၉၈)။***ရွှေဟောင်းမြန်မာကျောက်စာများ၊ပဉ္စမတွဲ***။ ရန်ကုန်၊ ယဉ်ကျေးမှုဝန်ကြီးဌာန ရွှေဟောင်းသုတေသနဦးစီးဌာန။

ထွန်းမြင့်၊ ဦး။(၁၉၉၅)။ ***ဘာသာဗေဒ***။ ရန်ကုန်၊ ရန်ကုန်တက္ကသိုလ်ဂျီအီးစီ(ပညာရေး)သမဝါယမလီမိတက်။

မြန်မာစာဌာန။ (၁၉၈၅)။ ***ကဗျာအထွေထွေရွေးချယ်ချက်***။ ရန်ကုန်၊ တက္ကသိုလ်ဘာသာပြန်နှင့် စာအုပ်ထုတ်ဝေရေးဌာန။

မြန်မာစာဌာန။ (၁၉၈၈)။ ***မြန်မာကဗျာရွေးချယ်ချက်***။ ရန်ကုန်၊ တက္ကသိုလ်ဘာသာပြန်နှင့် စာအုပ်ထုတ်ဝေရေးဌာန။

မြန်မာစာဌာန။ (၁၉၉၇)။ ***ဘာသာဗေဒနှင့် သဒ္ဒဗေဒဖို့ချချက်များ***။ ရန်ကုန်၊ တက္ကသိုလ်ဘာသာပြန်နှင့် စာအုပ်ထုတ်ဝေရေးဌာန။

ဧမောင်၊ ဦး(စုစည်းတင်ပြသူ)။ (၁၉၅၈)။ ***ပုဂံကျောက်စာလက်ရွေးစင် (ပထမအုပ်)***။ ရန်ကုန်၊ ပညာနန္ဒပုံနှိပ်တိုက်။

သြဘာသ၊ဦး(မင်းပူး)။ (၁၉၆၄)။ ***ဝေဿန္တရာဇာတ်တော်ကြီး***။ ရန်ကုန်၊ ဟံသာဝတီပုံနှိပ်တိုက်။

[၁] ဧမောင်၊ဦး၊ ၁၉၅၈၊ ၁၆၆။

[၂] –ယင်း–၊ ၁၆၈။

[၃] –ယင်း–။

Metadiscourse Markers in the Selected Assignments Written by Postgraduate Students at Shwebo University

Wai Mar Lwin[1], Than Than Htay[2]

Abstract

The present research aims to explore metadiscourse markers in the selected postgraduate students' assignments. The objectives of this research are to identify types of metadiscourse markers found in the postgraduate students' assignments, to examine what types of metadiscourse markers are most frequently used in the postgraduate students' assignments and to find out the postgraduate students' frequent use of matediscourse markers in writing assignments through a set of questionnaires. The theory proposed by Hyland (2005) is used to analyze the data in the selected undergraduate students' assignments. Data were collected from the written work of 53 postgraduate students at Shwebo University. In this research, types of metadiscourse markers are investigated, identified, classified and analyzed. The findings showed that more interactive resources (74%) were used than interactional resources (26%) in the selected assignments. It is likely that the writers use these markers to assist the reader to get clear interpretation and goals of their argument. In interactive resources, transitions (59%) are the most common subcategory. The remarkable result was that no endophoric markers and evidentials were found in the selected assignments. It may be assumed that the writers may not need to refer to information from other parts of the text and that they may not know the importance of the use of evidentials. The most common subcategory of interactional resources is hedges (51%). It is possible that the writers want to open their propositional information to negotiation. Another remarkable result was the absence of engagement markers in the interactional resources. It can be said that engagement markers and self - mentions are rarely used in academic writing as these markers are informal and conversational. This paper would be very useful not only for the teachers but also for the students in conducting research papers and in their writing.

Key words: metadiscourse, interactive, interactional, transitions, hedges

Introduction

Improving writing skills is a part of students' learning progress. Students have to write many types of writing: essays, letters, e-mails, summaries, etc throughout their learning programme. The quality of written work is important in their academic achievement. Students need to convey their ideas clearly in their written assignments. Moreover, writing is a kind of social interaction between writers and readers and metadiscourse is an important tool for writers to influence their readers. According to Hyland and Tse (2004), metadiscourse markers are important to designate how the texts are organized, to clarify difficult words and jargons for the readers to put into code what rhetorical acts are being performed. Therefore, students need to employ suitable metadiscourse markers in their writing so that the readers or teachers can interpret their writing.

Metadiscourse deals with the relationship between writers of the texts and their texts as well as texts' authors and their readers (Hyland, 2005). Metadiscourse markers are linguistic elements which help the writers to organize their arguments, to show their attitudes towards the text and to construct the interaction with the readers. Metadiscourse includes a list of cohesive and interpersonal features which help relate a text to its context by assisting readers to connect and interpret texts according to the discourse community (Hyland, 1998a).

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If metadiscourse markers are removed from the text, it would be less interesting and less easy to understand. Therefore, students, especially postgraduate students should be aware of metadiscourse markers when writing assignments and conducting a thesis as the final project for their master degree.

There have been many researches on metadiscourse markers of the texts. Some examples of researches on metadiscourse are “A comparison of metadiscourse markers and writing quality in adolescent written narratives" carried out by Sanford (2012) and “The metadiscourse markers in good undergraduate writers’ essays corpus” conducted by Mohamed and Rashid (2017). Similarly, the present research aims to explore the use of matadiscourse markers in the selected undergraduate students’ assignments at Shwebo University.

The objectives of the research are:

- to identify types of metadiscourse markers found in the selected postgraduate students’ assignments,
- to examine what types of metadiscourse markers are most frequently used in the postgraduate students’ assignments and
- to find out the postgraduate students’ frequent use of metadiscourse markers in writing assignments through a set of questionnaires.

Literature Review

In this section, theoretical background provided by Hyland (2005) and related researches are described.

Metadiscourse Markers

According to Chrismore (1989), derived from the Greek words for “beyond” and “discourse”, metadiscourse can be broadly defined as ‘discourse about discourse’ or as “those aspects of texts that affect the relations of authors to the readers. Hyland (2005) points out that metadiscourse reveals the writer’s awareness of the reader and his or her need for elaboration, clarification, guidance and interaction. Metadiscourse markers are words or parts of sentences that connect the writer to the readers. They help the readers organize, interpret, and evaluate the information in the text.

Hyland (2005) divided metadiscourse into interactive resources and interactional resources.

(1) Interactive Resources

According to Hyland (2005), interactive resources concern the writer's awareness of a participating audience and the ways he or she seeks to accommodate its probable knowledge, interests, rhetorical expectations and processing abilities. Those resources help writers to shape and constrain a text to meet the needs of particular readers, setting out arguments so that they will recover the writer's preferred interpretations and goals. There are five broad sub-categories:

(i) *Transition markers* help readers interpret pragmatic connections between steps in an argument. They express relationships between stretches of discourse. These markers are mainly conjunctions and involve addition *(and, furthermore, moreover, by the way, etc*.), comparisons (*similarly, likewise, in contrast, however, but, etc*.), and consequences (*thus, therefore, consequently, nevertheless, anyway, in any case, etc.*).

(ii) *Frame markers* signal text boundaries or elements of schematic text structure. Frame markers help the writers to sequence parts of the text or to internally order an argument (*first, then, next*), to label text stages (*to summarize, in sum, by way of introduction*), to announce discourse goals (*I argue here, my purpose is, there are several reasons why*), and to indicate topic shifts (*well, right, OK, now*).

(iii) *Endophoric markers* are items which point to other parts of the text or earlier materials (*see figure 2, refer to the next section, as noted above*).

(iv) *Evidentials* are expressions which guide the readers to distinguish the information of other sources from the information of the current text (*according to Y, (Y, 2012), Y states that*).

(v) *Code glosses* are expressions which supply additional information, by rephrasing, explaining or elaborating what has been said, to ensure the reader is able to recover the writer's intended meaning (*in other words, that is, this can be defined as, for example, such as,* etc.) Alternatively, they are marked off by parentheses (Hyland, 2005: 52).

(2) Interactional Resources

Hyland (2005) points out that interactional resources concern the ways writers conduct interaction by intruding and commenting on their message. The interactional resources help the writers to make his or her views explicit and to attract readers to take part in any argument of the text. There are five subcategories.

(i) *Hedges* are items which show the writer's decision to recognize alternative voices and viewpoints and so withhold complete commitment to a proposition (may, possible, perhaps, etc). Hedges emphasize the subjectivity of a position by allowing information to be presented as an opinion rather than a fact and therefore open that position to negotiation. (Hyland, 2005: 52)

(ii) *Boosters* are expressions which allow writers to close down alternatives, head off conflicting views and express their certainty in what they say (*clearly, obviously, demonstrate)*.

(iii) *Attitude markers* are items which highlight the writer's attitude to propositions. These markers convey surprise, agreement, importance, obligation, frustration, and so on. Attitude markers include attitude verbs (e.g. *agree, prefer*), sentence adverbs (*unfortunately, hopefully*) and adjectives (*appropriate, logical, remarkable*). (Hyland, 2005: 53)

(iv) *Self mentions* are expressions which refer to the extent of explicit author presence in the text in terms of first-person pronouns and possessive adjectives (*I, me, mine, exclusive, we, our, ours*).

(v) *Engagement markers* are devices that explicitly address readers, either to focus their attention or include them as participants in an argument through the use of pronouns (*you, your, inclusive we*), interjections (*by the way, you may notice*), questions, imperatives (*see, note, and consider)*, obligation modals *(must, have to, should*, etc.) and references to shared knowledge. (Hyland, 2005: 53)

The following Table 1 describes interactive and interactional metadiscourse markers.

Table 1: Interactive and Interactional Metadiscourse Markers

Category	Function	Examples
Interactive	**Help to guide the reader through the text**	**Resources**
Transitions	express relations between main clauses	in addition; but; thus; and
Frame markers	refer to discourse acts, sequences or stages	finally; to conclude; my purpose is
Endophoric markers	refer to information in other parts of the text	noted above; see fig; in section 2
Evidentials	refer to information from other texts	according to X; Z states
Code glosses	elaborate propositional meanings	namely; e.g; such as; in other words
Interactional	**Involve the reader in the text**	**Resources**
Hedges	withhold commitment and open dialogue	might; perhaps; possible; about
Boosters	emphasize certainty or close dialogue	in fact; definitely; it is clear that
Attitude markers	express writer's attitude to proposition	unfortunately; I agree; surprisingly
Self mentions	explicit reference to author (s)	I; we; my; me; our
Engagement markers	explicitly build relationship with reader	consider; note; you can see that

(Source: Hyland, 2005: 49)

Related Researches

A research entitled "A comparison of metadiscourse markers and writing quality in adolescent written narratives" was carried out by Sanford (2012). The aim of this research is to determine if a correlation exists between the number of metadiscourse markers used in written narratives and the subtest scores obtained in the Subtest 8, Story Construction, of the TOWL-3 (Hammil & Larsen, 1996). Data were collected from essays written by 69 adolescent students. Then, those data were compared to subtest scores of the Subtest 8, Story Construction, of the TOWL-3 (Hammil & Larsen, 1996). The researcher employed the theory proposed by Hyland (2005). In the study, the researcher showed that the use of metadiscourse markers and writing quality are positively correlated as high-scored essays contained more metadiscourse markers than low-scored essays. In this paper, the researcher not only analyzed the use of matadiscourse markers but also compared those data to subtest scores of the Subtest 8 while the present research explores only the use of metadiscourse markers found in the students' assignments.

Another related research is "The metadiscourse markers in good undergraduate writers' essays corpus" conducted by Mohamed and Rashid (2017). The aim of this research is to present the metadiscourse markers found in a corpus of good undergraduate writers' essays. Data were gathered from 269 Malaysian undergraduate writers' essays that got high marks in final examinations. The data were analyzed based on Hyland's model of metadiscourse (2005). The findings of that study showed that undergraduate writers used more interactive metadiscourse markers than interactional metadiscourse markers. The use of those markers is recorded as 55.9 % while that of interactional metadiscourse markers is 44.1%. This research is relatively similar to the present research.

Research Methodology

The present research focuses on the study of the use of matadiscourse markers in the selected postgraduate students' assignments at Shwebo University. The participants were 53 first year MA students majoring in English. They were asked to write an analysis of a prose passage as a written assignment. In order to get more reliable data and find how often they use metadiscourse markers in writing assignments, the questionnaire which consists of ten items was distributed to the students and the students were asked to choose one of five alternatives: I don't use them at all; I rarely use them; I occasionally use them; I use them quite often; and I always use them. The items of the questionnaire were adapted from the research by Bogdanovic and Mirovic (2018).

In order to collect data, first, their assignments were chosen. Next, metadiscourse markers (transitions, frame markers, endophoric markers, evidentials, code glosses, hedges, boosters, attitude markers, engagement markers and self-mentions) were identified and classified by using the theory of Hyland (2005). Then, the data were shown in tabular forms and figures. Finally, the data from the selected assignments were interpreted based on the data from the questionnaire.

Data Collection and Data Analysis

In collecting and analyzing the data by Hyland's (2005) theory, first of all, types of metadiscourse markers (transitions, frame markers, endophoric markers, evidentials, code glosses, hedges, boosters, attitude markers, engagement markers, self-mentions) were investigated, identified and classified. Secondly, the total number of each type was counted and their percentages were described in tables.

The following table 2 shows distribution of interactive and interactional metadiscourse markers in the selected assignments.

Table 2: Distribution of Interactive and Interactional Metadiscourse Markers in the Selected Assignments

Metadiscourse Markers	Frequency	Percentage
Interactive	639	74%
Interactional	225	26%
Total	864	100%

As seen in Table 2, the total number of interactive metadiscourse markers is 639 (74%) and that of interactional markers is 225 (26%). The percentage gap of total metadiscourse markers is over 40%.

Table 3 mentions distribution of interactive metadiscourse markers in the selected assignments.

Table 3: Distribution of Interactive Metadiscourse Markers in the Selected Assignments

Interactive Metadiscourse Markers	Frequency	Percentage
Transitions	377	59%
Frame markers	60	9%
Endophoric markers	0	0%
Evidentials	0	0%
Code glosses	202	32%
Total	639	100%

Table 3 shows that transition has the highest frequency of its use with 377 occurrences. The second highest frequency is code glosses (202) and the third one is frame markers (60). There are no endophoric markers and evidentials in the selected assignments.

Distribution of interactional metadiscourse markers in the selected assignments is described in the following table 4.

Table 4: Distribution of Interactional Metadiscourse Markers in the Selected Assignments

Interactional Metadiscourse Markers	Frequency	Percentage
Hedges	115	51%
Boosters	65	29%
Attitude markers	37	16%
Self- mentions	8	4%
Engagement markers	0	0%
Total	225	100%

According to Table 4, the highest frequency is hedges (115) while the second highest frequency is boosters (65). The third highest frequency is attitude markers (37). The frequency of self-mentions is only 8. No engagement markers are found in the selected assignments.

The following Table 5 mentions the frequent use of metadiscourse markers in writing assignments.

Table 5: The Frequent Use of Metadiscourse Markers in Writing Assignments

Metadiscourses	I don't use them at all.	I rarely use them.	I occasionally use them.	I use them quite often.	I always use them.	Total
Transitions	0%	0%	20%	57%	23%	100%
Frame Markers	0%	2%	57%	24%	17%	100%
Endophoric Markers	38%	45%	8%	4%	5%	100%
Evidentials	12%	28%	43%	4%	13%	100%
Code Glosses	0%	4%	11%	34%	51%	100%
Hedges	0%	13%	36%	23%	28%	100%
Boosters	9%	9%	13%	26%	43%	100%
Attitude Markers	7%	26%	36%	25%	6%	100%
Self-mentions	11%	6%	17%	4%	62%	100%
Engagement Markers	17%	57%	25%	11%	0%	100%

The above table 5 indicates that most of the students use transitions, attitude markers and code glosses in writing their assignments. Only 2% and 4% of the students rarely use those markers. 45% of the students rarely use endophoric markers and 38% of them do not use those markers at all. Only 5% of the students always use those markers. Evidentails are occasionally used by 43% of the students. Those markers are not used by 12% of the students at all.

Hedges and boosters are employed by most of the students while those markers are rarely employed by only a few students, 13% and 9% respectively. Over half of the students employ attitude markers. 57% of the students rarely use engagement markers. 62% of the students use self-mentions in writing assignments.

Findings and Discussion

As mentioned earlier, the present research tries to investigate the use of metadiscourse markers in the selected assignments written by postgraduate students at Shwebo University by using the theory proposed by Hyland (2005). According to data collection, it is found that the students use both interactive and interactional metadiscourse markers. The total occurrence of metadiscourse markers in the selected assignments of postgraduate students is 864. The percentage of the use of interactive metadiscourse markers (74%) is higher than that of interactional metadiscourse markers (26%). This finding is similar to the finding of Mohamed and Rashid (2017). According to Hyland (2005), interactive resources help to guide the readers through the text. Therefore, it implies that the postgraduate students have a greater tendency to use the interactive metadiscourse markers to assist and direct their readers to comprehend their messages. Moreover, the students focus more on organizing the text rather than on involving the reader in the text. This may be because of the fact that they did not get direct instruction of metadiscourse markers and its importance.

The percentages of different subcategories of interactive metadiscourse markers are shown in the following figure 1.

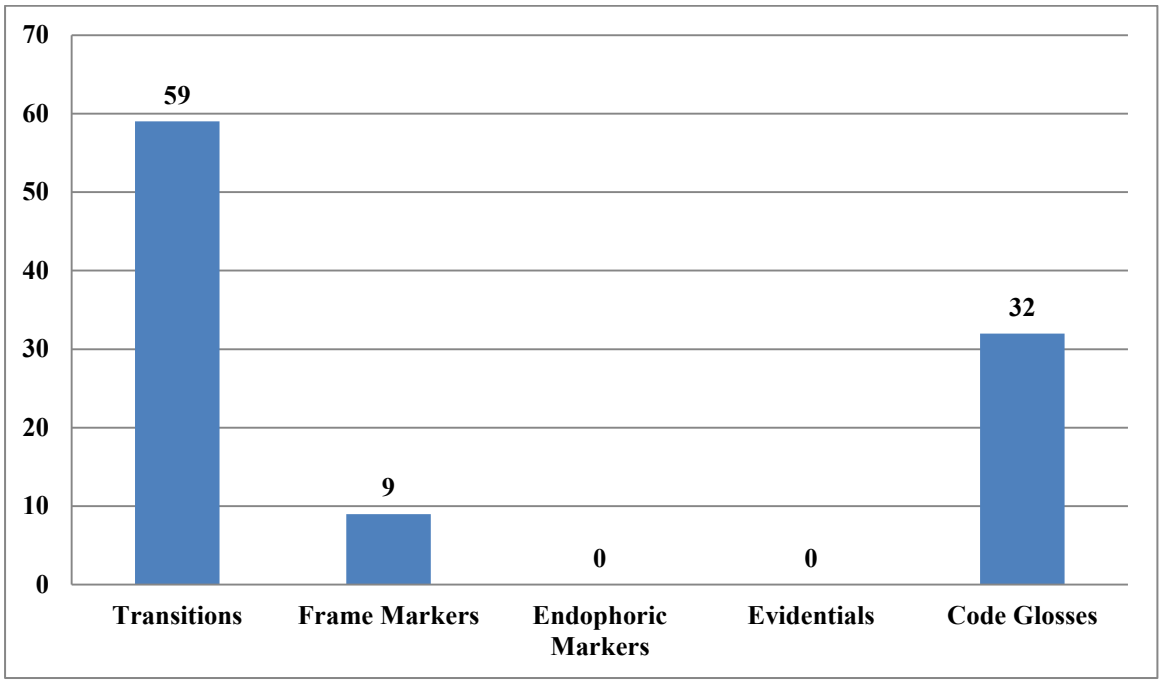

Figure 1: Percentages of Subcategories of Interactive Metadiscourse Markers

According to the figure above, the highest frequency of interactive markers is transitions (59%). The responses to the questionnaire show that 57 % of the students use transitions quite often when writing assignments. It is clear that these markers are mostly used to mark semantic relations between main clauses. Some examples of transitions used by the postgraduate students are 'because, and, therefore, etc.'

The second highest percentage is code glosses (32%) whose function is to elaborate on what the writer has just said. According to the responses to the questionnaire, 51% of the students always use code glosses to explain information for better understanding. It can be said that the students use code glosses to provide some examples of main points. Some exemplificatory markers mostly employed in the assignments are 'such as and like'.

The third highest percentage is frame markers (9%). The responses to the questionnaire point out that 57% of the students occasionally use frame markers. It is obvious that the students try to frame their proposition with the use of frame markers. Some framing devices found in the assignments are 'first, second, then, etc.'

Endophoric markers and evidentials are not used in the selected assignments. According to the questionnaires, most of the students rarely use those markers. Only a few students use those markers in writing assignments. It is also found that they did not use evidentials even where it is necessary to use in their assignments. This implies that they did not know that citation is important in academic writing as it helps the writer to persuade the readers in justifying his arguments and demonstrates the novelty of his position. No occurrence of endophoric markers may be due to the fact that the total number of words in the assignment is approximately 400 words and they may not need to refer to the other parts of the text such as sections or chapters (Hyland, 2005).

The following Figure 2 shows the percentages of sub-categories of interactional metadiscourse markers.

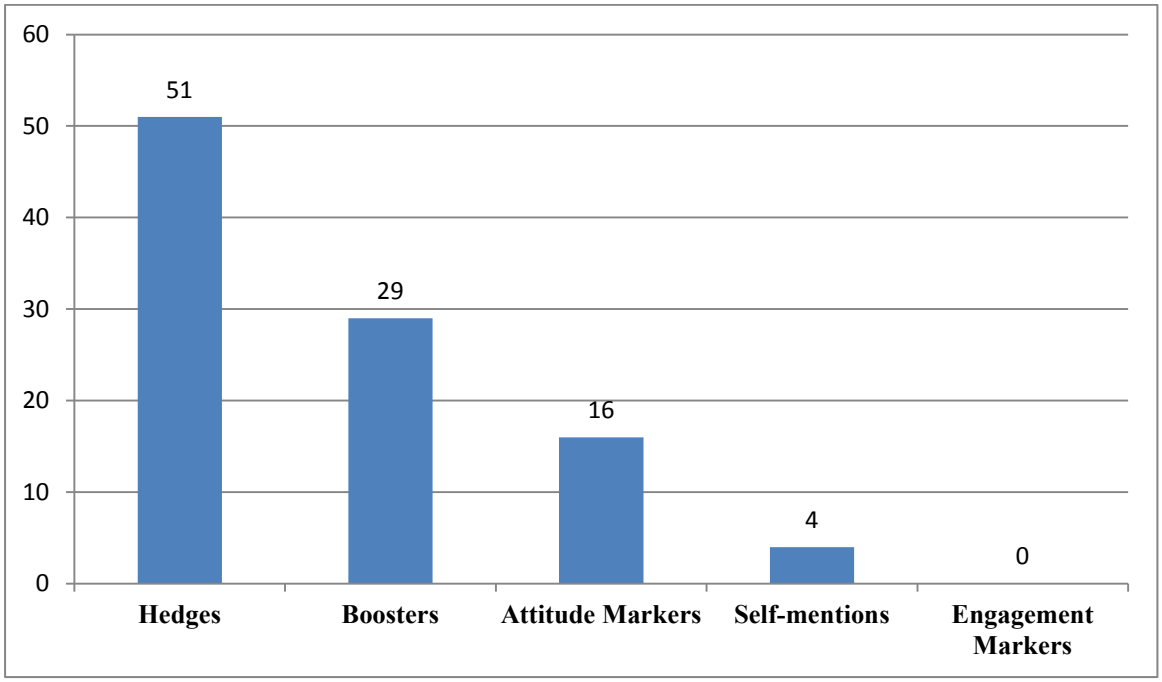

Figure 2: Percentages of Subcategories of Interactional Metadiscourse Markers

As shown in Figure (2), the highest frequently used sub-category of interactional metadiscourse markers is hedges (51%). The questionnaire indicates that 28% of the students

always use hedges and 23% of the students occasionally use those markers in their written assignments. Hedges emphasize the subjectivity of a position by allowing information to be presented as an opinion rather than a fact and therefore open that position to negotiation. (Hyland, 2005: 52) Therefore, the frequent use of hedges indicates that the students are able to present their opinions on their statements or unproven claims with the help of hedges. In this way, they can also provide the readers with the possibilities of accepting or rejecting their statements. Examples of hedges used in the assignments are 'may, can, and possible'.

The second most common used type is boosters (29%). The responses to the questionnaire show that 43% of the students always use those markers in writing their assignments. According to Hyland (2005), the use of boosters highlights the students' levels of confidence in the truth of propositions in the text. The most common boosters in the assignments are 'definitely, exactly and clearly'.

The third most common used type is attitude markers (16%). According to the questionnaire, 36% of the students occasionally use attitude markers and 25% of the students use those markers quite often in their written assignments. It may be said that some students can express their attitudes towards their statements. The frequent use of attitude markers is 'effective and important'.

Self – mentions (4%) are the fourth most common used sub-category of interactional metadiscourse markers. However, responses to the questionnaire mention that 62 % of the students always use self –mentions in their written assignments. The little use of self-mentions in the selected assignments indicates that Myanmar native academic writers usually avoid using self-mentions in their academic writing. Moreover, they may assume that this type of markers is not as useful a persuasive device as other types of markers.

The remarkable feature is the absence of engagement markers in the selected elements. According to the questionnaire, only 11% of the students use engagement marker quite often. According to Hyland (2005), engagement markers are linguistics resources employed by writers to explicitly address the readers and involve them in the dialogue. It may be said that Myanmar writers avoid explicit engagement with the readers in their academic research papers as they think that the use of these markers indicates a conversational tone.

According to the result of the study, it is found that postgraduate students at Shwebo University used more interactive metadiscourse markers in writing assignments than interactional metadiscourse markers. Hyland (2005) says that the use of interactional metadiscourse is crucial in engaging effectively the readers with the message of the text. Some scholars also point out that good writers use more interactional markers in their writing than inefficient writers. Therefore, the students need to be more aware of the importance of the international metadiscourse resources to be good writers.

It is also found that endophoric markers and evidentials are absent in the selected assignments. Those markers are also important for students, especially for postgraduate students in writing their thesis, their final project for MA degree. According to Hyland (2005), an awareness of metadiscourse helps the students to better understand the cognitive demands that texts make on readers and the ways writers can assist them to process information. Therefore, the students need more training and practice in using metadiscourse markers in order to be able to use metadiscourse effectively in their writing.

It is suggested that in order to highlight the use and functions of metadiscourse markers, the teachers should, first, ask the students to identify all examples of metadiscourse in the expert writers' texts and to discuss their functions with other students. Then, the students should be provided with some activities such as editing drafts or completing the

gapped text from which metadiscourse markers are removed. Finally, the teachers should encourage the students to create their own texts with appropriate metadiscourse markers. In this way, it is sure that the students can use metadiscourse appropriately and effectively in their writing.

Conclusion

According to the aim of the research, the use of matadiscourse markers has been explored in the selected undergraduate students' assignments at Shwebo University with the use of theoretical framework of Hyland (2005) and the questionnaire.

According to objective one, types of metadiscourse markers found in the selected postgraduate students' assignments were identified. It was found that in interactive resources, transitions, frame markers and code glosses are used in the selected assignments. Endophoric markers and evidentials are absent in the selected assignments. In interactional resources, hedges, boosters, attitude markers and self-mentions are utilized in the selected assignments. However, no engagement markers were found in the selected assignments.

Objective two tries to examine what types of metadiscourse markers are most frequently used in the postgraduate students' assignments. The findings reveal that more interactive metadiscourse markers (74%) were employed than interactional metadiscourse markers (26%) in the selected assignments. In interactive resources, the most common used subcategory is transitions (59%). One of the remarkable results is that no edophoric markers and evidentials were found. In interactional resources, hedges (51%) were most frequently used in the selected assignments. Another remarkable result is the absence of engagements markers in the selected assignments.

In order to achieve the objective three, postgraduate students' frequent use of metadiscourse markers was found out through the questionnaire. In interactive resources, most of the students use transitions, frame markers and code glosses when writing assignments. Only a few percentages of the students use endophoric markers and evidentials. In interactional resources, most of the students use hedges, boosters, attitude markers and self-mentions. They rarely use engagement markers in writing assignments.

The above results show that the students need the explicit instruction of the use of metadiscourse markers in order to improve their writing. It is hoped that this paper provides some implications not only for the teachers but also for the students to some extend as this study extends their knowledge of the use of metadiscourse markers. This knowledge can also help the learners to be more aware of the use of metadiscourse markers in their academic writing.

This research only encompassed the investigation of the use of metadiscourse markers found in the selected assignments of postgraduate students at Shwebo University. The future research should be conducted to investigate not only the use of metadiscourse markers by learners but also compare their use and their English language proficiency levels in order to know whether overuse or underuse of metadiscourse markers is related to language proficiency.

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Appendix
Questionnaire used to find out postgraduate students' frequent use of metadiscourse markers

How often do you use the following expressions when writing assignments?

1 – I don't use them at all, 2 – I rarely use them, 3 – I occasionally use them,

4 – I use them quite often, 5 – I always use them

a) Expressions that express semantic relation between main clauses and main sections in the paper (but, thus, in addition, consequently)

1 2 3 4 5

b) Expressions that refer to paper organization, express sequence, label text stages, announce discourse goals, or indicate topic shift (finally, to conclude, the purpose is, first, next)

1 2 3 4 5

c) Expressions that refer to information in other parts of the paper (noted above, see Fig., in section 2)

1 2 3 4 5

d) Expressions that refer to the source of information from other texts/papers/books (according to

X, Z 1990, Y states, as shown in [1])

1 2 3 4 5

e) Expressions that restate and explain information for better understanding (namely, e.g., such as, in other words)

1 2 3 4 5

f) Expressions that withhold your full commitment to the information (might, perhaps, possible, about, approximately, to some extent)

1 2 3 4 5

g) Expressions that emphasize your certainty in the information stated (in fact, definitely, it is clear that)

1 2 3 4 5

h) Expressions that explicitly express your attitude towards information in the paper (unfortunately, I agree, surprisingly, promising idea, important contribution)

1 2 3 4 5

i) Expressions that build relationship with the reader (consider, note that, you can see that)

1 2 3 4 5

j) Expressions that explicitly refer to you as the author (I, we, my, our)

1 2 3 4 5

Process Types of Transitivity System in the Short Story *The Nightingale and the Rose* by Oscar Wilde

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

Abstract

In this research, process types of transitivity system in the short story "The Nightingale and the Rose" written by Oscar Wilde is explored. The aim of this research is to analyse the kinds of process types frequently used by Oscar Wilde in the Short Story *The Nightingale and the Rose* and the objectives are to examine which type of process is found most and which one is found least and how they contribute to the development of the plot. The data are collected from each and every sentence of the story and analyzed by using transitivity system proposed by Halliday (1994). The findings show that there are 120 sentences in the story and the six types of process are discovered. The prominent process type is material type totalling to 163 occurrences (49.85%)followed by successively by the occurrences of relational (66 or 20.18%), verbal (45 or 13.76%), mental (28 or 8.56%), behavioral (18 or 5.50%) and existential process (7 or 2.14%). At the end of the study, it shows how the difference in using process types creates the development of the plot of the short story effectively.

Key words: process, transitivity, short story, Systematic Functional Linguistics

Introduction

Literature is defined as pieces of writing that are valued as works of art, especially novels, plays and poems. A short story is also a kind of literature. When English literature is studied, there are two main trends, namely literary approach and stylistic approach. Stylistics is the study of variation in language. Halliday concentrates exclusively on the functional part of grammar, that is, the interpretation of the grammatical patterns in terms of configurations of functions. Functional grammar can be used in analyzing literary texts because the study of the function of linguistic elements in texts is central, not only of their grammatical function, but more importantly of their function in relation to the meaning of the text. Approaching a text stylistically, one can become aware of a writer's attitude and purpose, and know whether a passage is intended to be taken seriously or not. With this idea in mind, in this research, the function of language will be examined in the short story "The Nightingale and the Rose" by Oscar Wilde in the light of Halliday's theoretical framework process types of transitivity system. The aim of this research is to analyse the kinds of process types frequently used by Oscar Wilde in the Short Story *The Nightingale and the Rose* and the objectives are to examine which type of process is found most and which one is found least and how they contribute to the development of the plot.

Literature Review

Systemic functional linguistics is beneficial to make the analysis and the interpretation of language itself. In SFL, Halliday (1985) proposed three interrelated metafunctions consisting of ideational or experiential, interpersonal and textual function to classify the various options available and choices by the speakers. He later claimed that:

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> "Language has developed in response to three kinds of social-functional need. The first is to be able to construe experience in terms of what is going on around us inside us. The second is to interact with the social world by negotiating social rules and attitudes. The third and final need is to be able to create messages with which we can package our meanings in terms of what is new or given."(Halliday, 1994)

From his statement, the ideational or experimental relates the way the language is used to express the perceptions of the world and explains how the language is used to describe 'doings' and happenings'. The interpersonal metafunction refers to language as medium for interaction, expressing attitudes and obligation. Then, the textual metafunction refers to 'the enabling function, the speaker's text-forming potential expressing the relation of language to its environment and weaving together the experimental and interpersonal meanings' (Plemenitas, 2004). Among them, only ideational function is used in this research paper.

Transitivity is part of ideational or experiential function, which concerns with the transmission of ideas. The system of transitivity specifies the different types of processes and consists of the process itself, participants in the process (e.g. actor, goal, beneficiary) and circumstances attendant on it (Plemenitas, 2004). Thus, transitivity can reveal how the writer uses the processes, participants and circumstances to depict the story.

Halliday claimed that transitivity represents process or experiences like actions, events, processes of consciousness, and relations that covers all phenomena and anything that can be expressed by a verb: event, whether physical or not, state or relations.

Processes can be used to analyze what is represented through the use of language. Processes are central to the transitivity. Processes can be subdivided into different types. There are six different processes that are identified by Halliday (1994)

(i) Material process (process of doing)
(ii) Mental process (process of sensing)
(iii) Verbal process (process of saying)
(iv) Behavioral process (process of behaving)
(v) Existential process (process of existing)
(vi) Relational process (process of being)

Those kinds of process are realized by verb. Traditionally, verbs have been defined as "doing words". But, as the above list indicates, it is very obvious that some verbs are not doing words at all, but other express agates of being or having.

(i) Material Process

Material processes are process of "doing" in the physical world. They express the notion that some entity "does" something _ which may be done "to" some other entity. In the material process, there are two participants role, namely: actor and gold.

For example;

1. The lion caught the tourist.
   (Actor) (Process) (Goal)

(ii) Mental Process

Mental process is process of sensing, feeling, thinking, and perceiving. Some processes involve not material action but phenomenon described as states of mind or psychological event. People are not always talking about concrete process if doing. They very

often talk not about what they are doing, but about what they think or feel. In the mental process, there are two participants, namely: sensor (the conscious being that is feeling, thinking, or seeing) and phenomenon (which is "sensed"- felt, thought, or seen).

Example:

1. John loves Mary.

(Sensor) (Process) (Phenomenon)

(iii) Verbal Process

Verbal process is a process of saying of symbolically signaling. Usually, three participants are involved in Verbal process: the Sayer is responsible for verbal process; the Receiver is the person at whom the verbal process is directed; and the Verbiage is the nominalised statement of the verbal process.

For example;

1. She tells me a story.

(Sayer) (Verbal process) (Receiver) (Verbiage)

From those examples above, we can conclude that "she" is called as sayer. The word "tells" is called as the mental function. The word "me" is called as receiver and the last word "a story" is called as verbiage.

(iv) Behavioral Process

Behavioral process is process of physiological and psychological behavior, like breathing, coughing, smiling, looking, watching, listening, dreaming, snoring. They are "represent outer manifestations of inner workings, the acting out of processes of consciousness and physiological states" [3].

Halliday describes the process semantically as a "half way hour" between mental and material process. It means that. The meanings they realized are midway between materials on the one hand and metals on the other. They are in part about action that has to be experienced by conscious being.

For example;

1. The old lady is breathing smoothly.
(Behavior) (Behavioral process) (Circumstance: Cause)

(v) Existential Process

Existential process represent that something exists or happens. These clauses typically have the verb be, or some other verb expressing existence, such as exist, arise, followed by a nominal group as Existent (a thing which exists in the process). The existent may be a phenomenon of any kind, and is often, in fact, an event. Circumstantial elements (particularly of location) are common in existential process.

For example:

1. There was snow on the roof.

(Existential Process) (Existent) (Circumstance: place)

(vi) Relational Process

Relational process is a process of being in the world of abstract relations. Relational process is typically realized by the verb be or some verb of the same class for examples: appear, become and seem.

Halliday "(1985: 115) says that semantically the token will be a "sign", name, form, holder or occupant of a value which gives the "meaning, referent, function, status or role "of the token. While, the token is the nominal group which contains the "name" which gives the classification. Token will always be subject in a passive clause.

For example:

1. You are very tall.
(Token) (Attributive process) (Value)
(Relative process)
2. He is a good singer.
(Carrier) (Attributive process) (Attribute)
(Relative process)

From those examples and explanation above, the relational function has four participants that are closely related to the clauses which are have analyzed. Token, Value, Carrier, Attribute are the participants and each participant has a function and position in a clause that has analyzed.

Data Collection and Data Analysis

In this study, the short story '*The Nightingale and the Rose'* by Oscar Wilde is selected as research material. The story is analyzed in the framework of the process types through transitivity system proposed by Halliday (1994). In collecting the data, the story is split into sentences and clauses. Each of these sentences is examined to determine the process type about whether it is material, mental, verbal, behavioral, existential or relational processes. The next step is counting the number of the sentences that belong to material type and other process types. Finally, by comparing the percentage of all process types, an attempt is made to determine the most frequent process type emerging in the text. Each of the processes is given a code. Material process is coded as *Ma*, Mental process as *Me*, Verbal process as *Ve*, behavioral process as *Be*, Existential process as *Ex* and relational process as *Re*. A Sample Analysis of Process Types is as follows.

Table 1: A Sample Analysis of Process Types

Sen. No.	Sentences	*Ma*	*Me*	*Ve*	*Be*	*Ex*	*Re*
1	"She **said** that she **would dance** with me if I **brought** her red roses," **cried** the young Student; "but in all my garden there **is** no red rose."	2		2		1	

The following table summarizes the processes identified according to their frequency and percentage distributions in the short story *"The Nightingale and the Rose"*.

Table 2: Types of Process Found in the Short Story "The Nightingale and the Rose"

Processes	Total	Percentage
Material process	163	49.85%
Mental process	28	8.56%
Verbal Process	45	13.76%
Behavioral Process	18	5.50%
Existential Process	7	2.14%
Relational Process	66	20.18%
Total	**327**	**100%**

The findings show that there are 120 sentences in the short story "The Nightingale and the Rose" and the six types of process are discovered. The prominent process type found in the story is material totaling to 163 occurrences (49.85%) followed successively by the occurrences of relational (66 or 20.18%), verbal (45 or 13.76%), mental (28 or 8.56%), behavioral (18 or 5.50%) and existential (7 or 2.14%).

The following figure indicates the distribution of process types in the short story*"The Nightingale and the Rose".*

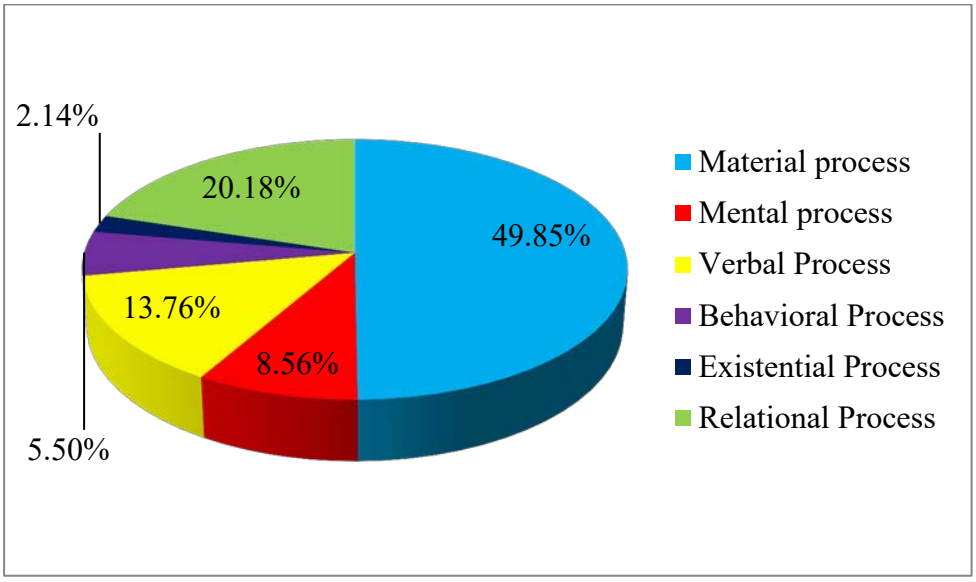

Figure 1: The distribution of process types in the short story*"The Nightingale and the Rose"*

Findings and Discussion

The transitivity analysis reveals three major processes that continually reappear through the story. The most frequently used processes are material, rational, and then verbal. This reveals a more physical nature of actions as compared to psychological revelations and conscious unravelling. The most occurring material processes entail the recurrent pattern of actions that the actors undergo and carry out. Furthermore the verbal processes represent the oral interaction and dialogue that is conducted between the sayer and recipient. When the actor undergoes an action through material processes and also reveals his state through verbal processes. Finally relational actions create links between the actions as well as the actors along with certain attributes that are associated with them. The comparative lack of mental and existential processes suggests that there is less psychological involvement in the short story. There is not much concern with the internal condition or insight of the characters.

These assumptions made by the readers may thus be more objective in nature by formulating their own opinion based on the actions portrayed through material, verbal and relational processes.

Conclusion

Oscar Wilde, a famous Irish writer and playwright, was one of the most controversial and influential artistic personalities of his time. In his lifetime, he wrote nine plays, one novel, numerous poems, short stories and essays. In this research, his short story "The Nightingale and the Rose" is analyzed in the framework of the process types through transitivity system proposed by Halliday (994). The transitivity analysis of the story indicates how the actions are performed through the use of material processes. The reader can get a clear idea from the verbal processes that describe the actions as well as revealing the situation and conditions. Furthermore this impact is strengthened by the relational processes. The physical actions are highlighted through these processes which give an outer view of the world portrayed in story. The few mental and existential processes form a vague outline leaving sufficient space for the reader to interpret on the own. In this way, the reader indulges in the mystery of imagination in order to explore the art of the writer revealed through his writing.

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Slang Words and Phrases Used in the Kyaukka Village Tracts

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Abstract

This research aims to investigate and analysethe slang words and phrases used in Kyaukka Village Tracts, to the north-east of Monywa, Sagaing Region, Upper Myanmar. The research questions are: What are the slangs used in the target area; and what are the sources that had formed the slangs? The objectives of this paper are (1) to find out the features of slangs of Kyaukka Village and (2) to analyze the influential social factors through Zhou and Fan's (2013) model. It is divided into four parts: (1) Slang terms for food (2) Slang terms for numbers (3)Everyday slangs and (4)Miscellaneous slang terms. Data were collected from interviews of the resource persons in Kyuakka region.

Key words: slang words, slang phrases, Kyaukka Village Tracts, social factors

Introduction

Slang is vocabulary that is used between people who belong to the same social group and who know each other well. Slang is very informal language. We usually use slang in speaking rather than writing. Slang, unconventional words or phrases, express something new or old in a new way. It is flippant, irreverent, indecorous; it may be indecent or obscene. Its colourful metaphors are generally directed at respectability, and it is this succinct, sometimes witty, frequently impertinent social criticism that gives slang its characteristic flavour. Maurer[4] proposes that slang includes not just words but words used in a special way in a certain social context.

Aim and Objectives

The aim of the research is to investigate and analyse the slang words and phrases used in Kyaukka Village Tracts, to the northeast of Monywa, Sagaing Region, Upper Myanmar.The objectives of the research paper are:

(1) to find out the features of slangs of Kyaukka Village and

(2) to analyze the influential social factors through Zhou and Fan's (2013) model.

Literature Review

The theoretical model used in this research is Zhou and Fan's (2013) model and then the features of slangs of Kyaukka Village, and influential social factors are discussed. Kyuakka Village is located to the north-east of Monywa, Sagaing Region. It is well noted for its local products, especially traditional handicraft like lacquer wares. The Shweguni Pagoda is very famous. Like those of Hla Taw Village famous for their use of colourful expressions, the village folks of Kyaukka also love using their own colourful slang words and phrases. A great deal slang and jargon terms are used so widely and naturally that these expressions have become a part of their everyday life. In this paper, some of the colourful expressions related to food, numbers, everyday life and miscellaneous are presented.

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Features of Slangs of Kyaukka Village

In analyzing slang words and phrases used in Kyaukka Village Tracts, to the north-east of Monywa, Sagaing Region, Upper Myanmar by Zhou and Fan's(2013) model, there are features of slangs of Kyaukka Village and they are classified into humour, conciseness, originality and instability.

A. Humour

Certain slangs of Kyaukka Village, usually shared among the men of the locality, carry a strong colour of humour. They are used as a code to be shared only among themselves, and not to be understood by the outsiders. For example, "*Myin-phyu-see-mae"* literally means: "Shall we go for a ride on the White Horse?" But its intended meaning is shared and understood only among the drunkards of the village. The word the White Horse is closely associated with the guardian spirits to whom beer and liquors are offered for propitiation. So it means, "Shall we go for a drink?"Another example is "*Gauk-yai-thwa-me".* Its literal meaning is: "Shall we go golfing?" But the story behind the expression is: There was a liquor shop run by a man named Mya Aye, who has the same name of a very famous golfer of those days. So the slang shared by the fellow drunkards means"Shall we have booze?" Another example is "**Banee-htaung**". **"Banee**" refers to a variety of red tamarind leaves tasting astringent and sour. Thus, to show one's negative attitude to a tough-nut-to-crack, he or she is referred to as ***"Banee-htaung".***Another example is " ***arr-nishar-ni"*(**red-palate, red-tongue) to say that a person chews a betel quid because chewing betel makes a red palate and a red tongue, which makes him or her look like a vampire. Another instance is"wearing sunglasses"."***Gon-ban***"means "***Myet-hman***" or sunglasses;***"Gon-ban-htithta tae"*** carries the tone of humour in that the speaker laughs at his or her friend who tries to look stylish by "wearing sunglasses".

B. Conciseness

Some slangs of Kyaukka Village are well noted for being concise since conciseness is essential for efficient communication. For instance, chili (***Nga-youk-thee or Nyouk-thee***) is referred to in a simple term: "***yè***"(red).The cause of its derivative is obvious in that when a chili is ripe, it turns deeply red.

C. Originality

The originality of a great number of the slangs of Kyaukka Village comes from the stories behind the expressions. The understanding of these expressions requires one to find out the sources so that one understands what it really means. For example, the number five is referred to as "***Ma Htwe Lay***", the name of a local fishmonger. Fish in Myanmar is "***Nga"*** (fish; five). To understand its intended meaning, one needs to think who is Ma Htwe Lay and what she does.

D. Instability

According to the nature of slangs, the expressions mostly fades out into obscurity. For example, Ohn-chan, a quarter in Monywa was formerly notorious for being a place that is rife with women of loose characters. But a new name is coined:"*Htan-bin-chan*". Ohn-bin and Htan-bin are of the same palmyra palm type. So a new code is coined. But "*Htan-bin-nyan*" is later shifted into "*Htan-bin-nyan*" and then to "*Hta-mein-nyan*".

Data Collection and Data Analysis

Slang words and phrases used in Kyaukka Village Tracts, to the northeast of Monywa, Sagaing Region, Upper Myanmar are collected and analyzed through Zhou and Fan's (2013) model. The Data are classified into four types according to Zhou and Fan's (2013) model and they are slang terms for food, slang terms for numbers, everyday slangs and miscellaneous slang terms. Then the data are interpreted into Myanmar equivalents.

(1) Slang Terms for Food in Kyaukka Village

In Kyuakka, if you partake of a meal(rice), the folk would be most likely to say "***Myauk-twin-gyi-hmu***", literally meaning "Northern well matter or case" instead. Normally, in Myanmar tradition, when you want to know if your addressee has had his lunch or dinner, your ordinary question will be "Have you had your meal(lunch or dinner)?"; however, here in this village , people say," Have you settled the northern well case?". Normally the literal translation can even drive you insane if you make an attempt to understand what the phrase really means.

Regarding "eating your meal", the jargon used by artistes or rather dramatic performers is "***Poun-tot-pyi-bi-la***?"Here'***poun'*** means 'a bucket'; 'tot' means 'fetch'or "take", meaning "Have you fetched the thing with the bucket or have you had your bucketful of stuff?"Kyuakka area is simply notorious for its scarcity of water. If you want some water,you need a bucket to fetch it from the northern public well. Then and there they use the word 'the northern well', which is a figure of speech—metonymy(a word or phrase is substituted for another with which it is closely associated; also, the rhetorical strategy of describing something indirectly by referring to things around it) implies '*poun'*(bucket)'. In this way, '***poun'*** and 'the northern well' are associated. In olden days, there used to be a big deep well northern part of Kyuakka Village.A funny local told a rib-tickling anecdote about the northern well ,which is so deep that if you look down,you can even see the nether world. Almost all village people went there to fetch water. And to carry or fetch water, they used buckets(***poun***); thus, artistes' jargon "***poun-tot*"** was substituted with " ***Myauk-twin-gyi-hmu***".Sometimes some villagers still tend to interchangeably use the phrase ***"poun-tot".*** For rice, they use***'poun'***. It is well noted that they use such phrases as **"*poun-shei"*(**long bucket) for "***mount-hin-gha***" (vermicelli gravy dish)and **"*khauk-swe*"** (Noodle).

The Kyaukkians say, "***Paaneehtit***" for "drinking water". Most may know ***"Paanee***" is not Myanmar word but Hindi word, which means "water", while only" ***htit***' is pure Myanmar word. They happily just borrowed it from Hindi. This phrase"***Paaneehtit***" is still in vogue up to date.It is learnt that "**hsan**" or rice is called "***zi***" in Monywa region and in Min Ywa village as well. The slang term for chili (***Nga-youk-thee or Nyouk-thee***) is "***yè***". It is assumed that the so term may have derived from the fact that when a chili is ripe,it turns deeply red("*yè*").As to chewing a betel quid, they will say, " ***arr-nishar-ni*(**red-palate , red-tongue) because when you chew a betel quid , it makes your palate and tongue red like a vampire's.Additionally,the Kyaukkians like to say, "Shall we take a white horse ride?"("***Myin-phyu-see-mae"***) instead of saying "Shall we go and drink palm beer or toddy?". The phrase may have derived from the worship of the Lord of the White Horse and other guardian spirits, to whom palm beer is offered in propitiation. Again, instead of saying, "Would you join us for a sip of grog?" they would say, "***Gauk-yai-thwa-me"***: "Are you coming along with us to play golf ?" The story behind this phrase is as follows:

Once there was a world-wide famous Myanmar golfer, whose name is Mya Aye. In the present village area, there is a moonshiner by the name of Mya Aye. His moonshine is sort of pre-nocturnal refreshment or spirit for worn-out and weary farm-hands, crofters and farmers alike.After working arduously the whole day on the farm or in the field, some of

them, except for the henpecked husbands,on their way home like to stop by the pub run by Mya Aye. Therefore, the illicit bar of the local moonshiner, named after the famed golfer, is one of the local haunts for the folk, and which is why, they say, "We are going golfing, are you coming?" The Kyaukkians, when they see a man who is drunk, would quip, "Oh My! This guy has done a shameful sin."He has committed a sin since devout Buddhists are supposed to avoid drinking intoxicants or alcohol. If you violate one of the five precepts, it is tantamount to doing a shameful act. Another slang term is "***Banee-htaung***". **"Banee**" actually means a variety of red tamarind leaves. They taste astringent and sour. Traditionally and literally, astringent and sour gives negative impression. The Kyaukkians, therefore,call a tough-nut-to-crack ***"Banee-htaung".***

(2) Slang Terms for Numbers in Kyaukka Village

The Kyuakkians love to use slang terms for numbers. However, it would be wiser to say " jargon" or "argot" instead of slang because only local hawkers mostly use them.For number one, they use "Chaung-oo"(the name of the town near Monywa); for two, "***Yei-hmout***"(dipper): such a dipper is used to dip into the water, which is expressed in Myanmar verb '***hnit***', which carries the homonym of Myanmar number 2, "**hnit**"); for three "C***hun***", which refers to 'three' sharp points (its homonym is"an iron hookor goad"). That's why, the jargon 'chun" has become a household word. For four, they use the jargon "Prince Ram" or "Yama Min Tha", who bears the bow and arrows, literally it means "lay"(four in English) and "Hmya". For number five, they use the term "***Yei-the***'" or "in the water" since it is clearly understandable that fish dwell in water. And another jargon for five is " ***Ma Htwe Lay***" who is a local woman, and ekes out a living as a fishmonger .Therefore Ma Htwe Lay is the coined jargon for fish (**nga**: in Myanmar or five).In this connection, "Canned fish" or "***Nga:theita***" is called there "***Htwe Lay Yat Pyan***". The Word 'Htwe Lay' does not need explanation or elaboration ; *Yat Pyan* or returning to one's native village is passing because when you die your body is laid in the coffin(here it means a can).Similarly fish are canned like a body is put in a coffin. "***Tha-but-taw*** "stands for number six. There are six villages in that area, which all bear the same name. In like manner, number seven is "***Ga-doo***" since there are seven Gadoo Villages in Katha District. Number eight stands for "***Ga-ngae***" (a Myanmar alphabet looks like Myanmar number *shit*(eight) in a printing form. However, another jargon for eight is Ma Ma Aye; nobody, unfortunately, knows how this usage came to exist. When it comes to number nine, they use "***Ma Shein*"** or "***Ma Cheik***". Both of them are spiritual mediums, natives of Kyaukka Village. When you worship a certain spirit, Myanmar counterpart is "**Koe-kwae**" or Nine is " **Koe**" in Myanmar Language.Number ten is "***Chuaung-oo***". This jargon stands for number one too. There are ten villages in the Chaung-oo village tracts, Monywa township. That is why, they use that word for ten.

To enrich their jargon, local hawkers extensively use these ten numbers by adding "***Khwe***" (half). As Chaung-oo means one or ten, when you want to say one thousand and five hundred or fifteen thousand, they use "***Chaung-oo Khwe***". The same way is applied for other numbers—"***Yei-hmout Khwe***"(two and half), "***Chun Khwe***" (three and half), "***Yama Khwe***" (four and half) and so on. In addition to these, the jargon term quarter (**A*h-seit***)is "***U Nyan Bwint***". U Nyan Bwint is also a native of Kyaukka Village. He is a great gambler, well-versed in playing cards. As a rule,to start the card playing, each player has to deposit a quarter or 25 kyats. U Nyan Bwint cannot articulate this number clearly; he clutters the sound like "Ah-theik" instead of "Ah-seit". Then in memory of the late U Nyan Bwint or in honor of the gambler U Nyan Bwint ,they use his name.

(3) Everyday Slangs Found in Kyaukka Village

Some everyday slangs used in Kyaukka village are highlighted here. When the folks see you wearing a sunglasses, they will say, "That guy is ***Gon-ban-htithta tae***". "***Gon-ban***" means "***Myet-hman***" or sunglasses while "***htit***" means wear.A two-wheeled vehicle is called "***Dwe-da-leint***", if it has four wheels, it is a"***Yama-da-leint***". If you drive a motorbike made in China,it is called "**Ah-ya-ya-tit".** Kyaukka folks tend to make a total stranger a sucker if he happens to be at the village. He is likely to be swindled. They use the slang term like "***Ma-tha-yu-la-pyi***" to alert one another."***Ma-tha-yu***" means a native of Kyaukka , who makes a living by selling sour snacks. Here 'sour' means a sucker or gullible person in Myanmar language. Therefore "***Ma-tha-yu-la-pyi***" (a native of Kyaukka has come) means that a sucker is coming.

At Kyaukka village, it is already mentioned in earlier part that a chili is called "***ye***". This term also refers to a cop. If cops are entering the village, they say, "***Nga-yout-thee-mya-yun-la-pyi***", meaning "Police are coming."'Yun" means"move or go" in Myanmar dictionaries.Moreover, Buddhist monks are termed as "***Yaw***". It appears it has derived from Saw and Yaw village tracts in Magwe region. According to the Sayadaw(abbot), it derives from Pali word " ***Jopanabikkhu***". In Myanmar language, 'jo' sounds yaw. A house is called "***bi***". A monastery is "***Yawbi***".

(4) Miscellaneous Slang Terms

Young men are called "***na-nge***" while young women are "***htan-bin-nyan***".The source of "***na-nge*** "is still unknown.In the past,Kyaukkians went to Monywa to satiate their lust. They went to a brothel house where they could meet hookers. The brothel house is called "Ohn-chan" (coconut grove). Since then, a place that is rife with women of loose characters is called Ohn-chan. In the course of time, Kyaukkians have used "Htan-bin-chan" instead of Ohn-chan. They both belong to borassus flabellifer. Simply put,they belong to the palmyra palms species. Htan-bin-nyan is distorted into "***Htan-bin-nyan***" and then to "***Hta-mein-nyan***". When a guy sees a pretty girl, he would say," ***Hta-mein-nyan-waik-laik-ohn-mae***", meaning that "he is going to court the girl"."***waik***" means "court or woo".

In the community, if there is an ill-tempered and foul-mouthed wag, who is going wild and vile and incandescent with rage, he is said to be "***di-na-ngae-ga-kaw-chin-pauk-tae***"(this small letter *na-ngae* is turning sour). This small letter na-ngae means a young man. If a young woman is beautiful,she is called "***good-ta-maw***"; if she is ugly, she is a "***good-ta-mo***". "***ah-hlut-oh***"means "way too old".

The slang term "***ah-hlut***" means "very or way too or far too". It is a common term in the community. In some other regions, "hlut" without "ah" is used as an adverb, as in, "***hlut-hsa:*** "(gorge or wolf downfood), "***hlut-eit***"(sleep well or soundly or oversleep). If someone is so loquacious(very talkative one),the correct term for him is that "***Pouk-pouk-hkut-mya-tae***".Here"pouk-pouk"is popcorn. Another slang term for "ugly" is "***pyaing***". And "***pyaing***" also means "dead" or "die". In Kyaukka village, artistes use "***Ah-ngan***"(salt) to refer to children because salt is essential for a meal, and a child is essential for a family.

Another slang term associated with a local business-minded woman is "***Mya-htay-hmu-ma-hmu-neq***".The story behind this is: Once there was a woman whose name is Ma Mya Htay. Her husband is a tenant farmer.When he went to the farm, she was left at home alone without rice or oil. She was at her wit's end. When her husband came back, she had to fabricate whatsoever she had for him to eat. At that moment, a woman who was hawking beef around happened to be in front of her house. A neat idea dawned on her. She bought some beef on credit. She halved it. She went around to sell the half. With the money she got, she

bought rice and cooking oil. Everything went well then. She has a streak of business skills. She just grabbed the opportunity.She is an opportunist. She acted from expediency. A time-server like her is termed "Ma Htay". Instead of saying, "Don't be an opportunist", the folks would say,"***Mya-htay-hmu-ma-hmu-neq***". This slang has been still in use to the present day.

Findings and Discussion

In analyzing slang words and phrases used inKyaukka Village Tracts, to the northeast of Monywa, Sagaing Region, Upper Myanmar by Zhou and Fan's(2013) model, four types of slangs which are slang terms for food, slang terms for numbers, everyday slangs and miscellaneous slang terms are found out in this research.Moreover, it is found that there are some influential social factors of the slangs of KyaukkaVillage and they are classified into gender, business and daily communication.

A. Gender

It is found that the sources of certain slangs come from the relationships of men in the setting of liquor shop. Men do not want women to know what they are doing in their absence and how they are going to spend the evenings together his fellows. That results in the coining of the slangs associated with drinking. The slangs "Ohn-chan"(coconut grove) and "Htan-bin-chan" (toddy palm grove) are shared only among the womanizers of the locality to refer towomen of loose characters.On the other hand, because village damsels are chiefly responsible fetching water in groups in the evening, the question,"***Poun-tot-pyi-bi-la***?" (‘***poun'*** means 'a bucket'; 'tot' means 'fetch'or 'take') is a slang presumably associated with the fair sex only.

B. Business

Slang terms for numbers may be used among the local people in their dealings, which might keep the outsiders out of their circle. These number slangs are coined as a code to be shared only among the close friends and local people.

C. Daily Communication

The slang term "***ah-hlut***" ("very or way too or far too") is common in use not only in Kyaukka Village and around but also in some other regions, where the more concise form "hlut' without "ah" is used as an adverb. To express the meaning of eating too much, "***hlut-has":*** *hlut* (very) + *hsa* (eat).

In studying slang words and phrases used in Kyaukka village tracts, we can find a lot of slangs which represent the person and artistes' usages in Kyaukka village tracts.In English language, salt or common salt is an ingredient that gives savor,piquancy, or zest in other words a flavor. In standard English language, the figurative usage of salt is a person who is full of life,vigor or a dependable steadfast person or group of people—usually used in the phrase salt of the earth. In middle English, a callous veteran sailor with a lot of experience is called an "***old salt****"*. If a person is a very good and honest one, he is called the "***salt of the earth****"*.

It is marvelous to learn that Myanmar language is no less rich in vocabulary. These slangs have come into existence, based on the local personalities, good or bad, personal experiences, pleasant or unpleasant, and been shared widely among the locals. For example, in the worlds of arts, artistes use "***Ah-ngan***"(salt) for children because like salt being an essential commodity in a household, a family without a kid is not complete in any sense(In some regions, they are called "small chiming bells" or *"celle"*). It is note-worthy that in Kyaukka region as well the locals in the similar sense call children "***Ah-ngan***"(salt).

As mentioned above, the slangs carry the tone of humour. For efficient communication, they coin and contract the forms for the sake of conciseness. The slangs of Kyaukka Village must be given credit for their originality: the sources come from the events and personal experiences of the particular local people. The majority of these slangs have their own interesting stories. Some slangs go through instability, as is the nature of slangs of all kinds that either fade out into obscurity or assume new meanings in combination with other words.

Conclusion

In this paper, "Slang Terms used in Kyaukka Region", one can have a chance to see the slang terms used across the countryside of Kyaukka Village. This is a kaleidoscope of slangs which can be enjoyed at one sitting or reading. More than that, it is so interesting to learn the slang terms used in Kyaukka region and at the same time it is a sort of firsthand knowledge to familiarize oneself with a region's everyday life or lifestyle and endearing characteristics through these slang terms. To put it simply, old idioms, slangs, jargons and the like are becoming clichés and disappearing into thin air and at the same time new idioms, new slangs and new jargons are coming here to exist for a certain period. This will be a continual process with no ends because language is never constant. Therefore, to make most out of this, one should study, do research,put them on records so that the new set can learn them as a national heritage.

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A Geographical Analysis on Agriculture Activity: A Case Study of Kanbalu Area

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Abstract

Kanbalu Township is located in Kanbalu District of Sagaing Region.It is composed of Kanbalu Town Proper and Zigon Town Proper and 85 village tracts. Its area is 1599.35 square miles (1,023,587 acres) and its shape is square. In relief features, it can be divided into two parts namely the highland region and the plain region. Most of the agriculture lands are in the plain region. The chief rivers are Ayeyarwady River and Mu River. For climate, the study area received high temperature and medium rainfall. According to Koppen's climate classification, Kanbalu gets the tropical savanna types of climate (Aw). The objectives are to discuss *Le* land, *Ya* land, *Kaing-Kyun* land and *Garden* land and to calculate the index of crop concentration method by Dr.SS Bhatia. Wet Agriculture, Dry Agriculture, Kaing-Kyun Agriculture and Garden Agriculture present the maps and diagrams by using the GIS techniques.The *"Ya"* agriculture was the largest area in the study area, the second largest was *"Le"* agriculture, the third largest was *"Kaing-Kyun"* agriculture and the fourth largest was *"*Garden*"* agriculture. During eight years from 2011-2012 to 2018-2019, the agricultural land use of Kanbalu Township was a little change. The future of Kanbalu Township can be expected to be more prosperous than today.

Key words: Wet Agriculture, Dry Agriculture, *Kaing-Kyun* Agriculture

Introduction

Myanmar's economic activity is primarily based on agriculture. About two-third of the country's agriculture sector is agro-based by agriculture products. So, Agriculture Activity is a portion of the physical environments and agriculture land use. Kanbalu Township is closely related to the physical bases of the township. Kanbalu Township's economy is based on agriculture. Kanbalu Township is located at Central Basin of Myanmar. The basic economy is agricultural as the outstanding of dry cultivation. Therefore, it is necessary to study the land use changes in the region and to find the consequences of land use changes.

Aim and Objectives

The aim of this research is to provide agriculture activity for regional development. The main aim is to describe more effective and systematic agriculture activity patterns of Kanbalu Township for the future. The objectives of this research are:

- To study the physical environment in the study area
- To analyze of the actual agricultural land use pattern of the study area.
- To examine the kinds of crop suitable for Kanbalu Township.

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- To classify agriculture activity such as *"Le", "Ya", "Kaing-Kyun"* and *"*Garden*"* griculture and how to support the economy of the study area.

Study Area

The study area is located between north latitude 20˚50˙ and 23˚43˙ and east longitude 95˚19˙ and 95˚59˙.

Method and Data Sources

The present research is based on primary and secondary data. The primary data for this research were available from field survey. The secondary data were collected from government offices, such as Department of Agricultural Land Management and Statistics, Kanbalu Township General Administration Department, Meteorology and Hydrology Department. The geographical interpretation has been done with the help of the maps and diagrams. In this work, Agriculture Activity concentration is calculated by Dr.S.S Bhatia's method.

Findings and Discussion

Geographical Factors

Kanbalu Township's economy is based on agriculture. Kanbalu Township is situated in Kanbalu District of Sagaing Region. It lies between the north latitudes of 20º50' and 23º 43' and also east longitudes of 95º 19' and 95˚ 59'.Figure(1)

Kanbalu Area is constituted of five wards,Zigon Town Proper, 85 village tracts and 268 villages. The township covers an area of 1599.35 square miles or 1,023,587 acres. Kanbalu Township can roughly be divided into (1) the highland region and (2) the plain region. The highland region is located in the northern portion of Kanbalu Township.The plain region is located in the southern portion of Kanbalu Township. It occupies the half of the total area of the township. This plain is deposited by Ayeyarwady River and its tributaries. This area is favourable for variety of crop cultivation. The chief rivers of Kanbalu Township are Ayeyarwady and Mu rivers. Mu River serves as a natural boundary between Kanbalu and Taze Townships.

Among the physical factors, climate is considered to be an important factor. According to the temperature records of Kanbalu station during 23years period from 1996 to 2018, the average maximum temperature is 90.85˚F, the average mean temperature is 79.68˚ F and the average minimum temperature is 68.79˚F. Among all of the months, April is the hottest with temperature of 99.48˚F in maximum, 85.18˚F in mean and 71.71˚F in minimum and January is the coldest with 82.99˚F in maximum, 69.26˚F in mean and 55.65˚F in minimum. Therefore the range of temperature is 15.92˚ F.Kanbalu receives the average annual rainfall of 43.74 inches during the 23year period from 1996to 2018. According to Koppen's climatic classification system, Kanbalu belongs to tropical savanna types of climate (Aw). As the main economy of Kanbalu Township is agriculture. There are nine main types of soils in Kanbalu Township. The natural vegetative cover of Kanbalu Township can be studied as follows:(1) Moist upper mixed forest, (2) Dry upper mixed forest, (3) "Indaing" forest, (4) Dry forest.

The basic economy is agricultural as the outstanding of dry cultivation. Agricultural activity is the main economy, depending on the total population.

According to the 2019 population data, Kanbula Township has a total population of 309,848 persons. Of this total, the urban population constitutes 38,178 persons with the 12.32 percent and the rural population 271,670 persons with 87.68 percent. In Kanbalu Township,

the proportion of rural population is very high. As a result the economy of Kanbalu Township depends heavily on Agriculture activities. Man-Land ratio of Kanbalu Township was 3.30 acres per person in 2019.

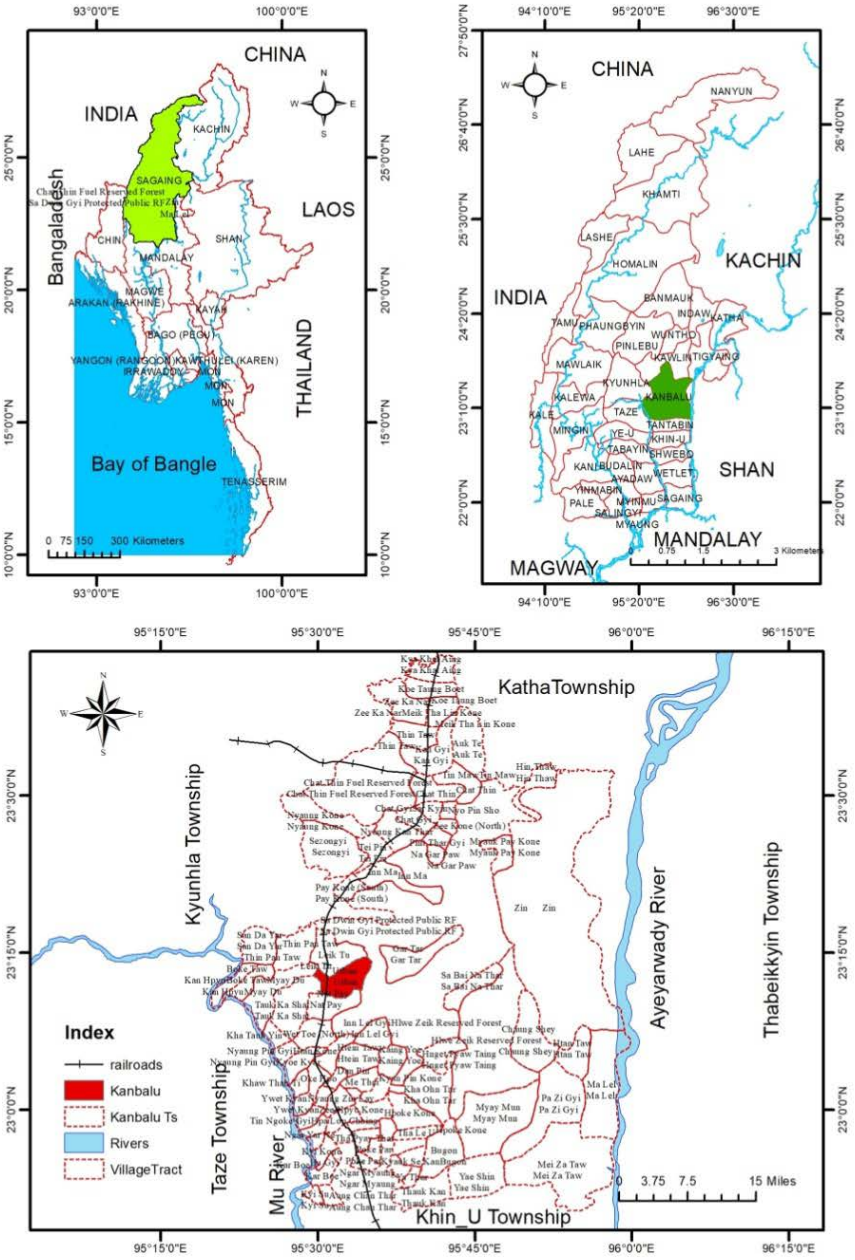

FIGURE (1) LOCATION MAP OF KANBALU TOWNSHIP (2019)

Source ; UTM 2295,2296

Analysis on Agriculture Activity in Kanbalu Area

Agriculture is the main economic activity in Kanbalu Township. The agricultural land use is the most dominant type of land use in the study area. There is a flat land at the northwest of the township and the main common land is agriculture activity because of the vicinity of dam and rivers. The largest is *"Ya"* land (Dry Agriculture). The second most is *"Le"* land (Wet Agriculture) and *"Kaing-Kyun"*land (*Kaing-Kyun* Agriculture) and *"*Garden*"* land (Garden Agriculture) are also found in the irrigation area and island in the river.

Types of Agriculture Activity

Depending upon the cultivation, there are four types practicing in the agricultural land. They are:

(1) *"Le"* Land (Wet Agriculture)
(2) *"Ya"* Land (Dry Agriculture)
(3) *"Kaing-Kyun"* Land (*Kaing-Kyun* Agriculture) and
(4) *"*Garden*"* Land (Garden Agriculture)

According to the sources, the total cultivated land in Kanbalu Township is 434,269 acres. *"Le"* land (Wet Agriculture) is 139,741 acres and the second largest in the study area. *"Ya"* land (Dry Agriculture) is 291,899 acres and the largest in the total cultivated area. *"Kaing-Kyun"* land *(Kaing-Kyun* Agriculture) is 2,024 acres and *"*Garden*"* land (Garden Agriculture) is 605 acres.

Agriculture activity concentration is calculated by Dr.S.S Bhatia's method. Agriculture activity concentration is described by *"Le", "Ya", "Kaing-Kyun",* and *"*Garden*"*. The index of land use concentration is classified into three groups as high, mediun and low.

$$\text{Index of concentration of crop} = \frac{\text{Area of Crop X in a component area unit}}{\text{Area of all crops in the component areal unit}} \div \frac{\text{Area of Crop X in entire region}}{\text{Area of all crops in the entire region}}$$

***Le* Agriculture Concentration**

Kanbalu Township lies at the Central Myanmar and its received high temperature and low rainfall. Most of the cultivation has depended upon irrigation. The common most of *"Le"* agriculture are found at the lowland area and the near Kabo dam. Ayeyarwady River and Mu River are supporting the agricultural farming. *"Le"* land (Wet Agriculture) is the most important agricultural land use and the total *"Le"* land is 139,741 acres.According to the sources, the majority of the *"Le"* agriculture is found to be concentrated at the flat plains of Ayeyarwady River, Mu River and Kabo dam. Zigon Town Proper and 33 village tracts has included in Kanbalu Township. The medium concentration levels are found at the central area. It comprises of 27 village tracts.The low concentration levels are found at the eastern portion and central. It obtained Kanbalu Town Proper and 25 village tracts.*"Le"* land used to support only one crop of paddy. Table (1)

Table (1) Le Agriculture Concentration Index in Kanbalu Township by Village Tracts (2019)

No	High Concentration (Above 2)	Medium Concentration (Between 1 - 2)	Low Concentration (Below 1)
1	Zigon Town Proper	Kyakhataik	Kanbalu Town Proper
2	Koetaungbo	Minthalingon	Kangyi
3	Aukte	Zikana	Nagapaw
4	Chatthin	Thindaw	Chatkyi
5	Nyobinsho	Tinmaw	Tebin
6	Sakyin	Zin	Nyaungon
7	Zigon (N)	Paygon(N)	Paygon(S)

Table (1) Continued

No	High Concentration (Above 2)	Medium Concentration (Between 1 - 2)	Low Concentration (Below 1)
8	Pinthagyi	Hinthaw	Inma
9	Kyatuaukyin	Nyaungkantha	Thinpandaw
10	Nyaungzin	Myedu	Sandaya
11	Phalanchaing	Boktaw	Leittu
12	Methe	Kanphyu	Natpay
13	Ziphyugon	Nyaungpingyi	Taukkashat
14	Kawthanni	Wetto (N)	Inlegyi
15	Ywetkyan	Htangon	Hngetpyawtaing
16	Kyokyar	Hteintaw	Khaohnta
17	Oakpho	Kaingyo	Bugon
18	Thabokkon	Kyunpingon	Ghata
19	Subokkon	Bugyi	Sabenatha
20	Danpin	Chinmyitkyin	Yeshin
21	Tinkokgyi	Kabo	Male
22	Sezongyi	Kyigon	Htantaw
23	Wetto (S)	Kyisu	Pazigyi
24	Nyaryanare	Bokgon	Chaungshe
25	Nyaungpinsate	Thale-U	Mezataw
26	Aungchantha	Kyauksekan	Myemon
27	Poppa	Htanawngaing	
28	Htantapin		
29	Thayetkangyi		
30	Thapyetha		
31	Chaungkan		
32	Yatha		
33	Ngarmyaung		
34	Thaukkan		

Source: Calculated by Researcher

Ya Agriculture Concentration

In Kanbalu Area, *"Ya"*agriculture is found as the most largest in area. *"Ya"*agriculture is with 291,899 acres and 67.22 percent of the total cultivated area. *"Ya"*agriculture is rely on rainfall and irrigation. According to the statistic, the high concentration levels of Dry Agriculture are found at the eastern and the central area. Kanbalu Town Proper and 24 village tracts has comprised in the township.The medium concentration level of *"Ya"*agriculture are found at the central place and the northern portion. It includes 28 village tracts.The low concentration level of *"Ya"*agriculture are found at the flat plain: some are northern and some are southern area. It obtained Zigon Town Proper and 33 village tracts. The crops cultivated are pulses, maize, sesamum, groundnut, sugarcane and betel. Table (2)

Table (2) *Ya* Agriculture Concentration Index in Kanbalu Township by Village Tracts (2019)

No	High Concentration (Above 1)	Medium Concentration (Between 0.5 - 1)	Low Concentration (Below 0.5)
1	Kanbalu Town Proper	Koetaungbo	Zigon Town Proper
2	Kangyi	Kyakhataik	Aukte
3	Nagapaw	Minthalingon	Chatthin
4	Chatkyi	Zikana	Nyobinsho
5	Tebin	Thindaw	Sakyin
6	Nyaungon	Tinmaw	Zigon (N)
7	Paygon (S)	Zin	Pinthagyi
8	Inma	Paygon (N)	Kyatuaukyin
9	Thinpandaw	Hinthaw	Nyaungzin
10	Sandaya	Nyaungkantha	Phalancaing
11	Leittu	Myedu	Methe
12	Natpay	Boktaw	Ziphyugon
13	Taukkashat	Kanphyu	Kawthanni
14	Inlegyi	Nyaungpingyi	Ywetkyan
15	Hngetpyawtaing	Wetto (N)	Kyokyar
16	Khaohnta	Htangon	Oakpho
17	Bugon	Hteintaw	Thabokkon
18	Ghata	Kaingyo	Subokkon
19	Sabenatha	Kyunpingon	Danpin
20	Yeshin	Bugyi	Tinkokgyi
21	Htantaw	Kabo	Sezongyi
22	Pazigyi	Kyigon	Wetto (S)
23	Chaungshe	Bokgon	Nyaryanare
24	Mezataw	Thale-U	Chinmyitkyin
25	Myemon	Kyauksekan	Nyaungpinsate
26		Htanawngaing	Kyisu
27		Thaukkan	Aungchantha
28		Male	Poppa
29			Htantapin
30			Thayetkangyi
31			Thapyetha
32			Chaungkan
33			Yatha
34			Ngarmyaung

Source: Calculated by Researcher

Kaing-Kyun Agriculture Concentration

In Kanbalu Township, the total area of *Kaing-Kyun* Agriculture is 2,024 acres. It is found near the Mu River and Kabo Dam. The high concentration level of *"Kaing-*

*Kyun"*agriculture is composed of four village tracts. These are Nyaungpinsate, Kabo, Kyisuand Male.The medium concentration level of "*Kaing-Kyun"*agriculture was found at Kawthanni, Chinmyitkyin village tracts.The low concentration level of *"Kaing-Kyun"*agriculture is composed of seven village tracts. These are Myedu, Boktaw, Nyaungzin, Ywetkyan, Tinkokgyi, Kyigon and Aungchantha. The crops cultivated are chilies, onion, peas, beans and vegetable. Table (3).

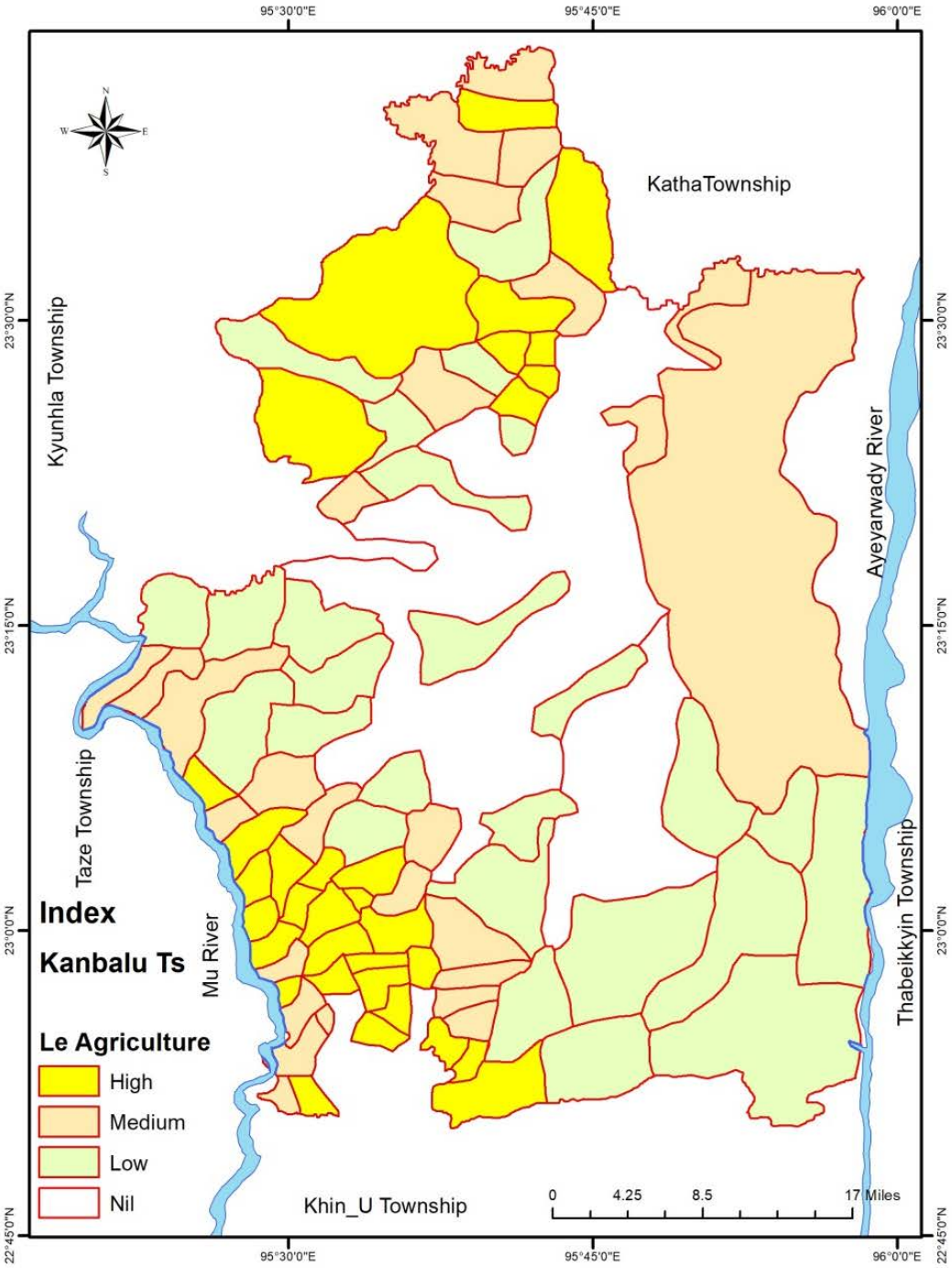

FIGURE (2) LE AGRICULTURE CONCENTRATION INDEX IN KANBALU TOWNSHIP BY VILLAGE TRACTS (2019)

Source ; Calculated by Researcher

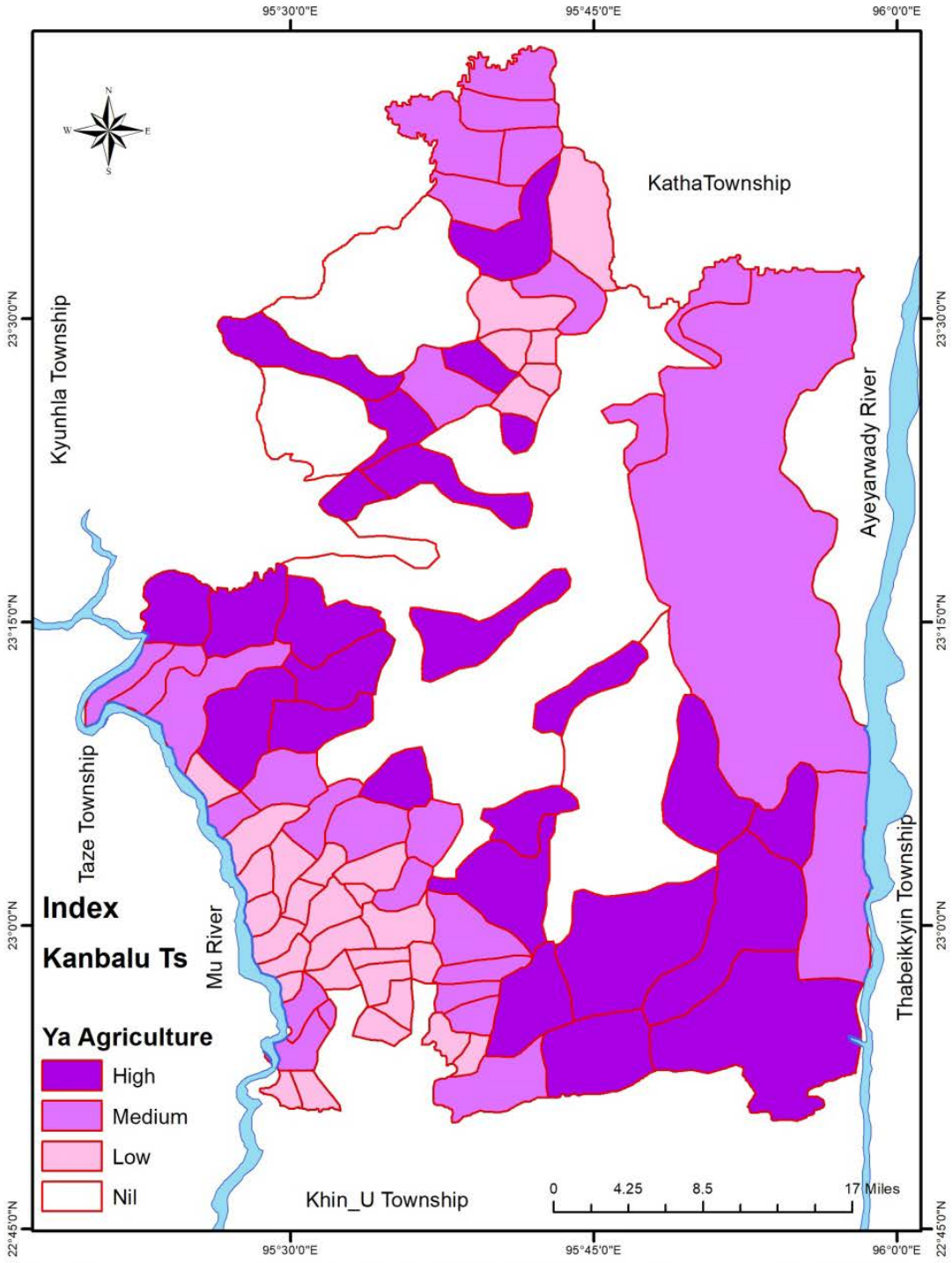

FIGURE (3)YA AGRICULTURE CONCRNTRATION INDEX IN KANBALU TOWNSHIP BY VILLAGE TRACTS (2019)

Source : Calculated by Researcher

Table (3) Kaing - KyunAgriculture Concentration Index in Kanbalu Township by Village Tracts (2019)

No	High Concentration (Above 30)	Medium Concentration (Betweeen 15 - 30)	Low Concentration (Below 15)
1	Nyaungpinsate	Kawthanni	Myedu
2	Kabo	Chinmyitkyin	Boktaw
3	Kyisu		Nyaungzin
4	Male		Ywetkyan
5			Tinkokgyi
6			Kyigon
7			Aungchantha

Source: Calculated by Researcher

Garden Agriculture Concentration

In Kanbalu Township, Garden Agriculture is found as the smallest in area. The *"*Garden*"*agriculture area is 605 acres. The high concentration level of garden agriculture includes Kanbalu Town Proper and three village tracts. These are Thinpandaw, Sandaya, Leittu village tracts. The medium concentration level of the garden agriculture obtained three village tracts namely Nyaungon, Natpay, and Kyisu village tracts. The low concentration level of garden agriculture falls in four village tracts. These are Chatthin, Paygon(S), Inma, and Htangon. Fruits and vegetable are cultivated in garden. Table (4)

Table (4) Garden Agriculture Concentration Index in Kanbalu Township by Village Tracts (2019)

No	High Concentration (Above 2)	Medium Concentration (Between 1 - 2)	Low Concentration (Below 1)
1	Kanbalu Town Proper	Nyaungon	Chatthin
2	Thinpandaw	Natpay	Paygon (S)
3	Sandaya	Kyisu	Inma
4	Leittu		Htangon

Source: Calculated by Researcher

Temporal Changes of Agriculture Activity

During eight years from 2011-2012 to 2018-2019, in 2011-2012, the agricultural land area was 429,218 acres which accounted for 41.93 percent of the total area of the township. The agricultural land area was 429,218 acres, the *"Le"*agriculture was 134,931 acres which accounted for 31.44 percent of the agricultural land area of the township. The *"Ya"*agriculture was 291,804 acres, which accounted for 67.99 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,028 acres which accounted

for 0.47 percent and the *"Garden"*agriculture was 455 acres, which accounted for 0.1 percent of the agricultural land area of the township.

In 2012-2013, the agricultural land area was 428,807 acres which accounted for 41.89 percent of the total area of the township. The agricultural land area was 428,807 acres, the *"Le"* agriculture was 134,820 acres which accounted for 31.44 percent of the agricultural land area of the township. The *"Ya"* agriculture was 291,354 acres, which accounted for 67.95 percent of the agricultural land area of the township. The *"Kaing-Kyun"* agriculture was 2,028 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural land area of the township.

In 2013-2014, the agricultural land area was 429,981 acres which accounted for 42.00 percent of the total area of township. The agricultural land area was 429,981 acres, the *"Le"*agriculture was 134,741 acres which accounted for 31.58 percent of the agricultural land area of the township. The *"Ya"*agriculture was 292,607 acres, which accounted for 68.05 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,028 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural land area of the township.

In 2014-2015, the agricultural land area was 429,297 acres which accounted for 41.94 percent of the total area of township. The agricultural land area was 429,297 acres, the *"Le"*agriculture was 135,545 acres which accounted for 31.58 percent of the agriculture land area of the township. The *"Ya"*agriculture was 291,119 acres, which accounted for 67.81 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,028 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural land area of the township.

In 2015-2016, the agricultural land area was 434,521 acres which accounted for 42.45 percent of the total area of township. The agricultural land area was 434,521 acres, the *"Le"* agriculture was 139,831 acres which accounted for 32.18 percent of the agricultural land area of the township. The *"Ya"*agriculture was 292,057 acres, which accounted for 67.21 percent of the agricultural land area of the township. The *"Kaing-Kyun"* agriculture was 2,028 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural land area of the township.

In 2016-2017, the agricultural land area was 434,508 acres which accounted for 42.45 percent of the total area of township. The agricultural land area was 434,508 acres, the *"Le"*agriculture was 139,830 acres which accounted for 32.18 percent of the agricultural land area of the township. The *"Ya"*agriculture was 292,049 acres, which accounted for 67.21 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,024 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural land area of the township.

In 2017-2018, the agricultural land area was 434,356 acres which accounted for 42.43 percent of the total area of township. The agricultural land area was 434,356 acres, the *"Le"*agriculture was 139,811 acres which accounted for 32.18 percent of the agricultural land area of the township. The *"Ya"*agriculture was 291,916 acres, which accounted for 67.21 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,024 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural area of the township.

In 2018-2019, the agricultural land area was 434,269 acres which accounted for 42.43 percent of the total area of township. The agricultural land area was 434,269 acres, the *"Le"*agriculture was 139,741 acres which accounted for 32.18 percent of the agricultural land

area of the township. The *"Ya"*agriculture was 291,899 acres, which accounted for 67.22 percent of the agricultural land area of the township. The *"Kaing-Kyun"*agriculture was 2,024 acres, which accounted for 0.47 percent and the *"Garden"*agriculture was 605 acres, which accounted for 0.14 percent of the agricultural area of the township.

During eight years from 2011-2012 to 2018-2019 the agricultural land use of Kanbalu Township was a little change. The *"Ya"*agriculture was the largest area in the study area, the second largest was *"Le"*agriculture, the third largest was *"Kaing-Kyun"*agriculture and the fourth largest was *"*Garden*"*agriculture.

Table (5) Temporal Changes of Agriculture Activity (2011-2019)

Sr. No	Year	*Le* Agriculture %	*Ya* Agriculture %	*Kaing-Kyun* Agriculture %	Garden Agriculture %	Total
1	2011-2012	31.44	67.99	0.47	0.10	100
2	2012-2013	31.44	67.95	0.47	0.14	100
3	2013-2014	31.58	68.05	0.47	0.14	100
4	2014-2015	31.58	67.81	0.47	0.14	100
5	2015-2016	32.18	67.21	0.47	0.14	100
6	2016-2017	32.18	67.21	0.47	0.14	100
7	2017-2018	32.18	67.21	0.47	0.14	100
8	2018-2019	32.18	67.22	0.47	0.14	100

Source: Calculated by Researcher

Findings

During eight years from (2011-2012) to (2018-2019) the agricultural land use of Kanbalu Township was a little changed. The *"Ya"* agriculture was the largest area in the study area, the second largest was *"Le"* agriculture, the third largest was *"Kaing-Kyun"* agriculture and the fourth largest was *"*Garden*"* agriculture.

Conclusion

Kanbalu Township is situated in Kanbalu District of Sagaing Region. It lies between the north latitudes of 20˚ 50' and 23˚ 43' and also east longitudes of 95˚ 19' and 95˚ 59'. The shape of the township is a square in shape. In topography, the township can be divided into two parts; the highland region and the plain region. According to Koppen's climatic classification system, Kanbalu experienced the tropical savanna types of climate (Aw). In studying the soil, there are main nine types of soil in the study area.

In studying the human bases of Kanbalu Township, the total population of 1911 is 51,895 persons and in1921 census year, the population is 54,560 persons. In 2019, the total population reached 309,848 persons which increased 34,373 persons with the growth rate of 2.37 percent. In studying the total population, the urban population is 38,178 persons (12.32%) and the rural population is 271,670 persons (87.68%).

In Agriculture land, it has 434,269 acres with 42.48 percent of the township's area. *Ya*agriculture is the largest land use with 261,899 acres (67.22%), *"Le"*agriculture is the second largest land use with 138,741 acres (32.18%), *"Kaing-Kyun"*agriculture is the third largest land use with 2,024 acres (0.46%) and the least is *"Garden"*agriculture with 605 acres (0.14%).

In analyzing the agriculture land, the agricultural land use concentration is measured by Dr. SS Bhatia method. Agricultural land use concentration is described by *"Le", "Ya", "Kaing-Kyun"* and the *"Garden"*. The value of index is classified into high, medium and low.During the eight years period from 2011-2012 to 2018-2019, the agriculture activity of Kanbalu Township was slightly change.

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The Variation of Monthly and Annual Precipitation Concentration Index of Katha Township

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Abstract

The storage of water and the increasing temperature have an effect on the distribution and the amount of rainfall. The main aim of this research is to evaluate the variability and concentration of rainfall byusing Precipitation Concentration Index (PCI) based on monthly and annually precipitation over 53-year period (1976-2019) of Katha Township. Data for the study area were collected from the Meteorology and Hydrology Department of Katha. Precipitation Concentration Index (PCI) of Oliver (1980) is used in this research.The PCI was calculated for annual and decadal rainfall concentration. Result shows that annual PCI value range from the lowest of 14.61 in 1973 to the highest of 31.16 in 1987. About 67.93 percent of the years were characterized by PCI values that fall within irregular range, an indication of irregular precipitation concentration while 22.64 percent of the years occurred high precipitation concentration and 9.43 percent of the years occurred moderate range indicating a moderate precipitation concentration within the 53-year period. Based on the results above, annual rainfall of Katha Township is irregular precipitation concentration in most of the years. Therefore, rainfall of Katha Township is sufficient for cultivation. Moreover, as there were high precipitation concentrations in some years, it is found that the loss of agricultural land and residential land near the Ayeyarwady River and Shweli River, soil erosion and other water related problems incident in the township.

Key Words: Annual, Decadal, Concentration, Precipitation, PCI

Introduction

The drought and the shortage of food due to climate change could be a problem for the world. Also the increasing in the mean precipitation in the globe could be the result of the rising atmospheric moisture content associated with warming. Therefore, making a plan and the management of precipitation that depend on predictions of precipitation amount can help humankind to face these problems. (Hasanain K.A.AL-Shamarti)

Study Area

The study area is Katha Township. Katha Township is situated on the north-eastern part of Sagaing Region. It lies between north latitudes 23° 53' and 24° 23 ' and between east longitudes 96° 15 ' and 96° 28'[6]. It has an area of 865.68 square miles. It consists of 10 wards and 32 village tracts[7]. It is over 313 feet above sea level. The shape of Katha Township Township likes a lamp's lap. It is bounded on the east by Mabein Township, on the west by Indaw Township, on north by Mohnyin Township and Shwegu Township and on the south by Htigyaint Township. Kayha Township is mainly the flood plain region of Ayeyarwady River.

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[6] UTM Map No 2395,2396
[7] Report, General Administrative Department, Katha

According to Koppen's classification the climatic type of Katha has Tropical Savanna (Aw) Climate. Figuer (1)

Aim

The main aim of this research is to evaluate the variability and concentration of rainfall by using Precipitation Concentration Index (PCI) based on monthlyand annually precipitation over 53-year period (1976-2019) of Katha Township.

Source of Data and Methodology

The monthly precipitation data of 53-year (1967-2019) are obtained from the Meteorology and Hydrology Department of Katha. Precipitation Concentration Index (PCI) of Oliver (1980) is used in this research.(PCI) of Oliver has expressed as an indicator of rainfall concentration for annual. According to Oliver

$$PCI = \sum_{i=1}^{12} P_i^2 / [\sum_{i=1}^{12} Pi]^2 \times 100$$

Where p_i is the monthly precipitation in i month.

(1) PCI≤10 indicates uniform precipitation distribution (low precipitation concentration)

(2) PCI > 11 and ≤15 indicates moderate precipitation concentration

(3) PCI > 16 and ≤ 20 indicates irregulardistribution

(4) PCI> 20 indicates a strong irregularity (high precipitation concentration)

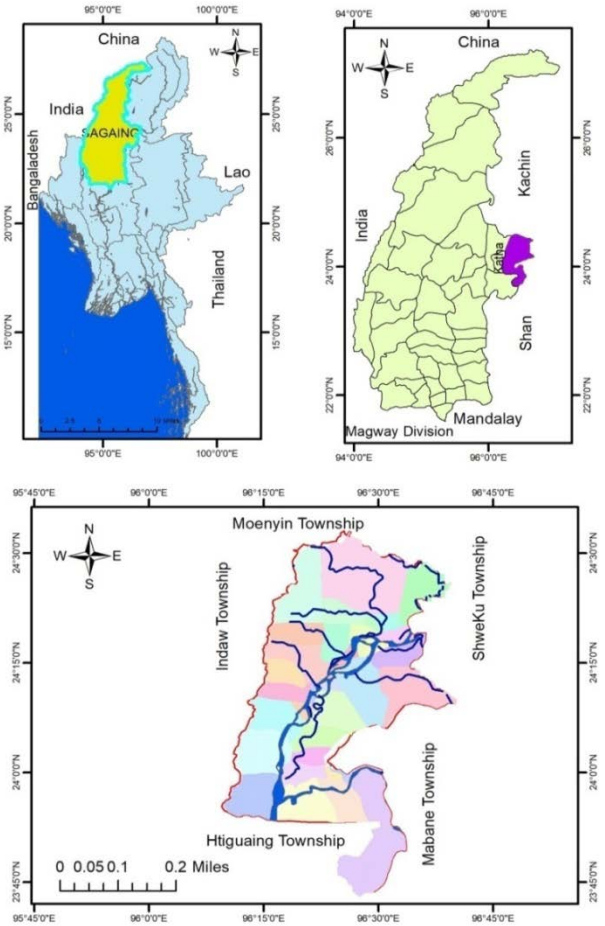


Figure: 1 Location Map of Katha Township (2019)

Source: UTM 2395, 2396

Findings and Discussion

Variance of Monthly and Annual Rainfall

In analyzing the monthly rainfall variability, according to mean monthly rainfall data (1967-2019), the highest average monthly rainfall was 305.54 mm in June and the lowest average monthly rainfall was 5.21 mm in December. Table (3) and Figure (2)

For January, there are 26 years with rain and another 27 years without rainfall. The mean value for January was calculated to be 7.69 mm; of the 53 years under study, only 15 years recorded values above the mean while 38 years were below the mean.

There are 28 years with rain and another 25 years without rainfall in February. The mean value for February was calculated to be 8.54 mm; of the 53 years under study, only 13 years recorded values above the mean while 40 years were below the mean.

For March, there are 35 years with rain and another 18 years without rain fall during 53 years. The mean value for March was 16.83 mm. Only 19 years recorded values above the mean while 34 years were below the mean.

In analyzing the rainfall record of April, the maximum rainfall has 119.89 mm in 2009 and the minimum rainfall has 1.27 mm. The mean value was 51.09 mm. In April, there are 24 years with above the mean while 29 years with below the mean.

For May, the maximum rainfall has 573.53 mm in 1988 and the minimum rainfall has 1.02 mm in 1979 during the 53 years. The mean value was 220.69 mm. In May, there are 24 years with above the mean while 29 years with below the mean.

During the 53 years, the maximum rainfall has 880.87 mm in 1990 and the minimum rainfall has 37.85 mm in 1999 for June. The mean value was 305.54 mm. In June, there are 23 years with above the mean while 30 years with below the mean..

For July, the maximum rainfall has 789.69 mm in 2015 and the minimum rainfall has 46.74 mm in 1998.The mean value was 260.88 mm. The monthly rainfalls for 23 years were above the mean and 30 years were below the mean.

There is only one year with no precipitation in 1987 for August. During the 53 years, the maximum rainfall has 486.41 mm in 1970 and the minimum rainfall has 30.48 mm in 1993.The mean value is 253.99 mm.The monthly rainfalls for 23 years were above the mean and 30 years were below the mean.

The mean value for September was calculated to be 234.47; of the 53 years under study, 24 years recorded values above the mean while 29 years were below the mean. There is only one year with no precipitation in 1987 for September. During the 53 years, the maximum rainfall has 652.01 mm in 1995 and the minimum rainfall has 37.59 mm in 1969.

In analyzing the monthly rainfall for October, there is only one year with no precipitation. The mean value is 157.33 mm. Only 22 years are above the mean while 31 years are below the mean.

In November, there are 39 years with rain and another 14 years without rainfall. The mean value is 35.19 mm. Only 22 years are above the mean while 31 years are below the mean.

During the 53 years, there are 18 years with rain and another 35 years without rainfall for December. The mean value is 5.21 mm. Only 10 years are above the mean while 43 years are below the mean. Table (2)

In analyzing the monthly rainfall variability of Katha Township, it is found that June is the highest monthly rainfall variation and December is the lowest monthly rainfall variation.

Table: (1) Annual Rainfall (mm) of Katha Township (1967-2019)

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1967	34.04	0	43.43	55.88	89.41	168.66	188.72	127.25	302	125.22	0	4.06
1968	12.19	12.19	8.13	49.28	222.8	252.73	360.43	432.82	323.09	89.41	0	0
1969	3.05	0	17.27	51.05	82.3	349.25	245.87	244.86	37.59	136.91	37.34	1.02
1970	0	0	0	7.11	281.4	532.89	108.97	486.41	191.26	71.88	45.47	6.1
1971	2.03	1.02	5.08	118.36	189.7	436.37	283.97	390.65	245.11	158.5	8.13	1.02
1972	5.08	4.06	4.06	70.36	59.44	140.72	100.33	322.07	122.17	61.47	22.35	0
1973	0	7.11	3.56	13.72	328.4	384.56	293.12	229.62	211.84	207.52	306.32	0
1974	0	0	25.65	96.01	185.9	170.94	498.09	245.11	352.3	65.79	83.82	0
1975	0	1.27	28.19	51.05	227.3	162.06	229.11	433.07	244.35	205.37	69.85	0
1976	9.14	19.81	9.14	23.11	184.2	419.86	415.8	319.53	152.91	191.77	115.06	0
1977	0	4.06	14.48	57.65	95.76	811.53	393.19	354.84	143.51	67.31	54.36	0
1978	0	2.03	0	13.72	439.2	277.11	395.73	209.55	297.94	66.29	18.29	0
1979	0	0	11.94	39.62	1.02	280.16	89.41	234.19	349.5	23.88	7.11	58.42
1980	0	3.05	19.05	1.27	48.77	318.52	223.01	206.25	206.25	150.37	0	0
1981	28.7	0	77.47	51.31	333.3	243.08	134.62	308.12	168.66	129.03	29.46	0
1982	0	0	0	100.58	82.55	231.9	89.15	343.92	158.5	84.33	108.2	46.99
1983	0	34.8	57.66	43.43	169.2	121.67	136.65	284.99	280.16	127.76	0	0
1984	0	0	0	72.64	319.3	145.72	102.87	185.17	248.92	115.57	18.29	0
1985	0	0	0	60.96	350	355.35	191.26	189.9	336.04	97.28	108.46	2.54
1986	0	26.67	0	75.18	76.96	252.48	552.16	375.92	215.39	255.78	0	0
1987	0	26.67	30.23	109.98	14.73	380.48	108.46	0	0	0	84.33	0
1988	0	7.87	0	24.64	573.5	271.27	222.25	266.95	136.14	159.77	0	0
1989	0	0	3.81	48.51	86.87	151.38	511.3	261.11	172.47	153.67	0	0
1990	0	1.27	119.89	50.29	491.5	880.87	281.69	219.96	473.96	92.71	42.67	0
1991	39.12	0	8.13	32.26	237	320.29	188.47	404.62	276.86	173.74	12.7	0.76
1992	10.67	65.02	0	21.84	262.6	228.35	328.68	138.68	138.68	474.47	21.34	9.91
1993	2.54	100.1	0	49.28	227.6	327.41	381.25	30.48	308.1	374.14	0	0
1994	0	13.72	35.05	31.24	90.17	483.36	260.1	245.62	428.75	154.43	16.51	0
1995	5.84	0	0	8.13	110.7	174.75	288.8	240.03	652.02	84.84	152.65	0
1996	0	0	82.04	86.11	199.9	156.72	346.71	149.61	431.8	164.59	14.99	0
1997	0	0	38.1	85.34	93.47	88.9	471.93	371.6	366.27	80.26	24.64	10.92
1998	17.27	2.29	24.38	59.69	333	122.43	46.74	223.52	45.97	186.44	6.86	0
1999	6.35	0	4.83	37.08	225.3	37.85	486.92	378.21	215.14	106.43	12.95	15.75

Table: (1) Continued

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2000	3.3	0	11.18	63.25	484.1	310.13	184.91	135.64	404.88	339.6	20.83	0
2001	0	4.57	14.22	5.59	154.2	625.6	170.94	163.32	109.73	247.4	120.9	0
2002	4.32	11.43	11.43	11.43	158	185.17	152.91	116.59	116.33	127	0	0
2003	10.67	47.5	0	76.45	167.1	264.92	250.7	88.9	204.72	106.42	26.67	2.03
2004	0	0	0	96.77	143.8	208.03	194.31	218.95	421.89	391.16	14.73	0.76
2005	1.27	0	19.05	40.39	48.26	520.7	102.62	213.11	67.82	189.23	5.59	40.89
2006	0	4.83	0	60.71	375.7	218.69	284.48	120.4	309.88	101.85	0	0
2007	50.04	0	0	14.99	306.3	340.61	177.8	376.94	110.24	296.42	45.47	0
2008	36.58	6.35	30.48	60.96	209.6	333.76	337.57	284.73	84.58	195.33	39.12	0
2009	0	0	0	119.89	124.5	197.87	75.95	256.79	161.54	169.16	2.79	0
2010	12.95	0	18.03	90.93	488.2	431.8	432.05	260.1	406.91	274.07	0	46.99
2011	19.05	0	53.09	28.96	402.8	570.99	291.08	207.01	260.1	155.96	0	5.84
2012	18.03	0	0	62.99	718.8	252.98	119.13	275.08	128.78	148.08	29.97	0
2013	0	3.05	6.86	29.97	252.2	411.99	179.83	247.14	224.03	161.8	0	0
2014	0	12.95	0	3.05	261.9	282.96	344.17	205.99	381	86.11	55.88	0
2015	40.13	0	3.05	33.78	286	246.13	789.69	245.11	184.91	213.87	1.02	0
2016	4.06	17.02	10.92	71.12	89.15	347.98	240.03	197.1	121.92	76.96	58.93	0
2017	0	2.03	21.08	58.93	117.9	163.07	266.95	472.19	234.95	213.87	13.97	18.03
2018	23.88	0	0	32	142.2	403.61	235.97	208.03	217.93	119.13	0	0
2019	7.11	9.91	21.08	49.02	53.85	197.1	39.88	313.94	41.15	87.88	7.11	4.06

Source: Meteorology and Hydrology Department of Katha

Table: (2) Monthly Rainfall Variation of Katha Township (1967-2019)

No.	Month	Mean	No. of year above the Mean	Percent	No. of year below the Mean	Percent
1	January	7.69	15	28.30	38	71.70
2	February	8.54	13	24.53	40	75.47
3	March	16.83	19	35.85	34	64.15
4	April	51.09	24	45.28	29	54.72
5	May	220.69	24	45.28	29	54.72
6	June	305.54	23	43.39	30	56.61
7	July	260.88	23	43.39	30	56.61
8	August	253.99	23	43.39	30	56.61
9	September	234.47	24	45.28	29	54.72
10	October	157.33	22	41.51	31	58.49
11	November	35.19	22	45.51	31	58.49
12	December	5.21	10	18.87	43	81.13

Source: Compiled by Researcher

Table: (3) Mean Monthly Rainfall of Katha Township (1967-2019)

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rain	7.69	8.54	16.83	51.09	220.69	305.54	260.88	253.99	234.47	157.33	35.19	5.21

Source: Compiled by Researcher

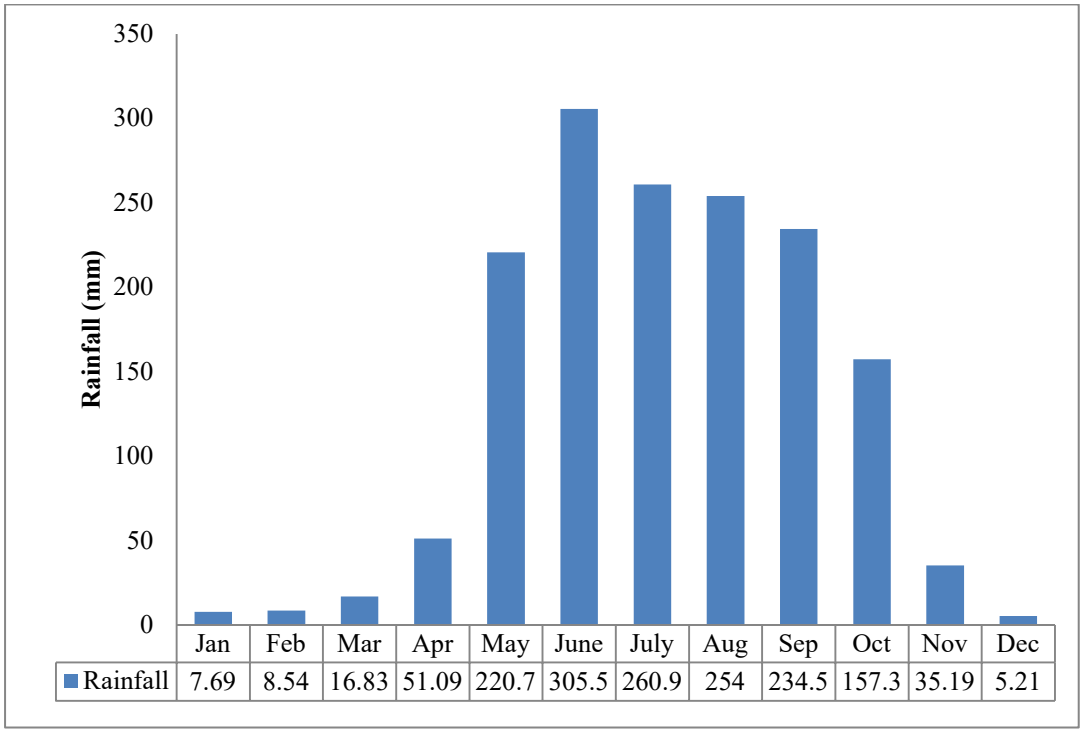


Figure: (2) Mean Monthly Rainfall of Katha Township (1967-2019)

Source: Based on Table (3)

Annual and Decadal Precipitation Concentration Index

On Annual Precipitation Concentration Index basis, the result of PCI calculated for Katha Township showed the PCI value range from the lowest value of 14.61 in 1973 to the highest of 31.16 recorded in 1987.During the 53-year from 1967 to 2019, the PCI mean value is 18.52. (Table 4 and Figure 3)

The result further showed that 67.93 percent of the years were characterized by a PCI value within the irregular range, an indication of irregular precipitation distribution while 22.64 percent of the years recorded annual PIC value within the high range indicating the high rainfall distribution and 9.43 percent of the years recorded annual PCI value within the low range indicating the low precipitation distribution of the yearswithin 53 years. Table (5)

This also indicates that in each of the years for which the PCI value falls within the irregular range with a PCI value of 16, precipitation will be concentrated more in half of the 53 years. The mean annual rainfall PCI value for Katha Township was calculated to be 18.52; of the 53 years under study, only 21 of those years recorded value above the mean while 32 years were predominately below the mean. Thus, the mean annual PCI value for 53 years is in the irregular range.

To further analyze the characteristics of PCI in Katha Township, decadal values were calculated. On the decadal scale, the mean annul PCI value for 1967-1976 has 17 while for the periods 1977-1986 and 2007-2016 with mean annul PCI value of 18, for the periods

1997-2006 with mean annul PCI value of 19 and for the periods 1987-1996 with mean annul PCI value of 20 respectively. For annually, mean annul PCI value showed that rainfall was irregular distributedfor 5 decades. Table (6)

In decadal analyzes, there are four years with above the decadal mean while six years are below the decadal mean for 1967-1976 (Figure 4). For 1977-1986 and 1997-2006, there are five years abovethe decadal mean and below the decadal mean (Figure 5 and 7). For 1987-1996, only four years are above the decadal mean while six years are below the decadal mean (Figure 6). There are only three years are above the decadal mean while seven years with below the decadal mean (Figure 8).

In analyzing the annual and decadal precipitation concentration index of Katha Township, the mean annual PCI value for the 53 years and five decades are found uniform irregular precipitation concentration. Based on the results above, annual rainfall of Katha Township is irregular precipitation concentration in most of the years. Therefore, rainfall of Katha Township is sufficient for cultivation. Among the 53years, there are 12 years withhigh precipitation concentration such as 1970, 1977, 1979, 1887, 1988, 1989, 1995, 1999, 2001, 2005, 2012 and 2019.As there were high precipitation concentrations in these years, it is found that the loss of agricultural land and residential land near the Ayeyarwady River and Shweli River, soil erosion and other water related problems incident in the township.

Table: (4) Precipitation Concentration Index Value (1967-2019)

Year	PCI Value	Year	PCI Value
1967	15.53	1994	18.75
1968	17.56	1995	21.67
1969	18.80	1996	16.32
1970	21.86	1997	19.82
1971	16.51	1998	19.21
1972	19.39	1999	21.09
1973	14.61	2000	17.40
1974	17.41	2001	21.40
1875	15.69	2002	15.78
1976	16.17	2003	14.88
1977	24.58	2004	17.16
1978	19.06	2005	23.95
1979	22.44	2006	18.09
1980	18.90	2007	16.53
1981	14.98	2008	15.38
1982	15.65	2009	15.91
1983	15.49	2010	15.36
1984	17.05	2011	17.89
1985	16.05	2012	23.22
1986	18.92	2013	17.56
1987	31.16	2014	17.43
1988	20.54	2015	21.75
1989	21.54	2016	16.73
1990	19.82	2017	17.56
1991	16.30	2018	18.44
1992	17.23	2019	22.30
1993	17.04	Mean	18.52

Source: Compiled By Researcher

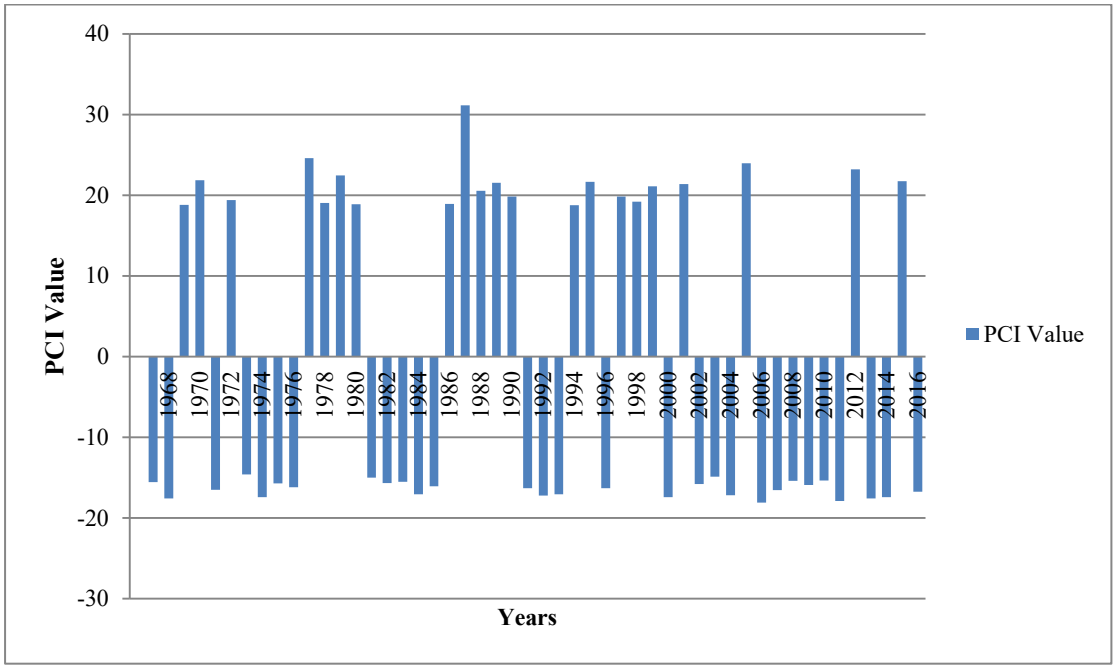


Figure: (3) Above and Below of PCI Mean Value (1967-2017)

Source: Based on Table (4)

Table: (5) Classification of Precipitation Concentration Index by Years at Katha Township (1976-2019)

PCI Value	Year	Percent
PCI≤ 10 (low precipitation concentration)	-	-
PCI (<11and ≤15) (moderate precipitation concentration)	1973,1981,2003,2008,2010	9.43
PCI <16 and ≤20) (irregular precipitation concentration)	1967,1968,1969,1970,1971,1974,1975,1976, 1978,1980,1982,1983,1984,1985,1986,1990, 1991,1992,1993,1994,1996,1997,1998,2000, 2002,2004,2006,2007,2009,2011,2013,2013, 2014,2015,2016,2017,2018	67.93
PCI > 20 (high precipitation concentration index)	1970,1977,1979,1987,1988,1989,1995,1999, 2001,2005,2012,2019	22.64

Source: Compiled by Researcher

Table: (6) Mean Decadal Values of Precipitation Concentration Index of Katha Township

Decade	Mean Decadal Value
1967-1976	17.35
1977-1986	18.31
1987-1996	20.0
1997-2006	18.87
2007-2016	17.7

Source: Compiled by Researcher

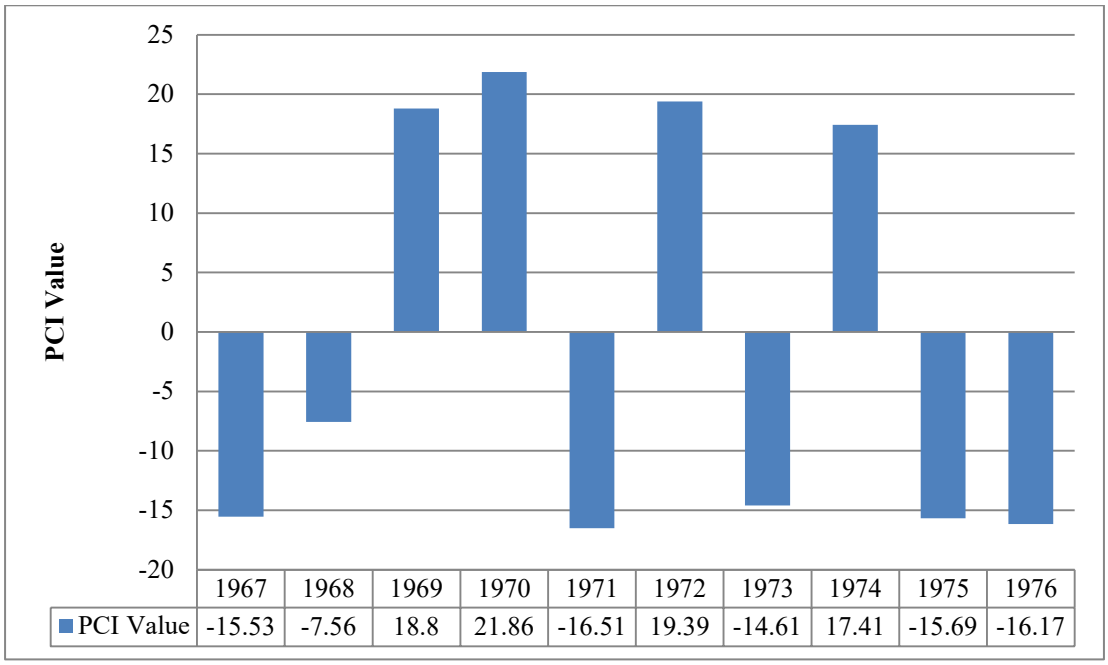


Figure: (4) Decadal Values of Precipitation Concentration Index (1967-1976)

Source: Compiled by Researcher

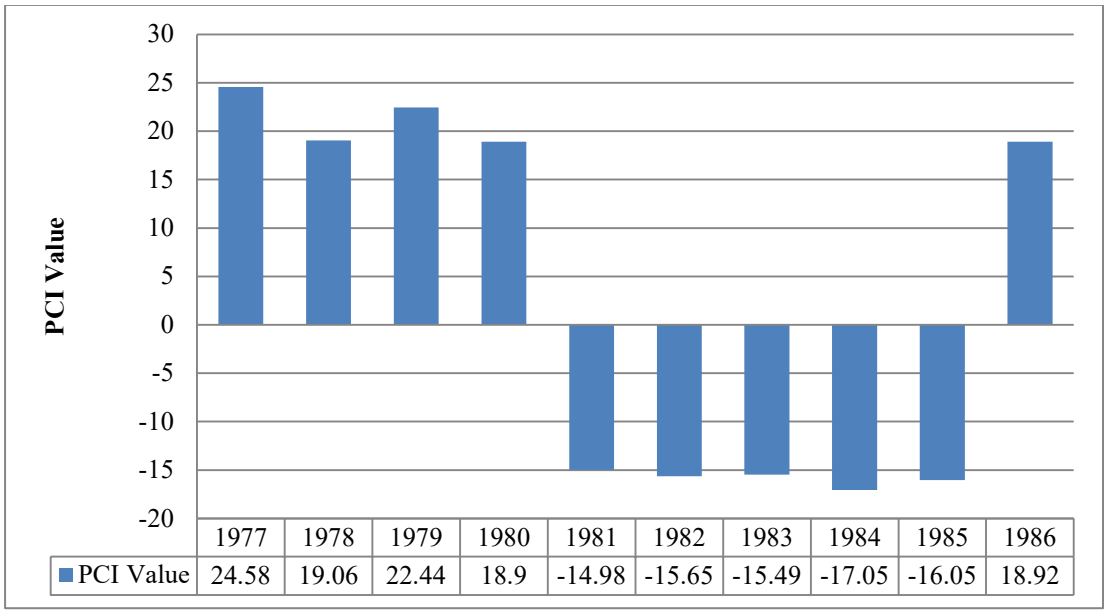
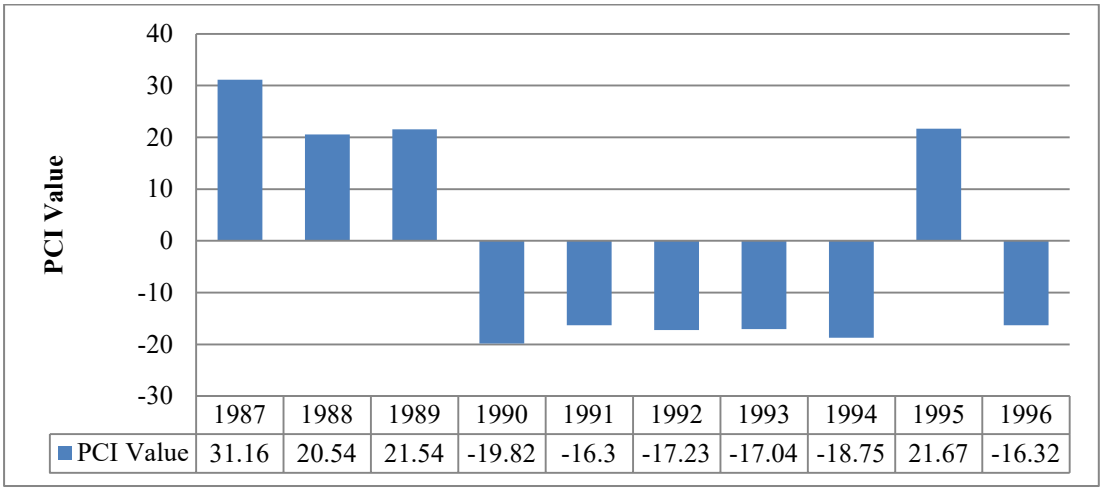


Figure: (5) Decadal Values of Precipitation Concentration Index (1977-1986)

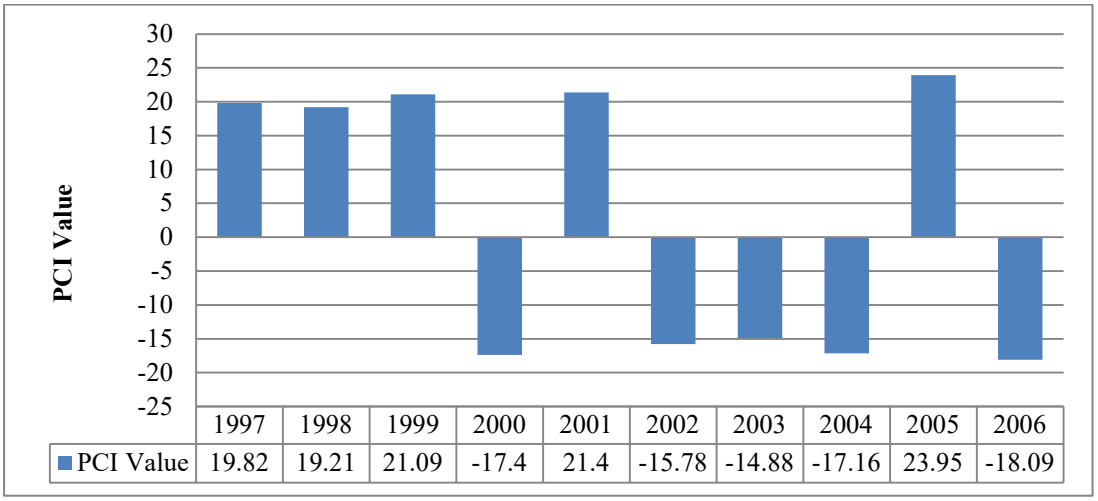
Source: Compiled by Researcher



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
PCI Value	31.16	20.54	21.54	-19.82	-16.3	-17.23	-17.04	-18.75	21.67	-16.32

Figure: (6) Decadal Values of Precipitation Concentration Index (1987-1996)

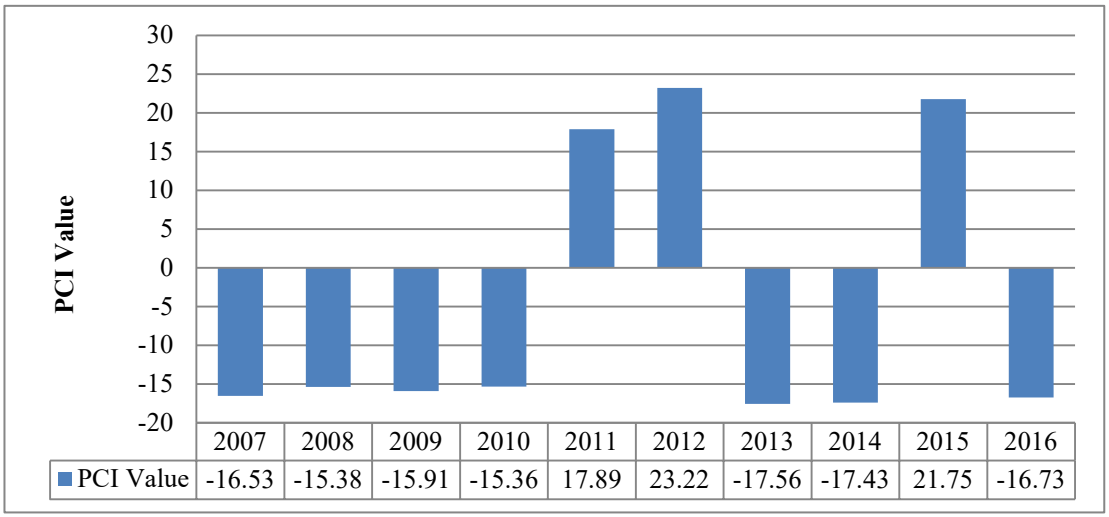
Source: Compiled by Researcher



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
PCI Value	19.82	19.21	21.09	-17.4	21.4	-15.78	-14.88	-17.16	23.95	-18.09

Figure:(7) Decadal Values of Precipitation Concentration Index (1997-2006)

Source: Compiled by Researcher



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PCI Value	-16.53	-15.38	-15.91	-15.36	17.89	23.22	-17.56	-17.43	21.75	-16.73

Figure:(8) Decadal Values of Precipitation Concentration Index (2007-2016)

Source: Compiled by Researcher

Conclusion

This paper has attempted to evaluate the variability and concentration of rainfall by using Precipitation Concentration Index (PCI) based on monthly and annually precipitation over 53-year period (1976-2019). In analyzing the monthly rainfall variability and precipitation ratio of Katha Township, it is found that June is the highest monthly rainfall variation and December is the lowest monthly rainfall variation.

In analyzing the annual and decadal precipitation concentration index of Katha Township, the mean annual PCI value for the 53 years and five decades are found uniform irregular precipitation concentration. Based on the results above, annual rainfall of Katha Township is irregular precipitation concentration in most of the years. Therefore, the result presented in this analysis have shown PCI to be a very important input, valuable for water resource planning and management, disaster preparedness provides information on water variability for the relevant government agencies.The implications of such observed change have strong influence on natural process of soil erosion, flooding, fluvial regimes and ground water recharge.

Acknowledgements

I am greatly indebted to Pro-rector Dr Win Swe (Rector Duty), and Pro-rector Dr Myo Myo, Shwebo University, for their permission on this research. I wish to express my special thanks to Dr Than Than Win, Professor and Head of Geography Department, Shwebo University for her guidance and encouragement of this research. Moreover, I am also thankful to all of Meteorology and Hydrology Department of Katha.

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A Geographical Analysis of Water Consumption in Shwebo

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Abstract

This paper is entitled "Geographical Analysis of Water Consumption in Shwebo Town.The main aim of this paper is to assess the water quality and spatial variation of water availability for domestic water. Primary data and Secondary data are used in this analysis. Primary data are based on field observation. To investigate the factors influencing residential water consumption, a sample of 500 households located in 10 wards of Shwebo town were randomly selected and each household fill up the questionnaire form and was made interview in some households. To know the quality of water, water samples were collected from five different water sources at the time of the survey on December 25th 2019. Water sampleswere sent to Public Health Laboratory, Ministry of Health and Sports, Mandalay. The results show that the spatial variation of water availability is influenced by the landscaping. The results of physical properties show that there were no considerable variations in water quality of different water sources. The chemical properties vary with different location

Key words: Consumption, Spatial variation, Landscaping

Introduction

Shwebo is located between 22º32' N and 22º 36' N Latitudes, and between 95º 39' E and 95º 44' E Longitudes. It is on the northern margins of the dry zone.The town, Shwebo has an area of 2986 acres or 4.67 square miles. The town comprises 10 wards. Shwebo lies at an average height of 310 feet above sea level on the flat plain in the Dry Zone of Central Myanmar. The elevation of the town slightly decreases from the east to the west and from north to south. The northeastern portion of the town has 110 meters (360.89 ft) in elevation and the west and southwestern portion has 90.2 m (295.27 ft.) in elevation.The Mahananda Tank lies at a distance of one-mile north of Shwebo. At present, it provides the domestic water to town dwellers. Another man-made drainage is a square-shaped moat and its each side is 2 miles long.In southern part of the town, there is MoksogyoneBranch Canal which is stretching west-east. Although it is an irrigation canal from the Mu River, its water is being used by the people living there.According to the climatic data (1989-2019) collected from the Meteorological Station of Shwebo, the average mean temperature is 81.1 ºF. The average rainfall is less than 41.3 inches. Therefore the town suffers from the Tropical Savanna Climate (Aw).

According to the Immigration and National Registration Department, the total population of Shwebo is 69036 persons in 2014 census and 72023 persons in 2019. During the period of five years from 2014 to 2019, the total increase of population is 2987 persons with 0.79 percent of annual growth rate.

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Aims and objectives

The main aim of this paper is to represent the current situation of domestic water availability of Shwebo Town and to assess the water quality for domestic water. The objectives are:

(1) To identify variation of water sources of the town

(2) To explain the water quality of Mahananda and Mu Cannal

(3) To access the role of factors influencingdomestic water consumption.

Data collection and Methodology

Primary data and Secondary data are used in this analysis. Secondary data are obtained from the General Administrative Department, Township Development Committee, Shwebo and W.H.O report.Location, elevation, and areas of Mahanada Tank and Shwebo town are surveyed by using G.P.S method. For base Map, such as river, roads and boundary are drawn by using ARC GIS. Primary data are based on field observation. To investigate the factors influencing residential water consumption, a sample of 500 households located in 10 wards of Shwebo town were randomly selected and each household fill up the questionaire form and was made interview in some households**.** To know the result of quality of water, water samples were sent to Public Health Laboratory, Ministry of Health and Sports, Mandalay.

Finding and Discussion

Water Sources

With regard to water sources, there are mainly two types of water supply in Shwebo. They are surface water and ground water. Shwebo has to rely upon the surface water supply, mostly through the use of pipelines and canals.

Surface Water-Before 1990, most of the people in Shwebo used the water from the Moksogyon Branch Canal even as a drinking water.At the time of State Peace and Development Council, in 1997, Kindat Weir was constructed to divert the Mu water through the Old Mu Canal which enters the Mahananda tank.

Whence, Mahanda tank was obtained permanently water. As a consequence, it could distribute water not only to irrigated areas but also for domestic use of people in Shwebo town. Water from the tank were distributed with the installation of water filtering tank with chlorine mixer. The project was Gravity flow system and started in 1997. At the present time, almost allof the people in every ward are relying on the municipal water supply system from the Mahananda Tank.

Ground Water-In Shwebo, Prior to 1979 people were depending on the Mu Canal for domestic water. The distribution system are mainly by push-carts and ox-carts. In April 1989, water supply was improved with the aid of Japan. There are nine tube wells from which ground water is pumped and sent to three overhead-tanks. Water is distributed to ten wards through pipes. It is distributed twice a day, once in the morning and once in the evening. The total amount of water supply from the three overhead tanks can supply 360,000 gallons per days. In summer water consumption is double than that of winter.However, it was unsuccessful to utilize for domestic purpose due to the deficite electric and blocking with sands in the pipe lines.According to the collected data in 2019, of total houses, there were 992 houses (9.31 %) in utilization of ground water with tube well and 736 houses (6.91%) in sanitary open well water utilization and 148 houses (1.39 %) in unsanitary open well water utilization.

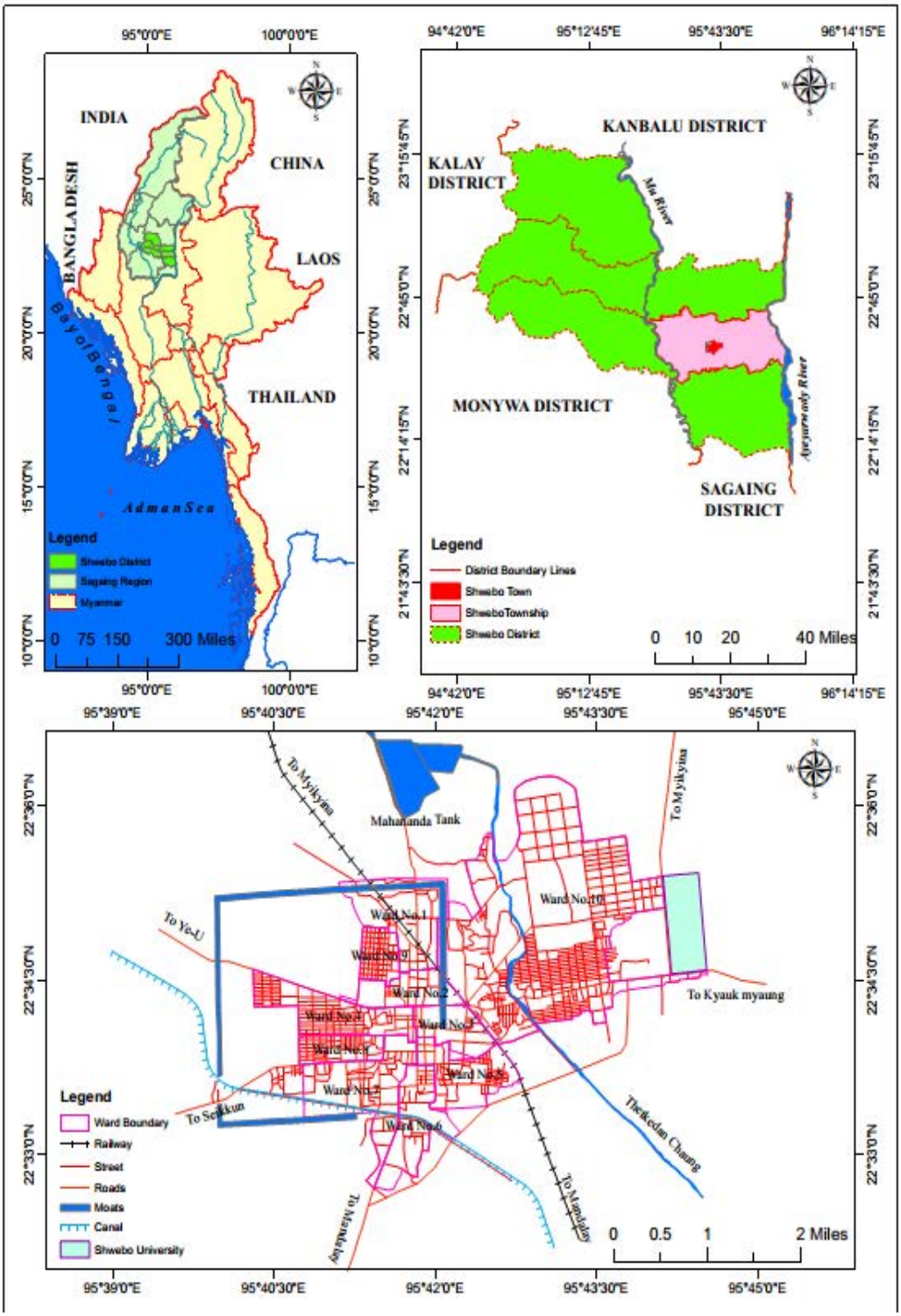

Figure (1) Location of Shwebo

Source: UTM Map 2295 & Department of Township Developmant Affairs, Shwebo.

Rain Water- Rain water harvesting is also common in Shwebo Town. Since the ground water is very salty, “hard”, and contains heavy metals, it cannot be used as drinking water. Rain water harvesting system is being installed in almost every house for the purpose of drinking water. When there is rain, rain water is the accumulation and storagefor reuse. It can be collected from roofs through gutter to tanks or earthen pots. It can be used as drinking water, long-term storage for other purposes. According to the collected data in 2019, of total houses, there were 2610 houses (24.51 %) in sanitary rain water utilization and 93 (0.84%) houses in unsanitary.

Pure Drinking Water-Formerly, most of the town dwellers used the pipeline water and canal water as drinking water. As portable fresh water, there are only one well possessed by U ZawPhay in No.3 wards just near north of AungZeYa football field and U Kyi Mg's well in western part of No.9 ward. Another one is in AungMyaeMonestry. The one who want to use fresh water had to buy with a price of 500 Kyats per barrel. There are wells in every wards of Shwebo. But water could not be used as drinking water owing to high content of salt. Some people use rain water the whole year round with storage brick tanks.Todays, with the development of use of purified drinking water, most of the people increasingly used purified drinking water. In 2019, there were 15companies distributing purified drinking water in Shwebo Township.

Analysis of Water Consumption

As the town of Shwebo is located in the Central Dry zone, it is an area of low rainfall. The annual rainfall is 41.3 inches.With regard to water resources, Shwebo has to rely upon the artificial water supply, mostly through the use of canal and pipelines from Mahananda Tank. Portable water is available in some places of the town. But, the quality of the ground water varies from place to place. Ground water is available through tube well or can be pumped up from deeper down. Before 1997, surface water was obtained from the Moksogyon Branch Canal in southern portion of the town and the moat in northern portion of the town. Water for the moat is filled from the Mahananda tank.

In order to analyze the domestic water consumption, a field survey was conducted with a sample size of 500 households in 2019. For each ward, 50 households was randomly selected and made a structured interview. According to the survey data, there are 269 households or58 percentin consumption of water from Mahananda Tank.Rain water with 112 households or 22.4 percent, Tube well water with 76 households or 15.2 percent, open-well water with 35 households or 7 percent and lake water with 8 households or 1.6 percent were found.

No.1 Wards has the highest with 34 houses or 68 percent in consumption of water from Mahananda tank and No.10 Ward is the least with 11 houses or 22 percent. This spatial variation of water availability is generally influenced by the landscaping. E.g. No.10 Ward stands at the average elevation of 319 feet and above. It is more 10 feet higher than the beginning point of water delivery of crossing rail road.

According to some authors, income, water prices and taxes have been widely used to study the determinants of residential water consumption. When studying the underlying causes of domestic water consumption; the consideration of three variables (household

members, housing type and consumer behavior with regard to water (attitudes) can be examined partially and, along with more economic instruments (Elena Domene).

In the study area, income may correlates positively with residential water consumption but it is not clear in their responding. Moreover, indoor water consumption (drinking, cooking, bathing, and washing clothes) remains similarity for different income categories. Besides, water price and tax for the use of water from the Mahananda Tank is the same in all wards of Shwebo. In 2019, the price is 150 Kyats per cubic meter. Water bills for most houses reveal that the charges are mostly from 2500 to 4000 Kyats per months. The total revenue collected from municipality is 19,286,100 kyats in 2018. The average cost per household is 3178.33 kyats per household. Housing type does not exist as a major factor influencing water consumption in Shwebo. The town doesn't have multistory building with apartments. Mostly, the town has only one and two stored buildings. There is no significant difference between housing Types. Though there is the use of canal water, well water, tube-well water and rain water, the use of water from the Mahananda tank is the highest in every ward. In order to take into account the attitude toward the use of water from Mahananda tank, consumers were interviewed with two indexes: satisfy and unsatisfy regarding with the use of water. This represents that there are averaging with 70 % in satisfy and the rest is unsatisfied with the reason of insufficient and unsafe water.

Assessment on the Topography and Water Utilization by Wards

The distribution of water and its supply also depends on the topography of its landscape consisting of steep slope, leveled and low lying area. Often water flows from higher area is to lower area. Although water can be pumped with force created by generators, water supply from Mahanada Tank is gravity flow system that brings spatial variation. The low lying settlements were more likely to receive higher amount of water than settlements at steep slope. Similarly, interruption in water supply was common according to their situation on nature of relief respectively.

In order to assess the relationship between elevation and different water utilization by wards, Pearson's Product Moment Correlation Method is used. Here, average elevation of each ward can be obtained by using the zonal statistics function in ARC GIS environment. Based on the sample survey data, the relationship between the elevation and water use pattern is calculated with the Pearson' Product Moment Correlation Coefficient.

The correlation between elevation and utilization of tank water is '- 0.28. This means that the higher the elevation, the lower the utilization of tank water. The correlation between the elevation and rain water utilization is '- 0.6. This value reveals that the utilization of rain is also reversed with the elevation. The correlation between elevation and utilization of tube well water is +0.5. There is direct positive relationship between elevation and tube well water utilization. The correlation between elevation and utilization of open well water is +0.4. This indicates that the communities living in higher elevation of the wards are more utilize the open well water. The correlation between average elevation and lake water utilization is +0.47. This value also reveals that the communities living far from the main pipeline and higher elevation use lake water.

Table (1) Water Utilization by Wards (2019)

Wards	T.W	R.W	Tu.W	O.W.W	L.W	Households
No.1	34	8	5	3	0	50
No.2	24	20	4	2	0	50
No.3	25	8	16	1	0	50
No.4	24	10	7	8	1	50
No.5	30	15	3	1	1	50
No.6	28	12	4	5	1	50
No.7	31	11	3	4	1	50
No.8	33	4	8	5	0	50
No.9	29	12	6	2	1	50
No.10	11	12	20	4	3	50
Total	269	112	76	35	8	500

T.W=Tank Water, R.W= Rain Water, Tu.W= Tube Well Water, O.W.W= Open Well Water, L.W= Lake Water

Source: Field Survey

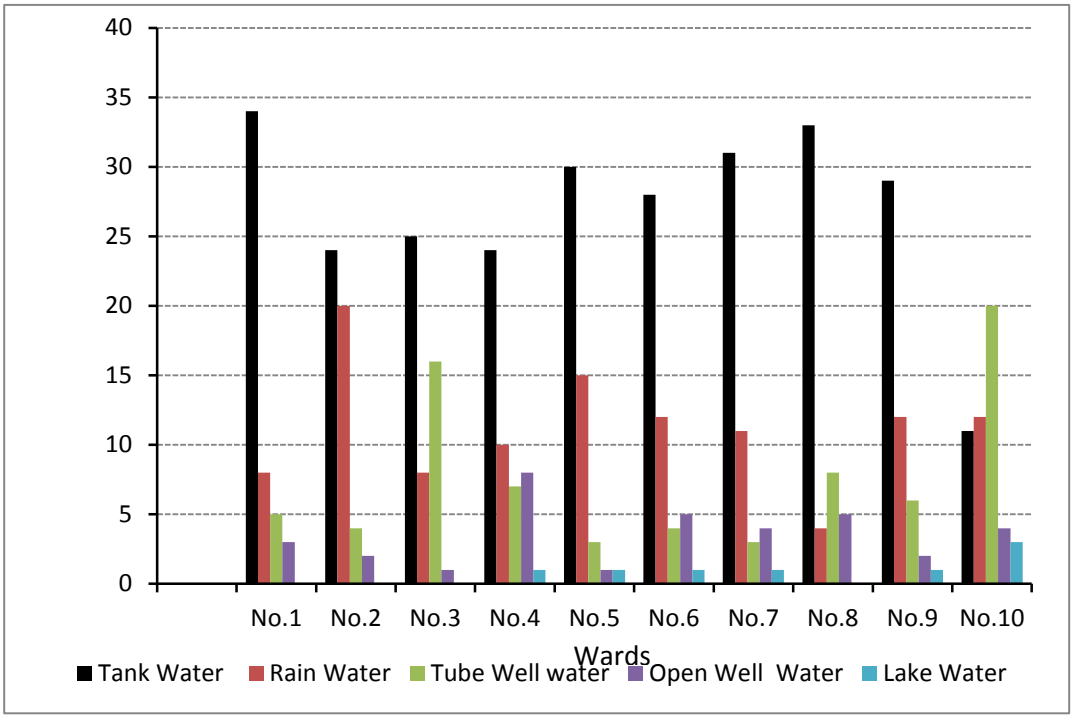

Figure (2) Water Utilization by Wards (2019)

Source: Based on Table (1)

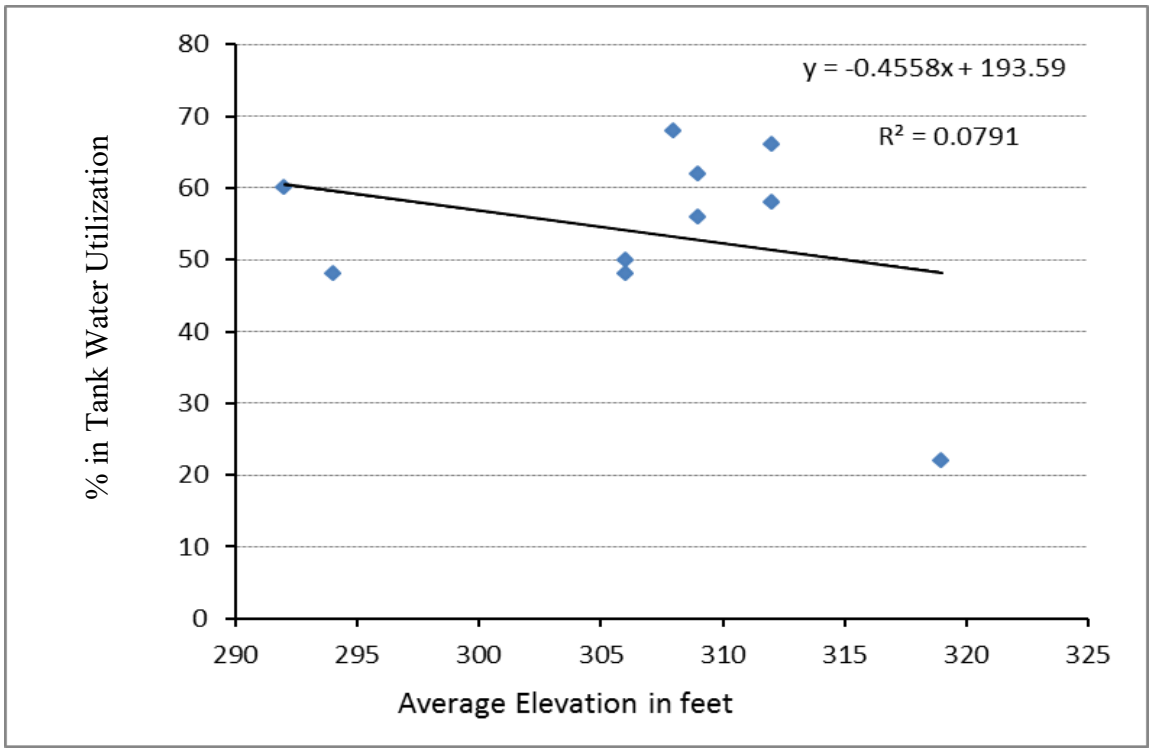

Figure (3) Correlation between Average Elevation and Tank Water Utilization

Source: Base On Table (1)

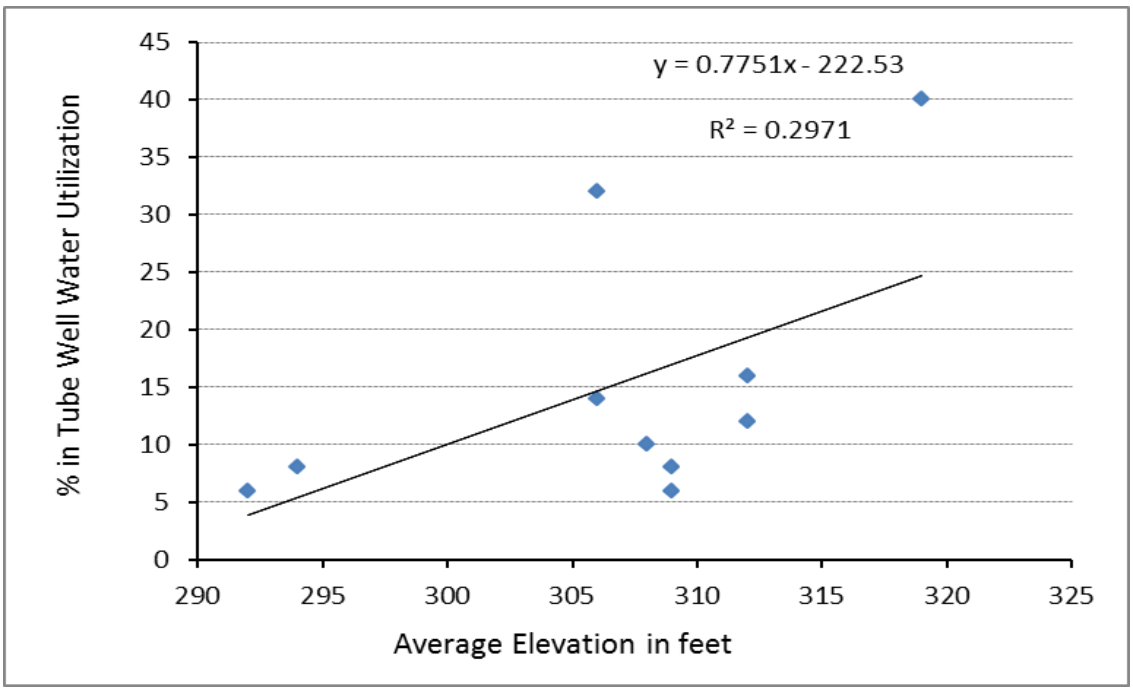

Figure (4) Correlation between Average Elevation and Tube Well Water Utilization

Source: Base On Table (1)

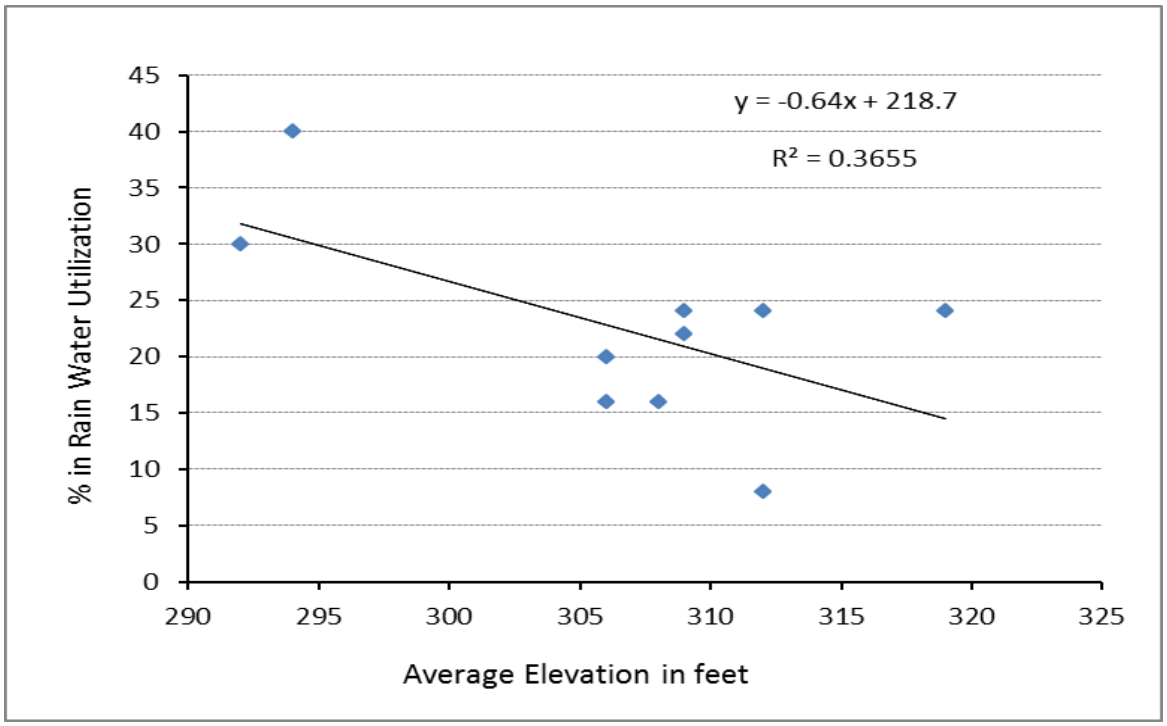

Figure (5) Correlation between Average Elevation and Rain Water Utilization

Source: Base On Table (1)

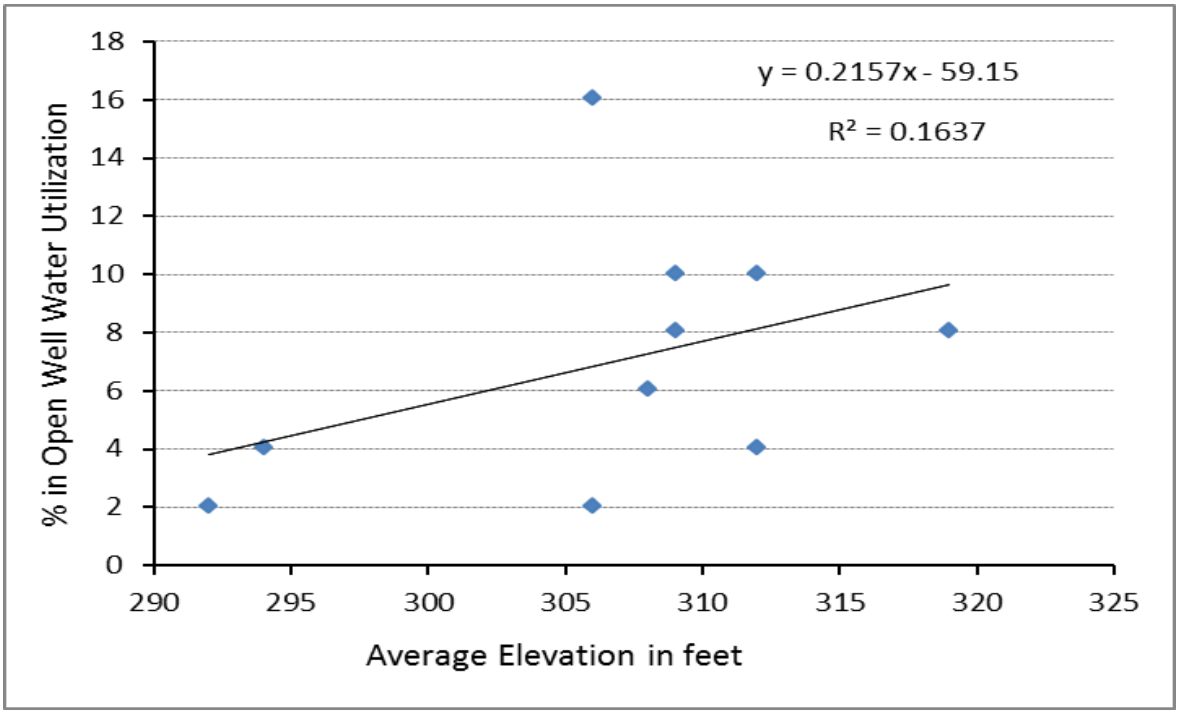

Figure (6) Correlation between Average Elevation and Open Well Water Utilization

Source: Base On Table (1)

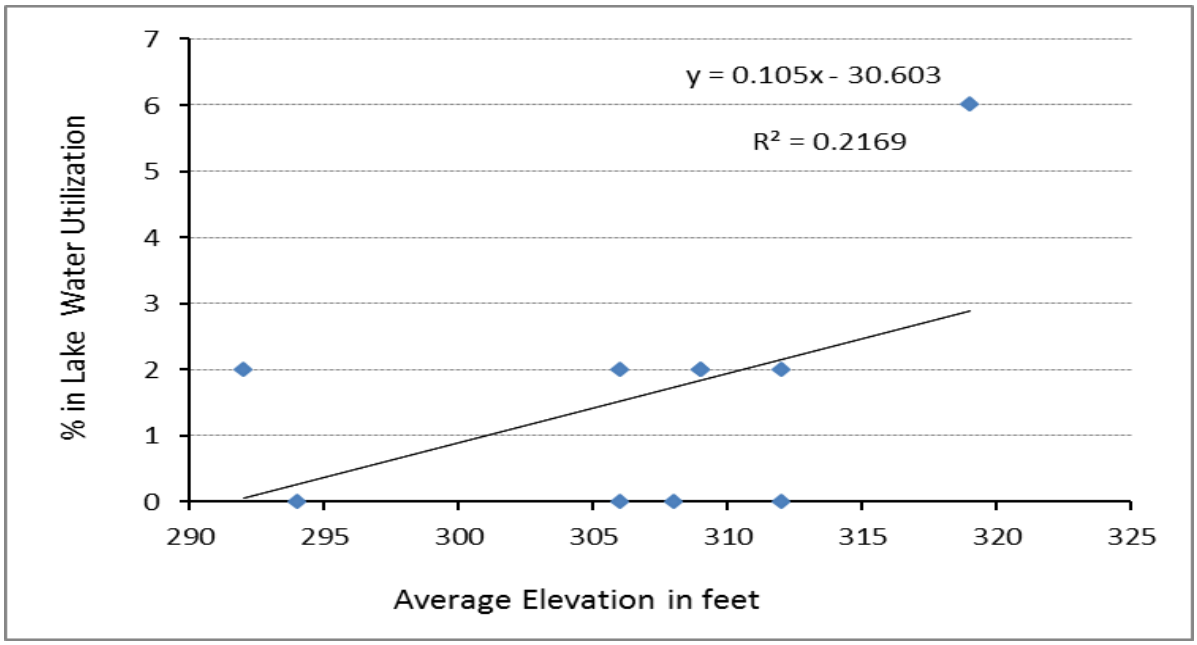

Figure (7) Correlation between Average Elevation and Lake Water Utilization

Source: Base On Table (1)

Water Testing

Samples were collected five different water sources available at the time of the survey on December 25 th2019.Samples were collected in plastic 5 purified drinking bottles and were sent to Public Health Laboratory, Ministry of Health and Sports, Mandalay within 24 hours of collection.An examination of water samples is to identify the concentration of component properties from different sources. These parameters will be different to some extent from one place to another. As Shwebo is dry and receives low rainfall,most of people usetank water which forms the main sources for household activities and drinking water in some places. Use of rain water is also important in almost every ward. Rian water is stored in brick tanks or glazed earthenware pots when rain receives. Ground water is the main source for No. 10 Ward which is located at an average elevation of 319 feet, but in some places elevation is over 360 feet. Canal water is important for the residents in southern tip of the town. Therefore water samples were taken from Mahanada Tank (Sample 1), rain water from storage tank of on household in No.10 ward (Sample 2), ground water from Public Distribution Pumping Station lying in No.3 Ward (Sample 3), canal water (Sample 4) and ground water from private home tank (Sample 5).

Analysis was carried out for various water quality parameters such as appearance, colour and turbidity in physical properties and pH, total solids, total hardness (as $CaCO_{3)}$, total alkalinity (as $CaCO_{3)}$, calcium (Ca), magnesium (Mg), chloride (Cl), sulphateSO_4 and total iron (Fe) in chemical properties.

The results of various physical,chemical propertiesof examined samples are shown in Table (2). A comparison of physical and chemical properties of the studied water samples has also been made with WHO standards.

Physical Properties

The results of physical propertiesshow that there were no considerable variations in the water quality of different water sources. The appearance is clear in all water sources. The colour is 5 units lower than the WHO standard (50 units). There is no turbidity.

Chemical Properties

The experimental results for pH analyses of S 1, S 2, S 3, S 4and S 5 samples are depicted in (Table2). Well known pH is a measure of acidity or alkalinity of a solution. In the case of water samples, the highest value of pH was found to be 7.9 which is from Mahanada Tank and in a compliance with the guideline range of pH values for drinking water (6.5- 8.5) prescribed by WHO, as a result there is no significant change in the pH values of water sources.

Total Dissolved Solids (TDS) can be considered as the summation of all dissolves solids in the water, such as non-organic materials, carbonate, bicarbonate, nitrate, sodium, potassium, chloride, and magnesium. TDS affects the other characteristics of drinking water such as taste and hardness. It has been reported that, the amount of TDS more than 500 mg/l of TDS is not considered desirable for drinking water supplies, in some cases will be allowed up to 1500 mg/l .The TDS values varied from 371 mg/l to 1024 mg/l. All water samples show a compliance of TDS values with the prescribed limit (1,500 mg/l) given by WHO.

Hardness can be considered one of the properties of water, it can be known by its lather formation with soap. The hardness of water mainly depends upon the amount of calcium or magnesium salts or both. The total hardness (TH) of water under the study shows values in the range from 80 mg/l to 120 mg/l. All samples values were lesser than the prescribed limit (500 mg/l) by WHO.

The alkalinity concentrations(as $CaCO_3$)were varied from 195 mg/l to 520 mg/l.. All Samples show a low concentration when compared to the prescribed limit by WHO.

The values of concentration of calcium varied from 16.00 mg/l to 32.00 mg/l. The presence of calcium related to hardness. This higher value of calcium related to the S 3 (Tube well water) compare to other samples and all found to be below permissible limit of WHO.

The increase amount of magnesium (Mg) is related to hardness. Magnesium content in the investigated water samples was ranging from 2 mg/l to 14.00 mg/l. All were found to be within WHO limits.

The chloride content in the study area varied from 40 mg/l to 360 mg/l. and found to be within the prescribed limit by WHO.

The concentration of sulphate varied from 59 mg/l and 118 mg/l. It is well known that its occurrence is fromdischarge of industrial wastes and domestic sewage tends to increase sulphate concentration. The result of analysis shows the values found within the prescribed limit by WHO.

The concentration of iron varied from 0.00 mg/l to 0.02 mg/l. (Table-2). All water sampling showlower iron concentration than the prescribed limit by WHO.

Table (2) Physical and Chemical Properties of Water Samples

No.	Post	S 1	S 2	S 3	S 4	S 5	Maximum Permissible Level	Unit
1	Appearance	Clear	Clear	Clear	Clear	Clear		
2	Colour (Platinum, Cobolot Scale)	5	5	5	5	5	50	Units
3	Turbidity (Silcoda Scale Unit)	-	-	-	-	-	25	NTU
4	pH Value	7.9	7.7	7.1	7.4	7.3	6.5 to 8.5	mg/l
5	Total Dissolved Solids (TDS)	459	371	1015	530	1024	1,500	mg/l
6	Total Hardness (TH)	80	60	120	100	120	500	mg/l
7	Total Alkalinity (as $CaCO_3$)	260	195	520	325	455	950	mg/l
8	Calcium as Ca	16	20	32	20	24	200	mg/l
9	Magniesium as Mg	10	2	10	12	14	150	mg/l
10	Chloride as CL	40	40	280	40	360	600	mg/l
11	Sulphate as SO_4	78	59	118	78	118	400	mg/l
12	Total Iron as Fe	Nil	Nil	Nil	Nil	Nil	1	mg/l

S 1= Tank Water, S 2= Rain Water, S 3= Private Ground Water, S 4= Canal Water,
S 5= Public Ground Water

Source : Laboratory, MDY

Findings

In order to assess the relationship between elevation and different water utilization by wards, Pearson's Product Moment Correlation Method is used. The correlation between elevation and utilization of tank water is '- 0.28. This means that the higher the elevation, the lower the utilization of tank water. The correlation between the elevation and rain water utilization is '- 0.6. This value reveals that the utilization of rain is also reversed with the elevation. The correlation between elevation and utilization of tube well water is +0.5. There is direct positive relationship between elevation and tube well water utilization. The correlation between elevation and utilization of open well water is +0.4. This indicates that the communities living in higher elevation of the wards are more utilize the open well water. The correlation between average elevation and lake water utilization is +0.47. This value also reveals that the communities living far from the main pipeline and higher elevation use lake water.

Water Samples were collected from five different water sources available at the time of the survey on December 25 th2019. The highest value of pH was found to be 7.9 which is from Mahanada Tank and in a compliance with the guideline range of pH values for drinking

water (6.5- 8.5) prescribed by WHO. The TDS values varied from 371 mg/l to 1024 mg/l. All water samples show a compliance of TDS values with the prescribed limit (1,500 mg/l) given by WHO. The analysis of total hardness (TH) of water under the study, shown values in the range from 80 mg/l to 120 mg/l. All samples values were lesser than the prescribed limit (500 mg/l) by WHO. The alkalinity concentrations(as $CaCO_3$)were varied from 195 mg/l to 520 mg/l. All Samples show a low concentration when compared to the prescribed limit by WHO. The values of concentration of calcium varied from 16.00 mg/l to 32.00 mg/l .Magnesium content in the investigated water samples was ranging from 2 mg/l to 14.00 mg/l. .All were found to be within WHO limits. The chloride content in the study area varied from 40 mg/l to 360 mg/l. and found to be within the prescribed limit by WHO. The concentration of sulphate varied from 59 mg/l and 118 mg/l. The result of analysis shows the values found within the prescribed limit by WHO.The concentration of iron varied from 0.00 mg/l to 0.02 mg/.All water sampling plants showed lower iron concentration than the prescribed limit by WHO.

Discussion

In the present study five different water sources available were collected. Samples were sent to Public Health Laboratory.The results of physical properties show that there were no considerable variations in water quality of different water sources. The chemical properties vary with different location.The results may not be completely satisfactory because data were could not be collected from the whole town. Finally the requirement of water is influencing by population growth and their use pattern. Housing types is less important factors but household member is must consider factors for sufficiency behind consumption.

Conclusion

Water covers 71% of the earth's surface. Only 2.5% of the earth's water is freshwater. 98.8% on that water is in ice. Only 0.3% of all freshwater is in river, lakes and atmosphere. So the major water requirements depend on the growth of population. According to calculation water requirement per day is based on the 25 gallons of averages per capital consumption, the water requirement changes from 1580725 gallons requirement per day in 1993 with63229 persons to 1,800,600 gallons per day in 2019 with 72023 persons.

Accordingto the survey data, there are 269 households or 58 percentin consumption of water from Mahananda Tank. Rain water with 112 households or 22.4 percent, Tube well water with 76 households or 15.2 percent, open-well water with 35 households or 7 percent and lake water with 8 households or 1.6 percent were found. No.1 Wards has the highest with 34 houses or 68 percent in consumption of water from Mahananda tank and No.10 Ward is the least with 11 houses or 22 percent.

Acknowledgement

I would like to express sincere thanks to the members of Shwebo University of Research Committee for the permission to present this research paper. I am also grateful to Professor DrThan Than Win, Professor and Head, Department of Geography, Shwebo University, for her invaluable advise and suggestion.

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A Geographical Study on Winter Paddy (*Mayin*) Cultivation of Kawlin Area

Thin Hlaing Hlaing Tun[1], Khin Mar Tin[2],
Mya Mya Soe[3], Khin San Win[4]

Abstract

Winter paddy is called *Mayin*paddy by local farmer in the riverine areas of dry zone of Myanmar. It is cultivated in the fringe areas of low water in December and January. According to the conditions of stored water of each location, the dates of cultivation are also different. Kawlin Township lies in the Daung Yu *Chaung* basin or fluvial area and between 23º28'48" and 23º54'53" north latitudes and between 95º17'51" and 96º0'36" east longitudes. Daung Yu *Chaung*take its sourced on the Wuntho Massif Volcanic which is resisted to erosion, and there are igneous rock of breccia and basalt and volcanic ash for fertile soil. Daung Yu *Chaung* flows through the Wuntho, Kawlin and Kanbalu Townships and enters into the Mu River. Daung Yu *Chaung* channel constructs the alluvial plains in Wuntho Township and also creates meandering scars and oxbow lakes in Kawlin Township. These meandering scars and oxbow lakes are flooded in rainy season and they can store the rain water. The fringe areas of these meandering scars and oxbow lakes areas are called "*Ins*" by the local farmers. In these *Ins*,the winter paddy (*Mayin*)is cultivatedin the first week of December in winter. The physical geographic supporting factors such as climate, especially in sufficient rainfall and deposited alluvial soils and human geographic factors such as governmental policy changed to open market policy encouraged to the development of paddy cultivation acreage.

Key words: Mayin, fringe, oxbow lake, basalt, volcanic ash, In.

Introduction

According to the deposited alluvial soil of Daung Yu *Chaung* which is sourced on the Wuntho Massif Volcanic area, thealluvial areais favoured for soil fertility and very suitable for cultivation of agricultural crops. The location and topography of study area is sufficient rainfall: mean annual rainfall of Wuntho (63.3 inches) in 1994-2017 and Kawlin (67.95 inches) in 1992-2017. So, it is also sufficient soil moisture for any crop, especially paddy. According to the sinuosity and meandering channel and combination of Daung Yu *Chaung* and Dondok *Chaung* at the (5) kilometres in the eastern of Kawlin town, many oxbow lakes and meander scars were left by Daung Yu *Chaung* channel shift.The cultivating areas of winter Paddy (*Mayin*) in meandering scars and oxbow lakes are flooded or water whelming by Daung Yu *Chaung*in the rainy season.Thus, any crop cannot be cultivatedin the flooded areas in the rainy season. In the study area, the using term of "winter paddy"(*Mayin*) has a little difference. Although the local farmers use the term of "winter paddy" (*Mayin*), the official usage of DALMS (Department of Agricultural Land Management and Statistics) is "summer paddy".

In general,summer paddy is cultivated by irrigation system in the Dry Zone of Myanmar especially in Mu valley area. The summer paddy is nursed in February

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andtransplanted fromthe last week of March to first week of April and harvested in July. This summer paddy is mainly cultivated by the irrigation.

In the study area, the nurseries of winter paddy are grown in the outer areas of fields in the first week of November and transplanted period is the first week of December. After the rainy season orthe starting period of winter, soil moisture, after reducing the flooded water,is suitable for *Mayin* paddy cultivation.According to relief and soil moisture, the winter paddy (*Mayin*) is cultivated in the oxbow lakes and old channel.

Study Area

The study area is located in the Daung Yu *Chaung* basin area and exactly in fluvial and alluvial areas ofKawlin Townshipin administrative boundary and between 23º28'48" and 23º54'53" north latitudes and between 95º17'51" and 96º0'36" east longitudes (Figure 1).Geographically in Myanmar, it is lies in the areas of Tropical Savana Type of climate and in the northern area of tropic of cancer. The source of Daung Yu *Chaung*,Wuntho Massif, locates in thenorthern area of study area and this watershed area turns to provide winter paddy (*Mayin*) cultivation areas in Kawlin Township.

Research Problem

According to the fluvial geomorphology and climatic data of the study area, the combination of alluvial soils and sufficient rainfallwill provide the normal agricultural lands of crops. But the Wuntho volcanic uplifting fringe area and Daung Yu *Chaung* alluvial channel are coinciding in Kawlin Township and it creates the alluvial flooded areas as the geographical features and also creates the abnormal winter paddy (*Mayin*)cultivation. There are many differences in nursery, transplanting,harvesting andgrowing functions of summer paddy from other places in the normal monsoon of Myanmar. This study focuses on the problem that other areas of flooding lowlands in Myanmar are suitable for any crop cultivation.

Objectives

The normal agricultural land use in Myanmar was occurred in flat plain and fertile soil in sufficient moisture condition. The conditions of relief, flooded soil moisture condition in the rainy season are useful for alignment crop of winter paddy (*Mayin*) cultivation.

Data Collection and Methodology

Kawlin Township, the study area, is the native of the researcher. The researcher is studying the agricultural activities in Daung Yu *Chaung* alluvial area. Field surveying along the Daung Yu *Chaung* channel with the help of brothers and sisters from Department of Agricultural Land Management and Statistics (DALMS) in Wuntho, Kawlin and Kanbalu Townships was done since 2016. The primary data are collected by surveying and through the questionnaires distributed to the farmers who are cultivating *Mayin* paddy and secondary data are also collected from DALMS of Kawlin Township. The combination of the primary data, secondary data, UTM maps and normal computer software such as the Microsoft Excel and GIS software, etc. are used.

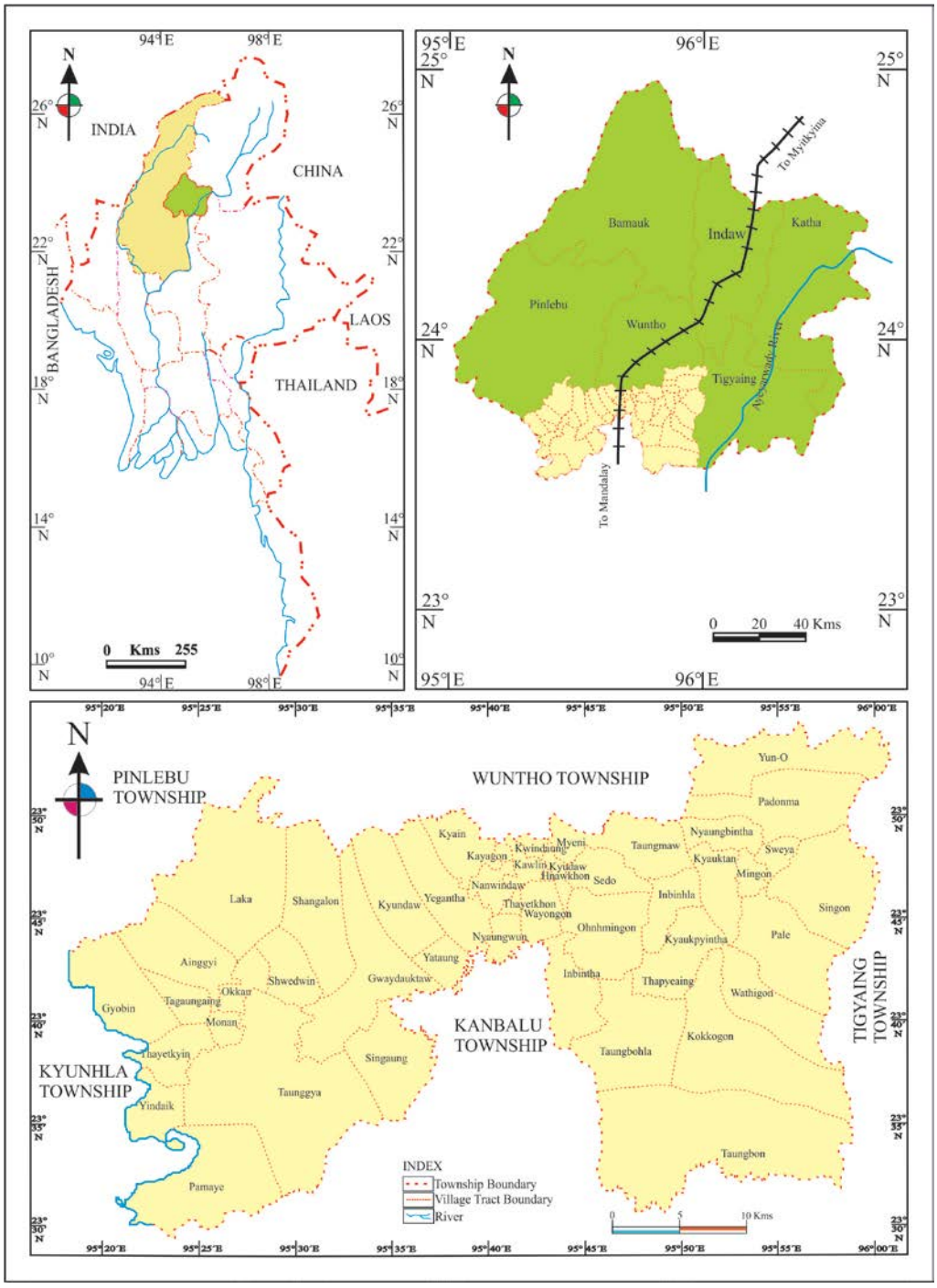

Figure (1) Location Map of Kawlin Township

Source: Department of Agricultural Land Management and Statistics, Kawlin

Findings and Discussion

Agricultural Land Utilization in Kawlin Township

About 75% area of Kawlin Township is lying in the Daung Yu *Chaung* alluvial area and the rest of northwestern area is the spur of Wuntho Massif and the southeastern area is also Minwun mountain range area. In exactly, Daung Yu *Chaung* flows from the north of Wuntho and constructs the meandering channel and oxbow lakes in the eastern, the southern

and the southwestern of Kawlin Township. Due to the geographical point of view, Daung Yu *Chaung* constructs the agricultural lands of Kawlin Township.

The total area of Kawlin Township is about (467,324) acres and out of which (138,553) acres or (29.65%) is agricultural land. These agricultural lands are divided into four types of *Le*, *Ya*, *Kaing/Kyun* and Garden lands. According to (2019) data from DALMS of Kawlin Township, there are *Le* (92,494) acres, *Ya*(43,455) acres, *Kaing/Kyun* (2,033) acres and Garden (571) acres respectively (Figure 2). And thus, most of the agricultural land area is the *Le* land (66.76%) of total agricultural land. In 2019, there were (99,154) acres of monsoon paddy and (4,276) acres of winter paddy (*Mayin*) cultivated areas. These winter paddy (*Mayin*) cultivated (21) village tracts are located in Daung Yu *Chaung* basin area.

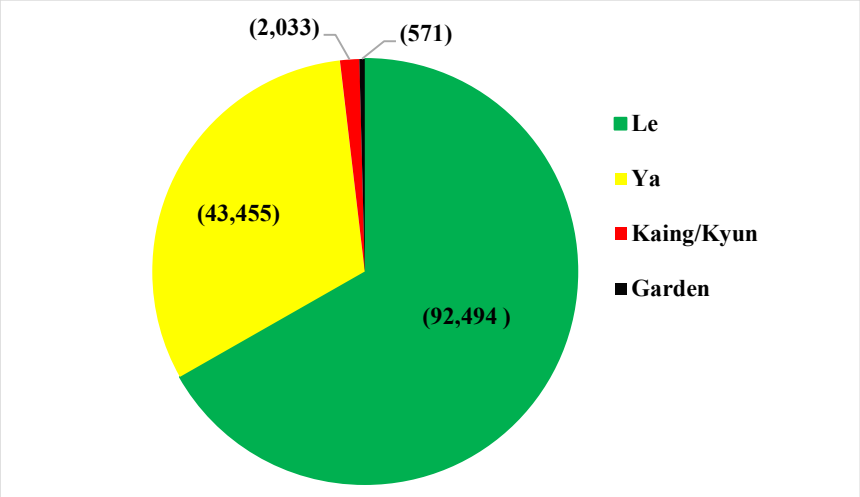

Figure (2) Agricultural Land Utilization in Kawlin Township (2019)

Source: Department of Agricultural Land Management and Statistics, Kawlin

Winter Paddy (*Mayin*) Cultivation

According to the matching of the winter paddy (*Mayin*) cultivation data and the location of village tracts cultivated "*Mayin*" paddy, these village tracts nearer to the oxbow lakes are the larger winter paddy (*Mayin*) cultivated areas. These winter paddy (*Mayin*) cultivated areas of oxbow lakes and old channels are not reliable for other crops because these areas are soaked or flooded by water in the rainy season. According to discussion of local farmers from field surveying, winter paddy (*Mayin*) is cultivated for domestic use of farmers' families in the villages near oxbow lakes.

According to the data of the monsoon and winter paddy cultivation areas from DALMS of Kawlin Township (from 1993-1994 to 2018-2019), the cultivated areas (acres) increase (Table 1). Although there is the correlation between monsoon and winter paddy cultivated areas (Figure 3), there is no relation between cultivated areas of *Le* lands and winter paddy cultivated areas. The winter paddy cultivated areas are not normal *Le* lands and are flooded areas in monsoon season or the rainy season. The winter paddy is cultivated asan only crop during the reduced water in oxbow lakes or old channels of Daung Yu *Chaung* and its tributaries.

After the government of MSPP (Myanmar Socialist Program Party), due to the purchasing of agricultural products especially in "paddy crop" and "opening market policy", the paddy cultivated areas are developed (Table 1). There are challenging competitions

between winter paddyand vegetables because the villages cultivated vegetables locate near Kawlin Town and are accessible to motor road. The vegetable cultivations are more easily and faster earning than winter paddy cultivation. But, the soil and water flooded areas are suitable for the winter paddy cultivation than vegetables cultivation. Some of the farmers are also busy in monsoon paddy cultivation and harvesting by the large amount of area (acres) and thus some winter paddy cultivation fields are fallowed and some areas are not cultivated in certain year of insufficient water.

According to discussion and questionnaire with farmers, winter paddy (*Mayin*) is high yield peracre of about (100) baskets and generally about (81) baskets. The cultivation cost is about (100,000) kyats per acre and at least price of paddy is about four or five or six lakhs per (100) baskets. So, it is returning of profit about three or four lakhs per acre of winter paddy. Most of winter paddy cultivations are the short term paddy (about 100 days or 3 months) andthese winter paddy are mixing with monsoon paddy in marketing.

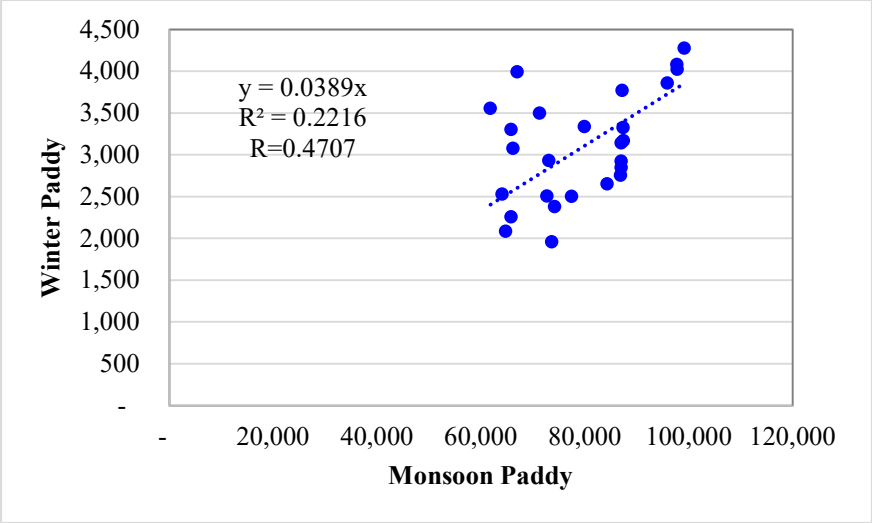

Figure (3) Correlation between Monsoon Paddy and Winter Paddy Cultivation Acres (1993-2019)

Source: Based on Table (1)

Comparative of Monsoon and Winter Paddy Cultivation

The total average paddy cultivation of Kawlin Township (from 1993-1994 to 2018-2019) is about (82,453) acres and which of these, the paddy cultivated acres (103,430 acres) in 2018-2019 are the largest (Figure 4 and 5). The average winter paddy cultivated area is about (3.91%) of monsoon paddy cultivated area from (1993-1994) to (2018-2019) and the largest is (4.31%) in (2018-2019). There are (21) village tracts which cultivate winter paddy in (2018-2019) (Table 2). The total monsoon paddy cultivated areas of these (21) village tractsare about (45,707) acres and thus the winter paddy cultivated areas of these village tracts are (9.36%). The certain winter paddy cultivated village tracts such as Okkan, Monan, Taunggya and Shwedwin are also challenging competition of gold mining in agricultural lands and more profitable than that of paddy cultivation.

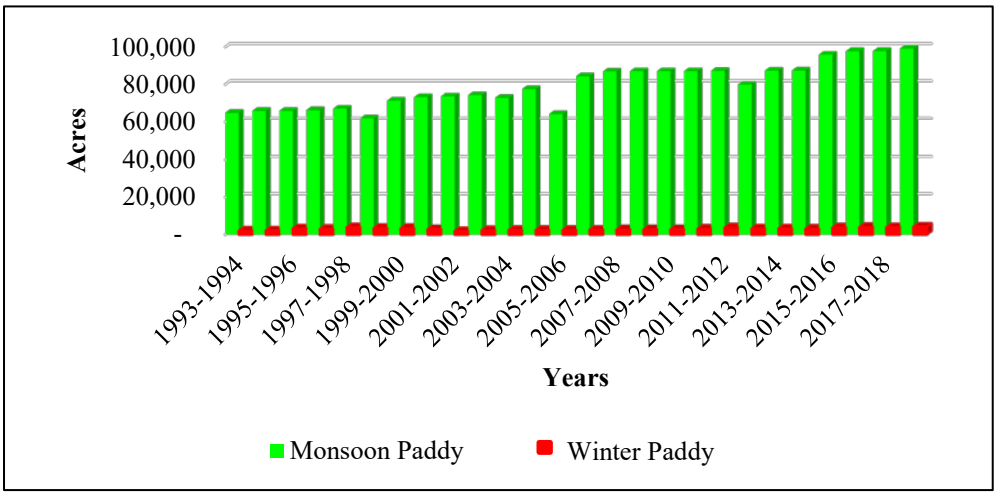

Figure (4) Comparative of Monsoon and Winter Paddy Cultivation (1993-2019)

Source: Based on Table (1)

Findings

According to the high rainfall of study area, 63.3 inches in Wuntho, catchment area of Daung Yu *Chaung* and 67.95 inches in Kawlin and the steep slopes of Wuntho Massif volcanic mountain ranges, the deposited fertile alluvial soils are very suitable for any crop cultivation, especially paddy. The secondary supporting function or encouragement of human factor is the opening market system of governmental policy of SLORC (State Law and Order Restoration Council). The physical geographic supporting factors such as climate, especially in sufficient rainfall and deposited alluvial soils, and human geographic factor such as governmental policy changed to open market policy encouraged to the development of paddy cultivation acreage. So, paddy cultivations are more developed in recent years: monsoon paddy from (64,800 acres) in 1993-1994 to (99,154 acres) in 2018-2019 and winter paddy from (2,084 acres) in 1993-1994 to (4,276 acres) in 2018-2019 (Table 1).

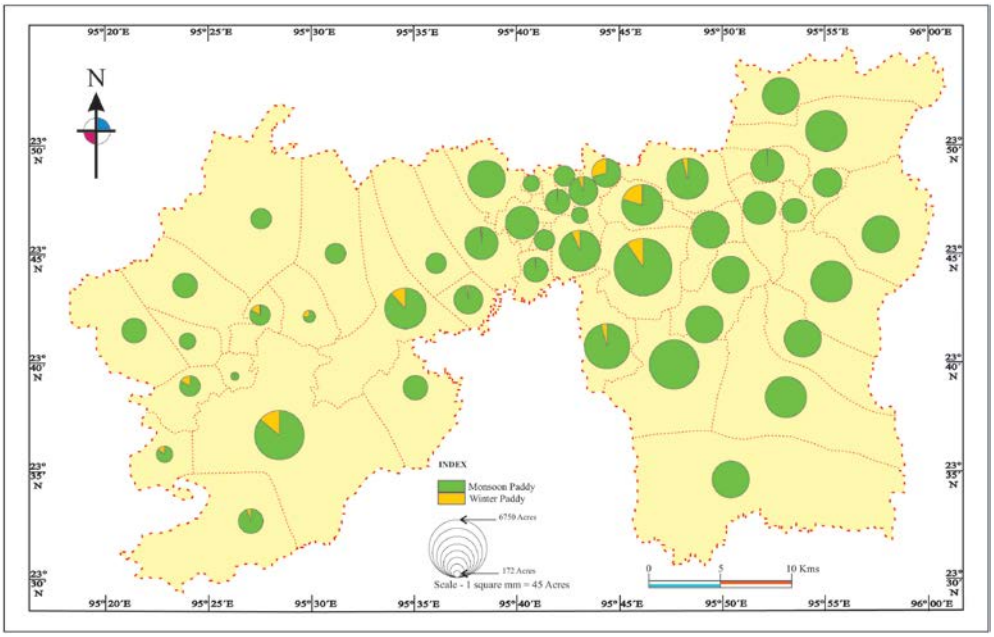

Figure (5) Distribution of Paddy Cultivation in Kawlin Township (2018-2019)

Source: Based on Table (2)

Conclusion

The agricultural products are the mainly source for people in Myanmar. The paddy is the most important agricultural product. Physical geographic factors such as soil moisture and fertility, and human factors such as marketing policy and the accessible of transportation are encouraging to the development of agricultural activities. The winter paddy cultivation in Kawlin Township is a sample of abnormal paddy cultivation in soil and land utilization.

Table (1) Yearly Cultivation Areas and Production in Monsoon and Winter Paddy in Kawlin Township (1993-2019)

Sr. No.	Years	Monsoon Paddy				Winter Paddy			
		Grow	Mature	Yield Per Acres	Top (bsk)	Grow	Mature	Yield Per Acres	Top (bsk)
1	1993-1994	64,800	63,080	51.76	3,264,732	2,084	2,084	57.30	119,420
2	1994-1995	65,814	64,319	54.48	3,504,099	2,256	1,563	65.25	101,986
3	1995-1996	65,813	62,490	52.74	3,295,723	3,300	3,300	68.06	224,605
4	1996-1997	66,204	60,828	52.73	3,207,460	3,077	3,077	68.03	209,340
5	1997-1998	66,991	59,155	52.58	3,110,329	3,992	3,992	69.95	279,240
6	1998-1999	61,806	56,847	50.83	2,889,533	3,556	3,556	67.95	241,630
7	1999-2000	71,316	70,009	56.14	3,930,305	3,497	2,832	67.18	190,244
8	2000-2001	73,138	73,030	58.53	4,274,760	2,932	2,932	67.30	197,317
9	2001-2002	73,633	73,344	59.67	4,376,450	1,956	1,956	64.52	126,204
10	2002-2003	74,232	74,034	59.77	4,425,012	2,377	2,377	67.31	159,996
11	2003-2004	72,751	72,751	64.65	4,703,352	2,506	2,506	71.51	179,203
12	2004-2005	77,465	76,492	69.05	5,281,397	2,502	2,502	75.96	190,052
13	2005-2006	64,115	64,115	69.39	4,448,767	2,529	2,529	80.30	203,088
14	2006-2007	84,332	84,332	73.59	6,205,573	2,652	2,652	88.99	235,998
15	2007-2008	86,905	86,704	75.55	6,550,171	2,754	2,754	92.00	253,363
16	2008-2009	87,042	87,042	83.83	7,296,731	2,846	2,846	97.89	278,598
17	2009-2010	87,057	87,057	84.97	7,396,849	2,924	2,924	97.80	285,980
18	2010-2011	87,053	87,053	85.54	7,446,452	3,141	3,141	99.24	311,718
19	2011-2012	87,210	85,442	85.83	7,333,479	3,770	3,770	98.92	372,934
20	2012-2013	79,949	79,949	82.10	6,563,817	3,338	3,338	90.59	302,403
21	2013-2014	87,389	87,389	82.24	7,186,871	3,323	3,323	90.70	301,396
22	2014-2015	87,438	86,903	82.54	7,172,974	3,166	3,166	90.84	287,599
23	2015-2016	95,900	89,839	83.20	7,474,605	3,856	3,856	90.42	348,660
24	2016-2017	97,778	96,688	83.74	8,096,491	4,079	4,022	90.45	363,790
25	2017-2018	97,795	92,223	83.78	7,726,445	4,022	4,022	90.47	363,870
26	2018-2019	99,154	99,154	83.80	8,309,105	4,276	4,198	89.53	375,847
Average		**79,349**	**77,703**	**70.12**	**5,595,057**	**3,104**	**3,047**	**80.71**	**250,172**

Source: Department of Agriculture Land Management and Statistics, Kawlin

Table (2) Distribution of Paddy Cultivation in Kawlin Township (2018-2019)

Sr.No	Village Tracts	Monsoon Paddy	Winter Paddy	Total
1	Laka	1,057		1,057
2	Ainggyi	1,473		1,473
3	Okkan	879	176	1,055
4	Tagaungaing	652		652
5	Gyobin	1,325		1,325
6	Thayetkyin	835	167	1,002
7	Yindaik	473	78	551
8	Panmaye	1,398	79	1,477
9	Singaung	1,439		1,439
10	Taunggya	4,207	676	4,883
11	Monan	161	11	172
12	Shwedwin	400	139	539
13	Shangalon	724		724
14	Gwaydauktaw	3,117	415	3,532
15	Yataung	1,469	30	1,499
16	Kyundaw	925		925
17	Yegantha	2,361	18	2,379
18	Kyain	2,782		2,782
19	Kayagon	461		461
20	Nanwindaw	2,146		2,146
21	Thayetkhon	763		763
22	Kawlin	1,286	6	1,292
23	Kwindaung	915		915
24	Nyaungwun	1,201	8	1,209
25	Wayongon	3,346	236	3,582
26	Hnawkhon	454		454
27	Kyudaw	1,148	471	1,619
28	Sedo	2,636	685	3,321
29	Myeni	1,672	97	1,769
30	Taungmaw	3,163	134	3,297
31	Yun-O	2,816		2,816
32	Padonma	3,199	3	3,202
33	Nyaungbintha	2,234	7	2,241
34	Kyauktan	2,030		2,030
35	Sweya	1,593		1,593
36	Singon	2,962		2,962
37	Mingon	1,410		1,410
38	Pale	3,607		3,607
39	Wathigon	3,024		3,024
40	Kyaukpyintha	3,095		3,095
41	Thapyeaing	2,767		2,767
42	Inbinhla	3,141		3,141
43	Umingon	6,118	632	6,750
44	Inbintha	4,404	208	4,612
45	Taungbohla	5,398		5,398
46	Kokkogon	3,513		3,513
47	Taungbon	2,975		2,975
	Total	**99,154**	**4,276**	**103,430**

Source: Department of Agricultural Land Management and Statistics, Kawlin

Acknowledgement

I would like to express my deepest appreciation to Dr.Win Swe, Rector and Dr. Myo Myo, Pro-Rector, Shwebo University for giving me the opportunity to write this paper. My sincere thanks are also extended to Dr. Than Than Win, Professor and Head, Department of Geography, Shwebo University for her kind permission, suggestion and encouragement to conduct this paper. I would like toextend my specialthanksto Dr. Khin Mar Tin, Professor, Department of Geography, Shwebo University for her kindness and suggestions. I would like to express my deep and sincere gratitude to Dr. Win Swe, Professor, Department of Geography, Pathein University and Dr. Mya Mya Soe, Professor and Head, Department of Geography, Sagaing University for their valuable and constructive supervisions, suggestions and guidance. My special thanks goes to my teachers, colleagues and the staffs of the Department of Land Management Statistics. Lastly, not at least, I would like to express my gratitude to my parents for their support and encouragement for my education.

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Mural Paintings in A-Myint and A-Nein Villages

Than Hlaing[1]

Abstract

This research tries to study about mural paintings which had been existed in A-myint and A-nein Village of Chaung-U Township on Sagaing Region. Although the paintings there depicted on religious motives, they may be assumed as contemporary documents. The figures and letters in the mural paintings may be assimilated with those of the Period. The purposes are to take the records as a historian, preserve these mural paintings like Myanmar cultural heritage by people and to develop the industry of eco-tourism for this region.

Introduction

Mural paintings of the period take its place in the cultural history of Myanmar and in order to present its role in cultural history, efforts were made to write this paper. The photographs are used as primary sources. The presentations mainly depended on field studies.

A-myint is a big village located on the east bank of the Chindwin River, and includes in Chaung-u Township, Monywa District, Sagaing Region. It is about twelve miles south to Monywa Township and seven miles west to Chaung-u Township. A-nein located about five miles, south of A-myint. The history of A-myint and A-nein goes back to Bagan Dynasty. They have gone through ages and, during the reign of Myanmar Kings. But in Colonial Period Chaung-u became a township. At present A-myint and A-nein have become the big villages included in Chaung-u Township. Many historical evidences such as *pe*s, *parabaik*s, inscriptions, and religious monuments referred to as primary sources throughout Myanmar monarchical period had abandoned in these villages. Mural Paintings were drawn in pagodas, monasteries and religious monuments. Although the paintings in there depicted on religious motive and decorating of the buildings, they bear the mirrors of that period. The economic, social, military conditions and foreign relations of the period are reflected in the mural paintings. This paper tries to trace about mural paintings which had been existed in A-myint and A-nein Villages.

Mural Paintings in A-Myint and A-Nein Villages

Decorating the Buddhist temples or pagodas with mural paintings of *Jataka* stories and the scenes from the Buddha's life spread from India in about the 6th Century A.D. Its origin is the Gupta Art of Ajanta caves.

No murals have been found in Pyu period in Myanmar. In Bagan the oldest mural painting is found in Pathothamya built in 1080. Murals which were depicted at Bagan Period have been seen in pagodas - Apeyadana, Minnanthu, Gupyaukgyi, Loka Hteikpan, Alopyi, Kyazin, Wetgyi-inn, Culamani, Htilominlo, Nandamanya, etc. [2]

The early 17 Century (Nyaungyan Period) can be found at Upali Thein (*sima*) in Bagan, Shwe-si-khone in Pinya, Tilokaguru Caves, Mi-pauk-gyi Pagoda, and Loka Hman Kin

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[2] She-yoe, "*She-yoe Myanmar Bagyi"* (Myanmar Traditional Art), Yangon, Archaeology Department, 1966, p.29-30 (Henceforth: She-yoe, *1966*)

Pagoda in Sagaing, Pho-win-taung in Yinmapin and Yesagyo (Pakhan). The mural paintings of Nyaungyan Period can be also seen at the temples of A-myint Township. [1]

Paintings of Konbaung Period can be seen at Ananda Ok-kyaung, Upali Thein, Lay-Htat Monastery, and Ratana Manju in Bagan, Lat-ya-u Monastery, Law-ka Aung-mye, Yok-son Pagoda, and Pyatthad Pagoda in Khin Mon (Chaung-U Twonship), Taung-tha-man Kyauk-taw-gyi pagoda in Amarapura, Pho Kala cave in Shwe-sa-yan of Mandalay, Pho-win-taung in Monywa District, Hsalingyi, A-myint and A-nein in Chaung-U Township. [2]

Many of the pagodas and temples in A-myint and A-nein used to have mural paintings, but some of them are damaged and some are almost completely lost due to the time and natural dangers. These mural paintings belong to the period from Nyaungyan to Ratanapon. The earliest mural paintings that belong to early Nyaungyan Period still exist in a temple named Thein Gu in A-nein Village. [3]

Presently, 138 pagodas and temples are still standing within the boundary of A-myint. Of all there are 59 temples and 79 *ceti*s and 9 pagodas with the Mural painting in A-myint. 124 pagodas and temples have in Anein Village. Of all there are 11 pagodas with the Mural painting in there. The paintings of pagodas at A-myint are as follows:

The List of Pagodas with the Mural painting in A-myint

No.	Title	Period
1	Min-yé Pagoda	Nyaungyan Period
2	That-taw-ya	Nyaungyan Period
3	Kun-taung Pagoda	Konbaung Period
4	Min-o Chan-thar Pagoda	Konbaung Period
5	Kyuang-lain	Konbaung Period
6	Unknown Title	Konbaung Period
7	Unknown Title	Konbaung Period
8	Yok-son Pagoda	Konbaung Period
9	Shit-myet- hnar Pagoda	Konbaung Period

Source: Field Work

The List of Pagodas with the Mural painting in A-nein

No.	Title	Period
1	Thein gu	Early Nyaungyan
2	Chin-thae-U pagoda	Late Nyaungyan
3	East pagoda in Thone-pan-hla complex	Konbaung Period
4	South pagoda in Ta-tine-shay complex	Konbaung Period
5	North pagoda in Zedidaw daik complex	Konbaung Period
6	South pagoda in Zedidaw daik complex	Konbaung Period
7	West pagoda in Zedidaw daik complex	Konbaung Period
8	Pitaka Taik	Konbaung Period
9	Shwe-myin-tin	Konbaung Period
10	East pagoda in Shwe Gu Htut	Konbaung Period
11	West pagoda in Shwe Gu Htut	Konbaung Period

Source: Field Work

[1] She-yoe, *1966*, 21
[2] She-yoe, *1966,* 30
[3] See Photo-1

According to the setting of mural paintings painted on the walls within the temples and monasteries, the main drawings are episodes from 550 *Jataka* stories. The twenty-eight previous Buddhas are shown as single images organized into series. These Buddhas are portrayed at the top of the walls seat in *Bhumisparsha* mudra under their respective trees of enlightenment. In some pagodas they are accompanied by kneeling disciples and devotees. [1]

Below the images of the previous Buddhas are scenes from the life of *Gotama* Buddha. These scenes are portrayed an extended and standardized format. Episodes of Buddha's life have been favoured for representation in most murals. The enlightenment is presented by illustrating the Buddha seated in *Bhumisparsha* mudra under the Bodhi tree, the attack of Mara, and the Earth Goddess wringing out her hair. [2]

Similarly, *Jataka* stories are organized to the scenes of the life of the Buddha. The *Jataka* stories are also depicted below the twenty-eight previous Buddhas and scenes of from the life of the Buddha. Scenes are divided primarily by wavy green and white dividers. Only the most important events are painted. The message of the story is therefore transmitted through a minimum of narrative incidents. The episodes of the *Mahanipata* mostly depicted in most murals in there. [3]

The life of Buddha is drawn in a wide variety of ways. Narratives selected for illustration include his birth, the Enlightenment, the seven stations occupied by the Buddha after reaching enlightenment, his first sermon in the deer park at *Sarnath*, the twin miracles at *Savatthi*, his ascent to and descent from and preaching in *Tavatimsa* Heaven, his retreat to *Parileyyaka* forest, the taming of *Nalagiri* elephant, preaching at *Nesali*, and the *Parinirvana*, cremation, and distribution of his relics. [4]

The focus of mural subject matter is almost entirely upon the last ten *Jataka* tales, the life of *Gotama* Buddha, and the twenty- previous Buddhas. On the temple walls the twenty-eight previous Buddhas are closest to the ceiling, and below them are scenes of *Gotama*'s life and *Jataka* stories. Scenes of hell are in close proximity to the floor.

From Innwa Period to Konbaung Period, the ceilings in the entrance halls of the temples have the images of the Buddha's foot-print, [5] the lotus flowers or crossing ivory. [6] At some temples, floral motifs, crossing mythical serpents [7] and image magic squares can be seen. [8] The remaining spaces on the walls from the ceilings to the floors in the temples are covered with floral drawings. The pictures of animals are mixed with the floral drawings and in the paintings of the related *Jataka* stories. The pictures of *Kinnara, Kinnari* and *Jamani*, etc. [9] were painted in minute detail on the gable ends at the entrances serving as the decoration.

The space was enough for all those paintings and the artists did not use too much space for each one so that they could paint many paintings on the walls. The temple has the central pillar and four entrances. There are Buddha images around the central pillar. The ceiling above the images was painted with floral paintings. The walls behind the Buddha images have pictures of Bodhi trees in floral paintings. Each leaf on the trees was painted minutely. Flowers convoluted lotus stems, buds, blossoms, etc., and animals' images were

[1] See Photo-2a,2b
[2] See Photo-2-1
[3] See Photo-4,5,6,7,8,9
[4] See Photo-10,11
[5] See Photo-12
[6] See Photo-13
[7] See Photo-14
[8] See Photo-15
[9] See Photo-16

painted to fill up the spaces. On the ceiling at the entrance hall, the Buddha's foot-print with a dragon coiling it was painted.

The murals may be thought as the meanings of cosmology. The cosmology is believed in Buddhism and Hinduism. The idea of cosmology was incorporated into the murals of pagodas. As cosmological concept, the lotus flowers of hundred petals were drawn at the right center of the ceiling of pagodas. As traditional maxim goes, "the symbol of world is lotus flowers", it seem to represent the attainment of Buddha-hood and to be the flower of paying to Lord Buddha. It also means that universe is situated under the abdomen of Lord Buddha and Lord Buddha had to face round and round of birth and death before he attained Buddha-hood. Wall paintings also depict the concept of the cosmology. Hinduism and Buddhism share the same concept of the universe which can be seen in building temples. The concept was adopted from Hinduism by Buddhists. The Hindu scholars worked for Myanmar Kings as astrologers (advisors for astronomy). Myanmar Kings built their palaces using the concept of the universe.[1] They considered themselves as the patronages of the *Sasana* and the the lord of the earth. Most pagodas with the wall paintings were the donations of kings, queens, and those in powers of monarchic days. Therefore, the construction workers at the pagodas and the painters were likely to know the concept of the universe.[2]

The right portions of the ceilings at the temples usually had a lotus flower with a hundred petals. This is the first concept of the universe. Lotus flower is the holy symbol of Myanmar Buddhists since it is the sign of the Buddha's enlightenment. It was said that lotus flower is the symbol of the earth. According to this idea, the universe exists under the stomach of the Buddha and therefore, the paintings of the universe were painted on the ceilings.

Wall paintings tell the true stories of the period they belong. The political, social, and cultural life can be found in the paintings. The artists depicted to express their negative feelings towards non-Buddhists British colonists in their paintings by illustrating foreigners as figures of villains or those with socio-economic status. For example representing foreigners like as Mara, soldiers of Mara, opium addicted door keepers, laborers who carries big grass bundles from here to there or milk cows. [3] In some murals foreigners can be seen as animals particularly monkey. [4] When the artists depicted the army of Mara, they painted the Mara on the black battle elephant and his soldiers with the faces of foreigners. Those soldiers held sticks, swords, heavy clubs, and axes. The painting depicts the army of Mara taken away by the water currant that flowed out from the hair of *Vasundaray*. [5] It seems that the painter tried to give the message showing the patriotic spirit that Myanmar did not want foreign rule in their country. Coming foreigners from other countries to Myanmar can be found in murals with foreigner figured in worshipping position.

The paintings show that **the dressing style of women** in Amarapura and Ratanapon Periods (late 18th century) had not much difference. The women of the royal palace in Ratanapon Period wore long sleeve jacket covering the hips and lower garments. They wore lower garments just to cover the hips. The chests were wrapped around with pieces of cloths and they wore thin hip-length jackets to cover their shoulders and arms. The hip-length jackets were, unlike the ones worn these days, tight at the arms and expose the chest part.[6]

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[1] Dr. Toe Hla, *Koé-hti Koé-nan Koé-kya-ngan Hnint* (With Our Own King, Our Own Palace and Our Own Sovereignty*)*, Yangon, Nawarat Press, 2005, p.10

[2] Dr. Ba Han, "Burmese Cosmogony and Cosmology" *Journal of Burma Research Society*, XLVIII, I, June 1965, pp. 9-16

[3] See Photo-17a, 17b

[4] See Photo-5

[5] See Photo-18

[6] See Photo-19,20

The women in the royal palace and the performers at the concerts wore the same kind of dresses. There are also images of women with cheroots in their hands. It shows that Myanmar women of that time were in habit of smoking.

Hair style of women was found at **s**ome paintings. They had hair knots on the top of their heads. They also wore rosaries of flowers or pearls wrapped around the hair knots. Some wore *Bya-pa-san* style (young girl's hair style with locks of hair falling from behind the ears). This hair style was started during Innwa Period and more popular during Amarapura and Ratanapon Periods. [1]

The art of wall paintings developed through the ages. In the same way there could be development in decorative art of carvings in different ages. These developments show the history of Myanmar people. When Myanmar people built pagodas and other religious buildings, they decorate their donations with artistic creations. The ten arts of Myanmar were used in the decoration of the religious buildings. In the decorative art, stucco carvings, stone sculpture, bronze casting, copper casting, or brass casting, goldsmith works or silversmith works, wood carvings, and turnery can be found together.

This devotion of the Buddhists gave rise to the professional handicrafts in Myanmar society. For instance, some people live on ten kinds of Myanmar traditional handcraftsmanship. It can be said that Myanmar culture is highly influenced by Buddhist culture.

Scenes from the life of Buddha in all mural paintings at A-myint Township were depicted. We can say that these depictions are exclusively related with the Buddhist religion. The episodes painted on the walls reflected social life of Konbaung Period with other ways. They are only of religious art.

Myanmar cultural arts derived from Buddhist symbols, animals, circles, other shapes, and floral carvings, etc that were originally Indian. However Myanmar artists did not copy Indian arts. They adopted these arts and molded in Myanmar traditions existed at those times. Therefore, these arts have been standing as peculiar Myanmar tradition, style, and culture.

Conclusion

It is assumed that mural paintings may support the promotion of propagation and Myanmar cultural history reflected by murals will be known. So it is a very good contribution to study the Myanmar traditional arts, to help for developing the fine art and commercial art of Myanmar, to become a place which can attract the tourists. It may thus preserve mural paintings as Myanmar cultural heritage or the early visual stories of books and edutainment.

Acknowledgement

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2. She-yoe, "*She-yoe Myanmar Bagyi"* (Myanmar Traditional Art), Yangon, Archaeology Department, 1966

3. Toe Hla, Dr. *Koé-hti Koé-nan Koé-kya-ngan Hnint* (With Our Own King, Our Own Palace and Our Own Sovereignty*)*, Yangon, Nawarat Press, 2005

[1] See Photo-19,20

Photo (1)

The earliest mural paintings of early Nyaungyan Period

Thein Gu Temple, Anein Village

Photo (2a)

Scene of the twenty-eight previous Buddhas

The northern wall from Kyaung Lein Pagoda, A-myint Village

Photo (2b)

Scene of the twenty-eight previous Buddhas

The northern wall from Shwe Myin Tin Pagoda, Anein Village

Photo (3)

The attack of Mara, and the Earth Goddess wringing out her hair

The eastern wall from Pitaka Taik near Thon Pan Hla Pagoda, A-nein Village

Photo (4)
Scene of *Vessantara* Jataka

The eastern wall from Chinthae-U Temple, Anein Village

Photo (5)
Scene of *SuwannaSama* Jataka

The eastern wall from southern pagodas of Zaydi daw Taik Complex

Photo (6)
Scene of *Budhidat Jataka*

The southern wall from Min-o Chan-thar Pagoda, A-myint

Photo (7)
Scene of *Temi Jataka*

The western wall from Chinthae-U Temple, A-nein Village

Photo (8)
Scene of *Narada Jataka*

The eastern wall from Chinthae-U Temple, A-nein Village

Photo (9)
Scene of *Candakumara Jataka*

The western wall from Chinthae-U Temple, A-nein Village

Photo (10)
The donation by Tapussa and Balika form the life of Buddha

The eastern wall from Pitaka Taik near Thon Pan Hla Pagoda

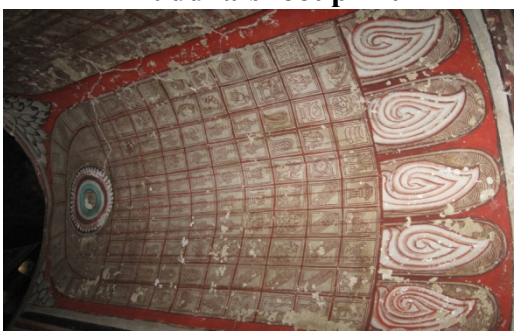
Photo (11)
The Parinirvana form the life of Buddha

The eastern wall from Shwe Myin Tin Pagoda

Photo (12)
The lotus flowers

The ceiling from Kun-taung Pagoda, A-myint

Photo (13)
Buddha's foot print



The ceiling from Kun-taung Pagoda, A-myint

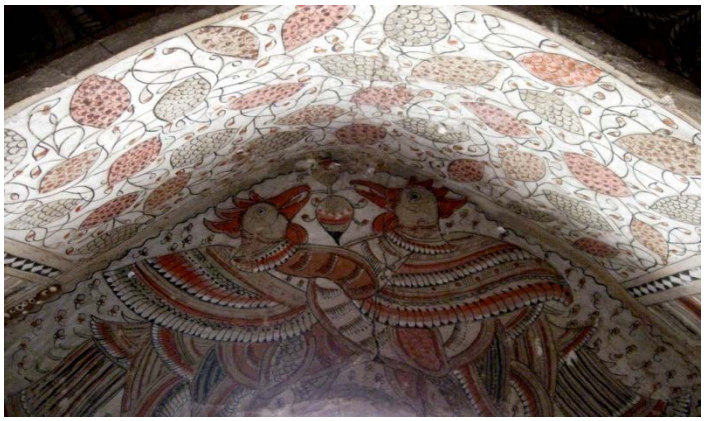
Photo (14)
Crossing mythical serpents

Pagoda near Shwe Gu in Taw Chaung Gyi

Photo (15)
Image Magic Square

The ceiling from Kun-taung Pagoda, A-myint

Photo (16)
***Jamani and* floral design**

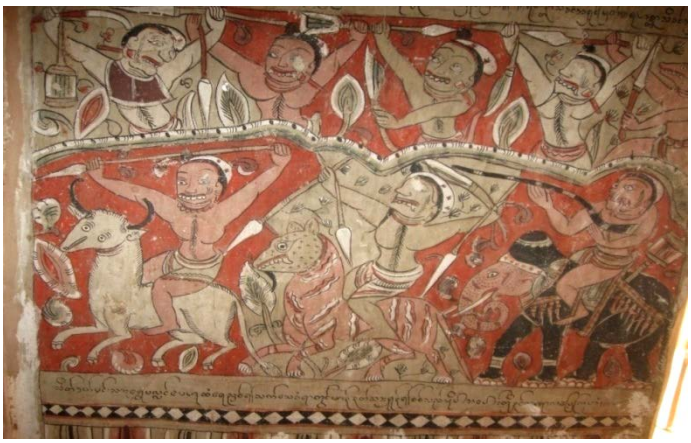


Pitaka Taik, A-nein

Photo (17a)
Foreigners

Eastern Pagoda in Zaydi daw taik Complex, A-nein

Photo (17b)
Figures of Foreigners and Soldiers of Mara



Eastern Pagoda in Zaydi daw taik Complex

Photo (18)
Scene of Eight Great Events of Buddha

Eastern Pagoda in Zaydi daw taik Complex

Photo (19)
Dressing and hair style of women

Western Pagoda in Zaydi daw taik Complex, A-nein

Photo (20)
Dressing and hair style of women

Western Pagoda in Zaydi daw taik Complex, A-nein

"Social Effects of Myanmar's *Zat Thabin* by Spreading Traditional and Cultural Customs of Human-Society in Konbaung Period"

Pyone Mar Kyi[1]

Abstract

Developing and spreading the traditions of Myanmar's drama (*Zat*) leads to the good benefits of human-world. The art of drama gives supports partially to administration, social affairs, economics and politics of the nation. Therefore, the governors gave the important role to the art of drama and traditional customs of Myanmar have spread through *Zats* into the whole society. Thus, the art of drama could be applied as media. Besides, it is also a precious tools which can direct and guide national cultures and traditions which are so valuable for the whole nation. To make the public know the art of drama is not only the core-place which delivers different knowledge but also it gives social effects.

Key words : Konbaung Period, Myanmar *Zat*, news-media, polite and kind attitudes.

Introduction

The art of drama (*Zat Thabin*) in Konbaung Period spread the traditional and cultural customs of humans and gave a lot of benefits to the whole world. The Kings or the governments kept the art of drama as the most important role because it was supporting partially for the administration, social affairs, economics, religious affairs, politics, tradition and culture. Knowledgeable and effective dramas shared tradition and customs and pointed out wrong decisions and unreasonable deeds. Thus, the art of drama made the human-world become beautiful. On the other hand, it was serving as media. Therefore, the art of the drama is a tool of the nation which can correct wrong things and guide the right ways to the public.

Findings

About the fact that the art of drama supports partially the administration, the Myanmar-Kings' order is described as follow:

"The artists of drama are supporting the administration. They make the poor have polite and kind attitudes and behaviors and keep the public pure souls and good deeds. Then, the public imitate and follow the dialogues and characters which are expressed in plays by the artists of drama. Thus, the Kings ordered that the plots and novels which can make the public become polite and kind-hearted, must be written and performed[2]."

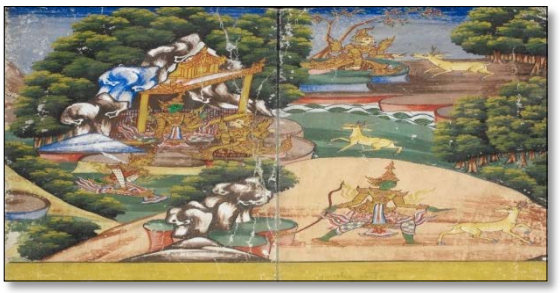


Photo1: Ramayana Story

Source :
https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwjsye2crp7mAhVMXn0KHbWbBXIQjRx6BAgBEAQ&url=https%3A%2F%2Fsoutheastasianlibrarygroup.wordpress.com%2F2013%2F04%2F&psig=AOvVaw0Leox5wcV2VnclN6dTGpqn&ust=1575630038378325

[1] Lecturer. Dr. Department of History, Shwebo University

[2] Hmaw Be SayarThein, *Myanmar ZatpweThabinhnint Myanmar pya Zats.* (Myanmar Drama and Play) HnalomehlaPublishing House, 1965, P-90-91 (Hence forth; Thein, 1965).

Only the dramas which can make the public's attitudes and characters become polite, are allowed to entertain. Thus, the art of drama creates the peaceful and beautiful human-world by performing 38 kinds of auspiciousness or the MingalaSutta translation from Pali to Myanmar[1]. It also teaches the public abiding ways of basic ethics, social ethics[2], morality[3], work-principles[4] and benefits[5] of good deeds. As a result, the public becomes mature in mental processes and possess noble ethics. From an individual to the whole society, it becomes peaceful and developed in all sides.

By performing the plays which point out the ethics, the rules and regulations that Kings, Presidents and governments have to abide and keep, they will emphasize on the development of the public and the safety in different sides. Thus, there will be a good relationship between the Kings and the public. To be able to get that relationship, SuwunnaTharma*Zat* and MaharHantha*Zat* which point out 8[6] and 10 ethics of a king[7], SattarLithaNipat and *Zat* of TethaKunna which point out 5 strengths of a king, Zat of Ei Nay Wun, Yama *Zat* and *Zat* of MaharZanaka Prince which encourage young princes and young children to imitate and become mature in morality with great perseverance, *Zats* of Parpa Hein, KaetharThiri, Thakin Patti, ParthuDaewa and Ginga Marla which show unity among nationalities and the ethics between youngers and elders, *Zat* of SudaPaduma which show how females or ladies in royal places break the social ethics which have to be kept between husband and wife or between single-ladies and married men; are the precious and essential plays to be performed.

Photo-2: Myay Wine Zat
Source: https://www.google.com/url?sa=i&source=images&cd

The other *Zats* were also performed to abide and keep good attitudes on the public, principles of *Thingaha*[8], principles of *Naryaka*[9], ethics of administrative officers[10], 5

[1] Phone Kyaw, U, oral Parita (Sutta), Aye Win Shwe Publishing House, Yangon October, 1997, P-100 - 104 (Hence forth; Phone Kyaw, 1997)
[2] Dr Toe Hla, Myanmar-ethics and moral, Nawarat Press, Yangon 2005, P-42(Hence forth; Toe Hla, 2005)
[3] Dr Toe Hla, 2005, P-41
[4] Dr ToeHla, 2005, P-41
[5] Dr Toe Hla, 2005, P-41
[6] Dr Toe Hla, 2005, P-10
[7] Dr Toe Hla, 2005, P-7
[8] Dr Toe Hla, 2005, P-14, 15
[9] Dr Toe Hla, 2005, P-16
[10] Dr Toe Hla, 2005, P-22

strengths of a king[1] and principles of *Apariharniya*[2]. Those *Zats* were used in administration administration and they are knowledgeable *Zats* for the public about administration.

By performing *Zats* which point out how administrative officers are discriminating and giving pressure on the public, the art of drama became a public forum where the public's wish and complaints are claimed to the kings or the Presidents. Nowadays, that public forum is similar to face book (social media), but social media does not include any plot of giving knowledge or teaching and warning dos and don'ts. Face book (social media) can only serve giving information. The important thing is that kings or Presidents must know and abide by necessary attitudes on the public and on the same way, the administrative officers must know and keep necessary attitudes on junior servants or the public. It means that they must have honourable and ideal ethics which can make the public peaceful and comfortable in social-life[3]. If Kings or administrative officers did not keep those good and essential ethics, the public became disappointed and complained by performing *Zats* or dramas as the public forum. Then the kings or administrative head-officers became aware of the public's complain and they reordered about certain matters in time. Thus, they could make the public pleased and calm from strikes. Those plays are described in table 1.

Photo-3 by Author: Theatres, Nan Twin Musician, Mandalay, (16-11-2019)

Photo-4 by Author: Theatres, *Nan Twin*, Mandalay, (16-11-2019)

[1] Dr Toe Hla, 2005, P-13
[2] Dr Toe Hla, 2005, P-16
[3] Dr Toe Hla, 2005, P-16

The Information of *Zats*

Table 1: *Pya Zats* which indirectly informed the king in the entertainment chamber as informative play in the form of forum about the points they did not to directly supplicate as they were misleading and suffering the people:

No.	Content	Period	Category	Remark
1	Nupathinkami	BodawPaya	Social-affairs	to follow the teachings of the Buddha
2	Neither too high nor too low in position	BodawPaya	Administration	to avoid partiality
3	Paid paddy field workers from Thaung Thaman and surrounding	King Mindon	Social-affairs	Amnesty
4	Showing the ogre-hunt in the place of calling a ghost	King Mindon	Social-affairs	to get the permission for charity
5	Minitatta Problem	King Mindon	Social-affairs	reduction the royal order
6	Riding the horse backwards	King Mindon	Politics	listen to the royal order
7	Great suffering trouble	King Mindon	Administration	Rights of the *Admudans*

Source:

From No (1) to (3)

(1) Nan Nyunt Swe, *"Shay Khit Zatthabin"* (Drama of Ancient Myanmar), *Journal of Union culture*, Yangon, 1955, September, episode (1), No-5, P-43-48 (Hence forth; Nan Nyunt Swe, 1955)

From No (4) to (7)

(2) Thein, 1965, P-112-117

Phto-5: The King *Zat Thabin* (Konbaung Period)

Source:

https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwiE2_firZ7mAhUNbisKHcIBBo8QjRx6BAgBEAQ&url=http%3A%2F%2Ftenez15.rssing.com%2Fchan-8895148%2Fall_p11.html&psig=AOvVaw0Leox5wcV2VnclN6dTGpqn&ust=1575630038378325

Zats or dramas were entertained on a stage in front of the King. During Konbaung Period, under the region of BodawPhaya and King Mindon, U Wun, the minister of art, had

to report about some matters of towns or quarters. Then, U Wun managed to know the king indirectly by performing a new-drama. The new-dramas were like the public's forum at that period.

Photo-6 by Author: 550 Jataka Stories, Mandalay Musician Culture and Library (7-9-2006)

Photo-7 by Author: Suwana Thama *Zat* - 550 *Jataka* Stories, Gold Monastery, Mandalay (16-11-2019)

The artists were the motivators who motivated the public to have patriotism and love for the independence of the country, by applying their artistic abilities. The actor of *Zat*, U Aung Maung, from Warkhaema Township, tried hard for the independence of the country by delivering speech against the colonists, performing Sakyar Minlay *Zat* and holding three coloured flag and wrapping brown-cotton cloth on his arm. He was also a patriotic master.

> "လွတ်လပ်ရေးအတွက် အသေခံရဲတယ်ဆိုတာအများသိတဲ့အတိုင်း အားရှိစရာ၊ ရာထူးသမားတွေက အတွင်းခရိုင်အကပ်ဘဲ၊ မင်းတိုင်ပင်အမတ်အတင်း တုပ်ကြတယ်၊ သင်းတို့ ဘဝထမင်းတစ်လုပ်၊ တုတ်တစ်ချက်ဖြစ်နေမှကိုး၊ စမုတ်အတွက် ဘာသာမှေးတော့ ဂျာအေးသူ့ အမေရိုက်သလို ယခုအနေမမိုက်မှရင်းစားရတော့မယ်၊ စဉ်းစားကြ၊နင်းပြားဘဝနှင့် ခိုကာတာမရှည်ရအောင် တို့ဗမာပြည်သဘင် အရောင်ကောင်းတဲ့သခင်အောင်မောင်းထွက်တော်မူစမ်း"

Translation:

"It was pleased to give up life for independence; the officers didn't approach and didn't agree with the king or the government; they pointed out how the king or the government was misleading and pressing the public without concerning their life (starving food) and any punishment. If the public didn't have any sense to strike on the press and any discrimination, they would never be free from the life of slavery."

It was the delivery of *Zats* from the stages to share knowledge and warn about the affairs of the country and to motivate the patriotic and national spirits in chance.

Table 2: List of educative and moral instructive plays (*Zats)*

No	Author's Name	*Zat*'s title	Type of play(*Zat)*	Remark for Human life
1	Minister MyaWaddy *Mingyi* U Sa and 7 member troupe	E-Naung	Political and social	Instructive
2	U Kho	Mahazanaka	Administrative and social	Instruction the king's quality
3	Mya Waddy *Mingyi* U Sa	Ramayana	Political	Instruction on bravery and gallantry
4	Tha-do DhammaYaza	ThinKhaPatta	Social	Instruction on for bearable tolerance
5	Tha Khin Min Mi	KaythaThiri	Social	Instruction on reasoning by caution and wisdom
6	U Kyin U	VessandarJataka	Religious	Instruction on dana (giving or donation)
7	U Kyin U	MahawThada 1,2	Political and social	*Nipatkhin* to expose British imperialism
8	U Kyin U	Dewagonman	Political	Diplomatic relation abroad
9	U Kyin U	Win Kanta Wei-LuwadduKumari	Political	to expose trickery of imperialists
10	U Kyin U	Papa Hein	Administrative	Power struggle for throne
11	U Kyin U	Kala Kanni	Administrative	Power struggle for throne
12	U Kyin U	TeyZathuyuin	Political	Pertaining to envoys
13	U Kyin U	MahaWinsana	Political	Pertaining to envoys
14	Ma MyaKalay Queen of the west palace	Eindawwda	Administrative, political and social	Instruction on Military assistance between countries
15	U Ponnya	Wizarabahu Mintha	Political and social	Parents love
16	U Ponnya	Gingamala (or)YeythePyaZat	Political and social	Brother relations effort to peace
17	U Ponnya	Kawthala	Social, administration and political	The king's (10) ethics
18	U Ponnya	Pathu Deva	Political and social	Reconciliation to the two Princely brothers harboured ground less suspicious
19	Hlaing Hteik Khaung Tin	EindaWuntha	Social	jouiny abroad for knowledge
20.	Hlaing Hteik Khaung Tin	VizayaKayi	Political, social and administration	high lighting count life custom, traditions

Source:

(1) U Thaw Zin, *ZatKahtar*, Yangon, SarpayBhiman Publishing house, 1981, (P-40 to 98)

(2) U Kyin U, Papa Hein *Zat*, Yangon, National Publishing house, 1960, January (P-1 to 66)

(3) U Ponya, Vizaya*Zat*, Mandalay YadanSaddi, Pitaka Publishing house, 1926

(4) Sale U Ponya, Paduma*Zat*, Yangon, PitakaPublishing house, 1949, (P-1 to 28)

(5) U Ponya, Kowthala*Zat*, Mandalay, YadanarSaddi, Pitaka Publishing house, 1926 (P-1 to 38)

(6) HlaingHteikKhaung Tin, Eaindawun*Zat*, First + Second, Yangon, HantharWaddy Publishing house, 1959

(7) *Zat* Literature, Papers from conferences, Discussions and reports, SarpayBhiman, Yangon, 1971, (P-1 to 40)

(8) Lists of ancient Myanmar-*Zats* (1872-1920), Total numbers (684), Yangon University Library and the small paper presented for the library diploma, (P-1 to 143)

(9) KhinMaung Lay, Mg, Shot *Zats* about Colonial Age, 1972, Master class of Art, (P-1 to 304)

Tape and Film

(1) U Kyin U, DaevaGonban*Zat*, Yangon, Tape and Film (P-1 to 273)

The art was a precious and effective tool organizing the public, motivating the patriotism, making irony about the government and correcting the mistakes of the administrative officers or the kings, and warning the public or the government to avoid don’ts and to carry out dos. So, the art of drama is very valuable because it can change human-society into a better or a right one by warning and spreading social ethics, political knowledge or, principles, economical needs, administrative rules, ethics that kings and the governments have to abide and keep. Thus, the whole country became peaceful because of the art of drama.

Therefore, the Konbaung Kings ordered that the art of drama was so effective for the public because it spread traditional customs into the hearts of people and made the public abide the basic ethics, learn knowledge and decide with great thought or criticize on everything based on cause and effect. To sum up, the art of drama was applied as new-media.

Conclusion

In Konbaung period, the artist of Zat performed knowledgeable and effective Zats. In these Zats, 38 kinds of auspiciousness, basic traditions and customs and do's and don’ts were performed and the public were able to criticize reasonably, know and decide which is right now which is wrong, abide do's but avoid don’ts and then the standard of life becomes rise and the human-society becomes valuable. The standard of ethic has risen up and it makes the world peaceful and beautiful. The nature of a Zat is vividly seen by songs, dances, recitation and reading. Our own traditions and customs need to be kept generation by generation. The development of Myanmar’s traditions and customs rise the national affairs and the human-value. If the value of social traditions, literature and cultures loses, new generations will look down own culture and tradition and they won’t have any respect and humility. Nowadays, as respect and humility has been disappearing, the traditions and customs in educational field will gradually change. While reliability and trusts decrease, the worthless society appears. So, everybody is responsible to keep own traditions and customs with great patriotism.

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The Concept of Truthfulness as a Moral Virtue in Myanmar Ethical Thought

Than Oo Swe[1]

Abstract

In studying ethics, there are many moral virtues by which we can judge human conduct. This paper aims to present the concept of truthfulness in Myanmar ethical thought. The word truthfulness means keeping one's agreements, stated or implied, until they cease to be valid agreements. From the Buddhist point of view, the Pali word *Sacca* is truthfulness. In common sense, truthfulness is the agreement of one's word with one's thought; it involves the intention and the responsibility of the person. A truthful person is free from duplicity or fraud. In Myanmar society, a person who is trusted can be regarded as a good person. Mostly Myanmar moral rules are based on Buddhism. It can be said that from the Buddhist perspective, the concept of truthfulness is a moral virtue principally based on the speaking the truth. In this study, the descriptive, analytic and evaluative methods are used. This paper is expected to provide the partial fulfillment to Myanmar ethical thought. It also contributes for Myanmar society to be virtuous and peaceful.

Key words: truthfulness, moral virtue, trust, speaking the truth

Introduction

There are many important things in human life and human society. Among them, truthfulness is the essential concept for the human life. In ethics, truthfulness is one of the moral concepts. Ethics is a normative study which investigates the basic principles of good conduct. Ethics is concerned with values, especially moral values. It deals with moral aspect of human behaviour. The concepts such as love, obedience, benevolence, loyalty, honesty and truthfulness are moral concepts. Virtue ethics is very significant in the field of ethics. Virtues are needed for a successful human being.

In the West, the Greek sought excellence of character. The Greek accepted justice, wisdom, courage and self-control as the fundamental virtues. Socrates expressed that "virtue is knowledge", "knowledge is virtue". For Plato, justice is the harmony of all virtues. Justice includes not only the fulfillment of contracts but also perfect honesty and fidelity in one's relationships with others. According to Aristotle, the foundation of morality is self-control. For Aristotle, everyman required ethical justice for a good life.

Truthfulness is one of the moral concepts which mainly deals with virtue ethics. Virtue ethics emphasizes the role of character and virtue in moral philosophy. Traditionally the term virtue is defined with man's moral character. Character is described as the sum total of a person's dispositions. In other words, man's character is the organization of habits, attitudes and value. The good traits of character are called the virtue whereas the bad traits of character are called as vices or evils. Virtue means behaviour showing high moral standard. Virtue consists of goodness, righteousness, truthfulness, benevolence, morality, integrity, dignity, honor, fairness, respectability, nobility, loyalty, gratitude, sacrifice, justice, honesty, etc. Truthfulness is one of the moral virtues and an important spiritual quality for mankind. So, truthfulness is one of the virtue concepts in human society.

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The Concept of Truthfulness in Dhammapada

The ethical teaching of the Buddha can be found in Dhammapada. In some stories and verses, the concept of truthfulness as a moral virtue is mentioned. According to Dhammapada verse 224, the venerable Mahamaggallana asked the Buddha a question concerning speaking the truth which was the basic of morality, Venerable Mahamoggalla came to a celestial abode. He asked a celestial goddess why she gained celestial abode. The goddess was answered the question asked by Mahamoggalla thus: "Your disciple had not performed any other work of merit. I gained this grand celestial wealth on account of speaking truth." then, Venerable Mahamoggallana asked the Buddha, "Venerable Sir, can speaking truth enable one to reach the celestial abode?" The Buddha answered, "Dear Son, have you not heard and witnessed by yourself?" And then, the Buddha preached verse 224 as follows:

"One should speak the truth; one should not yield to anger,
one should give when asked even if it is only a little. By
means of these three one may go the world of the devas."[1]

By studying the above verse, every person in this world should speak the truth. A person who is perfect with sincerity is beneficial not only in the present life but also in the next life. Therefore every person should speak truth. One the other hand, the Buddha preached that one who speaks lies is felt to hell.He goes to hell in the life after death. The Buddha preached that the person who is dishonest and who earns a living immorally is destined to life in hell after passing away in human life. Therefore one should avoid all deceitful conducts and should act and behave truthfully.One will be free from all evils by keeping one's conduct, speech and thought pure. Moreover monks should also be well-guarded in deed, word and thought. He should also restrain himself from committing evil deeds by all actions. One can be the right path to *Nibbana* by restraining all his bad behaviours. The Buddha preached on speaking truth in the verse 408,

"Him I call a brahmana, who speaks gentle, instructive
and true words and who does not offend anyone by speech."[2]

According to the above mentioned, persons or monks should speak truth. They should not speak words that are injurious to others. One should conduct with pure mind in everything. By following the Dhammapada admonitions, one should promote one's status in life. In promoting one's status in life, truthfulness is needed. Therefore truthfulness is the essential moral virtue.

The Concept of Truthfulness in Jataka Stories

The Jataka, stories of the Buddha's former births, are preceded in the Pali text by a long introduction, the Nidanakatha, which gives the Buddha's previous history both before his last birth, and also during his last existences until he attained the state of a Buddha. The Buddha's birth stories are deep rooted in moral principles and practices. Thus the Jakata stories, Bodhisatta had observed for self-development and perfection to attain Buddha-hood. In the Jataka, Bodhisatta often depicted as an embodiment of sacrifice, benevolence, truthfulness, compassion and honesty.

The famous Jataka is "Suvannasama," mainly concerned with truthfulness and honesty and gratitude. The Buddha preached this story to the monks while he was residing at the Jetavana monastery near Savatthi City. In this story, Dukula and Parika renounced the

[1] Daw Mya Tin, *The Dhammapada Verses & Stories*, Yangon: Myanmar Pitaka Association, 1995, p.76
[2] Ibid., p.130

secular life and donned hermit robes. They had a son called Suvannasama. One day Dukula and Parika were searching for their food. They become blind when they were subject to poisonous fumes released by a snake. Suvannasama looked after his blind parents respectly.

One day Suvannasama was shot by with an arrow while he was searching for water in in the forest. When Suvannasama fell down unconscious, a goddess who was Suvannasama's former mother came and looked after him. As Suvannasama was an honest son who looked after his blind parents, he received the protection of a goddess.

When the two parents came, they spoke truths with the honest desire to revive conscious their son. Firstly the mother Parika spoke truths thus: "My son is in the habit of doing good deeds. He is the one who is honestly practicing noble practice. He is telling the truths. He is looking after his two blind parents. He pays respect to those who are older in age. I love my son more than I have my life. With the power of meritorious deeds that I and Dukula had done in the past, may the poisonous fumes wear off." At the end of Parika spoke truth, Suvannasama was taken less action.

And then Dukula also spoke truth like the mother Parika. At the end of the father's truth, Suvannasama was taken more action. Then the goddess also spoke truth as: "I have been living for a very long time at mount Gandhamadana. I had no son whom I loved more dearly than Suvannasama. There is not a tree that is essenceless among all the trees on this mountain. With the power of truth, may the poison wear off and regain his normal condition." At the end of telling truth of goddess, Suvannasama regained consciousness and set up. In this story, Truthfulness is the value of mind. Truthfulness is great moral conducts. The king Piliyekkha surprised on seeing the power of truth.

Then the king asked Suvannasama thus: "Suvannasama, why did you become normal consciousness?" Suvannasama answered, "goddess cures the one who looks after his parents. The one who honestly looks after the two parents enjoy blessing in the present life and in the next life." And then, the king was lived truthfully to govern the country in accordance with responsibility.

By studying this story, everybody is performed with job or another. Everybody should uphold righteous conducts. For example, when a tree is studied, it has tree-fold, root portion, trunk and portion of branches. Human life plays three parts-moral conducts, knowledge of arts and crafts and official position and wealth. If the root portion of a tree is destroyed, the remaining parts become useless, just like a dry firewood. Similarly if a person is morally corrupted, the remaining parts of life are corrupted.Therefore, the most requirement for everybody is morality. One who is perfect with morality is the one who is upright and truthful. So, the most important thing for a person is to effort to become reputed of good character and good behavior.

The Concept of Truthfulness in Proverbs

The word 'Proverbs' means in Myanmar 'Sagabaung.' Proverb is a short saying in general use, stating a general truth. Myanmar proverbs are influenced by the very rich cultural values, moral values and the strong belief of Theravada Buddhism.Moreover, it can be said that proverbs is a well known saying that can give us good advise or instruction of an ideal guideline to do something. Accordingly, most of Myanmar proverbs, state human nature, moral norms and human relationship, etc. So, it may be said that proverb is one of the sources of moral thinking.

In Myanmar society, Myanmar people accept that one should follow to keep his promise in human relationship.The famous proverb concerning the promise is;

“Pledge for the king and promise for the Layman.
(မင်းမှာသစ္စာ၊ လူမှာကတိ)
At a time when men were truthful and kept their word, every
plant on this earth was blessed with medicinal properties.
(ကတိသစ္စာ တည်သောခါဝယ်၊ ဩဇာလေးနက် ပေါဆီတက်၍ နွယ်မြက်သစ်ပင် ဆေးဖက်ဝင်၏)”[3]

This proverb shows how a man should do in life. It means that the king must be faithful and the layman must be kept his promise. The king who governs a country must be loyal.In our daily life, a person’s speech reflects on his thought and honour. In Myanmar culture a good speech is a moral virtue in the welfare of human being. Therefore we should speak honestly, sincerely, politely and truthfully. By this speaking, one will gain the trust of others.

Accordingly, one should value one’s promise in social relationship with one another. Keeping promise is the basis foundation of social relation. One should build up the basis of social affairs for the development of the society. Moreover, just as truthful persons are noble persons; deceit persons and liars are degrading their honour. The liars usually give promises easily. Those who believes such persons are likely to suffer losses. It is important not to believe in the promise given by the dishonest persons. The leaders of the country have to establish loyalty. Only then they will gain the confidence of the people.In dealing with one another, human beings are talking and conducting with trust in one another. One must be truthful and honest to gain this trust.

If a person is honest or loyal, his behaviour and speech are noble and valuable. It means all plants will have medicinal if all people in this world are truthful. In order to associate with friends for a very long time, it must be based on truthfulness.

Moreover there is a proverb that says;

“Crookedness yields scarce provender, straightness begets aplenty.
(ကောက်သော်မစားလောက်၊ ဖြောင့်သော် စားမကုန်)
If the leading goes straight, the whole herd will follow suit.
(ရှေ့ဆောင်နွားလားဖြောင့်ဖြောင့်သွားက နောက်နွားစဉ်စိုက် ဖြောင့်ဖြောင့်လိုက်၏)„[4]

According to this proverb, some persons perform to lying for one’s own profit. To become the straight-mindedness, one should be cultivated since childhood. Therefore truthful persons can obtain beneficial effect more than they can consume. A leader or parents should be honest and straight as an example. Only then the followers take the example of the leader or parents. Everybody should practice the moral virtue in this proverb. Therefore every person should associate with truthful and upright persons at anytime and anyplace. So, the concept of truthfulness plays an essential moral virtue in Myanmar proverbs.

The Concept of Truthfulness in Homily Poem

Homilies are kinds of ethical outlook in Myanmar literature. They also represent the Myanmar moral values. Central to their religious beliefs is law of Karma: the concept that good begets good and evil begets evils. Most Myanmar people were influenced by Buddhist philosophy. It can be said that ancient Myanmar homilies are admonitions.

According to this admonition, since people have to associate with one another in this world, speaking is very important. It is important to speak carefully whether one speaks good things or bad things. In speaking one should be able to speak proper words at the right time to

[3] Lu Zoe, *Myanmar Proverbs*, Yangon: Ava Publishing House, 1996, p.62
[4] HlaThamein, *Myanmar Proverbs*, Yangon: Patamyar Nga Mouk Sarpay, 2000, p.129

be effective. In speaking between friends, teachers and pupil, parents and children, it should be truth. According to Shin MahaRahtathara, in this famous poet "LatthitTaungtar" homily, (Do not deceive others and speak what is true: (သူ့ကိုမမှား၊ မလှည့်စားနှင့်၊ စကားစမြည် မြွက်သည်စစ၊ ပြောသမျှကိုမှန်လှစေ)This homily poem is a rule of moral conduct that should be followed and obeyed by every person. Truthfulness is an essential morality for every person.

Moreover, Nyaunbinthar U Punnya's homily poem, (Be sincere and faithful to friends; မိတ်ဆွေတို့မှာဖြောင့်မှန်စွာ၊ သစ္စာမဖောက်နှင့်၊Entrust property to those who keep their promise (ကတိသစ္စာရှိသူကိုသာ၊ ယုံကြည်ရာ၊ ဥစ္စာအပ်နှင်းရမည်) In the homily poem, one must associate with persons who are faithful. One has to cultivate straight-forward mind in social relationship. Homilies can give us to become a virtuous man. So the homilies encourage all of Myanmar people in order to keep good relationship between human being.

The Concept of Truthfulness in Lokaniti

Niti is a Pali word. It means in Myanmar 'Lanhnyun' (Guide). Lokaniti is a treatise purporting to guide people in the affairs of the world, so they may make progress in life. There are many kinds of Niti treatises. The famous treatises are Kakyunniti, Lokaniti, Rajaniti, Dhammaniti and MahaRahaniti. Among them, Lokaniti is well known to many people. The Lokaniti is used to instruction the youth to know the moral principles of good conduct.According to Lokaniti, the good man is very important in society. A good and virtuous person is honest and right. He avoids ill deeds. Associate with good men and learn from the law.

> **"Associate with good men; from friendship with them.**
> **knowing the law from the good men is being noble, not mean."**[5]

Accordingly, the virtuous persons are honest. They are not like the wicked who put up appearances. They have good hearts. For Niti, Jack fruit have thorns on the outside, but inside is sweet, juicy sweet, also the good men are of good heart.The virtuous person, though lacking wealth, never resorts to ill deeds, and walks along the right path. And then, the scent of the sandalwood and the light of the moon are respectively pleasant. The speech of the virtuous is much more pleasant.If one follows the instruction of the Lokaniti, one will be a good person.So,Lokaniti gives all good conduct of human being.

The Use of Truthfulness in Solving the Ethical Problems

Ethics is also one of the branches of philosophy. Concerning ethics, different philosophers have given different ideas and doctrines. As ethics is one of the axiological doctrines, the main question is "what are the criteria by which we can judge human action?" Concerning these criteria, the arisen problems are such as: Is and Ought, Value and Fact, Subjective and Objective, Egoistic and Altruistic, Deontological and Teleological problems are the prominent views in ethics.

Truthfulness is a good moral character; "Is" means what actually occurs in the nature. Ought means what ought to do. The ought is concerned with standards, norms, criteria and so on. Truthfulness is an ethical criterion. So, Truthfulness is concerned with the "Ought". So in solving the problem of Is and Ought, truthfulness can point out what we ought to do what we should do.

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[5] တက်တိုး၊ *လောကနီတိ*၊ စတုတ္ထအကြိမ်၊ ရန်ကုန်မြို့၊ တက်တိုးစာပေ၊ ၂၀၁၃၊ စာ-၃၉

The concept of truthfulness depends on the objective character. The problem is -Is morality subjective or objective? Morality has both subjective and objective aspects which are both equally important. As human being the subjective aspect should not be neglected. In fact, truthfulness is needed to obey and practice as moral rule in any time and any where. One must think objectively to have truthfulness to the others. So, one should behave truthful action objectively for the welfare of others. So, it may be said that the ethical criterion truthfulness must be objective.

Moreover, the concept of truthfulness deals more with 'Value' rather than 'Fact'. In fact, it is true that facts cannot be neglected. But on the foundation of facts, we must consider truthfulness to think for the valuable results. Then with regard to the problem of Egoism and Altruism, the concept of truthfulness is mainly concerned with the altruistic attitude rather than egoistic attitude. In philosophy, egoism is the theory that one's self is the motivation and the goal of one's own action. Altruism is the performance of duties to others without any sort of personal gain for one's efforts. Egoism is working for self and altruism is working for others. So, one should practice the truthful action for the welfare of the society. So, the altruistic manners are good for both oneself and the society. In our daily life, it should be practice fairly self-interest and the interests of others. So, if the egoism and altruism are fairly accepted and practiced in daily life, peaceful life can be possessed.

Conclusion

Human conduct and behaviour are considered to be right or wrong and good or bad. The morality of a society is concerned with what is considered to be approved or disapproved for that group. Myanmar society has its own standards of morality. It can be said that the moral concept of truthfulness is the concrete application of the Myanmar standard of morality.

In Myanmar society, a person who is trusted can be regarded as a good person. Mostly Myanmar moral virtues are based on Buddhism. In Myanmar literature, the Dhammapada verses can be founded to develop morality for the welfare of human being. In social world, the good and the bad, the cause and the effect always occur in pairs. Just as there is the good, there is also the bad. A truthful person and deceit person are quite different. Having truthfulness in deed, in word and in thought is the basic moral virtue in social relationship. By studying the Myanmar literature, Myanmar moral views are reflected in the Myanmar literature. Moreover, Myanmar scholars have attempted in writing ethical development of Myanmar people. The proverbs, homilies, Lokaniti, Jataka stories and some kinds of literature are represented the value of Myanmar Buddhist life.

In human society, the value of morality is greater than that of the property. A person of good character can be succeeded in every activity. In the life of a person, there are many things which are not one's own choice. For example one has no chance to choose the place of birth and one's parents. But one is found to have the chance to choose one's trait of character. According to Dr. Nanissara , "There is nothing great in the world but men. There is nothing great in man but character". The character of a person is directly concerned with morality. Therefore, it may be concluded that truthfulness is essential not only in economy, education, politics but also in another areas. So, the concept of truthfulness as a moral virtue plays a vital role not only in Myanmar society but also in the human society.

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တက်တိုး၊ (၂၀၁၃)၊ ***လောကနီတိ***၊ စတုတ္ထအကြိမ် ရန်ကုန်မြို့၊ တက်တိုးစာပေ။

အောင်သိန်း၊ ဦး။ တည်းဖြတ် (၁၉၆၀)၊ ***ဟံသာဝတီဆုံးမစာပေါင်းချုပ်***၊ ရန်ကုန်မြို့၊ ဟံသာဝတီပုံနှိပ်တိုက်။

Salient Features of Myanmar Philosophical Thought Reflected in Myanmar Literary Works

Min Thura Kyaw[1]

Abstract

Eastern philosophy and Western philosophy are the two fundamental trends in philosophy. The East consists of various countries with different languages, cultures, beliefs and ways of thinking. The chiefly influenced ones in the East are Indian and Chinese philosophies. Myanmar philosophical thought, one Eastern philosophy, is based on Buddhist philosophy, an Indian philosophy. It is a distinct philosophy which is a combination of Buddhist philosophy and Myanmar people's own views. However, Myanmar philosophical thought, like other eastern philosophies, has not been built as a philosophical system. It has explored in Myanmar literature such as proverbs, folk-songs, folktales and poems, and presented their own views reflected in these works. There are the two significant concepts in Myanmar philosophical thought. They are human-centered thinking and emphasis on the concept of change. This paper describes these two concepts which are reflected in Myanmar literature. Indeed, Myanmar philosophical thought is regarded as implicit philosophy but not explicit one. The aim of this paper is to discuss the nature of Myanmar philosophical thought and to investigate the two main significant concepts of Myanmar philosophical thought.

Key words: Myanmar philosophical thought, human-centered thinking, change

Introduction

Generally, there are two trends of philosophical thought. They are the Western philosophy and the Eastern philosophy. The Western philosophy has its own characteristics and the Eastern also has its significant features. Although the Easterners did not build great philosophical systems like the Westerners, they found out various views mainly emphasized on human beings and their society. The term "Eastern" comprises the various countries with different languages, cultures, customs and traditions, beliefs and ways of thinking. Among the Eastern countries, their respective customs, traditions and culture are communicated just a little, and so similarly, their own ways of thinking are various. Moreover, even within a country, there are different schools of thought and some of those are totally opposites.

In the Eastern philosophy, Myanmar philosophical thought is a distinct one with its own characteristics. Although Myanmar philosophical thought has been influenced mainly by Buddha's philosophy, which is one of the Indian philosophies, Myanmar is a country with its own cultures and traditional customs and conventions. Like this, it has been the country with its own way of thinking before Buddhism. In the Bagan period, after Buddhism in Myanmar, Buddha's philosophy and those of Myanmar philosophical thought are mixed and then Myanmar philosophical thought has become more systematic and wider than before. Myanmar philosophical thought, which is harmonious with Myanmar characters and traditions, has been continually developed with the support of Buddha's philosophy.

This paper presents a brief summary of the Western philosophy, the nature of Myanmar philosophical thought and the significant concepts of Myanmar philosophical thought. Myanmar philosophical thoughts are reflected in such literary works of poems,

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songs, folktales, folklores proverbs and many others. Among them, some Myanmar proverbs and poems are used here in this paper.

The Nature of Philosophy

Greek philosophy is considered as a starting point for the Western philosophy. The later philosophy was shaped by this philosophy. Philosophy begins with wonder in natural events. The term Philosophy is widely used in the Western countries and East Asian countries. However, the word philosophy is difficult to define. And it is derived from the two Greek words: *Philien*, which generally means to love, and *Sophia*, which means wisdom. Therefore, the etymological meaning of the word Philosophy is love of wisdom.

In the beginning, the term philosophy was loosely used by Greek thinkers and it conveyed many things. Implying his love for wisdom, Pythagoras proclaimed himself as a philosopher. Philosophers are interested in grasping the essential nature of things. Thus, philosophy was defined as a reflective and reasoned attempt to infer the character and content of the universe taken in its totality. The subfields of philosophical investigations are metaphysics, the study and structure of reality; epistemology, one's limits and resources of knowledge; ethics, the moral judgments that human beings have to deal with; logic, the principles of correct reasoning; and aesthetics, philosophy of art. All Western philosophical ways of thought deal with all, some, or only a few of these areas of study. Philosophy deals with intangible objects such as ideas, concepts, reasoning, definitions and meanings. And its function is not to change the world but to understand it.

The Nature of Myanmar Philosophical thought

Most of Western philosophers have believed that Eastern philosophy is not the same with Western philosophy in many ways. Some philosophers have believed that there is no philosophy like Western philosophy in the East. F. S. C. Northrop also believed that the ways of thinking of the East and of the West are not the same. According to him, Easterner and Westerner are different in their attention upon the nature of everything in their own way. He has believed that there are two major conceptions. They are concept by intuition and concept by postulation. This view can be seen in the F. S. C. Northrop's work *"The Complementary Emphases of Eastern Intuitive and Western Scientific Philosophy"* as follows:

> **"A concept by intuition is one which denotes, and the complete of which is given by, something which is immediately apprehended. For example, blue is the sense of the sense colour is a concept by intuition. And a concept by postulation is one the complete meaning of which is designated by the postulates of the deductive theory in which it occurs. Blue in the sense of the number of a wave-length in electromagnetic theory is a concept by postulation."**[1]

The hallmark of Eastern people, for Northrop, is concept by intuition by which immediately apprehends the things. This immediately apprehended fact was termed by Northrop as the differentiated aesthetic continuum. In his work "*the Meeting of East and West*", Northrop stated as follows.

> **"The East tends to concentrate its attention upon this differentiated aesthetic continuum in and for itself for its own sake."**[2]

But Hajime Nakamura did not agree with Northrop's view that Eastern people are intuitive. Nakamura stated as follows in his works, *"Ways of thinking of Eastern People"*.

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[1] F. S. C. Northrop, *The Complementary Emphases of Eastern Intuitive and Western Scientific Philosophy, Philosophy – East and West,* Princeton University Press, 1964, p. 173

[2] F. S. C. Northrop, *The Meeting of East and West,* New York: The Macmillan Company, 1947, p. 375

> **"… people of the East are intuitive and accordingly or systematic or orderly in grasping things; by contrast the Westerners are said to be "postulational" or logical, and that they try to grasp things systematically and by orderly planning. Indeed, the ways of thinking of the Chinese or the Japanese may be characterized as "intuitive". But in the case of the Indians this label is hard to apply. For example, the intricate arguments of the *Abhidharmā* literature are logical and can never be called intuitive."[1]**

So it can be said that the hallmark of Eastern philosophy has been containing not only the concept by intuition but also the concept by postulation.

After Buddhism in Bagan, Myanmar philosophical thought has been developed more systemically with the support of Buddha's philosophy. But there had been many proverbs, poems, folktales, folklores, legendries, songs, etc., which reflected Myanmar people's own views long before the era of Bagan. It is found that Myanmar people could have expressed their own thoughts since that time. Such kind of idea can be seen in the motto described in the Legendary named Maung Pauk Kyaing in Tagaung era.

> **"If you walk on and on, you get to your destination. If you question much, you get your information. If you do not sleep and idle, you preserve your life!"[2]**

In this motto, it is found that the practical and useful concept was accepted more than the theory in making a proper and successful life.

Two Main Significant Concepts in Myanmar Philosophical thought

Myanmar philosophical thought has been developed with momentum more systematically than before after Buddhism in Myanmar. Long before the Buddhism, Myanmar people have already possessed their own thoughts. It can be seen in Myanmar proverbs, songs, folktales and folklores. Therefore, although Myanmar philosophical thought is based on Buddhism, it is mixed with their own thoughts and a wider Myanmar's own thought has appeared.Myanmar philosophical thought is a particular philosophical thought.

Emphasis on the concept of change as a basic principle is an important view of Myanmar philosophical thought. There is a philosophical problem that, "Is everything, animate or inanimate, changing or not?" According to Parmenides, the absolute real is being whereas not being or becoming is unreal. Becoming is the world of change and it is illusory. Being is the sole reality. It is imperishable and eternal. Heraclitus contested this view. For him, only Becoming is real. He said that into the same river no one can go down and does not go down because it flows and flows out. All things is flux. Everything is changing from moment to moment. These are views of change argued by Westerners.

In the East, Buddhism does not accept the unchanging and unchanging things like the God and souls. Buddha denied the God the creator, the eternal soul, permanent things. He said that everything is changing all the time. He said about changing as follows.

> **"The Buddha postulate that life is a stream of becoming. There is nothing permanent in the empirical self. One thing is dependent or another. This is the law of dependent origination (*pratityasamutpada*). Even the self is a composite of *samjna* (perception), *vedana* (feeling), *samkaras* (volitional dispositions), *vijnana* (intelligence), and *rupa* (form). All these forms change according to the law of *Karma*."[3]**

Nevertheless, in the East, most philosophical systems such as Hinduism, Jainism and Vedanta, do not accept the law of change. Myanmar scholars as well as people emphasize on

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[1] Hajime Nakamura, *Ways of Thinking of Eastern People (Indian-China-Tibet-Japan),* United State of America: East-West Center press, 1964, p. 13

[2] Maung Htin Aung, *Burmese Folk-tales,* London: Oxford University Press, 1954, p. 87

[3] SarvepalliRadhakrishnan, *A Source Book in Indian Philosophy,* London: Oxford University Press, 1957, p. 272

the changing nature of things. Myanmar peoples understand and realize the significant nature of the law of change in their mundane life and supramundane life. This significant view of Myanmar philosophical thought, concept of change, can be seen in ancient Myanmar poem "The Nature of Things" as follows:

"Often a man suffers destruction
In order that another man
Might enjoy well-being.
Such is the nature of things!
A courtier's satisfaction
In enjoying kingly confidence
In golden palaces
And a King's own good fortune
Are merely bubbles
On the surface of a vast ocean
Momentary and evanescent
If dictated by commiseration
I were to be released
And freed from execution
I would not escape Death
Inseparable am I from Karma
All sentient beings
Being subject to dissolution.
Respectfully I salute His Majesty.
Should I again meet my Lord the King
In one of my future rebirths
In the cycle of samsara
Begrudging him nothing
I would lovingly forgive him
Impermanent is my body of blood."[1]

It is found that Myanmar people have accepted "Changes" deeply in their mind since the ancient times. It can be seen also in a Myanmar traditional proverb as follows.

"A gilded pinnacle once, now relegated to the wood pile."

This proverb is the one used in the daily life of Myanmar people. It refers to Change in particular. This means that the ornamental pinnacles of the building with a tiered roof which is a splendid one has to turn into the firewood at a time due to the nature of changing. Like these splendid pinnacles altering to the firewood at its suitable time, the high situation can transform into low at a time. This proverb shows the Changing concept firmly accepted in Myanmar philosophical thought. It is the one indicating the nature of changing of everything in this world. Dealing with changes there are not only changes from high to low but also those from low to high vice versa. This opposite nature of changing has been realized and widely accepted by Myanmar people. This view can be seen in following proverbs.

"Tree stump heightens over grass, the grass does over the stump in turn.
There is the water falling down or back.
Snake gourd or flying fish on water will float in turn."

According to the above-mentioned proverbs, it is found that Myanmar philosophical thought has accepted Change as a basic concept. It can also be seen that the problems faced in the daily life are usually solved on the basic concept of change by Myanmar people. While they are meeting with those sufferings such as both mental and physical uneasiness, agonies, sacrifices and losses, they are still holding the nature of impermanence, changing and

[1] Ashin Ananda (translated), *English Translations of Myanmar Poems through the Ages,* First Edition. Yangon: Siekku Cho ChoSarpay, 2019, p. 105

disappearance, so they can face those problems with calmness and stability. Therefore, it is quite proper for Myanmar individuals and Myanmar society to accept the concept of changing included in Myanmar philosophical thought as the basic one.

One of the significant concept in Myanmar philosophical thought is human-centered thinking. It is more emphasized on the human-centered thinking rather than nature-centered thinking. In the field of philosophy, there are two ways of thinking, human-centered thinking and nature-centered thinking. Human-centered thinking is the thinking about man, existence of man, and the role of man in this world, the interrelationships between man and his environment and his economic, political and social affairs. On the other hand, nature-centered thinking is thinking about nature like the nature of external world, the origin of the universe and the first principle of all things.

Nature-centered thinking was found mainly in ancient Greek philosophy. Milesian philosopher Thales, the founder and father of Western philosophy, attempted to explain the natural phenomena by natural principle. He said that the first principle of the universe is water. The water is the source or fundamental nature of everything. Similarly, other Milesian philosophers, Anaximander and Anaximenes also explored the natural world and attempted to answer the question "What substance is the first principle of all things?" The philosophies of Milesian philosophers centered on natural phenomena.

Moreover, pre-Socratic philosophers such as Heraclitus, Parmenides and Democritus were interested in natural phenomena rather than nature of human being. According to Heraclitus, everything in the world is changing but Parmenides believes that nothing is changing. Heraclitus sees the world of change. He said that only becoming is, and Being, that is permanent, is nothing but illusion. Into the same river, we go down and we do not go down for water flows and flows out. On the other hand, the Eleatics philosopher, Parmenides, believed only Being is and that all change, all Becoming is merely an illusion. Democritus said that everything in the universe is composed of atoms. So above all philosophers are mainly interested in the natural phenomena but not in man.

On the other hand, human-centered thinking was found mainly in Eastern philosophy. The philosophies of India and China, two main philosophies of the East, center on man. Most of the Indian systems of thoughts such as Buddhism, Hinduism and Jainism have centered on human affairs. The teaching of Buddha, the enlightened person, aims at all men, monks as well as laymen, to reach the state free from all sufferings because, for him life is full of sufferings but there is a state free from sufferings. Hinduism aims at the emancipation of one's soul from his body, and reunion of the soul with the Brahman. Indian philosophical systems aim for peaceful life and to get free from all of the sufferings. Similarly, Chinese philosophy is interested in man and his society, and their thoughts center on man.

Myanmar philosophical thought focuses on man rather than nature. Myanmar people's traditional thoughts are found in Myanmar traditional proverbs, stories, poems, folklores and folktales. It is found that Myanmar philosophical thought, reflected in those works, has focused on human beings. However, it does not mean that they are not concerned with the nature. They pay great attention and emphasis on the nature. Although the thought-provoking literary works on the outside world are found, they are not the kinds of the nature-centered ones finding out those such as the Being of the outside world, its reality and its fundamental basis. They are about the pleasantness of the natural world, its beauty and its greatness, and they are written with the feelings of the writers such as their enjoyment and fulfillment on the views of the nature. It can be seen that human-centered thoughts are used to compose the literary works of the nature outside. One such kind of poems, "***Forest Flowers***" by U Kyawt, is as follows.

"Budding branches sway daintily in the winds
Blooming forth into abundance
Red-dappled white flowers of *nan-tha*
And blooms of sandalwood
Sweetly scent the foothills.
Summertime ends
But it is not yet the season of rains.
From the ground below
Rises *Khatta'*soverwhelming perfume
While from above
Jasmine's small swinging branches
Send down their fragrance.
Climbing the forest trees
***Khaboung*flowers sway in the wind**
Like rain-soaked silver strands.
Later in the rains their stems too
Will be all a silver hue.
And in the valleys
Surprisingly charming too
Are the strange flower
Crocodile flowers."[1]

In this poem, those things such as the nature of the flowers, their manner, and their related being and reality with the outside world are not described. But its message is to make the readers pleasant by enjoying the natural beauty of those Forest Flowers and so it is composed with human-center. Therefore, Myanmar people's human-centered thoughts can be seen in this poem in spite of telling about the nature in it. Behind this, it can be said that, the philosophy on the reality that Myanmar people have accepted the external world as a reality can be seen through the appreciation of the beauty of Forest Flowers, that of the external world. If they were believed as a phenomenon world, their beauty can neither be enjoyed nor be wanted to do so. Those phenomena would be avoided and realities would be searched for instead. There raises many questions in the readers mind: Does this world exist really or not? or Is this external world where those Forest flowers are growing and can be perceived with the sense experience, a real world or a phenomenon world? Is there another real world behind it if it is the phenomenon one? and How is this real world?. But Myanmar people had never had such kinds of skeptical problems because they had been accepting the existence of Forest flowers as real. Plato said that, concerning with these problems, the world which can be known by sense experience is not real, because it is not permanent but in a state of perpetual change. On the other hand, Universal ideas are real because they are perfect, do not change in any way but remain forever. These Universal ideas cannot be known by sense experiences. It can be known by reasoning only. From this poem, it can be seen that Myanmar people have accepted the external world that can be perceived with the five senses as a reality, dealing with the concept of reality.

Moreover, Myanmar people's human-centered thought can also be studied in the following proverbs.

"If body is fit and strong, head can't move anywhere.
If the monk climb up the reality, why not the novice onto the rack above a fireplace?"

These are the human-centered proverbs which are suggested from the point of view of morality that should be practiced well when dealing with people.

"If the leading bull goes straight at front, his herd will follow his way.
All human beings have their own different ways of breathing."

[1] Ibid., p. 162

There are proverbs that describe dos and don'ts in Myanmar society. From these, it is found that Myanmar philosophical thought reflected in them has centered on human beings. Concerning with it, there are not only those which lead to the altruism but also those to the egoism.

"You can gallop your horse to Sagaing or anywhere.
You can row your boat to Pegu or anywhere.
If something is beyond you, you can't believe even your kneels."

Such this kind of the selfish egoism can harm the whole world and its people. These philosophical ideas should be avoided. Although they are human-centered, such philosophy that brings the progress of both oneself and many others should be developed.

These are the significant concepts of Myanmar philosophical thought. The influence of Buddhism on Myanmar philosophical thought can be seen in these concepts. It is not a total acceptance of the Lord Buddha's philosophy by removing all their conventional concepts. But it is the progressive flourishment from the combination of their concepts and Buddha's philosophy as Myanmar way of thinking.

Conclusion

The word philosophy is derived from the two Greek words and philosophy formed of those words "Philien", and "Sophia" which means love of wisdom. The later philosophy was shaped by Greek philosophy. The Western philosophy originated from Greek traditions. Most of the Westerners have accepted that philosophy is only in their West. But there is philosophy with its own peculiar characteristics in the East in spite of not meeting the standards in the Western philosophy. Generally, the Eastern philosophy consists of the respective philosophies of many different countries. All of these philosophies are considered as the Eastern philosophy in general. However, it consists of different thoughts and ideas, and their general commonly significant characteristic is focusing on human beings and their society. The two main kinds of the Eastern philosophies are Indian philosophy and Chinese philosophy. These two have mainly influenced in the East.

Myanmar is mainly influenced by Buddha's philosophy, one of the Indian philosophies. But Myanmar has already possessed its own culture and philosophical thought before Buddhism. Although it is not found that Myanmar philosophical thought harmonious with Myanmar people's characters, their own culture, customs and traditions and the philosophy based on them are described explicitly, it can be seen in Myanmar traditional poems, proverbs, folktales, folklores and legendries in which Myanmar philosophy is implicitly consisted. After Buddhism, Myanmar philosophical thought has been developed and spread more systematically and widely.

In Myanmar philosophical thought, there are significant philosophical concepts. Among them, the two significant concepts are human-centered thinking and accepting the concept of change.The first significant concept is an acceptance of changes of everything in the world. Myanmar people have accepted changes since the ancient times. It can be found that there are a lot of poems and proverbs in Myanmar, all of which reflect the thoughts of Myanmar people tending to see those things such as up and down, success and failure, poverty and richness, gain and loss, and life and death from the point of view of changing. Accordingly, accepting the law of changes is viewed as one distinct characteristic in Myanmar philosophical thought.

The next significant view of Myanmar philosophical thought is paying more attention to humans and interrelationships between human beings and the external world. But, in fact,

Myanmar philosophical thought also emphasizes on the nature. It is not a kind of extreme philosophical thought centering on humans only, regardless of the nature. However, it has paid much more emphasis on human affairs rather than on the nature and so it is human-centered thinking that remains as a significant view of Myanmar philosophical thought. The above-mentioned are two significant concepts of Myanmar philosophical thought. Myanmar people have accepted Buddha's philosophy, combined them with their own conventions, traditions, customs, and their way of thinking, and they have practiced the new one. In this way, more widely and more systematically developed Myanmar philosophical thought has appeared in Myanmar society.

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မြန်မာကျမ်းကိုးစာရင်း

ပညာရေးဝန်ကြီးဌာန၊ မြန်မာစာနှင့်ဘာသာစကားပညာရေးဦးစီးဌာန၊ (၂၀၁၆) ***မြန်မာစကားပုံ***၊ အဋ္ဌမအကြိမ်၊ မြန်မာစာနှင့် ဘာသာစကားပညာရေး ဦးစီးဌာန ညွှန်ကြားရေးမှူးချုပ်။

စန္ဒာဆွေ (၁၉၇၇) ***စကားပုံကဗြောသောဒဿန***၊ ပထမအကြိမ်၊ ရန်ကုန်မြို့၊ ရွှေသိမ်သားပန်းချီနှင့်စာပေ။

စန္ဒာဆွေ (၂၀၁၄) ***ဆုံးမစာကဗြောသောဒဿန***၊ ပထမအကြိမ်၊ ရန်ကုန်မြို့၊ ပုဂံစာအုပ်တိုက်။

The Root Causes of Four Accomplishments (*Sampadā*)

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

Abstract

Sampada means perfection or accomplishment. Just before the Buddha took a trip, *Ujjaya* Brahmin requested the Buddha to teach him some Dhamma. The Buddha taught him four *sampadā-dhamma* and four dhamma that can give wholesome results in the lives after death, and he also taught him four dhamma that can produce painful results in those lives. Everyone wishes to live a happy life. They want to be successful in their lives. The teachings in this *Ujjayasutta,* including the teaching on the four dhammas, can give anyone who practice them happiness in this very life and the lives after death.

Key words: *Saddhā, Sīla, Cāga, Paññā*

Introduction

All beings only want to experience pleasure, not pain. They only want to be successful, not fail. People who are unwise and ignoble minded perform evil actions without paying attention to others' wishes and gains. On the other hand, people who are wise and noble minded perform the actions that do not harm anyone. However, there is no individual who does not want to experience pleasure.

The Buddha taught the Dhamma that guided living beings to be successful and happy. He taught the Dhamma himself and also encouraged his disciples to teach the Dhamma.

The Buddha travelled around to different places during the period between his enlightenment and final demise to teach the Dhamma, day and night, without much rest. He lived in the Dhamma himself, too. The Dhamma taught by the Buddha can help one who practices happy, successful, and finally liberate from the round of *saṃsāra.*

All the teachings of the Buddha aim at *Vimuttirasa* (to experience the taste of liberation). However, the teachings do not neglect material success in life. There are some teachings that only concern with lokuttarā (supra-mundane) attainments while there are also some that aim at lokiya (mundane) achievements. Some teachings are for the happiness in this very life and some are for the journey of life after life. And there are some teachings that are mixed with both mundane and supra-mundane achievements. Here in this dissertation, the studies and discussions are focused on mundane and supra-mundane attainments as taught in *Ujjaya Sutta* of *Gotamī Vagga* from *Dutiyapaṇṇāsaka, Aṭṭhakanipāta Pāḷi* in *Aṅguttra Nikāya*. Therefore, the teachings of *Saddhāsampadā,* etc. can help one to achieve both mundane and supra-mundane benefits.

The Buddha taught the four dhammas – the beginning with the benefit of mundane are *Uṭṭhanasampadā*-perfect alternass or effort, *Ārakkhasampadā*- the perfection of protection, *Kalayāna mitta sampadā*- having good friend, *Samajivitā* – having righteous livelihood *Saddhāsampadā, Sīlasampadā, Cāgasampadā,* and *Paññāsampadā* – in the *Ujjayasutta.* Having a successful life now can lead to having successful lives in *saṃsāra*. Therefore, these teachings that are named as the benefits for present life can be considered as benefits for the lives after death. These dhammas can help one to achieve mundane and supra-mundane benefits. The Buddha taught the benefits (of wholesome deeds) experienced in lives after

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death and the pleasant experience in lives after death. These four benefits of supra-mundane are:

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[1].

Materials and Method

In this paper, all of the data were collected from *pāḷi, Aṭṭhakathā* and *Ganthantara* Texts. And then the descriptive method is used in this research.

Saddhā-sampadā- the perfection of faith

Saddhā-sampadā means the perfection of faith. If one does not have any doubt in the Triple Gems for he has full faith in them, he has *saddhā-sampadā*. This kind of *saddā* is also described as '*saddhādhimokkha*' in some places.

When the ruby of the Universal Monarch is put into the muddy water, the water becomes clean. In the same way, when saddha arises in the mind, the mind becomes clear.

Having perfect faith or accomplishment through faith is called *saddhāsampadā*. The Buddha taught concerning with *saddhāsampadā* in *Ujjayasutta* as follows.

In this world, a man from a decent family has faith. He is devoted in the enlightenment of the Buddha, the attributes of the Buddha, and he is, for this reason, called *saddhāsampadā* (a man of faith).[2]

The Buddha, in this sutta, taught that a person was called *saddhāsampadā* if he or she was endowed with the faith on the omniscience of the Buddha and the attributes of him. And the Buddha taught that this *saddhāsampadā* is beneficial in the lives after death.

"*Saddhīdhavittaṃ purisassa seṭṭhaṃ*."
"Faith is the noblest property of beings in this world."
"*Saddhāya karati oghaṃ*".

"With faith one can go across the four *ogha*. With faith one can overcome all difficulties." This is what the Buddha taught to *Aḷāvaka* the Ogre in *Aḷāvakasutta*.[3]

"The current of water can take down buildings, man and animals. In the same way, *lobha*, *ditthi*, and moha can take down the beings whose mind is filled with them to the four woeful abodes. There *lobha*, *ditthi* and moha are called *ogha*.[4] These *ogha* are:

1. *Kāma ogha (kāmogha),*
2. *Bhava ogha (bhavogha),*
3. *Diṭṭhi ogha (diṭṭhogha),* and
4. *Avijjā ogha (avijjogha)*.

Kamogha and *bhavogha* are craving (*lobha*). *Diṭṭhogha* is wrong view (*diṭṭhi*). And avijjogha is ignorance (*moha*). Therefore, *lobha, diṭṭhi* and *moha* are *ogha,* and they are unwholesome. The ogha can be overcome with *saddhā*. Therefore, one who has faith (*saddhāsampadā*) can overcome all kinds of difficulties and also eradicate lobha, diṭṭhi and

[1] A III, 111.
[2] Ibid. 113
[3] Khu, I(Suttani),306
[4] သဂြိုလ်ဘာသာ ဋီကာ, ၅၅၂

moha. Thus, that person with faith can have benefits in this very life as well as in the lives after, and also in mundane and supra-mundane world.

Sīlasampadā - the perfection of sīla

"*Sīlayati kāyavacīkammāni sammā dahatīti sīlaṃ*". It means "*Sīla* is so called since it keeps bodily and verbal actions wholesomely." With *sīla*, one keeps his bodily and verbal actions away from unwholesome actions, and this wholesome intention is called *sīla. Sīla* is of four kind: *bhikkhu sīla, bhikkhunī sīla, sāmaṇera sīla,* and *gahaṭṭha sīla. Sīla* described in *bhikkhupāṭimokka* is called *bhikkhu sīla. Sīla* described in *bhikkhunīpāṭimokkha* is called *bhikkhunī sīla.* These *sīla* are laid down by the Buddha for *bhikkhu and bhikkhunīs* to abide by as long as they are in the order. As they received ordination as *bhikkhu* and *bhikkhunī,* they are to abide by these rules.[1]

In the same way, when a young boy becomes a *sāmaṇera*, he has to abide by the concerned rules laid down for *sāmaṇera*.[2]

Laypeople are termed as '*gahaṭṭha*'. For them, five precepts play the necessary role in their daily life. After taking refuge in the Triple Gems, they are considered lay disciples of the Buddha. However, just by taking refuge in the Triple Gems, they are not considered to have taken five precepts. They have to take five precepts separately. When they take five precepts, if they say, "*Pañcasikkhāpadaṃ samādiyāmi* – I will observe five precepts", and break one of these precepts, they break all the precepts. If they take each precept separately, like, "*Pāṇātipatā veramanisikkhāpadaā samādiyāmi* – I will abstain from killing living beings", and if they break one of them, they are breaking only that particular precept. They just need to take that precept again. They can also determine how many days or months they are going to observe the precepts. When the determined period is over, the observance of the precepts is also over. They can take the precepts again if they want to. However, five precepts are *niccasāla* that means they are to be observed by laypeople. If they do not abstain from any of these precepts, although they haven't taken these precepts, the act is unwholesome. Even if they do not take five precepts, but they control their actions not to commit any of these unwholesome actions, they can get wholesome benefits. By taking precepts purposely and observing them, however, produce better wholesome results.[3]

The Buddha, in *Ujjayasutta*, taught concerning with *sīlasampadā*, the perfection of *sīla* as follows:

In this world, a man from a decent family abstain from killing living beings, ... abstain from taking intoxicated drinks and drugs. This is called *sīlasampadā*."[4]

Sīla is of two kinds – *cārittasīla* and *vārittasīla*. There are some decent acts that some people perform in their life, and even if they do not perform them, they are not doing anything unwholesome. However, if they perform them, they are doing wholesome actions, and those actions produce wholesome results. This kind of actions is considered cārittasīla. This cārittasīla is beneficial if one practices them, but if one does not practice, one is not doing anything unwholesome although one may be blamed. On the other hand, there are some actions that one has to abstain from since if one performs any of these actions, one

[1] သင်္ဂြိလ်ဘာသာ ဋီကာ, ၃၉၄
[2] ယင်း၊ ၃၉၃
[3] ယင်း၊ ၃၉၆
[4] A III, 113.

commits unwholesome deeds. Such actions are called *vārittasīla*. These *sīla-s* keep the bodily and verbal action wholesomely under control.[1]

The Buddha, in this sutta, taught the perfection of *sīla, sīlasampadā*, and he only mentions five precepts that are niccasila. In other words, he only teaches vārittasīla, not *cārittasīla*, there. Observance of five precepts can produce desirable results in this very life as well as in the lives after death. It is also beneficial for mundane achievements and supra-mundane attainments. Therefore, it can be said that sīla is one of the dhamma that can produce good results for mundane and supra-mundane world.

Cāgasampadā - the perfection of generosity

Cāga literally means giving freely, and *cāgasampadā* means perfectness of generosity or accomplishment through generosity.[2] The Buddha taught "*cāgasampada*" in *Ujjayasutta* as follows:

"In this world, a man from a decent family lives his life without stinginess in his mind. He gives things without any expectation. He has the hands that are pure (the hands that give things away), and enjoys giving things away. He always associates with those who ask things from him. He enjoys giving things. These actions are called *cāgasampadā*."[3]

Cāga or giving things away is the same thing is *dāna* (donation). Therefore, *cāgasampadā* is taught as muttacāga, with the word '*cāga*' or *dānasamvibhāgarato*, with the word '*dāna*'. These *Pāḷi* expressions show that *cāga* and *dāna* are synonyms.

Giving things away is called *dāna*. *Dāna* is of two kinds: (1) *cetanādāna* and (2) *vaṭṭhudāna*. The items donated such as food, clothes, accommodations, etc. are called *vatthudāna*. When one gives these things away, there is the intention (cetanā) of doing this action, and this cetana is called *cetanādāna*. This cetanā produces wholesome results in future lives. The things that are donated are the object of the cetanā that arises in the mind. Therefore, it is possible that if the things donated are of good quality, the mind also has good quality cetanā.

While one is offering food to the monks, one has the intention in the mind that takes the objects of food and monks, etc. These cetanās that arise and cease in moments, but they have the ability to produce the results in the future.[4]

Giving things away is in fact every enjoyable. When a person who enjoys donations sees people who are in need, he or she has compassion arises in their mind. This is *karuṇā* (compassion). And they wish to make those people happy and get what those people need, and this is *mettā* (loving-kindness). When one sees those people get what they needed, one is happy, and this is *muditā* (sympathetic joy). With these wholesome qualities – *karuṇā, mettā,* and *muditā* – in the mind, one looks so peaceful and happy.

Those who receive the donations show their appreciation to the donors and make good wishes for them. In other words, they develop *mettā* towards the donors. They are happy to see the donors becoming prosperous, and this is *muditā*. Therefore, the act of *dāna* alone can produce *Brahmacariya-dhamma*. When a donation is true and sincere, it is not only

[1] သင်္ဂြိလ်ဘာသာ ဋီကာ, ၃၉၆-၃၉၇
[2] ပါဠိ၊ မြန်မာအဘိဓာန်၊ ၃၈၇
[3] A III, 113.
[4] ကိုယ်ကျင့်အဘိဓမ္မာ ၁၇၆

the act of dāna, but it is also the act of *mettā*, *karuṇā* and *muditā,* and therefore, it can be said that *dāna* helps *bhāvanā* (meditation).[1]

Adanta damanaṃ dānam – In the world, giving can make a rude person gental.

Dānaṃ sabbattha sādhakaṃ – Through giving, every task can be accomplished.

Dānena unnamanti namanti ca – Through giving, one can stand higher than others and one will be respected by others.

Dānam sineha bhesajjaṃ – In the world, giving is a medicine that makes people to love one another.

Dānaṃ yassasi bhesajjaṃ – Giving is the way to get many friends.

These are the statements appeared in stanza number 1၂0 and 1၂1 in *Lokanīti Arājagandha*. According to these stanzas, *dāna* is the reason to accomplishment in mundane and supra-mundane world.

Paññāsampadā* - the perfection of *paññā

Paññā is wisdom through which one knows the kamma and the results of kamma, the meaning given in various texts, the nature of reality (*vipassanāñāṇa*), the realization attainable through magga (*maggañāṇa*) and through phala (*palañāṇa*). It can be even the omniscience wisdom of the Buddha. Therefore, all kinds of wisdom that are pure and wholesome are called true *paññā*.[2] The perfectness of paññā or the accomplishment through *paññā* is *paññāsampadā*.

The Buddha taught *paññāsampadā* as follows:

"In this world, a man from a decent family is wise, has the wisdom to know arising and falling of mental and material phenomena. He has pure wisdom that can penetrate through *kilesa* (defilements) in order to see the reality. He is endowed with the wisdom that can take one to the end of dukkha. This is called *paññāsampadā*.[3]

"*Paññājīviṃ jīvitamāhu seṭṭhaṃ*". "It is said that earning a living through wisdom is considered to be a noble way". (It is noble to earn a living through wisdom).

The Buddha taught, in *Āḷāvakasutta, "Paññāya parisujjhati* – Defilements are to be removed through wisdom". Thus the Buddha taught how panna can make one attain mundane and supra-mundane results.[4]

A man of wisdom does every task till the end, take refuge in the Triple Gems, know what the best way to give donations is, and observe five or eight precepts. A layperson knows how to keep his observance of precepts pure, and a monk knows how to keep his observance of Vinaya rules and his mind pure. This is possible only with the wisdom. A layperson and a monk with pure sila live pure living, and this is called earning a living through wisdom.[5]

True wisdom is wholesome, and therefore having skills, abilities and qualities in wholesome things can be called true wisdom. There are people who are intelligent and some of them might be deceitful. There was a woman named "*Kuṇḍalakesi*" whose husband was a thief before their marriage. The man could not give up his behaviour and tried to rob

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[1] ကိုယ်ကျင့်အဘိဓမ္မာ ၁၇၆
[2] ယင်း၊ ၉၇
[3] A III, 111, 113.
[4] Khu, 1(Suttani), 306
[5] KhpA. 226

Kuṇḍalakesi. He persuaded her to go up a mountain with him with the plan to rob her and kill her. *Kuṇḍalakesi* told her husband that she did not mind being killed but she wanted to pay respect to him whom she had been in love for he was her first love. She pretended to pay respect to him, and pushed him down the cliff. The deity of the forest there admired,

However, the wisdom mentioned by the deity was not a true wisdom. She was so intelligent that she could escape the danger that fell upon her. She could deceive the man. It was intelligent thought (*vitakka*) called *vañcaṇapaññā*. It can also be called as '*māya*'. The main mental factor behind this thinking was an unwholesome one that associated with lust (*taṇhā*) and craving (*lobha*). When she saw that she could deceive the man, she was happy, and that was *somanassa*. When she decided to push him down, she had the mind filled with *domanassa* (anger or hatred). Those who have wrong views also can deceive others, too, and their ability is *vañcaṇapaññā*.

These days, weapons have been invented and produced. In order to do this, intelligence plays an important role in such inventions. That is unwholesome thinking skill. However, some people are responsible to protect the innocent ones, and they have to use their thinking ability to defeat the evil enemies. In such cases, they have compassion, loving-kindness and true wisdom.[1]

In *Ujjayasutta*, the Buddha taught *paññāsampadā* which referred to both mundane and supra-mundane wisdom. The expression, 'paññavā hoti', refers to the wisdom that belongs to both mundane and supra-mundane world. The expression, *'udayaṭṭha gāminiyā paññāya sammannāgato*', the Buddha referred to *vipassanāpaññā*, the wisdom that can discern the impermanence nature of mental and material phenomena. The expression, '*ariyāya niddhigāha',* the *maggañāṇa* that can penetrate through defilements (*kilesa*) is referred. The Buddha refers to the *arahattamagga* and arahattaphala wisdom with the word *'sammādukkhakkhaya gāminiyā*', the wisdom that makes the end of *dukkha* possible. Therefore, when the Buddha said '*paññāsampadā*', he meant not only mundane wisdom, but also supra-mundane wisdom that is deep and pure. When one has such panna, one will experience mundane and supra-mundane benefits in this life as well as in the lives after death.

Results and Findings

The teachings on sampada that can produce desirable results in this very life as well as in the lives after death can be found in Pāḷi literature. With the practice of these dhammas, people can live happily and successfully. On the other hand, knowing what the dhamma that can lead one to suffering are, one can abstain from them, and free from painful results.

Conclusion

The Buddha travelled around to different places during the period between his enlightenment and final demise to teach the Dhamma, day and night, without much rest. He lives in the Dhamma himself, too. The Dhamma taught by the Buddha can help one who practices happy, successful, and finally liberate from the round of *saṃsāra*.[2]

All the 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. The Buddha also taught the dhammas that can make one fail in this very life as well as in the lives after death

[1] သင်္ဂြိလ်ဘာသာ ဋီကာ, ၁၆၀-၁၆၁

[2] KhpA, 1, 16

and also in mundane as well as supra-mundane world: These dhammas are: *Iddhidhutta* – too much sexual pleasure, *Suradhutta* - too much intoxication, *Akkhadhutta* - too much gambling, *Pāpamitta* – having evil friends.

A person who does one of these things habitually will fail in life, both in this very life and the lives after death, and also fail in mundance and supra-mundane world. A person who does not do any of these things while fulfilling Saddhāsampāda will be successful in this very life as well as in the lives death in both mundane and supra-mundane world.

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.

The Buddha taught the Dhamma including *Saddhāsampadā*, etc. answering the requests made by Jānusoṇi and *Ujjaya* Brahmin. Anyone who follows the advices given in these *Dīghajānusutta* and *Ujjayasutta* will be benefited.

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ဟုတ်စိန်၊ ဦး၊ ပါဠိ–မြန်မာအဘိဓာန်၊ ဒေးလီးဂေဇက်စာပုံနှိပ်တိုက်(ပထမအကြိမ်)၊ရန်ကုန်၊၁၉၇၅။

အရှင်ဇနကာဘိဝံသ၊ သင်္ဂြိလ်ဘာသာဋီကာ၊ မြကျွန်းသာ ကုမ္မဏီလီမိတက်၊ မိတ္တူ။ ရန်ကုန်၊၁၉၉၅။

Study on Physicochemical Characteristics of Ground Water Quality from Shwebo University Campus, Sagaing Region

Su Lay Yee[1], Khin Myo Myint[2], Jue Sandi Thin[3]

Abstract

Water is one of the most important and abundant compounds of the ecosystem. Groundwater is their primary source of potable water. Fresh water has become a scarce commodity due to over exploitation and pollution. In this study, water samples were collected from different locations within Shwebo University campus and analyzed for their physicochemical characterizations. The collected water samples were treated with gravel (2″), fiber of toddy palm leave (2″), charcoal (2″) and sand (2″). The quality analysis has been made through pH, turbidity, total suspended solid (TSS), total dissolved solid (TDS), total hardness, total alkalinity, chloride, salinity and nitrite-nitrogen, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD) and mineral elements of water samples before and after treatment. The results were compared with water quality standards prescribed by WHO. The results of this study revealed the physicochemical parameters such as pH, turbidity, total hardness, nitrite nitrogen, dissolved oxygen (DO), chemical oxygen demand (COD) of water samples before and after treatment were found to be within the maximum permissible limit of WHO drinking water standard. But, total suspended solid (TSS), total alkalinity, chloride, salinity and biochemical oxygen demand (BOD) of water samples were higher than WHO standard. The result of mineral determination revealed sodium (Na) composition before and after treatment samples 2 and 3 were found to be very higher than WHO standard. Furthermore, toxic element lead and arsenic were not detected in all samples of before and after treatment.

Key words: water quality, physicochemical parameters, ground water, toxic element

Introduction

Water plays an important role in the development of healthy society. It is the most abundant and the most useful compound in the world. Life is not possible without water. 70% surface of earth is covered by water and the majority of water available on the earth is saline in the nature only 3 % of exists as fresh water. Fresh water has become a scarce commodity due to over exploitation and pollution but due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity it is highly polluted with different harmful contaminants. Therefore, it is necessary that the quality of drinking water should be checked at regular time interval, because due to the use of contaminated drinking water, human population suffers from various water borne diseases (Basavaraja, *et al.*, 2011).

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading causes of pollution of surface and ground water. In many parts of the country available water is rendered non-potable because of the presence of heavy metal in excess. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health problems (Guptaa, 2009).

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The research aims to study some physicochemical properties and elemental contents of ground water from Shwebo University Campus, Sagaing Region.

Physicochemical Parameters of Water

It is very essential and important to test the water before it is used for drinking, domestic, agricultural or industrial purposes. Water must be tested with different physicochemical parameters. Selection of parameters for testing of water is solely depends upon for what purpose we are going to use that water and to what extent we need its quality and purity. Water does content different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Some physical test should be performed for testing of its physical appearance such as temperature, color, odour, pH, turbidity, TDS etc., while chemical tests should be performed for its BOD, COD, dissolved oxygen, alkalinity, hardness and other characters (Adnan, *et al.,*2014). For obtaining more and more quality and purity water, it should be tested for its trace metal, heavy metal contents and organic i.e. pesticide residue. It is obvious that drinking water should pass these entire tests and it should content required amount of mineral level. Only in the developed countries all these criteria are strictly monitored. The different physicochemical parameters are tested regularly for monitoring quality of water (Gupta, *et al*., 2009).

Trace Elements in Ground Water

A major concern in the large spectrum of water quality problems is that of trace elements, their occurrence in water. Although water is not normally a major source of minerals but all essential minerals occur to some extent in water. Water occasionally contains elements at toxic concentrations. The important dissolved inorganic constituents in natural water classified into three classes:

(a) Major constituents: These are calcium, magnesium, sodium, potassium, chloride, sulfate, sulfide, carbonate and bicarbonate.

(b) Minor constituents: These are iron, manganese, boron, fluoride, strontium and nitrate.

(c) Trace constituents: Trace elements in natural water are copper, cobalt, zinc, molybdenum, vanadium, nickel, arsenic, lead, cadmium and chromium may be present in amounts of only a few micrograms per liter.

The drinking water, due to its source of origin contain certain amount of trace elements. Pure water is tasteless, but water is a strong natural solvent and will dissolve minerals that may give it an odor or flavor. Sodium is a natural constituent of raw water, but its concentration is increased by pollution sources such as rock salt, precipitation runoff, soapy solution and detergent. Presence of high concentration gives bitter taste to water. Magnesium is often associated with calcium in all kind of water, but it concentration remain generally lower than the calcium.

Heavy metals can pose health hazards to man and aquatic lives if their concentrations exceed allowable limits. Concentrations of heavy metals below these limits have potential for long-term contamination, because heavy metals are known to be accumulative within biological systems (Adeyeye,1994). Lead in drinking water usually comes from water distribution lines or household plumbing rather than lakes wells or steams. Lead in a naturally occurring toxic metal found in the Earth's crust. It widespread use has resulted in extensive environmental contamination, human exposure and significant public health problems in many parts of the world.

Arsenic is one of the most toxic metal ions and possesses a serious health risk in many countries of the world. The presence of As in water causes a number of diseases such as, cancer, cardiovascular diseases, skin cancer, diabetes and black foot disease. Hence treatment of As contaminated water and provision of safe potable water to the society is an imperative concern at present (Hammer, 2012). The world health organization (WHO) recommended that many authorities reduce their regulatory limits and it has established a provisional guideline value of 10 μg/L for arsenic in drinking water.

Materials And Methods

Collection and Treatment of Samples

In this study, the three water samples were collected from different sites of Shwebo University Campus, Sagaing Region in January,2019 (Figure 1). At each sampling location, water samples were collected in polyethylene bottles. Before taking final water samples, the bottles were rinsed three times with water to be collected. The sample bottles were labelled with date and sampling source. Then collected samples were treated with prepared gravel (2″), toddy palm leaf (2″), pieces of charcoal (2″) and sand (2″) filter (Figure 2 and 3). Filtration is a process which improved the water quality by the removal of suspended solids, colloidal matter and the reduction of number of bacteria, colour, odour etc. A filter was designed, using locally available adsorbents, such as toddy palm leaf, sand and gravel which removes the physical and chemical impurities from water.

Determination of Physicochemical Properties

The experiments and measurements were carried out at the Department of Chemistry, Shwebo University. Sensors play a vital role in detecting the impurities in water. In this research, sensors namely pH, nephelometer, Palin test photometer (7500), Lovibond water testing meter (MD 100), Palin test arsenator and atomic absorption spectrometer (AAS) were employed. The before and after treatment samples were analyzed for their physicochemical parameters such as pH, conductivity, turbidity, total suspended solid, total dissolved solid, total alkalinity, total hardness, salinity, chloride, nitrite, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand and elemental contents.

Table 1. Location of Sampling Sites of Shwebo University Campus

Sample	Sampling site	Depth of tube well
1	Building 8, Teacher Avenue	970 ft
2	Building 2, Teacher Avenue	380 ft
3	Chemistry Department	400 ft

Sample 1 Sample 2 Sample 3

Figure 1. Three tube well water samples from Shwebo University Campus

Figure 2. Gravel, fiber of toddy palm leaf, charcoal and sand for water treatment

Figure 3. Filtration of water sample

Results and Discussion

Physical Parameters of Water Samples

Some physical parameters of water samples from Shwebo university campus were summarized in Table 2. The pH value of water sample before treatment was found to be 7.9 to 8.37 and after treatment of pH values were found to be 7.47 to 7.79. The acceptable pH for WHO standard is between 6.5 to 8.5 usually indicating good quality. The pH value of water sample before and after treatment exist within the standard range. The turbidity values of water samples were found to be in the range of 1.55 to 2.53 NTU in before treatment and 1.15 to 2.31 NTU in after treatment. Turbidity should ideally be below 5 NTU, since the appearance of water with a turbidity of less than this value is usually acceptable to consumers.

Solids refer to the suspended and dissolved matter in water. Total suspended solids of water samples were determined by gravimetric method. The contents of total suspended solids (TSS) of before treatment water samples were found to be in the range of 100 to 1100 ppm and after treatment was 100 to 280 ppm. The total suspended solids for WHO standard is maximum 150 ppm. The total suspended solid values of water before treatment exist higher than the standard range and the total suspended solid of water samples 2 and 3 significantly decreased to 280 and 200 ppm after treatment.

The total dissolved solid value of all water samples before treatment were found to be 1000 to 2000 ppm. The total dissolved solid value of the water samples after treatment were found to be 497 to 1100 ppm. The acceptable total dissolved solid value for WHO standard is 500 ppm. The total dissolved solid value of water sample before and after treatment were higher than the standard range. Hence, these ranges were not acceptable to use as potable water.

Table 2. Physical Parameters of Water Samples

Sample	pH		Turbidity (NTU)		TSS (ppm)		TDS (ppm)	
	*BT	*AT	*BT	*AT	*BT	*AT	*BT	*AT
1	8.09	7.52	1.55	1.15	100	100	1000	497
2	7.9	7.47	2.53	2.31	1100	280	2000	1100
3	8.37	7.79	2.13	1.78	1100	200	1000	750
WHO standard	6.5 – 8.5		5		150		500	

*BT = Before Treatment *AT = After Treatment
*TDS = Total Dissolved Solids *TSS = Total Suspended Solids

Chemical Parameters of Water Samples

The values of some chemical parameter found in water samples were shown in Table 3. Regarding total hardness of all studied samples considered safe for drinking purposes, the hardness value of water sample before treatment were found to be 60 to 220 ppm. The hardness value of the water sample after treatment were found to be 60 to 110 ppm. The acceptable hardness value for WHO standard is 500 ppm. These results showed that hardness of water was good agreement with WHO standards and it was for local inhabitants.

The alkalinity value of water samples before treatment were found to be 430 to 800 ppm. The alkalinity value of the water samples after treatment were found to be 272 to 480 ppm. The acceptable alkalinity value of drinking water for WHO standard is 150 ppm. The alkalinity values of both water samples of before and after treatment were found to be higher than the standard range.

In the study area, the chloride ranged from 200 to 640 ppm for before treatment and after treatment, it was found to be 120 to 480 ppm. The chloride values were greater than the drinking water quality standards. The reported the range of chloride was 250 ppm. High chloride content may harm metallic pipes and structures as well as growing plants. Chlorides in excess impart the salty taste to water and people not accustomed to high chloride are subjected to laxative effect. The water salinity ranged from 391 to 1185 ppm for before treatment and 246 to 896 ppm after treatment. The salinity of water samples 2 and 3 for before treatment and after treatment were higher than the maximum permissible limits 500 ppm.

Table 3. Chemical Parameters of Water Samples

Sample	Total Hardness (ppm)		Total Alkalinity (ppm)		Chloride (ppm)		Salinity (ppm)	
	*BT	*AT	*BT	*AT	*BT	*AT	*BT	*AT
1	60	40	430	272	200	120	391	246
2	220	110	550	480	640	480	1185	896
3	100	60	800	460	440	400	824	752
WHO standard	500		150		250		500	

*BT = Before Treatment *AT = After Treatment

Biological Parameters of Water Samples

Some biological characteristics of water samples were shown in Table 4. Nitrite is one of the most important diseases causing parameters of water quality particularly blue baby syndrome infants. In this research, the nitrite-nitrogen of water sample before treatment were found to be 0.40 to 0.58 ppm. The nitrite content of all water samples after treatment were

found to be 0.165 ppm. The nitrite content of the water sample before and after treatment were lower than the permissible level.

Dissolved oxygen (DO) reflects the physical and biological processes prevailing in the water. The DO values indicate the degree of pollution in water bodies. In this research, the dissolved oxygen of all water samples before treatment were found to be 0.5 ppm. The dissolved oxygen of the water sample after treatment were found to be 0.3 to 0.4 ppm. The dissolved oxygen values of water samples were within the acceptable WHO standard (<5 ppm). Occurrence of low DO value has been attributed to the process of decomposition of organic matter involving the utilization of oxygen.

The chemical oxygen demand (COD) of water sample before treatment to be 0.28 to o.64 ppm. COD values of the water sample after treatment were found to be 0.16 to 0.50 ppm. The acceptable chemical oxygen demand for WHO standard is 10 ppm. High COD may cause oxygen depletion by decomposition of microbes. The chemical oxygen demand values of water samples were within the standard range.

The biochemical oxygen demand (BOD) is a measure of the dissolved oxygen consumed by microorganisms during the oxidation of reduced substances in water. It is a good index of pollution and therefore helps in deciding the suitability of water for consumption. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water. BOD of water sample before treatment were found to be 4 to 8 ppm. The biochemical oxygen demand of the water sample after treatment were found to be 2 to 5 ppm. The acceptable biochemical oxygen demand for WHO standard is <5 ppm. The biochemical oxygen demand of water sample after treatment exists within the standard range.

Table 4. Biological Parameters of Water Samples

Sample	Nitrite-nitrigen (ppm)		DO (ppm)		COD (ppm)		BOD (ppm)	
	*BT	*AT	*BT	*AT	*BT	*AT	*BT	*AT
1	0.40	0.165	0.5	0.4	0.50	0.20	4	2
2	0.56	0.165	0.5	0.3	0.64	0.20	8	5
3	0.58	0.165	0.5	0.4	0.28	0.16	4	3
WHO standard	10		5		10		5	

*BT = Before Treatment *AT = After Treatment *DO = Dissolved Oxygen
*COD = Chemical Oxygen Demand *BOD = Biochemical Oxygen Demand

Trace Elements of Water Samples

Concentration of metallic elements such as Na, Mg, Ca and Pb were measured in water samples before and after treatment by atomic absorption spectrometer. Toxic element As was determined by arsenator. The results of the mineral elements concentration in water samples are shown in Table 5.

According to the AAS results, Na content were found to 118.86 to 2253.8 ppm for before treatment and 112.02 to 2163.4 ppm after treatment. The sodium element contents of sample 2 and 3 were found to be very higher than WHO standard for drinking water. Mg contents were 7.036 to 62.12 and 5.596 to 25.776 ppm before treatment and after treatment respectively. Ca contents were 10.9566 to 40.9552 and 6.8210 to 10.5934 ppm before treatment and after treatment respectively. Magnesium and calcium contents were found within WHO standard range. Toxic elements Pb and As were not detected in all samples.

Table 5. Element composition of water samples

Mineral element	Relative abundance of Before Treatment			elemental contents (ppm) After treatment			WHO standard (ppm)
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample3	
Na	118.66	2253.8	1864.6	112.02	2163.4	1629.8	200
Mg	7.036	62.14	10.648	5.596	25.776	8.766	150
Ca	11.4982	40.9552	10.9566	6.8210	7.8358	10.5934	75
Pb	0.00	0.00	0.00	0.00	0.00	0.00	0.01
As	0.00	0.00	0.00	0.00	0.00	0.00	0.001

Conclusion

The water samples were collected from different locations of Shwebo University Campus, Sagaing Region. The water treatment system was created with gravel (2″), toddy palm leaf of fiber (2″), charcoal (2″) and sand (2″). The water samples passed through this treatment systems. The water samples of before and after treatment were analyzed for physicochemical properties, trace element and heavy metal pollution. According to the experimental results physicochemical determination pH, turbidity, total hardness, nitrite nitrogen, dissolved oxygen (DO) and chemical oxygen demand (COD) of water samples before and after treatment were found to be within the WHO standard. Total suspended solid (TSS), total alkalinity, chloride, salinity and biochemical oxygen demand (BOD) of water samples were higher than WHO standard. But these physicochemical parameters could be reduced after filtration. According to the quantitative analysis of mineral element such as Na, Mg, Ca, Pb and As, the result of sodium Na composition in before and after treatment samples 2 and 3 were found to be higher than WHO standard. Excessive amount of sodium in drinking water is harmful to persons suffering from cardiac, renal and circulatory diseases. Calcium and magnesium content of all water samples before and after treatment were also found to be lower than WHO standard. Toxic elements, Pb and As were not detected all samples of before and after treatment. In the study, water samples of before and after treatment showed total suspended solid (TSS), total alkalinity, chloride, salinity, biochemical oxygen demand (BOD) and sodium (Na) values indicating poor water quality. However, simple construction of water treatment system can be made as low cost available and natural adsorbent for reducing of impurity from ground water.

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The researchers would like to thank, Rector Dr Win Swe and Pro-rector Dr Myo Myo, for the permission of doing this research. We would like to express deep sense of gratitude to Dr Kyu Kyu Swe, Professor and Head (Retired), Department of Chemistry, Shwebo University for her kind provision of the research facilities. Special thanks are extended to Professor and Head, Dr Nyunt Nyunt Sein, Department of Chemistry, Shwebo University for her kind encouragement.

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Investigation on the Properties of Chitosan and Chitosan-Rice Starch Biodegradable Films

Khin Myo Myint[1], Su Lay Yee[2], Myint Myint San[3]

Abstract

In this research, chitosan was extracted from prawn shells by a chemical process involving deproteinization, demineralization and deacetylation. Chitin was produced from prawn shells by deproteinization with sodium hydroxide and demineralization with hydrochloric acid solution by boiling method. Chitosan was prepared from deacetylation of chitin with 50% sodium hydroxide solution. The physical properties of prepared chitosan such as pH, moisture, ash were determined. The functional groups contained in synthesized chitin and chitosan powder samples were identified by FT-IR spectrophotometric method. Moreover, the mechanical properties such as thickness, tear strength, tensile strength and elongation at break of different prepared films were determined. Moreover, the mechanical properties such as thickness, tear strength, tensile strength and elongation at break of different prepared films were examined. The biodegradation of the films were carried out by soil burial experiment. The chitosan and chitosan-rice starch films degraded faster in the soil environment.

Key words: prawn shell, chitin, chitosan, biodegradable films

Introduction

Chitin or β (1-4)-N-acetyl-D-glucosamine is one of the most abundant polysaccharides found in nature (Panya, *et al*., 2005). It occurs in animals, particularly in crustacean, prawn, mollusc and insects, where it is a major constituent of the exoskeleton, and in certain fungi. Chitin and its derivatives have many properties that make them attractive for a wide variety of applications from food, nutrition and cosmetics to biomedicine, agriculture and environment. Chitin can be used for various economical applications. Moreover, the chitin can be further deacetylated to produce chitosan, a valuable chemical substance having a wide range of viable uses (Kumar, 2000).

Chitosan is primarily produced from chitin, which is widely distributed in nature, mainly as the structural component of the exoskeletons of arthropods (including crustaceans and insects), in marine diatoms and algae, as well as in some fungal cell walls. Chitin is a white, hard, inelastic, and inert solid. It is highly hydrophobic and is insoluble in water and most organic solvent (Jang, *et al*., 2004).

Chitosan is biodegradable, biocompatible and exhibits bio adhesive characteristics. It is a copolymer of glucosamine and N-acetyl glucosamine linked by β 1-4 glucosidal bonds obtained by N-deacetylation of chitin (Kumar, *et al*., 2010).

Chitosan forms good films and membranes. Chitosan film has a potential to be employed for packaging, particularly as an edible packaging (Bangyekan, *et al*., 2006). Chitosan is a semi crystalline polysaccharide that, unlike many biodegradable polymers, is insoluble in water at neutral pH (Murray, 2006).

The development of new biodegradable packaging material films, for example, chitosan film is needed to find alternative to petroleum based plastics because of environmental

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concerns (Khamhan, *et al*., 2008). Chitosan has been used as edible films and coating in the food industry.

Biodegradation is the disintegration of materials by bacteria, fungi, or other biological means. Although often conflated, biodegradable is distinct in meaning from compostable. Biodegradable matter is generally an organic material that serves as a nutrient for microorganisms. Biodegradable chitin and chitosan can strengthen recycled paper and increase the environmental friendliness of packaging and other products. Chitosan is already involved in the manufacture of paper because chitosan molecules greatly resembles those of cellulose the main constituents of plants walls. Lastly the paper produced with chitosan has a smoother surface and is more resistant to moisture. Hydroxymethyl chitin and other water soluble derivatives are useful end derivatives in paper making (Dutta, *et al*., 2002).

In textile industry, chitin can be used in printing and finishing preparations, while the chitosan is able to remove dyes from dye processing effluents (Bhavani, *et al*., 1999). Besides these, both chitin and chitosan have made remarkable contribution to medical related textile sutures, threads, and fibers (Le, *et al*., 1997).

Chitin, chitosan and their derivatives offer uses in three areas of cosmetics, hair care, skin care and oral care. Chitosan can be used in shampoos, rinses permanent wave agents, hair colorants, styling lotions, hair sprays, and hair tonics. Several derivatives of chitosan and chitin have potential applications in hair care. Both chitin and chitosan can be used in toothpaste, mouthwashes and chewing gum. They fresh the breath and prevent the formation of plaque and tooth decay (Zhang, *et al*., 2009).

Starch has been widely used to produce the biodegradable film in recent years (Wittaya, 2012) as it is a natural polymer that can be an alternative solution to the environmental problem caused by plastic uses. Starch has shown a promising application as a food packaging due to its plentifully availability, biodegradability, low cost and flexibility (Parra, *et al*., 2004). Rice starch and its major components, amylose and amylopectin are biopolymer, which are the attractive raw materials focusing as barriers in packaging materials. They have been used to produce biodegradable films to partially or entirely replace plastic polymers because of its low cost and renewability. However, a wide application of starch film is limited by its poor mechanical properties. This constraint has led to the improvement of the properties of rice starch-based films either by modifying its starch properties and/or incorporating other materials.

The aim of this research is to investigate the mechanical properties and biodegradation of chitosan and chitosan- rice powder composite films.

Materials and Methods

Sample Collection and Preparation

The waste prawn shell samples were collected from the local market, Aung Myay Tharzan Township, Mandalay Region. The collected prawn shells were washed with water by several times to remove unwanted materials. Then the shells were dried in the sunlight. After that, the dried shells were crushed and ground by a blender. The dried shell powder was sieved with a 100 mesh size sieve.

Figure 1. Prawn shells and prawn shells' powder

Determination of Elemental Composition in Prawn Shell

The prawn shell powdered sample was measured for the constituents of element by EDXRF (Energy Dispersive X-ray Fluorescence) method.

Extraction of Crude Chitin

Chitin was extracted by Deproteinization and Demineralization. Prawn shell powder 5 gm was placed in a conical flask and 25 mL of 5% NaOH was added. The mixture was boiled for 30 minutes. Then the mixture was washed with distilled water until neutral and filtered by using filter paper. After that 25 ml of 25% HCl was added and stand for 24 hours. Finally the mixture was washed with distilled water until neutral and filtered. The residue was dried in the sunlight (Hosssain, & Iqbal, 2014).

Figure 2 Extraction of chitin by deproteinization and demineralization

Extraction of Chitosan

Deacetylation was used for extraction of chitosan. The crude chitin was obtained from 5% NaOH and 25% HCL was used to extract chitosan. Crude chitin (5 gm) was mixed with 100 mL of 50% NaOH in a round bottom flask. Then the flask was refluxed for 8 hours. After that the mixture was washed with distilled water to neutral. The residue was dried in sunlight (Gopalakannan, *et al*., 2000).

Figure 3. Extraction of chitosan by deacetylation

Determination of Ash Content

An accurately weight of the sample 1 g was placed in preheated, cooled and weight of porcelain. The crucible was on heated carefully on a hot plate for 3 hours and finally heated in an electric oven at 100% for 3 hours. The heating was contained until the resultant ash was uniformed in color (i.e. white color) and the crucible containing the residue was cooled at room temperature in a desiccator and weighed the process of heating, cooling and weighing was carried out reproducible until constant weight was obtained (AOAC, 1990).

Preparation of Chitosan and Chitosan-rice Starch Films

Chitosan powder 1 gm and 50 mL of 2 % acetic acid were put into 250 mL beaker. The mixture was stirred for 2 hours on the magnetic stir to become homogeneous solution. After degassing, 10 mL of the mixture solution was poured into each petridish and it was maintained at room temperature for 5 days (Wongpanit, *et al*., 2005). Chitosan – rice powdered film was prepared by similar procedure of chitosan film (Bourtoom, *et al*., 2008).

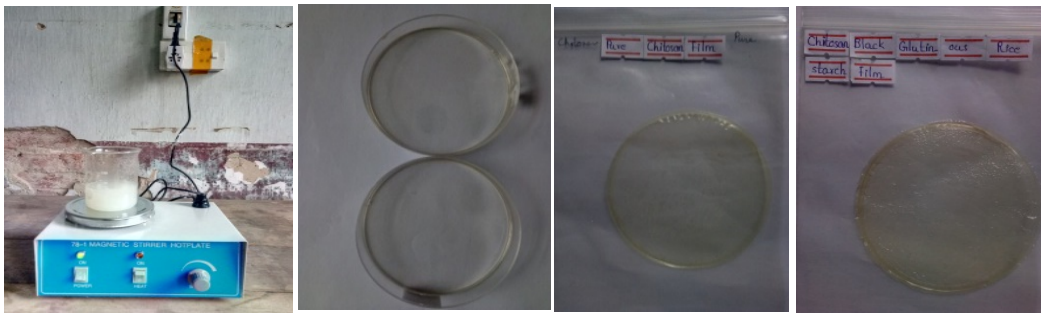

Figure 4. Prepared pure chitosan film and chitosan-rice powder film

Determination of Functional Groups in the Chitin and Chitosan

Functional groups in the chitin and chitosan were determined by FT-IR (Fourier transform infrared) spectroscopy at Department of Chemistry, Monywa University.

Physical Properties of Chitosan

Moisture, pH and ash contents of prepared films were examined by AOAC methods.

Determination of Mechanical Properties and Biodegradation of Prepared Films

The mechanical properties of prepared films such as thickness, tensile strength, elongation at break, tear strength were measured at Rubber Research and Development Centre by ASTM standard Method. The Biodegradation of all prepared films were investigated by soil-burial test.

Results and Discussion

According to Figure 5, the EDXRF spectrum of prawn shell powder, informed that calcium was more abundant than the others and the toxic heavy metal does not contain in the prawn shell. Relative abundances of elements in the sample were tabulated in Table 1.

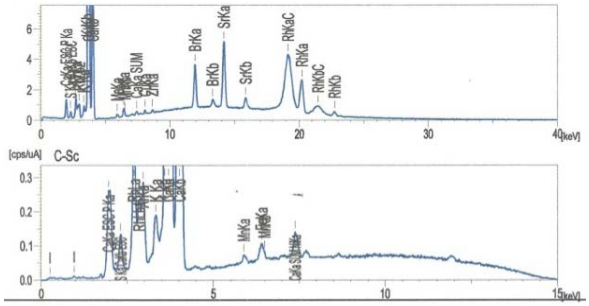

Figure 5. EDXRF spectrum of prawn shell

Table 1. Elemental Composition in Prawn Shell

No.	Symbol	Element	Amount (%)
1	Ca	Calcium	96.928
2	K	Potassium	0.655
3	S	Sulfur	0.624
4	Sr	Strontium	0.556
5	Br	Bromine	0.419
6	P	Phosphors	0.361
7	Fe	Iron	0.239
8	Mn	Manganese	0.131
9	Cu	Copper	0.051
10	Zn	Zinc	0.037

The yield % of chitin was the range of 20 to 24 % based upon the crude sample. And 20-22% of chitosan was obtained from the chitin.

The extracted chitin and chitosan were measured for constituents of functional groups by applying FT-IR spectrometry. The FT-IR spectrums of chitin and chitosan powder were shown in Figure 6.

According to the FT-IR spectrums chitin and chitosan, Figure 6, N-H stretching vibration of primary amine, O - H stretching vibration of alcohol, C = O stretching vibration, N - H bending vibration of amide group and C- C- O stretching vibration of primary alcohol groups in chitin were observed at 3434.83 cm^{-1}, 3255.27 cm^{-1}, 1548.00 cm^{-1}, 1065.25 cm^{-1}, and 1009.32 cm^{-1}, and O-H stretching vibration of alcohol, C-N stretching vibration of amide III band and C-O-C stretching vibration of ether group in chitosan would be found the peaks at 3361.98 cm^{-1}, 1586.85 cm^{-1}, 1079.01 cm^{-1} and 1031.93 cm^{-1}.

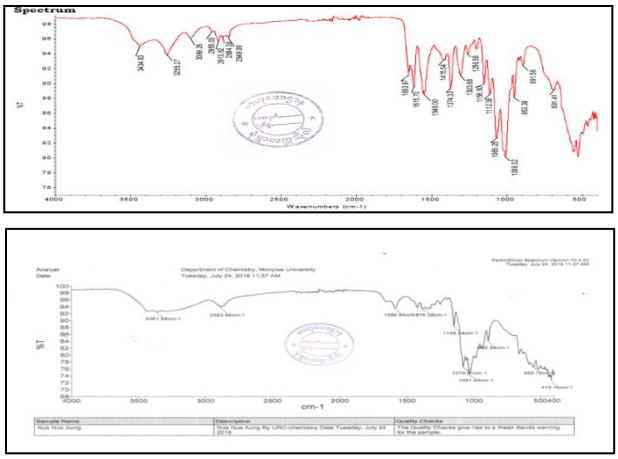

Figure 6. FT-IR spectrums of extracted chitin and chitosan

Some physical properties of chitosan were found 2.23 % in moisture, 8.38 in pH and 3.25 % in ash content. The value of pH showed that extracted chitosan is alkaline medium. The moisture was less and ash content was higher than the reported value. In the reported paper, chitosan contained as 7.69- 8.25 % in moisture and 0.26-0.3 % in ash (Hossain, M. S., 2014). Mechanical properties of prepared chitosan film and chitosan-rice starch film were determined. The results are shown in Table 2.

The thickness of chitosan film was observed as 0.01 mm, tensile strength as 20.00 MPa, and % elongation at break was found to be 7.00 %. Moreover, tear strength was also found as 10.00 kN/m. The thickness of chitosan-rice starch film was measured as 0.02 mm, tensile strength as 12.30 MPa, and % elongation at break was observed as 10.00%. Moreover, the tear strength would be observed as 7.6 kN/m.

Biodegradation of prepared films in soil environment were studied. The chitosan film was not seen after six days and chitosan- rice starch film was not seen after four days. Chitosan-rice starch film is more easily degradable.

Table 2. Mechanical Properties of Chitosan Film and Chitosan-rice Starch Film

No.	Test	Chitosan Film	Chitosan –Rice Starch Film
1	Thickness (mm)	0.01	0.02
2	Tensile strength (MPa)	20.00	12.30
3	Elongation at break (%)	7.00	10.00
4	Tear strength (kN/m)	10.00	7.60

Figure 7. Biodegradation test for (a) chitosan film and (b) chitosan-rice starch film

Conclusion

EDXRF spectrum informed the constituents of elements in prawn shell. Calcium was the highest content. The yield percent of extracted chitin was found to be 20%-24%. Chitosan extracted from chitin was found to be 20%-22%.

Some physical parameters of chitosan (pH, moisture content and ash content) were determined. The pH was found to be 8.38 and it was slightly alkaline medium. The moisture content was 2.23% and the ash content was 3.25%.The chitosan can be used in edible film because the important functional characteristics of an edible film are its resistance to the moisture.

According to the measurement of mechanical properties of prepared films, the thickness of chitosan film was smaller than the other. The smaller tensile strength and tear strength in chitosan-rice starch film were found to be 12.30 MPa and 7.6 kN/m. The value of elongation at break in chitosan film was observed 7.00 % and 10 % in chitosan–rice starch film. It indicated that the chitosan-rice starch film is poor mechanical properties than chitosan film.

For biodegradability of the prepared films, soil burial method was used. After 4 days, chitosan-rice starch film was not seen in the soil. After six days, chitosan film disappeared completely in the soil. By comparing biodegradable activity of different films, chitosan-rice starch film was found to be more biodegradable than chitosan film but the better condition of mechanical properties was found in chitosan film. Both prepared films are easily degradable in soil environment. These films should be modified to be better mechanical properties by suitable chemical methods. Biodegradable films should be used instead of plastic to reduce environmental pollution.

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Total Phenolic Content and Structure Elucidation of Pure Compound MMS-1 from *Achyranthes aspera* L. (Kyetmauk Su-Pyan)

Myint Myint San[1], Aye Aye Khaing[2],
Khin Myo Myint[3], Hla Myo Min[4]

Abstract

Local wild plant, *Achyranthes aspera* L. family Amarathaece (Kyetmauk-su-pyan), was collected for chemical analysis. Quantitative determination of phenolic content in *Achyranthes aspera* L. was carried out by Folin-Cioucalteu reagent using spectrophotometer at 760 nm. Complete structure elucidation of compound MMS-1 was assigned by FT-IR spectrum, Proton Nuclear Magnetic Resonance (^{1}H NMR), Carbon Nuclear Magnetic Resonance (^{13}C NMR), Double Quantum Filtered ^{1}H–H Correlation Spectroscopy (DQF-COSY), Heteronuclear Multiple Quantum Coherence (HMQC), Distortionless Enhancement by Polarization Transfer (DEPT) and Heteronuclear Multiple Bond Coherence (HMBC), NOESY and DART-mass, spectral data respectively.

Key words: *Achyranthes aspera* L., phenolic content, Folin-Cioucalteu

Introduction

Nature has been a source of medicinal plants for thousands of years and an impressive number of modern drugs have been isolated from natural sources.(Marinova., 2011).Various medicinal plants have been used for years in daily life to treat various diseases all over the world.(Harbone.,1984) They have been used as remedies and for health care preparations. (B.Shiney ramya, 2012).Herbal remedies used in folk medicine provide an interesting and still largely unexplored source for the creation and development of potentially new drugs for therapy. (Pandey, Sharma., 2013) which might help overcome the growing problem of resistance and also the toxicity of the currently available commercial antibiotics/pesticide and discovery of new bioactive compounds.(Kubo, 1983)

Achyranthes aspera L. (kyetmauk-su-pyan) was selected for chemical analysis. The plant is widespread in the world, as Tropical Asia, Africa, Australia and America. (Pandey, Sharma, 2013) In Myanmar, it is easily found anywhere and road sides or on the edge of field. The whole plant is used in different systems of folk medicine, especially diarrhoea and dysentery, diuretic, hepato-proptective, antiallergic, antidiabetic and various other important medicinal properties. (Pandey,2013)Therefore, it is of great interest to carry out a screening of these plants in order to validate their use in folk medicine and to reveal the active principle by isolation and characterization of their constituents.

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Botanical Description

Scientific name : *Achyranthes aspera* L.
Myanmar name : Kyetmauk-su-pyan
Family : Amaranthaceae
English name : Chaff-flower
Medicinal uses : antiasthmatic, antidiabeti, anti-allergic, dysentery, analgesic, fever

Figure 1. Plant of *Achyranthes aspera* L.

Materials and Methods

Sample Collection

Plant materials were collected from Shwebo Township, Sagaing Region. Three collected samples, (whole plants) were washed and cut into small pieces and dried in the well ventilated shade. Then, the dried sample was stored in a well stoppered bottle and used throughout the experiment.

General Experimental Procedure

Commercial grade reagents and solvents were used in this research. Solvents were purified by simple distillation. Thin layer chromatography was performed by using aluminium precoated sheet silica gel (Merk-Co-Lnc, Kiesel gel 60 F54) and silica gel (mark-Co.Inc, Kiesel gel 70-230 mesh ASTM) were used for column chromatography. FT-IR spectrometer (Shimadsu, Japan) at Mandalay University was used for the identification of the functional groups of the isolated compound and NMR experiments were performed on a Bruker 600 MHz (^{1}H) and 150 MHz (^{13}C) with TMS. NMR chemical shift (δ) were reported in ppm and solvent peaks were used s internal standards .The coupling constant (J) values were reported in Hertz (Hz). The multiplicity of each carbon atom was determined by DEPT spectrum. DQF-COSY, NOESY, HMQC and HMBC spectra were recorded using standard pulse sequences. DART–MASS spectral data show the mass number of isolated compound. (Sliverstein.,2005) Quantiative determination of phenolic content by Folin-Cioucalteu reagent was done by using spectrophotometer at 760 nm **.**

Extraction and Isolation of Pure Compound MMS-1 from the *Achyranthes aspera* L.

The air dried plant material (1.0kg) was percolated with ethanol (3L) for about two weeks. The percolated solution was filtered and evapourated to dryness at room temperature. The ethanol crude extract (5g) was extracted by ethylacetate. The ethylacetate fraction was concentrated to dryness at room temperature and dried extract (2.23 g) was obtained. These crude extract (2.23g) was chromatagraphed over a silica gel column, eluted with a gradient solvent system of increasing polarity(n-hexane, 19:1-1:9, then ethylacetae only) to give (135) fractions. Each fraction was checked by TLC, iodine vapour and UV lamp. Then the fractions of the same R_f values were combined.

Elution was conducted with the solvent ratio of n-hexane: ethylacetate (7:3) to give pure compound MMS-1 (7.2 mg, R_f = 0.49) as white crystalline powder.

Results and Discussion

Total Phenolic Contents of *Achyranthes aspera* L.

The total phenolic content of ethanol extract of plant sample was estimated by Folin-Ciocalteu's method using garlic acid standard. The total phenolic contents of the plant extract was shown in Table 1 and histogram in Figure 2. It appears that ethanol extract had high content of phenolic compounds.

Table 1. Absorbance of Standard Gallic Acid

Concentration of Gallic Acid (µg/mL)	Absorbance at 760 nm
6.25	0.058
12.50	0.099
25.00	0.163
50.00	0.297
100.00	0.580

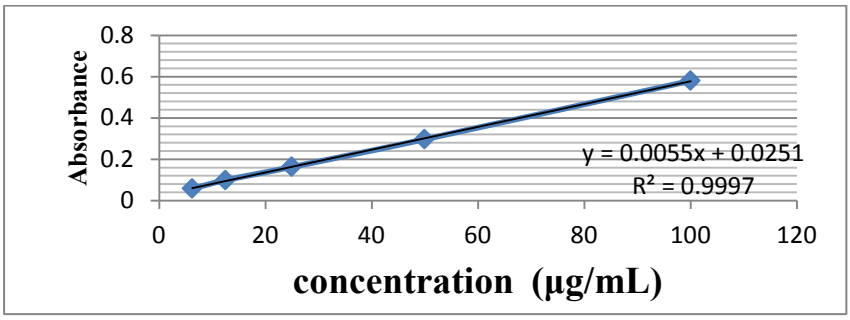


Figure 2. Standard calibration curve of gallic acid

Table 2. Total Phenolic Contents of *Achyranthes aspera* L.

Sample (500ppm)	Absorbance	Total Phenolic Content (µg*GAE/mg of extract)
EtOH extract	0.385	65.5

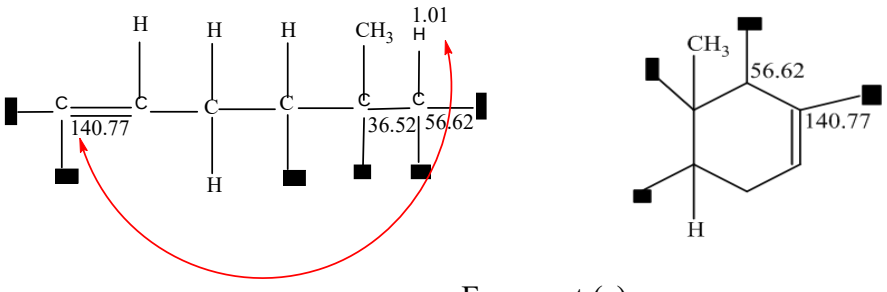
*GAE= Gallic Acid Equivalent

Structure Elucidation of Pure Organic Compound (MMS-1)

The structure elucidation of pure compound could be done by applying FT-IR, ^{1}HNMR, ^{13}CNMR, DEPT, DQF-COSY, HSQC, HMBC, NOESY and DART- MASS spectral data, respectively.

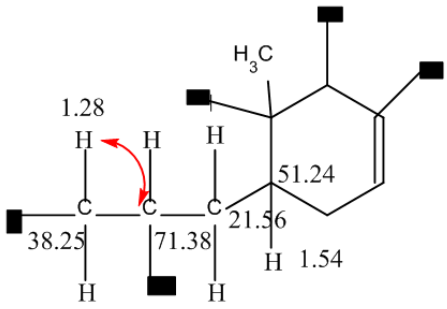
In HMBC spectrum, the sp^2 methine proton at (δ 5.34 ppm) has α ^{1}H-^{13}C long range couplings with sp^2 methine carbon at (δ32.09ppm). In HMBC spectrum, the sp^3 methylene proton at (δ 1.835.34 ppm) has α ^{1}H-^{13}C long range couplings with sp^2 quartnary carbon at (δ 140.77 ppm). The observation of α ^{1}H -^{13} C long range signal at δ 1.54 ppm methine proton has δ 32.09 sp^3 ppm methylene proton. In DQF-COSY spectrum, two sp^3 methine protons (δ 1.54 ppm) and sp^3 methylene protons (δ 1.83 ppm) were correlated each other. In HMBC spectrum, the methyl proton at δ 0.8ppm has α ^{1}H -^{13} C long range coupling with sp^3 methine carbon at δ 0.8ppm .The observation of α ^{1}H -^{13} C long range signals at δ 1.01 ppm

methine proton has δ 36.52 ppm sp^3 quartnary carbon ,the methylene proton at δ 1.01 ppm has α ^1H -^{13} C long range coupling with sp^2 quartnary carbon at δ 140.77 ppm. All these spectral data give rise to the following fragment (a).



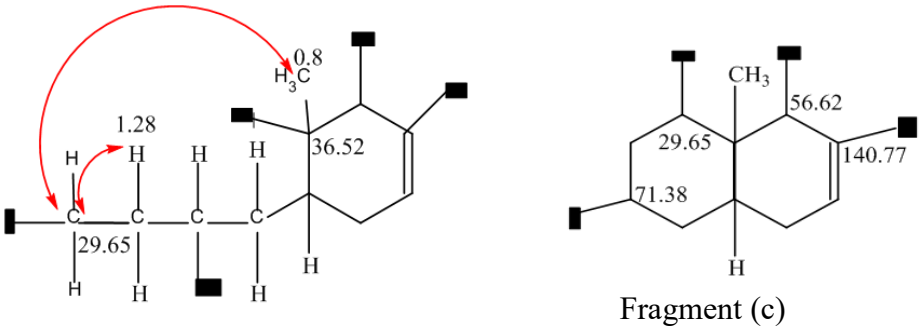
Fragment (a)

In HMBC spectrum, the methine proton at δ 1.54 ppm has α ^1H -^{13} C long range coupling with sp^3 methylene carbon at δ 21.56 ppm ,the sp^3 metylene proton at (δ 1.28 ppm) has α ^1H-^{13}C long range couplings of sp^3 methine carbon at δ 71.38 ppm ,the sp^3metylene proton at (δ 1.28 ppm) has α ^1H-^{13}C long range couplings of sp^3 methine carbon at δ 71.38 ppm which implies the following fragment (b).



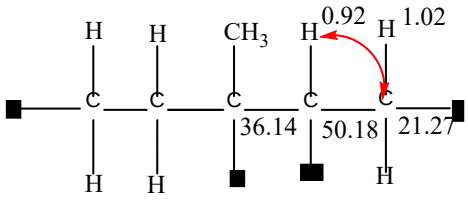
Fragment (b)

The observation of α ^1H -^{13} C long range signal at δ 0.8 ppm methyle proton and δ 1.28 ppm methylene proton with δ 29.65 ppm sp^3 methylene carbon leading to the fragment (c).



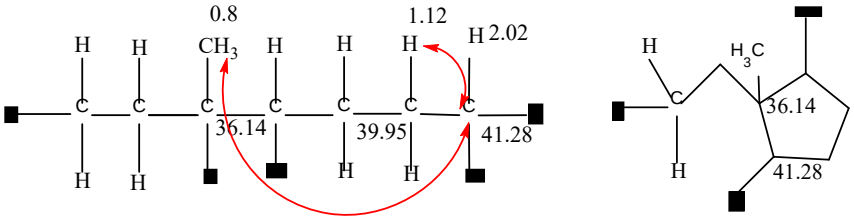
Fragment (c)

On the other hand in HMBC spectrum, δ 2.3 ppm methylene proton has α ^1H -^{13} C long range coupling with sp^3methylene carbon at δ 37.27 ppm , the methyl proton at δ 0.82 ppm and δ 2.3 ppm methylene proton have α ^1H -^{13}C long range coupling with sp^3quartnery carbon at δ 36.14 ppm. The observation of α ^1H -^{13} C long range signals at δ 0.92 ppm methine proton has δ 36.14 ppm sp^3 quartnery carbon. On the other hand, methine proton at δ 0.92 ppm has α ^1H -^{13} C long range coupling with sp^3 methylene carbon at δ 21.27 ppm which implies to the fragment (d).



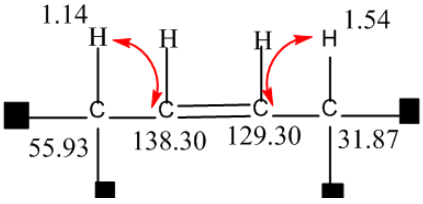
Fragment (d)

In HMBC spectrum, the methyl proton at δ 1.02 ppm has α ^{1}H -^{13} C long range coupling with sp^{3}methylene carbon at δ 39.95 ppm .The occurrence of α ^{1}H -^{13} C long range coupling between δ 0.8 ppm methyl proton and methylene proton at δ 1.12 ppm with δ 41.28 ppm methine carbon which confirm to the following fragment (e)



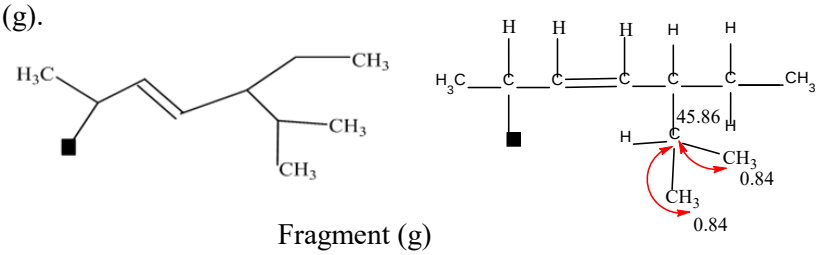
Fragment (e)

On the other hand, two methylene proton δ 5.02 ppm and δ 5.15 ppm have α ^{1}H -^{13}C long range coupling with two sp^{3} methine carbon δ 129.30 ppm and δ 138.30. In DQF-COSY spectrum, two sp^{2} methine protons δ 5.02 ppm and δ 5.15 ppm were correlated each other and small giving rise graphic area. In HMBC spectrum, the sp^{3}metylene proton at (δ 1.54 ppm) has α ^{1}H-^{13}C long range couplings of sp^{2} methine carbon at δ 129.30 ppm and sp^{3}methine proton at (δ 1.14 ppm) has α ^{1}H-^{13}C long range couplings of sp^{2} methine carbon at δ 138.30 ppm which implies the following fragment (f).



Fragment (f)

Moreover in DQF-COSY spectrum, the correlation between sp^{3} methine protons δ 1.54 ppm and sp^{2} methine protons δ 5.02 ppm .In HMBC spectrum, the metyl proton at (δ 0.55 ppm) has α ^{1}H-^{13}C long range couplings of sp^{3} methine carbon at δ 55.93 ppm.The observation of α ^{1}H -^{13}C long range signal at δ 1.55 ppm methylene proton has δ 31.87 ppm sp^{3} methiene carbon. Metyl proton at (δ 1.00 ppm) has α ^{1}H-^{13}C long range couplings of sp^{3} methylene carbon at δ 24.29 ppm, methyl proton at δ 0.93 ppm has α ^{1}H -^{13}C long range coupling with sp^{3} methine carbon at δ 31.87 ppm ,the two methyl proton at δ 0.84 ppm have α ^{1}H-^{13}C long range coupling with sp^{3}methine carbon at δ 45.86 ppm give rise to the following fragment (g).

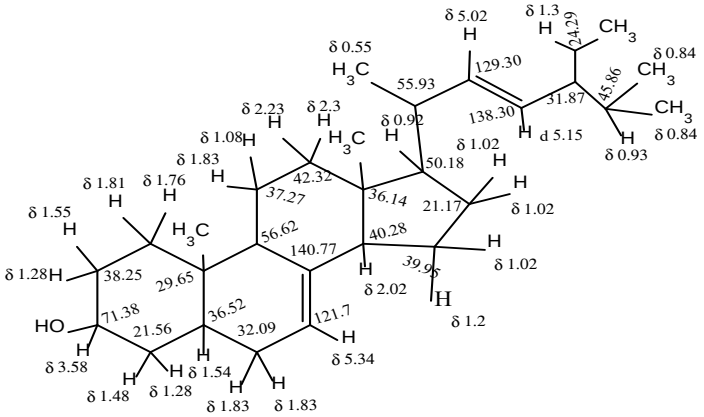


Fragment (g)

Functional group Determination of Pure Compound MMS-1 By FT-IR Spectral Data

Firstly**,** in the functional group determination of compound MMS-1, the FT-IR spectrum showed 3350.38 cm $^{-1}$ showed that the OH strectching vibration of alcohol or phenol group. 3049cm^{-1} indicated the presence of CH stretching vibration of sp^2 hydrocarbon, asymmetric and symmetric-CH stretching vibration of sp^3 hydrocarbon at 2931.90 cm^{-1} and 2867.28 cm^{-1}. The spectrum also displayed at 1713.81cm^{-1}, C=C stretching vibration of alkenic group at 1540.21 cm^{-1}, C-H in plane bending vibration of phenol group at 1458.23 cm^{-1} and C-H in plane bending vibration of gem dimethyl group at 1380.11 cm^{-1}. The additional evidence for the existence of C-C-O stretching vibration could be determined at 1264.36cm^{-1} and C-O-C stretching vibration of ether group at 1049.31 cm^{-1} respectively. The band at 971.19 cm^{-1} was the evidence of C-H out of plane bending vibration of trans or' E alkenic group.

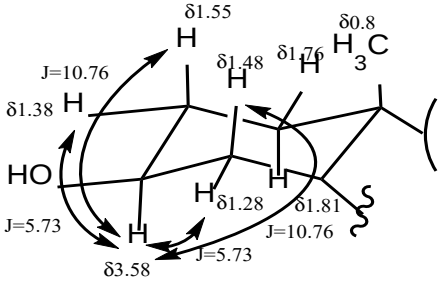
Finally, the combination of these three partial structures was shown, following complete structure of compound MMS-1 in accordance with DART-MASS and FT-IR spectrum.



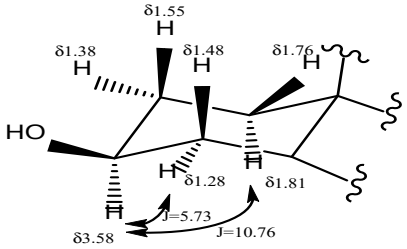
Conformational Analysis of Pure Compound MMS-1

The conformational analysis of pure compound (MMS-1) was assigned on the basis of the splitting patterns and the coupling constants of the protons in the ^{1}H NMR spectrum, NOESY spectral data and the model study.

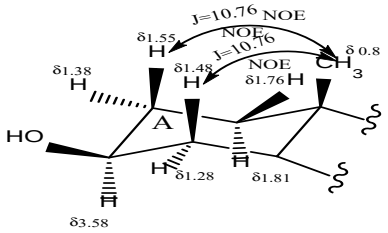
The splitting pattern of the carbinol proton at δ 3.58 ppm, its J values are 10.76 and 5.73 Hz respectively. It is coupled with the two axial protons (δ 1.48 ppm and δ 1.55 ppm) and equatorial protons (δ 1.38 ppm and δ 1.28ppm). So its coupling constant values show that this carbinol proton is at axial position (below the plane) giving the following chair like conformer of ring (A).



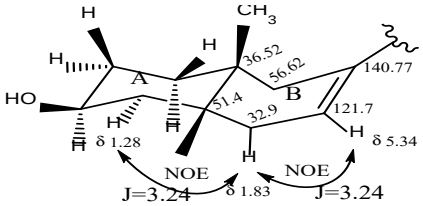
It could be confirmed by the correlation of this carbinol proton at δ 3.58 ppm and the equatorial proton at δ 1.28 ppm and the axial proton at δ 1.81ppm in NOESY spectrum showing all the protons are below the plane.



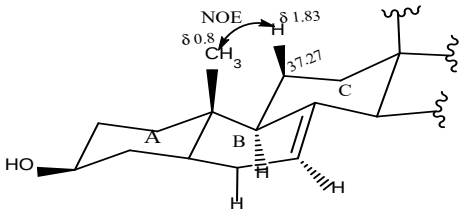
The junction methyl proton (ring A and B) at δ 0.8ppm has medium NOE with the axial protons at δ 1.55 ppm and 1.48 ppm. So all these protons are above the plane showing this junction methyl proton is at axial position. All these facts point out the following chair conformer of ring A.



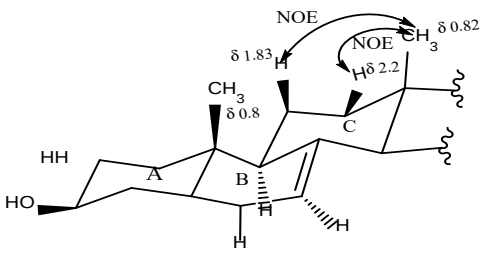
The boat like conformer of ring (B) was assigned by model study. The splitting pattern of sp^2 methine proton at δ 5.34 ppm and its J value 3.24 Hz. It is couple with the axial proton at δ 1.83 ppm and equatorial proton at δ 1.28 ppm. So its coupling constant value shows that sp^2 methine proton is at axial position (above the plane) giving the boat conformer of ring (B).



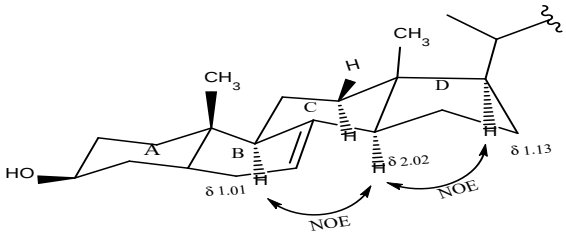
The cross peak between the junction methyl proton at δ 0.8 ppm and sp^3 methylene proton at δ 1.83 ppm in NOESY spectrum shows that these protons are above the plane showing chair conformer of ring (C).



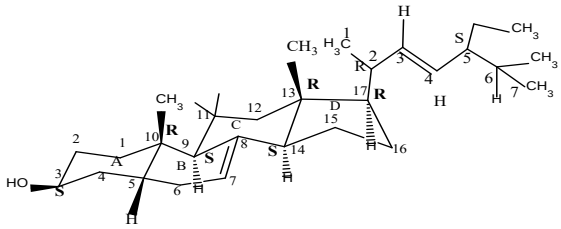
Morever, the junction methyl proton at δ 0.82 ppm is correlated with axial protons at δ 1.83 ppm and the equatorial proton at δ 2.2 ppm in NOESY spectrum. All these correlations display that the junction methyl proton is above the plane showing the following conformer of ring (C).



The junction methine proton at (ring C and D) δ 2.02 ppm has medium NOE with sp^3 methine protons at δ 1.13 ppm and 1.09 ppm indicating these protons are below the plane.



The complete conformational structure of the isolated pure organic compound (MMS-1) and its absolute configuration are shown below.



(3S, 5S, 9S, 10R, 13R, 14S, 17R)-17- [(E, 2R, 5S)-5 ethyl-6- methyl hept-3en-2yl]-10 -13- dimethyl-2, 3, 4, 5, 7, 9, 11, 12, 14, 15, 16, 17-dodecahydro-1H-cyclopenta[a] phenanthren-3ol)

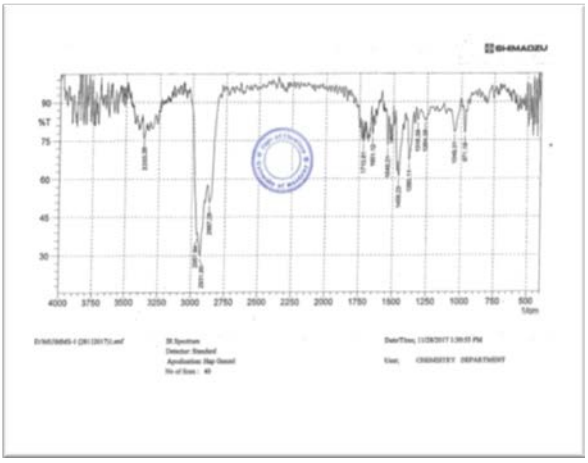


Figure 3. FT-IR Spectrum of MMS-1

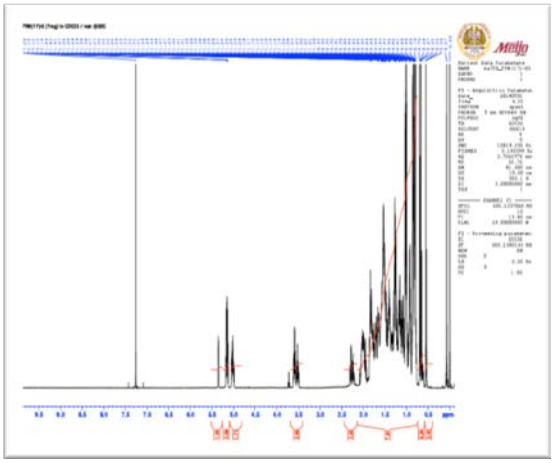


Figure 4. ^{1}H NMR Spectrum of MMS-1

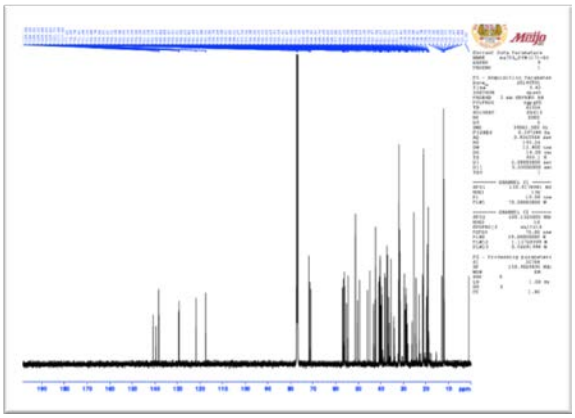


Figure 5. ^{13}C NMR Spectrum of MMS-1

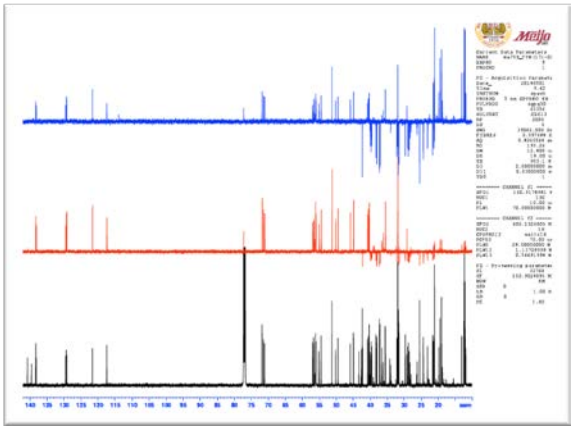


Figure 6. DEPT Spectrum of MMS-1

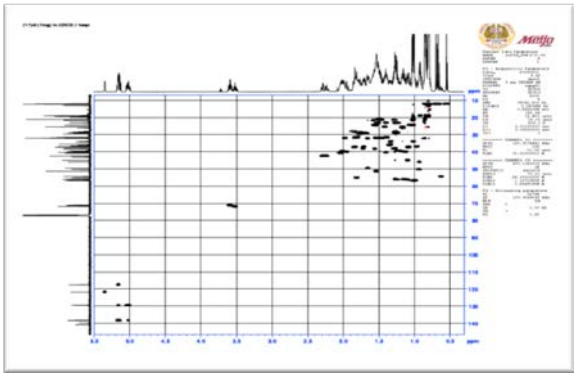


Figure 7. HSQC Spectrum of MMS-1

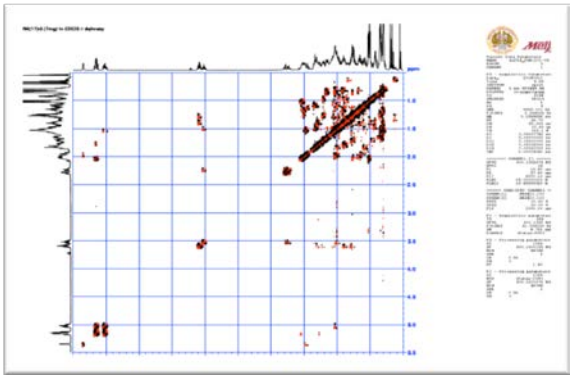


Figure 8. FDQF-COSYSpectrum of MMS-1

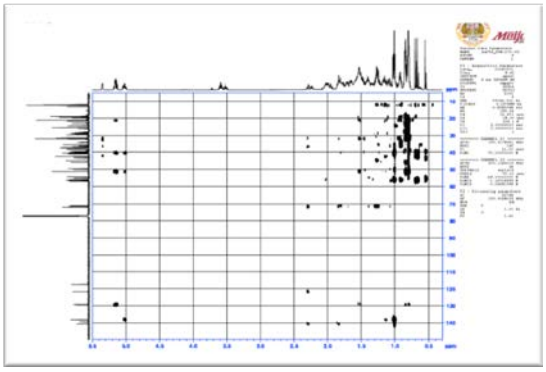


Figure 9. HMBC Spectrum of MMS-1

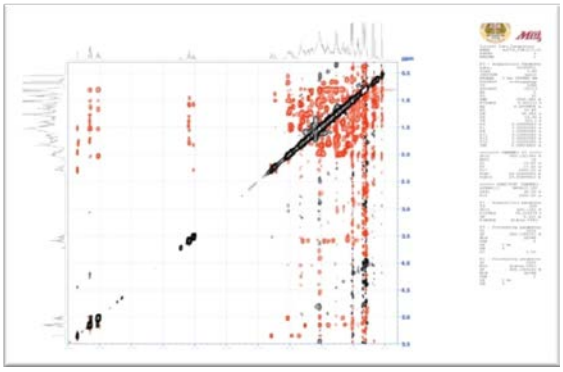


Figure 10. NOESY Spectrum of MMS-1

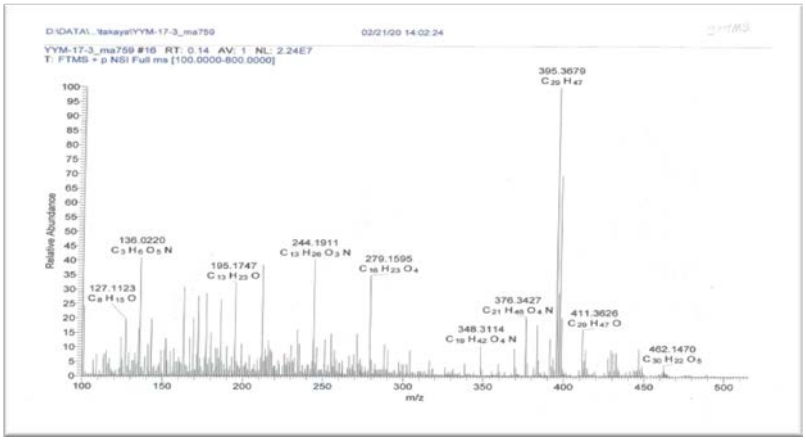


Figure 11. DART-MASS Spectrum of MMS-1

Conclusion

Achyranthes aspera L. (Kyetmauk-su-pyan) was selected for this research due to medicinal purposes for different kinds of diseases such as antiasthmatic, antidiabetic anti-allergic, dysentery, analgesic, fever and antidote in snake bite.Phenolic content of Kyetmauk-su-Pyan could be evaluated by UV spectrophotometer using the Folin-Ciocalteau reagent at 760nm. The total phenolic content of plant sample was found to be (65.5)*GAEμg/mg. Phenolics possess a wide spectrum of biochemical activities such as antioxidant, antimutagenic, anti carcinogenic as well as ability to modify the gene expression. Complete structure elucidation of organic compound MMS-1 was assigned by ^{1}H NMR, ^{13}C NMR, DEPT, DQF-COSY, HSQC, HMBC, NOESY and DART-MASS spectral data respectively.

According to the structure of pure compound MMS-1 is type of phytosterol, especially stigmasterol. Stigmasterol is a plant sterol has a number of health benefit. Stigmasterol is usually used for health diseases, hypercholesterolemia, anti-diabetic agent, antibacterial activity, anticancer, cobra venom characteristic and modulating the immune system.

Acknowledgements

We would like to express our deepest gratitude to Dr Win Swe, Rector, Dr Myo Myo, Pro-rector, Shwebo University for their interest and encouragement on our research. We also wish to show our thanks to Dr Nyunt Nyunt Sein, Professor and Head, Department of Chemistry, Shwebo University, for her permission and advice. We are very thankful to Dr Yoshiaki Takaya, Associate Professor, Faculty of Pharmacy, Mejio University, Nagoya, Japan for giving us for the opportunity to have valuable spectra.

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Preparation of Nanoferrite Particle

Nilar Tun[1], Nilar Shwe[2] , Zin Mar Thwe[3]

Abstract

Ferrite nanocrystallites could be synthesized by various methods. In the present work, samples were prepared by sole-gel auto-combustion method with low temperature. Iron III nitrate ($Fe(NO_3)_3 \cdot 9H_2O$), zinc nitrate ($Zn(NO_3)_2 \cdot 6H_2O$), Magnesium nitrate ($Mg(NO_3)_2 \cdot 6H_2O$), and citric acid ($C_6H_8O_7 \cdot H_2O$) were used as raw materials. The samples were characterized by X-ray diffraction (XRD). Ferrite nanoparticles are widely used in high frequency applications such as Electromagnetic Wave Interference (EMI) Shielding.

Key words: Sole-gel auto combustion method, X-ray diffraction

Introduction

Nanostructure materials are single phase or multiphase polycrystalline solids with a typical average size of a few nanometers (1nm = 10^{-9}m). Basically, the range from (1-100nm) is taken as nano-range. Particles which have this range are called nanoparticles.

Magnesium zinc ferrites belong to a group of soft ferrite materials characterized by high magnetic permeability and low loses. These materials are used in many applications such as magnetic recording media, Ferro fluids and radar absorbing coatings.

In the present work, the composition of mixed ferrite nanoparticle $Mg_{1-x}Zn_xFe_2O_4$ (where x = 0.5) has been prepared by using sol-gel auto combustion method. In the literature review, nanotechnology, synthesis methods, crystal characterization, structure and X-ray diffraction method are viewed. Then, sample preparation, experimental procedure and result have been presented followed by conclusion.

Materials and Methods

The raw materials were selected by technical processing conditions and the ultimate requirements of the finished products (as spinel ferrites) are very sensitive to composition. In this work, high purity materials were used to prepare reproducible ferrite materials. The molecular weight and the purity of the raw materials are listed in Table 1. Aqueous solutions of ferric nitrate, magnesium nitrate, zinc nitrate and citric acid were prepared separately and magnetically stirred for 10 min. Deionized water (50 ml for each material) was used to prepare the aqueous solution of metal ions and chelating agent. The molar concentrations are listed in Table 2 were used to in the starting solution. The calculated weight fractions are presented in Table 3. The synthesis procedure is shown in Figure 1.

[1] Associate Professor, Dr., Department of Physics, Shwebo University
[2] Associate Professor, Dr., Department of Physics, Monywa University
[3] Assistant Lecturer, Department of Physics, Kyaukse University

Table 1: Physical properties of starting materials to synthesize by SGAC

Raw Material	Purity (%)	Molecular Weight (g/mol)	Supplier
$Mg(NO_3)_2.6H_2O$	99	290.731	Myanmar supply
$Zn(NO_3)_2.6H_2O$	99	291.023	Myanmar supply
$Fe(NO_3)_3.9H_2O$	100	403.9972	Myanmar supply
$C_6H_8O_7.H_2O$	99.5	210.1388	Myanmar supply

Table 2: Molar ratio of the starting solutions to synthesize by SGAC

Molarity of $Mg(NO_3)_2.6H_2O$	Molarity of $Zn(NO_3)_2.6H_2O$	Molarity of $Fe(NO_3)_3.9H_2O$	Molarity of $C_6H_8O_7.H_2O$
0.5 M	0.5 M	2.0 M	3.0 M

Table 3: The calculated weight fraction

Weight of $C_6H_8O_7.H_2O$ (g)	Weight of $Mg(NO_3)_2.6H_2O$ (g)	Weight of $Zn(NO_3)_2.6H_2O$ (g)	Weight of $Fe(NO_3)_3.9H_2O$ (g)
7.8833	7.2685	7.256	8.5518

Then, the three metal solutions (ferric nitrate, zinc nitrate and magnesium nitrate) were poured into the chelating solution (citric acid) simultaneously and magnetically stirred for 10 min. Then, the solution was evaporated on a hot plate with constant stirring at a solution temperature 180 °C to form a sticky gel. Upon the formation of a dense sticky gel, the temperature was then increased rapidly and large amount of gases (CO_2, H_2O, N_2) were liberated and a dark brown ferrite powder was produced after the combustion process. Then the powder was ground in Agate mortar and pastel. After the hydrolysis and condensation process, the dried gel precursors were characterized by x-ray diffraction analysis. The starting solutions are shown in Figure 2. The hydrolysis of the sol and combusted powder is shown in Figure 3.

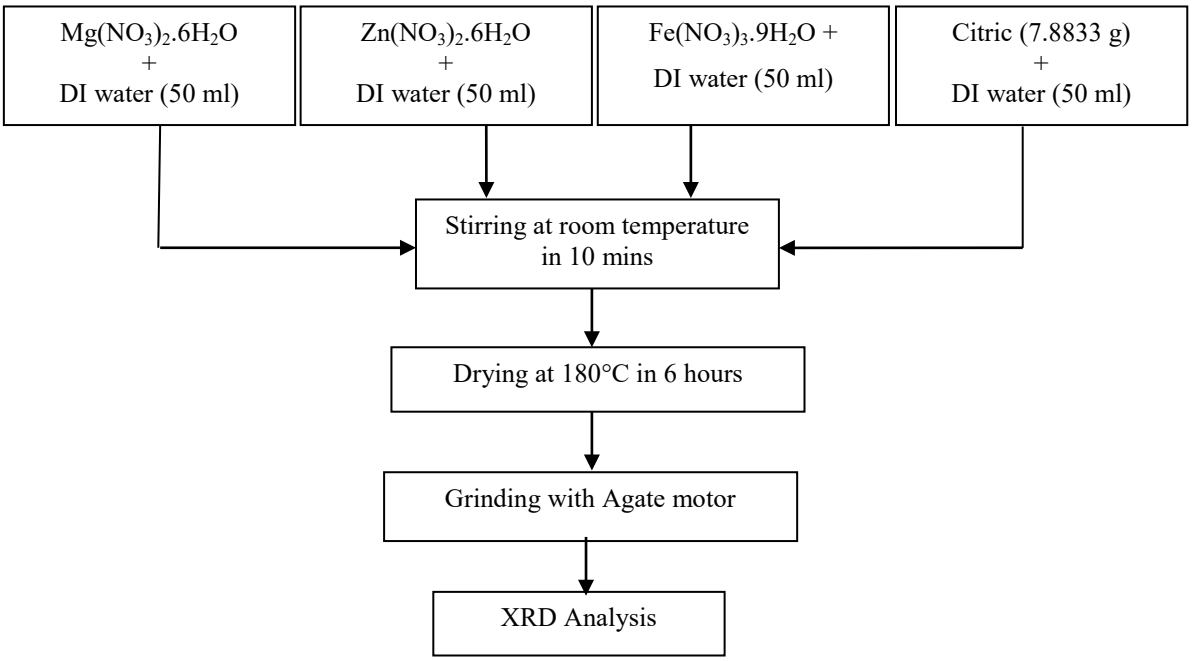

Figure 1. Flow chart to synthesize $MgZnFe_2O_4$ in SGAC

Figure 2. The starting solutions

Figure 3. hydrolysis of the sol and combusted powder

Phase Confirmation

The formation of ferrites prepared by using the sol-gel auto-combustion method is confirmed from the XRD patterns of the samples. Powder X- ray diffraction patterns were obtained using a RIGAKU - MultiFlux 2kW X-ray diffractometer with CuK_{α} radiation of wavelength 1.5406 Å. The tube voltage is 40 kV and the tube current is 20 mA for the whole operation. An examination of the major diffraction peaks in powder XRD pattern with those from the library file proves that ferrites are single phase poly crystals. Each peak in the XRD pattern can be indexed on a cubic unit cell. Again, a computer analysis of peak position and peak intensities of the X-ray diffraction pattern showed that all the samples possess a cubic spinel structure.

Lattice Parameter and Crystallite Size Analysis

The lattice parameters were determined using the following relationship for cubic spinel structure;

$$d_{hkl} = \frac{a_o}{\sqrt{h^2 + k^2 + l^2}}$$

where, a is lattice parameter (Å) and (hk$l$) is Miller Index.

The crystallite size of the particle of powder was determined using Scherrer's equation as follows:

$$t = \frac{0.9\lambda}{B\cos\theta}$$

where, t is the crystallite size, B is the full width at half- maximum in radians, and λ is the wavelength of the X- ray.

Result and Discussion

XRD analysis was conducted to check the phase formation of the as-burnt powder as shown in Figure 4. All patterns reveal that the phase precipitated out in each sample is fcc spinel structure. There is no trace of parent materials. Therefore, it was confirmed that a single phase spinel structure was formed after auto-combustion.

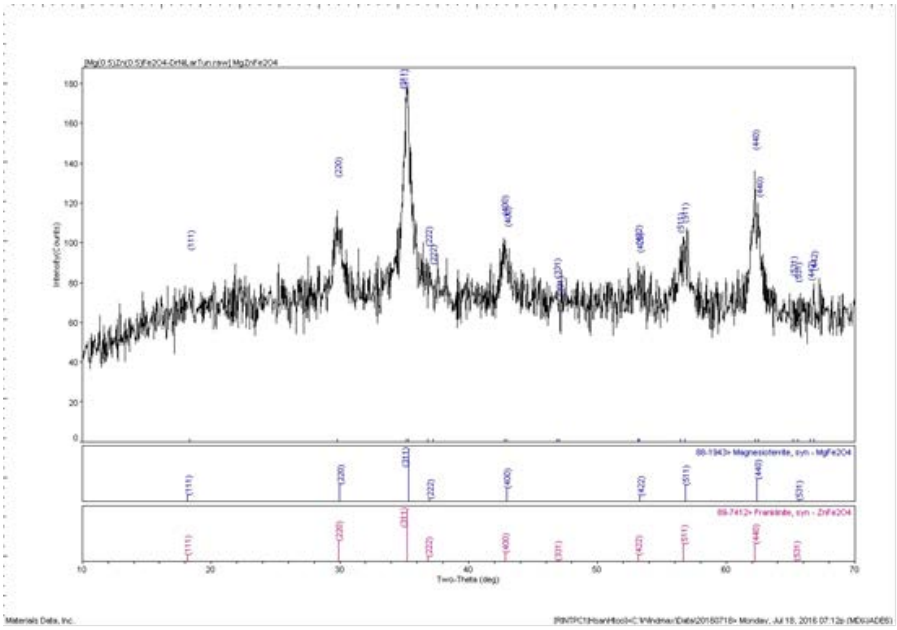

Figure 4. XRD spectrum of $MgZnFe_2O_4$ powder

The sample was of typical cubic spinel crystal structure with different intensity due to the different orientations. The lattice parameter and the crystallite size for seven intense reflection peak estimated by the scherrer equation are presented in Table 4. It was observed that the average lattice parameter was to be 8.4399 Å which is consistent with typical values. The average crystallite size was obtained about 21.32nm.

Table 4: The variation of lattice parameter and the crystallite size for all intense reflection peaks

hkl plane	2θ (degree)	d (Å)	FWHM (degree)	Lattice constant (Å)	Crystallite size (nm)
111	18.340	4.8335	0.148	8.3720	27.18
220	29.783	2.9973	0.267	8.4776	15.394
311	35.140	2.5517	0.314	8.463	13.28
222	36.821	2.4390	0.176	8.4489	23.79
400	42.767	2.1126	0.196	8.4504	21.76
422	53.142	1.7220	0.154	8.4360	28.81
440	62.236	1.4905	0.244	8.4313	19.02
Average				**8.4399**	**21.32**

Conclusion

The main objective of this research was to prepare $MgZnFe_2O_4$ nanoparticles in the same molar ratio of the starting solution by auto-combustion assisted sol-gel method to investigate the behavior of the ferrite and structural properties.

According to the XRD characterizations, the sample was successfully formed typical cubic spinel crystal structure with different intensity. The average lattice parameter was to be 8.4399 Å which is consistent with typical values. The average crystallite size was obtained about 21.32 nm. $MgZnFe_2O_4$ powder were composed of the nano sized showing the possibility of uniform heat treatment of the sample. Thus, it is concluded that smaller crystallites could be produced with less heat energy of crystallization at the same concentration of the starting solution.

Acknowledgements

I wish to express my gratitude to Ractor Dr Win Swe, Shwe Bo University for his permission. I also would like to extend my gratitude to Dr Min Swe, Professor and Head, Department of Physics, Shwe Bo University and Dr Khin Hinn Ei, Professor, Department of Physics, Shwe Bo University.

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Assessment of Natural Radio Activity Levels and Radiation Hazards in Soil from the Vicinity of Gold Mine, Kawlin

Thida Win[1], Aye Than Kyae[2], Thandar Swe[3]

Abstract

In this work, the activity concentrations of natural radionuclides in soil samples from the gold mine area in Kawlin were determined by using NaI(Tl) gamma ray spectrometer. Radiological hazard assessments due to these natural radionuclides were carried out. The range of average activity concentrations of ^{238}U, ^{232}Th and ^{40}K in the soil varies from 17.46 to 31.31 $Bqkg^{-1}$, 17.12 to 27.30 $Bqkg^{-1}$ and 17.31 to 34.61 $Bqkg^{-1}$ respectively. The mean values of radium equivalent activity, the external and internal hazard indices in the study area were less than the world average values. The results showed that there is no significant radiation effect on working in the study area.

Key words: activity concentrations, gamma ray spectrometer, radium equivalent activity, external and internal hazard.

Introduction

The majority of naturally occurring radionuclides belong to the radionuclides in the ^{238}U and ^{232}Th series and the single decay radionuclide ^{40}K. Natural radioactivity and the associated external exposure due to gamma radiation depend primarily on the geological and geographical conditions and appears at different levels in the soil of each region in the world. The concentration of the ^{238}U, ^{232}Th and ^{40}K were varied depending on soil type, the mineral content, geological features and geological conditions. Mining gives rise to soil erosion and environmental contamination by generating waste driving from extraction and processing of minerals. Accordingly, side effects of mining were left in unsafe and unhealthy condition, increasing the potential health risk to the residents living near the mine area. Myanmar has a number of rich mineral resource deposits including gold. Gold is formed deep within the earth's surface by a series of geological processes which involves extraction or mining. Radiation exposures arising in the mining and mineral processing industries are in three ways. These are external gamma radiation from ores, inhalation of dusts containing long-lived alpha-emitting radionuclides and inhalation of short-lived decay products of radon. Inhalation of radon decay products in poorly ventilated underground mines can lead to exposures in excess of current radiation exposure limits, and this could cause high incidence of lung cancer in mine workers. The aim of this study is to determine the activities of natural radionuclides in the soil samples from the vicinity of gold mine in Kawlin, Sagaing Region by using NaI(Tl) detector and to calculate the radium equivalent activity, external hazard index and internal hazard index.

Materials and Method

Study Area

It is located between the north latitude 23˚ 47′ and 38˚ 2′ between the longitudes of 95˚ 40′ and 52˚ 9′ east and it has a temperature of about 30˚C. The area of Kawlin Township is 1888 km^2. The sample location map is shown in Fig.(1).

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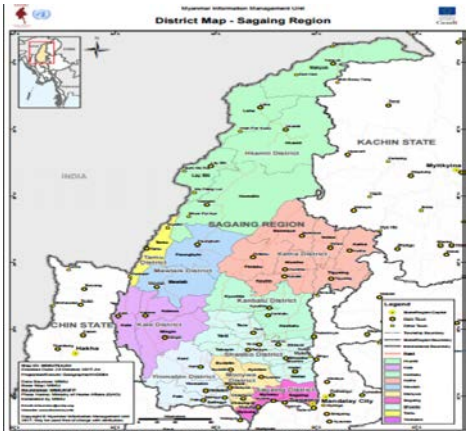

Fig. (1.a) The sample location map map

Fig. (1.b) The sample collection area

Sample Collection and Preparation

In this study, three soil samples were randomly collected for the surface soil from the vicinity of Gold Mine, Kawlin, Sagaing Region. After collection, the collected soil samples were dried at room temperature and the dried samples were crushed into fine grains sieved to remove stone and other particles. And then, the soil samples were sifted to get fine powder by using 40 mesh sieves. After that, each sample is weighed 0.5kg (500g). Finally each sample was packed and sealed in airtight plastic container and kept for about four weeks period to allow radioactive equilibrium among the daughter products of radium (^{226}Ra), thorium (^{232}Th) and their short lived decay. Measurements were made in three different soil samples were labeled as S-1 to S-3.

Gamma-ray Measurement

The Gamma-ray spectroscopy consists of a scintillation detector of 3" x 3" NaI (Tl) crystal which is connected to PC based 1024 multichannel analyzer (MCA) with a program installed data acquisition and analysis of the gamma-ray spectrum. The experimental set up is shown in Fig. (2). Before the radioactivity measurement in soil samples, energy calibration was done using standard gamma sources, for 300 s to get good statistics. Background radiation was measured for 1 hr (3600 s). Then, each soil sample was measured for 1 hr (3600 s). The spectrum was stored in a PC-based 1024 multichannel analyzer (MCA) and then the spectrum was analyzed by the Gamma Vision 32 software.

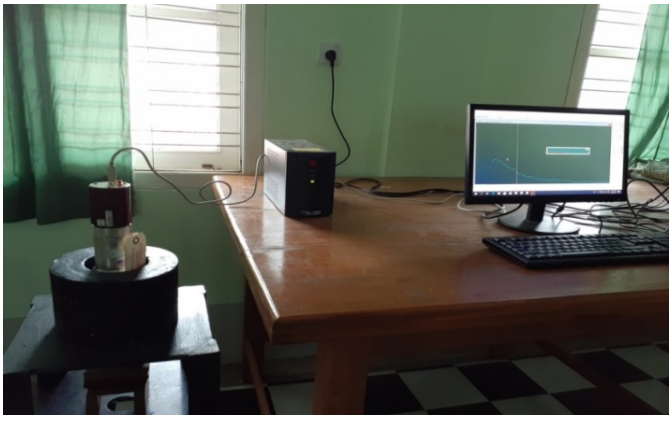

Fig.(2) Gamma detection system

Determination of Activity Concentration and Radiation Hazards

The activity concentration for each radionuclide and the radiation hazards can be calculated by the following equations

$$\text{Activity, } A = \frac{N}{m \varepsilon p_{\gamma} T} \quad (1)$$

Where, A is activity of the sample ($Bqkg^{-1}$), N is net count rate for sample, m is mass of the sample, ε is efficiency of detector, P_γ is gamma emission probability and Tis measuring time in seconds.

$$\text{Radium Equivalent Activity, } Ra_{eq} = 1.43\ A_{Th} + A_{Ra} + 0.077 A_K \quad (2)$$

Where, A_{Th}, $A_{Ra}$and A_K are the activity concentrations (in $Bqkg^{-1}$) for ^{226}Ra, ^{232}Th and ^{40}K.

$$\text{External hazard index, } H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \quad (3)$$

$$\text{Internal hazard index, } H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \quad (4)$$

Results

In the present work, three surface soil samples were randomly collected from the vicinity of Gold Mine, Kawlin, Sagaing Region. These soil samples were determined using NaI(Tl) detector.The results of activity levels of radionuclides in three surface soil samples are presented in Table1. The average activity concentration of ^{238}U, ^{232}Th, and ^{40}K ($Bqkg^{-1}$) for all soil samples are also presented in Table 2. The radium equivalent activity, the external and internal hazard indices for different soil samples are presented in Table 3. The comparison graph of average activity concentration of ^{238}U, ^{232}Th, and ^{40}K in soil samples is shown in Fig.(3). The comparison graph of radium equivalent activity, the external and internal hazard indices in different soil samples are shown in Fig.(4),(5) and (6).

Discussion

According to table (1), the daughter nuclei ^{214}Pb, ^{214}Bi, ^{226}Ra and ^{232}Th of ^{238}U decay series were observed in these samples. And also, the daughter nuclei ^{228}Ac, ^{212}Bi and ^{208}Tl of ^{232}Th decay series were also observed in these samples. The average activity concentration of ^{238}U, ^{232}Th, and ^{40}K ($Bqkg^{-1}$) for all soil samples are also presented in Table 2. From the table, sample (S-3) has the highest values of ^{232}Th and sample(S-1) has the highest values of ^{238}U and ^{40}K. It is found that the average activity values of ^{238}U, ^{232}Th, and ^{40}K are lower than UNSCEAR (2000) recommended limits. Their specific activities vary depending on soil type, the mineral contents and geological conditions. According to Table 3, The radium equivalent concentration for the soil samples ranged from 39.03 $Bqkg^{-1}$ (S-1) to 71.82 $Bqkg^{-1}$ (S-3). From the results showed that the values of radium equivalent activity concentration are lower than the recommended maximum value of 370 $Bqkg^{-1}$. The external hazard index H_{ex} and internal hazard index H_{in} were both calculated from the activity concentration of the soil samples. The range of external hazard, internal hazard values are 0.11 to 0.19 $Bqkg^{-1}$, 0.16 to 0.25 $Bqkg^{-1}$. All values of (H_{ex}) and (H_{in}) are less than the acceptable limit of unity. The results showed that there is no significant radiation effect on working in the study area.

Table 1. Activity levels for radionuclides in soil samples

Nuclide	Activity Concentration ($Bqkg^{-1}$)					
^{238}U-Series	Energy (keV)	Probability P_γ	Efficiency ε	S-1	S-2	S-3
^{214}Bi	609	0.461	0.0036	22.76	7.36	ldl
^{214}Pb	295	0.192	0.0086	17.49	27.59	21.87
^{226}Ra	185	0.53	0.0066	30.02	16.84	6.83
^{234}Th	63	0.038	0.0042	54.97	18.04	27.92
^{232}Th-Series						
^{208}Tl	583	0.309	0.0038	11.36	16.56	52.99
^{228}Ac	338	0.124	0.0074	ldl	84.22	14.53
^{212}Bi	727	0.067	0.0028	22.88	9.48	14.38
^{40}K						
^{40}K	1460	0.107	0.0012	34.61	17.31	21.63

***ldl* = Low Detection Limit**

Table 2. Average Activity Concentration of ^{238}U, ^{232}Th and ^{40}K ($Bqkg^{-1}$) in soil samples

Sample	^{238}U ($Bqkg^{-1}$)	^{232}Th ($Bqkg^{-1}$)	^{40}K ($Bqkg^{-1}$)
S-1	31.31	17.12	34.61
S-2	17.46	24.42	17.31
S-3	18.87	27.30	21.63
UNSCEAR (2000)	130	30	400

Table 3. Radium equivalent activity, external hazard index (H_{ex}) and internal hazard index (H_{in})

Sample	Ra_{eq} ($Bqkg^{-1}$)	H_{ex}	H_{in}
S-1	39.03	0.11	0.16
S-2	64.42	0.17	0.22
S-3	71.82	0.19	0.25
UNSCEAR (2000)	370	1	1

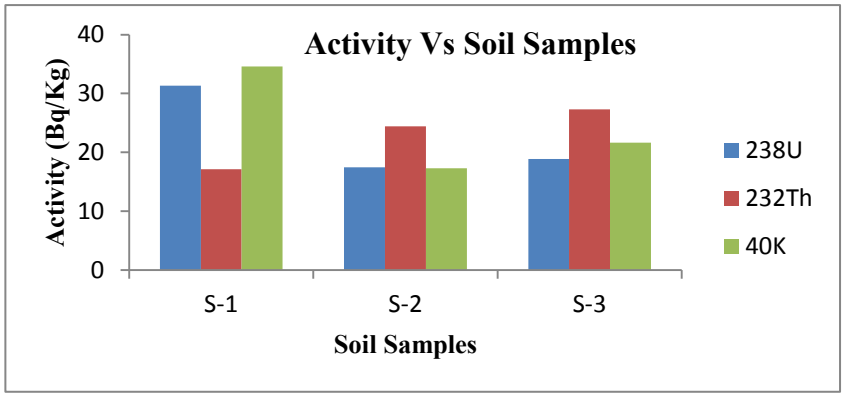

Fig.(3) Comparison of activity concentration of ^{238}U, ^{232}Th and ^{40}K in soil samples

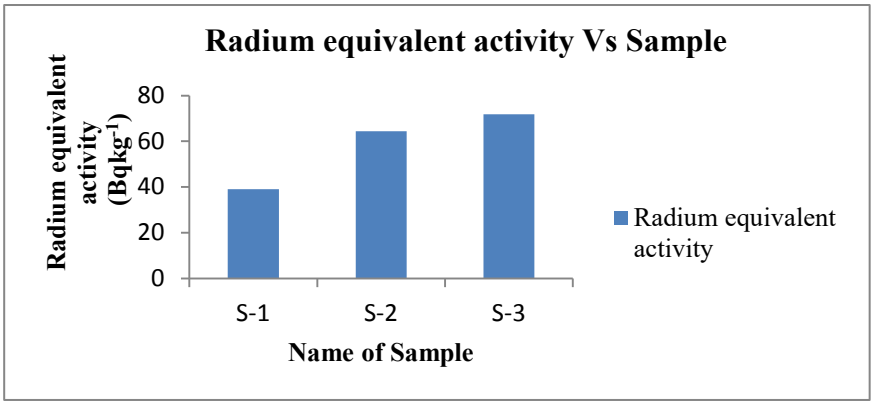

Fig.(4) Comparison of radium equivalent activity in different soil samples

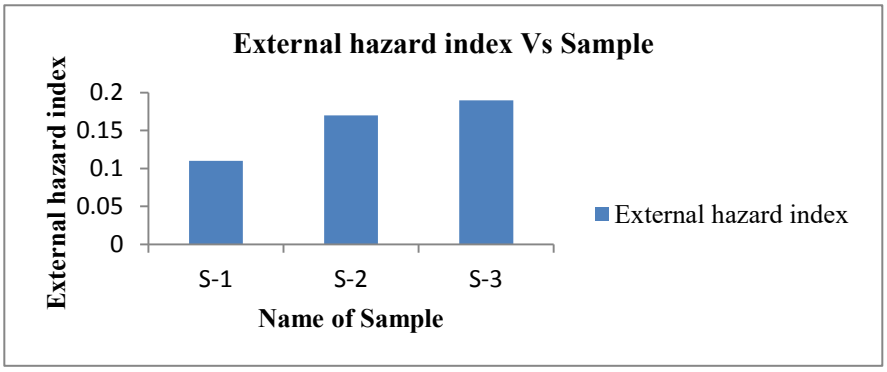

Fig.(5) Comparison of external hazard index in different soil samples

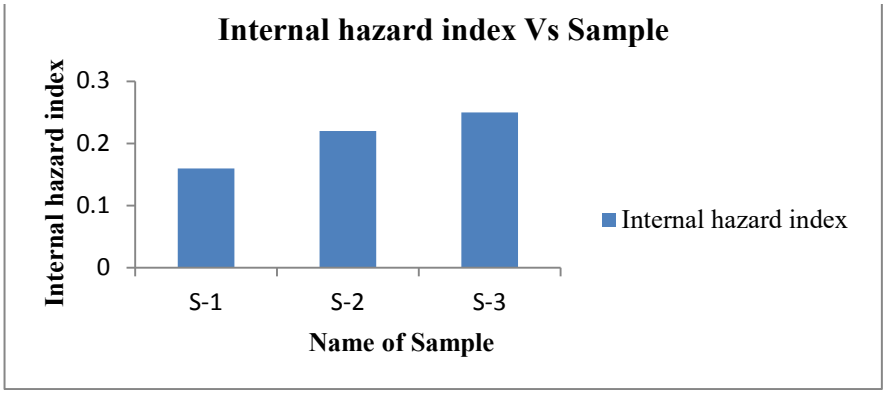

Fig.(6) Comparison of internal hazard index in different soil samples

Conclusion

The activity concentration of ^{238}U, ^{40}K and ^{232}Th in soil samples from Kawlin gold mine area were determined using NaI(Tl) gamma ray spectrometry. The results obtained showed that the distribution of natural radionuclides in these soil samples was not uniform. From the gamma activity measurement, the results revealed that the average activity concentration of ^{238}U, ^{40}K and ^{232}Th in these soil samples are lower than their corresponding allowed limit according to the worldwide values. Also, all the calculated values of radiological hazard are within the permissible range reported by UNSCEAR (2000). The average values of radiation hazard indices of all samples are less than unity. So, these region is safe the residents living where the gold mine for inhabitation.

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Fitting the Charge Density Distribution Parameters of Silicon Isotope $^{29}_{14}Si$ for 3PG-Model

Win Moe Thant[1], Tin Htun Naing[2],
Khin Mar Win[3], Khin Hnin Ei[4]

Abstract

We fitted the charge density distribution parameters of Silicon isotope ($^{29}_{14}Si$) nucleus for 3pG model. Firstly, we studied the Rutherford electron scattering and derived the differential scattering cross-section for that elastic electron scattering in which the target is considered as a point charge. And then, we also studied the differential scattering cross-section theoretically in which the target is considered as a whole charge distribution in a nucleus. From this study, we have been obtained the factor with the Ruther ford differential scattering cross section. In an experiment, the form factor can be obtained directed result. From these two results; theoretically and experimentally; we will get the difference factor between them and this factor is call form factor which gives the form of the internal structure of the nucleus. We will study the charge density distribution and form factor for the nucleus of silicon isotope ($^{29}_{14}Si$) by using already known charged distribution parameters 3pF model and; based on this charged distribution parameters of 3pF model, we fitted the parameters for 3pG model. We concluded that, our fitted data which obtained from comparison between these charged distribution parameters of 3pF with 3pG model, these data are good in agreement and can be used as the charge density distribution parameters for 3pG model of ($^{29}_{14}Si$).

Key words: charge density distribution parameters, form factors.

Introduction

The search for the ultimate building blocks of the matter has always been a central issue in physics. As our understanding of physical facts, improves our view changes. There was a time when the atom was considered as an indivisible entity and the basic building block of the matter, but now with the invent of high energy technology our views about the constituents of matter have changed considerably. At present the accepted view is that the basic building blocks of all the matter are quarks and leptons, except the particles that mediate the interactions between them, like photons, bosons and gluons.

An atom is still the smallest particle representing an element. The atom consists of a nucleus and electron(s) around it. The fact that the size of the nucleus is far smaller compared with that of an atom, was established before there was much else known about the nucleus. Before 1911, the model of an atom that embodied most of the observations known at that time consisted of a uniform distribution of the positive charge throughout the entire volume of the radius ~ 10^{-10} m occupied by the atom. If this were true, the scattering of a charged particle, like an alpha particle would only experience Coulomb scattering with the cross section given by the Rutherford formula; $(\frac{d\sigma}{d\Omega})_{Rutherford} = \left[\frac{e^2\ z\ Z}{4\ T\ \sin^2(\frac{\theta}{2})}\right]^2$, where zis the charge

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number of the projectile and is equal to two for the alphaparticle, Z is the number of protons in the target nucleus, T is the kinetic energyof the alpha particle in the center of mass system and (θ) is the scattering angle, most of the alpha particles were expected to emerge in a small forward cone.

Nuclear Structure and General Properties

After having established the nuclear model of the atom, we are now in a position to discuss the general characteristic of the atomic nuclei in their ground states.The properties of the nuclei which will be discussed in this part correspond to their ground states and are usually called their static properties, the important properties of the nuclei include their electric charge, mass, binding energy, size, shape, angular momentum, magnetic dipole moment, electric quadrupole moment, statistics, parity and iso-spin.

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Nuclear Mass and Size

As we shall see later, the atomic nuclei are made up of protons and neutrons. The protons and neutrons are held together inside the nucleus by strong short range attractive force.

Nuclei with the same atomic number (Z), but different mass number (A) are called isotope. A particular element with a given z may have isotopes of different mass numbers. Their nuclei contain the same number of protons, but different numbers of neutrons. Elements having more than one stable isotope in the nature state are mixtures of these isotopes in fixed proportion, known as their relative abundance, which remain more or less the same, irrespective of the source from which they are derived. Thus natural lithium is a mixture of the two stable isotopes ^{6}Li and ^{7}Li with the relative abundance 7.4% and 92.6% respectively.

We assume that the nucleus has a spherical shape, this is expected because the short-range character of the nuclear force. Experiments show that this is very nearly so and the nuclear charge density ρ_{charge} is also approximately constant. Experiment evidence also shows that the charge distribution of nucleon is nearly uniform, so that the nucleon density $\rho_{nucleon}$ is also approximately constant. Since, nuclear mass is almost linearly proportional to the mass number (A), this mean that

$$\rho_{nucleon} \approx \frac{A}{V}$$

$$R = r_0 A^{\frac{1}{3}} \tag{1}$$

where r_0 is the nuclear radius parameter. The value of r_0 is taken 1.2-1.5fm.R should be note that the nuclear radius and is the radius of nucleons distribution. Now we will discuss the about the charge radius of nuclear charge distribution. Since nuclear charge parameter (i.e., the atomic number, Z) is almost linearly proportional to the mass number (A) and the nuclear charge density charge is approximately the same through the nuclear volume, the distribution of the nuclear charge (+Ze) should follow the pattern of the nucleons distribution.

Calculation of the Charge Density and Nucleon Density for $^{29}_{14}Si$

For the isotope of the Silicon, it has the atomic number Z=14, the mass number A=29.

The radius of the nucleus can be calculated by using the equation (1) as

$$R = r_0 A^{\frac{1}{3}}$$

Then $R = 3.6867\ \text{fm},$

where, the radius parameter is taken from Refresher Nuclear Course and it take r_0= 1.2 fm.Then, the charge density for $^{29}_{14}Si$ is

$$\rho_0 = \frac{\text{nuclear charge}}{\text{volume of nucleus}}$$

$$\rho_0 = 0.066\,\text{C fm}^{-3}$$

$$\rho_{\text{nucleon}} = \frac{\text{no of nucleon}}{\text{volume of nucleus}}$$

$$\rho_{\text{nucleon}} = 0.138\ \text{nucleons fm}^{-3}$$

If the nucleons are assumed to be placed in a cubic lattice, then we can estimate the lattice spacing 'a' for a nucleus which has the nucleon density, $\rho_{\text{nucleon}} = 0.138\ \text{nucleons fermi}^{-3}$.

Let the number of nucleon in the lattice volume a^3=1.

Then, the nucleon density is, $\rho_{\text{nucleon}} = \frac{\text{no of nucleon}}{\text{volume of nucleus}}$

$$\rho_{\text{nucleon}} = \frac{1}{a^3}$$

$$a = 1.935\,\text{fm}$$

Thus the distance between the two nucleons in a nucleus is 1.935 fm.

Scattering Theory and Cross Section

Much of our understanding about the structure of the matter is extracted from the scattering of particles. The usual means for determining the size and shape of an object is to examine the radiations scattered from it. To see the object and its details, the wavelength of the radiation must be smaller than the dimensions of the object; otherwise the effects of diffraction will partially or completely obscure the image. The nuclear charge distribution is studied in terms of the form factor orscattering cross section. The cross section is a measure of the relative probability for the scattering to occur. If we have a detector placed to record particles scattered in the direction (θ,ϕ) with respect to the beam direction, the detector defines a small solid angle $d\Omega$ at the scattering center. Experimentally measured quantity is known as the differential cross-section, the integral of this quantity over all the angles is called total integrated cross-section. Form factor can be obtained by dividing $(d\sigma/d\Omega)_{\text{Exp}}$ by $(d\sigma/d\Omega)_{\text{Mott}}$ i.e.,

$$F(q)^2 = \frac{(d\sigma/d\Omega)_{\text{Exp}}}{(d\sigma/d\Omega)_{\text{Rutherford-Mott}}}$$

where $(d\sigma / d\Omega)_{Mott}$ means Mott differential scattering cross section, which is obtained by considering target as a point particle. When discussing the size of atomic and subatomic particles, it is necessary to give some operational meaning to this notion.In fact, it can be asked more generally how the properties of subatomic particles are established, including their mass, charge,spin, or their possible substructure.An important tool for answering such questions is provided by scattering experiments.

Rutherford scattering

Rutherford scattering is the elastic scattering of charged particles by the Coulomb interaction. Rutherford scattering relies only upon the static electric (Coulomb) potential, andthe minimum distance between particles is set entirely by this potential. The classical Rutherford scattering process of alpha particles against gold nuclei is an example of "elastic scattering". From this,Rutherford concluded that the majority of the mass was concentrated in a minute, positively charged region (the nucleus) surrounded by electrons. When a (positive) alpha particle approached sufficiently close to the nucleus, it was repelled strongly enough to rebound at high angles. The small size of the nucleus explained the small number of alpha particles that were repelled in this way. Rutherford showed, using the method outlined below, that the size of the nucleus was less than about 10−14 fm (how much less than this size, Rutherford could not tell from this experiment alone).

Rutherford Elastic ElectronsScattering Cross Section

In 1911, Rutherford discovered the nucleus by analyzing the data of Geiger and Marsden on the scattering of α-particles against a very thin foil of gold. The data were explained by making the following assumptions.

- The atom contains a nucleus of charge Ze, where Z is the atomic number of the atom (i.e. the number of electrons in the neutral atom),
- The nucleus can be treated as a point particle,
- The nucleus is sufficiently massive compared with the mass of the incident α-particle that the nuclear recoil may be neglected,
- That the laws of classical mechanics and electromagnetism can be applied and that no other forces are present,
- That the collision is elastic.

In a scattering experiment, one observed the collisions between a beam of incident particles and the target material. The total number of collision over the duration of the experiment is proportional to the total number of incident particles and to the number of target particles per unit area in the path of the beam.The number of particles coming out varies from one direction to the other. The number of particles scattered into an element of solid angle is proportional to a quantity that plays a central role in physics of scattering: the differential scattering cross-section. The differential cross section, which is denoted by $\frac{d\sigma}{d\Omega}$, is defined as the number of particles scattered into an element of solid angle $d\Omega$ in the direction (θ, ϕ) per unit time and incident flux.

$$\frac{d\sigma(\theta,\phi)}{d\Omega} = \frac{1}{J_{inc}} \frac{dN(\theta,\phi)}{d\Omega} \tag{2}$$

where, J_{inc} is the incident flux, it is equal to the number of incident particles passing through the unit cross sectional area per unit time, and $\frac{d\sigma}{d\Omega}$ has the dimensions of an area, hence it is appropriate to call differential cross section.

Scattering Amplitude of Spin-less Particles

The case of the elastic scattering which means that the initial state and the structure of colliding particles do not change, between two spin-less, non-relativistic particles of masses m_1 and m_2. During the scattering process, the particles interact with one another.

If the interaction is time independent, we can describe the two-particle system with stationary states;

$$\psi(\vec{r}_1,\vec{r}_2,t)=\psi(\vec{r}_1,\vec{r}_2)e^{-iE_T t/\hbar}.$$

where E_T is the total energy and $\psi(\vec{r}_1,\vec{r}_2)$ is a solution of the time independent Schrödinger equation;

$$[-\frac{\hbar^2}{2m_1}\vec{\nabla}_1^2-\frac{\hbar^2}{2m_2}\vec{\nabla}_2^2+\hat{V}(\vec{r}_1,\vec{r}_2)]\,\psi(\vec{r}_1,\vec{r}_2)=E_T\,\psi(\vec{r}_1,\vec{r}_2)$$

where $V(\vec{r}_1,\vec{r}_2)$ is the potential representing the interaction between the two particles. In this case, the interaction between m_1 and m_2 depends only on their relative distance $r=|\vec{r}_1-\vec{r}_2|$ [i.e., $\hat{V}(\vec{r}_1,\vec{r}_2)=\hat{V}(r)$],and in considering the center of mass system ($M=m_1+m_2$) which is no concern to us here, But we will consider the particle with a reduced mass ($\mu=\frac{m_1m_2}{m_1+m_2}$) which moves in the potential $\hat{V}(r)$, is the following expression;

$$-\frac{\hbar^2}{2\mu}\vec{\nabla}^2\,\psi(\vec{r})+\hat{V}(\vec{r})\,\psi(\vec{r})=E\,\psi(\vec{r}) \tag{3}$$

Thus the problem of the scattering between two particles is reduced to solve above equation (3), In Quantum mechanics, incident particle is described by means of wave packet that interacts with the target. After scattering, the wave function consists of unscattered part propagation in the forward direction and scattered part that propagates along some direction (θ,ϕ). We can also be seen in equation (3) the scattering of particle of mass (μ) from a fixed scattering center that is described by $V(r)$,where (r) is the distance from the particle (μ) to the center of $V(r)$,and $V(r)$ has a finite range 'a'. Thus the interaction between the particle and the potential occurs only in a limit region of space $r\le a$, which is called the range of $V(r)$, or scattering region. Outside the region $r>a$, the potential vanished, $V(r)=0$; then equation (3) becomes,

$$(\vec{\nabla}^2+k_0^2)\,\psi_{inc}(\vec{r})=0 \tag{4}$$

where $k_0^2=2\mu E/\hbar^2$. In this case (μ) behave as a free particle before collision and hence can be described by a plane wave

$$\psi_{inc}(\vec{r}) = e^{i\vec{k}_0.\vec{r}} \ , \tag{5}$$

where $\vec{k}_0$ is the wave vector associated with the incident particles and the particles of the incident beam are independent of each other.

When the incident wave collides or interacts with the target, an outgoing wave $\psi_{sc}(\vec{r})$ is scattered out. Then, in the case of an isotropic scattering, the scattered wave is spherically symmetric, having the form ($e^{i\vec{k}.\vec{r}}/r$). However, in general, the scattered wave is not spherically symmetric; its amplitude depends on the direction along which it is detected and hence, the scattered wave is

$$\psi_{sc}(\vec{r}) = f(\theta,\phi)\frac{e^{i\vec{k}.\vec{r}}}{r} \text{ (or) an outgoing wave.} \tag{6}$$

where $f(\theta,\phi)$ is called the scattering amplitude, $\vec{k}$ is the wave associated with the scattered particle and (θ) is the angle between $\vec{k}_0$ and $\vec{k}$ displaced in figure (1-a). After the scattering has taken placed see figure (1-b), the total wave consists of superposition of the incident plane wave equation (5) and the scattered wave equation (6);

$$\Psi(\vec{r}) = e^{i\vec{k}_0.\vec{r}} + f(\theta,\phi)\frac{e^{i\vec{k}.\vec{r}}}{r} \tag{7}$$

We now need to determined $f(\theta,\phi)$ and $(d\sigma/d\Omega)$. The scattering amplitude plays a central role in the theory of scattering, since it determines the differential cross section. To show this, let us introduced the incident and scattered flux density 'J';

Now we consider the density of particles in incident wave is

$$\rho_{inc} = |\psi_{inc}(\vec{r})|^2 = 1 \tag{8}$$

Incident flux density is $J_{inc=}\frac{\hbar k_0}{\mu}$

For the flux densities of scattered is, $J_{sc} = \frac{|f(\theta,\phi)|^2}{r^2} J_{inc}$ (9)

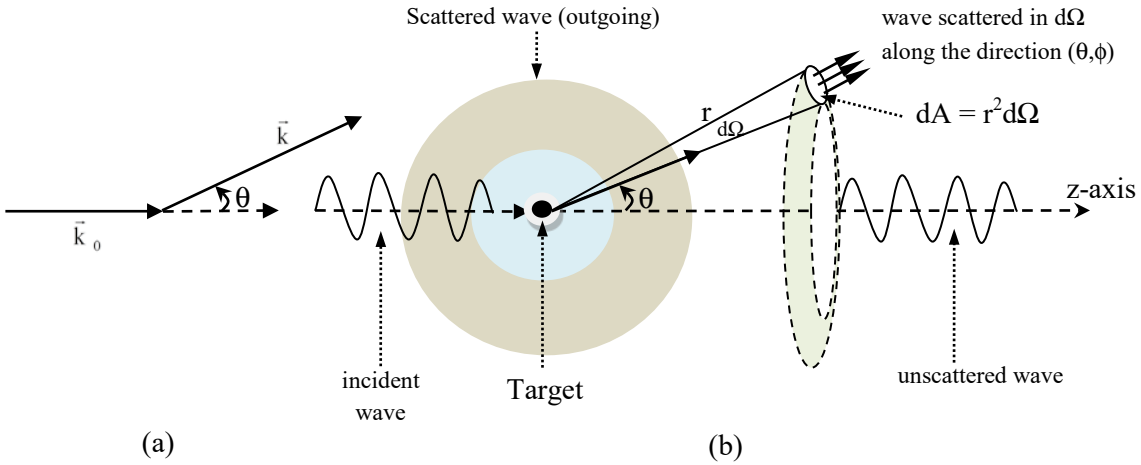


Figure (1) (a) Angle between the incident and scattered wave vector $\vec{k}_0$ and $\vec{k}$.
(b) Incident and scattered waves.

Now we may recallthat the number $dN(\theta,\phi)$ of particle scattered into an element of solid angle $d\Omega$ in the direction (θ,ϕ) and passing through a surface element $dA = r^2 d\Omega$ per unit time of previous section is given as,

$$dN(\theta,\phi) = |f(\theta,\phi)|^2 \, J_{inc} d\Omega \tag{10}$$

$$\frac{d\sigma(\theta,\phi)}{d\Omega} = \frac{\mu}{\hbar k_0} |f(\theta,\phi)|^2 \frac{\hbar k}{\mu}$$

For elastic scattering $\vec{k}_0$ is equal to $\vec{k}$, hence equation (10) reduced to

$$\frac{d\sigma}{d\Omega} = |f(\theta,\phi)|^2 \tag{11}$$

Derivation of Rutherford Differential Scattering Cross Section

The solution of the Schrödinger equation. Let us first focus on the determination $f(\theta,\phi)$;

$$\vec{\nabla}^2 \psi(\vec{r}) + \frac{2\mu}{\hbar^2}[E - \hat{V}(\vec{r})]\psi(\vec{r}) = 0 \tag{12}$$

This equation (12) in turn can be rewritten as follow;

$$(\vec{\nabla}^2 + k^2)\, \psi(\vec{r}) = \frac{2\mu}{\hbar^2} V(\vec{r}) \psi(\vec{r}) \tag{13}$$

Thus the general solution of equation (13) is given by

$$\Psi(\vec{r}) = \psi_{inc}(\vec{r}) + \frac{2\mu}{\hbar^2} \int G(\vec{r} - \vec{r}') V(\vec{r}') \psi(\vec{r}') d^3 r' \tag{14}$$

where, $\psi_{inc}(\vec{r})$ and $G(\vec{r} - \vec{r}')$ is a Green's function corresponding to the operator on left hand side on equation (14). The function $G(\vec{r} - \vec{r}')$ is obtained by solving the point source equation;

$$(\vec{\nabla}^2 + k^2)\, G(\vec{r} - \vec{r}') = \delta(\vec{r} - \vec{r}') \tag{15}$$

where $\delta(\vec{r} - \vec{r}')$ is Dirac delta function. $G(\vec{r} - \vec{r}')$ and $\delta(\vec{r} - \vec{r}')$ are given by the Fourier transform as follow;

$$G(\vec{r} - \vec{r}') = \frac{1}{(2\pi)^3} \int e^{i\vec{q}.(\vec{r} - \vec{r}')} G(\vec{q})\, d^3 \vec{q} \tag{16}$$

and

$$\delta(\vec{r} - \vec{r}') = \frac{1}{(2\pi)^3} \int e^{i\vec{q}.(\vec{r} - \vec{r}')}\, d^3 \vec{q} \tag{17}$$

A substitution of above equation (16) and (17) into (15), we get

$$(-\vec{q}^2 + k^2) G(\vec{q}) = 1$$

$$G(\vec{q}) = \frac{1}{(k^2 - \vec{q}^2)} \cdot \tag{18}$$

The expression for $G(\vec{r}-\vec{r}')$ is obtained as follow;

$$G(\vec{r}-\vec{r}') = \frac{1}{(2\pi)^3}\int \frac{e^{i\vec{q}.(\vec{r}-\vec{r}')}}{(k^2-q^2)} d^3\vec{q} \tag{19}$$

By integrating over the angles $\int \vec{d}^3q = \int_0^{\infty}\int_0^{\pi}\int_0^{2\pi} q^2 \sin\theta\, dq\, d\theta\, d\phi$ in equation (19), then

$$G(\vec{r}-\vec{r}') = \frac{1}{4\pi^2\, i\,|\vec{r}-\vec{r}'|}\int_0^{\infty} \frac{q}{(k^2-q^2)}\,(e^{iq|\vec{r}-\vec{r}'|} - e^{-iq|\vec{r}-\vec{r}'|})\, dq \tag{20}$$

By using counter integration method,

we get $$G(\vec{r}-\vec{r}') = -\frac{e^{ik|\vec{r}-\underline{r}'|}}{4\pi\,|\vec{r}-\vec{r}'|} \tag{21}$$

Therefore, the general solution of equation (7) is as follow

$$\Psi(\vec{r}) = e^{i\vec{k}_0.\vec{r}} - \frac{\mu}{2\pi\hbar^2}\int \frac{e^{ik|\vec{r}-\underline{r}'|}}{|\vec{r}-\vec{r}'|} V(\vec{r}')\,\psi(\vec{r}')\, d^3r' \cdot \tag{22}$$

In a scattering experiment, since the detector is located at distance away from the target that larger than the size of the target, we have $r >> r'$, where 'r' represent the distance from the target to the detector and 'r''the size of the target. If $r >> r'$, we may approximate $|\vec{r}-\vec{r}'|$ as $r - r'\cos\theta$,and $\frac{1}{|\vec{r}-\vec{r}'|} \approx \frac{1}{r}$, then we can express as;

$$\Psi(\vec{r}) = e^{i\vec{k}_0.\vec{r}} + \left[-\frac{\mu}{2\pi\hbar^2}\int e^{-i\vec{k}.\vec{r}'}\, V(\vec{r}')\psi(\vec{r}')\, d^3r'\right]\frac{e^{ikr}}{r} \tag{23}$$

where, $\vec{k} = k\hat{r}$ is the wave vector associated with the scattered particle. From the above two approximation, we may write the asymptotic form of equation (23) as follow;

$$\psi(\vec{r}) = e^{i\vec{k}_0.\vec{r}} + f(\theta,\phi)\frac{e^{ikr}}{r} \qquad (r \to \infty) \tag{24}$$

we get the scattering amplitude $f(\theta,\phi)$ is

$$f(\theta,\phi) = -\frac{\mu}{2\pi\hbar^2}\int e^{-i\vec{k}.\vec{r}'}\, V(\vec{r}')\,\psi(\vec{r}')\, d^3r' \tag{25}$$

where the integration variables (r') extends over the spatial degrees of freedom of the target. The differential cross section is then given by

$$\frac{d\sigma}{d\Omega} = |f(\theta,\phi)|^2 = \frac{\mu^2}{4\pi^2\hbar^4}\left|\int e^{-i\vec{k}.\vec{r}'}\, V(\vec{r}')\psi(\vec{r}')\, d^3\, r'\right|^2 \cdot$$

If the potential V(r) is weak enough, it will distort only slightly the incident plane wave. The first Born Approximation consists of approximating the scattered wave function $\psi_{sc}(\vec{r})$ by a plane wave, suppose that is not much differ from plane wave (or) free particle wave function as;

$$\psi_{sc}(\vec{r}') \approx \psi_{inc} = (\vec{r}')e^{i\vec{k}_0.\vec{r}'}$$

Thus, this approximation corresponds to the first interaction of the equation (23) which well-known total wave function that we obtained from the general solution of equation (13) in terms of Green function as the following form;

$$\Psi(\vec{r}) = \psi_{inc}(\vec{r}) - \frac{\mu}{2\pi\hbar^2}\int \frac{e^{ik|\vec{r}-\vec{r}'|}}{|\vec{r}-\vec{r}'|} V(\vec{r}')\ \psi_{inc}(\vec{r}')\ d^3r' \tag{26}$$

We can write using equation (25), the scattering amplitude and differential scattering cross section in the first Born approximation as follow;

$$f(\theta,\phi) = -\frac{\mu}{2\pi\hbar^2}\int e^{-i\vec{k}.\vec{r}'}\ V(\vec{r}')\ \psi_{inc}(\vec{r}')\ d^3r' \tag{27}$$

where $\psi_{sc}(\vec{r}') \approx \psi_{inc} = (\vec{r}')e^{i\vec{k}_0.\vec{r}'}$ and $d^3r' = \int_0^\infty r'^2 dr' \int_0^\pi \sin\theta' d\theta' \int_0^\pi d\phi'$

$$f(\theta,\phi) = -\frac{\mu}{2\pi\hbar^2}(2\pi)\int_0^\infty r'^2 V(\vec{r}')\, d\ r' \int_0^\pi e^{i\ \vec{q}.\vec{r}'}\ \sin\theta' d\theta' \tag{28}$$

where, $\vec{q} = \vec{k}_0 - \vec{k}$ and $\hbar\vec{q}$ is the momentum transfer, $\hbar\vec{k}_0$ and $\hbar\vec{k}$ are the linear momentum of the incident and scattered particles, respectively.

In an elastic scattering, the magnitude of $\vec{k}_0$ and $\vec{k}$ are equal, hence $q = 2\ k\ \sin(\frac{\theta}{2})$

If the potential is spherically symmetric, $V(\vec{r}') = V(r')$ and choosing the z- axis along $\vec{q}$, then

$$\vec{q}.\vec{r}' = qr'\cos\theta'$$

And therefore,

$$f(\theta,\phi) = -\frac{\mu}{2\pi\hbar^2}(2\pi)\int_0^\infty r'^2 V(\vec{r}')\, dr' \int_{-1}^{1} e^{i\ q r'\cos\theta'} dx \tag{29}$$

where, $x = \cos\theta',$ and $-dx = \sin\theta' d\theta'$ and the value of $\int_{-1}^{1} e^{-i\ q r'\cos\theta'} dx = \frac{2\sin q r'}{q r'}$

Then, equation (29) become the following form,

$$f(\theta,\phi) = -\frac{1}{q}\frac{2\mu}{\hbar^2}\int_0^\infty r'\ V(\vec{r}')\ \sin q r'\ dr' \tag{30}$$

$$\frac{d\sigma}{d\Omega} = |f(\theta,\phi)|^2 = -\frac{1}{q^2}\frac{4\mu^4}{\hbar^4}\left|\int_0^\infty r'\ V(\vec{r}')\ \sin q r'\ dr'\right|^2 \tag{31}$$

This above equation (31) is the differential scattering cross section on the first Born approximation.

We consider the electron scattering cross section for the case that an electron is incident on a neutral atom which has surrounded the nuclear charge as shield a screened by surrounding atomic electron, the screened Coulomb potential between an electron and a point charge nucleus is

$$V(r) = -\frac{Ze^2}{r} e^{-\alpha/r}. \tag{32}$$

where α is the range of potential.

We recalled the equation (30) which is the scattering amplitude by the first Born approximation is as follow;

$$f(\theta,\phi) = -\frac{1}{q}\frac{2\mu}{\hbar^2}\int_0^\infty r\, V(\vec{r}) \sin q r\, dr$$

The potential V(r) is inserted to the above equation, then

$$f(\theta,\phi) = \frac{2\mu}{\hbar^2}\frac{Ze^2}{\alpha^2 + q^2}$$

where, $q = 2\ k\ \sin(\frac{\theta}{2})$,

$$f(\theta,\phi) = \frac{2\mu}{\hbar^2}\frac{Ze^2}{\alpha^2 + [2\ k\ \sin(\frac{\theta}{2})]^2}$$

For the pure Coulomb's potential, the range $\alpha = 0$ and then, we can write as follow;

$$f(\theta,\phi) = \frac{2\mu}{\hbar^2}\frac{Ze^2}{4\ k^2\ \sin^2(\frac{\theta}{2})}$$

Since $\frac{d\sigma}{d\Omega} = |\ f(q)\ |^2$, we made by squaring of both sides to the above equation. Then we get, the differential scattering cross section is

$$\frac{d\sigma}{d\Omega} = |f(\theta,\phi)|^2 = \frac{4\mu^2 Z^2 e^4}{\hbar^4\ (2^4\ k^4\ \sin^4(\frac{\theta}{2}))}$$

$$\left(\frac{d\sigma}{d\Omega}\right)_{\text{Rutherford–Mott}} = \frac{4\mu^2 Z^2 e^4}{\hbar^4 q^4} \tag{33}$$

The above equation (33) is the Rutherford differential scattering cross section.

Form Factor F(q)

In an electron elastic scattering process with a target nucleus, we have presented about the non-relativistic differential cross section (Rutherford) and relativistic differential cross section (Mott). The differential cross section of Rutherford scattering does not include the spins while Mott scattering takes into account the spin of the colliding particles. In both cases, it is assumed that the target nucleus is a point charge.

For a target nucleus having an extended finite size, the differential cross section differs from that of the Rutherford or Mott by a factor called form factor F(q) such as

$$\left(\frac{d\sigma}{d\Omega}\right)_{\text{extended charge distribution}} = \left(\frac{d\sigma}{d\Omega}\right)_{\text{Rutherford (or) Mott}} |F(q)|^2 \tag{34}$$

Thus the form factor indicates the effect of nuclear size upon the differential cross section, where q is the momentum transfer of the scattering process and $\vec{q} = \vec{k}_0 - \vec{k}$. When $|\vec{k}_0| = |\vec{k}| = k$, which can be express as, $q = 2\,k\sin(\frac{\theta}{2})$.

The form factor is known as the Fourier transform of the charge density distribution and it can be express as follow;

$$F(q) = \frac{1}{Z}\int \rho_{ch}(r)\; e^{i\vec{q}.\vec{r}}\, d^3\vec{r} \tag{35}$$

and the verification of the above equation (35) will be given later the next section.

The form factor plays an important role because it is the most important link between experimental observation and theoretical analysis. In an experiment, the form factor is the direct result of a cross section measurement.

From the theoretical side, charge density distribution $\rho_{ch}(r)$ is a solution of the Schrodinger equation, which can be considered as the following relation.

$$\frac{d\sigma}{d\Omega}_{\text{Experiment}} \rightarrow |F(q)| \Leftrightarrow |F(q)| \leftarrow \frac{d\sigma}{d\Omega}_{\text{Theory}} \leftarrow \rho_{ch}(r) \leftarrow \Psi(r) \leftarrow \text{Schrödinger Equation}$$

Derivation of the relation between form factor and density distribution

Now we will give the derivation of equation (35). Let us compute the scattering of an electron by a spherically symmetric nucleus having a finite sizeof figure (3).The screened Coulomb potential between an electron and a point charge nucleus is

$$V(x) = -\frac{Ze^2}{x}\, e^{-x/a}. \tag{36}$$

However, we now consider the interaction between the electron and nucleus having a charge distribution. Thus, the screened Coulomb potential V(x) at the position of the electron "x" consists of contributions from the entire nucleus. An infinitesimal volume element $d\vec{r}$ contains a charge $dq = Ze\rho_{ch}(r)d\vec{r}$ which gives a contribution of

$$dV(x) = -\frac{Ze^2}{y} e^{-y/a}\rho_{ch}(r)d\vec{r}, \quad \text{where } \vec{y} = \vec{x} - \vec{r}$$

$$V(x) = -Ze^2\int \rho_{ch}(r)\frac{e^{-y/a}}{y}d\vec{r} \tag{37}$$

The vector $\vec{y}$ from the volume element $d\vec{r}$ to the electron is shown in figure (3). It is well known that the first Born approximation for a scattering amplitude f(q) is given by

$$f(q) = -\frac{m}{2\pi\hbar^2}\int V(x)\, e^{i\vec{q}.\vec{x}}\, d\vec{x} \tag{38}$$

where $q = 2k\sin(\theta/2)$ is the momentum transfer of the elastic scattering process with scattering angle θ. By substituting the value of V(x) of equation (37), into the equation (38), we obtain the following form,

$$f(q) = \frac{mZe^2}{2\pi\hbar^2}\int\int \rho_{ch}(r)\frac{e^{-y/a}}{y}d\vec{r}\, e^{i\vec{q}.\vec{x}}\, d\vec{x} \tag{39}$$

By using $\vec{x}=\vec{r}+\vec{y}$ yields see from figure (3),

$$f(q)=\frac{mZe^2}{2\pi\hbar^2}\int\int \rho_{ch}(r)\,\frac{e^{-y/a}}{y}\,d\vec{r}\,e^{i\vec{q}.(\vec{r}+\vec{y})}\,d\vec{x}$$

$$f(q)=\frac{mZe^2}{2\pi\hbar^2}\int e^{i\vec{q}.\vec{r}}\,\rho_{ch}(r)d\vec{r}\int \frac{e^{-y/a}}{y}e^{i\vec{q}.\vec{y}}d\vec{x} \tag{40}$$

For fixed r, $d\vec{x}$ can be replaced by $d\vec{y}$ .Then

$$f(q)=\frac{mZe^2}{2\pi\hbar^2}\int e^{i\vec{q}.\vec{r}}\,\rho_{ch}(r)d\vec{r}\int \frac{e^{-y/a}}{y}e^{i\vec{q}.\vec{y}}d\vec{y} \tag{41}$$

In the above equation (41), the integral term $\int \frac{e^{-y/a}}{y}e^{i\vec{q}.\vec{y}}d\vec{y}$ is evaluated as;

$$\int \frac{e^{-y/a}}{y}e^{i\vec{q}.\vec{y}}\,d\vec{y}=\frac{4\pi}{q^2+(1/a^2)} \tag{42}$$

If a >>1, equation (42) becomes the below form,

$$\int\frac{e^{-y/a}}{y}e^{i\vec{q}.\vec{y}}\,d\vec{y}=\frac{4\pi}{q^2}$$

Therefore, the equation (41) for the scattering amplitude f (q) can be written as;

$$f(q)=\frac{mZe^2}{2\pi\hbar^2}\int e^{i\vec{q}.\vec{r}}\,\rho_{ch}(r)\,d\vec{r}\times\frac{4\pi}{q^2}$$

and then, we get the scattering amplitude f (q) is in the form of;

$$f(q)=\frac{4\pi mZe^2}{2\pi\hbar^2q^2}\int e^{i\vec{q}.\vec{r}}\,\rho_{ch}(r)d\vec{r} \tag{43}$$

Since, $\frac{d\sigma}{d\Omega}=|f(q)|^2$, we made by squaring of both sides to equation (43), Then we get

$$\frac{d\sigma}{d\Omega}=\left|f(q)\right|^2=\frac{4m^2Z^2e^4}{\hbar^4q^4}\left|\int e^{i\vec{q}.\vec{r}}\,\rho_{ch}(r)d\vec{r}\right|^2 \tag{44}$$

However, the differential scattering cross section for electron scattering by a point nucleus (Rutherford scattering) is known to be previous section, which is

$$\left(\frac{d\sigma}{d\Omega}\right)_{Rutherford-Mott}=\frac{4m^2Z^2e^4}{\hbar^4q^4} \tag{45}$$

By comparing equations (45) which is the differential scattering cross section for the target nucleus is considered as a point-charge and (44) the target nucleus is considered as with extended charge distribution. In these cases, the factor term is appeared and we can express as;

$$\left(\frac{d\sigma}{d\Omega}\right)_{experiment} = \left(\frac{d\sigma}{d\Omega}\right)_{\substack{(extended\\ charge\\ distribution)}} = \left(\frac{d\sigma}{d\Omega}\right)_{\substack{Rutherford-Mott\\ (point\ charge)}} |F(q)|^2$$

$$|F(q)|^2 = \frac{\left(\frac{d\sigma}{d\Omega}\right)_{Experiment}}{\left(\frac{d\sigma}{d\Omega}\right)_{\substack{Ruther-Mott\\ (point-charge)}}} \tag{46}$$

The form factor is in the form of

$$F(q) = \int e^{i\vec{q}.\vec{r}}\, \rho_{ch}(r)\, d\vec{r} \tag{47}$$

If the normalization for form factor is chosen to be $F(q=0)=1$, the form factor can be written as;

$$F(q) = \frac{1}{Z}\int e^{i\vec{q}.\vec{r}}\, \rho_{ch}(r)\, d\vec{r} \tag{48}$$

The form factor $F(q)$ is the Fourier transform of the charge density distribution and the pervious equation (35) has been verified.

The form factor $F(q)$ can also be expressed as the following form,

$$F(q) = \frac{1}{Z}\int e^{i\vec{q}.\vec{r}}\, \rho_{ch}(r)\, d^3\vec{r}$$

$$= \frac{1}{Z}\int_{r=0}^{\infty}\int_{\theta=0}^{\pi}\int_{\varphi=0}^{2\pi} e^{iqr\cos\theta}\, \rho_{ch}(r)\, r^2 dr \sin\theta\, d\theta\, d\varphi \tag{49}$$

$$= \frac{2\pi}{Z}\int_{r=0}^{\infty} r^2 \rho_{ch}(r)\, \frac{e^{iqr} - e^{-iqr}}{iqr} dr$$

$$= \frac{4\pi}{Z}\int_{r=0}^{\infty} r^2\, \rho_{ch}(r)\, \frac{\sin(qr)}{qr} dr \tag{50}$$

Nuclear Charged Density Distributions

Nuclear charged density distribution is obtained by taking the Fourier inverse of the form factor.

The form factor is expressed as the form of equation (47).By multiplying the equation (47) with $\int e^{-i\vec{q}.\vec{r}'}\, d\vec{q}$ in both sides, and then

$$\int F(q) e^{-i\vec{q}.\vec{r}'}\, d\vec{q} = \int\int e^{i\vec{q}.\vec{r}}\, e^{-i\vec{q}.\vec{r}'}\, \rho_{ch}(r)\, d\vec{r}\, d\vec{q}$$

$$\rho_{ch}(r') = \frac{1}{(2\pi)^3}\int F(q) e^{-i\vec{q}.\vec{r}'}\, d\vec{q}$$

$$\rho_{ch}(r) = \frac{1}{(2\pi)^3}\int F(q) e^{-i\vec{q}.\vec{r}}\, d\vec{q} \tag{51}$$

From an electron scattering experiment, the form factor can be deduced by the following equation,

$$\left|F(q)\right|^2 = \frac{\left(\frac{d\sigma}{d\Omega}\right)_{experiment}}{\left(\frac{d\sigma}{d\Omega}\right)_{Rutherford-Mott}} \tag{52}$$

If the form factor $F(q)$ is known for all q, the inverse Fourier transform might be computed in order to get the charge density distribution, $\rho_{ch}(r)$ from the following equation

$$\rho_{ch}(r) = \frac{1}{(2\pi)^3} \int_{q=0}^{\infty} F(q)\ e^{-i\vec{q}.\vec{r}}\, d\vec{q}\,. \tag{53}$$

However, this is impossible because the form factor can be measured only in a limited range of momentum transfer "q". Thus the simplest analysis is to construct a model of the charge distribution. Such models have parameters which can be adjusted until the calculated form factor provides the best fit to the available experimental measurements.

$$F(q)\big|_{calculated} = \frac{4\pi}{Z} \int_{r=0}^{\infty} r^2\, \rho_{ch}^{model}(r)\ \frac{\sin(qr)}{qr}\ dr. \tag{54}$$

Results and Conclusion

The charge density distribution parameters for 3pF model which means Three parameters Fermi Model are already be known form the reference data of Atomic and Nuclear Tables 36 (1987). We used the formulas of charge density distributions for the 3pF model is $\rho_{ch}(r) = \rho_0(1+wr^2/c^2)/(1+\exp((r-c)/z))$ and for form factor is $F(q)\big|_{calculated} = \frac{4\pi}{Z} \int_{r=0}^{\infty} r^2\, \rho_{ch}^{model}(r)\ \frac{\sin(qr)}{qr}\ dr.$ Then we constructed the form factor and charge density distribution profiles by the help of GFORTRAN CODE Program for that 3pF model.

After that we have been fitted the charge density distribution parameters for 3PG model that is Three parameters Gaussian Model by using the formula $\rho_{ch}(r) = \rho_0(1+wr^2/c^2)/(1+\exp((r^2-c^2)/z^2))$ and we fitted these parameters based on 3pF profile as reference. We have shown these fitting parameters in Table (2) and then we constructed the profiles by using these fitted parameters from Table (2). And we compared these 3pG profiles with already known 3pF profiles for both charge density distribution and form factor to get the corresponding fitted parameters for 3pG model. These comparing profile are shown in Figure (2-a) to (2-b).by the used of our fitted data from Table (2).

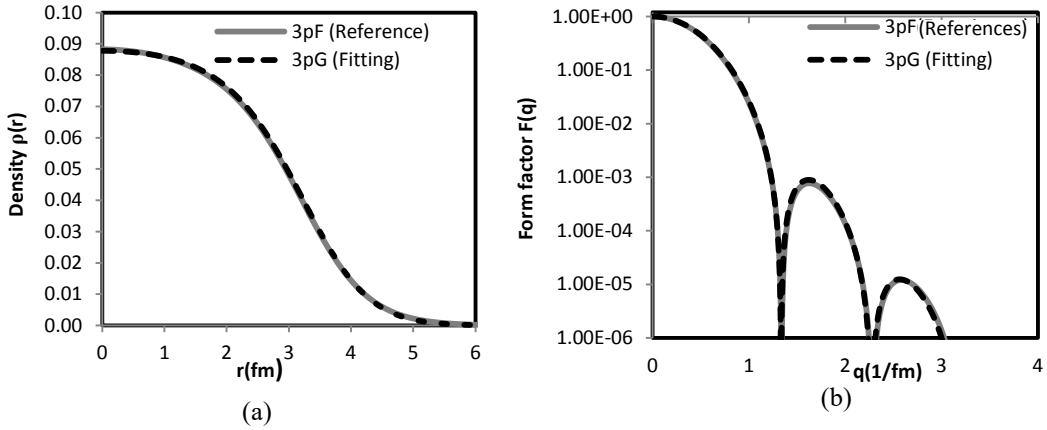
From these comparing of profiles, Figure (2-a) to (2-b), we can clearly say that our fitted parameters are good in agreement to use as a charged density distribution parameters for 3pG model because from the Figure (2-a) to (2-b), the reference and fitted curve are nice the same as a single line in the momentum transfer range of 3fm for both charge density distribution and charge form factor see Figure (2-a) to (2-b).

Table (1) Reference charge density distribution parameters for 3pF model of silicon isotope $^{29}_{14}$Si

Nucleus	Atomic no	c	z	w
		radius parameter	skin thickness parameter	wine-bottle parameter
$^{29}_{14}$Si	14	3.338	0.547	-0.203

Table (2) Fitted charge density distribution parameters for 3pG model of silicon isotope $^{29}_{14}$Si

Nucleus	Atomic no	c	z	w
		radius parameter	skin thickness parameter	wine-bottle parameter
$^{29}_{14}$Si	14	2.8613	1.9982	0.0848



(a) (b)

Figure(2) (a) Comparison of the charge density distribution for reference 3pF model (solid curve) and 3pG model (dash curve) and (b) Comparison of charge form factor for reference 3pF model (solid curve) and 3pG model (dash curve) of silicon isotope $^{29}_{14}$Si using the fitted data of Table (2)

Acknowledgements

The author gratefully acknowledges many useful and enlightening discussion with Dr Khin Swe Myint, Rector (Rtd;), Emeritus Professor, Department of Physics, University of Mnadalay, her suggested and advised the above research paper. I am grateful to the full support of Professor and Head, Dr Min Swe, Department of Physics, Shwebo University. I also would like to thank Dr Khin Mar Win, Lecturer, Department of Physics, Sagaing University of Education for her discussion.

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Study on The Sensitivity of Neutron Activation Method By Different Sample Sizes

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Abstracts

The sensitivity of neutron activation analysis method on different sample masses was investigated by using Manganese IV Oxide (MnO_2) powder sample, Am-Be neutron source and NaI(Tl) gamma spectroscopy system. Activation product is Mn^{56} and the emitted gamma energies are 846.60 keV, 1811.20 keV and 2112.60 keV. Fast neutron from Am-Be source is applied for activator or neutron irradiator. To study the sensitivity on different sample masses, a total of 6 samples (0.25 g, 0.5 g, 1 g, 5 g and 15 g) were used. According to the results, it is found that the sensitivity of neutron activation method is different for different sample masses. It can also be observed that the gamma intensity increases with the increasing sample mass.

Key words: sensitivity, neutron activation, neutron source, gamma energy

Introduction

Neutron activation analysis, based on the nuclear reaction between neutrons and target nuclei, is a qualitative and quantitative method of high efficiency for the simultaneous determination of about 5-30 major, minor and trace elements of geological, environmental, biological samples in ppb-ppm range without or with chemical separation. The sensitivity of neutron activation is a function of nuclear parameters of the element in question; neutron cross-section, isotope abundance, half-life, gamma-ray abundance, available neutron flux, length of irradiation, detector efficiency and the total sample size. Neutron activation analysis can also be used to determine the activity of a radioactive sample. The samples that can be analyzed with this method obtained from a number of different fields, including medicine, nutrition, biology, chemistry, forensics, the environment and mining. Neutron activation analysis takes advantages of the unique relation between photon energy and the emitting nucleus. Neutron activation means that the sample is bombarded with neutrons and becomes radioactive. Analysis refers to the measurement of the energies of the gamma photons released in the radioactive decay process. Gamma-ray intensity is proportional to the element content in the sample.

The objective of this work is to investigate the variation of gamma intensity of activation product with different sample sizes using Manganese IV Oxide (MnO_2) powder sample, Am-Be neutron source and NaI(Tl) detector. This study is important for the research activities based on neutron activation analysis because proper sample size is necessary and it should be considered deep in mind.

Materials and Methods

In this research, the experimental facilities available at Physics department, University of Mandalay are Am-Be neutron source, NaI(Tl) detector, model No. 671 spectroscopy

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amplifier and Gamma vision-32 software installed in PC with 4096 MCA. The sample under this study is MnO_2 powder purchased from local market.

Am-Be Neutron Source

The Am-Be source is an isotopic neutron source based on the ^{9}Be (α,n) ^{12}C reaction, and it is in the form of a capsule of outer diameter 3.10 cm and 3.35 cm in length. It was produced by Gammatron, INC, U.S.A. The source capsule is an insert gas welded double encapsulation constructed of stainless steel. According to IAEA certificate, radioactive contents in this Am-Be source are not more than 0.74 TBq (20 Curies) of either Americium-241 or an Americium-241/Beryllium mixture in the form of americium oxide or wire. The neutron yield of this source is approximately 1.04×10^{6} neutrons per second according to the manufacture's remark. Specification of Am-Be neutron source is shown in Table (1).

Sample Preparation and Irradiation

The sample under this study is MnO_2 powder (99% pure) available from local market. In this research work, the sensitivity of neutron activation was studied by changing different sample sizes with the same irradiation time.

To study the sensitivity of neutron activation method on different sample sizes, the sample in the polyethylene bag was weighed by using digital balance (PW 254). A total of (6) samples with different masses (0.25 g, 0.5 g, 1 g, 5 g, 10 g and 15 g) were activated with Am-Be neutron source with irradiation time of 20 hr. The reason for choosing the irradiation time of 20 hr is that the maximum equilibrium is achieved after the neutron exposure has continued for five half-lives of the activation product.

Determination of Gamma Intensity from Activation Product

In this work, the 3" x 3" NaI(Tl) scintillation detector is used to detect the gamma radiation after passing through the crystal and then passed information (electron pulse) are amplified by the preamplifier and collected by using 4096 multichannel analyzer (MCA) based on personal computer. This system is surrounded by lead shield of thickness (7.5) cm to reduce background radiation.

Before the measurement, detection system has to be calibrated. Energy calibration was made for 1800 seconds by using the standard gamma source of Eu-152. After activating the sample, gamma radiation emitted from the sample was measured by gamma spectroscopy system. Counting time for different sample sizes was 2 hr and the cooling time was 2 min.

Fig (1) MnO_2 powder samples with different masses

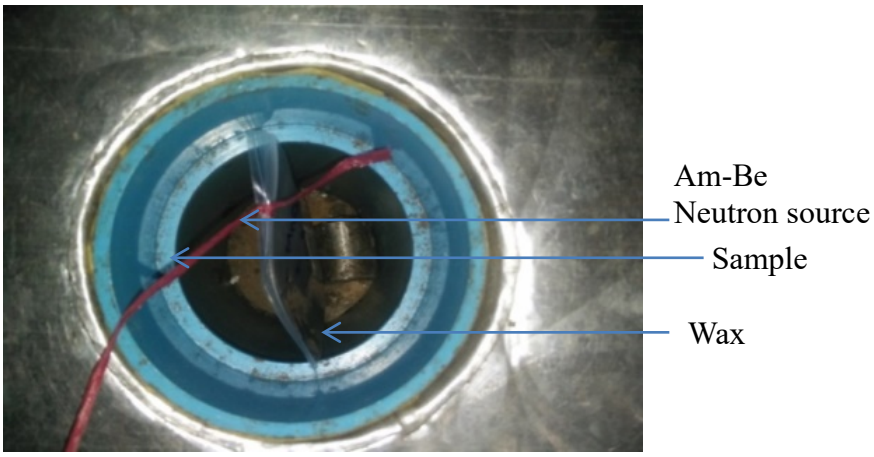

Fig (2) Sample Irradiation

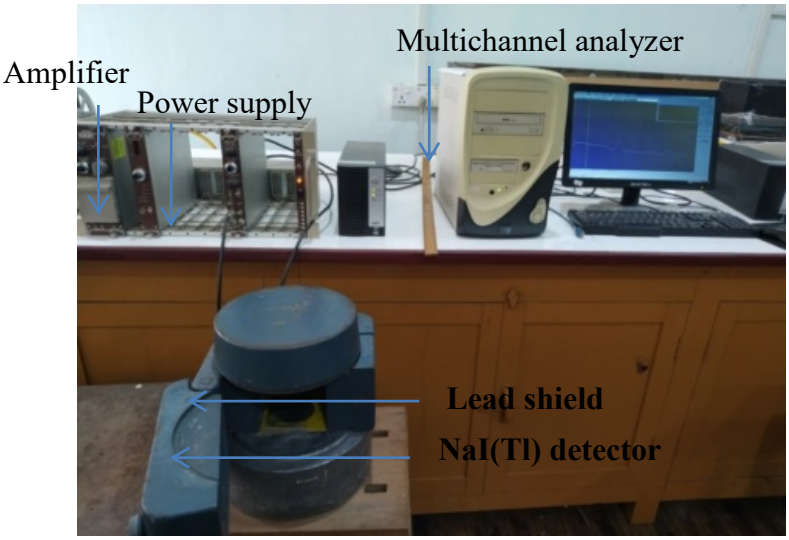

Fig (3) Gamma Detection System

Table (1) Specification of Am-Be neutron source

Model	AN-HP
Manufacturer	Gammatron, INC (USA)
Reaction	$^{9}Be(\alpha,n)^{12}C$
Active Material	Am-241Be
Activity Maximum content	550mCi
Activity Minimum content	475 mCi
Neutron yield	1.04×10^{6}nps
Average energy	3~4MeV
Surface(Dose rate)	20mRem/hr

Results

The gamma intensity from the activation product, Mn^{56}, has been detected by using NaI(Tl) scintillation detector and the gamma spectrum has been accumulated in 4096 MCA.

The spectrum analysis was performed using Gamma Vision-32 software. The spectrum analyzed data including net counts are shown in Table (2). According to the data, the variation of counts with different sample masses for different energies is graphically represented by Fig (4).

Discussion

According to Fig (4), it can be seen that the gamma intensity depends on the mass of sample. Gamma intensity is directly proportional to the sample size. As the mass of sample increases, the gamma intensity also increases.

In this work, fast neutron was applied as neutron irradiator. But, in neutron activation analysis, thermal neutron is usually applied because of high neutron cross-section. Thus, further study may be needed for the application of thermal neutron activation method.

Conclusion

The sensitivity of neutron activation method on different sample sizes has been investigated using Am-Be neutron source, MnO_2 sample and NaI(Tl) gamma spectrometry system. It can be observed that the sensitivity depends on the sample size. Therefore, the mass of sample should be considered in the research work based on the neutron activation method.

Table (2) Spectrum analysis data for different sample sizes

Sr. No	Mass of sample (g)	Net count		
		for 846.6 keV	for 1811.2 keV	for 2112.6 keV
1	15	152284±991	21021±594	9208±445
2	10	112938±898	15143±534	7608±376
3	5	47385±644	6449±389	3127±294
4	1	13234±478	2241±287	1131±237
5	0.5	6619±439	1414±249	802±217
6	0.25	1645±395	349±245	722±188

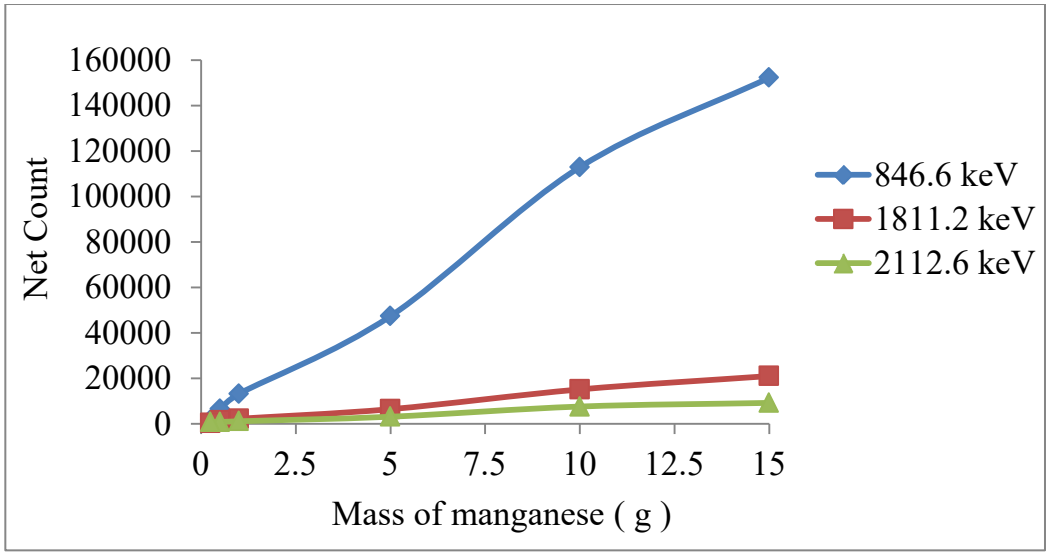

Fig (4) Variation of net counts with different sample sizes

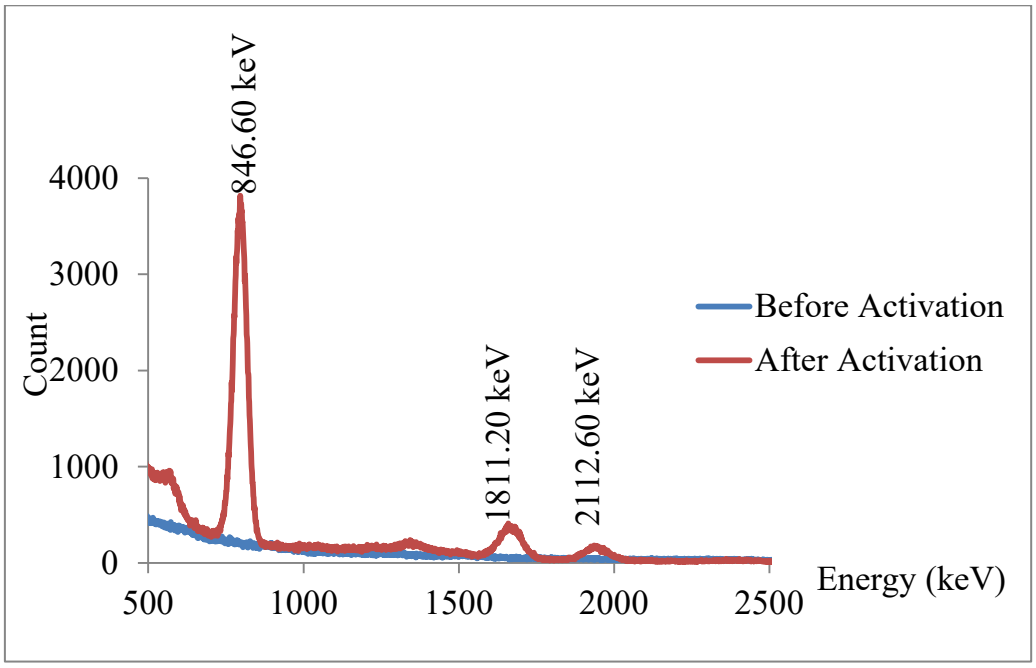

Fig (5) Comparison of gamma spectrum before and after activation for MnO_2

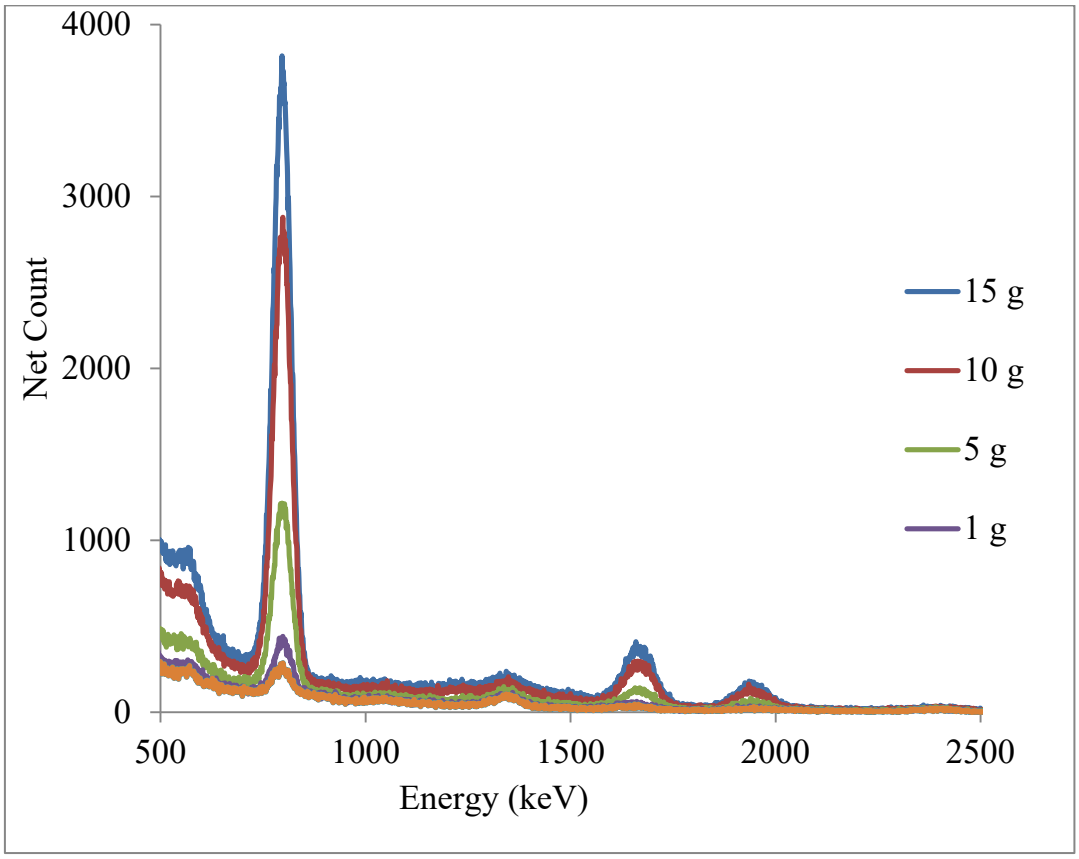

Fig (6) Comparison of gamma spectrum for different sample masses

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Shrinkage Effect of Λ The Paricle In ${}^{7}_{\Lambda}\mathrm{Li}$ $(\alpha+\mathrm{d}+\Lambda)$ Three-Body System

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Abstract

In order to study structural change in core nucleus ${}^{6}\mathrm{Li}$ by inclusion of Λ particle, we have performed ${}^{7}_{\Lambda}\mathrm{Li}$ within the frame work of three-body $\alpha+\mathrm{d}+\Lambda$ calculation by using Kamimura's three coupled- rearrangement channel method. We employed Furutani and Nishioka $\alpha-\mathrm{d}$ potentials and MSA $\Lambda-\alpha$ potential. We have constructed $\Lambda-\mathrm{d}$ potential phenomenologically which gives the experimental Λ-binding energy of ${}^{3}_{\Lambda}\mathrm{H}$. By using the above potentials, we obtained two values of Λ -binding energies of ${}^{7}_{\Lambda}\mathrm{Li}$ for two sets of $\alpha-\mathrm{d}$ potentials. Those are 5.83 MeV (MSA, Furutani), 5.57 MeV (MSA, Nishioka), which are in fair agreement with the experimental value, 5.58 ± 0.03 MeV. We found that Λ -binding energy is larger than the separation energy of $\alpha+\mathrm{d}$ core nucleus which is 1.48 MeV.

Key words: Shrinkage Effect, Lambda Binding Energy, Interaction.

1. Introduction

The Λ -binding energy for ${}^{7}_{\Lambda}\mathrm{Li}$ at the ground state in the E336 experiment is consistent with the result as 5.58 ± 0.03 MeV in a nuclear emulsion experiment at BNL [1].

In 1985, Motoba et al., [2] theoretically investigated the ${}^{7}_{\Lambda}\mathrm{Li}$ system as $\alpha+\mathrm{d}+\Lambda$ three-body system. For the microscopic description of low-lying states of light p- shell nuclei, the $\alpha+\mathrm{d}$ two-cluster model works well within the frame work of the generator-coordinate method (GCM). For the $\alpha+\mathrm{d}$ part they employ the orthogonality condition model (OCM) which has been proved to be a good approximation of GCM.

They discussed not only the ground state but also the spin-orbit splitting of the $5/2^{+}-1/2^{+}$ and $7/2^{+}-3/2^{+}$ states. The calculated binding energy of ${}^{6}\mathrm{Li}(1^{+})$ in ground state is 1.43 MeV below the $\alpha+\mathrm{d}$ threshold and the total binding energy of ${}^{7}_{\Lambda}\mathrm{Li}$ is 7.02 MeV below the $\alpha+\mathrm{d}+\Lambda$ threshold. Therefore, the ground state Λ-binding energy, $B_{\Lambda}({}^{7}_{\Lambda}\mathrm{Li})$ is 5.59 MeV which agrees satisfactorily with the experimental value. In 1996, Hiyama et al., [3] performed theoretical analysis of ${}^{7}_{\Lambda}\mathrm{Li}$ as ${}^{5}_{\Lambda}\mathrm{He}+\mathrm{n}+\mathrm{p}$ three-body system within the frame work of the complex-coordinate rotation method. The ground state Λ -binding energy, $B_{\Lambda}({}^{7}_{\Lambda}\mathrm{Li})$ is 5.87 MeV in this ${}^{5}_{\Lambda}\mathrm{He}$ cluster model.

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In 2006, Hiyama et al., [4] also calculated the ${}^{7}_{\Lambda}\mathrm{Li}$ as $\alpha+\Lambda+n+p$ four-body system with the use of coupled-rearrangement-channel Gaussian basis variational method [5]. The binding energy of the ${}^{6}\mathrm{Li}(1^{+})$ is 3.7 MeV below the $\alpha+n+p$ threshold and the total binding energy of ${}^{7}_{\Lambda}\mathrm{Li}$ is 9.29 MeV below the $\alpha+\Lambda+n+p$ threshold. Thus the calculated Λ-binding energy $B_{\Lambda}({}^{7}_{\Lambda}\mathrm{Li})$ is 5.59 MeV. We are going to investigate the structure of ${}^{7}_{\Lambda}\mathrm{Li}$ system as $\alpha+d+\Lambda$ cluster model within the frame work of couple-rearrangement-channel Gaussian basis variational method [5]. Before we determine the ground state binding energy of three-body system, we first calculated that of two-body subsystems such as ${}^{3}_{\Lambda}\mathrm{H}(\Lambda+d)$, ${}^{5}_{\Lambda}\mathrm{He}(\Lambda+\alpha)$ and ${}^{6}\mathrm{Li}(\alpha+d)$ in ${}^{7}_{\Lambda}\mathrm{Li}(\alpha+d+\Lambda)$ system.

2. Interactions

2.1 Pauli Principle between Alpha and Deuteron Clusters

In the study of ${}^{7}_{\Lambda}\mathrm{Li}$ based on the $\alpha+d+\Lambda$ three-body model, it is absolutely necessary and important to examine before the three-body calculation, whether the model with the interactions adopted is able to reproduce reasonably well the following observed quantities: (i) energy of the bound state (ii) radius of the hypernucleus (iii) B_{Λ} of hypernuclei composed of $\Lambda+d$ and $\Lambda+\alpha$ (iv) B_{Λ} of ${}^{7}_{\Lambda}\mathrm{Li}\equiv\alpha+d+\Lambda$.

The Pauli principle between nucleons belonging to alpha and deuteron clusters is taken into account by the orthogonality condition model (OCM) [6]. The OCM projection operator V_{Paul} is represented by

$$V_{\mathrm{Paul}}=\lim_{\lambda\to\infty}\lambda\sum_{f}\left|\phi_{f}(\vec{r}_{\alpha d})\right\rangle\left\langle\phi_{f}(\vec{r}'_{\alpha d})\right|$$

which rules out the amplitude of the Pauli forbidden $\alpha-d$ relative states $\phi_{f}(r_{\alpha d})$ from the three-body total wave function [7]. The forbidden states are f= {0s, 0p} for $\alpha-d$ part. In the actual calculations, the strength λ for V_{Pauli} is taken to be 10^{6} MeV, which is large enough to push the unphysical forbidden states into the very high energy region while keeping the physical state unchanged. Usefulness of this Pauli operator method of OCM has been verified in many cluster-model calculations. In the calculation [8] of three-body system including two α clusters, use is made of an $\alpha\alpha$ potential with a strong repulsive core so as to describe the Pauli exclusion role which prevents the two α clusters from overlapping. But it is well known that this approximate prescription of the Pauli principle is not suited for the case where the presence of the third particle makes the two α clusters come closer to each other, in other words, the off-energy-shell behavior of the repulsive potential is not appropriate in the three-body system. Moreover, there is no available potential reported for the $\alpha+d$ system of this type. Therefore we do not employ this prescription in the present systematic study of the structure change of the $\alpha+d$ system due to the addition of Λ particle. We take the orthogonality condition model instead, which is suited even for the case of heavy overlapping between the two clusters.

2.2. Furutani $\alpha - d$ Potential

Furutani et al., employed the potential between the clusters α and d which has been often used in the OCM based cluster-model study of light nuclei. Namely, it is the $V_{\alpha d}$ potential [9], which reproduces reasonably well the low-lying state and low-energy scattering phase shifts of the $\alpha + d$ system. The potentials are described in the following parity dependent form with the central and spin-orbit terms.

$$V_{\alpha-d}(r) = \sum_{k=1}^{k_{max}} V_k \, e^{-\left(\frac{r}{\mu_k}\right)^2} + \sum_{k=1}^{k_{max}} (-1)^{\ell} V_k^p \, e^{-\left(\frac{r}{\mu_k^p}\right)^2} + \left[\sum_{k=1}^{k_{max}} V_k^{\ell s} e^{-\left(\frac{r}{\mu_k}\right)^2} + \sum_{k=1}^{k_{max}} (-1)^{\ell} V_k^{\ell s,p} \, e^{-\left(\frac{r}{\mu_k^p}\right)^2} \right] \ell . s_d$$

where ℓ = the relative angular momentum between alpha and deuteron

s_d = the spin of deuteron

V_k = central potential, (i= 1, 2, …)

V_k^p = central potential with depend on ℓ (parity)

$V_k^{\ell s}$ = spin orbit potential

$V_k^{\ell s,p}$ = spin orbit potential with depend on ℓ (parity)

μ_k = range parameter in fm

μ_k^p = range parameter with depend on ℓ (parity) in fm

The $\alpha - d$ interaction is dependent on ℓ (parity). Since the relative angular momentum between alpha and deuteron is zero, the spin-orbit term of the $\alpha + d$ system is missing. We have slightly modified the strength of the central force in $V_{\alpha d}$ to obtain better agreement with the energy levels of ^{6}Li. Therefore we have actually employed the following potential form:

$$V_{\alpha-d}(r) = -66.027 e^{-\left(\frac{r}{2.236}\right)^2} - 10.21 \, e^{-\left(\frac{r}{2.236}\right)^2}.$$

The forbidden states between alpha and deuteron are 0*s* and 0p. We have calculated the binding energy and rms distance for $\alpha + d$ two-body system which are 1.48 MeV and 4.1 fm. Furutani $\alpha - d$ potential is shown in Fig. 2.1.

2.3. Nishioka $\alpha - d$ Potential

We also used Nishioka [10] $\alpha - d$ potential in ${}^{7}_{\Lambda}\mathrm{Li}$ calculation. It contains central and spin-orbit terms which are Gaussian form between the alpha and deuteron clusters.

$$V_{\alpha-d}(r) = V_k^c e^{-\left(\frac{r}{\mu_k^c}\right)^2} + V_k^{\ell s} e^{-\left(\frac{r}{\mu_k^{\ell s}}\right)^2} (\ell.s).$$

Then we employed $\alpha - d$ potential by the following expression

$$V_{\alpha-d}(r) = -72.594 e^{-\left(\frac{r}{2.294}\right)^2}$$

and it is shown in Fig. 2.2. This potential gives the binding energy of ${}^{6}\mathrm{Li}$ to be 1.48 MeV and the rms distance is 4.1 fm.

Coulomb interaction between alpha and deuteron is described as

$$V_{Coul}(r) = \frac{z_1 z_2 e^2}{r}.$$

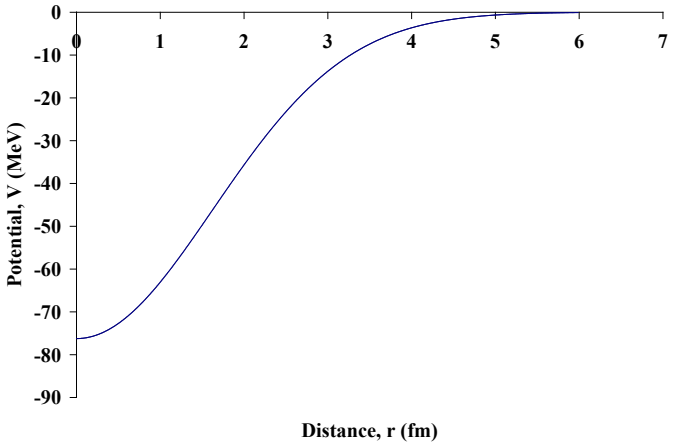

Fig.2.1 Furutani $\alpha - d$ potential

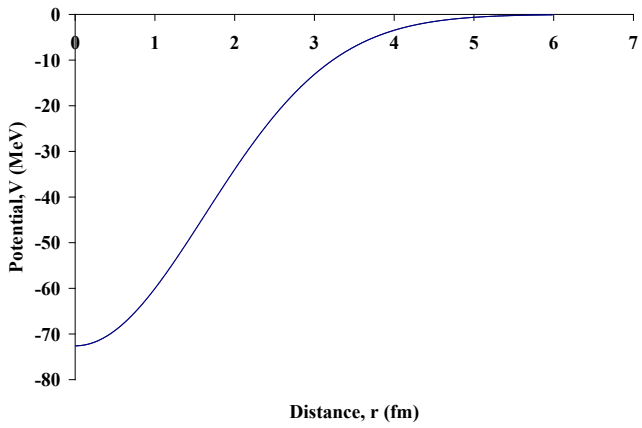

Fig. 2.2 Nishioka $\alpha - d$ potential

2.4. Lambda –Alpha and Lambda-Deuteron Interactions

There are many $\Lambda-\alpha$ potentials which were obtained from $\Lambda-N$ interactions by using different folding techniques, not by using an exact five body calculation. Therefore, a number of variations exist, especially in the short-range region of the effective $\Lambda-\alpha$ interactions. We will adopt two traditional effective potentials, which are Myint, Shinmura and Akaishi (MSA) potential [11].

2.5. MSA Λ - α Potential

Among the various $\Lambda-\alpha$ potentials, we first discussed the potential which is introduced by Myint, Shinmura and Akaishi [11], which we will call it MSA $\Lambda-\alpha$ potential. It is derived from the realistic one-boson-exchange YN potential of Nijimegen model D [12]. The original Nijimegen potential is simulated by Shinmura so as to reproduce the phase shift parameters as the original Nijimegen potential. The effective $\Lambda-N$ potential is derived by the Bruckner Theory. The required $\Lambda-\alpha$ potential which based on this effective $\Lambda-N$ potential is constructed by Hartree-Fock method. It is slightly modified so as to reproduce the experimental binding energy of the ${}^{5}_{\Lambda}He$ hypernucleus and is expressed in the following two-range Gaussian form:

$$V_{\Lambda-\alpha}(r)=91.0e^{-\left(\frac{r}{1.3}\right)^2}-95.0e^{-\left(\frac{r}{1.7}\right)^2}.$$

Our calculated binding energy and rms distance are 3.12 MeV and 3.11 fm respectively. The MSA two-range Gaussian $\Lambda-\alpha$ potential is shown in Fig. 2.3.

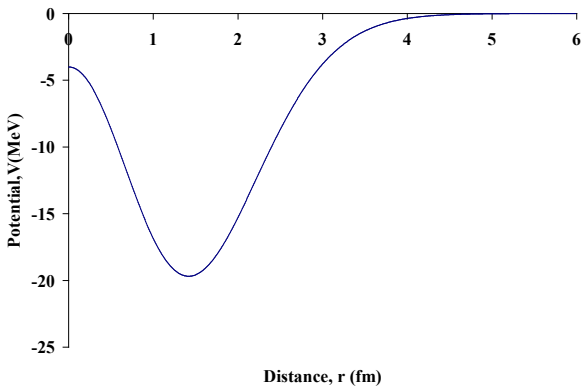

Fig. 2.3 MSA $\Lambda-\alpha$ potential

2.6. Lambda-Deuteron Phenomenological Potential

We constructed the phenomenological $\Lambda-d$ potential by adjusting the parameters to fit the value $B_\Lambda=0.13\pm0.05$ MeV [1]. This potential is three-range Gaussian form as follows:

$$V_{\Lambda-d}(r)=-30.84e^{-\left(\frac{r}{1.78}\right)^2}-103.40e^{-\left(\frac{r}{1.32}\right)^2}+181.70e^{-\left(\frac{r}{1.08}\right)^2}$$

Our constructed phenomenological $\Lambda-d$ potential is shown in Fig. 2.4.

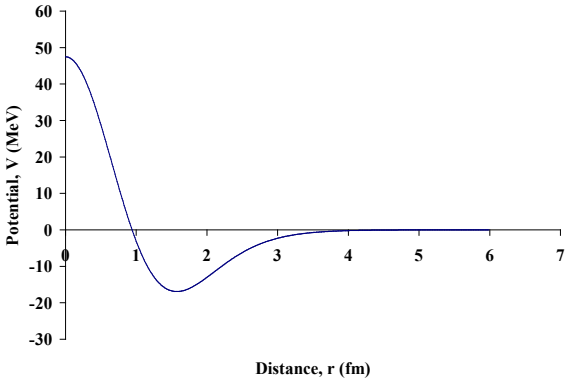

Fig. 2.4 Phenomenological $\Lambda - d$ potential

3. Mathematical Calculation

3.1. Three-Body Schrödinger Equation

The Schrödinger equation for the three- body system in rectangular coordinate is

$$\left[-\frac{\hbar^2}{2m_1}\vec{\nabla}^2_{\rho_1}-\frac{\hbar^2}{2m_2}\vec{\nabla}^2_{\rho_2}-\frac{\hbar^2}{2m_3}\vec{\nabla}^2_{\rho_3}+\begin{pmatrix}V(r_1)+V(r_2)+V(r_3)\\+V_{Paul}(r_3)+V_{Coul}(r_3)\end{pmatrix}\right]\Psi(\vec{\rho}_1,\vec{\rho}_2,\vec{\rho}_3) \quad (3.1.1)$$
$$=E\Psi(\vec{\rho}_1,\vec{\rho}_2,\vec{\rho}_3)$$

We used the relation between Jacobi and rectangular coordinates for three configurations in our calculation.

We have to transfer Jacobi coordinates from one channel to another channels according to channel coordinates relation. The relations between channel coordinates are as follows:

$$\vec{r}_1=\frac{m_1}{m_1+m_3}\vec{r}_2-\vec{R}_2,\vec{R}_1=-\frac{m_3(m_1+m_2+m_3)}{(m_1+m_3)(m_2+m_3)}\vec{r}_2-\frac{m_2}{(m_2+m_3)}\vec{R}_2 \quad (3.1.2)$$

$$\vec{r}_2=\frac{m_2}{m_2+m_3}\vec{r}_1-\vec{R}_1\ ,\ \vec{R}_2=-\frac{m_3(m_1+m_2+m_3)}{(m_1+m_3)(m_2+m_3)}\vec{r}_1-\frac{m_1}{(m_1+m_3)}\vec{R}_1 \quad (3.1.3)$$

$$\vec{r}_3=-\frac{m_3}{m_2+m_3}\vec{r}_1-\vec{R}_1,\ \vec{R}_3=\frac{m_2(m_1+m_2+m_3)}{(m_1+m_2)(m_2+m_3)}\vec{r}_1-\frac{m_1}{(m_1+m_2)}\vec{R}_1 \quad (3.1.4)$$

$$\vec{r}_1=-\frac{m_1}{m_1+m_2}\vec{r}_3+\vec{R}_3,\ \vec{R}_1=-\frac{m_2(m_1+m_2+m_3)}{(m_1+m_2)(m_2+m_3)}\vec{r}_3-\frac{m_3}{(m_2+m_3)}\vec{R}_3 \quad (3.1.5)$$

$$\vec{r}_2=\frac{m_2}{m_1+m_2}\vec{r}_3+\vec{R}_3\ ,\ \vec{R}_2=\frac{m_1(m_1+m_2+m_3)}{(m_1+m_3)(m_1+m_2)}\vec{r}_3-\frac{m_3}{(m_3+m_3)}\vec{R}_3 \quad (3.1.6)$$

$$\vec{r}_3=\frac{m_3}{m_1+m_3}\vec{r}_2+\vec{R}_2,\ \vec{R}_3=\frac{m_1(m_1+m_2+m_3)}{(m_1+m_3)(m_1+m_2)}\vec{r}_2-\frac{m_2}{(m_1+m_2)}\vec{R}_2 \quad (3.1.7)$$

where 1, 2, 3 represent the three different configurations.

Then Schrödinger equation becomes

$$\left[-\frac{\hbar^2}{2\mu_c}\vec{\nabla}^2_{\vec{r}_c}-\frac{\hbar^2}{2M_c}\vec{\nabla}^2_{\vec{R}_c}+\begin{Bmatrix}V_{d\Lambda}(r_1)+V_{\alpha\Lambda}(r_2)+V_{\alpha d}(r_3)\\+V_{Paul}(r_3)+V_{Coul}(r_3)\end{Bmatrix}\right]\Psi(\vec{r},\vec{R})=E\,\Psi(\vec{r},\vec{R}) \quad (3.1.8)$$

where c is the channel, c=1, 2 and 3 which are described in Fig. 3.1. The relative distance vector between m_2 and m_3 is denoted by $\vec{r}_1$ and $\vec{R}_1$ is the radius vector distance between m_1 and the center of mass of m_2 and m_3. The reduced masses (μ_c, M_c) associated with the coordinates (r_c, R_c) are used in our calculation.

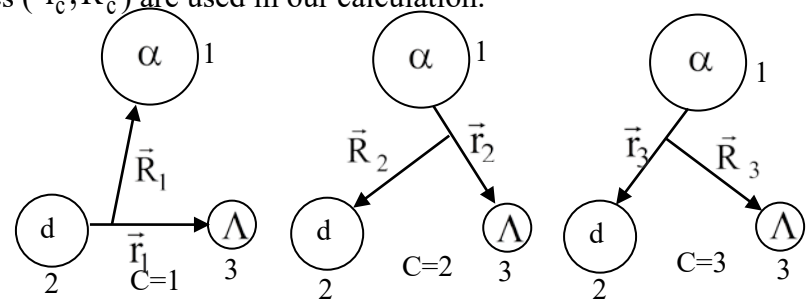

Fig. 3.1 Three rearrangement channels of the $\alpha-d-\Lambda$ system and their Jacobian coordinates

The total wave function of ${}^{7}_{\Lambda}\mathrm{Li}$ system has the following form:

$$\Psi(\vec{r},\vec{R})=\sum_{c=1}^{3}\sum_{ij}A^c_{ij}\,r_c^{\ell}\,e^{-\left(\frac{\vec{r}_c}{b_i}\right)^2}\,R_c^{L}\,e^{-\left(\frac{\vec{R}_c}{B_j}\right)^2} \quad (3.1.9)$$

where b_i's, B_j's are range parameters and are taken as geometrical progression.

Since the ground state of the ${}^{7}_{\Lambda}\mathrm{Li}$ system has total orbital angular momentum J=0, we take $\ell=0$ and L = 0. The Schrödinger equation is

$$H\Psi(\vec{r},\vec{R})=E\Psi(\vec{r},\vec{R})\ . \quad (3.1.10)$$

We calculated the matrix element by multiplying both sides of the above equation by $e^{-(\vec{r}/b_k)^2}e^{-(\vec{R}/B_\ell)^2}$ from the left and integrating through the equation with $d\vec{r}d\vec{R}$. The above equation becomes

$$\iint\sum_{c=1kl,ij}^{3}\sum A^c_{ij}\,e^{-\left(\frac{\vec{r}}{b_k}\right)^2}e^{-\left(\frac{\vec{R}}{B_l}\right)^2}\left\{\begin{pmatrix}-\frac{\hbar^2}{2\mu_c}\vec{\nabla}^2_{\vec{r}_c}-\frac{\hbar^2}{2M_c}\vec{\nabla}^2_{\vec{R}_c}\end{pmatrix}\right.$$
$$\left.+\left(V_{d\Lambda}(r_1)+V_{\alpha\Lambda}(r_2)+V_{\alpha d}(r_3)+V_{Paul}(r_3)+V_{Coul}(r_3)\right)\right\}$$
$$e^{-\left(\frac{\vec{r}}{b_i}\right)^2}e^{-\left(\frac{\vec{R}}{B_j}\right)^2}d\vec{r}_c d\vec{R}_c=E\iint\sum_{c=1}^{3}\sum_{kl,ij}A^c_{ij}\,e^{-\left(\frac{\vec{r}}{b_k}\right)^2}e^{-\left(\frac{\vec{R}}{B_l}\right)^2}e^{-\left(\frac{\vec{r}}{b_i}\right)^2}e^{-\left(\frac{\vec{R}}{B_j}\right)^2}d\vec{r}_c d\vec{R}_c$$

(3.1.11)

Then, the Schrödinger equation is expressed as a matrix form:

$$[H]\,[C] = E[N][C] \text{ (or) } [N]^{-1}[H][C] = E[C] \text{ (or) } [A][C] = E[C] \quad (3.1.12)$$

where [H] and [N] are Hamiltonian and Norm matrices and [C] is the column matrix which represents the expansion coefficient A's.

We have to transfer Jacobi coordinates from one channel to another channels according to eq. (3.1.11) to (3.1.16) when we compute the matrix elements between the different channels. In this way we obtain the kinetic energy, potential energy and norm matrix elements analytically. By diagonalizing the matrix A, we obtained the energy eigen values. The lowest energy eigen value is ground state binding energy of the system.

3.2. Pauli Suppression Effect in Three-Body System

Since alpha is a composite particle of four nucleons, Pauli exclusion effect must be included between alpha and deuteron in our formalism. The Pauli principle characterizes the relative state between clusters in the overlapping region of them. The Pauli effect is represented by non-local potential $V_{Paul}(\vec{r},\vec{r}')$ as

$$V_{Paul}(\vec{r},\vec{r}') = \lim_{\lambda\to\infty} \lambda \sum_{f} \left|\phi_f(\vec{r}_{\alpha d})\right\rangle\left\langle\phi_f(\vec{r}'_{\alpha d})\right| \quad (3.2.1)$$

where $\phi_f(\vec{r})$ is a forbidden state.

The forbidden states are 0s and 0p between alpha and deuteron particles in ${}^{7}_{\Lambda}\mathrm{Li}$ [7]. We used 0s state only for ground state calculation.

Harmonic oscillator wave functionsin three-body system for 0s is described as follows:

$$\phi_{0s}(\vec{r}) = 2\sqrt{\pi}\left(\frac{a}{2\pi}\right)^{3/4} e^{-(1/4)ar^2} Y_{00}(\hat{r}) \quad (3.2.2)$$

$$\phi_{0s}(\vec{R}) = 2\sqrt{\pi}\left(\frac{a}{2\pi}\right)^{3/4} e^{-aR^2} Y_{00}(\hat{R}) \quad (3.2.3)$$

where harmonic-oscillator strength is taken to be $a = 0.6947\,\mathrm{fm}^{-2}$ for alpha. By using the channel coordinates, the matrix element of V_{Paul} can be expressed as follow:

$$\left\langle\Psi\left|V^{0s}_{Paul}\right|\Psi\right\rangle = \lim_{\lambda\to\infty} \lambda\, 4\pi\left(\frac{a}{2\pi}\right)^{3/2}\left(\frac{\pi}{C}\right)^{3/2} 4\pi\sum_{\ell}(2\ell+1)\int_0^{\infty} i^{\ell}\, r^2\, e^{-Ar^2}\, j_{\ell}(-iDr^2)dr \quad (3.2.4)$$

In the Eq. (3.2.2) constants A, C and D are related to the Gaussian-basis parameters of the wave function and range parameters of the potentials.

4. Results And Discussion

4.1. Lambda Binding Energy of ${}^{7}_{\Lambda}\mathrm{Li}$

We have carried out the three-body calculation to study the structure of $\alpha + d + \Lambda$ system in the coordinate space. In our calculations we have used the coupled-rearrangement channel Gaussian basis method [5]. We have calculated the binding energy of $\alpha + d + \Lambda$

three-body system by using Furutani $\alpha-d$ potential as well as Nishioka potential and MSA potential for $\Lambda-\alpha$ interaction. We have constructed $\Lambda-d$ potential phenomenologically which gives the Λ-binding energy of ${}^{3}_{\Lambda}H$. For ground state spin parity of ${}^{7}_{\Lambda}Li$, $J^{\pi}=1/2^{+}$, we have considered the total orbital angular momentum, $\vec{L}_{total}=\vec{\ell}+\vec{\lambda}=0$ which is obtained with $\ell=\lambda=0,1,2,\ldots$. We have taken into account in our calculation only $\ell=\lambda=0$ and higher orbital angular momentum states are omitted since their contributions are very small to be negligible.

Since Pauli forbidden states between alpha and deuteron are 0s and 0p [7], we have taken into account Pauli suppression and Coulomb effect between alpha and deuteron in ${}^{7}_{\Lambda}Li$ ($\alpha+d+\Lambda$) system. The Λ-binding energies of ${}^{7}_{\Lambda}Li$ which is obtained by using the above mentioned potentials are shown in Table 4.1. The various threshold energy levels related to $\alpha+d+\Lambda$ system are shown in Fig. 4.1. It is found that our calculated lambda binding energies are in fair agreement with the experimental value 5.58 ± 0.03 MeV [1]. These values are obtained by choosing the input parameters $N_1= N_2= N_3=12$ and range parameters $b_1=0.1$ fm and $\beta=1.996$, $\beta=\left(\frac{b_N}{b_1}\right)^{\frac{1}{N-1}}$. It is found that the total wave function of the three-body system is sensitive to the values of the above mentioned parameters.

Table 4.1 Calculated total binding energies and lambda binding energies for ${}^{7}_{\Lambda}Li$ system in MeV with Λ–d phenomenological potential

$\Lambda-\alpha$ interaction	Furutani $\alpha-d$ potential		Nishioka $\alpha-d$ potential	
	B.E $V_{\alpha-d}+V_{Paul}+V_{Coul}$	B_Λ	B.E $V_{\alpha-d}+V_{Paul}+V_{Coul}$	B_Λ
MSA	7.31	5.83	7.05	5.57
$B_\Lambda({}^{7}_{\Lambda}Li)=5.58\pm0.03$ MeV [1]				

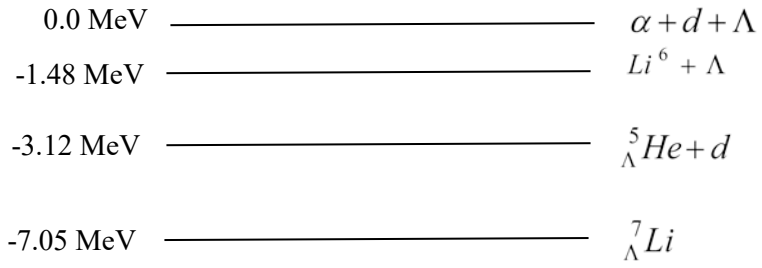

Fig. 4.1 Energy levels of ${}^{7}_{\Lambda}Li$ on the basis of the $\alpha+d+\Lambda$ threshold level

4.2. Structural Change of the Core Nucleus

The possibility that a nuclear core shrinks when a Λ particle is added was pointed out by using the $\alpha+d+\Lambda$ cluster model for light p-shell Λ-hypernuclei [13]. In order to see such a shrinkage effect in our analysis, we have investigated change of the relative $\alpha-d$ density distribution $\rho(r_{\alpha-d})$ in ${}^{6}Li$ and ${}^{7}_{\Lambda}Li$.

We have studied the relative motion between the alpha and deuteron in our three-body hypernuclear system. The relative $\alpha-d$ density distribution is obtained by integrating out the total wave function with $\vec{R}_3$ and angular parts of $\vec{r}_3$ i.e $\hat{r}_3$. The relative density distribution is defined as

$$\rho(r_3) = \int |\psi_{\alpha-d-\Lambda}|^2 d\vec{R}_3 d\hat{r}_3 / 4\pi$$

$$= \left(\frac{\pi}{A}\right)^{3/2} e^{-(a-c^2/4A)r_3^2}$$

where constants a, c and A are related to the Gaussian-basis parameters of the wave function. The $\alpha-d$ relative wave functions with and without Pauli effect are shown in Fig. 4.2. It demonstrates the strong shrinkage of the $\alpha+d$ in ${}^{7}_{\Lambda}\mathrm{Li}$ from that in ${}^{6}\mathrm{Li}$. The obtained density distribution of the relative motion between α and d particles is displayed in Fig. 4.3. It can be seen that the maximum peak is found at $\alpha-d$ distance $r_{\alpha-d}$ = 3.2 fm and $r_{\alpha-d}$ = 1.9 fm for ${}^{6}\mathrm{Li}$ and ${}^{7}_{\Lambda}\mathrm{Li}$ respectively. In ${}^{6}\mathrm{Li}$, the bound state solution of the $\alpha-d$ system has one node, lacking of the 0s type solution. It indicates that the relative wave function is orthogonal to the 0s forbidden state.

We also calculated the rms distance between alpha and deuteron in three-body calculation. It is defined as

$$\tilde{r}_{\alpha d} = \left[4\pi \int r_3^2 \rho(r_3) r_3^2 \, dr_3\right]^{1/2}$$

$$= \left[\frac{3\pi^3 A}{2(aA - c^2/4)^{5/2}}\right]^{1/2}.$$

Our calculated rms distance of $\alpha-d$ in ${}^{7}_{\Lambda}\mathrm{Li}$ is found to be 3.44 fm which is significantly smaller than that of $\alpha-d$ in ${}^{6}\mathrm{Li}$ which is 4.1 fm. We can see clearly that the ground state of $\alpha+d$ core nucleus is changed due to the participation of Λ particle.

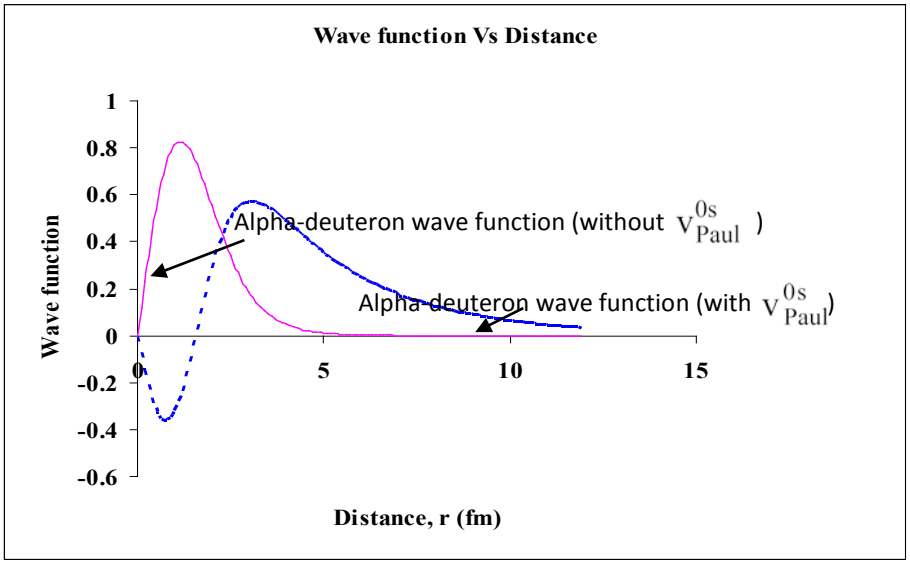

Fig. 4.2. The α-d wave functions with and without Pauli effect

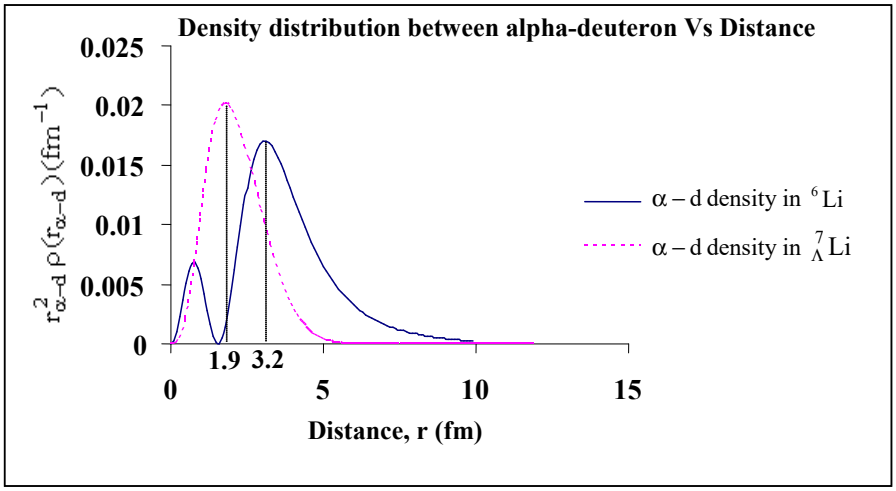

Fig. 4.3 The density distribution of relative motion between α-d

5. Conclusion

In this paper, we have investigated the structural change of the $\alpha + d$ nuclear core by the participation of the Λ particle. We have first constructed the [illegible]d potential phenomenologically which reproduces the experimental Λ-binding energy of ${}^{3}_{\Lambda}H$. We have carried out structure calculations of ${}^{7}_{\Lambda}Li$ within the frame work of $\alpha + d + \Lambda$ cluster model. We have employed the interactions between constituent particles which reproduce reasonably the properties of the $\alpha + d$ nucleus and existing data of Λ-binding energy of the $\Lambda + \alpha$ system [1]. The three-body calculations of the system were performed by using the Jacobian-coordinate Gaussian basis coupled-rearrangement-channel method. We have excluded the Pauli forbidden states from the solution of Schrödinger equation with OCM model. Calculated binding energies for various potentials with range parameters, b_1 = 0.1 fm and β =1.996 are close to the experimental value. Structural change of the $\alpha + d$ nuclear core by the participation of the Λ particle is seen in ${}^{7}_{\Lambda}Li$ hypernucleus, which is about 16% shrinkage of the rms distance $r_{\alpha-d}$ in ${}^{7}_{\Lambda}Li$ compared to that in ${}^{6}Li$.

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Application of Matching Theory to Timetabling Problem

Tin Tin Ya[1]

Abstract

In a school, there are five teachers and six classes, and the teaching requirement matrix $P=[p_{ij}]$ is given. One possible 5-period 6-room timetable is shown. We find a 5-period 4-room by using matching theory.

Key words: component, matching, timetabling problem.

1. Introduction

In a school, there are m teachers $X_1, X_2, \ldots, X_m$, and n classes $Y_1, Y_2, \ldots, Y_n$. Given that teacher X_i is required to teach class Y_j for P_{ij} periods, schedule a complete timetable in the minimum possible number of rooms.

The above problem is known as the timetabling problem. We can solve completely using matching theory. We represent the teaching requirement by a bipartite graph G with bipartition (X, Y), where $X=\{X_1, X_2, \ldots, X_m\}$, $Y=\{Y_1, Y_2, \ldots, Y_n\}$ and vertices X_i and Y_j are joined by P_{ij} edges. Now, in any one period, each teacher can teach at most one class, and each class can be taught by at most one teacher, at least, in our assumption. Thus a teaching schedule for one period corresponds to a matching in a graph and, conversely, each matching corresponds to a possible assignment of teachers to classes for one period. Our problem, therefore, is to partition the edges of G into as few matchings as possible. Let us assume that only a limited number of classrooms are available. With this additional constraint, how many periods are now needed to schedule a complete timetable?

Suppose that altogether there are L lessons to be given, and that they have been scheduled in a p-period timetable. Since this timetable requires an average of $\frac{L}{P}$ lessons to be given per period, it is clear that at least $\left\lceil \frac{L}{P} \right\rceil$ rooms will be needed in one period. It turns out that one can always arrange L lessons in a p-period timetable so that at most $\left\{ \frac{L}{P} \right\}$ rooms are occupied in any one period. This follows from Theorem 2.2 below.

2. Matching

A graph $G=(V,E)$ consists of a finite set V of vertices and a set E of edges such that each edge connects two vertices. If an edges $e \in E(G)$ and $e=uv$ where u and v are in V(G), then we say that u and v are **adjacent** and e is **incident** with u and v. The degree of a vertex v in a graph G is the number of edges incident to it and is denoted by deg(v) or d(v). The **maximum degree** of G is the maximum degree among the vertices of G and is denoted by

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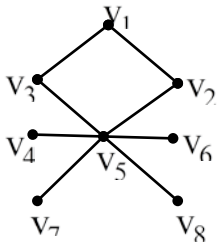
$\Delta(G)$. A **walk** W in G is a finite sequence $W = v_0e_1v_1e_2v_2\ldots e_kv_k$, whose terms are alternately vertices and edges, such that, for $1 \le i \le k$, the ends of e_i are v_{i-1} and v_i. In a simple graph, a walk W is expressed by the sequence $v_0v_1\ldots v_k$, of its vertices. If the vertices $v_0, v_1, \ldots, v_k$, are distinct, a walk W is called a **path**. The number of edges in a path is called **length** of the path. Two vertices are said to be connected if they are joined by a **path**. A graph G is **connected** if every pair of vertices is joined by a path. A graph H is **subgraph** of G if $V(H) \subset V(G)$ and $E(H) \subset E(G)$. Suppose that E' is a nonempty subset of E. The subgraph of G where vertex set is the set of ends of edges in E' and where edge set is E' is called the subgraph of G **induced** by E' and is denoted by $G[E']$. Maximal connected subgraph of G is called a **component** of G. A subset M of E(G) is called a **matching** in G if its elements are links and no two are adjacent in G. A bipartite graph is a graph whose vertex set can be partitioned into two subsets so that no edge has both ends in any one subset. The number of elements in any set A is denoted by |A|. The notation [x] means the greatest integer less than or equal to x and {x} means the least integer greater than or equal to x.



$$X = \{u_1, u_2, u_3\}$$
$$Y = \{v_1, v_2, v_3, v_4\}$$
$$V(G) = \{u_1, u_2, u_3, v_1, v_2, v_3, v_4\}$$

Figure 1. A graph G

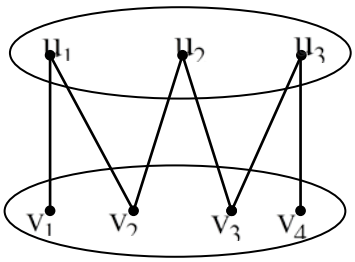


Figure 2. A bipartite graph G

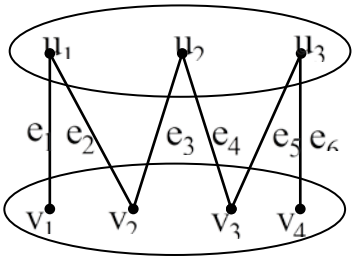


Figure 3. Matching $M_1 = \{e_1, e_3, e_5\}$

Matching $M_2 = \{e_4, e_6\}$

2.1 Lemma

Let M and N be disjoint matchings of G with $|M| > |N|$. Then, there are disjoint matchings M' and N' of G such that $|M'| = |M| - 1, |N'| = |N| + 1$ and $M' \cup N' = M \cup N$.

2.2 Theorem

If G is bipartite, and if $p \geq \Delta(G)$, then there exist p disjoint matchings $M_1, M_2, \ldots, M_p$ of G such that

$$E(G) = M_1 \cup M_2 \cup \ldots \cup M_p \text{ and, for } 1 \leq i \leq P$$

$$\left\lfloor \frac{|E|}{P} \right\rfloor \leq |M_i| \leq \left\{ \frac{|E|}{P} \right\}. \quad (1)$$

(Note: condition (1) says that any two matchings M_i and M_j differ in size by at most one).

3. Application

As an example, suppose that there are five teachers and six classes, and that the teaching requirement matrix $P = [p_{ij}]$ is as given in figure 4(a). One possible 5-peroid timetable is shown in figure 4(b).

$$P = \left[P_{ij} \right] = \begin{array}{c} \\ X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{array} \begin{array}{c} \begin{array}{cccccc} Y_1 & Y_2 & Y_3 & Y_4 & Y_5 & Y_6 \end{array} \\ \begin{bmatrix} 2 & 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 0 & 2 & 2 \end{bmatrix} \end{array}$$

Figure 4(a)

	Period				
	1	2	3	4	5
X_1	Y_1	Y_1	Y_3	Y_4	-
X_2	Y_2	-	Y_4	-	-
X_3	Y_3	Y_4	-	Y_2	Y_5
X_4	Y_4	-	Y_1	Y_5	Y_4
X_5	Y_5	Y_5	Y_6	-	Y_6

Figure 4(b)

We can represent the above timetable by a decomposition into matchings of the edge set of the bipartite graph G corresponding to P, as shown in figure 5(a). (Edges numbered 1 corresponds to period 1, edges numbered 2 to period 2, edges numbered 3 to period 3, edges numbered 4 to period 4, and edges numbered 5 to period 5).

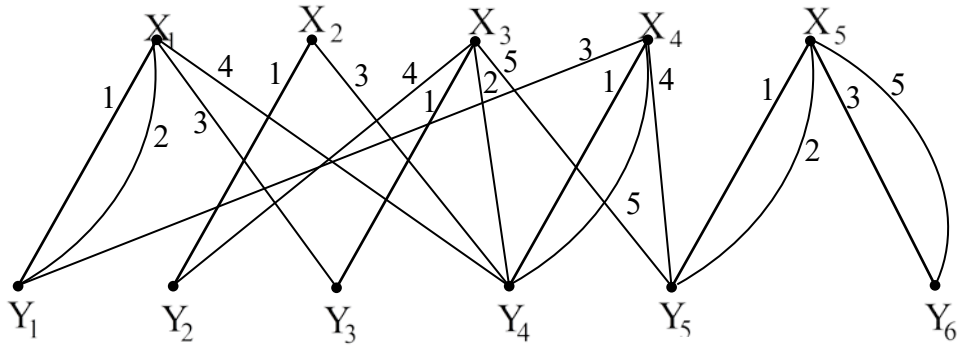


Figure 5(a)

From the table, we see that five classes are taught in period 1, and so five rooms are needed. However $|E(G)|=18$ and so a 5-period timetable can be arranged so that in each period either $3\left(=\left[\frac{18}{5}\right]\right)$ or $4\left(=\left\{\frac{18}{5}\right\}\right)$ classes are taught. Let M_1 denote the matching numbered 1 and M_4 denote the matching numbered 4. We observe that $|M_1|=5$ and $|M_4|=3$.

We can now find a 5-period 4-room timetable by considering $G[M_1 \cup M_4]$ (figure 5(b)).

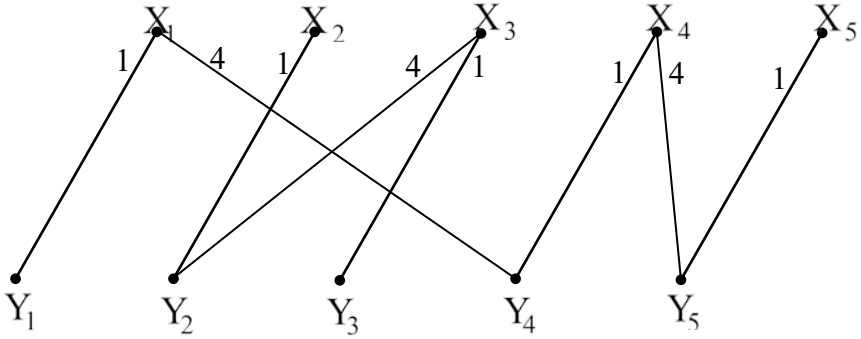


Figure 5(b)

$G[M_1 \cup M_2]$ has two components: one has a path of length three $(X_2Y_2X_3Y_3)$ and another has length five $(Y_1X_1Y_4X_4Y_5X_5)$. Both paths start and end with edges numbered 1 and so, by interchanging the matchings on one of the two paths, we shall reduce the matching numbered 1 to one of five edges and at the same time increase the matching numbered 4 to one of five edges. If we choose the path $Y_1X_1Y_4X_4Y_5X_5$, making the edges Y_1X_1, Y_4X_4 and Y_5X_5 numbered 4 and the edges X_1Y_4 and X_4Y_5 numbered 1, we obtain the decomposition of E shown in figure 6(a).

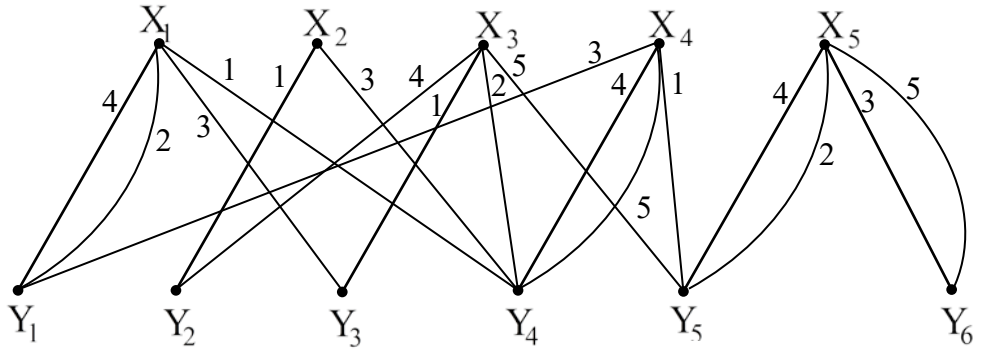


Figure 6 (a)

	1	2	3	4	5
X_1	Y_4	Y_1	Y_3	Y_1	-
X_2	Y_2	-	Y_4	-	-
X_3	Y_3	Y_4	-	Y_2	Y_5
X_4	Y_5	-	Y_1	Y_4	Y_4
X_5	-	Y_5	Y_6	Y_5	Y_6

Figure 6 (b)

Now we obtain the revised timetable shown in figure 6(b). Here only four rooms are needed at any one time.

Conclusion

There are several scheduling problems in operational research which can be formulated in graph theoretical terms. In this paper, we handle the scheduling problem in the form of the timetabling problem. In practice, most problems on timetabling are complicated by preassignments (that is, conditions specifying the periods during which certain teachers and classes must meet). The generalization of the timetabling problem may be studied by the mathematician who are interested in this filed.

Acknowledgements

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A Transition Probability Matrix

Myint Win Yi[1]

Abstract

We study a stochastic process $\{X_n, n = 0,1,2,...\}$ that takes on a finite or countable number of possible values. We define a discrete-time Markov chain. Then, we study transition probability matrices. Finally, we discuss the limiting probability of Markov chain.

Key words: random variables, Markov chain, Chapman-Kolmogorov equation, transition probability

1.1 Random Variables

The set of all possible outcomes of an experiment is known as the sample space. These real-valued functions defined on the sample space are known as **random variables**.

1.2 Example

Let X denote the random variable that is defined as the sum of two fair dice.

The experiment consists of rolling two dice , then the sample space is

$$\begin{Bmatrix} (1,1) & (1,2) & (1,3) & (1,4) & (1,5) & (1,6) \\ (2,1) & (2,2) & (2,3) & (2,4) & (2,5) & (2,6) \\ (3,1) & (3,2) & (3,3) & (3,4) & (3,5) & (3,6) \\ (4,1) & (4,2) & (4,3) & (4,4) & (4,5) & (4,6) \\ (5,1) & (5,2) & (5,3) & (5,4) & (5,5) & (5,6) \\ (6,1) & (6,2) & (6,3) & (6,4) & (6,5) & (6,6) \end{Bmatrix}.$$

$P\{X = 2\} = P\{(1,1)\} = \frac{1}{36}$, $P\{X = 3\} = P\{(1,2),(2,1)\} = \frac{2}{36}$, and so on.

1.3 A Stochastic Process

A stochastic process $\{X_t, t \in T\}$ is a collection of random variables. 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 $T = \{0,1,2,...\}$, 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 variables X_t can assume.

2.1 Markov Chain

Let $\{X_n, n = 0,1,2,...\}$ be a discrete-time stochastic process. If $X_n = i$, then the process is said to be **state iat time n**. A stochastic process $\{X_n, n = 0,1,2,...\}$ is called **a Markov chain** if

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$$P\{X_{n+1}=j \mid X_n=i,\ X_{n-1}=i_{n-1},\ \ldots,\ X_1=i_1,\ X_0=i_0\}=P_{ij}, \qquad (1)$$

for all states $i_0, i_1, \ldots, i_{n-1}, i, j$ and $n \geq 0$.

Equation (1) may be interpreted as stating that ; for a Markov chain , the conditional distribution of any future state X_{n+1} given in the past states X_0, $X_1, \ldots, X_{n-1}$ and the present state X_n, is independent of the past states and depends only on the present state .

The value P_{ij} denotes the probability that Markov chain, whenever in state i (the current) moves next (one unit time later) into state j, is referred to as **a one-step transition probability**.

The transition probabilities are collected into the one- step transition probability matrix:

$$\mathbf{P} = \begin{bmatrix} P_{00} & P_{01} & P_{02} & \ldots & \ldots \\ P_{10} & P_{11} & P_{12} & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ P_{i0} & P_{i1} & P_{i2} & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \end{bmatrix}.$$

We note that the transition probability matrix **P** for a Markov chain has the following properties:

$$(i)\ 0 \leq P_{ij} \leq 1 \quad , i, j \geq 0.$$

$$(ii)\ \sum_{j=0}^{\infty} P_{ij} = 1, i = 0, 1, 2, \ldots.$$

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.

2.2 Example

A rat is put in the maze illustrated in Figure (1)

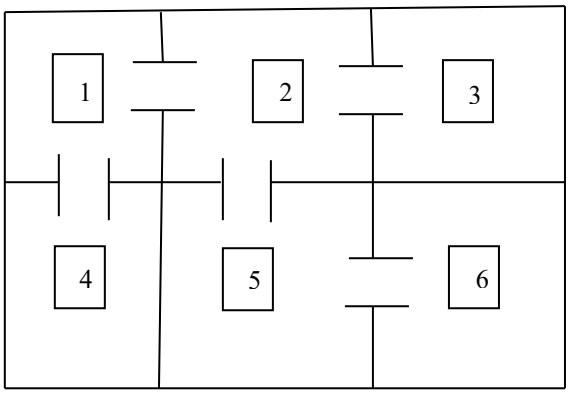

Figure (1)

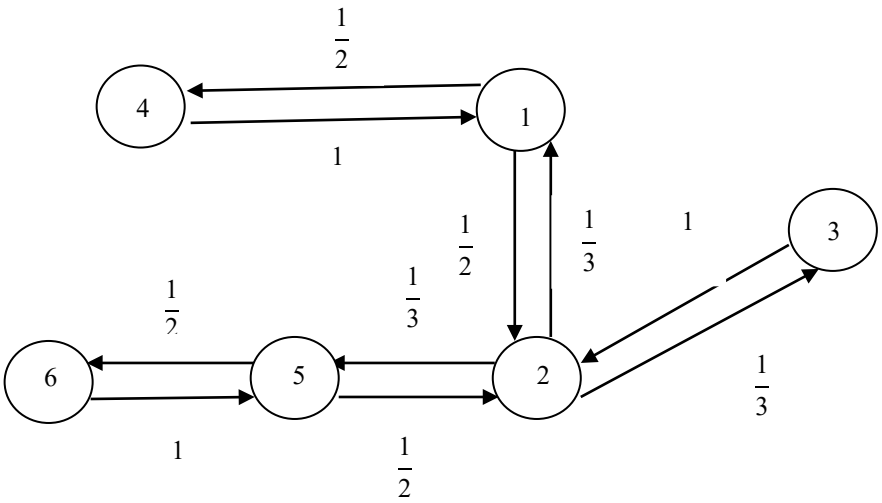

Figure (2)

At each time, it changes room, choosing its exist at random. Here X_n is the room that the rat is occupying during (n,n+1) . We consider the figure (2).

Thus, the transition probability matrix is $\begin{bmatrix} 0 & \frac{1}{2} & 0 & \frac{1}{2} & 0 & 0 \\ \frac{1}{3} & 0 & \frac{1}{3} & 0 & \frac{1}{3} & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$.

2.3 Forecasting the Weather

We suppose that the chance of rain tomorrow depends on previous weather conditions only through whether or not it is raining today and not on the past weather conditions. We also suppose 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 . We can find the one- step transition probability matrix.

If we say that the process is in the state 0 when it rains and in the state 1 when it does not rain, then there are 2 states in this case.

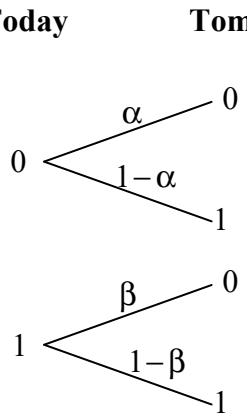

Figure (3)

The above is a Markov chain whose transition probabilities are given by $\mathbf{P} = \begin{bmatrix} \alpha & 1-\alpha \\ \beta & 1-\beta \end{bmatrix}$.

2.4 Transforming a Process into a Markov Chain

We suppose that whether or not it rains today, depends on previous weather conditions through the last two days. Specifically, we suppose that if it has rained for the past two days, then it will rain tomorrow with probability 0.7; if it rains today but not yesterday, then it will rain tomorrow with probability 0.5; if it rained yesterday but not today, then it will rain with probability 0.4; if it has not rained in the past two days, then it will rain tomorrow with probability 0.2. We can find the transition probability matrix.

If we let the state at time n depend only whether or not it is raining at time n, then the preceding model is not a Markov Chain. However, we can transform this model into a Markov chain by saying that the state at any time is determined by the weather conditions during both that day and the previous day. In other words, we can say that the process is in

State 0 if it rained today and yesterday,

State 1 if it rained today but not yesterday,

State 2 if it rained yesterday but not today ,

State 3 if it did not rain either yesterday or today.

By given, $P_{00} = 0.7, P_{10} = 0.5, P_{21} = 0.4, P_{31} = 0.2.$ Then $P_{02} = 0.3$ since state 0 to state 2 is 1 - 0.7=0.3. Similarly, we confirm $P_{12} = 0.5,\ P_{23} = 0.6, P_{33} = 0.8.$.

Let state $0-(R,R)$, state $1-(NR,R)$, state $2-(R,NR)$, state $3-(NR,NR)$.

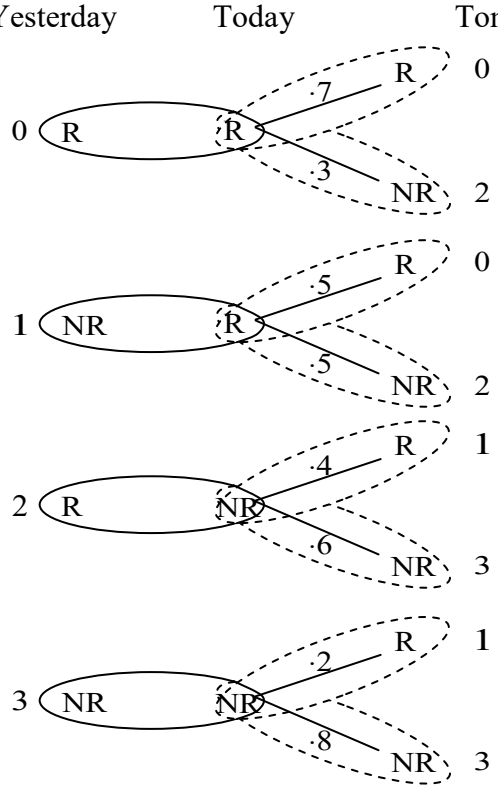

Figure (4)

Then, the preceding would represent a four –state Markov chain having a transition probability matrix

$$\mathbf{P} = \begin{bmatrix} 0.7 & 0 & 0.3 & 0 \\ 0.5 & 0 & 0.5 & 0 \\ 0 & 0.4 & 0 & 0.6 \\ 0 & 0.2 & 0 & 0.8 \end{bmatrix}.$$

2.5 Chapman-Kolmogorov Equations

We have already defined the one-step transition probabilities P_{ij}. We now define 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,

$$P_{ij}^{n} = P\left\{X_{n+k} = j \middle| X_k = i\right\}, \; n \geq 0, \; i, j \geq 0.$$

Of course, $P_{ij}^{1} = P_{ij}$. The Chapman–Kolmogorov equations provide a method for computing these n-step transition probabilities. These equations are

$$P_{ij}^{n+m} = \sum_{k=0}^{\infty} P_{ik}^{n} P_{kj}^{m} \text{ for all } n, m \geq 0, \text{ all } i, j \qquad (2)$$

and are most easily understood by noting that $P_{ik}^{n} P_{kj}^{m}$ represents the probability that starting in i, the process will go to state j in n + m transitions through a path which takes it into state k at the nth transition. Hence, summing over all intermediate states k yields the probability that the process will be in state j after n + m transitions. Formally, we have

$$\begin{aligned} P_{ij}^{n+m} &= P\left\{X_{n+m} = j \middle| X_0 = i\right\} \\ &= \sum_{k=0}^{\infty} P\left\{X_{n+m} = j, X_n = k \middle| X_0 = i\right\} \\ &= \sum_{k=0}^{\infty} P\left\{X_{n+m} = j \middle| X_n = k, X_0 = i\right\} P\left\{X_n = k \middle| X_0 = i\right\} \\ &= \sum_{k=0}^{\infty} P_{kj}^{m} P_{ik}^{n} \end{aligned}$$

If we let $P^{(n)}$ denote the matrix of n-step transition probabilities P_{ij}^{n}, then Equation (2) asserts that

$$P^{(n+m)} = P^{(n)} \cdot P^{(m)}$$

where the dot represents matrix multiplication. Hence, in particular,

$$P^{(2)} = P^{(1+1)} = P \cdot P = P^2$$

and by induction

$$P^{(n)} = P^{(n-1+1)} = P^{n-1} \cdot P = P^{n}.$$

That is, the n-step transition probability matrix may be obtained by multiplying the matrix P by itself n times.

2.6 Example

We consider (2.3) in which the weather is considered as a two- state Markov Chain .If $\alpha = 0.7$ and $\beta = 0.4$, we can find the probability that it will rain four days from today given that it is raining today. We have

$$\mathbf{P} = \begin{bmatrix} \alpha & 1-\alpha \\ \beta & 1-\beta \end{bmatrix}.$$

The one- step transition probability matrix is given by

$$\mathbf{P} = \begin{bmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix}.$$

Hence

$$\mathbf{P}^{(2)} = \mathbf{P}^2 = \begin{bmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix}\begin{bmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix} = \begin{bmatrix} 0.61 & 0.39 \\ 0.52 & 0.48 \end{bmatrix}$$

and

$$\mathbf{P}^{(4)} = \left(\mathbf{P}^2\right)^2 = \begin{bmatrix} 0.61 & 0.39 \\ 0.52 & 0.48 \end{bmatrix}\begin{bmatrix} 0.61 & 0.39 \\ 0.52 & 0.48 \end{bmatrix} = \begin{bmatrix} 0.5749 & 0.4251 \\ 0.5668 & 0.4332 \end{bmatrix}.$$

Therefore, the desired probability is $P_{00}^4 = 0.5749 \approx 58\%$.

2.7 Classification of states

State j is said to be **accessible** from state i if $P_{ij}^n > 0$ for some $n \geq 0$. Two states i and j that are accessible to each other are said to **communicate**.

Two states that communicate are said to be in the same class. The concept of communication divides the state space up into a number of separate classes.

For any state i, we let f_i denote the probability that, starting in state i, the process will ever reenter state i. State i is said to be **recurrent** if $f_i = 1$ and **transient** if $f_i < 1$.

2.8 Example

We consider the Markov chain consisting the three state 0, 1, 2 and transition probability matrix. Then, we can show that Markov chain is irreducible.

$$P = \begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \end{pmatrix}$$

$$P_{01} = \frac{1}{4} \quad \text{and} \quad P_{10} = \frac{1}{2}.$$

State 0 and state 1 are accessible to each other.

State 0 and 1 communicate.

Similarly, state 1 and 2 also communicate.

All states communicate with each other.

3.1 Limiting Probabilities

There seems to exist **a limiting probability** that the process will be in state j after a large number of transitions, and this value is independent of the initial state.

The Markov chain is said to be **irreducible** if there is only one class, that is, if all states communicate with each other.

If state i is recurrent and if, starting in state i , the expected time until the process returns to state i is finite, then it is said to be **positive recurrent**. A positive recurrent, aperiodic state is called **ergodic.**

State i is said to have period d if P_{ii}^{n} [?]=0 for all n whenever n is not divisible by d, and d is the largest integer with the property. If a state with period 1, then it is said to be **aperoidic**. A Markov chain is said to be **aperiodic** if all states are **aperiodic.**

3.2 Theorem

For an irreducible ergodic Markov chain, $\lim_{n\to\infty} P_{ij}^{n}$ exists and is independent of i. Furthermore, letting

$$\pi_j = \lim_{n\to\infty} P_{ij}^{n},\ j \geq 0,$$

then π_j is the unique nonnegative solution of

$$\pi_j = \sum_{i=0}^{\infty} \pi_i P_{ij}, \quad j \geq 0 \ ,$$

$$\sum_{j=0}^{\infty} \pi_j = 1.$$

3.3 Example

We can find the limiting probability of rain in 2.3, we have

$$\mathbf{P}= \begin{bmatrix} \alpha & 1-\alpha \\ \beta & 1-\beta \end{bmatrix}.$$

The nonnegative solutions of

$$\pi_0 = \alpha\pi_0 + \beta\pi_1 ,$$
$$\pi_1 = (1-\alpha)\pi_0 + (1-\beta)\pi_1 ,$$
$$\pi_0 + \pi_1 = 1,$$

which yields that

$$\pi_0 = \frac{\beta}{1+\beta-\alpha},\ \pi_1 = \frac{1-\alpha}{1+\beta-\alpha}.$$

For example if $\alpha = 0.7$ and $\beta = 0.4$, then the limiting probability of rain is

$$\pi_0 = \frac{4}{7} = 0.571.$$

3.4 Example

A plant with genotype RW can produce red (R), pink (P) or white (W). When two plants of this genotype are crossed, they produce the three colors according to the following matrix;

$$\begin{array}{c} \\ \text{flower of parent} \end{array} \begin{array}{c} \text{flower of offspring} \\ \begin{array}{ccc} \text{R} & \text{P} & \text{W} \end{array} \\ \begin{array}{c} \text{R} \\ \text{P} \\ \text{W} \end{array} \begin{pmatrix} 0.50 & 0.50 & 0 \\ 0.25 & 0.50 & 0.25 \\ 0 & 0.50 & 0.50 \end{pmatrix} \end{array}.$$

Flowers of this genotype are crossed for successive generations. When the process reaches a steady state, we can find the percentages of the flowers that will be red, pink, and white.

We have the transition probability matrix:

$$\mathbf{P} = \begin{array}{c} \\ \text{R} \\ \text{P} \\ \text{W} \end{array} \begin{array}{c} \begin{array}{ccc} \text{R} & \text{P} & \text{W} \end{array} \\ \begin{pmatrix} 0.50 & 0.50 & 0 \\ 0.25 & 0.50 & 0.25 \\ 0 & 0.50 & 0.50 \end{pmatrix} \end{array}.$$

From theorem 3.2, we get

$$\pi_0 = 0.50\pi_0 + 0.25\pi_1$$

$$\pi_1 = 0.50\pi_0 + 0.50\pi_1 + 0.50\pi_2$$

$$\pi_2 = 0.25\pi_1 + 0.50\pi_2$$

$$\pi_0 + \pi_1 + \pi_2 = 1 \quad (\text{or}) \quad \pi_2 = 1 - \pi_0 - \pi_1 .$$

These equations can be solved which yields

$$\pi_0 = 0.25,\ \pi_1 = 0.50,\ \pi_2 = 0.25.$$

The percentages of the flowers that will be red, pink, and white are 25%, 50%, and 25%.

3.5 Example

A country is divided into three geographic regions. It is found that each year 5% of the residents move from region I to region II and 5% move from region I to region III. In region II, 15% move to region I, and 10% move to region III. In region III, 10% move to region I, and 5% move to region II. We can find the steady- state population distribution.

We have the transition probability matrix

$$\mathbf{P} = \begin{pmatrix} 0.90 & 0.05 & 0.05 \\ 0.15 & 0.75 & 0.10 \\ 0.10 & 0.05 & 0.85 \end{pmatrix}.$$

From Theorem 3.2, we get

$$\pi_0 = 0.90\pi_0 + 0.15\pi_1 + 0.10\pi_2,$$

$$\pi_1 = 0.05\pi_0 + 0.75\pi_1 + 0.05\pi_2,$$

$$\pi_2 = 0.05\pi_0 + 0.10\pi_1 + 0.85\pi_2,$$

$$\pi_0 + \pi_1 + \pi_2 = 1 \quad (\text{or}) \quad \pi_2 = 1 - \pi_0 - \pi_1.$$

These equations can be solved which yields

$$\pi_0 = \frac{13}{24},\ \pi_1 = \frac{1}{6},\ \pi_2 = \frac{7}{24}.$$

The population distribution of region I $\simeq 54.17\%$

The population distribution of region II $\simeq 16.67\%$

The population distribution of region III $\simeq 29.17\%$.

Conclusion

Modern probability theory studies chance process for which the knowledge of previous outcomes influences predictions for future experiments. In principle, when we observe a sequence of chance experiments, all of the past outcomes could influence our predictions for the next experiment.

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Analysis of some Anthropometric Characteristics among Students in Monywa and Chaung U Environs

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Kay Thi Khin[4], Bawm Htang[5]

Abstract

A total sample of 433 students including 220 boys and 213 girls aged five to eleven years from Monywa and Chaung U environs were taken measurements of the body height and weight to analyse the three anthropometric parameters with respect to the body height, body weight and Body Mass Index (BMI) during the study period of October, 2016 to February, 2017. Measurements were taken by using the centrimetric measuring tape for height and the Mechanical Personal Scale (Model: BR 3010) for weight. The BMI was calculated using the National Heart, Lung and Blood Institute's BMI calculator available from the website http://www.nhlbi.nih.gov and then the students were classified as underweight, healthy weight, overweight or obese according to the CDC (Centers for Disease Control and Prevention) system. There were numerically higher mean values of three anthropometric parameters for the girls in comparison to the boys in Monywa environs and for the boys in comparison to the girls in Chaung U environs. The healthy weight was most prevalent among the total number of 433 students in two environs. The differences between the anthropometric measurements of the boys and girls as well as of the students in two environs were analysed using the t-test at the 0.05 level of significance.

Key words: Anthropometric parameters, body height, body weight, Body Mass Index (BMI), students, Monywa, Chaung U.

Introduction

Anthropometry is the measurement and analysis of body characteristics, including stature, sizes of body parts and the space in which the body functions (Steinfeld *et al*., 2002).

Children are the wealth of any country. Special attention should be paid to meet the needs of this group. The physical growth of children is reflected by different anthropometric measurements especially weight and height (Bharati *et al*., 2005). Body height is primarily the best and most stable indicator of growth and development. Body weight as an indicator represents a mixture of various kinds of tissue and thus varies during growth and development (Durašković *et al*., 2009).

Body Mass Index (BMI) is one of the most commonly used ways of estimating whether a person is overweight and more likely to experience health problems than someone with a healthy weight. BMI is a summary measure of an individual's height and weight (National Obesity Observatory, 2009). The use of BMI is a widely accepted and affordable method to infer body composition in children and adults (Gonzalez-Casanova *et al*., 2013).

There is a worldwide consensus that the concept of growth assessment is a usable measure for defining the health and nutritional status of a child. Child growth data are an

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important indicator of general health and well-being. The stunting, under-nutrition and thinness are recognised as the largest contributors to diseases in a population. The childhood stunting, defined as low height-for-age and thinness, defined as low Body Mass Index (BMI)-for-age, are associated with long-term negative cognitive and physical consequences. Suboptimal conditions for children are reported from many countries, mainly in Africa and Southeast Asia. Despite rich natural resources, Myanmar is one of the poorest countries in the world in terms of its health situation (Prenkert and Ehnfors, 2016).

The physical dimensions of the body are much influenced by nutrition in growing period of school age. Poor health and nutritional status will affect work capacity as well as cognitive functions. This age group is a dynamic period of growth and development as children undergo physical, mental, emotional and social changes (Bharati *et al*., 2005).

There is a need to focus on the Body Mass Index (BMI) measurement programs in schools since the BMI measurement programs identify the percentage of students who are potentially at risk for weight-related health programs. Thus, the present study was conducted with the specific objectives to analyse the three anthropometric parameters of the students in two environs, to classify the students according to the Body Mass Index (BMI) classification system of CDC (Centers for Disease Control and Prevention) and to analyse the statistically significant difference between the anthropometric parameters of students in two environs.

Materials and Methods

Study Sites and Study Period

The sampling sites are the Basic Education Post Primary Schools of Ywa Htaung, Monywa environs (22˚ 6' 30.80" N and 95˚ 8' 9" E) and Ma Hti Thar, Chaung U environs (22˚ 9' 15.7" N and 95˚ 59' 39.1" E) (Plate 1 and 2). The sample numbered a total of 433 students aged five to eleven years including 243 students (129 boys and 114 girls) from Monywa environs and 190 students (91 boys and 99 girls) from Chaung U environs. The present study was carried out from October 2016 to February 2017.

Study Design

Data collection was based on the date of birth, sex, height and weight measurements. To determine the mean value ± standard deviation for height and weight measurements, samples were grouped according to the age. Measurements were taken by using the centrimetric measuring tape for height and the Mechanical Personal Scale (Model: BR 3010) for weight and recorded by the metric scale. Body Mass Index (BMI) was calculated using the National Heart, Lung and Blood Institute's BMI calculator available from the website http://www.nhlbi.nih.gov and recorded for each sample group. BMI was calculated using the formula: weight (kg) / [height (m) x height (m)] for all samples, who then were classified as underweight, healthy weight, overweight, or obese according to the CDC (Centers for Disease Control and Prevention) cut-off points based on the charts of Body Mass Index-for-age percentiles available from the website http://www.cdc.gov/ growthcharts. The CDC system defines underweight as a BMI less than the 5^{th} percentile of the reference population, healthy weight as a BMI the 5^{th} percentile to the 84^{th} percentile, overweight as a BMI the 85^{th} percentile to the 94^{th} percentile, and obesity as a BMI the 95^{th} percentile to above the 95^{th} percentile.

Statistical Analysis

The differences between the anthropometric measurements of the boys and girls as well as of the students in two environs were analysed using the t-test at the 0.05 level of significance.

(Source: Google earth, 2016)

Plate 1. Location map of the sampling site (Monywa environs)

(Source: Google earth, 2016)

Plate 2. Location map of the sampling site (Chaung U environs)

Results

The parameters for three anthropometric characteristics were analysed for 243 students in Monywa environs and 190 students in Chaung U environs (Table 1).

Table 1. Descriptive parameters for three anthropometric characteristics of the students in two environs

Anthropometric characteristics	Monywa environs		Chaung U environs	
	Number	Mean	Number	Mean
Body height (m)	B-129	1.22 ± 0.10	B-91	1.27 ± 0.12
	G-114	1.25 ± 0.11	G-99	1.23 ± 0.13
Body weight (kg)	B-129	21.26 ± 5.17	B-91	23.75 ± 5.61
	G-114	23.12 ± 6.76	G-99	22.78 ± 6.70
BMI (kg/m^2)	B-129	13.95 ± 1.37	B-91	14.70 ± 1.11
	G-114	14.58 ± 2.01	G-99	14.60 ± 1.87

B = Boys; G = Girls

According to the results for three anthropometric characteristics of the students in Monywa environs, the mean body height of boys was 1.22 ± 0.10 m and that of girls was 1.25 ± 0.11 m. The girls on average had numerically higher values for body height, a total of 0.03 m compared to the boys. The mean values for body weight were 21.26 ± 5.17 kg for the boys and 23.12 ± 6.76 kg for the girls. There was numerically higher value (1.86 kg) of body weight for the girls in comparison to the boys. The mean values for Body Mass Index (BMI) were 13.95 ± 1.37 kg/m^2 for the boys and 14.58 ± 2.01 kg/m^2 for the girls. The mean BMI value for the girls was numerically higher (0.63 kg/m^2) than for the boys (Table 1).

According to the results for three anthropometric characteristics of the students in Chaung U environs, the mean body height of boys was 1.27 ± 0.12 m and that of girls was 1.23 ± 0.13 m. The boys on average had numerically higher values for body height, a total of 0.04 m compared to the girls. The mean values for body weight were 23.75 ± 5.61 kg for the boys and 22.78 ± 6.70 kg for the girls. There was numerically higher value (0.97 kg) of body weight for the boys in comparison to the girls. The mean values for Body Mass Index (BMI) were 14.70 ± 1.11 kg/m^2 for the boys and 14.60 ± 1.87 kg/m^2 for the girls. The mean BMI value for the boys was numerically higher (0.10 kg/m^2) than for the girls (Table 1). Thus there were numerically higher mean values of three anthropometric parameters for the girls in comparison to the boys in Monywa environs and for the boys in comparison to the girls in Chaung U environs.

The results for three anthropometric characteristics of the students in two environs revealed that the mean values of three anthropometric parameters for the boys were observed as Chaung U environs > Monywa environs. The same result was also found in the mean BMI values for the girls. However, the mean values of body height and weight for the girls were observed as Monywa environs > Chaung U environs (Table 1).

The students were classified as healthy weight, underweight, overweight or obese according to the CDC (Centers for Disease Control and Prevention) cut-off points (Table 2).

Table 2. Prevalence of BMI classified groups among the students in two environs

BMI classified groups	Monywa environs			Chaung U environs		
	Boys	Girls	Total	Boys	Girls	Total
Healthy weight	64 (49.61%)	71 (62.28%)	135 (55.56%)	65 (71.43%)	65 (65.66%)	130 (68.42%)
Underweight	65 (50.39%)	41 (35.96%)	106 (43.62%)	25 (27.47%)	33 (33.33%)	58 (30.53%)
Overweight	-	1 (0.88%)	1 (0.41%)	1 (1.10%)	-	1 (0.52%)
Obese	-	1 (0.88%)	1 (0.41%)	-	1 (1.10%)	1 (0.52%)
Total	**129**	**114**	**243**	**91**	**99**	**190**

Based on the results presented in Table 2, it was recorded that the pattern of prevalence for the boys in Monywa environs was 65 individuals or 50.39% BMI in the underweight > 64 individuals or 49.61% BMI in the healthy weight > zero BMI in the overweight or obese. The pattern of prevalence for the girls in Monywa environs was 71 individuals or 62.28% BMI in the healthy weight > 41 individuals or 35.96% BMI in the

underweight > 1 individual or 0.88% BMI in the overweight or obese. Thus the BMI in the healthy weight was more prevalence in the girls than in the boys with respect to Monywa environs.

As regards Chaung U environs, the pattern of prevalence for the boys was 65 individuals or 71.43% BMI in the healthy weight > 25 individuals or 27.47% BMI in the underweight > 1 individual or 1.10% BMI in the overweight > zero BMI in the obese. The pattern of prevalence for the girls was 65 individuals or 65.66% BMI in the healthy weight > 33 individuals or 33.33% BMI in the underweight > 1 individual or 1.01% BMI in the obese > zero BMI in the overweight (Table 2). Thus the BMI in the healthy weight was considerably higher prevalence in the boys than in the girls with respect to Chaung U environs.

Among the total number of 243 students in Monywa environs, the healthy weight was most prevalent with 135 individuals or 55.56% followed by 106 individuals or 43.62% BMI in the underweight and only a single individual or 0.41% BMI in the overweight or obese. Among the total number of 190 students in Chaung U environs, the healthy weight was most prevalent with 130 individuals or 68.42% followed by 58 individuals or 30.53% BMI in the underweight and only a single individual or 0.52% BMI in the overweight or obese (Table 2). Thus the healthy weight was most prevalent among the total number of 433 students in two environs.

The process of determining the differences between the anthropometric measurements of the boys and girls as well as of the students in two environs was analysed using the t-test at the 0.05 level of significance (Table 3 and 4).

Table 3. Statistical analysis for the anthropometric parameters of the boys and girls

Anthropometric characteristics	Monywa environs			Chaung U environs		
	Boys	Girls	t-value	Boys	Girls	t-value
Body height (m)	1.22 ± 0.10	1.25 ± 0.11	2.22	1.27 ± 0.12	1.23 ± 0.13	2.20
Body weight (kg)	21.26 ± 5.17	23.12 ± 6.76	2.42	23.75 ± 5.61	22.78 ± 6.70	7.41
BMI (kg/m^2)	13.95 ± 1.37	14.58 ± 2.01	2.88	14.70 ± 1.11	14.60 ± 1.87	0.44

Critical value at 0.05 level = 1.96

According to Table 3, there were statistically significant differences ($p < 0.05$) in the anthropometric measurements between boys and girls from Monywa environs as well as from Chaung U environs though no statistically significant difference ($p > 0.05$) in the mean BMI values was observed between boys and girls in Chaung U environs.

Table 4. Statistical analysis for the anthropometric parameters of the students in two environs

Anthropometric characteristics	Boys			Girls		
	Monywa	Chaung U	t-value	Monywa	Chaung U	t-value
Body height (m)	1.22 ± 0.10	1.27 ± 0.12	3.36	1.25 ± 0.11	1.23 ± 0.13	1.22
Body weight (kg)	21.26 ± 5.17	23.75 ± 5.61	3.39	23.12 ± 6.76	22.78 ± 6.70	0.37
BMI (kg/m^2)	13.95 ± 1.37	14.70 ± 1.11	4.31	14.58 ± 2.01	14.60 ± 1.87	0.08

Critical value at 0.05 level = 1.96

According to Table 4, the differences of anthropometric measurements between the boys in two environs were statistically significant ($p < 0.05$). In regard to the girls in two environs, no statistically significant difference ($p > 0.05$) was observed for any of the anthropometric measurements.

Discussion

The two anthropometric measurements with respect to the body height and body weight of 220 boys and 213 girls showed that in Monywa environs, the girls on average had numerically higher values for the body height (1.25 m > 1.22 m) and body weight (23.12 kg > 21.26 kg) than the boys. In Chaung U environs, the boys on average had numerically higher values for the body height (1.27 m > 1.23 m) and body weight (23.75 kg > 22.78 kg) than the girls. Bharati *et al*. (2005) reported the mean anthropometric measurements of the school age children from Raichur region, Karnataka and concluded that the boys showed higher measurements (127.07 cm > 124.67 cm and 23.00 kg > 21.53 kg) than the girls. Graf *et al.* (2004) also recorded the anthropometric data of children from the primary schools in the region of Cologne and concluded that the boys showed significantly better results (123.51 cm > 121.93 cm and 25.14 kg > 23.80 kg) than the girls. It was found that the gender differences with regard to the body height and weight may be attributed to the dietary pattern.

The results of present study indicated that in Monywa environs, the girls had a higher mean BMI than the boys and in Chaung U environs, the boys had a higher mean BMI than the girls. This gender difference in the mean BMI was according to the gender differences with respect to the mean body height and body weight indicating higher values for the girls in comparison to the boys in Monywa environs and for the boys in comparison to the girls in Chaung U environs. Mikolajczyk *et al*. (2010) also found that the gender difference in the mean BMI was according to the gender differences in respect to the mean values of body height and body weight revealing higher values in the boys than in the girls.

Bharati *et al*. (2005) assessed the nutritional status of the school age children from Raichur region, Karnataka using the anthropometric measurements. They stated that 55% of these children had a BMI in the normal weight and the higher percentage (29.46%) of boys were normal than the girls (24.82%). Gonzalez-Casanova *et al*. (2013) evaluated the overweight and obesity in the children in Columbia and stated that 89.2% of the boys and 86.2% of the girls had a BMI in the normal weight, being more prevalence in the boys than in the girls. Mikolajczyk *et al*. (2010) compared the relationship between perceived body weight and BMI based on the self-reported height and weight in the student populations across different European countries and reported a normal BMI (72-84% of boys and 65-83% of girls), being more prevalence in the boys than in the girls. In the present study, 55.56% of the students in Monywa environs had a BMI in the healthy weight and there was more prevalence in the girls (62.28% of the girls) than in the boys (49.61% of the boys). In Chaung U environs, 68.42% of the students had a BMI in the healthy weight and there was considerably higher prevalence in the boys (71.43% of the boys) than in the girls (65.66% of the girls). It was found that the BMI in the normal or healthy weight was not according to the sex, reflecting the gender discrimination in providing the nutrition in terms of food.

The process of determining the inter-group differences in terms of anthropometric measurements was analysed with the help of the t-test and the results indicated that the differences recorded for any of the anthropometric parameters between boys and girls in individual environs were statistically significant, the only exception being the mean BMI values between boys and girls in Chaung U environs, that had no statistically significant difference. Durašković *et al*. (2009) reported that there were no statistical significant

differences for the body height, body weight and BMI between the boys and girls in the city of Niš. Prenkert and Ehnfors (2016) assessed the growth data (height-for-age, weight-for-age and BMI-for-age) of children living in poor socioeconomic conditions in rural areas of Chin State, Myanmar and also described that there were no statistical differences between boys and girls in the three variables studied except for girls' height in one subgroup. Nevertheless, Graf *et al*. (2004) used a sample of 341 boys and 327 girls and determined statistically significant inter-group differences for the body height, body weight and BMI. A possible explanation for these results may be due to the more homogeneous or heterogeneous groups which showed greater or lesser differences.

The present findings revealed that there was a statistically significant difference in three anthropometric measurements between the boys in two environs and no statistically significant difference in three anthropometric measurements between the girls in two environs. Prenkert and Ehnfors (2016) explored the growth data of underprivileged and ordinary children including 322 boys and 317 girls living in rural areas of Chin State, Myanmar and compared the underprivileged children with the ordinary ones. Their results showed no statistically significant difference for any of the growth data (height, weight and BMI) between underprivileged and ordinary boys as well as girls.

Conclusion

The present findings showed the numerically higher mean values of three anthropometric parameters for the girls in comparison to the boys in Monywa environs and for the boys in comparison to the girls in Chaung U environs. The healthy weight was most prevalent among the total number of 433 students in two environs. The differences recorded for any of the anthropometric parameters between boys and girls in individual environs were statistically significant, the only exception being the mean BMI values between boys and girls in Chaung U environs, indicating no statistically significant difference. There was a statistically significant difference in three anthropometric measurements between the boys in two environs and no statistically significant difference in those between the girls in two environs.

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Occurrence and Abundance of some Fish Species from Khu-Lei Inn, Singu Township, Mandalay Region

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Abstract

The occurrence and abundance of fishes in Khu-Lei Inn, Singu Township, Mandalay Region was conducted during November 2018 to August 2019. A total number of 30 fish species confined to 23 genera, 15 families under eight orders and 151182 individuals were collected in the study area. It was indicated that the percent species composition of order Cypriniformes were predominate in the highest with 12 species (40%), followed by Perciformes with seven species (23.33%), Siluriformes with five species (16.67%) and Synbranchiformes with two species (6.68%) from the study area. The remaining four orders with only a single species and the species composition was (3.33% each) in the study period. In this work, the highest species richness (30) was found in November, 2018 while the lowest (18) in April, 2019. The highest total numbers of *Pseudambassis ranga* (26124 individuals) whereas the lowest number of *Leiodon cutcutia* (146 individuals) was recorded in the study area. Based on the relative abundance, 13 fish species were recorded uncommon, eight species as common and nine species as very common during the study period.

Key words: Occurrence, abundance, fish species, Khu-Lei Inn

Introduction

Fishes constitute almost half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats; 21,723 living species of fish have been recorded out of 39,900 species of vertebrates. Of these, 8411 are freshwater species and 11,650 are marine (Jayaram, 1999).

Fishes are one important group of vertebrates which influences the life of human in various ways. Fishes provide several by-products such as fish meal, fish glue, fish oil, and fish diet provides proteins, fats and vitamins A and D. Fish diets provide rich source of protein in the form of simple proteins with different essential amino acids and fats. They have good taste and are easily digestible and growth promoting value (Shaikh *et al*., 2010).

Fish is crucial in Myanmar people while it is certainly recognized that fish is second only to rice in the diet of Myanmar. They have been a staple item in the diet of many people. Fisheries provide much of the human diet in many parts of the world (DoF, 2007).

The fishery sectors are of major important to Myanmar. Since most of the protein in the diet of the population comes from fish. It is also the fifth largest earner of foreign currency for the country (Win Aung, 1995).

The Khu-Lei Inn is one of the seasonal flooded 'Inn' of Ayeyarwady River. This 'Inn' is directly connected with the Ayeyarwady River. The water from Ayeyarwady River enters into the 'Inn' along with different fishes during the rainy season. Thus, Khu-Lei Inn was chosen as the study site to conduct the present research work with the following objectives:

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- to identify and record the fish species from Khu-Lei Inn
- to investigate the occurrence and abundance of fish species from Khu-Lei Inn

Materials and Methods

Study site

The Khu-Lei Inn is situated near the Khu-Lei village, in Singu Township, Mandalay Region. It is located 16 miles east of Shwebo Township. It is east of Ayeyarwaddy River. Khu-Lei Inn is 8.80 km away from Singu Township. The Khu-Lei Inn lies between Latitude 22° 15' 55" and 22° 16' 30" North and between Longitude 95° 31' 12" and 95° 31' 18" East. The location map of study area is shown in Fig. 1.

Study period

The present study was carried out from November 2018 to August 2019.

Collection of fish specimens

Collection of the specimens was conducted first and third weeks of every monthly throughout the study period. The external characters and measurements were noted down in fresh forms. Photographs were taken immediately to record the natural colour and features of fishes. At least five specimens for each species were collected and preserved in 10% formalin for future references. The local names were recorded.

Identification of fish specimens

Identification of fish were made with references to Lagler (1977), Day (1889), Talwar and Jhingran (1991), Ferraris (1998) and Jayaram (2013).

Data analysis

The average relative abundance was calculated using the formula as given by Bisht *et al.* (2004). Different species encountered monthly were recorded and total number of individuals of each species was also counted, to assess the relative abundance.

$$\text{Relative abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of individuals of all the species in a particular site}}$$

The Average Relative Abundance

The average relative abundances were analyzed 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

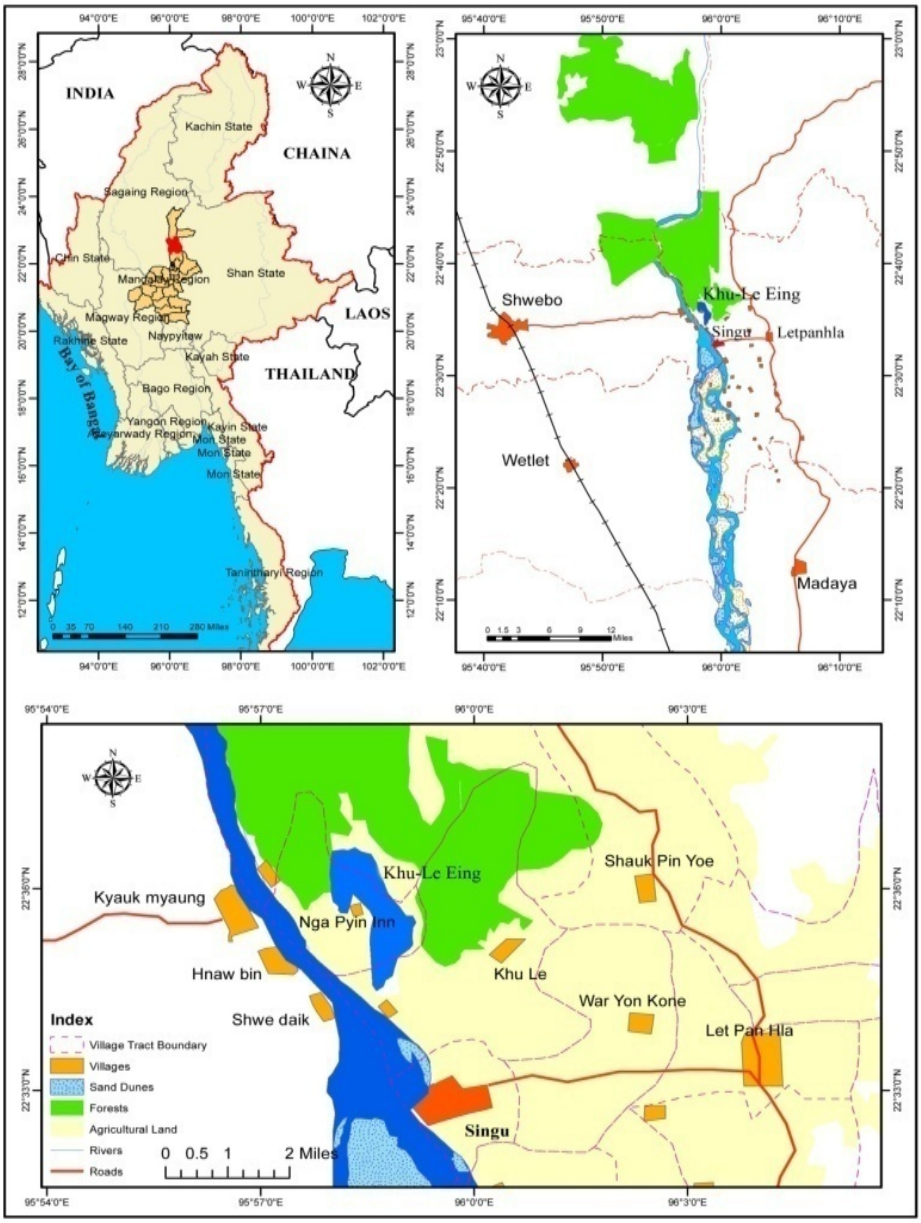


Fig. 1 Location map of Khu-Lei Inn, Singu Township, Mandalay Region

(Source: Department of Geography, Shwebo University)

Results

Species composition recorded in the study area

A total number of 151182 fishes representing 30 fish species distributed among 23 genera, 15 families and eight orders were recorded (Table 1). The eight orders were Osteoglossiformes, Clupeiformes, Cypriniformes, Siluriformes, Cyprinodontiformes, Synbranchiformes, Perciformes and Tetraodontiformes. The most dominant order Cypriniformes was confined to two families, eight genera and 12 species. The second dominant order Perciformes was confined to six families, six genera and seven species; Siluriformes was confined to two families, three genera and five species while Synbranchiformes was a single family, two genera and two species. The remaining orders were represented a single family, genus and species each (Table 2).

Based on the monthly data, the percentage species composition of recorded fish species was found to be the highest 40% under the order Cypriniformes, followed by 23.33% in Perciformes, 16.67% in Siluriformes, 6.68% in Synbranchiformes. The remaining orders of Osteoglossiformes, Clupeiformes, Cyprinodontiformes and Tetraodontiformes (3.33% each) were found to be less dominant groups (Table 2).

Monthly occurrence and abundance of fish species

A total number of 151182 fishes representing 30 species confined to 23 genera, 15 families and eight orders were identified and recorded from Khu-Lei Inn during the study period (Table 3).

According to monthly total catch data, the highest total number of 30 fish species and 34656 individuals were recorded in November, 2018 while the lowest numbers of 18 fish species and 3544 individuals were recorded in April, 2019 during the study period (Table 3).

Among the respective species recorded, the highest total number of individuals was *Pseudambassis ranga* (26124 individuals) whereas the lowest total number of *Leiodon cutcutia* was collected rather very low, amounting to only 146 individuals (Table 3).

According to their relative abundance of each species, 13 species out of the 30 species were found to be uncommon (uC), 8 species as common (C) and 9 species as very common (vC) based on their relative abundance during the study period (Table 3).

During the present study, the fish species with a number of more than 3000 individuals were regarded as predominant species from Khu-Lei Inn. These fish species are *Notopterus notopterus*, *Gudusia variegata*, *Labeo boga*, *Osteobrama belangeri*, *Osteobrama cunma*, *Puntius chola*, *Salmostoma sardinella*, *Amblypharyngodon atkinsonii*, *Mystus cavasius*, *Mystus pulcher*, *Wallago attu*, *Pseudambassis ranga*, *Glossogobius giuris*, *Colisa fasciatus* and *Oreochromis* sp. (Table 3).

Table 1. List of fish species collected from Khu-Lei Inn, Singu Township during November 2018 to August 2019

No	Order	Family	Scientific Name	Common Name	Local Name
1	Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Grey featherback	Nga-phe
2	Clupeiformes	Clupeidae	*Gudusia variegata*	Burmese rivershad	Nga-la-bi-bay-gya
3	Cypriniformes	Cyprinidae	*Labeo angra*	Angralabeo	Nga-loo-myi-kyut
			Labeo boga	Bogalabeo	Nga-loo-phyu
			Labeo calbasu	Kalbasu, black rohu	Nga-net-pya
			Labeo rohita	Rohu	Nga-gyin-myat-san-nee
			Osteobrama belangeri	Manipur osteobrama	Nga-phan-ma, Nga-phe-aung
			Osteobrama cunma	Cunmaosteobrama	Nga-lay-daung
			Puntius chola	Swamp barb	Nga-khone-ma-myi-ni
			Salmostoma sardinella	Sardinellarazorbelly minnow	Yin-baung-zar
			Amblypharyngodon atkinsonii	Burmese carplet	Nga-pyet
			Raiamas guttatus	Burmese trout	Nga-la-war
		Cobitidae	*Lepidocephalus thermalis*	Loach	Nga-tha-le-doe
			Botia histrionica	Burmese loach	Nga-shwe-yae
4	Siluriformes	Bagridae	*Mystus cavasius*	Gangeticmystus	Nga-zin-yaing-phyu
			Mystus menoda	Menoda catfish	Nga-ngik, Nga-aik
			Mystus pulcher	Pulchermystus	Nga-zin-yaing-kyet-chee
		Siluridae	*Ompok bimaculatus*	Indian butter catfish	Nga-nu-than
			Wallago attu	Boal freshwater shark	Nga-but
5	Cyprinodontiformes	Belonidae	*Xenentodon cancila*	Freshwater garfish	Nga-phaung-yoe
6	Synbranchiformes	Mastacembelidae	*Macrognathus aral*	One-stripe-spinyeel	Nga-mway-ni
			Mastacembelus armatus	Spinyeel	Nga-mway-nagar
7	Perciformes	Ambassidae	*Pseudambassis ranga*	Indian glassy fish	Nga-zin-sat
		Gobiidae	*Glossogobius giuris*	Tankgoby	Nainglon-nga or Nga-lone
		Anabantidae	*Anabas testudineus*	Climbing perch	Nga-pyay-ma
		Belontiidae	*Colisa fasciatus*	Stripled Gourami	Nga-phin-tha-let
		Cichilidae	*Oreochromis* sp.	Nile tilapia	Ta-la-bi-ya
		Channidae	*Channa striata*	Striped snakehead	Nga-yant-auk
			Channa orientalis	Asiatic snakehead	Nga-yant-gaung-doh
8	Tetraodontiformes	Tetraodontidae	*Leiodon cutcutia*	Ocellatedpufferfish	Nga-pu-si, Nga-pu-tin

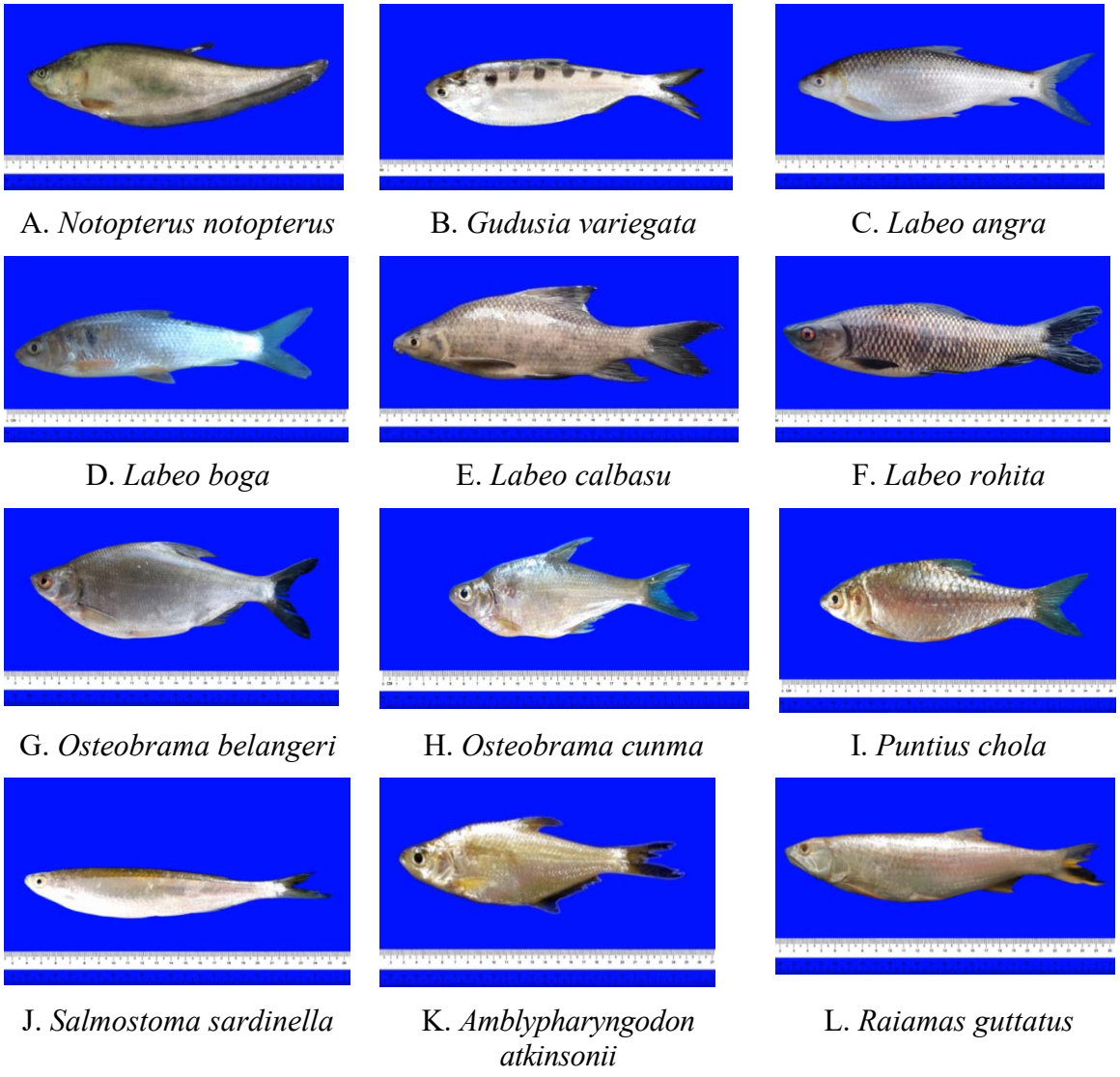
Table 2. Percent species composition of fish species in different orders from Khu-Lei Inn, Singu Township during November 2018 to August 2019

Sr. No	Order	Number of family	Number of genus	Number of species	Percent (%) species composition
1	Osteoglossiformes	1	1	1	3.33
2	Clupeiformes	1	1	1	3.33
3	Cypriniformes	2	8	12	40
4	Siluriformes	2	3	5	16.67
5	Cyprinodontiformes	1	1	1	3.33
6	Synbranchiformes	1	2	2	6.68
7	Perciformes	6	6	7	23.33
8	Tetraodontiformes	1	1	1	3.33
	Total	15	23	30	100

Table 3. Monthly occurrence and abundance of fish species in Khu-Lei Inn, Singu Township during November 2018 to August 2019

Sr. No.	Species	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total	Relative abundance	Average relative abundance
1	*Notopterus notopterus*	422	456	578	312	241	152	185	233	302	421	3302	0.02184	C
2	*Gudusia variegata*	2531	2123	1103	1115	512	36	140	52	1230	2203	11045	0.07306	vC
3	*Labeo angra*	46	39	-	-	-	35	-	72	102	-	294	0.00194	uC
4	*Labeo boga*	2523	1870	1321	523	211	-	89	-	74	2145	8756	0.05792	vC
5	*Labeo calbasu*	236	125	198	56	37	25	-	41	35	307	1060	0.00701	uC
6	*Labeo rohita*	523	452	214	257	153	42	90	29	117	412	2289	0.01514	C
7	*Osteobrama belangeri*	2120	1998	1677	1243	566	68	78	125	227	1168	9270	0.06132	vC
8	*Osteobrama cunma*	1869	1776	712	355	263	86	144	35	-	488	5728	0.03789	C
9	*Puntius chola*	1863	1545	1523	1324	1504	788	1053	526	1133	1067	12326	0.08153	vC
10	*Salmostoma sardinella*	3758	3210	1145	506	145	-	97	-	1886	2546	13293	0.08793	vC
11	*Amblypharyngodon atkinsonii*	1752	1826	1536	1126	548	715	1096	214	1485	1826	12124	0.08019	vC
12	*Raiamas guttatus*	75	43	41	-	-	-	-	-	12	-	171	0.00113	uC
13	*Lepidocephalus thermalis*	722	212	236	206	-	-	387	299	211	587	2860	0.01892	C
14	*Botia histrionica*	55	33	-	22	14	9	-	15	-	48	196	0.00130	uC
15	*Mystus cavasius*	622	788	567	412	199	214	957	-	413	450	4622	0.03057	C
16	*Mystus menoda*	145	-	45	-	-	-	36	-	28	34	288	0.00190	uC
17	*Mystus pulcher*	785	963	753	452	315	223	965	-	785	467	5708	0.03776	C
18	*Ompok bimaculatus*	324	274	223	178	157	36	56	-	72	114	1434	0.00949	uC
19	*Wallago attu*	1532	1247	358	245	112	57	89	38	30	89	3797	0.02512	C
20	*Xenentodon cancila*	113	108	119	173	199	95	171	-	-	188	1166	0.00771	uC
21	*Macrognathus aral*	85	90	68	105	-	-	-	-	77	56	481	0.00318	uC
22	*Mastacembelus armatus*	52	49	56	47	38	-	-	-	52	55	349	0.00231	uC
23	*Pseudambassis ranga*	6596	4846	3872	2549	2536	1057	1458	1437	926	847	26124	0.17280	vC
24	*Glossogobius giuris*	856	325	423	221	142	245	133	466	395	458	3664	0.02424	C
25	*Anabas testudineus*	201	153	115	108	45	37	-	85	57	90	891	0.00589	uC
26	*Colisa fasciatus*	2634	2145	1753	742	-	55	-	423	296	1143	9191	0.06079	vC
27	*Oreochromis* sp.	1563	1214	1786	1087	236	202	181	310	579	1526	8684	0.05744	vC
28	*Channa striata*	537	321	189	117	45	-	-	56	87	77	1429	0.00945	uC
29	*Channa orientalis*	79	56	75	69	57	-	-	78	43	37	494	0.00327	uC
30	*Leiodon cutcutia*	37	22	37	-	27	-	-	23	-	-	146	0.00097	uC
	Total number of individuals	34656	28309	20723	13550	8302	3544	5125	7470	10654	18849	151182		
	Total number of species	30	29	28	26	24	18	19	22	25	27			

uC = Uncommon (13 species) C = Common (8 species) vC = Very common (9 species)



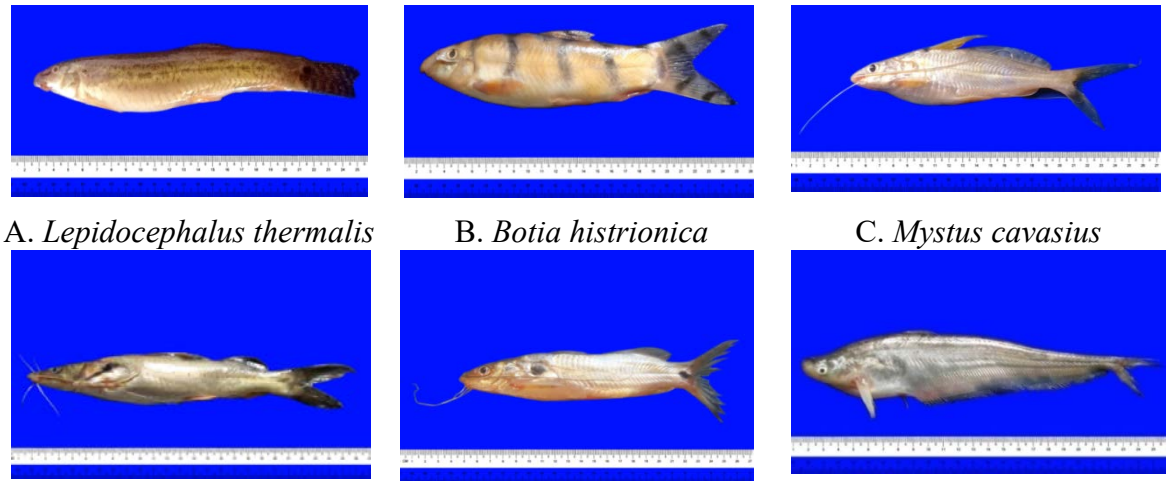
A. *Notopterus notopterus* B. *Gudusia variegata* C. *Labeo angra*

D. *Labeo boga* E. *Labeo calbasu* F. *Labeo rohita*

G. *Osteobrama belangeri* H. *Osteobrama cunma* I. *Puntius chola*

J. *Salmostoma sardinella* K. *Amblypharyngodon atkinsonii* L. *Raiamas guttatus*

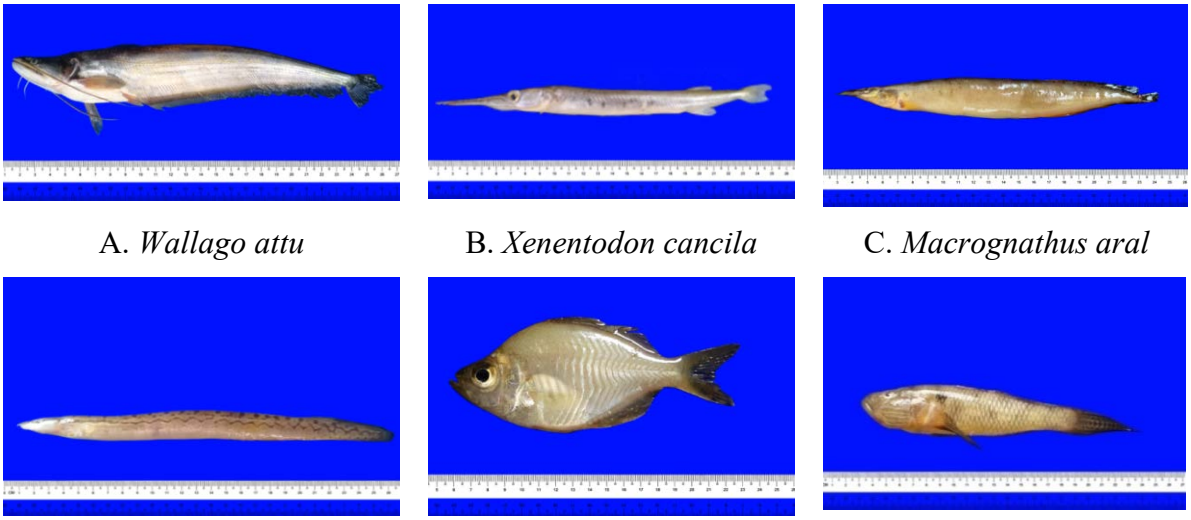
Plate 1. Fish species recorded under Order Osteoglossiformes, Clupeiformes and Cypriniformes



A. *Lepidocephalus thermalis* B. *Botia histrionica* C. *Mystus cavasius*

D. *Mystus menoda* E. *Mystus pulcher* F. *Ompok bimaculatus*

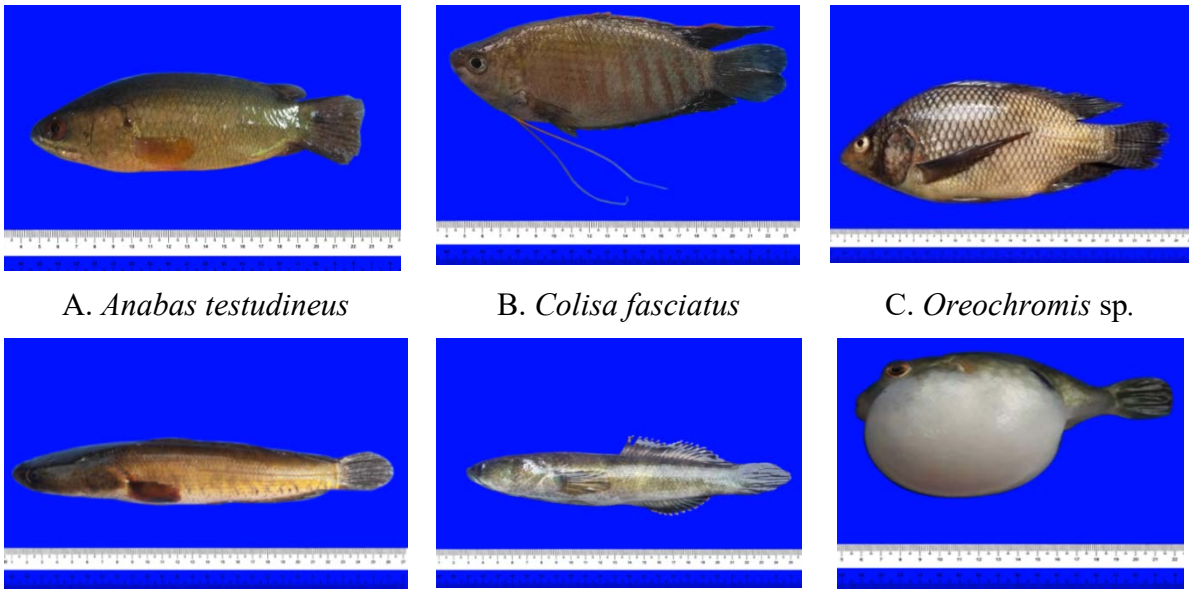
Plate 2. Fish species recorded under Order Cypriniformes and Siluriformes



A. *Wallago attu* B. *Xenentodon cancila* C. *Macrognathus aral*

D. *Mastacembelus armatus* E. *Pseudambassis ranga* F. *Glossogobius giuris*

Plate 3. Fish species recorded under Order Siluriformes, Cyprinodontiformes, Synbranchiformes and Perciformes



A. *Anabas testudineus* B. *Colisa fasciatus* C. *Oreochromis* sp.

D. *Channa striata* E. *Channa orientalis* F. *Leiodon cutcutia*

Plate 4. Fish species recorded under Order Perciformes and Tetraodontiformes

Discussion

In the present study, a total of 30 fish species belonging to 23 genera and 15 families under eight orders representing 151182 individuals were recorded from Khu-Lei Inn.

During the study period, the highest 12 species under the order Cypriniformes, followed by seven species in Perciformes, five species in Siluriformes and two species in Synbranchiformes, in the remaining four orders, Osteoglossiformes, Clupeiformes, Cyprinodontiformes and Tetraodontiformes were represented by only one species each. Therefore it appeared that Khu-Lei 'Inn' is rich in cyprinid, percid and silurid fishes and it is assumed natural, since these orders constitute a large number of species.

In the present work, among the eight orders included, the most dominant order is Cypriniformes. This finding is supported by Pyone Pyone Hla (2009) and Htay Htay Sein (2010), who reported that order Cypriniformes is the most dominant order group in their studies. Because of Cypriniformes is dominant group in inland fisheries.

Dua and Parkash (2009) reported that the species composition of order Cypriniformes was higher than those of remaining orders of the freshwater fishes group. The present study agrees with the findings of above mentioned authors.

When comparison was made with the previous local workers who conducted their studies in a particular area, Pyone Pyone Hla (2009) reported 30 species of fishes confined to 25 genera and distributed among 15 families and seven orders in Kyee Inn, Madaya Township. Out of which, 25species of fish are the same in the present study.

Htay Htay Sein (2010) studied that the diversity of fishes in Lay-Ein-Su-Let-Kya Inn, Myingyan Township. She reported 43 fish species belonging to 30 genera, 18 families and seven orders. Among her reported fish species, 30 species were the same in the present study.

Pyone Pyone Hla (2009) stated that *Notopterus notopterus*, *Labeo rohita, Osteobrama belangeri, Ompok bimaculatus, Wallago attu* and *Oreochromis* sp. were commercial fishes in her study area. During the study period, *Notopterus notopterus*, *Labeo rohita*, *Osteobrama belangeri*, *Ompok bimaculatus*, *Wallago attu* and *Oreochromis* sp., were of great value in the local market as nutrition food fishes for local consumers. Thus the fishery of Khu-Lei Inn plays an important role in supplying natural resources for the local people.

The differences in fish species between present work and previous local workers may depend upon several factors including environmental conditions, habitat degradation, pollution of waterand usage of inappropriate methods for collection of fish.

The recorded fish species are more or less commercially important fishes. *Notopterus notopterus* (Ng-phe) is highly economic important food fish of the Southeast Asia. *Wallago attu* (Nga-but) is also important exported species of Myanmar (Chavalit *et al*., 2005).

Based on monthly data, the highest number of individuals 34656 and species number 30 were recorded in November, 2018 (cold month) while the lowest number of individuals was 3544 and species number 18 in April, 2019 (hot month). It is assumed that, the highest incidence of fish species and individual number during the cold month was due to environmental factors such as water level and available food were optimal for the fish aggregated in the 'Inn'. Thus, the highest number of fish species and individual number were also recorded in this 'Inn'.

With respect to monthly data, the total number of individuals was the highest in *Pseudambassis ranga* (Nga-zin-sat) (26124 individuals) whereas the lowest in *Leiodon cutcutia* (Nga-pu-si) (146 individuals) in total of 151182 individuals. It was assumed that *Pseudambassis ranga* has high production than the remaining fish species from Khu-Lei Inn.

The distribution and composition of the fish species in each habitat were closely associated with various factors such as the availability of food, breeding sites, water current, depth, topography and physicochemical properties of water (Harris, 1995).

Based on the relative abundance, 13 fish species out of the 30 species were found to be uncommon (uC), 8 species as common (C) and 9 species as very common (vC) during the study period.

Notopterus notopterus, *Gudusia variegata*, *Labeo rohita*, *Osteobrama belangeri*, *Puntius chola*, *Amblypharyngodon atkinsonii*, *Wallago attu*, *Pseudambassis ranga*,

Glossogobius giuris and *Oreochromis* sp. is characterized by high numbers and occurrence throughout the study period.

The present study on the fish fauna of Khu-Lei 'Inn' is a natural flooded 'Inn' and a break channel of the main Ayeyarwady River. Most people of that area depend on that 'Inn' for fishery work site. Nevertheless, Khu-Lei Inn provides significant contribution to animal proteins requirements in the local population. Fish are important as they not only provide socio-economic value in fishery resources for the people but also for the normal functioning of the ecosystem. The findings from the present study will benefit the planning and management of sustainable fisheries and conservation of natural resources for studied area.

Conclusion

Based on the present results, further investigation on economic importance of fish species and their future sustainable resource management strategies could be promoted. According to the recorded data, Khu-Lei Inn supports the fish resources (as fish, dried or preserved fish) for the township populations and neighbouring areas. Further results of this work are still needed to fulfill the complete information of fish fauna in this 'Inn'.

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Occurrence and Abundance of Avian Fauna around Sinkut Lake, Shwebo Township, Sagaing Region

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Htay Htay Lin[4], Ko Lay[5]

Abstract

Avian fauna around Sinkut Lake, Shwebo Township was investigated during October 2017 to July 2018. A total of 32 bird species belonging to 30 genera, 23 families and ten orders were recorded. Among the species recorded, 27 species were residents and five species were winter visitors. Moreover, 11 species of waterbirds and 21 species of terrestrial birds were represented in the avifauna of Sinkut Lake. Only one Myanmar endemic bird species *Turdoides gularis* (White-throated babbler) was recorded in this study period. *Passer domesticus* (House sparrow) was recorded as the most abundant species in the study area. Among the recorded species, five species were found to very common, 20 species were recorded as common species and seven species were recorded as uncommon species according to relative abundance index.

Key words: Occurrence, Abundance, avian fauna, Sinkut Lake

Introduction

Birds are useful as indicators of environmental change because of their abundance and diversity in virtually all terrestrial habitats, diurnal nature, discrete reproductive seasonality, intermediate longevity, and high ecological position on most food webs (Keller *et al*., 2015).

Birds are the best-studied class of organism and various investigations have established their significance as important mobile links in the dynamics of natural and human-dominated ecosystems (Sekercioglu, 2006).

Birds move in most number across the hemispheres, playing essential roles as consumers of insects, pollinators of flowers, and dispersal of seeds. Birds are pivotal players in ecosystem dynamics and provide essential services to human societies. The current classification of living bird is a hierarchical arrangement of roughly 29 orders, 187 families, over 2000 genera, and over 9600 species (Gill, 2007).

International ornithological committee provides 10,530 extant species and 150 extinct species of birds of the world (version 4.2), with subspecies (20,964) and annotations (Wikipedia website, 2016).

This is a list of the bird species recorded in Myanmar. The avifauna of Myanmar includes a total of 1062 species, of which six are endemic, two have been introduced by humans, and ten are rare or accidental. One species listed is extirpated in Myanmar and is not included in the species count. 51 species are globally threatened (Wikipedia website, 2016).

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Wetlands are the important bird habitats and birds use them for feeding, roosting and breeding. Wetland birds are excellent indictors of water quality and measures of biodiversity. The wetland birds were used as an indicator of wetland function or as measures of success in wetland management, restoration, and creation (Kannan, 2011).

The study of occurrence of some birds in this area may be essential for conservation scheme of biological resources in Myanmar. Thus, the present study was carried out within the specific area with the following objectives.

- to identify and record the some birds around Sinkut Lake
- to determine the abundance and status of bird species from Sinkut Lake

Materials and Methods

Study site

It is located in Shwebo District of Sagaing Region in Myanmar. Sinkut Lake lies at the east of the Shwebo Township, positioning latitudes 22º 36' 20" N and longitudes 95° 45' 25" E. It has an area of about 0.34 km^2. It is situated at an elevation of 64.6176 m.

Study period

The study period lasted from October, 2017 to July, 2018.

Figure 1. Location Map of Sinkut Lake in Shwebo Township
Source : Department of Geography, Shwebo University

Birds watching and data collection

Birds were observed by binocular and recorded as photographs by using digital camera. During the study period, bird watching, the size, color and behavior of the birds were noted. Data collections were carried out around Sinkut Lake.

Identification

The identification and classification of birds were made following Smythies (2001), King and Dickinson (1975) and Robson (2011).

Results

Throughout the study period from October 2017 to July 2018, a total of 32 bird species were belonging to 23 families and ten orders were recorded. Among them 11 species were represented of water birds and 21 species were terrestrial birds.

Out of 32 species, 14 species from order Passeriformes six species from Pelecaniformes, three species from Columbiformes, two species each from Gruiformes, Coraciiformes and Anseriformes, Ciconiiformes, Chardriiformes, Strigiformes and Apodiformes with one species in each were included.

Among ten orders, Passeriformes was the largest order containing 14 species (43.75%) and next to this was order Pelecaniformes containing six species (18.75%), Columbiformes containing three species (9.38%), Gruiformes and Coraciiformes containing two species in each order (6.25%), Anseriformes, Ciconiiformes, Charadriiformes, Strigiformes and Apodiformes containing one species in each order (3.13%) respectively.

Monthly occurrence of bird species

During the study period, the total number of species was found to be the highest in January (28 species), followed by December (25 species). During the study period, the highest temperature was 37.3˚C in April 2018 and the lowest temperature was 28.6 ˚C in January 2018. When temperature was high, number of bird species (14) and individuals (76) were recorded whereas the number of bird species (28) and individuals (173) were recorded.

Relative abundance and status

Concerned with relative abundance, *Passer domesticus* (House sparrow) showed the highest relative abundance (0.15) and then followed by *Fulica atra* (Eurasian coot) and *Acridotheres burmannicus* (Common myna) (0.07 in each) and *Bubulcus coromandus* (Eastern cattle egret) and *Hirundo rustica* (Barn swallow) (0.06 in each) and so on.

The status of birds in the study period indicated that five species were winter visitors and 27 species were resident.

Moreover, average relative abundance indicated that the five species were very common, 20 species were common and seven species were uncommon in the year from October 2017 to July 2018.

Table 1. List of recorded bird species in Sinkut Lake during October 2017 to July 2018

Sr No	Order	Family	Scientific name	Common name	Status	IUCN (2018)
1	Anseriformes	Anatidae	*Anas zonorhyncha**	Eastern Spot-billed Duck	M	LC
2	Ciconiiformes	Ciconiidae	*Anastomus oscitans**	Asian Openbill	M	LC
3	Pelecaniformes	Threskiornithidae	*Threskiornis melanocephalus**	Black-headed Ibis	M	NT
4			*Plegadis falcinellus**	Glossy Ibis	R	LC
5		Ardeidae	*Ardeola bacchus**	Chinese Pond Heron	R	LC
6			*Bubulcus coromandus**	Eastern Cattle Egret	R	LC
7			*Egretta garzetta**	Little Egret	R	LC
8		Phalacrocoracidae	*Microcarbo niger**	Little Cormorant	R	LC
9	Gruiformes	Rallidae	*Amaurornis phoenicurus**	White-breasted Waterhen	R	LC
10			*Fulica atra**	Eurasian Coot	M	LC
11	Charadriiformes	Scolopacidae	*Actitis hypoleucos**	Common Sandpiper	M	LC
12	Columbiformes	Columbidae	*Columba livia*	Rock Dove	R	LC
13			*Streptopelia decaocto*	Eurasian Collared Dove	R	LC
14			*Spilopelia chinensis*	Spotted Dove	R	LC
15	Strigiformes	Strigidae	*Athene brama*	Spotted Owlet	R	LC
16	Apodiformes	Apodidae	*Apus affinis*	Little Swift	R	LC
17	Coraciiformes	Alcedinidae	*Alcedo atthis*	Common Kingfisher	R	LC

Table 1. Continued

Sr No	Order	Family	Scientific name	Common name	Status	IUCN (2018)
18		Coraciidae	*Coracias benghalensis*	Indian Roller	R	LC
19	Passeriformes	Dicruridae	*Dicrurus macrocercus*	Black Drongo	R	LC
20		Corvidae	*Corvus splendens*	House Crow	R	LC
21		Laniidae	*Lanius schach*	Long-tailed Shrike	R	LC
22		Passeridae	*Passer domesticus*	House Sparrow	R	LC
23		Motacillidae	*Motacilla alba*	White Wagtail	R	LC
24		Sturnidae	*Acridotheres tristis*	Common Myna	R	LC
25			*Acridotheres burmannicus*	Vinous-breasted Starling	R	LC
26		Muscicapidae	*Copsychus saularis*	Oriental Magpie-robin	R	LC
27			*Saxicola caprata*	Pied Bush Chat	R	LC
28		Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	R	LC
29			*Pycnonotus conradi*	Streak-eared Bulbul	R	LC
30		Hirundinidae	*Hirundo rustica*	Barn Swallow	R	LC
31		Leiothrichidae	*Turdoides gularis*	White-throated Babbler	R	LC
32		Cisticolidae	*Prinia inornata*	Plain Prinia	R	LC

NT = Near Threatened, LC = Least Concern, M = Migrant, R = Resident

* = Water birds, Without asterisk = Terrestrial birds

Table 2. Occurrence and relative abundance of bird species from Sinkut Lake

Sr No	Scientific name	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul	Total	RA	AI
1	*Anas zonorhyncha*	0	0	0	6	0	0	0	0	0	1	7	0.0068	uC
2	*Anastomus oscitans*	0	0	20	10	0	0	0	0	0	0	30	0.0295	C
3	*Threskiornis melanocephalus*	0	0	0	25	0	0	0	0	0	0	25	0.0246	C
4	*Plegadis falcinellus*	0	0	0	0	0	0	0	0	20	29	49	0.0482	C
5	*Ardeola bacchus*	3	1	4	2	0	2	0	0	3	1	16	0.0157	C
6	*Bubulcus coromandus*	3	5	12	3	3	0	5	0	20	11	62	0.0610	vC
7	*Egretta garzetta*	3	1	3	5	3	6	0	0	5	10	36	0.0354	C
8	*Microcarbo niger*	1	1	3	4	3	4	0	0	2	3	21	0.0206	C
9	*Amaurornis phoenicurus*	0	0	1	0	1	1	0	0	0	0	3	0.0029	uC
10	*Fulica atra*	0	0	78	0	0	0	0	0	0	0	78	0.0767	vC
11	*Actitis hypoleucos*	0	0	1	3	0	4	0	0	5	3	16	0.0157	C
12	*Columba livia*	1	1	2	3	0	9	5	0	2	12	35	0.0344	C
13	*Streptopelia decaocto*	1	1	1	4	3	3	0	0	4	1	18	0.0177	C
14	*Spilopelia chinensis*	5	6	5	4	2	3	4	0	1	5	35	0.0344	C
15	*Athene brama*	0	0	0	1	0	0	0	0	0	0	1	0.0009	uC
16	*Apus affinis*	3	5	0	10	15	3	0	0	3	0	39	0.0383	C
17	*Alcedo atthis*	0	2	2	1	1	0	1	0	0	0	7	0.0068	uC
18	*Coracias benghalensis*	1	0	1	1	0	0	1	0	2	3	9	0.0088	uC
19	*Dicrurus macrocercus*	2	2	1	4	1	0	1	0	2	0	13	0.0127	C
20	*Corvus splendens*	1	2	4	9	1	0	4	3	1	0	25	0.0246	C
21	*Lanius schach*	1	0	1	2	0	0	0	0	0	0	4	0.0039	uC
22	*Passer domesticus*	10	15	10	19	8	10	13	25	30	15	155	0.1525	vC
23	*Motacilla alba*	2	0	2	3	5	9	1	0	2	0	24	0.0236	C
24	*Acridotheres tristis*	10	3	6	21	3	10	2	9	4	7	75	0.0738	vC
25	*Acridotheres burmannicus*	3	5	3	10	7	5	0	0	2	0	35	0.0344	C
26	*Copsychus saularis*	2	1	2	1	1	2	0	0	0	0	9	0.0088	uC
27	*Saxicola caprata*	3	7	3	2	1	0	2	6	5	7	36	0.0354	C

Table 2. Continued

Sr No	Scientific name	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul	Total	RA	AI
28	*Pycnonotus cafer*	1	4	0	2	2	0	2	0	5	2	18	0.0177	C
29	*Pycnonotus conradi*	2	3	2	10	3	4	0	0	2	5	31	0.0305	C
30	*Hirundo rustica*	0	0	0	0	0	30	32	0	0	0	62	0.0610	vC
31	*Turdoides gularis*	1	0	1	2	2	2	3	0	3	0	14	0.0137	C
32	*Prinia inornata*	6	3	6	6	0	0	0	0	2	5	28	0.0275	C
	Total	65	68	174	173	65	107	76	43	125	120	1016		

RA = Relative Abundance, AI = Abundance index
C = common (20 species), vC = very common (5 species), uC = Uncommon (7 species)

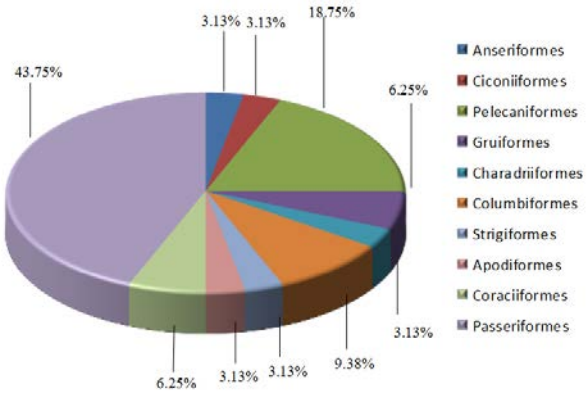

Figure 2. Composition of bird species in different orders

A. *Anas zonorhyncha*,

B. *Anastomus oscitans*

C. *Threskiornis melanocephalus*

D. *Plegadis falcinellus*

E. *Ardeola bacchus*

F. *Bubulcus coromandus*

G. *Egretta garzetta*

H. *Microcarbo niger*

I. *Amaurornis phoenicurus*

Plate 1. Some recorded species in the study area

A. *Fulica atra*

B. *Actitis hypoleucos*

C. *Columba livia*

D. *Streptopelia decaocto*

E. *Spilopelia chinensis*

F. *Athene brama*

G. *Apus affinis*

H. *Alcedo atthis*

I. *Coracias benghalensis*

J. *Dicrurus macrocercus*

K. *Corvus splendens*

L. *Lanius schach*

M. *Passer domesticus*

N. *Motacilla alba*

O. *Acridotheres tristis*

Plate 2. Some recorded species in the study area

A. *Acridotheres burmannicus* B. *Copsychus saularis* C. *Saxicola caprata*

D. *Pycnonotus cafer* E. *Pycnonotus conradi* F. *Hirundo rustica*

G. *Turdoides gularis* H. *Prinia inornata*

Plate 3. Some recorded species in the study area

Discussion

Throughout the study period from October 2017 to July 2018, a total of 32 species, 30 genera belonging to 23 families and ten orders were recorded. Among them 21 species were terrestrials birds and 11 species were water birds.

Concerned with studies on the occurrence of bird species. Khin Lay Mu (2008) described 57 waterbird species within her study period. Khin Maung Oo (2009) recorded 31 species of waterbirds in Paleik In (Lake), Sintkaing Township during this study period. Nu War (2009) recorded 27 species of waterbirds in Sintkaing Township. Yu Yu Hlaing (2010) recorded 24 species of birds in Htan Taw Inn and its environs. Hla Toe (2012) recorded a total number of (39652) individuals at four study sites falling under 22 species. Of these recorded species 18 resident species, three visitors and one migratory species were recorded in Sunye In. Nwe Nwe Win (2012) recorded a total number of 36 species of waterbirds in Pauk In (Lake), Pakokku Township. Win Mar Yae (2014) reported that a total on 55 species of 39 genera belonging to 28 families under 11 orders of terrestrial birds were recorded around the southern part of Thapanzeik Dam.

During the study period, a total of 32 species belonging to 30 genera, 23 families and ten orders have been recorded from Sinkut Lake. Among ten orders, Anseriformes contains one species of water bird, Ciconiiformes contains one species of water bird, Pelecaniformes contains six species of water bird, Gruiformes contains two species of water bird, Charadriiformes contains one species of water bird, Columbiformes contains three species, Strigiformes contain one species, Apodiformes contains one species, Coraciiformes contains two species and Passeriformes contains 14 species.

Among the recorded 32 species of birds in this study, 27 species of residents, and five species of migrants were included. Among the migrants, *Anas zonorhyncha* (Eastern Spot-billed Duck) was found in January and July, *Anastomus oscitans* (Asian Openbill) was found in December and January, *Threskiornis melanocephalus* (Black-headed Ibis) was found in January, *Fulica atra* (Eurasian Coot) was found in December, *Actitis hypoleucos* (Common Sandpiper) was found in December, January, March, June and July.

In this study period, among five orders, Anseriformes contains only one species, Ciconiiformes contains only one species, Pelecaniformes contains six species, Gruiformes contains two species, Charadriiformes contains only one species. *Anas zonorhyncha* (Eastern spot-billed Duck), *Anastomus oscitans* (Asian Openbill), *Threskiornis melanocephalus* (Black-headed Ibis), *Plegadis falcinellus* (Glossy Ibis), *Ardeola bacchus* (Chinese Pond Heron), *Bubulcus coromandus* (Eastern Cattle Egret), *Egretta garzetta* (Little Egret), *Microcarbo niger* (Little Cormorant), *Amaurornis phoenicurus* (White-breasted Waterhen), *Fulica atra* (Eurasian Coot) and *Actitis hypoleucos* (Common Sandpiper) were found in aquatic habitat of study area.

Myanmar is one of the regions for overwintering of some migratory birds from northern hemisphere and also a place of stopover for migrants during their migration. Due to occurrence of migrants, area of Sinkut Lake is considered to be one of the wintering grounds of migratory birds. Regarding the status of the bird species according to IUCN, one near threatened was recorded in this study period. *Threskiornis melanocephalus* is a species of wading bird of the ibis family Threskiornithidae. *Threskiornis melanocephalus* (Black-headed Ibis) predominantly a wetland bird. It frequently inhabits swamps, lake, wet grasslands and paddy fields. *Threskiornis melanocephalus* (Black-headed Ibis) is classified as near threatened species (Birdlife International, 2017). The status of birds in the study period indicated that five species were winter visitors and 27 species were residents.

Only one Myanmar endemic bird species, *Turdoides gularis* (White-throated Babbler) was recorded in this study period. They occur in bushes, borders of cultivation and small trees. There are trees, shrub, submerged plant, near Sinkut Lake. These habitats provide good shelter for birds.

Among 32 species of recorded birds, members of order Passeriformes 14 species (43.75%) predominate in the study area. Passeriformes is the largest order of birds and among the most diverse order of terrestrial vertebrates.

Concerned with relative abundance, *Passer domesticus* (House sparrow) showed the highest relative abundance (0.15) and then *Fulica atra* (Eurasian coot) *Acridotheres burmannicus* (Common myna) (0.07 in each) and *Bubulcus coromandus* (Eastern cattle egret), *Hirundo rustica* (Barn swallow) (0.06 in each) and so on. During the study period, the total number of species was found to be the highest in January (28 species), followed by December (25 species).

During the study period of October 2017 to July 2018, two species were found almost every month of study period. These species may be considered very common species in the study area.

Moreover, average relative abundance indicated that the five species were very common, 20 species were common and seven species were uncommon in the year from October 2017 to July 2018.

According to Myanmar protected wild animals, altogether two species, were included during study period, *Ardeola bacchus* (Chinese Pond Heron) in family Ardeidae, *Alcedo atthis* (Common Kingfisher) in family Alcedinidae, were recorded in the present study. According to Myanmar totally protected wild animals, altogether three species were included

Actitis hypoleucos (Common Sandpiper) in family Scolopacidae, *Athene brama* (Spotted Owlet) in family Strigidae and *Turdoides gularis* (White Throated Babbler) in family Leiothrichidae were recorded in the present study. Regarding with seasonally protected species, total of six species were included *Streptopelia decaocto* (Eurasian Collared Dove), *Spilopelia chinensis* (Spotted Dove) in family Columbidae, *Dicrurus macrocercus* (Black Drongo) in family Dicruride, *Copsychus saularis* (Oriental Magpie-robin) in family Muscicapidae and *Pycnonotus cafer* (Red-vented Bubul), *Pycnonotus conradi* (Streak-eared Bubul) in family Pycnonotidae were recorded in the present study.

Nowaday more and more habitats are subjected to environmental effects. Regarding to the conservation aspect, based on the findings, it may be concluded that nature of mixed habitat favours the existence of more variety of birds.

Sinkut Lake may be considered as an important place for maintenance and conservation of terrestrial and aquatic birds. Furthermore birds are useful in controlling pests in agricultural areas, near Sinkut Lake.

Conclusion

Among the species recorded, 27 species were residents and five species were winter visitors. Moreover, 11 species of waterbirds and 21 species of terrestrial birds were represented in the avifauna of Sinkut Lake. Only one Myanmar endemic bird species *Turdoides gularis* (White-throated babbler) was recorded in this study period. *Passer domesticus* (House sparrow) was recorded as the most abundant species in the study area. Among the recorded species, five species were found to very common, 20 species were recorded as common species and seven species were recorded as uncommon species. Sinkut Lake should be protected, because endemic birds, migratory birds and near threatened birds were observed inhabiting around this habitat. The future workers need to study more extensive and to carry on the rest areas which previous researchers have not yet studied.

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Distribution of some Snakes in Shwebo Environs, Sagaing Region

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Abstract

A total of 16 species of snake were recorded in the Shwebo environs during the study period. Ten species of non-venomous snakes and six species of venomous were recorded during the study period. *Amphiesma stolatum* and *Ptyas mucosa* utilized all habitat types. The highest number of snake species was recorded in November and August, and the lowest in April. The highest number of species (12) was encountered in Groundnut field plantations and the lowest (6) in the Rice field were recorded. The distribution of snake species mostly in Groundnut field was indicated by the value of (0.28) Relative Frequency Distribution (RFD). A total of 124 individuals were recorded. Among them *Daboia siamensis* was one of the most commonly encountered venomous species and total of 23 individuals were recorded during the study period. According to the IUCN red list, as regarded as one vulnerable species, five endemic species including two endemic to Southeast Asia and three endemic to Myanmar species were noted. Four species of snakes were included in the list of CITES (2017) in status as appendix II and III.

Key words: Habitat, distribution, endemic, CITES

Introduction

Snakes can be found on every continent except Antarctica, in the sea, and as high as 16,000 feet (4,900 m) in the Himalayan Mountains of Asia. They range in size from the tiny; 10.4 cm (4.1 in) long thread snake to the reticulated python of 6.95 meters (22.8 ft) in length (Roland Bauchot, ed., 1994). Most snake species are considered harmless to humans and most venomous species don't even produce venom that's toxic enough to kill a person. While most people are afraid of snakes due to their fear of snake venom, the reality is that about 85% of snake species are nonvenomous (AnimalSake, 2018).

Snakes are misunderstood animals that serve as an important component of many types of ecosystems. Without snakes, the ecosystem could not survive. The biggest threats to snake populations are habitat loss, persecution by humans, overuse of pesticides, and collection of wild snakes by hobbyists and reptile dealers (Wildlife Conflicts, 2016).

It is known that the snakes occupy a wide range of habitats. These include fields, forests, wetlands, ponds, lakes, streams, rocky hillsides, farmland, uncompleted buildings and residential neighborhoods.

Shwebo Township is located in the Sagaing Region of Myanmar. Although located in dry region of Myanmar, Shwebo environs are covered with agricultural crops (lands/fields) which use water supply from Thaphnseik Dam. The major crops are rice, sesame and groundnut. Other crops cultivated in this area are millet, maize, sunflower, beans and pulses.

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Thus, these regions fulfill suitable ecological conditions such as feeding, roosting and breeding places to sustain for snake species.

The purposes of the present study were:

- to collect relevant data on the snake species composition in the Shwebo environs
- to give information for future management strategies

Materials and methods

Study area

The study area, Shwebo environs is located in Shwebo District, Sagaing Region at Latitude 22º 34' N and Longitude 96º42' E (Figure. 1). It is located on the plains between the Mu River and the Ayeyarwady River. Different habitats like sesame and groundnut field, rice fields, maize fields, and pigeon pea fields are found in these environs.

Study period

The present study was undertaken from November, 2017 to October, 2018.

Study sites and different habitats

A total of five study sites were allocated such Seik Khun Village environs as Study Site I, Zigon lay Village environs as Study Site II, vicinity of Shwepyi Thar Village as Study Site III, Sin Koot Village environs as Study Site IV and Ta Ga NanVillage environs as Study Site V. Sesame fields, Groundnut fields, Rice fields, Maize fields and Pigeon pea fields are predominant within the study area (Plate 1).

Specimen collection and preservation

Field surveys were conducted to cover the main habitats of the study site during the year (2017-2018). Active ground searches were undertaken twice a week during the evening in all habitats and collection of specimens were made with the help of local farmers. At night-survey for nocturnal snake the head lamp, touch light, long-neck boot, fork-stick and hand net were used in catching of snakes. Snakes were collected manually with the aid of thick plastic bags. Any evidences of snakes were also collected. Local name of the species, size, color, habitat type and encountered frequency in numbers of individual of the collected specimens were recorded. Some snakes were killed and preserved in formalin 5-10% according to their size. The collected specimens were brought to the laboratory at the Department of Zoology, Shwebo University for identification of the species.

Identification

Snakes were identified with reference to Boulenger (1890), Smith (1943), Leviton, (2003), Das (2010) and Das (2012). Measurements of body length and tail length of the snakes were taken. The scales on belly, scale rows on mid-body, subcaudal scales and scutes on the head were counted.

Analysis of data

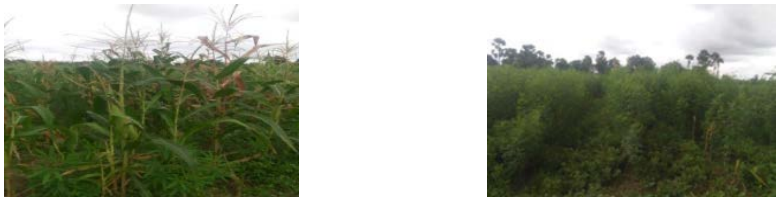
Relative Frequency Distribution (RFD) evaluated following Spiegel (1992). The value of RFD was calculated as the sum of a total number of frequencies in all habitats divided by the number of frequencies in a particular habitat.

$$\text{Relative Frequency Distribution (RFD)} = \frac{\text{The number of frequencies in a particular habitat}}{\text{The sum of a total number of frequencies in all habitats}}$$

Figure 1. Map of the study sites

(Source from Google earth, 2018)

A. Sesame field B. Groundnut field C. Rice field



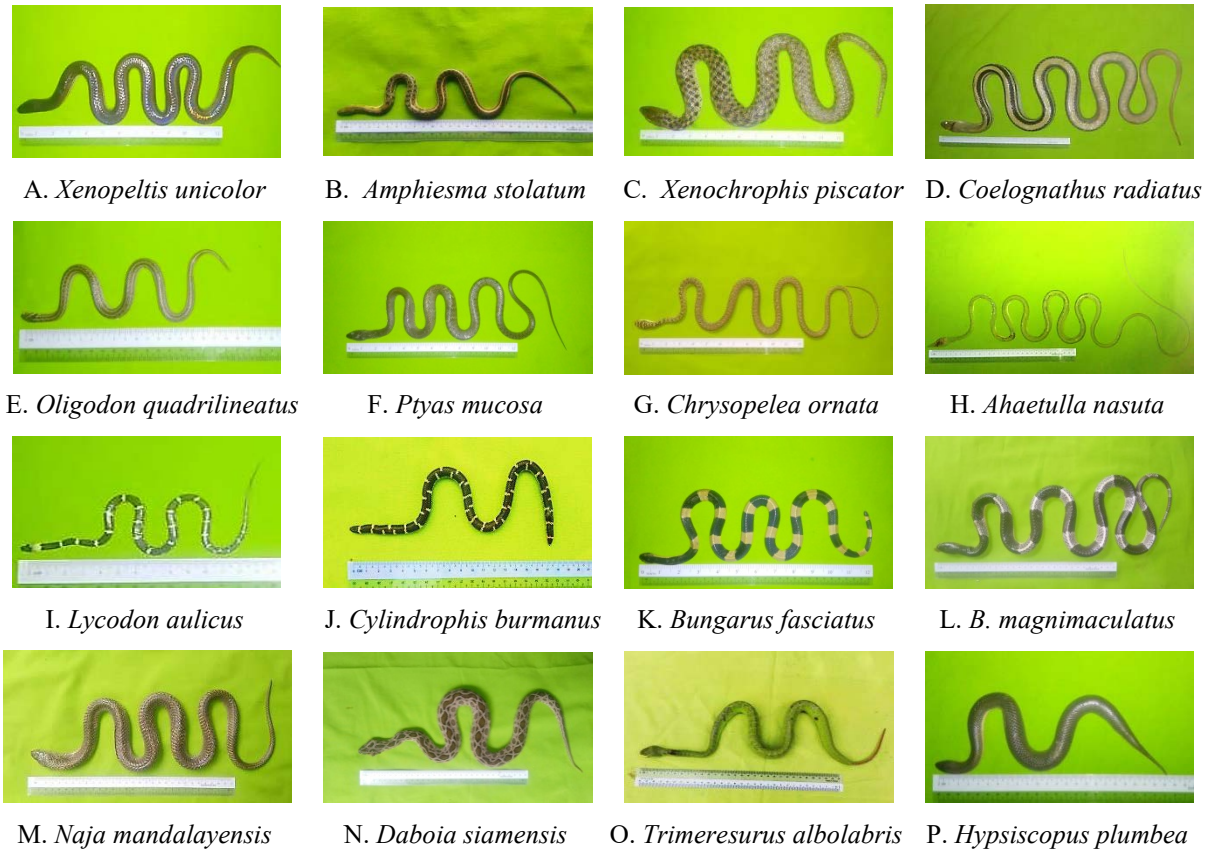
D. Maize field E. Pigeon pea field

Plate 1. Different habitat types of the study area

Results

Snake species recorded in the study area

In the study period, a total of 16 species belonging to 15 genera and six families were recorded under suborder Serpentes and order Squamata and a total of 124 individuals were recorded. Species composition of family Colubridae was found to be the highest (50%), followed by the family Elapidae (19%) and by Viperidae (13%), Homalopsidae, Cylindrophiidae and Xenopeltidae with the least of (6%). During the study period, 10 species of non-venomous snakes and six species of venomous were recorded. According to the IUCN (2017) red list, one species appeared as vulnerable was recorded. A total of five endemic species including two endemic to Southeast Asia and three endemic to Myanmar species were noted. In the present study four species of snakes according to CITES (2017) were included appendix II and III (Plate 2, Table 1, 2, 3 and 4).



A. *Xenopeltis unicolor* B. *Amphiesma stolatum* C. *Xenochrophis piscator* D. *Coelognathus radiatus*

E. *Oligodon quadrilineatus* F. *Ptyas mucosa* G. *Chrysopelea ornata* H. *Ahaetulla nasuta*

I. *Lycodon aulicus* J. *Cylindrophis burmanus* K. *Bungarus fasciatus* L. *B. magnimaculatus*

M. *Naja mandalayensis* N. *Daboia siamensis* O. *Trimeresurus albolabris* P. *Hypsiscopus plumbea*

Plate 2. Some snake species recorded in the study areas

Table 1. Species composition of snakes in different families recorded in the study sites

Sr. No.	Suborder	Family	Genus	Species	Percentage (%)
1	Serpentes	Xenopeltidae	1	1	6
2		Colubridae	8	8	50
3		Cylindrophiidae	1	1	6
4		Elapidae	2	3	19
5		Viperidae	2	2	13
6		Homalopsidae	1	1	6
	Total	**6**	**15**	**16**	

Table 2. Status of snake species recorded according to CITES (2017)

Scientific name	Common name	CITES, status	Remark
Xenochrophis piscator	checkered keelback	App. III	Common
Ptyas mucosa	Indian rat snake	App. II	Common
Naja mandalayensis	Mandalay cobra	App. II	Occasional
Daboia siamensis	Russell's viper	App. III	Common

App= Appendix (CITES)

Table 3. Species composition of snake species recorded in the study period and their status

Sr. No.	Order	Family	Genus	Species	Common name	Type	Status
1	Squamata	Xenopeltidae	*Xenopeltis*	*Xenopeltis unicolor*	Sunbeam snake	NV	
2		Colubridae	*Amphiesma*	*Amphiesma stolatum*	Buff striped keelback	NV	
3			*Xenochrophis*	*Xenochrophis piscator*	Checkered keelback	NV	
4			*Coelognathus*	*Coelognathus radiatus*	Radiated ratsnake	NV	
5			*Oligodon*	*Oligodon quadrilineatus*	Striped kukri snake	NV	
6			*Ptyas*	*Ptyas mucosa*	Indian rat snake	NV	
7			*Chrysopelea*	*Chrysopelea ornata*	Ornate flying snake	NV	
8			*Ahaetulla*	*Ahaetulla nasuta*	Long-nosed whip snake	NV	
9			*Lycodon*	*Lycodon aulicus*	Common wolf snake	NV	
10		Cylindrophiidae	*Cylindrophis*	*Cylindrophis burmanus*	Burmese pipe snake	NV	Endemic to Myanmar
11		Elapidae	*Bungarus*	*Bungarus fasciatus*	Banded krait	V	
12				*Bungarus magnimaculatus*	Burmese krait	V	Endemic to Myanmar
13			*Naja*	*Naja mandalayensis*	Mandalay cobra	V	Endemic to central Myanmar (vulnerable)
14		Viperidae	*Daboia*	*Daboia siamensis*	Chain viper	V	
15			*Trimeresurus*	*Trimeresurus albolabris*	white-lipped pit viper	V	Endermic to Southeast Asia
16		Homalopsidae	*Hypsiscopus*	*Hypsiscopus plumbea*	rice paddy snake	V	Endemic to South Asia

V = Venomus

NV = Non-venomus

Monthly occurrences of snake species recorded in the study area

A total number of 10 species (14%) belonging to ten genera and five families were recorded in November and accounted to a total of 15 individuals. Seven species (9%) belonging to eight genera and four families were recorded in December whence a total of eight individuals were recorded. Six species (8%) belonging to six genera and three families were recorded in January and a total of 11 individuals were recorded during this month. Six species (8%) belonging to six genera and three families were recorded in February and nine individuals were recorded. Six species (8%) belonging to six genera and three families were recorded in March and ten individuals were recorded. Three species (4%) belonging to four genera and three families were recorded in April and five individuals were recorded. Nine species (12%) belonging to ten genera and four families were recorded in May and 16 individuals were recorded. Eight species (11%) belonging to seven genera and three families were recorded in June and 12 individuals were recorded. Nine species (12%) belonging to nine genera and four families were recorded in July and 17 individuals were recorded. Ten species (14%) belonging to eight genera and four families were recorded in August and 17 individuals were recorded. During the study period, the highest number of species was recorded in November and August, and the lowest in April (Table 5).

Snake species recorded in different study sites and habitats

In the present study, six species namely *Amphiesma stolatum, Ptyas mucosa, Ahaetulla nasuta, Cylindrophis burmanus, Naja mandalayensis, Daboia siamensis* and *Hypsiscopus plumbea* were recorded in Study Site I. Seven species namely *Amphiesma stolatum, Xenochrophis piscator, Coelognathus radiates, Chrysopelea ornata, Ahaetulla nasuta, Daboia siamensis* and *Hypsiscopus plumbea* were recorded in Study Site II. Except the species *Cylindrophis burmanus* and *Naja mandalayensis*, the rest of all recorded species were observed in the Study Site III. In the Study Site IV, five species of *Xenopeltis unicolor, Amphiesma stolatum, Chrysopelea ornata, Daboia siamensis* and *Hypsiscopus plumbea* were recorded. The six species of *Coelognathus radiates, Bungarus fasciatus, Ptyas mucosa, Naja mandalayensis, Daboia siamensis* and *Hypsiscopus plumbea* were recorded in Study Site V. According the data recorded, the highest number of species was recorded in the Study Site III and the lowest in Study Site V. The highest number of species (12) was recorded in Groundnut fields and the lowest (6) in the Rice fields (Table 6).

Relative frequency distribution in different habitats

The predominance of snake species in Groundnut field was indicated by the value (0.28) of Relative Frequency Distribution, followed by (0.3) in Sesame fields, then followed by Pigeon pea plantations (0.19) and Maize fields (0.16). The least was in Rice fields (0.14) (Table 3).

Table 4. Relative frequency distribution of snakes in different habitats

	Sesame	Groundnut	Rice field	Maize field	Pigeon pea
F	10	12	6	7	8
RFD	0.23	0.28	0.14	0.16	0.19

F = No. Of frequency of species distributed in a particular habitat

FRD = Relative Frequency Distribution

Table 5. Monthly occurrences of snake species recorded in the study area

Sr.No.	Scientific Name	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
1	*Xenopeltis unicolor*	+	+	-	-	+	-	-	+	-	
2	*Amphiesma stolatum*	+	+	+	+	+	-	-	-	+	+
3	*Xenochrophis piscator*	+	+	+	-	-	+	+	+	+	+
4	*Coelognathus radiatus*	+	+	-	-	-	-	+	-	+	-
5	*Oligodon quadrilineatus*	-	+	-	-	+	-	-	+	-	-
6	*Ptyas mucosa*	+	-	+	-	+	-	+	+	+	+
7	*Chrysopelea ornata*	+	-	-	+	-	-	+	+	+	+
8	*Ahaetulla nasuta*	+	-	+	+	-	-	+	+	+	+
9	*Lycodon aulicus*	-	-	-	-	-	-	+	-	-	-
10	*Cylindrophis burmanus*	-	-	-	-	-	-	-	+	-	-
11	*Bungarus fasciatus*	+	-	-	+	-	+	-	+	-	+
12	*Bungarus magnimaculatus*	-	+	-	-	-	-	-	-	-	+
13	*Naja mandalayensis*	-	-	-	-	-	-	+	-	+	+
14	*Daboia siamensis*	-	-	+	+	+	-	+	-	+	+
15	*Trimeresurus albolabris*	+	-	-	+	-	-	-	-	-	-
16	*Hypsiscopus plumbea*	+	+	+	-	+	+	+	-	+	-
	Total numbers	10	7	6	6	6	3	9	8	9	9

\+ = Present

\- = absent

Table 6. Snake species recorded in different study sites and habitats

Scientific Name	Study Sites					Habitats				
	Site I	Site II	Site III	Site IV	Site V	Sesame	Ground nut	Rice field	Maize field	Pigeon pea
Xenopeltis unicolor	-	-	+	+	-	+	+	+	-	-
Amphiesma stolatum	+	+	+	+	-	+	+	+	+	+
Xenochrophis piscator	-	+	+	-	-	-	-	+	-	-
Coelognathus radiatus	-	+	+	-	+	+	+	-	-	+
Oligodon quadrilineatus	-	-	+	-	-	+	+	-	-	-
Ptyas mucosa	+	-	+	-	+	+	+	+	+	+
Chrysopelea ornata	-	+	+	+	-	-	+	-	+	+
Ahaetulla nasuta	+	+	+	-	-	+	-	-	+	+
Lycodon aulicus	-	-	+	-	-	-	+	-	-	-
Cylindrophis burmanus	+	-	-	-	-	-	-	-	+	-
Bungarus fasciatus	-	-	+	-	+	+	+	-	-	-
Bungarus magnimaculatus	-	-	+	-	-	-	+	-	-	-
Naja mandalayensis	+	-	-	-	+	+	+	-	-	-
Daboia siamensis	+	+	+	+	+	+	+	+	+	+
Trimeresurus albolabris	-	-	+	-	-	-	-	-	-	+
Hypsiscopus plumbea	+	+	+	+	+	+	+	+	+	+

\+ = Present
\- = absent

Discussion

A total of 16 species of snake were recorded in the Shwebo environs during the study period. According to data it was noted that, the study area harbors 10.25% of total recorded number (156) in Myanmar, 3.75% of total recorded species (426) in Southeast Asia and 0.44% of total recorded species (3600) in the world respectively.

Hrae Don (1982) reported that the nine species of non-venomous and 12 species of venomous snakes in some township and their environs, Burma. Naing Ko Ko chit et al. (2000) recorded nine species of non-venomous and five venomous snakes were recorded in their taxonomic study on the ophidian fauna of upper Myanmar.

Matt Ellerbeck, (2011) stated that the natural predatory behaviors of snakes are also extremely valuable to humans. Many snake species prey heavily on insects and rodents. When snake populations decline the populations of these prey items increases, often causing serious problems to people. Many people have a natural aversion of snakes, while many others simply hate them. However, snakes are in fact extremely beneficial animals to have around and they are extremely valuable components to the ecological communities in which they live; playing several complex roles, including that of predators and prey.

Aye Nyein San (2013) reported four species of colubride and only one species of venomous snakes in her study on the occurrence of some reptiles in Yinmar Bin Township. Ko Myint (2014) reported that the 15 species of colubrid and five species of venomous snakes on the Hinthada University Campus. In the present study, 10 species of non-venomous snakes and six species of venomous were identified and recorded.

Among the six families, recorded during the study, the family of Colubridae with eight species appeared highest in species composition of non-venomous snakes and suggested that these species are very beneficial to the environment in controlling the rodents and balancing the ecosystem. It was known that *Coelognathus radiates* helps control lizard populations in Bangkok, especially small skinks.

In the present study, *Amphiesma stolatum* and *Ptyas mucosa* utilized all habitat types which assumed that they feeds on a variety of prey mostly on rodents and frogs; also feeds upon birds, small mammals, other snakes, all kind of lizards, eggs etc.. These species are

non-venomous and harmless. They are actually a useful snake as they prey on rats that destroy crops or raid places of food storage.

Snakes and venomous snakes are capable of producing venom, which is used primarily for immobilizing preys and defense mostly via mechanical injection of poison by fangs. There are around 600 venomous snake species in the world.

In the present study, a total of six species under the three families, Elapidae, Viperidae and Homalopsidae were recorded. The species of *Daboia siamensis* under the family Viperidae and the species *Hypsiscopus plumbea* under the family Homalopsidae were recorded as common species and observed in all study sites. It is alluded to the abundance of prey and the habitats friendly to these species.

It is known that these venomous snakes are still very capable of causing human fatalities but these help in saving the lives of millions of people every year, as the venoms from snakes are being used to treat many serious health ailments like cancers, heart and stroke disease, Parkinsons, and many more.

It was observed that, the highest number of snake species was recorded in November and the lowest in April. As November is the season of harvesting the paddy, groundnut, and other crops, provided abundance of food prey such as rats and other insects, this situation tended to invite many predators including snakes during the harvest season.

The highest number of species was recorded in the Study Site III and the lowest in Study Site V. It was noted that the livelihood of most people in this Study Site III area are agriculturist and have many crop fields which attracted prey for the snakes. During the study period, the highest number of species (12) was found in Groundnut fields while the lowest (6) in Rice fields, probably due to the rodents, the most important prey for snakes preferred the Groundnut fields, because of easy food access. Moreover many other prey species inhabit there field since, well. Groundnut provided cover not only for snakes, but also for their prey as well. The distribution of snake species mostly in Groundnut field was indicated by the value (0.28) Relative Frequency Distribution (RFD).

In the present study, a total of 124 individuals were observed. Among them *Daboia siamensis* was one of the most commonly encountered venomous species and total 23 individuals were recorded during the study period. According to the IUCN red list, one species was recorded as vulnerable. Five endemic species including two endemic to Southeast Asia and three endemic to Myanmar species were also noted. Among them *Naja mandalayensis* is very restricted to the dry zone in central Myanmar. Also the species *Cylindrophis burmanus* is very restricted and only recorded in Myanmar.

Trading of some rare and economically important snakes has been banned by the CITES. In the present study, four species of snakes were included in the list of CITES (2017) in status as appendix II and III which means those species would become extinct within maximum of 100 years in the future if they are not prohibited from illegal trade (CITES, 2017). In Myanmar, only two snake species, *Python reticulatus* and *Python molurus* have been protected at national level.

Conclusion

In the present study, the highest number of snake species was recorded in November because November is the season of harvesting the paddy, groundnut, and other crops, provided abundance of food prey such as rats and other insects. This situation tended to invite many predators including snakes during the harvest season. *Daboia siamensis* was one of the most commonly encountered venomous species and total 23 individuals were recorded. The

highest number of species (12) was found in Groundnut fields. It was probably due to the rodents, the most important prey for snakes preferred the Groundnut fields, because of easy food access. It is suggested that snake species should be protected by the law since illegal trade in snake's acres border is going on, more public awareness is needed to keep those valuable natural assets sustainable in the ecosystem.

Acknowledgements

I would like to express my sincere thanks to Dr Win Swe, Rector, Shwebo University for encouragement to conduct this research. I'm deeply indebted Dr Khin Than Htay, Professor (Head) and Dr Kyi Kyi Thaw, Professor, Department of Zoology, Shwebo University for their guidance and suggestions given on this work.

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Traditional Fishing Gears and Their Target Caught Fish Species in Shwebo Environs, Sagaing Region

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Abstract

A study on traditional fishing gears and their target caught fish species was conducted from November 2018 to February, 2019 in Shwebo environs, Sagaing Region. The surveyed result, 13 kinds of fishing gears and 35 targeted caught fish species including shrimp were identified in the catches of different gears used by the fishermen. Structure and function of fishing gears and fish species have been described by coloured photographic plates.

Key words: fishermen, fishing gears and targeted caught fish species

Introduction

Fish and fishing business is an important sector of many nations of the world from the standpoint of income and employment generation. Fishing plays an important role in supporting livelihood worldwide and also forms an important source of diet for over one billion people Kalita *et al.,* 2015.

Fisheries in Myanmar can be classified into inland fisheries and marine fisheries. The inland fisheries are mainly flood fisheries made possible by the vast river systems and heavy rainfall. There are also leasable fisheries, which cover a large area. Fish culturing operations are undertaken extensively in ponds, lakes and reservoirs (Win Aung, 1995).

Many types of fishing gears have emerged over the centuries and a vast range of gear now exists to exploit inland waters. The choice of gear is conditioned by many factors including the characteristics of the water to be fished, the target species, the season of the year, the value of the fish caught and the cost of the gears. Most fisheries rely on a range of fishing gears by different strata of society (Welcomme, 2009).

Fishing gears and methods designed to lure and capture fish have been in use for thousands of years. Stone-tipped fishing spears, hooks, lines, nets made of tree fibers, and traps were used in some of the first civilizations throughout the world. Although simple in design, theses prehistoric concepts are the blueprints for many of the gears used in modern fisheries.

Traditional fishing gear, including nets, beach seines and various types of trap nets, still prevail in Myanmar inland fisheries. Active fishing gear comprises mainly drag nets, seines and traditional trawls. Passive fishing gear such as straight nets, gill nets, and traps are still very common in Myanmar; the designs are simple with low cost and easy to make. Regarding fishing effectiveness, modern equipment performed much better passive gear play an important role in Myanmar inland capture fisheries for a long time (Berka, 1990).

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Shwebo Township is a Shwebo District, Sagaing Region in Myanmar. It is located on the plains between the Mu River and the Ayeyarwady River. The ancient palace of King Alaungmintaya is being excavated there its administrative seat is the city of Shwebo.

The most area of Shwebo Township is supported by rice farming, fisheries and production of timber. The water is always supplied from Kabo and Kindat dams. So, there are many fishing grounds in Shwebo Township.

Shwebo Township was chosen as the study site to conduct the present study with the following objectives:

- to record the various kinds of fishing gear used in Shwebo Township
- to access the fishery scale in relation to gear and
- to investigate the relationship between the fishing gear and the collected fishes

Materials and Methods

Study Area

Shwebo Township is located in Shwebo District, Sagaing Region which lies between North Latitudes 22º 33' 59.99" N and East longitudes 96º 41' 59.99" E. The area of Shwebo Township is about 14,860 km^2.

Shwebo Township is bounded on the east by the Ayeyarwady River, across which is Singu Township of Mandalay District in Mandalay Region. To the north of Shwebo Township is Khin-U Township, to the south is Wetlet Township, and to the west is Tabayin Township (Fig 1).

Figure 1. A map of study area

Study Period

The study period lasted from November, 2018 to February, 2019.

Data collection

Field surveys were conducted once a week and interviews with local fishermen from the study area. During the study period, the measurement of fishing gears were recorded and photographed the fishery processes including the kind of gear used, frequency of fishing time per day, fishing methods and the relationship of fishing gears and collected fishes were investigated by fishermen.

Classification of recorded fishing gears

The fishing gears were classified after Talwar and Jhingram (1991), Loeung *et al*., (2003) and FAO (2005), Khin Maung Aye *et al*., (2006) and Aung Lwin (2008).

Identification of plants

The plant species was checked with Hundley and Chit Ko Ko (1987). Common names as well as local names were also provided.

Results

Fishing gears used in study area

Thirteen kinds of fishing gears were recorded in study area of Shwebo environs. The fishing gears used in the Shwebo Township can be classified into two groups. They may be classified as (i) large-scale and (ii) small-scale fishing gear. The large scale fishing gear, consists of a Beach-seine (Wonn-pu-pike) and the other is the small scale fish trap (Bon-to-hmyone, Za-lah-hmyone, Kap-pah-hmyone and Piano-hmyone), Eel trap (Nga-shint-pone), Upright trap (Nga-khyu-Pone), Pole and lines (Nga-hmyar-tan), Lift-net (Suie-sie-pike), Push-net (Yin-tun-pike), Gill-net (Tann-pike), Falling gear (Kun) and Miscellaneous (Cover pot or plunge basket). Fishing gears along with their local names, dimensions, mesh size, number of fishermen required for operation, targeted species, average catch per/day are given in Table 1 and Plate 1 A to M.

Catch fish species in study area

A tota1 of 35 species of fish including shrimp were identified in the catches of different gears used by the fishermen in Shwebo environs, Sagaing Region (Table 2 and Plate 2 A to II).

Table 1. Types of gears used by fishermen and target catch fish species in Shwebo environs

Sr No.	Category	Fishing gear type	Local name	Dimensions	Mesh size (cm)	Materials used	Number of fishermen required	Targeted species	Average Catch/day (Kg/day)
1	Seine nets	Beach seine	Wonn-pu-pike	310 m length, 3.7 m long in both lateral side and 9.2 m width	4	Nylon twine	17	*Cyprinus carpio, Labeo catla, Labeo rohita, Piaractus brachypomus, Pangasius pangasius* and *Puntius gonionotus*	34-85 Kg
2	Traps	Fish traps	Bon-to-hmyone	76 cm length, 54 cm width and 48 cm height	-	Bamboo sticks, nylon and plastic-ropes	1	*Mystus cavasius, Mystus pulcher, Macrognathus aral, Macrognathus zebrinus, Mastacembelus armatus* and shrimp	3.4 kg to 5.1 kg
			Piano-hmyone	151 cm length, 23 cm width and 62 cm height	-	Bamboo sticks, nylon and plastic-ropes	1	*Labeo boga, Puntius sophore, Systomus sarana, Salmophasia sardinella, Ompok bimaculatus* and *Amblypharyngodon atkinsonii*	3.5 kg to 6.0 kg
			Kah-pah-hmyone	61 cm height, 33 cm length as well as width	-	Bamboo sticks and red-vine, *Convolvulus*	1	*Oreochromis* sp., *Anabas testudineus, Channa orientalis, Channa punctatus* and *Channa striata*	0.85 kg
			Za-lah-hmyone	47 cm length, 30 cm height as well as width		Bamboo, nylon-rope and red-vine,*Convolvulus strigosus* (nwe-ni)	1	*Macrognathus aral, Macrognathus zebrinus, Mastacembelus armatus* and *Oreochromis* sp.	0.90 kg
		Eel trap	Nga-shint-pone	0.56 height m and 0.24 m width	-	Bamboo spikes	1	*Monopterus albus*	0.85 kg
		Upright trap	Nga-khyu-pone	0.28 m height and 0.54 m width	-	Bamboo spikes	1	*Clarias batrachus, Channa orientalis, Channa punctatus* and *Channa striata*	0.80 kg
3	Poles and lines	Fishing rods	Nga-hmyar-tan	1 hook	-	Nylon-string (polyamid or polyethylene) tied to the tapering end of the bamboo	1	*Clarias batrachus, Channa striatus, Channa orientalis, Channa punctatus, Mystus cavasius, Mystus pulcher, Oreochromis* sp., and *Wallago attu*	According to size of catch fish

Table 1. Continued

Sr No.	Category	Fishing gear type	Local name	Dimensions	Mesh size (cm)	Materials used	Number of fishermen required	Targeted species	Average Catch/day (Kg/day)
4	Falling Gears	Cast net	Kun	314 cm length	1cm	Nylon	1	*Labeo boga, Labeo catla, Labeo rohita, Puntius sophore, Systomus sarana, Mystus cavasius, Mystus pulcher, Macrognathus aral, Mastacembelus armatus Oreochromis* sp., *Anabas testudineus, Trichogaster fasciatus, Channa striatus, Channa orientalis, Channa punctatus,* and *Wallago attu*	8.5 kg to 17 kg
5	Lift net	Portable hand lift net	Suie-sie-pike	81 cm length and 90 cm width	1 cm	Bamboo, rattan, and nylon	1	Shrimp	1.00 kg
6	Man push net	Scoop net	Yin-tun-pike	Anterior part is about 2.6 m and the posterior part is about 0.4 m length	1 cm	Bamboo sticks and nylon	1	*Labeo boga, Osteobrama belangeri, O. cunma, Puntius sophore, Systomus sarana, Salmophasia sardinella, Amblypharyngodon atkinsonii, Raiamas guttatus, Acantopsis choirorhynchos, Xenentodon cancila, Mystus cavasius, M. pulcher, Macrognathus aral, Macrognathus zebrinus, Oreochromis* sp., *Anabas testudineus, Tricopodus pectoralis* and shrimp	0.50 Kg to 8.0 kg
7	Gill nets and Entangling net	Set gill net	Tann-pike	12.2 m length and 1.5 m depth	2 cm to 6 cm	Nylon difilament	2	*Labeo catla, Labeo rohita, Clarias batrachus, Oreochromis* sp., and *Wallago attu*	0.50 kg to 1.00 kg
8	Miscellaneous	Cover pot or Plunge basket	Saung	0.6 m height, mouth of the bottom 0.64 m and upper opening 13 cm width	-	Bamboo, nylon-rope and *Convolvulus strigous* (nwe-ni)	1	*Macrognathus aral, Macrognathus zebrinus, Mastacembelus armatus, Clarias batrachus, Oreochromis* sp., *Channa striatus, Channa orientalis* and *Channa. punctatus*	According to size of catch fish

Table 2. Local name and scientific name of the fishes recorded from Shwebo environs

Roll No.	Local name	Scientific name
1	Nga-moke	*Piaractus brachypomus*
2	Shwe-war-nga-gyin	*Cyprinus carpio*
3	Nga-lu-phyu	*Labeo boga*
4	Nga-ohn-don	*Labeo catla*
5	Nga-gyin-myat-san-ni	*Labeo rohita*
6	Nga-phan-ma	*Osteobrama belangeri*
7	Nga-lay-daunt	*Osteobrama cunma*
8	Thai-nga-khone-ma	*Puntius gonionotus*
9	Nga-khone-ma-myi-kyut	*Puntius sophore*
10	Nga-khone-ma-toke	*Systomus sarana*
11	Yin-baung-zar	*Salmophasia sardinella*
12	Nga-byet	*Amblypharyngodon atkinsonii*
13	Nga-la-war	*Raiamas guttatus*
14	Nga-pyaw-myit	*Acantopsis choirorhynchos*
15	Nga-zin-yaing-phyu	*Mystus cavasius*
16	Nga-zin-yaing-kyet-chay	*Mystus pulcher*
17	Nga-dan	*Pangasius pangasius*
18	Nga-myin-oat-phar	*Eutropiichthys bumannicus*
19	Nga-myin-kun-man	*Eutropiichthys vacha*
20	Nga-nu-than	*Ompok bimaculatus*
21	Nga-but	*Wallago attu*
22	Nga-khu	*Clarias batrachus*
23	Nga-phaung-yoe	*Xenentodon cancila*
24	Nga-mway-ni	*Macrognathus aral*
25	Nga-mway-htoe-kyan-sit	*Macrognathus zebrinus*
26	Nga-mway-nagar	*Mastacembelus armatus*
27	Nga-shint-ni	*Monopterus albus*
28	Salapia	*Oreochromis* sp.
29	Nga-pyay-ma	*Anabas testudineus*
30	Nga-phyin-tha-lat	*Trichogaster fasciatus*
31	Japan-nga	*Tricopodus pectoralis*
32	Nga-yant-gaung-doh	*Channa orientalis*
33	Nga-yant-panaw	*Channa punctatus*
34	Nga-yaunt-gaung-shay	*Channa striata*
35	Shrimp	*Macrobrachium* sp.

A. Beach seine net

1. (Wonn-pu-pike used in fishery pond)
2. Catching fish by Wonn- pu-pike

B

1. Fish trap (Bon-to-hmyone)
2. Bon-to-hmyone used in channel

C

1. Piano-hmyone
2. Piano-hmyone used in channel

D

1. Kap-pah-hmyone
2. (Kap-pah-hmyone used in channel)

E

1. Za-lah-hmyone
2. Za-lah-hmyone used in channel

F

1. Eel trap (Nga-shint-pone)
2. Eel trap used in channel

Plate 1. Different types of fishing gears used in study area

1. Upright trap (Nga-khyu-pone)

2. Upright trap (Nga-khyu-pone) used in channel

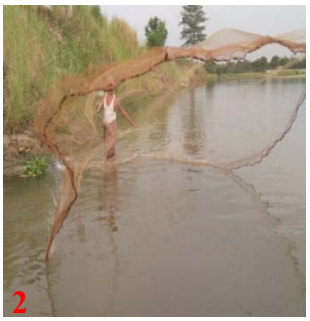
G

1. Different size of fishing rods (Nga-hmyar-tan)

2. Fishing rods (Nga-hmyar-tan) used in channel

H

1. Cast net (Kun)



2. Cast net (Kun) used in Mu River

I

1. Portable and lift net (Suie-sie-pike)

2. Portable and lift net (Suie-sie-pike) used in channel

J

K

Man Push net or Scoop net (Yin-tun-pike)

L

Set gill net (Tann-pike)

1. Cover pot or Plunge basket (Saung)

2. Cover pot or Plunge basket (Saung) used in channel

M

Plate 1. Continued

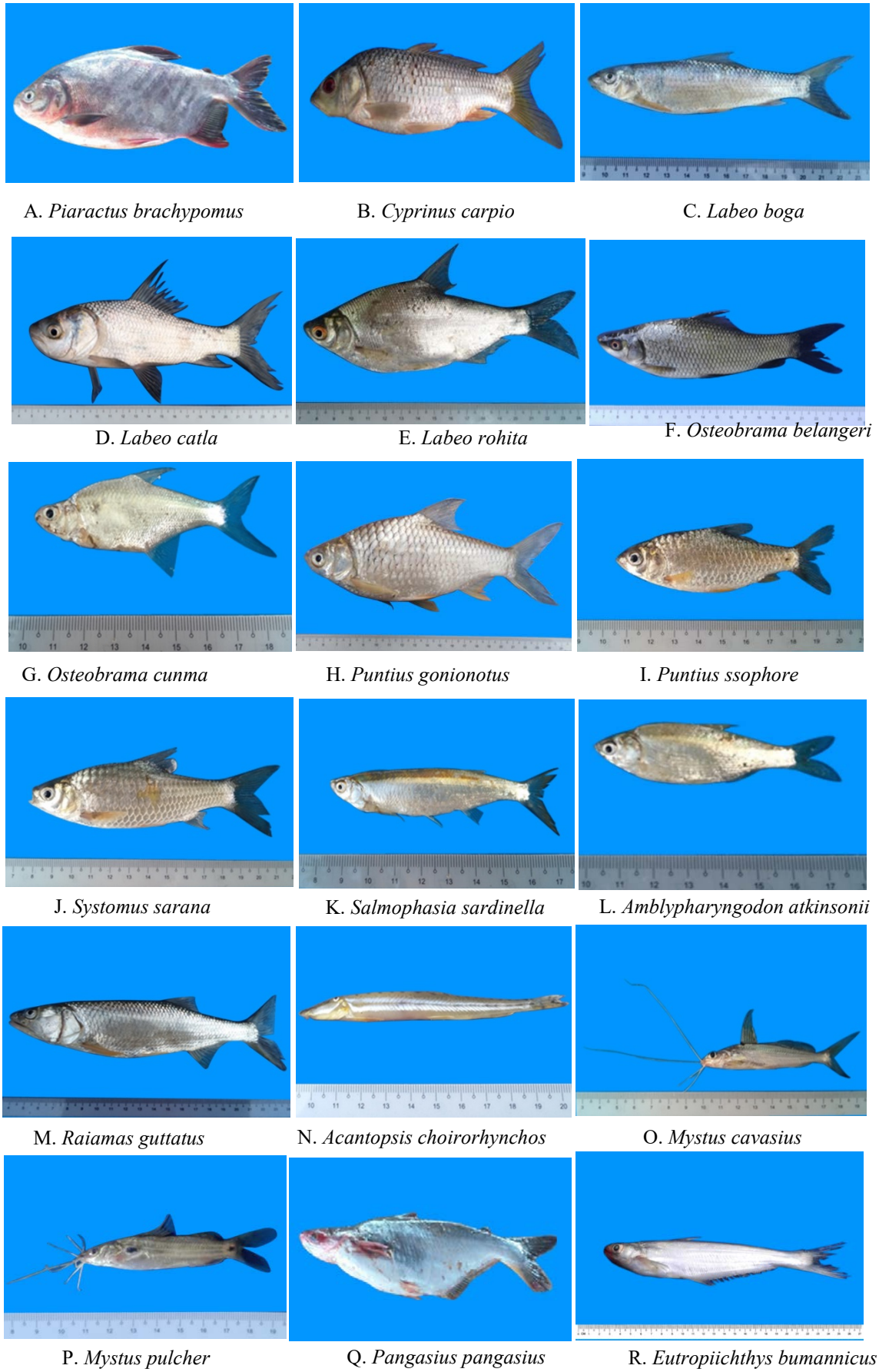
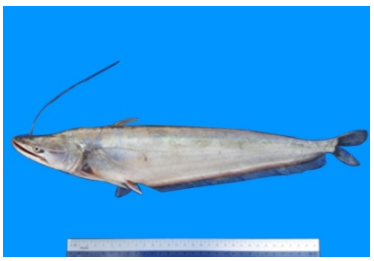
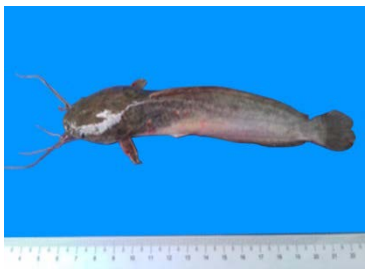


Plate 2. Targeted caught fish species recorded in study area

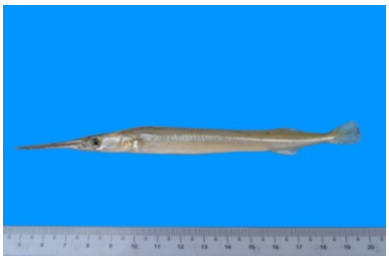
S. *Ompok bimaculatus*



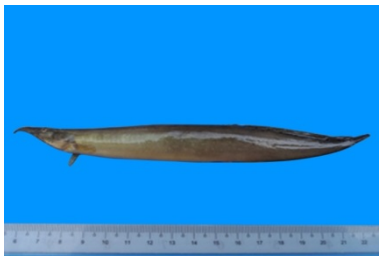
T. *Wallago attu*



U. *Clarias batrachus*



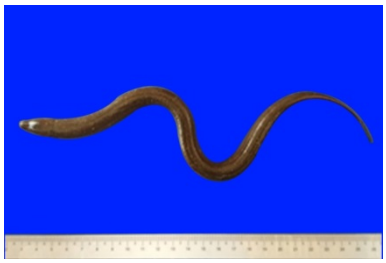
V. *Xenentodon cancila*



W. *Macrognathus aral*

X. *Macrognathus zebrinus*

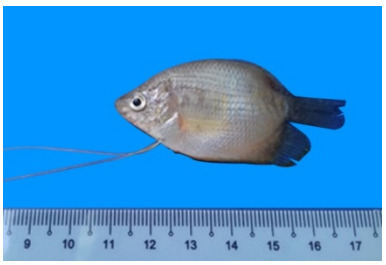
Y. *Mastacembelus armatus*



Z. *Monopterus albus*

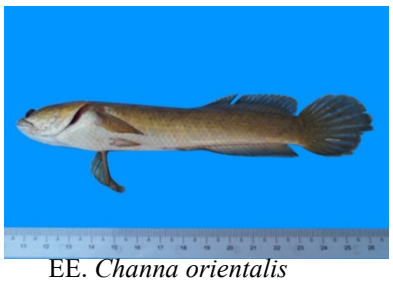
AA. *Oreochromis* sp.

BB. *Anabas testudineus*

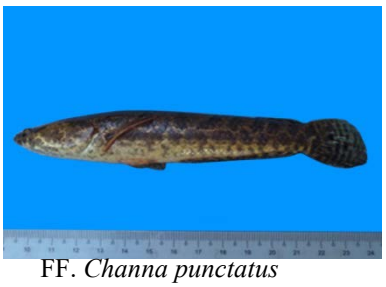


CC. *Trichogaster fasciatus*

DD. *Tricopodus pectoralis*



EE. *Channa orientalis*



FF. *Channa punctatus*

GG. *Channa striata*

HH. *Eutropiichthys vacha*

II. *Macrocbanchium* sp.

Plate 2. Continued

Discussion

Traditional fishing arts have been developed over the years to adapt to local body conditions; the species of fish desired and targeted size. The most successful fishing methods of an area or a region are those that have stood the test of time (Eyo and Akpati, 1995).

Fishery management requires a good knowledge of fishing gear. There is great divergence in the efficiency of different forms of fishing gear, in their adaptability to certain conditions, and in their desirability for specific job.

Fish capture methods can be divided into two groups, active and passive. Active methods are those that effectively pursue the fish or are moved in order to capture them (example include seine netting). These methods are particularly effective at catching sedentary species, but the efficiency is species and size dependent and they perform best in shallow, smooth bottomed rivers and backwaters.

Passive methods rely on the movement of fishes for their capture (examples include gill nets and fish traps) and have often proved useful for the study of fish migrations (Jensen, 1990, Lucas and Baras, 2000, Bojsen, 2002 and Jellyman and Graynoth, 2005, Cited by Aung Lwin, 2008).

In present study at Shwebo environs, the different characters of gears were observed on functional activities. Among the 13 kinds of fishing gears used in these study area, Beach seine (Wonn-pu-pike) and Cast net (Let-pyit-kun) were active gears and the remaining gears of set gill net, long line (Nga-hmyar-tann), Fish trap (Za-lah-hmyone, Bon-to-hmyone, Kah-pah-hmyone, Piano-hmyone), Eel traps (Nga-shint-pone), Upright trap (Nga-khyu-pone). Portable hand lift net (Suie-sie-pike), Scoop net (Yin-tun-pike) and Cover pot or plunge basket (Saung) were passive.

In this paper, a tota1 of 35 species of fish including shrimp were catcher of different gears used by the fishermen in Shwebo environs.

Beach seine net are generally used in fishery ponds in study area of Shwebo Township. This gear is composed of a bunt (bag or lose netting) and long coins often lengthened with long ropes for towing the seine to the beach. The head rope with floats is on the surface, the footrope is in permanent contact with the bottom and the seine is therefore a barrier which prevents the fish from escaping from the area enclosed by the net. Beach seine net are generally expensive, high cost and the catch of fish are high. The used of beach seine is restricted by law in Myanmar because of disturb the breeding activities and lead frequently to the capture of juvenile.

Traps may be operated from the shore or by wading in shallow rivers, lakes and swamps. Normally they more require some form of fishing craft for transport, setting and control. The fish caught remain alive within the trap so they may be left for several days.

Trapping is one of the most versatile fishing methods. It can be used in a wide variety of habitats and to catch a wide variety of species. Traps are generally cheap to buy and even cheaper to make. Because trapping has been used for adopt local trapping technology usually savers time and money. Trapping may become labor-intensive when a large number of traps are used; the catches of fish are high although regular maintenance of traps is required.

Poles and lines fishing gear are widely used by fishermen throughout the year in study area. Variety of fish species are catch by this type of gear. As like trapping, pole and lines are generally cheaper to make and low cost. Cast net are relatively cheap and long lasting, although regular maintenance is necessary. Cast nets are used from the shore or from a boat. The operation of a cast net requires considerable knowledge and skill from the fisherman.

Catch of juvenile fishes cannot be avoided, but they can be released alive if needed. This gear is widely used in Shwebo Township. The construction of the giant cast net is basically the same as the normal cast net different only in size. The giant cast net is shaped as a bag. At the mouth of the net, there are small bags where the fish is caught. The top of the net has a line so that casting and hauling can be done more easily. The, giant cast net are relatively expensive to make, high cost and the catch of fish are high. This gear is used in the study area of fishery pond of Shwebo Township.

Portable hand lift nets are small lift nets operated by hand, often supported by ringed frames. After being submerged and kept a while at the certain depth, the net is lifted and hauled out of the water, by hand. As like trapping, portable hand lift nets are generally cheaper to make, low cost and the catches of fish are high although regular maintenance is required. The main targeted caught species is only shrimp in study area.

Push nets are scoop nets which are pushed, footing in very shallow waters or before a small boat. The net bag is fixed on scissors like cross-sticks to keep the net open. The gear is pushed over the bottom in shallow waters, especially to catch shrimp or shrimp larvae. It is pushed forward by manpower but the use of boats for pushing the gear is common, too. To ensure that the points of the gross sticks glide smoothly over the bottom, they are provided with runners.

Gill nets are relatively cheap and long lasting, although regular maintenance is necessary. Removing gilled fish and rubbish from the net is time consuming, particularly if the net is long. Gill nets are the most selective of nets because mesh size determines exactly the body diameter of fish that will be caught.

A major disadvantage of gill netting is that the fish caught in gill nets often die, especially if the net was set for too long or too many fish were caught. In addition, gill nets can entangle untargeted animals, including turtles, snakes, birds and mammals.

Miscellaneous Fishing gear of cover pot is usually operated by one-man in paddy fields and shallow waters. When a fish is detected in the water, the fishermen suddenly cover the fish. Cover pot are generally cheaper to make and saver money but regular maintenance is required.

Conclusion

In the present work, it was observed that Beach seine net (Wonn-pu-pike) and Cast net (Let-pyit-kun) were commercially used in fisheries ponds and other types of gears were non-commercial used in study area of Shwebo environs. Sensitization of fishers towards the importance of best management practices through awareness campaign and imposition of gear restrictions, mesh size regulations and ban if needed, can ensure healthy ecosystem and sustainable fisheries. People's participation through cooperation in the management of these aquatic resources by selecting the appropriate gears during different fishing season will be useful for proper exploitation of fishes and thereby promoting sustainable fisheries in Shwebo environs.

Acknowledgements

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Gonadosomatic Index (GSI), Hepatosomatic Index (HSI) and Fecundity (F) of *Glossogobius giuris* (Hamilton-Buchanan, 1822) from Ayeyarwady River Segment near Kyauk Myaung Township, Sagaing Region

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Abstract

The present study was conducted to assess the gonadosomatic index, hepatosomatic index and fecundity of *Glossogobius giuris* from Ayeyarwady River Segment Near Kyauk Myaung Township, Sagaing Region during the study period from December, 2018 to September, 2019. Monthly variations of GSI showed that the higher values during the period from February to August when HSI values were lower. Variation in GSI, HSI, fecundity, total length, body weight and ovary weight of the studied species were found in the entire study period. The fish was found to spawn for several months with two spawning peaks. One in February and other in August as indicated by the peaks of gonadosomatic index. The present study revealed that the *G.giuris* is high fecund fish when compare to its size and weight and has a prolonged breeding season.

Key words: *Glossogobius giuris*, gonadosomatic index, hepatosomatic index and fecundity

Introduction

Fish is a rich source of animal protein. Fish and fishery products represent a valuable source of nutrients of fundamental importance for diversified and healthy diets (FAO, 2012).

Gobies are originally marine species, which are still under the process of fresh waterization. Due to their marine origin still many freshwater gobies are observed to tolerate high salinity ranges. Distribution range of *Glossogobius giuris* (Hamilton) is reported from freshwater and estuaries of Bangladesh, India, Pakistan, and Burma (Bhuiyan, 1964).

Now a day its abundance in nature is decreasing day by day due to various human interferences. According to IUCN (2000), bele is considered as rare or very rare species. One of reproduction activity in fish is spawning season. The spawning season can be determined by ovary maturation that analyzed temporally (Pusey *et al.*, 2001).

The "Fecundity" of a fish is defined as the number of eggs that are likely to be laid during a spawning season (Bagenal, 1957). Fecundity is an important parameter in fishes for determing the reproductive potential of fish species (Zin *et al*., 2011). Now a day, the knowledge of fecundity has been applied for detecting the different population of the same species of fish in different locations (Mishra and Saksena, 2012).

Fecundity along with other indices such as gonadosomatic index (GSI) and hepatosomatic index (HSI) are used to access the reproductive condition of a fish changes in the gonadosomatic index (GSI) helps to determine the reproductive season of the fish (Arruda *et al*., 1993).

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Gonadosomatic index determines the state of maturity and onset of spawning season used to follow the reproductive cycle of a species over the year at monthly or less intervals. The size of ovary and eggs is used to characterize the relative sexual maturity of the fish (Islam and Das, 2006).

HSI is defined as liver weight and fish weight ratio. HSI term usually used in fisheries science as an indicator of energy reserves in the liver (Cerda *et al*., 1996)

Glossogobius giuris is a source of food for all people and found abundantly in almost all streams and rivers in Myanmar. Taking these facts into consideration, some reproductive parameter of *Glossogobius giuris* were assessed with the following objectives.

- to assess the different reproductive periods of *G.giuris* based on GSI, HSI and K values
- to investigate the reproductive potential on basis of fecundity

Materials and Methods

Study area

The study area, Ayeyarwady River segment near Kyauk Myaung Township, Sagaing Region are located in between North latitude 22°39'50" and East longitude 95°54'29"(Fig.1).

Study period

The duration of the study period was from December, 2018 to October, 2019. Collection of specimens was made from December, 2018 to September, 2019.

Collection of specimens

A total of 200 *Glossogobius giuris* was collected and used in this study.

Identification of specimens

The identification of fish was followed after Talwar and Jhingran (1991) and Jayaram (2013).

Measurements and dissection of specimens

Body weight and length (both total and standard) of collected specimens were taken to the nearest gram and centimetre respectively. The body of fish was cut open abdominally along mid-ventral line starting from cloacal aperture. The fresh paired ovaries and liver were removed from the body cavity and weight by digital balance and fixed in 10% formalin solution for at least 24 hours to bring hardness of eggs to make it much easier to separate the eggs from the walls of ovary and then transferred to 70% alcohol.

Parameters employed

The monthly changes in the gonadosomatic index (GSI) and hepatosomatic index (HSI) were calculated using the formulae given by Wingfield and Grimm (1997).

$$GSI = \text{Gonad weight} / \text{Body weight} \times 100$$

$$HSI = \text{Liver weight} / \text{Body weight} \times 100$$

$$K = \text{Body weight} / \text{Length}^3 \times 100$$

Fecundity Estimation

To calculate the fecundity, the subsample method was applied. Three different sections were taken from the anterior, middle and posterior portions of the ovary, respectively. Sections were weighted on digital balance. Ova from these three small sections of ovary were separated and counted under Dissecting Microscope. As it was over, the individual number of these sections was added and made a sum total of it. Then the fecundity of the collected specimen was calculated according to (Yeldan and Avsar, 2000).

Absolute fecundity = Ovary weight × no. of egg in the subsample／Subsample weight

Statistical analysis

The relationship between each paired parameters was calculated using regression equation given by Bailey (1968).

$$y = a + bx$$

Where, y = fecundity

x = body length or body weight or liver weight or ovary weight

"a" and "b" = constant, etc.

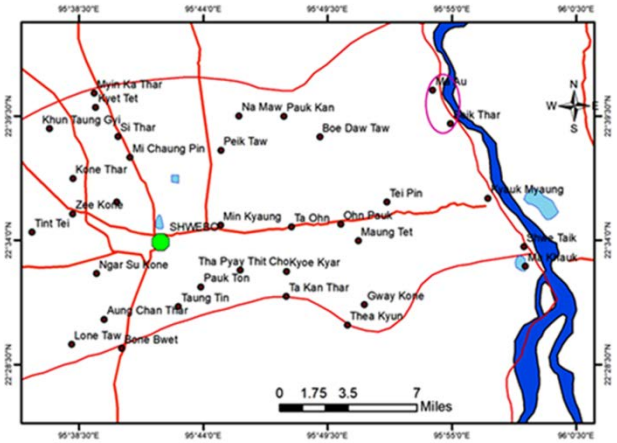

Figure 1. Location map of the study area
Source: Geography Department, Shwebo University

Results

A total of 200 female fish samples were examined to determine the reproduction of *Glossogobius giuris.*

Morphology of the ovary

The ovaries of *Glossogobius giuris* were paired tubular organs lying dorsal to the alimentary canal and ventral to the swim bladder. They were attached to the body cavity by the thin mesentery. The ripe ovaries were found to extend up to the end of the urinogenital pore. They were usually equal in size but occasionally one was larger than the other.

Gonadosomatic Index (GSI)

Monthly changes of GSI values were presented in Table 1 and Fig. 2. The lowest GSI value of 0.90 ± 0.51% was observed in December and the highest was 5.01 ± 1.13% in August.

Hepatosomatic Index (HSI)

Monthly variation of HSI values were shown in Table 1 and Fig. 2. The minimum HSI value of 1.86 ± 0.56% was found in September and the maximum was 3.61 ± 0.97% in April.

Condition Factor (K)

Monthly variations of the condition factor (K) were shown in Table 1 and Fig. 2. The lowest mean K value of 0.84 ± 0.08% was found in September and the highest values was 1.08 ± 0.34% in February.

Fecundity

The fecundity was estimated from 140 randomly collected fish samples ranging from 9.06 ± 0.7 to 11.52 ± 2.47 cm in total length, 6.42 ± 1.36 to 15.68 ± 10.29 g in body weight and 0.24 ± 0.11 to 0.49 ± 0.27g in ovary weight. The fecundity was found to vary from 8955 ± 2713 in June to 18841 ± 8237 in February (Table 2). The average numbers of eggs was found 11808 ± 6546 in fish length from 1.90 to 16cm and body weight from 2.71 to 41.18 g (Table 3).

Fecundity and Total Length

Fecundity and total length in *G. giuris* showed a linear relation with correlation coefficient was poor correlation $R^2 = 0.397$ (Fig. 3).

Fecundity and Body Weight

A linear poor relation was observed between fecundity and body weight with correlation coefficient $R^2 = 0.4146$ (Fig. 4).

Fecundity and Ovary Weight

A close relation was found between fecundity and ovary weight $R^2 = 0.5745$ (Fig. 5).

Length-weight Relationship (LWR)

The relationship between total length and body weight was given in Fig. 6. A high relation between total length and body weight was observed in correlation coefficient $R^2 = 0.8531$.

Table 1. Monthy variations of Gonadosomatic index (GSI), Hepatosomatic index (HSI) and Condition factor (K) of *Glossogobius giuris* (December, 2018 to September, 2019)

Months	GSI (%)		HIS (%)		K (%)	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
December	0.28-2.09	0.90 ± 0.51	1.18-4.25	2.35 ± 0.89	0.67-2.01	0.96 ± 0.26
January	0.41-5.31	1.08 ± 1.04	1.06-3.90	2.30 ± 0.67	0.63-1.08	0.86 ± 0.12
February	1.32-6.55	3.74 ± 1.33	1.59-14.82	3.43 ± 2.83	0.87-2.47	1.08 ± 0.34
March	1.29-5.30	2.40 ± 1.12	1.32-3.56	2.05 ± 0.56	0.79-1.42	0.92 ± 0.14
April	2.19-4.88	3.69 ± 0.88	1.31-5.26	3.61 ± 0.97	0.85-1.16	0.99 ± 0.08
May	1.05-6.34	2.72 ± 1.52	1.27-4.68	2.42 ± 0.93	0.73-1.23	0.91 ± 0.13
June	1.14-8.37	3.54 ± 2.00	0.77-5.36	2.79 ± 1.39	0.81-2.35	1.01 ± 0.32
July	0.72- 6.12	2.73 ± 1.14	0.98 - 7.06	1.97 ± 1.44	0.74 -1.05	0.86 ± 0.09
August	2.83 - 7.13	5.01 ± 1.13	1.76 - 5.59	3.36 ± 1.08	0.71 - 0.94	0.85 ± 0.06
September	0.96 - 3.79	1.78 ± 0.88	0.75 - 2.95	1.86 ± 0.56	0.65 - 0.95	0.84 ± 0.08

Based on 200 individuals as sample size

Table 2. Monthly variations of total length, body weight, ovary weight, hepatic weight and absolute fecundity of *Glossogobius giuris* (December, 2018 to September, 2019)

Months	No. of fish examined	Statistics	Total Length (cm)	Body Weight (g)	Ovary Weight (g)	Hepatic Weight (g)	Absolute Fecundity
December	20	Mean ± SD	11.37 ± 2.23	15.54 ± 9.32	0.10 ± 0.04	0.37 ± 0.28	NA
January	20	Mean ± SD	11.14 ± 1.07	12.26 ± 4.07	0.16 ± 0.26	0.29 ± 0.13	NA
February	20	Mean ± SD	11.12 ± 1.58	14.96 ± 4.91	0.49 ± 0.27	0.42 ± 0.16	18841 ± 8237
March	20	Mean ± SD	11.12 ± 1.90	13.52 ± 7.53	0.32 ± 0.24	0.27 ± 0.17	11597 ± 5848
April	20	Mean ± SD	9.69 ± 2.02	9.86 ± 5.88	0.34 ± 0.18	0.33 ± 0.21	11531 ± 5452
May	20	Mean ± SD	11.52 ± 2.47	15.68 ± 10.29	0.35 ± 0.2	0.38 ± 0.33	11772 ± 7478
June	20	Mean ± SD	9.71 ± 1.05	9.09 ± 2.51	0.29 ± 0.14	0.24 ± 0.11	8955 ± 2713
July	20	Mean ± SD	9.83 ± 1.50	8.75 ± 4.5	0.24 ± 0.11	0.17 ± 0.12	10348 ± 6170
August	20	Mean ± SD	9.06 ± 0.7	6.42 ± 1.36	0.32 ± 0.1	0.21 ± 0.05	9613 ± 3509
September	20	Mean ± SD	8.45 ± 0.88	5.15 ± 1.42	0.08 ± 0.02	0.1 ± 0.04	NA

NA-not available due to immaturity of the ovary itself

Table 3. Mean (± SD) and Range value of fecundity and other parameters of *Glossogobius giuris* (December, 2018 to September, 2019)

Parameters	Mean ± SD	Range
Total Length (cm)	10.37 ± 1.90	1.90–16.00
Body weight(g)	11.36 ± 6.87	2.71-41.18
Ovary weight(g)	0.27 ± 0.22	0.05-1.25
Hepatic weight(g)	0.28 ± 0.20	0.04-1.22
Absolute fecundity	11808 ± 6546	2639–33440
GSI	2.78 ± 1.72	0.28-8.37
HSI	2.65 ± 1.42	0.77-14.82
K	0.93 ± 0.20	0.63-2.47

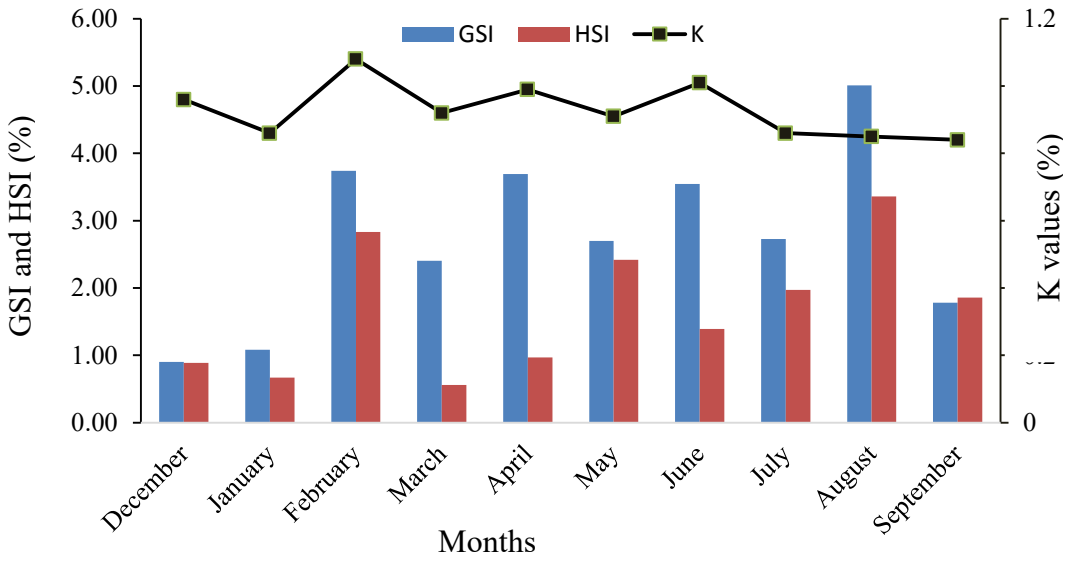

Figure 2. Monthly variation of gonadosomatic index (GSI), hepatosomatic index(HSI) and condition factor (K) of *Glossogobius giuris*

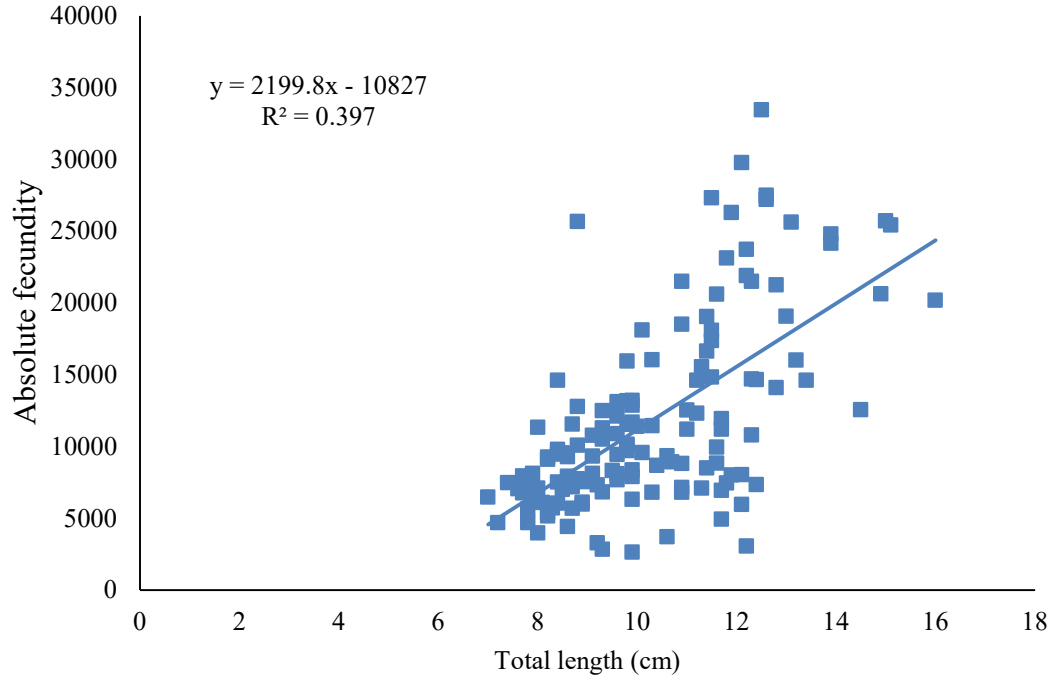

Figure 3. Relationship between fecundity and total length of *Glossogobius giuris*

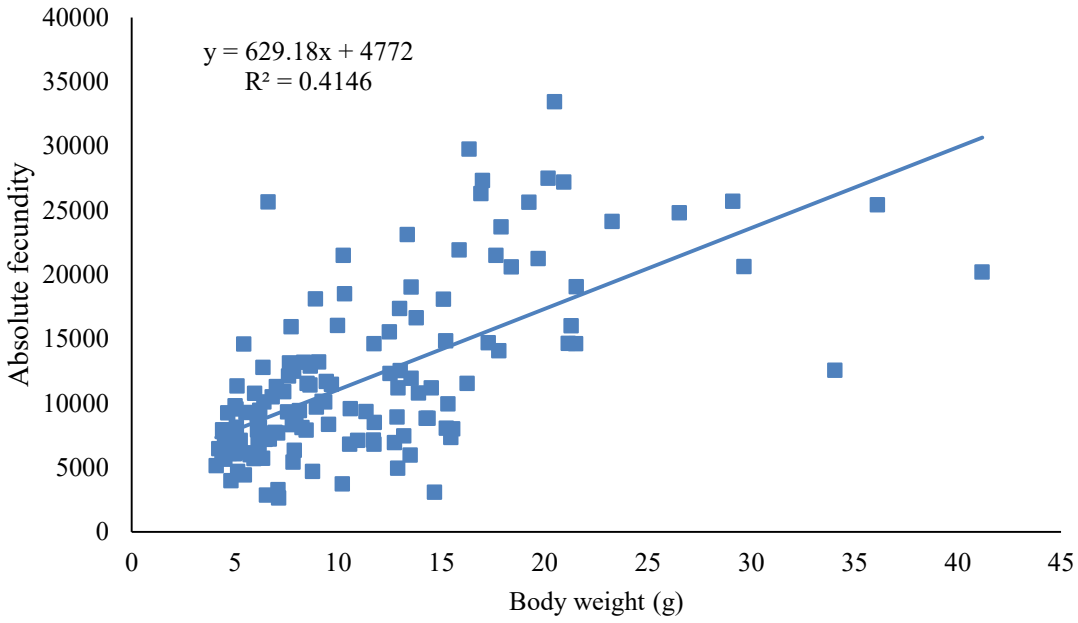

Figure 4. Relationship between fecundity and body weight of *Glossogobius giuris*

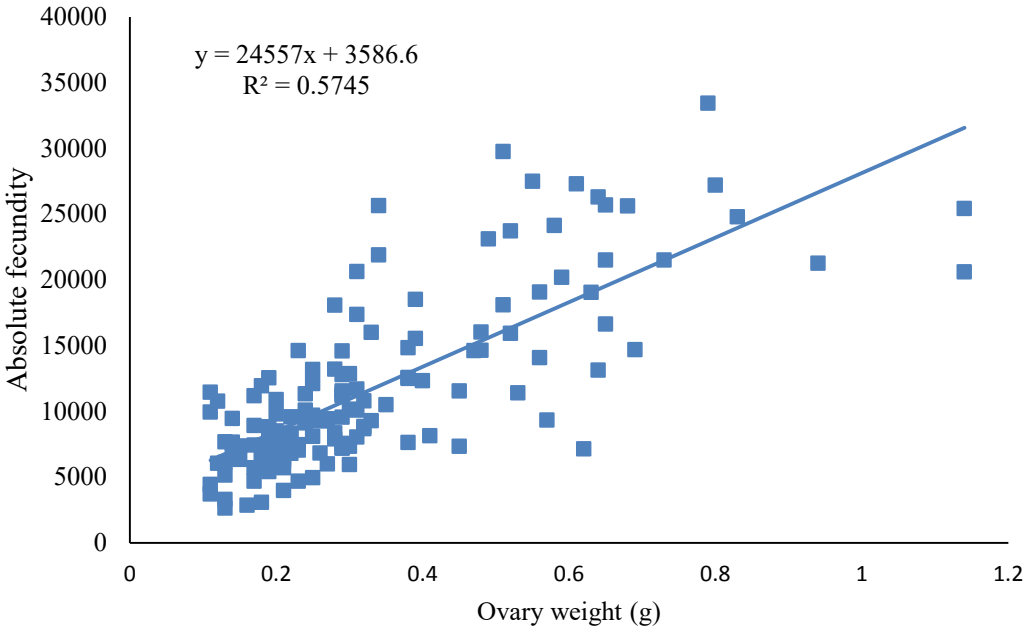

Figure 5. Relationship between fecundity and ovary weight of *Glossogobius giuris*

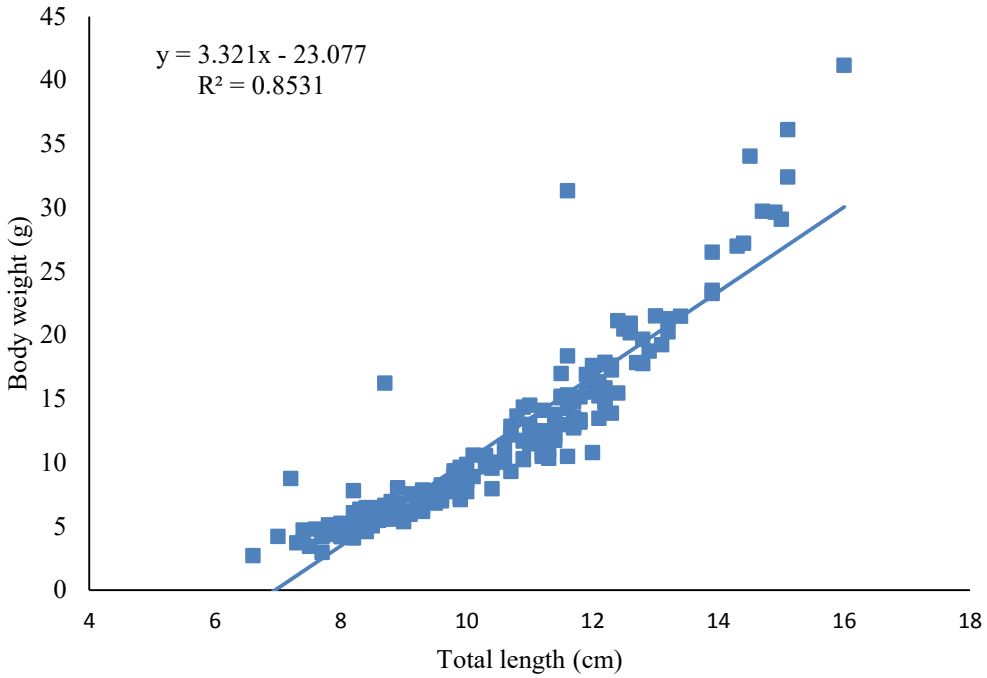

Figure 6. Relationship between body weight and total length of *Glossogobius giuris*

Discussion

A total of 200 female *Glossogobius giuris* were collected during December, 2018 to September, 2019 for the analysis of gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (K), fecundity (F) and length-weight relationship(LWR).

GSI indicates gonadal development and maturity of fish which increases with the maturation of the fish and declines thereafter (Parameswarn and Radhakrisshnan, 1974). Yeldan and Avsar (2000) also reported that GSI is widely used especially for the bony fishes in order to examine the spawning period because its value is directly related to the development of the gonad.

In the present study, the highest GSI values were observed in February (3.74), April (3.69), June (3.54) and August (5.01) with two spawning peak one in February and other in August. Therefore, the fish spawned for several months and this also indicate prolonged breeding season which was extend from February to August. Thant Zin (1988) observed that the highest value of GSI in April and lowest in December in *G. giuris*. Myin Zu Minn (1989) also stated that the highest of GSI value in April and lowest in October in *G. giuris*. Therefore, their findings are found to be contrast with the present study.

The highest GSI values recorded during the present study were in the month of August which shows peak breeding season with lower values of HSI. It was observed that when the HSI values were at its minimal, the GSI values were highest and this condition suggests the point that the liver has a weight loss during reproduction which may indicate the mobilization of hepatic reserve for gonads maturation (Zin *et al.,* 2011). HSI is associated with liver energetic reserves and metabolic activity (Lenhardt *et al.*, 2009).The mean HSI of fish fluctuated from minimum 1.86 in the month of September to maximum 3.61 in April in the present study.

The condition factor is an index reflecting interaction between biotic and abiotic factors in the physiological conditions of fishes. Therefore, the condition factor may vary among fish species in different locations (Blackwell *et al.*, 2000). In this work, condition factor was the highest in February 1.08 ± 0.34% and the lowest in September 0.84± 0.08%. A small variation of mean K value was observed in this work. Anibeze (2000) stated that different values in K of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species.

Fecundity is the estimation of ova content in the ovary of a matured female specimen. The present study reveals that the maximum fecundity was 18841±8237for fish measuring 11.12 ± 1.58cm in mean total length and 14.96±4.91 g in mean body weight and minimum fecundity 8955± 2713was observed in fish having mean total length of 9.71 ± 1.05cm and mean body weight of 9.09±2.51g. This study revealed that larger fish were more fecund than smaller fish. Similar results were also reported in the other fish species such as *Mystus cavasius* (Su Hlaing Thant, 2011) and *Channa orientalis* (Zin *et al*., 2011).

Variation in the fecundity among the fishes is the same as well as different species in very common depending upon the various factors such as size of the fish, age and condition of the fish, and also depends upon the space and food intake by the fish (Jan and Ahmed, 2016). Bagenal (1967) has reported that length and weight are reliable indicators of the capacity of egg production, and hence the fecundity increases with the increase of the fish in size and weight. This condition is also found in the present work, in which the number of eggs increases with an increase of length and weight of fish. In the present study the correlation between fecundity and total length was found to be R^2 = 0.397, fecundity and

body weight R^2 = 0.4146 and fecundity and ovary weight R^2 = 0.5745. Therefore, ovary weight is more correlated with capacity of egg production.

The length-weight relationship of fish is an important fishery management tool. Its importance is pronounced in estimating the average weight at a given length group and in assessing the relative well being of a fish population (Bloger and Connoly, 1989). In this work, the relationship between total length and body weight had shown that there is a close linear relationship having a value of R^2 = 0.8531.

Conclusion

In this study, the fish spawned for several months in the year with highest peak spawning season in February to August. This basic information will be helpful to evaluate reproductive potential of individual fish species in similar studies. Similarly, it will be useful for fishery biologist to conserve adequate regulation for substainable fishery management to control over exploitation.

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.

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Phytochemical Screening and Antioxidant Activity of Rhizome Extract of *Alpinia conchigera* Griff.

Khin Myo Aye[1], Khin Hnin Yee[2], Khin Soe Aye[3]

Abstract

Morphological of rhizome of *Alpinia conchigera* Griff. belonging to the family Zingiberaceae was reported. In addition, this rhizome was studied by using phytochemical test and antioxidant activity of rhizome was investigated. The phytochemical tests indicated that tannins, saponins, flavonoids, alkaloids, phenols and proteins were present in this rhizome. Furthermore,the antioxidant activity of the extracts was carried by1,1-diphenyl-2-picrylhydrazyl radical (DPPH) scavenging assay to obtain an IC_{50} value. Strong antioxidant activity of *Alpinia conchigera* Griff. was shown in this experiment compared with the control ascorbic acid.

Key words: *Alpinia conchigera,* Phytochemical test, Antioxidant activity, DPPH free radicals,

Introduction

Human beings are dependent upon the plants and plant products for their basic needs, and in modern civilization, they still need the plants and plant products in daily life, as sources of food, oxygen, wood, drugs, many fibers, fossil fuel, insecticides, biofertilizers, ornamentals, as well as rubber and other products.

Most of the members of the Zingiberaceae have been used worldwide in traditional medicines for the treatment of diseases. Herbal medicine is a traditional medicine or folk medicine based on the use of plant parts and plant extracts.The herbal medicines have been recognized as a valuable and readily available resource of primary health care (Cruickshank, 1970).

Alpinia conchigera Griff is used in cooking, medicine and flavouring liquers and bitters. The extracts of rhizomes of *Alpinia conchigera* probably contain phenol and polyphenolic compounds that are responsible for its antioxidant activitiy. So this specimen was selected for this research.

The family Zingiberaceae comprises of about 47 genera and 1400 species distributed in tropical and subtropical regions of the world (Hutchinson,1967; Lawrence, 1964).Hooker (1894) reported that the family comprises of 40 genera and 400-500 species. 42 genera and 750 species were recorded by Rendle (1930). According to Hundley and Chit Ko Ko (1987), 125 species belonging to 18 genera are represented in the Union of Myanmar.

The family is taxonomically characterized by the presence of the leaves which are distichous or in spiral, the sheathing petioles usually opened, rarely closed, the presence of aromatic oils, ligulate and zygomorphic, trimerous flowers with the marked differentiation of the outer perianth series from the inner, the single fertile stamen, the large, usually petaloid staminodium, the inferior ovary and the seeds with copious hard or mealy endosperm.

The phytochemistry has developed with the chemical aspects of various metabolite processes taking place in plants. The phytochemicals are plant chemicals that they have

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health enhancing effects. The plant produces numerous substances such as phenols, terpenoids, alkaloids, glycosides and various phytohormones (British Pharmacopoeia, 1968).

There is an improved and increased interest in plants secondary metabolites like polyphenols, because of their therapeutic effects. Polyphenols or phenolic compounds form a large group of secondary compounds including phenolic acids, carotenoids, flavonoids, tannins, flavones, glycosides, etc. These phenolic compounds have the property of quenching oxygen-derived free radicals by donating a hydrogen atom or an electron (Madhu, K., 2013).

Phenolic compounds are responsible for antioxidant property. Antioxidants are classified into two major categories, natural and synthetic antioxidant. Plants are prospective source of natural antioxidants. The natural antioxidants are safer and environment friendly than synthetic antioxidants. Plants are a potential source of natural antioxidants which are secondary metabolites of plant, that exhibit a wide range of biological effects like antibacterial, anti-inflammatory, anti-allergic, antihepatotoxic and antithrombotic activities and prevention of cardiovascular diseases (Sadeghi, Z., Valizadeh, J., 2015).

Antioxidants are capable of blocking the effect of the Reactive Oxygen Species (ROS). In living organisms, the imbalance in the production and detoxification of free radicals by the biological system causes oxidative stress. Free radicals are generated by different types of exogenous chemicals and a number of endogenous metabolic processes oxidize the bio molecules leading to cell death and tissue damage. The organism must keep free radicals at relatively low concentrations using different defence systems and antioxidant molecules (Bhattacharyya, A.,Chattopadhyay, R.,Mitra, S., 2014).

Production of high amount of reactive oxygen species overcomes inbuilt antioxidant system and damages the cells, tissues and organs and hence, there is a need to develop new drugs from traditional medicine to protect and support the biological system to avoid serious disorders of liver, cardiac and cancer diseases,etc (Shivasharanappa, K., Londonkar, R., 2014).

Most of the antioxidant compounds in a typical diet are derived from plant sources and belong to various classes of compounds with a wide variety of physical and chemical properties. The main characteristic of an antioxidant is its ability to trap free radicals (Walton and Brown, 1999).

Finally the aim of this research is to provide the information of morphological characters; to observe the preliminary phytochemical findings; to interest the pharmacological active compounds and its effects.

Materials and Method

Plant Material Collection:

The specimens had been collected from Mansan Fall, Lashio Township, Northern Shan State, during June to August 2018. The collected specimen was recorded by photographs while flowering and fruiting periods. The collected specimens were described, identified and classified by referring to Flora of British India (Hooker, 1894), Flora of Java (Backer, 1963), Flora of Ceylon (Dassanayake, 1976) and Brummit (1992).

Preparation of Plant Extract:

The collected specimens were washed to remove dust and rinsed again with distilled water. The plant samples were air dried at room temperature 35ºC-40ºC for one month. After drying the samples, they were ground to get powder and stored in air-tight containers for further chemical analysis.

Preparation of Methanol Extract:

The dried powder of rhizomes 100g was percolated with 500 ml of methanol for one week and filtered with filter paper for three times respectively. The filtrates were evaporated by removing the solvent under reduced pressure, using rotary evaporators at 50ºC.Then the filtrates were dried in a beaker placed on a water bath at 60ºC. The dried extract was stored in the desiccator for further analysis.

Phytochemical Screening

The preliminary phytochemical screening for bioactive compounds was carried out by the standard methods (Trease & Evans, 1989; Harbone, 1998). The phytochemical examinations were performed on the liquid and dried extracts. The preliminary phytochemical screening of *Alpinia conchigera* rhizome extracts was carried out for the presence or absence of alkaloids, carbohydrates, tannins, saponins, flavonoids, phenols, and proteins, etc.

Test for Carbohydrates

2ml of Molisch´reagent and few drops of concentrated sulphuric acid were added to 5ml of rhizome extracts. Reddish violet ring was formed at the junction of the acid and carbohydrate solution indicated the presence of carbohydrates.

Test for Tannins

2ml of ferric chloride were added to 5ml of rhizome extracts. The extracts turn into greenish black indicated the presence of tannins.

Test for Saponins

5ml of distilled water added to 5ml of rhizome extracts and vigorously shaken for 15 minutes lengthwise. Formation of 1cm layer of foam indicated the presence of saponins.

Test for Flavonoids

6ml of dilute ammonia solution was added to 2ml of rhizome extracts,followed by addition of concentrated sulphuric acid. Appearance of yellow coloration indicated the presence of flavonoids.

Test for Alkaloids

2ml of concentrated hydrochloric acid were added to 5ml of rhizome extracts.Then few drops of Wagner´s reagent were added. Formation of turbidity or reddish brown precipitate indicated the presence of alkaloids.

Test for Phenols

2ml of distilled water were added to 5ml of rhizome extracts, followed by few drops of 10% ferric chloride. Turning of green colour indicated the presence of phenols.

Test for Proteins

5ml of rhizome extracts were boiled with 2ml of Ninhydrin solution, violet colour appeared suggesting the presence of proteins.

Antioxidant Activity

The methanol extract of Padegaw-gyi was determined its antioxidant activity by DPPH Scavenging Assay.

Chemical and materials:

Reagents and chemical used in this experiment were of the highest analytical grade. The antioxidant activity of plant extracts was determined by the DPPH free radical scavenging assay according to Lee *et.al.* The samples were dissolved in DMSO (10mg/ml) and the dissolved samples were diluted with 50% EtOH for various concentrations. Briefly, the reaction mixture containing 50µl of diluted test sample of various concentrations and 50 µl of DPPH (300 µml) dissolved in ethanol, was taken in a 96-well micro-liter plate and kept standing at 37ºC for 30 min. The absorbance was measured at 517 nm by using 96-well microplate reader (Spectrostar Nano, BMG Labtech Microplate reader). Ascorbic acid was used as positive control, 50% EtOH was used as negative control and added to the 96-well plate instead of the sample. Percent Radical Scavenging Activity (% RSA) was calculated by using the following formula:

%RSA = [1-(ABS test compound/ABS control)]x100

ABS = Absorbance

RSA = Radical Scavenging Activity

Statistical Analysis

The experimental work was performed by triplicates test. The results were reported as mean ± standard deviation (SD).Calibration curve was obtained by plotting percentage inhibition against standard concentration. The IC_{50} value was calculated from linear regression analysis, using Microsoft excel.

Results

Morphological characters

Alpinia conchigera Griff. Not. Pl. Asiat. 3:424. 1851.

Myanmar Name : Padegaw-gyi

English Name : Greater galangal

Family : Zingiberaceae

Flowering period : June to September

Perennial rhizomatous herbs, about 2.0 m high, brownish without and light yellow within, more or less aromatic, aerial stems terete Leaves simple, alternate and distichous, oblong-lanceolate,18 - 25 cm long and 7.0 - 9.0 cm wide, obtuse at the bases, undulate along the margins, acuminate at the apex, sheathing petioles 27 -45 cm long and 1.5 -2.0 cm wide. Inflorescences terminal, dense paniculate cymes, oblongoid, 15 - 25cm long and 7.0 - 8.0 cm wide; peduncles elongate; bracts variable, the lateral bracts linear-oblong, the floral bracts oblong, 7 -10 cm long and 2 -3 mm wide. Flowers purplish- white, zygomorphic, 3.5 -4.7 cm long and 2.0 - 3.0 cm wide. Calyx tubular, 1.0 -1.3 cm long and 5 -10 mm wide; tubes 0.5 - 1.5 cm long and 8 -10 mm wide; lobes unequal. Corolla infundibuliform, pale green; tubes 1.0 -1.2 cm long and 3 -4 mm wide, lobes unequal, the dorsal 1.3 -1.5 cm long and 5 - 7 mm wide, the laterals 1.2 - 1.5 cm long and about 4 mm wide. Fertile stamens one, 2.0 - 2.5 cm

long and about 4 mm wide;filaments flattened;anther ellipsoid;2 basal staminodes oblongoid, yellow, 4 - 5 mm long and about 2 mm wide; labellum obovate, 1.5-2.0 cm long and 1.0 -1.5 cm wide.Ovary inferior,oblongoid,triloular, 2 ovules in each locule on the axile placenta; styles filiform; stigmas subgloboid.

Specimen examined : Mansan Fall, Lahio Township, Northern Shan State,11 July, 2018, Khin Myo Aye, Collection No.1.

Figure (1). ***Alpinia conchigera*** **Griff. plants bearing inflorescences**

Figure (2). ***Alpinia conchigera*** **Griff. plants rhizomes and roots**

Preliminary Phytochemical Analysis

The preliminary phytochemical studies for the methanol extract of *Alpinia conchigera* Griff., show the presence of tannins, saponins, flavonoids, alkaloids, phenols and proteins; and the absence of carbohydrates. The phytochemical constituents of the plants investigated are summarized in Table1.

Table (1). Preliminary phytochemical test of rhizomes of methanol extract for ***Alpinia conchigera*** **Griff.**

No	Chemical Constituents	Chemical Reagents	Observations	Results(+/-)
1	Carbohydrates	Molisch's reagent	Violet ppt	-
2	Tannins	5% Ferric chloride	Greenish black	+
3	Saponins	Distilled water	Layer of Foam	+
4	Flavonoids	Dil. NH_3 sol+ con H_2SO_4	Yellow color	+
5	Alkaloids	con HCl+ Wagnar's reagent	Reddist brown ppt	+
6	Phenols	10% Ferric chloride	Green color	+
7	Proteins	Ninhydrin solution	Violet color	+

\+ presence of chemical constituent

\- absence of chemical constituent

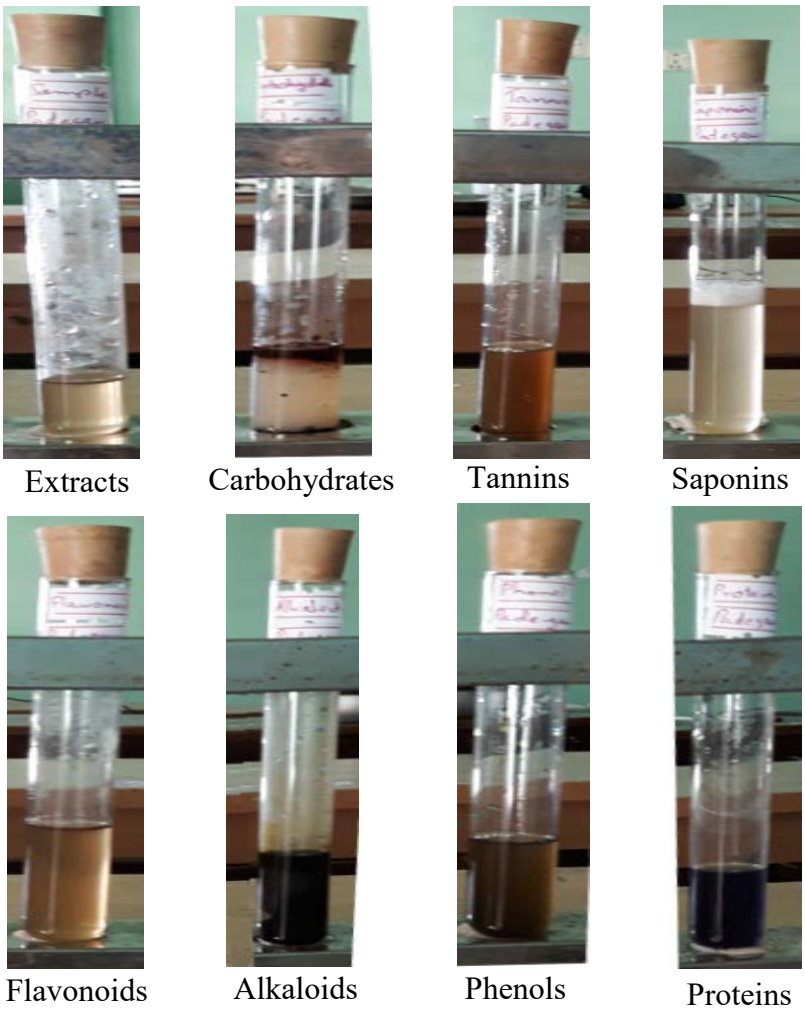

Figure (3). Preliminary phytochemical tests of rhizomes of methanol extract for *Alpinia conchigera* Griff.

Antioxidant Activity

The antioxidant activity of Padegaw-gyi was carried out by DPPH scavenging assay. Strong antioxidant activity of (IC_{50}: 795.01 ±39.73) µg/ml was shown in this experiment, compared with the control ascorbic acid(IC_{50}: 84.78± 0.39) µg/ml.

Table (2).The antioxidant activity of Padegaw-gyi was carried out by DPPH scavenging assay

Sample (Concentration µg/ml)	**1000**	**500**	**250**	**125**	**62.5**	**31.25**	**IC(µg/ml) ± SD**	**Method**
DPPH Scavenging (%)±SD	65.48±4.47	28.23±1.71	20. 93±4.35	12.62±0.71	4.30±2.98		**795.01±39.73**	**DPPH Radical Scavenging Assay**

All data were represented as Mean±SD from triplicate experiments. Ascorbic acid was used as a positive control for DPPH Radical Scavenging Assay.IC_{50} of Ascorbic acid is 84.78± 0.39µg/ml. The concentration of DPPH used for this experiment was 0.3mM.

Antioxidant Activiy Test Report

MINISTRY OF EDUCATION

BIOTECHNOLOGY RESEARCH DEPARTMENT

Medical Biotechnology Laboratory

Tasoe Gate, Kyaukse-Myitthar Road, Kyaukse District, Mandalay Region, Myanmar

Ph: 066-50622, Fax: 066-50623, email: brdkse1234@gmail.com

Antioxidant Activity Test Report

Sample From: Dr. Khin Myo Aye

BRD-PRD-11/2019
Page 1

Date Received: 25.11.2019

Date Analyzed: 27.11.2019

Date Reported: 6.12.2019

Sample Name: Alpinia Extract (MeOH)

Sample (Concentration µg/ml)	1000	500	250	125	62.5	31.25	IC_{50} (µg/ml) ± SD	Method
DPPH Scavenging (%) ± SD	65.48 ± 4.47	28.23 ± 1.71	20.93 ± 4.35	12.62 ± 0.71	4.30 ± 2.98		795.01 ± 39.73	DPPH Radical Scavenging Assay

All data were represented as Mean ± SD from triplicate experiments. Ascorbic acid was used as a positive control for DPPH Radical Scavenging Assay. Ascorbic acid shows 94.63± 0.34 % inhibition at 500 µg/ml and IC_{50} of Ascorbic acid is 84.78 ± 0.39 µg/ml. The concentration of DPPH used for this experiment was 0.3mM.

Antioxidant activity test was performed at Medical Biotechnology Laboratory, Biotechnology Research Department (BRD), Kyaukse, Mandalay Division, Myanmar.

Not a certificate of conformance
စံချိန်စံညွှန်းကိုက်ညီကြောင်းထောက်ခံချက်မဟုတ်ပါ

Tested by: Dr. Khine Zar Wynn Myint

Checked by: Dr. Khin Mar Mya

Confirmed by: Dr. Aye Aye Khai

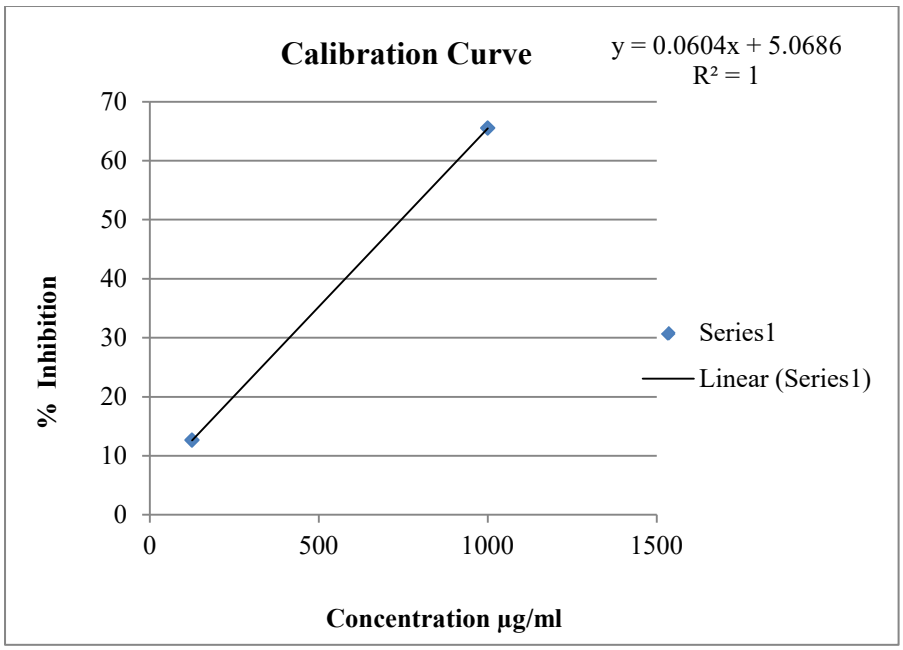

Figure (4). Calibration curve

Discussion

Alpinia conchigera Griff. are characterized by perennial underground stems (rhizomes), leaves simple and distichous, petioles long, the sheathing petioles usually opened, rarely closed, and ligulate.The flowers are irregular, trimerous, with single fertile stamen and two to five petaloid staminodes. The ovary was inferior, trilocular, axile placentation. These morphological characteristics were in accordance with those described by Rendle (1930), Lawrence (1964), Nyunt Nyunt San (1992).

Phytochemical constituents in the plant samples are known to be biologically active compounds and they are responsible for different activities such as antioxidant, antimicrobial, antifungal and anticancer (Hossain and Nagooru, 2011).

The phytochemical screening carried out on the methanol extract of *Alpinia conchigera* Griff. rhizomes show the presence of tannins, saponins, flavonoids, alkaloids, phenols and proteins; and the absence ofcarbohydrates .

The phenolic compounds are commonly found in all plants but every plant contains different phenolic combinations; and the characters of these compounds are not well known. Therefore, evaluation methods, spectrophotometric method are commonly used for total phenolic content.

The antioxidant activity of Padegaw-gyi was carried out by DPPH scavenging assay. Strong antioxidant activity of (IC_{50}: 795.01 ± 39.73) µg/ml was shown in this experiment compared with the control ascorbic acid (IC_{50}: 84.78 ± 0.39%) µg/ml.

Conclusion

The extracts of *Alpinia conchigera* Griff. plant contain chemical compounds such as phenols and phenolic compounds that are responsible for its antioxidant activity. The result

showed that *Alpinia conchigera* Griff. extracts have interesting pharmacological active compounds and thus could be used in ethano medicine for the treatment of diseases.

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Morphological And Chromosomal Behaviour of *Pisum sativum* L. (Sadaw-Pe)

Khin Myo Swe[1], Nilar[2]

Abstract

The chromosomal feature of *Pisum sativum* L. Sadaw-Pe of fabaceae (leguminosae) family was studied. In the present study, univalent chromosomes are the lowest, ring bivalent chromosomes are highest and rod bivalent chromosomes, the second highest in metaphase I. Bridge chromosome and laggard chromosomes are found in anaphase I but not in telophase I. Normal spore tetrad and normal pollen numbers are found to be the highest.

Key words : Metaphase Characters of chromosomes

Introduction

There are about 400-500 genera and 10,000 species in fabaceae. The members of family are being distributed in the temperate regions of both Northern and Southern hemispheres. In our country the Papilionaceae is represented by many important genera commonly found in hills and plains. Usually the herbs belonging to this family appear flower in winter. (Nyo Maung, 2001).

Pisum sativum L. (garden pea) were probably originated in south west Asia; now cultivated in many temperature countries as a cool season crop in the subtropics and at higher altitudes in the topics (Vander Maesen, 1992).

One of its most well known characteristics is that many of its taxa are able to bind atmospheric nitrogen. This is a cosmopolitan family with about 11,000 species, and is one of the most important families. It includes many plants used as food; for example, numerous species of beans (*Phaseolus* and *vigna spp*., *Vicia faba* L.), peas (*Pisum sativum* L.), soy (*Glycine max* CL. Merril), fodder plants (*lupinus* spp.) and medicines.

The legumes or pulses belong to the family leguminosae. Most tropical countries have used leguminous pulse crops for centuries as staple food to supply some or all of their protein requirements and their experience with such crops. The food, the essential need for man and animal primarily comes from plants in the form of cereals, legumes or pulses, vegetables and fruits. Among them, the legume seeds, pulses are second only to cereals as a source of human and animal food. Nutritionally, they are 2-3 times richer in protein than cereal crops. Not only the seed but also all other parts of the plants are used as edible products. Therefore, legumes are very valuable food and forage crops (Vander Maesen, 1992).

The legumes or pulses belong to the family leguminosae. The legumes are next in importance to cereals as source of human food. They contain more protein materials than any other vegetative product. The pulses form an important item in India where the majority of the population consists of vegetarians. Carbohydrates and fats are also present in legumes. The proteins occur as aleurone grains in the same cells with the starch grains. The high protein contain is related with the presence on the roots of legumes with nodules containing

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nitrogen fixing bacteria. The pulses are also important from the point of view of animal nutrition, to which they contribute by their seeds, hulls and the green parts. The legumes have been cultivated and used for food for centuries all over the world. The pulses figure prominently in crop rotations and in the mixed cropping commonly practiced in Indian agriculture. About one-seventh of cultivated area in India is under pulses. Of this, about 37% is occupied by gram and 13% by the pigeon pea. The other important Indian pulses are black gram (urd), green gram (moong), lentil (masur), pea (matar), dew gram (moth), etc. (PANDY.B.P.2000).

When Mendel began his studies of inheritance using *Pisum sativum* L, the garden pea, chromosomes and the role and mechanism of meiosis were totally unknown. Nevertheless, he determined that discrete units of inheritance exist and predicted their behavior in the formation of gametes. Subsequent investigators, with access to cytological data, saw a relationship between their own observations of chromosome behavior during meiosis and Mendel's principles of inheritance. Once this correlation was recognized, Mendel's postulates were accepted as the basis for the study of what is known as transmission genetics, how genes are transmitted from parents to offspring. These principles were derived directly from Mendel's experimentation. Even today, they serve as the cornerstone of the study of inheritance. (William & Michaeal, 2009)

The graden pea seeds are eaten green or are used for canning. The seed is also used for human consumption in the from of pea meal or split peas. The peas are used as pulses, and they are good source of proteins. The plants are used for forage and green manuring. The peas are also available as canned, frozen and dehydrated peas. Peas have high content of proteins, i.e, up to 28 percent or more and also supply adequate quantities of vitamins and minerals, and potassium and phosphorus. Pea oil when given parenterally showed possibility of preventing pregnancy, the active principle being m-xylo hydroquinone. Trials on women with capsules containing 300-350 mg of m-xylo hydroquinone, twice a month, for variable periods showed 50-60 percent reduction in pregnancy rate. The drug is non-toxic and has no side effects. In trials on men, the drug caused 50 per cent reduction is the number of spermatozoa. (PANDY B.P.2000)

The "mummy pea" is a variety of *Pisum sativum* Linn. in which the upper part of the axis is funnel-shaped and bears a dense cluster of leaves and short inflorescence. "In the uppermost region of the swollen funnel-shaped axis, two continuous con-centric rings of vascular tissue are present. The outer of these rings is directly continuous with the single ring of bundles below, and the different vascular elements of the xylem, phloem etc. have normal orientation. The inner ring, on the other hand, has an inverse orientation of tissues. Between the two rings of vascular bundles, a zone of parenchymatous tissues, histologically like a medulla, is found. No vascular connection was discovered between the bundles of the outer cylinder and those of the inner, either at the node at which the latter takes its origin, or at any point of its course. (METCALFEC.R, 1950).

The history *Pisum sativum* L.of agriculture can be viewed as a series of human attempts to overcome environmental limitations and problems. It is also a history in which each new solution has created new environmental problems, which have, in turn, required their own solutions. Thus, in seeking to improve agricultural system, we should expect some undesirable side effects and be ready to cope with them. (John wiley & sons, 2003).

The basic nature of the gene was defined by Mendel more than a century ago. Summarized in his two laws, the gene was recognized as a "particulate factor" that passes unchanged from parent to progeny. A gene may exist in alternative froms (alleles). In diploid organisms, which have two sets of chromosomes one copy of each chromosome is inherited

from each parent. This is the some behavior that is displayed by genes. The equivalence led to the discovery that chromosomes in fact carry the genes. (Benjamin lewir (2000).).

Garden pea is an important cool season pulses in Myanmar. It is cultivated as second crop after rice. It is also sown as mid-monsoon crop in some areas of Upper Myanmar, such as Sagaing Division and Kachin State. In Myanmar, garden pea is produced for export as well as for local consumption.

The family fabaceae is well known for its economic and medical value.The present study will provide valuable knowledge of cytogenetics. The present research deals with the chromosomal feature study on *Pisum sativum* L. of He-Lon village in Mohnyin Township, Kachin State.

Materials and Method

The investigation is mainly focused on the morphological character of *Pisum sativum* L. The specimens were collected from the field of He-Lon village in Mohnyin Township, Kachin State. The sample collections were carried out in the cultivated fields, at 6:00 AM (i.e the optimal collection time) the best time for collection. It was recorded and photographed in the field trip.

After the collection, vegetative and floral parts of fresh specimens were studied and identified. The samples of pollen mother cell were collected at the early bud stages still moderately mature bud stages and immediately fixed in freshy prepared 1:3 (acetic acid : alcohol solution) containing brown glass vials. After fixing the specimens; one of the flower buds were selected and placed on glass slide. The anthers were crushed by using prepared forceps and needle pointer, and the sample was added one drop of Giesma stain and then covered thin glass cover slip.The samples were prepared, studied and recorded by using binocular microscopes and imaged by digital camera. Samples were prepared and recorded by photomicrographs.

Results

Morphological characters

Scientific name - *Pisum sativum* L.

Myanmar name - Sadaw-Pe

English name - Garden pea

Family - Fabaceae (Leguminosae)

An annual climbing herb, 3.5 m tall. Leaves alternate, petiolate, stipulate, with leaflets dark green,entire, acuminate,pubescent on both sides, reticulate venation and a terminal tendril, leaflets sometimes converted into tendrils. Inflorescence clustered axillary , flowers breateate, bisexual ,pentamerous, zygomorphic and hypogynous . Calyx sepal 5 green united and corolla of 5 are white,apopetalous, purple or pink petals. Stamens 10, diadelphous(9)+1nine stamens fused to form a bundle and free. Anthers dithecous,basifixed. Ovary superior, unilocular,with 4 to 15 ovules on marginal placentation,style simple and curve, stigma capitate. Fruit 3-11 cm long, with 3-11 seeds. Seeds round or wrinkled, green in colour when it is immature but it turns into dark yellow when it is mature.


Habit

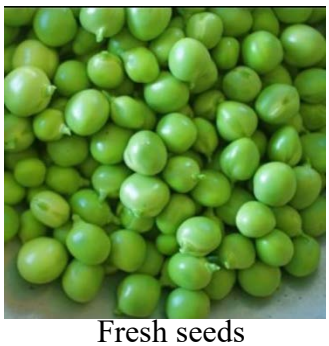

Infloresence


Leaves


Flowers


Pods

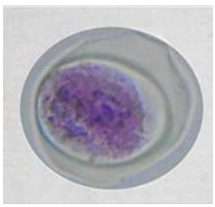

Pod with its seeds


Fresh seeds


Dry seeds

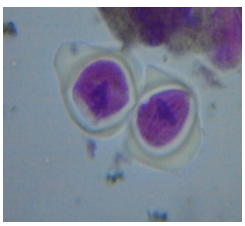
Chromosome Charaters

Prophase


Prophase

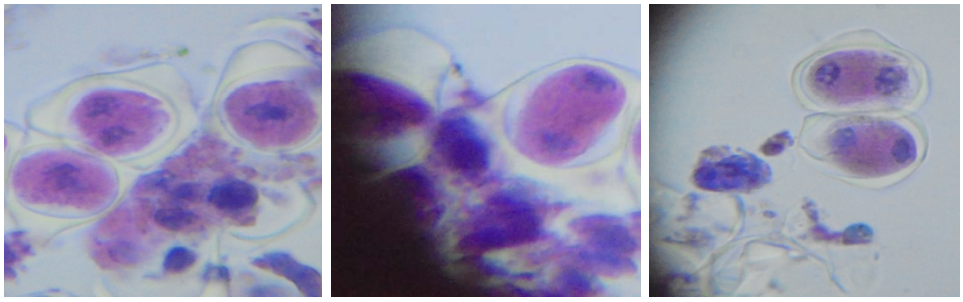
In the present study, *Pisum sativum* L. has possessed, the late substage of prophase is diakinesis. In this stage, chromosomes appear highly contracted due to formation of major coils. The separation of homologous chromosome is complete. The nuclear membrane begins to disappear gradually. The surface of chromosome appear rough. The chromosomes are spread in the whole cell. Chromatids condense, synapsis occurs each homologous pair of chromosomes. The chromosomes undergo marked differences in their shape and structure.

Metaphase I


Metaphase I

In the present study, univalent chromosomes were observed on metaphase I of meiosis. The chromosomes that stood separately without pairing with any other chromosome were recorded as univalent chromosome. Number of univalent chromosome per cell was based on observation of 50 number of cells. Therefore *Pisum sativum* L has possessed the lowest univalent chromosome number.

At metaphase I of meiosis, the two homologous chromosomes that paired with each other were regarded as bivalent. Due to synapsis of homologous chromosome pair, two types of bivalent have been observed and recorded. The pair chromosome that synapse at both end of the chromosome was recorded as close bivalent or ring bivalent, and the one that synapse only at one end and left open at the other end was recorded as open bivalent or rod bivalent. The chromosomes are associated in the middle in the cell plate and some chromatics are separated of chromosome in the cell. Therefore, *Pisum sativum* L. has possessed the highest ring bivalent chromosome and the second highest rod bivalent chromosome.



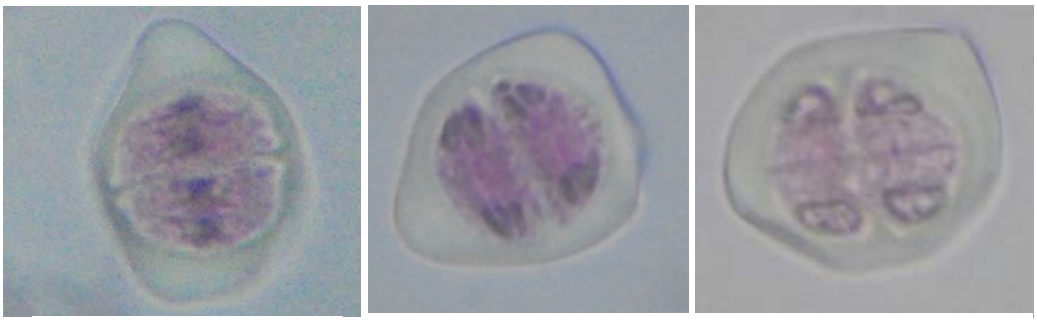
Early Anaphase I Late Anaphase I Telophase I

Early anaphase I, Late anaphase I and Telophase I

In the present study, chromosomes that left behind during the other chromosome move to their pole (Anaphase I) and those pole reached chromosome enclosed in newly formed nuclear envelope. (Telophase I) was recorded as laggard chromosomes at Anaphase I and Telophase I respectively.

Metaphase II , Anaphase II and Telophase II

Paired chromosomes that do not segregate and stretched along center of the dividing cell in the form of bridge were named as bridge chromosome. They were also studied and recorded for further analysis. Therefore, *Pisum sativum* L has exhibited normal cell (i.e with no laggard and bridge chromosome). In the present study of Metaphase II, Anaphase II and Telophase II, normal chromosome pairing were observed in *Pisum sativum* L.



Metaphase II Anaphase II Telophase II

Spore Tetrad

In the present study, laggard chromosomes that left behind formed by themselves as small nucleus known as micronuclei. The spore tetrad which has only one large nucleus and has no small nucleus was recorded as normal spore tetrad. Abnormal spore tetrad was observed many micronuclei and large normal nuclei. Therefore, *Pisum sativum* L has possessed the highest normal spore tetrad.

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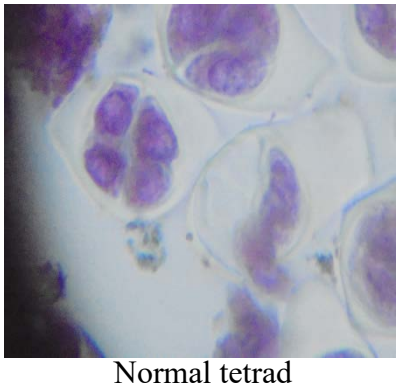
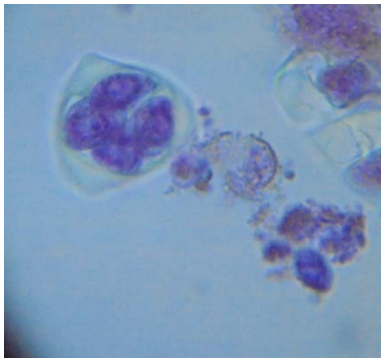


Normal tetrad



Abnormal tetrad

Normal and Abnormal Pollen

In the present study, normal pollen has one generative nucleus and two vegetative nuclei in normal condition. Abnormal pollen was observed lack one or both vegetative nucleus and only the generative nucleus. Normal and abnormal pollens were also counted. Therefore *Pisum sativum* L. has possessed the highest normal pollen.

Normal pollen

Abnormal pollen

Discussion and Conclusion

In the present study, the chromosomal features of *Pisum sativum* L. (Sadaw-Pe) was examined. The chromosomal feature has been based on the basis of meiosis characters from *Pisum sativum* L. grown in Mohnyin Township were studied.

Pisum, the famous experimental plant of Mendel, is one of the genetically best analysed organisms. *Pisum* has 14 chromosomes and tentative chromosome maps with a great number of identified loci exist for all seven chromosome pairs. (Klasterska and C. Ramel 1981).

A great number of genetically well analysed stocks are available and stocks with high fertility are of economic value. *Pisum* meiosis has only been studied by a few cytologists and in fact, this area has been almost neglected during the last few years. The reason for this seems to be the difficulty to interpret the meiotic prophase and to analyses the meiotic events in *Pisum*. (Klasterska and C. Ramel 1981).

In the present study, the chromosomes undergo marked differences in their shape and structure. The chromosomes are spread in the whole cell in prophase.

Metaphase I of all studied *Pisum sativum* L. was showed that non-significantly in univalent chromosome. In the present study, in metaphase I ring bivalent and rod bivalent chromosomes were significantly of *Pisum sativum* L.

In the present study, (Sadaw-Pe) *Pisum sativum* L. showed that synchronous chromosome pairing was observed in anaphase I, telophase I. Metaphase II, and Telophase II were observed all normal chromosome separation, (no laggard chromosome and bridge chromosome formation).

In the present study, spore tetrad was observed in *Pisum sativum* L. It was observed that occurrence of micronuclei per spore tetrad is lowest in Sadaw-Pe. Therefore, the pollen fertility was found that (Sadaw-Pe) was highest pollen fertility.

The present study deals with chromosomal feature of *Pisum sativum* L. (Sadaw-Pe) grown in Mohnyin Township and the present data will be served valuable information for further investigation and further work with cytogenetics of family fabaceae.

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Sedimentary Facies Analysis of the Paleocene-Neogene Rocks of the Kyauktan-Khantha Area, Kawlin Township, Sagaing Region

Khin Khin Lin[1]

Abstract

The study area is located in the Kawlin Township, Sagaing Region.The study area lies in the central volcanic line which extends from Mt. Loime, north of jade mine area in the north through the Wuntho, Monywa, Mt. Popa to the Barren and Narcondam Island in the south. In the study area, lithostratigraphic units ranging in age from Mesozoic to Cenozoic are exposed. The eastern part of the study area is composed of the metamorphics which are sepentinites and unfossiliferous, probably Mesozoic limestones, slate, greywackes, cherts and basalt (Kywethe Chaung Limestone, Ngapyawdaw Chaung Formation). It is overlained by the Tonkyauk Chaung Conglomerate and grades into Eocene Male Formation and Oligocene- Miocene units of Sadwingyi Formation. At least 10 lithofacies are recognized and each facies is a sedimentary sequence that has well-defined set of lithology, stratification, primary depositional structure, texture and fossil content under a defined hydrodynamic condition. At least three facies association can be established. The prodelta/shelf facies association, the occurrences of green sandstone of the Sadwingyi Formation indicate that marine transgression occurred at the beginning of Miocene. The upper part of the sequences indicates that the near the seaward limit of distributary channel sandstone and mudstone interbed unit may be deposited in sandy shoal. During flooding stage, gritty sandstone with mudclast is deposited the upper part of the shelf environment. The Delta front distributary channel lag and distributary mouth bar facies associations indicate that the Tonkyauk Chaung conglomerate and Male Formation may be deposited under Deltaic condition of delta front environment. In the delta front facies, no marine and wave influence characters are found. Fluvial influence sedimentation pattern is developed in this environment.by the nature of delta front, the type of delta may be fluvial dominated delta. The Sadwingyi sandstones indicate the age dating analysis of the mean maximum depositional age (MDA) derived by the youngest zircon and titanite grains provided a robust 25.27±0.68 (MSWD=1.3) which agrees with the Oligocene biostratigraphic age.

Key words: lithofacies, facies association, depositional environment.

Introduction

The study area is located in the Kawlin Township, Sagaing Region.The area is accessible throughout the year either by car or by motorcycle from Shwebo to the study area. The study area lies in the central volcanic line which extends from Mt. Loime, north of jade mine area in the north through the Wuntho, Monywa, Mt. Popa to the Barren and Narcondam Island in the south (Chibber, 1934). Location map is shown in Fig 1. In the study area, lithostratigraphic units ranging in age from Mesozoic to Cenozoic are exposed. The study area on the South-Eastern of the Wuntho Massif is mainly composed of various igneous rocks such as volcanic rocks (andesite, dacite, rhyolite and trachyte) and the plutonic rocks (diorite and granitic rocks). These igneous rocks are related to the Mesozoic to Tertiary igneous activities of the northern part of the Western Myanmar Arc (WMA). Moreover, the dykes and veins of granite-apalite, tonalite, andesite and quartz veins intruded into these rocks. The Tertiary sedimentary rocks were deposited over the igneous rocks.The igneous unit, Ubye serpentinite (Triassic?) crops out at the eastern region of the study area.

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According to Myint Thein, 1991, the eastern part of the study area is composed of the metamorphics which are sepentinites and unfossiliferous, probably Mesozoic limestones, slate, greywackes, cherts and basalt (Kywethe Chaung Limestone, Ngapyawdaw Chaung Formation). It is overlained by the Tonkyauk Chaung Conglomerate and grades into Eocene Male Formation and Oligocene-Miocene units of Sadwingyi Formation.

Stratigraphy

Tonkyauk Chaung Conglomerate

In this study area, Tonkyauk Chaung Conglomerate (Paleocene) is the oldest Tertiary Formation, well developed at the western margin of Minwun range of the study area and overlying pre-Tertiary rocks unconformably and consisting of alluvial fan sediments, with a maximum thickness of 300m (in Tonkyauk Chaung 7 km SW of Kyaukpahto Gold Mine). As described by Myint Thein et al, 1987 unconformably overlying the Ngapyawdaw Chaung Formation are Cenozoic units, of which the basal unit is Ton Kyauk Chaung Conglomerate. The conglomerates are composed of fragments of argillite and slate (i.e. Ngapyawdaw Chaung Formation). The beds generally dip NNW about 30-40. Passing up section, the conglomerates become thinner, sandier and grade into the Lower Male beds.

The unit is resistant nature; it forms a ridge with a steep west-facing dip-slope. It extends northwards through the Kanyit-in village to the upper reaches of the Dobin Chaung. The basal beds of the unit are exclusively composed of angular fragments of argillite and slate. The basal beds are followed by the sandy layers with lenses of conglomerates. The conglomerate is predominantly dark-gray and weathers to buff colour. A few sandy lenses are present and it breaks across the phenoclasts (Figs.1 and 2). The phenoclasts are argillite, clay-slate, chert, calc-silicate, quartz, limestone and wood fossils, in descending order. This striking ruditic formation is well exposed along the eastern margin the Shwebo basin, this area, consisting of thick-bedded, indurated pebble to cobble conglomerate and grades upward into the Male Formation.

The fossils have not been obtained from the Tonkyauk Chaung Conglomerate. The field relation indicates that the unit is definitely younger than the Ngapyawdaw Chaung Formation, (see Myint Thein et al, 1983). The Tonkyauk Chaung Conglomerate may be correlated with the Paunggyi conglomerate which according to most authors is Paleocene. The Palynological analysis of the Tonkyauk Chaung conglomerate revealed Diporricellaesporites sp., Pcoxaperites operculates, Polyporia sp., and Psitodisporite sp., indicating an Early Eocene Age (Hla Mon, 2013).

Male Formation

The name was originally used by Myint Thein *et.al* 1979 to describe a clastic sedimentary unit of Middle to lower Eocene. This formation is extensively exposed in the study area. One of these is locally known as Singaung Taung. This formation also especially exposed central and western region of the study area. The bold massive sandstones and units are interbedded sandstone and shale and the sandstones are light-grey, less indurated, gritty to coarse - grained and cross-bedded, which form the entire portion of the Minwun Range (Fig.3). The Male formation consists of very thick bedded to massive sandstones, coarse-grained, gritty to pebbly conglomerate interbedded with mudrocks, shale and clay (Fig.4). Argillaceous intervals become thicker towards the upper part and they are colour banded in red, yellow clay and siltstone. The interbedded sandstone and mudrock are locally rich in freshwater pelecypod and brackish fossils (Cerithium and Cyrena) and a few leaf impressions and with carbonaceous streaks and chips of coal lenses. Some of the sandstone are either dark

bluish-grey or greenish-grey colour and contain a rich Mollusca (mainly gastropods) fauna and a few leaf impressions (Fig.5).

The upper part of the formation comprises more massive sandstone with pebbly horizons, and cross-bedding. Thin shales and clays are present. The beds trend roughly N-S in the area south of Kyaukpahto, passing northwards they tend to strike more NNE-SSE.

Sadwingyi Formation

The name Sadwingyi Formation was first described by Than Zaw (1980) for a lithostratigraphic sequence of dark, bluish-gray, concretionary clays and intraformational clay pebble conglomerates. The Sadwingyi Formation is well exposed near Kyauktan village and along the Kyauktan to Kawlin car road. It is mainly composed of thick bedded to massive, green sandstone are intercalated with coal chips of up to 1 m long (Fig.6). The siltstone and clay are intercalated with thinly bedded fine sandstone. The green sandstone beds are intercalated with coal chips and exposed near Kyauktan village. Some conglomerate beds were found occasionally.

Sedimentary Facies Analysis

Siliciclastic depositional environments give rise to characteristic sedimentary facies, as outlined with composition, textures and sedimentary structures dependent mainly on sediment source and supply and depositional process. Tectonic context, position of sea level and climate are major external factors affecting and controlling the pattern of sedimentation. Also stratigraphic facies representing any aerially restricted part of a designated stratigraphic unit or any genetically related body of the sedimentary deposit which exhibits lithologic and paleontologic characters significantly different from those of another part of the same unit. Each lithofacies represents on individual depositional events. Lithofacies may be grouped into lithofacies associations or assemblages which are characteristic of particular depositional environments (Miall, 1984).

The present investigation of this area, the Tonkyauk Chaung Conglomerate, Male Formation and Sadwingyi Formation are a succession of sandstone, shale, siltstone and conglomerate with combined thickness of about 2084 feet. At least 10 lithofacies are recognized and each facies is a sedimentary sequence that has well-defined set of lithology, stratification, primary depositional structure, texture and fossil content under a defined hydrodynamic condition. Facies which have been formed contemporaneously in a particular depositional environment are grouped into a facies association. Facies columns are shown in figures (21-22).

Description of Facies

Facies A (Crudely bedded conglomeratic sandstone)

This facies is characterized by buff colour, crudely bedded, moderately to poorly sort conglomeratic sandstone. The thickness ranges from 2 to 6 m in thickness. The sandstone consists of medium to coarse grained, grits and contains pebbles. Isolated pebbles are common within sandstone beds and size ranges from 2 to 4mm and light grey colour. The clasts are argillite, clay-slate, chert, calc-silicate, quartz, and limestone clasts (Fig.7). The crude horizontal bedding and the absence of cross stratification implies unconfined sheet flood-dominated flow rather than channelized stream flow. Conglomerate stringers suggest bed load traction transport in a turbulent flow regime.

Fig.1 Photograph showing textural characteristics of Tonkyauk Chaung Conglomerate

Fig.2 Photograph showing textural characteristics of Tonkyauk Chaung Conglomerate

Fig.3 Thick bedded to massive, buff colour gritty sandstone of Male Formation

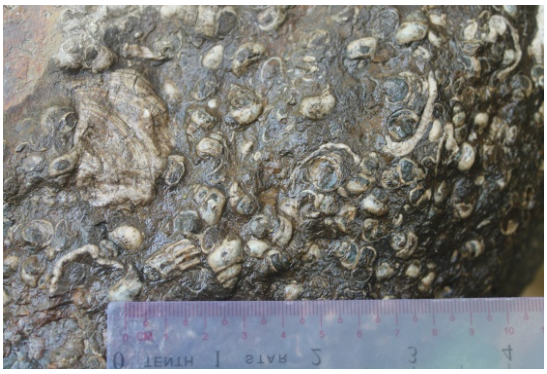


Fig.4 Dark bluish-grey or greenish-grey colour and contain a rich Mollusca (mainly gastropods) fauna of Male Formation

Fig. 5 Thick bedded to massive sandstone with leaf imprint in Male Formation

Fig. 6 Thick bedded to massive, green sandstone are intercalated with coal chips of Sadwingyi Formation

Facies B (Thick-bedded to massive, medium to coarse-grained sandstone with trough cross bedding)

This facies is characterized by grey to buff color, trough cross bedded, medium to coarse grained sandstone. Each cross set is varying in thickness ranging from 0.5 to 1.5 m thick. This facies is erosive based and pebbles sometimes are scattered. It is associated with medium to thick bedded sandstone with conglomerate beds and planar type sandstone beds (Figs.8 and 9). The trough cross bedded is interpretative of distributary channel.

Facies C (Medium to thick-bedded sandstone and pebble conglomerate with planar cross bedding)

This facies is characterized by grey to dark grey colour, medium to thick bedded, medium to coarse-grained, large scale planar type cross bedded sandstone. The cross sets are 1 to 1.3 m in thickness. Pebbles and dispersed mud clasts are found along the cross strata. Sand with pebbles and pebbles size are ranged from 2 to 4mm (Figs.10 and 11). This facies is

sharp and straight base. Planar cross bedding is most abundant in pebbly coarse sand sediments of braided streams (Reneick and Singh, 1980). The planar cross-bedded sandstone is interpreted as bar deposit of distributary channels.

Facies D (Medium to thick-bedded, medium to coarse-grained sandstone with parallel lamination)

This facies is characterized by grey to buff colour, medium to thick bedded, medium to coarse-grained sandstone with parallel lamination. They are 1m to 2m in thickness. This facies is sharp and straight base. This facies is associated with planar and trough cross-bedded sandstone facies (Fig.12). The gritty to coarse-grained sandstone deposited in standing body of water and interpreted to have formed under weak flow deposit (Reneick and Singh, 1980).

Facies E (Medium to thick-bedded, gritty to coarse-grained sandstone with mudclast)

This facies is characterized by yellow to buff colour, massive, gritty to coarse-grained sandstone. Pebbles and dispersed mud clasts are found. The grits are mostly rounded and clear quartz grain. The characteristic feature of this facies is the presence of mudclast throughout the unit (Figs.13 and 14). The occurrence of massive, gritty sandstone and presence of mudclasts indicate that this unit may be developed under rapid sedimentation.

Facies F (Thick-bedded to massive, fine to medium-grained sandstone with pebble clast)

This facies is characterized by yellow to buff colour, massive, fine to medium-grained sandstone. This facies is widespread distributed in the Male Formation and Sadwingyi Formation. Sandstones are associated with pebble clasts of mostly quartz and ripple mark structures are found. Also leaf imprints, wood chips and minor coal seams are also found (Fig.15). They commonly occur toward the base of channel sand bodies and are attributed to rapid deposition from suspension during flood (Reading, 1996). The massive sandstone in clast supported conglomerate is deposited by freezing of sand debris flow. This facies is interpreted as very rapid stream flow or weaker debris flow (Reading, 1996).

Facies G (Alternations of thin-bedded sandstone, siltstone and silty clay)

This facies is characterized by yellow to buff colour, fine-grained sandstones, siltstones and clays are alternated. The individual bed thickness ranges from 0.5 cm to 3cm. Clays are yellowish brown to brown colour and wavy bedded (Fig. 16). This facies is interpreted as levee and crevasse splay deposit formed at the distributary channels.

Facies H (Massive variegated clays and mud layers)

This facies is associated with Facies F and they are up to 5m thick. This facies can be interpreted as swampy deposits at basin margin and interdistributary bay deposits (Fig.17)

Facies I (Thick-bedded to massive sandstone intercalated with pebble conglomerate layer)

This facies is characterized by medium to coarse-grained, yellow to buff colour, sandstone are massive bed which are intercalated with pebble layer of up to 0.5 m and clasts are 2 to 3mm in size (Fig. 18). This facies is associated with the alternations of sand, silt and clay facies. It is mostly found in the upper part of Male Formation and Sadwingyi Formation.

Facies J (Green colour, medium to coarse-grained sandstone with coal seams)

This facies is characterized by the massive grey and green colour, medium to coarse-grained (glauconitic) sandstone. The current ripples and trough cross bedding are identified. Sandstone is intercalated with conglomerate layer of up to 8 cm thick and wedge out. Also coal seams of up to 2.5 m are widely distributed in this sandstone (Fig. 19).

Facies K (Massive sandstone with concretions)

This facies is characterized by massive sandstone with abundance of sandstone concretions. The sandstones are yellowish brown to buff colour, coarse-grained and massive bedded. The average diameter of concretion is measured to be 16 cm and maximum size up

to 36 cm in diameter. Concretions are mostly of spherical shape. In some horizon, quartz pebbles are scattering (Fig. 20). The lower and upper boundaries are sharp and straight with its overlying and underlying facies. Massive sandstone is interpretative of rapid sedimentation or sandy debris flow (Reading, 1996).

Fig.7. Facies A (Crudely bedded conglomeratic sandstone)

Fig.8. Facies B thick-bedded to massive, medium to coarse-grained sandstone with trough cross bedding

Fig.9. Facies B thick-bedded to massive, medium to coarse-grained sandstone with trough cross bedding

Fig.10. Facies C Medium to thick-bedded sandstone and pebble conglomerate with planar cross bedd ing

Fig.11. Facies C Medium to thick-bedded sandstone and pebble conglomerate with planar cross bedding

Fig.12. Facies DMedium to thick-bedded, medium to coarse-grained sandstone with parallel lamination

Fig.13. Facies EMedium to thick-bedded, gritty to coarse-grained sandstone withmudclast

Fig.14. Facies EMedium to thick-bedded, gritty to coarse-grained sandstone withmudclast

Fig.15 Facies F Thick-bedded to massive, fine to medium-grained sandstone with pebble clast

Fig.16. Facies G Alternations of thin-bedded sandstone, siltstone and silty clay

Fig.17. Facies H Massive variegated clays and mud layers

Fig.18. Facies I Thick-bedded to massive sandstone intercalated with pebble conglomerate layer

Fig.19.Facies JGreen colour, medium to coarse-grained sandstone with coal seams

Fig. 20. Facies K Massive sandstone with concretions

Facies Associations

At least three facies association can be established in the Paleo-Neogene sequence of Tonkyauk Chaung conglomerate, Male and Sadwingyi Formations.

Delta front distributary channel lag facies association

This association is the combination of the facies A,B, C and D. It is well exposed in the western part of the study area of Tonkyauk Chaung conglomerate and lower part of the Male Formation. The sequence starts with the crudely bedded conglomerate sandstone beds and grades to the large scale planar type and trough type cross bedded sandstone and parallel laminated sandstone.They occupy the lowest part of the channel lag or point bar sequences. (Reneick and Singh, 1981).

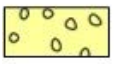
Delta front distributary channel bar facies association

This facies association commences with the thick-bedded to massive sandstone with pebble clast of the facies B, facies F, facies D and facies E. The lithology and grain size of the point bar deposits depend upon the grain-size available. Besides the channel lag deposits, bar deposits are commonly composed of the coarsest sediment available in a stream. The lower part of the sequence several channel lag layers may become incorporated. Cross bedding of the current ripple origin are the major bedding types. This facies association is characteristically found in the lower part of the Male Formation. The grain size of overall cross-bed data show a large scatter. And also do not conform with the direction of flow of the river and two closely spaced profiles do not show a similar direction.

Prodelta /Shelf facies association

This facies association represents the combination of facies G,H, I, J and K. In this association green sandstone of medium to coarse-grained sandstone with coal seams fines upward into thick-bedded to massive silty clay unit, thick-bedded to massive sandstone intercalated with pebble conglomerate layer, Massive sandstone with concretions and alternations of thin-bedded sandstone, siltstone and silty clay facies. The sequence is rather thick and suggests that these sediments may be deposited in shallow marine shelf environment.

Description of Facies

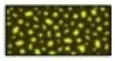


FaciesA Crudely bedded conglomeraticsandstone

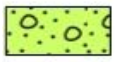
FaciesB thick-bedded to massive, medium- to coarse-grained sandstone with trough cross bedding

Facies C Medium to thick-bedded sandstone and pebble conglomerate with planar cross bedding

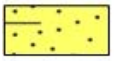
Facies D Medium to thick-bedded, medium- to coarse-grained sandstone withparallel lamination



Facies E Medium to thick-bedded, gritty to coarse-grained sandstone withmudclast

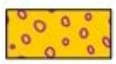


Facies F Thick-bedded to massive, fine- to medium-grained sandstone with pebble clast



Facies G Alternations of thin-bedded sandstone, siltstone and silty clay

FaciesH Massive variegated clays and mud layers



Facies I Thick-bedded to massive sandstone intercalated with pebble conglomerate layer

Facies J Green colour, medium- to coarse-grained sandstone with coal seams

Facies K Massive sandstone with concretions

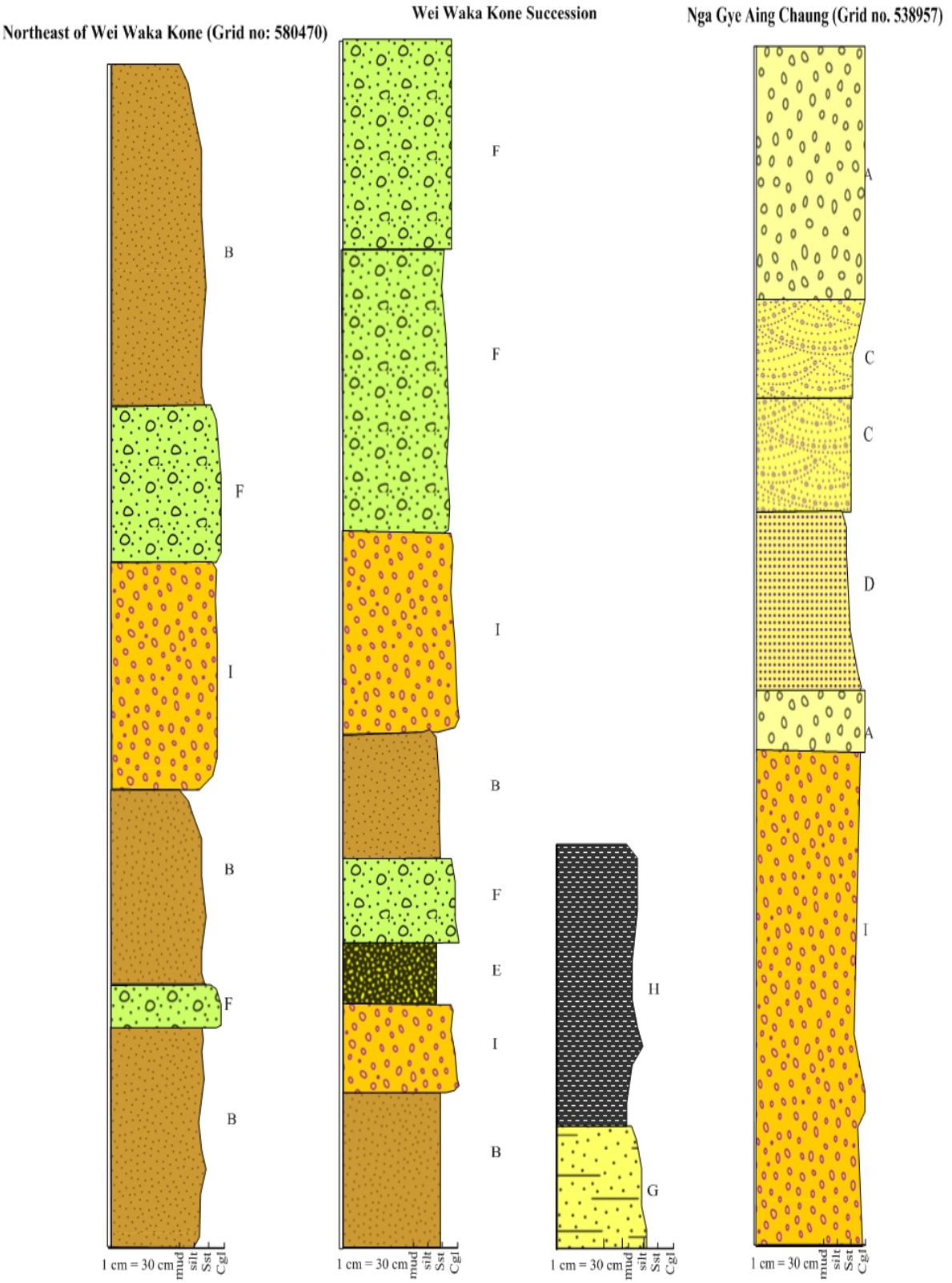


Fig.21. Detailed sedimentological log of thedelta front distributary channel bar facies association of the Male Formation

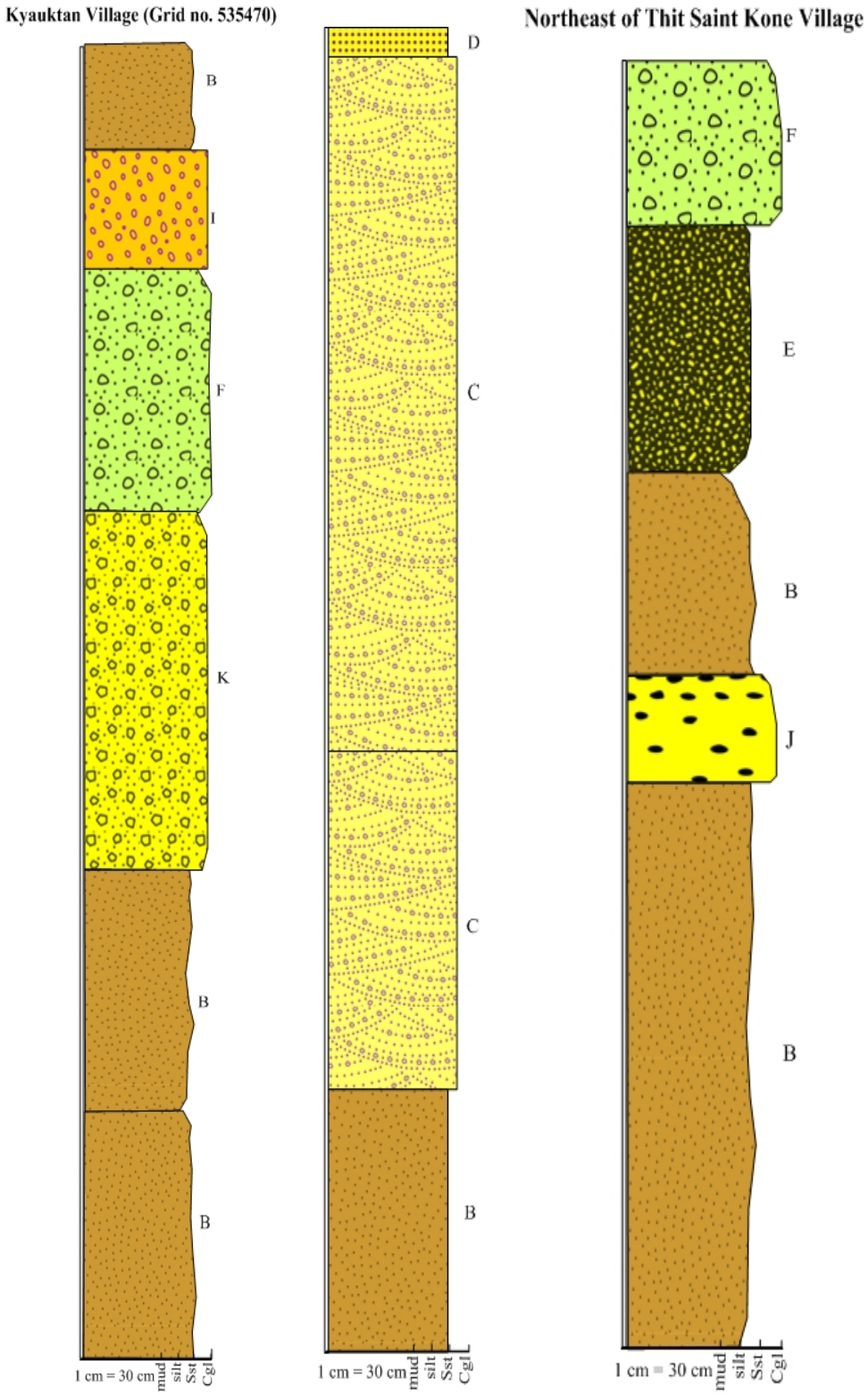


Fig.22. Detailed sedimentological log of the prodelta/shelf facies association of Sadwingyi Formation.

Depositional Environment

In prodelta/shelf facies association, the occurrences of green sandstone of the Sadwingyi Formation indicate that marine transgression occurred at the beginning of Miocene. The upper part of the sequences indicates that the near the seaward limit of distributary channel sandstone and mudstone interbed unit may be deposited in sandy shoal. During flooding stage, gritty sandstone with mudclast is deposited the upper part of the shelf environment. The Delta front distributary channel lag and distributary mouth bar facies associations indicate that the Tonkyauk Chaung conglomerate and Male Formation may be deposited under Deltaic condition of delta front environment. In the delta front facies, no marine and wave influence characters are found. Fluvial influence sedimentation pattern is developed in this environment.by the nature of delta front, the type of delta may be fluvial dominated delta.

Conclusion

The Tonkyauk Chaung Formation of the delta front distributary channel lag deposits and the delta front disstributary mouth bar deposits of the Male Formation are commonly composed of the coarsest sediment available in a stream. Cross bedding of the current ripple origin are the major bedding types. They may be deposited under Deltaic condition of delta front environment. In the delta front facies, no marine and wave influence characters are found. Fluvial influence sedimentation pattern is developed in this environment.by the nature of delta front, the type of delta may be fluvial dominated delta. In the area of this study, the Sadwingyi Formation of medium to coarse-grained, quartz rich, grey to green (glauconitic) sandstones and well-rounded, channelized pebbly conglomerates with silty to very fine grained sandstones may be deposited during marine transgression of the prodelta/shelf environment. The sandstone unit described the sedimentary structures of alternate 2D current ripples (generally eastward-oriented) to NE-SW striking channels. Also the Sadwingyis indicate the age dating analysis of the mean maximum depositional age (MDA) derived by the youngest zircon and titanite grains provided a robust 25.27±0.68 (MSWD=1.3), (Personal Communication with Francesco Arboit, 2019) which agrees with the Oligocene biostratigraphic age of the Sadwingyi Formation.

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The Source Rocks of the Lower Cenozoic Sediments in Myintha Area in Gangaw Township in Magway Region by Geochemistry Point of View

Nyi Nyi Lwin[1], Htay Maung[2]

Abstract

The study area, Myintha Area, is situated in Gangaw Township in Magway Region. In the study area, Four Formations (Kabaw Formation, Paunggyi Formation, Laungshe Formation and Tilin Formation), Maw gravels and recent alluvium are exposed. Among them, the source rocks of the Lower Cenozoic sediments were researched by geochemical methods. According to the composition of trace elements such as Cr, Ni, Co, V, Ba, Sr, Y, Zr, Th and La, the source rocks are mafic and ultramafic rocks. The element ratios such as SiO_2/ Al_2O_3, La/Co, Th/Co, Cr/Th, La/Cr, Zr/Cr, Ti/Zr and Y/Ni indicate that the source area mainly consists of intermediate and mafic rocks. The binary diagrams namely TiO_2-Zr diagram, K_2O-Rb diagram, Th/Co – Zr/Co diagram and Cr/V – Y/Ni diagram indicate that the source area mainly contains intermediate and basic rocks. The Zr/TiO_2 – Nb/Y diagram shows that the source rocks are andesite and andesite-basalt. The TiO_2-Ni diagram shows that the source rocks are mainly magmatogeric graywackes; some intermediate and a few acidic rocks. In Th/U- Th diagram, most of the samples show depleted mantle source and a few show upper crust source. When these data are combined together, it can be concluded that the Lower Cenozoic sediments in Myintha area were mainly derived from the source rocks such as intermediate rocks, basic rocks, ultramafic rocks, some magmatogeric graywackes and a few acidic rocks.

Key words: Myintha area, source rock, intermediate rocks, basic rocks, ultramafic rocks

Introduction

The study area, Myintha Area, is situated in Gangaw Township in Magway Region. It lies between Latitude 22°32' N and 22°40'N and Longitude 94°07'E and 94°12'E in one-inch topographic map, 84 J/2. The study area is located at the south-western marginal portion of Chindwin Basin. In the study area, four formations (Kabaw Formation, Paunggyi Formation, Laungshe Formation and Tilin Formation), Maw gravels and recent alluvium are exposed.

The main objective of this work is to detect the source rocks of the Lower Cenozoic sediments exposed in Myintha area by geochemistry point of view. To get information, sandstone samples from Paunggyi Formation, Laungshe Formation and Tilin Formation in the study area were collected. Twelve sandstone samples (four from each formation) were selected for chemical analyses. The selected samples were tested by X-ray fluorescence spectrometry (XRF) at Physics Department in Mandalay University. Representative samples were subjected to a geochemical analysis of sediment whole rock compositions. Average chemical compositions of each stratigraphic unit were also compared (Table (1, 2 and 3) (Fig. (1 and 2). Binary diagrams of several models were used to deduce the source rocks based on geochemical variations of sandstones.

Geochemistry

Geochemical analysis can be used for the interpretation of source rock, degree of weathering conditions, tectonic setting and depositional conditions. There are some variations in geochemical ratios during weathering and diagenesis (Taylor and McLennan, 1985,

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Nesbitt and Young, 1989). However, the bulk compositions of rocks are not totally altered and provide the interpretation of source and tectonic settings discrimination (McLennan, 1993).

Source rock composition by major elements

SiO_2/Al_2O_3 ratio may indicate the source rock. The sample whose SiO_2/Al_2O_3 value is about 3 indicates basic rock source; 5, acidic rock source, and more than 5, mature sedimentary rock source (Le Maitre, 1976, Roser *et al.*, 1996 in Akarish and El-Gohary, 2011). Most of the samples in Paunggyi Formation have the SiO_2/Al_2O_3 value of 2.32 to 3.22. They may indicate basic and ultrabasic rock source. PG-2 has the SiO_2/Al_2O_3 value of 22.93 and so it may indicate mature sedimentary rock source. The samples in Laungshe Formation have the SiO_2/Al_2O_3 value of 2.86 to 4.22. They may indicate ultrabasic, basic and intermediate rock source. The samples in Tilin Formation have the SiO_2/Al_2O_3 value of 3.05 to 4.76. They may indicate basic, intermediate and acidic rock source.

For clastic sediments, Hayashi *et al.*, 1997 stated that Al_2O_3/TiO_2 value of 3-8 for mafic rock source, 8-21 for intermediate rock source and 21-70 for felsic igneous rock source. According to this statement, all the samples in the study area show intermediate rock source because they have Al_2O_3/TiO_2 value of 9.55 to 21.71.

Source rock composition by trace elements

Trace elements such as Cr, Ni, Co, and V are useful indicators of mafic and ultramafic sources (Wronkiewicz, D.J., Condie, K.C., 1990). Felsic source rocks usually contain lower concentrations of Cr, Co, Ni, and V and higher concentrations of Ba, Sr, Y, and Zr than mafic and intermediate source rocks (Taylor, S.R., McLennan, S.M., 1985). The samples in the study area contain higher concentrations of Cr and V, and lower concentrations of Ba, Sr, Y, and Zr. So, the possible source rocks of the samples in the study area are mafic and intermediate rocks. Trace element such as Cr is useful in identifying accessory detrital components such as chromite, commonly derived from mafic to ultramafic sources (Floyd *et al*., 1990). All the analyzed samples in the study area have high concentration of Cr and so they may be derived from mafic and ultramafic rocks.

Th, Zr and La are enriched in felsic rather than in mafic rocks, because they are highly incompatible during most igneous melting and fractionation processes (Cullers, 1994). Then, all the analysed samples in the study area have lower concentration of Th, Zr and La. This result underlines the insignificance of a felsic source.

Source rock composition by binary diagrams

According to TiO_2-Zr diagram of Hayashi *et al*., 1997, most of the samples in the study area fall in the fields of intermediate igneous rock and basic igneous rock (Fig. 3(a)).

According to Zr/TiO_2 – Nb/ Y diagram of Winchester and Floyd, 1977, most of the samples in the study area fall in the fields of andesite and andesitic basalt (Fig. 3(b)).

In the Th/ Co – Zr/ Co diagram (McLennan, 2001), most of the samples plot near intermediate and mafic side (Fig. 3(c)).

In Ni-TiO_2 diagram (Floyd et. al, 1990), most of the samples show magmatic greywacke source; some show intermediate igneous source; a few show acidic igneous source; and one shows mature sediment source (Fig. 3(d)).

In the diagram of Th /U versus Th (Mc Lennan, 2001), most of the samples fall in the field of depleted mantle source and some, upper crust source (Fig. 4(a)).

In the K_2O-Rb diagram (Shaw et. al, 1968), about half of the samples fall in the field of acid+ intermediate compositions and the other half fall in the field of basic compositions (Fig. 4(b)).

In the Cr/V versus Y/ Ni diagram, many of the samples plot near UCC point which is andesite composition but some of the samples plot near ophiolitic component (Fig. 4(c)).

Table (1). Major element compositions of sandstones in the study area and UCC, Upper Continental Crust after Taylor and McLennan (1985) and McLennan (2001)

	Paunggyi Formation					**Laungshe Formation**					**Tilin Formation**					
%	PG-1	PG-2	PG-3	PG-4	Mean	LS-1	LS-2	LS-3	LS-4	Mean	TL-1	TL-2	TL-3	TL-4	Mean	UCC
Al_2O_3	15.23	4.07	13.73	18.79	12.96	17.7	18.18	14.55	18.32	17.19	14.6	14.14	10.64	14.59	13.49	15.17
SiO_2	48.93	93.29	38.3	43.66	56.05	58.55	57.34	61.45	52.49	57.46	44.58	64.56	50.68	66.53	56.59	65.89
P_2O_5	0.13	0.02	0.19	0.45	0.2	0.13	0.22	1.79	0.2	0.59	0.17	0.22	0.13	0.19	0.18	0.2
SO_3	0.03	0.02	0.12	0.11	0.07	0.07	0.05	0.16	0.04	0.08	0.43	0.26	0.48	0.03	0.3	
Cl	0.16	0.14	0.12	0.09	0.13	0.1	0.14	0.08	0.09	0.10	0.15	0.12	0.13	0.08	0.12	
K_2O	1.22	0.51	0.44	1.29	0.87	1.05	1.14	1.77	1.07	1.26	0.89	1.23	0.84	2.32	1.32	3.39
CaO	19.40	0.27	34.21	23.29	19.29	6.97	4.82	7.99	5.42	6.3	18.24	8.57	28.88	3.99	14.92	4.19
TiO_2	1.28	0.31	0.72	1.52	0.96	0.13	1.54	0.96	1.92	1.11	1.08	0.98	0.49	0.97	0.88	0.5
MnO	0.31	0.02	0.86	0.48	0.42	0.11	0.24	0.33	0.33	0.76	0.65	0.19	0.55	0.14	0.38	0.07
Fe_2O_3	13.26	1.35	11.32	10.32	9.06	15.24	16.33	10.92	20.12	15.65	19.21	9.73	7.18	11.16	11.82	4.49
Na_2O																3.9
MgO																2.2
Total	100	100	100	100		100	100.12	100	100		100	100	100	100		

Table (2) Trace element compositions of sandstones in the study area and UCC, Upper Continental Crust after Taylor and McLennan (1985), and McLennan (2001)

	Paunggyi Formation					Laungshe Formation					Tilin Formation					
ppm	PG-1	PG-2	PG-3	PG-4	Mean	LS-1	LS-2	LS-3	LS-4	Mean	TL-1	TL-2	TL-3	TL-4	Mean	UCC
V	140.04	63.83	68.82	166.92	109.9	172.52	185.4	80.1	211.73	162.44	208.37	80.1	101.94	99.71	122.53	107
Cr	84.85	109.95	137.39	355.87	172.02	205.56	138.28	316.05	155.59	173.08	157.67	377.7	314.61	362.31	303.07	85
Co	3.06	3.06	3.06	< 3.06	3.06	3.06	3.06	3.06	< 3.06	3.06	3.06	3.06	3.06	3.06	3.06	17
Ni	7.70	3.61	5.18	16.42	8.23	4.63	5.11	47.22	5.73	15.67	9.19	40.71	27.97	32.69	27.64	44
Cu	12.86	24.36	11.34	18.53	16.77	65.82	36.58	35.54	14.93	38.22	56.39	43.29	91.38	27.48	54.64	25
Zn	67.32	36.79	36.55	66.68	51.84	134.8	105.24	71.98	94.31	101.58	128.22	90.86	142.92	71.16	108.29	71
Ga	13	1.6	6.2	13.2	8.5	14.9	16.4	11.2	17.4	14.98	12.1	7	6.2	11.5	9.2	17
Ge	<0.5	<0.5	<0.5	0.2	0.43	0.3	< 0.5	0.3	0.7	0.45	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.6
As	1.59	1.73	2.55	6.62	6.67	1.88	1.95	6.84	1.81	3.12	< 0.52	6.69	3.61	4.51	3.83	1.5
Se	0.7	0.6	1.2	2.1	1.15	0.9	0.5	1.2	0.9	0.88	0.6	0.8	0.8	0.9	0.78	0.05
Br	0.8	0.7	0.3	0.5	0.58	0.1	1.1	0.30	0.1	0.4	0.6	0.1	1.1	< 0.5	0.58	
Rb	12.34	5.76	9.05	24.87	13.01	12.52	12.61	40.69	11.33	19.29	12.16	27.52	15.72	46.81	25.55	112
Sr	176.47	7.48	19.36	155.59	89.73	134.72	163.45	132.16	123.71	138.51	300.18	120.83	200.07	93.32	182.82	350
Y	13.4	6.8	10.5	32.8	15.88	10.5	12.5	19	12	13.5	27.1	16.6	11.1	16.1	17.73	22
Zr	58.33	24.07	73.95	148.13	76.12	65.51	74.17	117.11	83.43	85.06	58.7	163.62	45.23	181.96	112.38	190
Nb	1.33	0.76	2.37	6.15	2.65	0.91	2.58	4.47	1.82	2.44	2.44	3.91	1.18	4.54	3.02	12
Mo	0.3	< 1	2	2.2	1.38	0.8	0.3	0.9	< 1	1.03	1.3	0.9	0.8	2.1	1.28	1.5
SnO_2	2.5	2.8	< 3.9	< 3.9	3.28	< 3.9	2.3	1.6	1.6	2.35	< 3.9	0.2	< 3.9	< 3.9	2.98	
Sb	3.76	10.98	< 3.01	3.31	5.27	1.65	7.3	4.59	2.48	4.01	0.9	3.16	7.22	3.23	3.63	0.2
Cs	<4	12.7	< 4	20.5	10.3	18.1	< 4	18.1	< 4	11.05	< 4	< 4	10.8	< 4	5.7	4.6
Ba	205	39.4	731	201	294.1	145	129	199	117	147.5	< 2	103	45.4	181	82.85	550
La	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	6.3	< 2	< 2	3.08	30
Ce	< 2	< 2	< 2	< 2	< 2	2.9	3	< 2	< 2	2.48	8	17.1	< 2	5.1	8.05	64
Hf	7.1	8	8.2	10.8	8.53	9.2	7.9	9.3	8.1	8.63	9	13.4	11.4	10.6	11.1	5.8
Ta	1.96	4.17	6.63	5.32	4.52	4.39	3.68	5.65	4.83	4.64	9.01	13.59	3.19	4.91	7.67	1
WO_3	6.1	< 1.3	< 1.3	< 1.3	2.5	< 1.3	6.9	< 1.3	<1.3	2.7	6.4	< 1.3	7.1	< 1.3	4.03	<1.3
Hg	1.7	2.3	3.4	3.3	2.68	2.2	0.8	2.4	2.2	1.9	1.6	3.2	1.6	3.4	3.2	
Tl	1.5	1.2	1.6	1.6	1.23	2.1	1.3	1.4	2.2	1.75	1.7	1.7	1.4	1.5	1.58	0.75
Pb	5.47	3.81	7.42	13.08	7.45	3.15	7.79	11.97	7.98	7.72	9.19	8.72	9.93	12.81	10.16	17
Bi	1.1	2	1.2	0.8	1.28	1.8	1.4	1.3	1.8	1.58	1.3	0.9	1.6	1.4	1.3	0.13
Th	1	1	2.5	5.5	2.5	< 1	0.4	4.1	< 1	1.63	1.5	3.8	1.8	3.4	2.63	10.7
U	<1	< 1	< 1	< 1	< 1	< 1	<1	< 1	<1	< 1	< 1	< 1	< 1	< 1	< 1	2.8

Table (3) Values of some elemental ratios in the study area and UCC, Upper Continental Crust after Taylor and McLennan (1985), and McLennan (2001)

	Paunggyi Formation					Laungshe Formation					Tilin Formation					UCC
	PG-1	**PG-2**	**PG-3**	**PG-4**	**Mean**	**LS-1**	**LS-2**	**LS-3**	**LS-4**	**Mean**	**TL-1**	**TL-2**	**TL-3**	**TL-4**	**Mean**	
SiO_2/Al_2O_3	3.22	22.93	2.79	2.32	7.815	3.29	3.15	4.22	2.86	3.38	3.05	4.56	4.76	4.55	4.23	4.34
K_2O/Al_2O_3	0.08	0.13	0.03	0.07	0.08	0.06	0.06	0.12	0.06	0.08	0.06	0.08	0.07	0.15	0.09	0.22
Al_2O_3/P_2O_5	117.15	185.4	72.26	41.76	104.1	136.69	82.64	8.12	91.6	79.76	85.88	64.27	81.85	76.78	77.2	75.85
Al_2O_3/TiO_2	11.89	13.13	19.08	12.36	14.1	13.24	11.76	15.16	9.55	12.44	13.52	14.42	21.71	15.03	16.17	30.4
Fe_2O_3/K_2O	10.86	2.66	25.72	8.00	11.8	14.51	14.28	6.17	10.52	11.4	21.59	7.91	8.5	4.81	10.7	1.47
Th/Cr	0.01	0.01	0.02	0.02	0.015	0.004	0.003	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.13
Cr/Th	84.85	109.95	54.95	64.7	78.6	205.56	345.7	77.08	155.59	196	105.11	99.39	174.78	106.56	121.5	7.9
Cr/V	0.61	1.72	2.01	2.13	1.62	1.19	0.75	3.95	0.73	1.66	0.75	4.71	3.08	3.63	3.04	0.79
Cr/Ni	11.02	30.45	26.52	21.67	22.4	44.39	27.06	6.69	27.15	26.3	17.15	9.27	11.25	11.08	12.2	1.93
Cr/Zr	1.45	4.56	1.85	2.4	2.57	3.13	1.86	2.69	1.86	2.39	2.68	2.31	6.95	1.99	3.48	0.45
Th/U	1	1	2.5	5.5	2.5	1	0.4	4.1	1	1.63	1.5	3.8	1.8	3.4	2.63	3.82
Th/Nb	0.75	1.32	1.05	0.89	1	1.1	0.15	0.92	0.55	0.68	0.61	0.97	1.52	0.74	0.96	0.89
Th/Ta	0.51	0.23	0.37	1.03	0.54	0.23	0.11	0.73	0.21	0.32	0.16	0.27	0.56	0.69	0.42	10.7
Th/La	0.5	0.5	1.25	2.75	1.25	0.5	0.2	2.05	0.5	0.8	0.75	0.6	0.9	1.7	0.99	0.36
La/Cr	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.35
La/Nb	1.5	2.63	0.84	0.33	1.33	0.455	0.77	0.45	1.1	0.69	0.82	1.61	1.69	0.44	1.14	2.5
Ce/Pb	0.36	0.52	0.27	0.15	0.33	0.92	0.38	0.17	0.25	0.43	0.87	1.96	0.2	0.39	0.86	3.76
La/Ta	1.02	0.48	0.3	0.38	0.55	0.46	0.54	0.35	0.41	0.44	0.22	0.46	0.62	0.41	0.43	30
La/Th	2	2	0.8	0.36	1.29	0.2	5	0.48	2	1.92	1.33	1.66	1.11	0.58	1.17	2.8
La/Co	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	2.05	0.65	0.65	1	1.76
La/Y	0.15	0.29	0.19	0.06	0.17	0.19	0.16	0.11	0.17	0.16	0.07	0.38	0.18	0.12	0.19	1.36
Nb/Ta	0.68	0.18	0.36	1.16	0.6	0.21	0.7	0.79	0.38	0.52	0.27	0.28	0.37	0.92	0.46	12
Nb/U	1.33	0.76	2.37	6.15	2.7	0.91	2.58	4.47	1.82	2.5	2.44	3.91	1.18	4.54	3	4.29
K/U	4408.9	3635.7	1606.3	6305	3994	5003	4496.9	9023.7	3938.2	5615.5	3415.2	5652.4	3607.8	11672	6086.9	10000
K/Rb	357.28	631.2	177.5	253.51	354.9	399.6	356.6	221.76	347.59	331.4	280.85	205.39	229.5	249.34	241.27	250
Rb/Cs	3.09	0.45	2.26	1.21	1.75	0.69	3.15	2.25	2.83	2.23	3.04	6.88	1.45	11.7	5.77	24.35
La/Cs	0.5	0.16	0.5	0.09	0.31	0.11	0.5	0.11	0.5	0.31	0.5	1.57	0.18	0.5	0.69	6.52
Zr/Hf	8.21	3.01	9.02	13.72	8.5	7.12	9.38	12.59	10.3	9.9	6.52	12.21	3.96	17.16	9.96	32.76
Zr/Cr	0.68	0.22	0.54	0.42	0.47	0.32	0.54	0.37	0.54	0.44	0.37	0.43	0.14	0.5	0.36	2.24

Table (3) continued

	Paunggyi Formation					Laungshe Formation					Tilin Formation					UCC
	PG-1	PG-2	PG-3	PG-4	Mean	LS-1	LS-2	LS-3	LS-4	Mean	TL-1	TL-2	TL-3	TL-4	Mean	
Zr/Th	58.33	24.07	29.58	26.93	34.7	65.51	185.42	28.56	83.43	90.73	39.13	43.05	25.12	53.51	40.2	17.76
Zr/La	29.17	12.03	36.98	74.07	38.1	32.76	37.08	58.56	41.72	42.53	29.35	25.97	22.61	90.98	42.2	6.33
Zr/Nb	43.86	31.67	31.2	24.09	32.7	71.98	28.74	26.19	45.84	43.2	24.05	41.84	38.33	40.07	36.1	15.8
Zr/Y	4.35	3.53	7.04	4.52	3.11	6.23	5.93	6.16	6.95	6.32	2.16	9.85	4.07	11.3	6.8	8.64
Zr/Co	19.06	7.86	24.17	48.41	24.9	21.4	24.23	38.27	27.26	27.79	19.18	53.47	14.78	59.46	36.7	11.18
Ti/Zr	57.33	58.17	25.13	36.24	44.21	74.97	59.19	30.42	61.51	56.5	50.55	19.82	33.78	19.35	30.9	15.79
Hf/La	3.55	4	4.1	5.4	4.3	4.6	3.95	4.65	4.05	4.3	4.5	2.12	5.7	5.3	4.41	0.19
Rb/Sr	0.06	0.77	0.47	0.16	0.37	0.09	0.08	0.31	0.09	0.14	0.04	0.22	0.07	0.5	0.21	0.32
Ba/Sr	1.16	5.26	37.76	1.29	11.37	1.07	0.78	1.51	0.95	1.1	0.01	0.85	0.22	1.93	0.75	1.57
Ba/Co	66.99	12.87	238.89	65.68	96.1	47.38	42.16	65.03	38.24	48.2	0.65	33.66	14.83	59.15	27	32.35
Nb/Y	0.1	0.11	0.22	0.19	0.16	0.08	0.21	0.24	0.15	0.17	0.09	0.23	0.11	0.28	0.18	0.55
Ce/Nb	1.50	2.63	0.84	0.33	1.33	3.19	1.16	0.45	1.1	1.48	3.27	4.37	1.69	1.12	2.6	5.33
Y/Nb	10.09	8.94	4.43	5.33	7.2	11.54	4.84	4.25	6.6	6.8	11.11	4.24	9.41	3.54	7.1	1.83
Y/Ni	1.74	1.88	2.03	1.99	1.91	2.28	2.44	0.4	2.09	1.8	2.95	0.41	0.39	0.49	1.06	0.5
Th/Co	0.33	0.33	0.82	1.79	0.82	0.32	0.13	1.34	0.33	0.53	0.49	1.24	0.58	1.11	0.86	0.629
Zn/Co	22.0	12.02	11.94	21.79	16.94	44.05	34.39	23.53	30.82	33.2	41.9	29.69	46.71	23.25	35.39	4.18
U / Th	1	1	0.4	0.18	0.65	1	2.5	0.24	1	1.19	0.67	0.26	0.56	0.29	0.45	0.26
V / Cr	0.64	0.58	0.5	0.47	0.55	0.84	1.3	0.25	1.4	0.95	1.3	0.21	0.32	0.28	0.53	1.26
Ni / Co	2.5	1.2	1.7	5.4	2.7	1.5	1.67	15.4	1.9	5.1	3	13.3	9.1	10.7	9	2.59

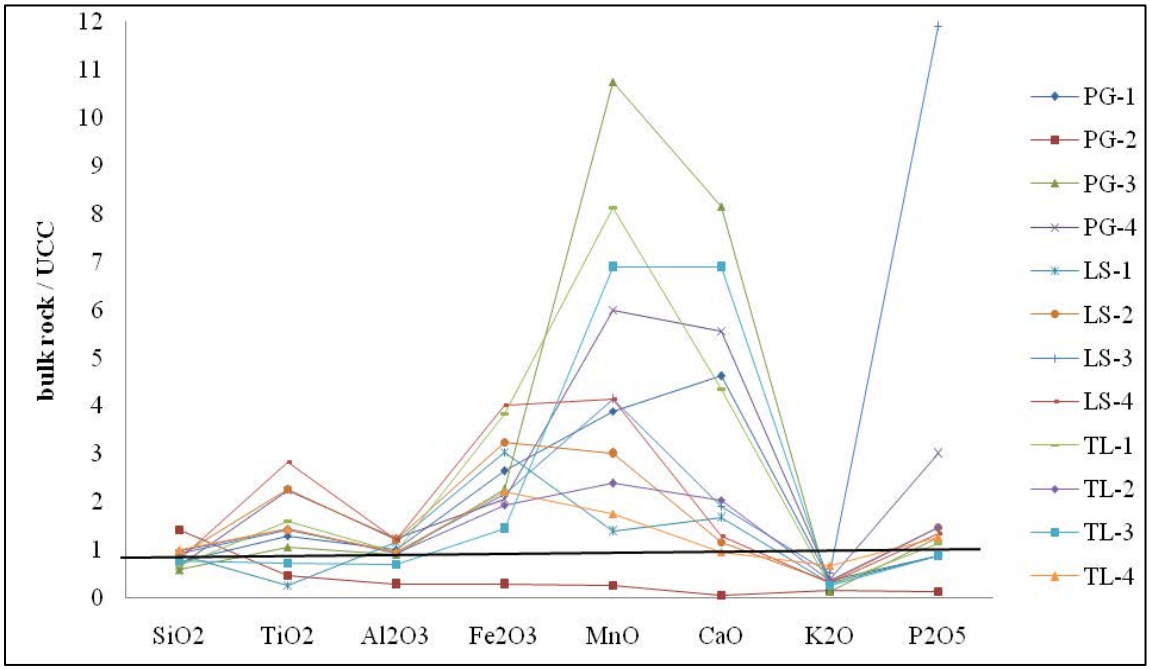

Fig. (1) Major element compositions of the samples in the study area normalized to UCC after Taylor and McLennan (1985) and McLennan (2001).

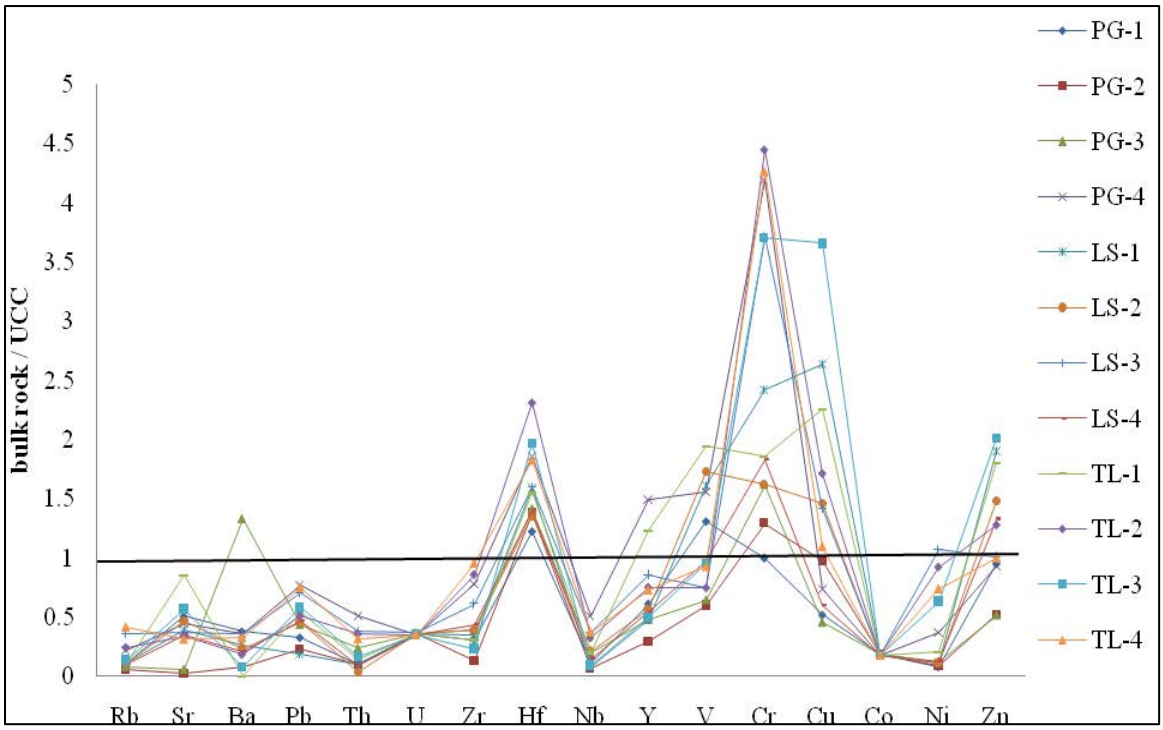

Fig. (2) Multi-element normalized diagram for the sandstones in the study area, normalized against upper continental crust (Taylor and McLennan (1985), and McLennan (2001)).

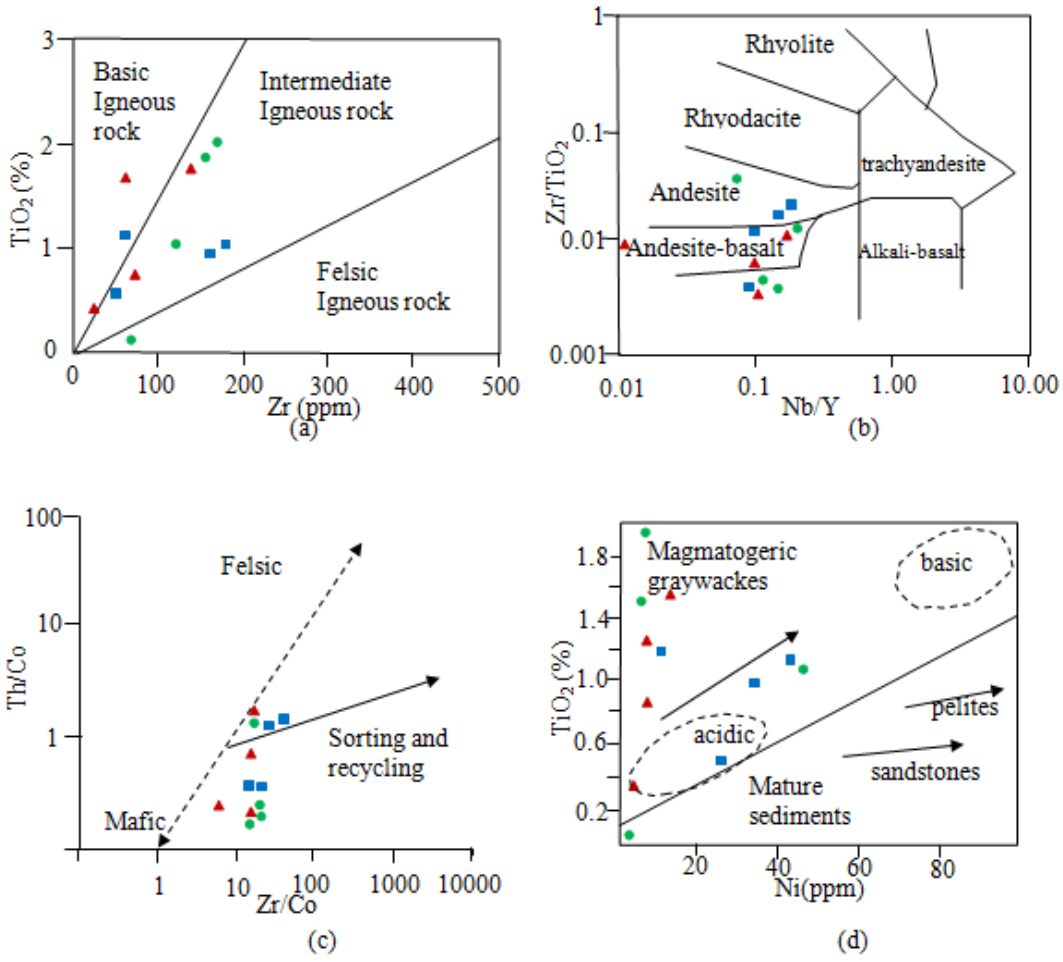

Fig. (3) Plots of Early Tertiary sandstone samples in the study area for the interpretation of provenance.

(a) TiO_2-Zr diagram (Hayashi *e.al.*,1997); most of the samples fall in the fields of intermediate igneous rock and basic igneous rock, but one sample falls in the field of felsic igneous rock.

(b) Winchester and Floyd (1977) diagram; most of the samples fall in the andisite and andisite-basalt fields.

(c) Th/Co – Zr/Co diagram (McLennan, 1993); all of the samples show intermediate and mafic character, and recycling.

(d) TiO_2-Ni diagram (Floyd *et al.*, 1990); Most of the samples show magmatic greywacke source; some show intermediate igneous source; a few show acidic igneous source; and one shows mature sediment source.

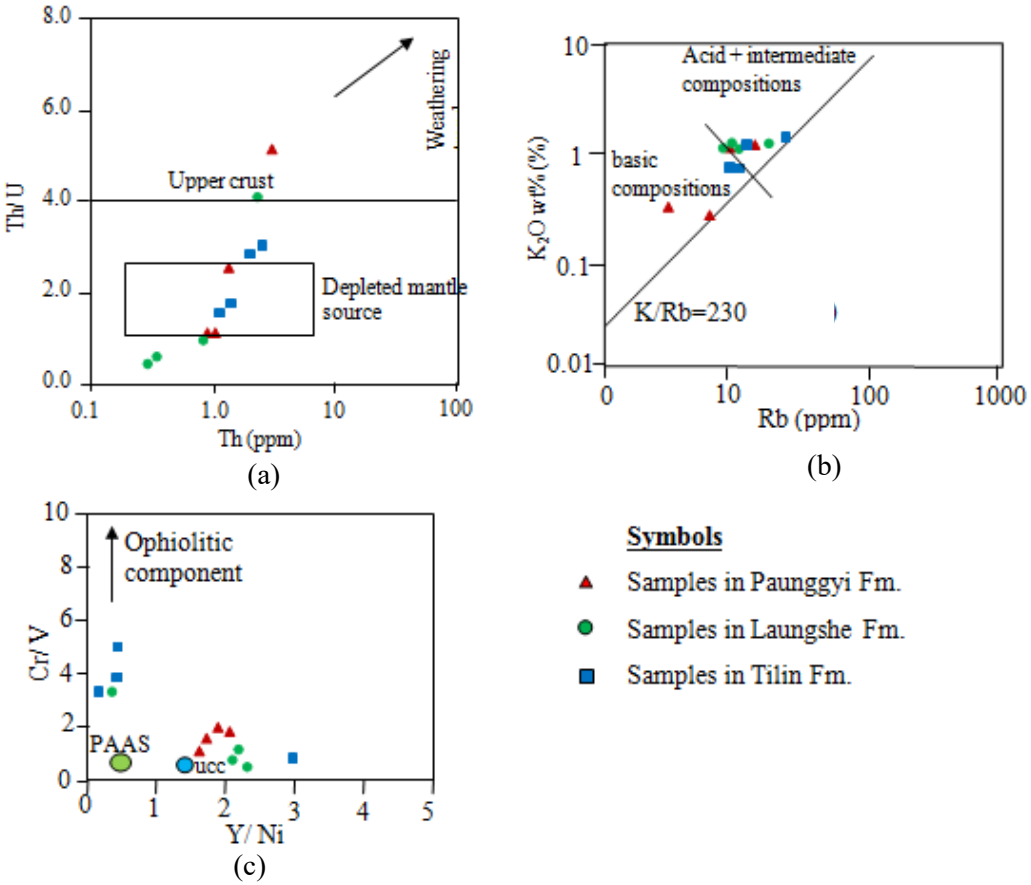

Fig. (4) Plots of Early Tertiary sandstone samples in the study area for the interpretation of provenance.

(a) Plots of Th /U versus Th (Mc Lennan, 1993); most of the samples fall in the field of depleted mantle source and some, upper crust source.

(b) K_2O-Rb diagram (Shaw et. al, 1968); half of the samples fall in the field of acid+ intermediate compositions and the other half fall in the field of basic compositions.

(c) Plot of Cr/V versus Y/Ni. PAAS (post-Archean Australian shales); UCC (upper continental crust). The arrow points toward an ophiolitic end member composition with extremely high Cr/V ratios. Most of the samples have similar composition with UCC but some have similar composition with ophiolitic compoment.

Source rock composition by trace element ratios

The following table collectively shows the element ratios of the samples in the study area comparing to the element ratios of sediments derived from felsic rock, the upper continental crust (intermediate rock) and mafic rock source. According to these ratios, the possible source rocks of most of the samples in the study area are intermediate to basic (mafic) rocks.

Element ratio	Paunggyi Formation	Laungshe Formation	Tilin Formation	Felsic source	UCC (andesite)	Mafic source	Possible source rock
La/Co	0.65	0.65	0.65	1.8 to 13.8 (1)	1.76 (2)	0.14 to 0.38 (1)	Intermediate to mafic Except TL-2 (2.05,felsic)
Th/Co	0.33 to 1.79	0.13 to 1.34	0.49 to 1.24	0.04 to 3.25 (1)	0.63 (2)	0.04 to 1.40 (1)	Intermediate to mafic
Cr/Th	54.95 to 109.95	77.08 to 345.7	99.39 to 174.78	4.0 to 15.0 (1)	7.9 (2)	25-500 (1)	Mafic source
La/Cr	0.01 to 0.02	0.01	0.01 to 0.02	3 (3)	0.35 (2)	0.08 (3)	Mafic source
Zr/Cr	0.22 to 0.68	0.32 to 0.54	0.14 to 0.5	>2 (4)	2.24 (2)	<1 (4)	Mafic source
Ti/Zr	25.13 to 58.17	30.42 to 74.97	19.35 to 50.55	<20 (4)	15.79 (2)	>50 (4)	Intermediate to mafic
Y/Ni	1.74 to 2.03	0.4 to 2.44	0.39 to 2.95	>10 (5)	0.5 (2)	<1(5)	Intermediate to mafic

(1) Cullers *et al*., (1988); Cullers (1994,2000)

(2) McLennan (2001); Taylor and McLennan (1985)

(3) Condie (1993)

(4) Taylor and McLennan (1985); Cullers (1994); Shao *et al*.(2001) in Tijani *et al*., (2010)

(5) Huntsman-Mapilaa *et al.* (2005)

Conclusion

According to the composition of trace elements such as Cr, Ni, Co, V, Ba, Sr, Y, Zr, Th and La, the source rocks are mafic and ultramafic rocks.

The element ratios such as SiO_2/ Al_2O_3, Al_2O_3/ TiO_2, La/Co, Th/Co, Cr/Th, La/Cr, Zr/Cr, Ti/Zr and Y/Ni indicate that the source area mainly consists of intermediate and mafic rocks.

The binary diagrams namely TiO_2-Zr diagram, K_2O-Rb diagram, Th/Co – Zr/Co diagram and Cr/V – Y/Ni diagram indicate that the source area mainly contains intermediate and basic rocks.

The Zr/TiO_2 – Nb/Y diagram shows that the source rocks are andesite and andesite-basalt.

The TiO_2-Ni diagram shows that the source rocks are mainly magmatogeric graywackes; some intermediate and a few acidic rocks.

In Th/U- Th diagram, most of the samples show depleted mantle source and a few show upper crust source.

When these data are combined together, it can be concluded that the Lower Cenozoic sediments in Myintha area were mainly derived from the source rocks such as intermediate rocks, basic rocks, ultramafic rocks, some magmatogeric graywackes and a few acidic rocks.

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Geochemistry of Sandstones of Red Bed Unit Exposed in Hopang Area, Implication for Tectonic Setting, Northern Shan State

Zar Ni Swe[1], Si Si Mar[2]

Abstract

The geochemical study of red sandstones are examined in order to describe paleo weathering and tectonic settings. Geochemical investigation of 6 sandstones samples were collected and subjected to whole rock geochemistry of major and trace elements. The results show large variation in the major oxides of high SiO_2, Al_2O_3 and CaO with low values of Fe_2O_3, MgO and TiO_2 from the red sandstones of Red Bed Unit. The sandstones were classified as of arkosic and subarkosic sandstones based on major oxide composition. Chemical Index of Alteration values (CIA, 25.12-44.86; mean: 33.59) andChemical Index of Weathering (CIW, 26.30-49.68; mean: 36.13), indicates low to moderate degree of chemical weathering. Index of Compositional Variation (ICV, 1.61-3.54; mean: 2.59) suggests immature sediments deposited in tectonically active settings. The discriminant function plot indicates intermediate igneous provenance and to some extent the felsic igneous provenance, derived from weathered granite, gneissic terrain. The tectonic setting discriminant diagram log [K_2O/Na_2O] *vs.* SiO_2 indicates an active continental margin.

Key words*:* red sandstones, tectonic setting, chemical weathering, active continental margin

Introduction

The research area is situated in Hopang Township, "Wa" Self-Administered Division in northern Shan State. This area lies between the North Latitude 23º 19' 00" to 23º 26' 30" and East Longitude 98º 42' 30" to 98º 48' 00" in UTM map sheet No.2398 (11and15). It covers about 48 square miles. The location map of the study area is shown in figure1.

The clastic sediments are essentially products of breakdown of preexisting rocks weather igneous, metamorphic or even sedimentary. These are transported via various agents to their depositional site. During these processes the sediments are subjected to a large number of activities. The chemical weathering rates also depend on the type of source rocks, its geochemistry and mineralogy, the tectonic setting and geomorphology of the source area. In this study, geochemical characteristics of red sandstones are used to determine the nature of the source area weathering and discriminating tectonic settings.

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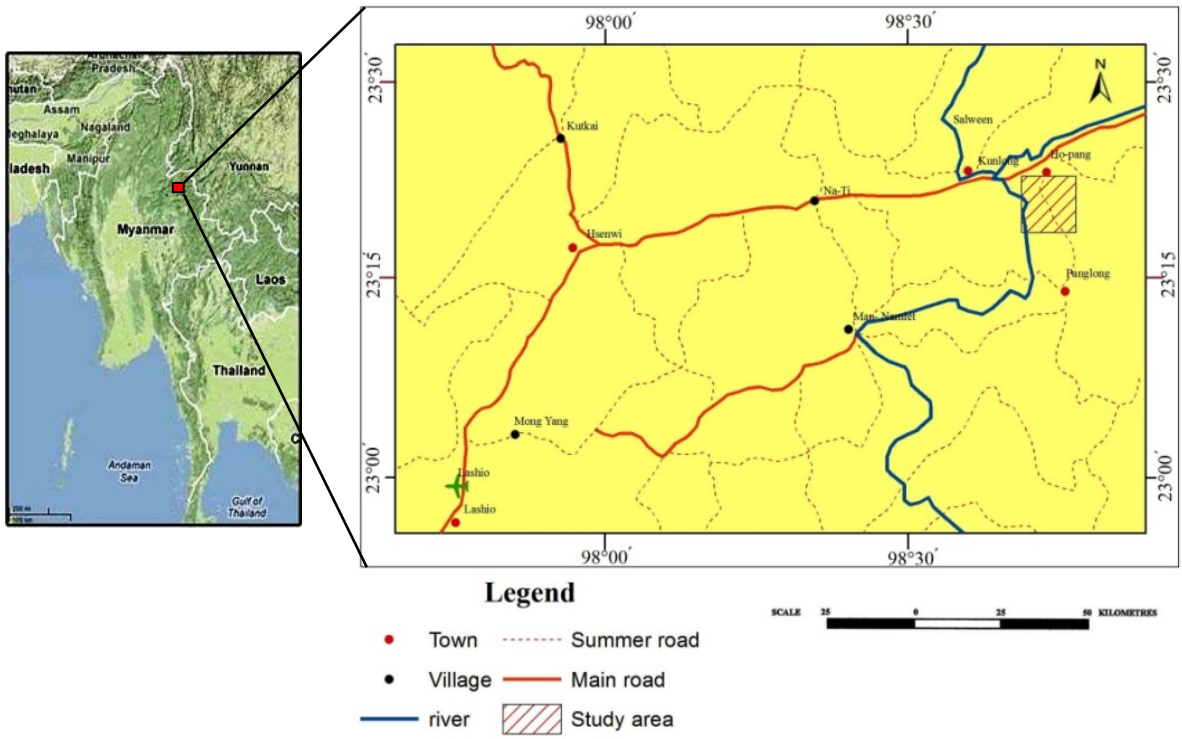


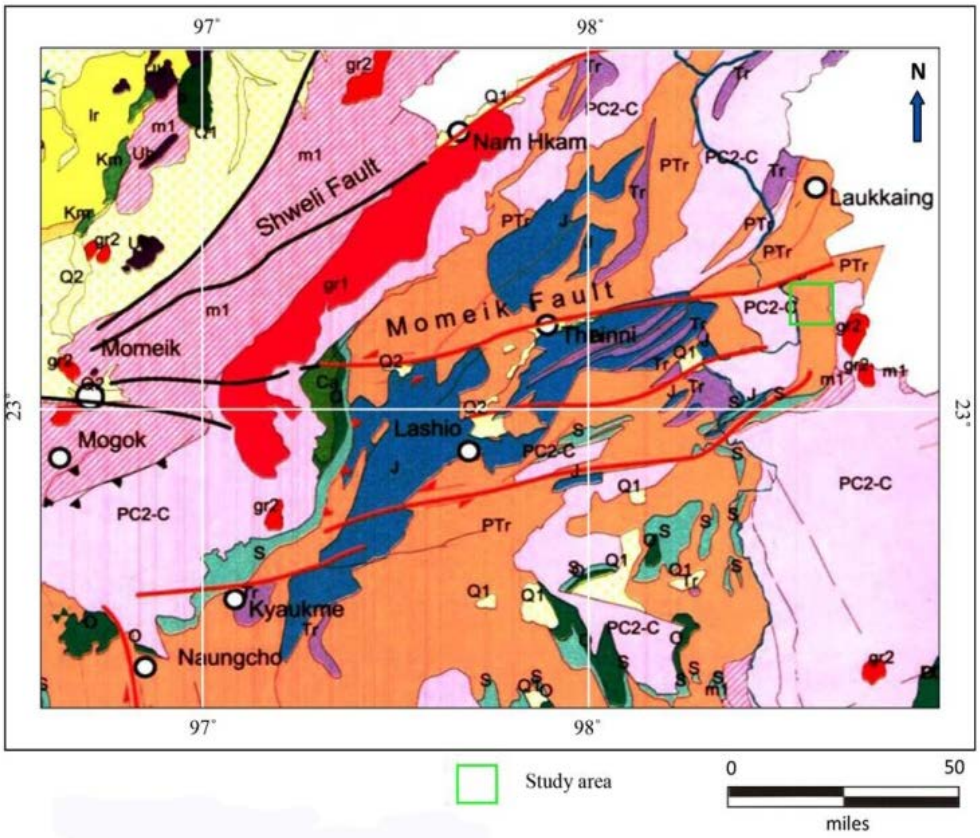
Figure (1) Location map of the study area

Regional Geologic Setting

The study area is located in Shan-Tanintharyi Block (MaungThein, 2014) which generally trending NNW-SSE direction. The regional geologic setting of the present study area is shown in (Figure.2).The Shan Plateau is part of the Sibumasu Terrane and mostly consists of Paleozoic to lower Mesozoic sedimentary rocks (Mitchell, 1992). Major cross fault namely Momeik fault is trending approximately ENE-WSW in direction. This area lies between the Momeik Fault (Nanting) in the north and Lashio Fault in the south of the area. It is mainly composed of Precambrian metasedimentary rocks, Paleozoic to Mesozoic carbonate and clastic sedimentary rocks and igneous rocks. The sedimentary units cover considerable aerial extent and exposed two third of the study area, consisting carbonate and clastic sedimentary rocks.

The red sandstones unit is distributed in the western part of the study area and well exposed along the car road section of Ma-hwe to Hwai-pon. It is mainly consisted of grayish purple, thinly bedded, brecciated siltstone and reddish brown, medium-to coarse-grained sandstone. This unit showed fining upward sequence (Figure. 3 a, b, c, d). In some place, buff colour siltstone, shale and sandstone are interbedded. This red sandstones unit is faulted contact with the underlying Nwabangyi Dolomite Formation and Plateau Limestone in the western part.

In some place, this unit lies unconformably rests upon the Nwabangyi Dolomite Formation with sharp contact. On the basis of lithology and stratigraphic position, the red sandstones unit of the study area can be correlated with the Hsipaw Red Beds of northern Shan State (La Touche, 1913). Based on the stratigraphic position, lithostratigraphic similarity, the red sandstone unit of the study area may be assigned as Late Jurassic age.



Explanation

Q2	Holocene	Alluvium
Q1	Pleistocene	Older Alluvium, Gravels
Km	Cretaceous	Kalaw Red Beds, and Kabaw Formation and other marine units
J	Jurassic	Loi-an Group; Namyau Group; and their equivalents; Red Beds of Tanintharyi Region
Tr	Triassic	Thanbaya Formation; Bawgyo Group; Kamawkala limestone; and their equivalents
PTr	Middle Permian-Middle Triassic	Plateau Limestone Group; Moulmein Limestone; and their equivalents; Yinyaw Beds, and its equivalents
S	Silurian	Minbayataung Group; Nyaungbaw Fm; Pang-has-pye Fm; Namhsin Fm; and their equivalents
Pe2e	Upper Precambrian - Lower Cambrian	Chaung Magyi Group (including Mong Long Mica Schists); Pawn Chaung Series; and their equivalents
m1	Paleozoic and partly Jurassic	Metamorphosed units of mainly Lower Paleozoic rocks-Mogok Metamorphic Belt and its extensions
gr2	Mesozoic and Lower Tertiary	Granitoids-granite, granodiorite, diorite, and non-basic intrusive; locally transformed into granite gneiss and metadiorite
gr1	Upper Paleozoic	Granitoids

Figure (2) Regional geologic setting of the study area. (Source: MGS, 2014)

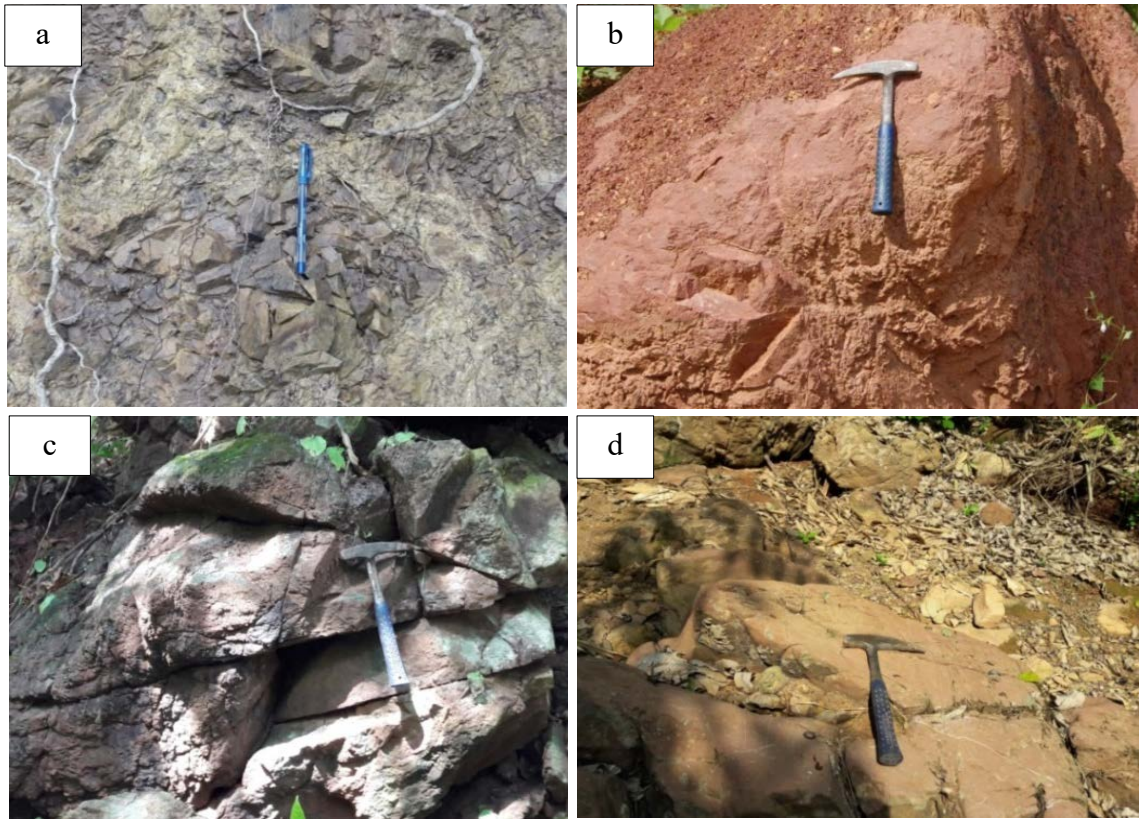


Figure (3) Sandstones ofRed Bed Unit. (a) Light buff to various shade of grey colour of ball clay in upper most part. (b) Reddish brown coloured of siltstone and shale. (c) Purple to red coloured, fine-grained cross-bedded sandstone. (d) Reddish brown medium-to coarse-grained sandstone.

Materials and Methods

Six outcrops exposures of fresh samples were collected during field investigation. These samples were subjected to whole rock geochemistry using (XRF, WD-XRF) were conducted at Department of Geology, Mandalay University Research Centre (MURC) Mandalay and Defense Service Science and Technology Research Center (DSSTRC) Pyin-oo-lwin Township.

The various indices viz: Chemical Index of Alteration (Nesbitt and Young 1982), Chemical Index of Weathering (Herron 1988) and index of Compositional Variability (Cox et.al., 1995) are used in the present study. Ratios of major oxides and significant discriminant functions were calculated for tectonic environment and provenance discrimination.

Results and Discussion

The results of geochemical analysis of the red sandstones computed parameters for provenance-indicative elements are present in (Table.1). The geochemical character displayed by the sediment is directly related to the composition of its framework components and other authigenic minerals resulting from diagenesis.

Table (1) Major Oxides (in wt%) for Sandstones of Red Bed Unit

Sample	S-01	S-02	S-03	S-04	S-05	S-06
SiO_2	58.90	57.20	55.70	58.53	55.96	67.82
TiO_2	0.70	0.79	0.63	0.54	0.68	0.49
Al_2O_3	15.40	12.20	12.70	8.93	12.08	7.08
Fe_2O_3	4.31	4.13	4.26	3.94	4.74	3.41
MnO	0.07	0.10	0.09	0.05	0.07	0.09
MgO	0.83	0.99	0.86	0.46	0.97	0.60
CaO	14.50	20.50	19.60	24.58	22.16	15.51
Na_2O	1.10	0.45	0.80	0.45	0.41	0.43
K_2O	3.33	2.47	2.93	1.59	1.79	1.48
P_2O_5	0.27	0.20	0.26	0.05	0.09	0.07
SO_3	0.14	0.06	0.08	0.05	0.04	0.13
Total	99.54	99.09	97.92	99.17	98.99	97.11
CIA	44.86	34.25	35.25	25.12	33.15	28.90
CIW	49.68	36.80	38.37	26.30	34.86	30.76
DFF1	0.40	-0.45	0.35	-2.78	-3.34	-1.55
DFF2	-0.70	0.63	-0.42	-1.98	-1.04	-0.61
ICV	1.58	2.35	2.25	3.48	2.50	3.06

The characteristic of the major oxides is principally a reflection of the source material. The red sandstones consist of 55.7 to 67.82 wt% SiO_2, 0.49 to 0.79 wt% TiO_2,7.08 to 15.40 wt% Al_2O_3, 3.41 to 4.31 wt% Fe_2O_3, 0.05 to 0.10 wt% MnO, 14.50 to 24.58 wt% CaO, 0.46 to 0.99 wt% MgO, 1.48 to 3.33 wt% K_2O, and 0.05 to 0.27 wt% P_2O_5 respectively. Total iron is expressed as Fe_2O_3.

Variations in chemistry of the sediments often result not only from the parent materials, but from the prevalent climatic setting and the extent to which the sediment remained exposed to chemical alteration either during transportation and/or after deposition (McLennan, 1989). There is negative correlation exists between SiO_2 with Al_2O_3, MgO, Fe_2O_3 and TiO_2(Figure.4).

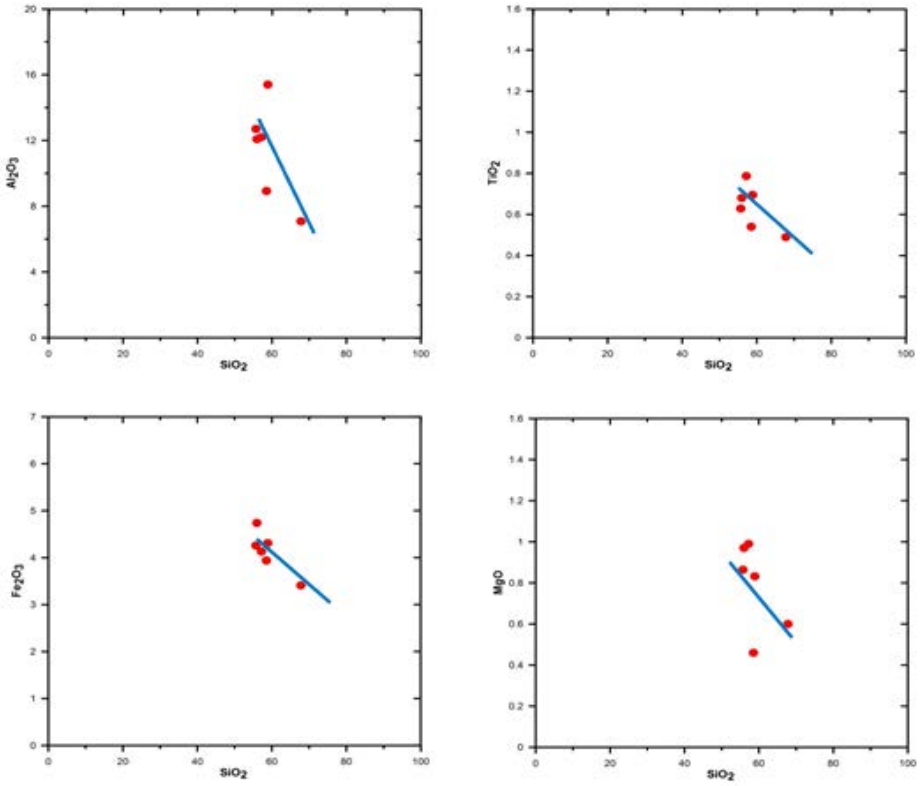


Figure (4) Harker Plots for the sandstone of Red Bed Unit

Using the Pettijohn et al (1972) benchmark chemical classification (based on major oxides ratio) the sandstones were classified as predominantly arkose and except for one sample in subarkose (Figure. 5).

The ratio of SiO_2/Al_2O_3 reflects the abundance of quartz and that of feldspar derived clays. The Na_2O/K_2O have been used to differentiate arkoses from greywackes but fails to properly distinguish sandstone with abundance of albite with corresponding high value of Na_2O/K_2O ratio (Herron 1988).

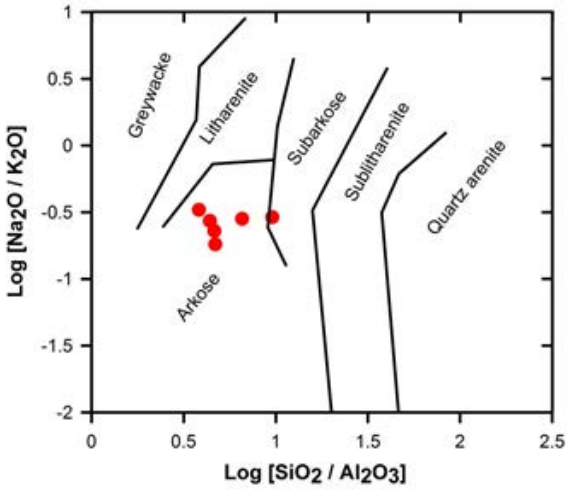


Figure (5) Geochemical Classification for sandstones of Red Bed Unit (fields after Pettijohn et al 1972)

Source Area Weathering

Several means exist by which alteration of sedimentary rocks can be examined e.g Chemical Index of Alteration, CIA - (Nesbitt and Young, 1982; McLennan *et. al.,* 1990); Chemical Index of Weathering, CIW; Index of Compositional Variability, ICV; and all have successfully been applied in several cases in the past. Nesbitt and Young (1982) defined and calculated the Chemical Index of Alteration (CIA) from the major element of bulk sediments to express the extent to which the sediments have experienced chemical weathering.

Index of chemical weathering (ICW) and the Index of compositional variation (ICV) are used to determine the nature of the source area weathering of the red sandstones unit. The nature and characteristics of the sediments revealed that the red sandstones unit are largely arkose to subarkose in composition with a characteristic fining upward succession.

The geochemical composition of the red sandstone unit of Hopang area which may have resulted largely from a complex interplay of variables such as provenance, weathering rates, nature and distance of transportation as well as diagenesis. Studies have shown that the CIA can be affected by changes in provenance of sediments, independent of changes in weathering intensity. The CIA for this study ranges from 25.12-44.86 (mean: 33.59) andCIW values 26.30-49.68 (mean: 36.13) indicates low to moderate degree of chemical weathering at the source area. Index of Compositional Variation (ICV, 1.61-3.54; mean: 2.59) suggests immature sediments deposited in tectonically active settings.

Provenance and Tectonic Setting

The major element analysis was used to discriminate the tectonic setting and Provenance (Roser and Korsch 1988). The discriminant function plot indicates sediments from sandstones of Red Bed Unit were sourced from intermediate and to some extent felsic igneous provenance(Figure 6) derived from weathered granite, gneissic terrain.

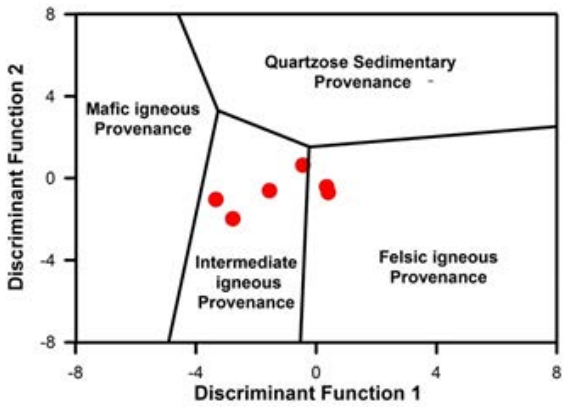


Figure (6) Discriminant function analysis using major oxide (field after Roser and Korsch 1988)

The whole rock geochemistry of sediments has shown to be an invaluable tool for fingerprinting provenance composition and depositional environment (Meinhold et al 2007). Distinctive geochemical signatures exhibited by plate tectonic processes on sediments enabled the distinction into four provinces (Bhatia and Crook, 1986); these include: Oceanic Island Arc (OIA), Continental Island Arc (CIA), Active Continental Margin (ACM), and Passive Continental Margin (PCM). Roser and Korsch (1986) also established a discrimination diagram using the log ratio of (K_2O/Na_2O) against SiO_2 (Figure 7) to determine the tectonic setting.

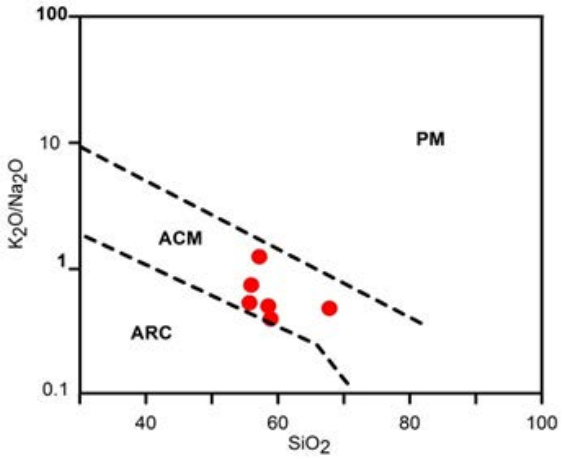


Figure (7) Tectonic discrimination diagram using log ratio of K_2O/Na_2O vs. SiO_2 for clastic sediments from Hopang area (boundaries after Roser and Korsch,1986)

The discriminant diagram log ratio [K_2O/Na_2O] *vs.* SiO_2 indicates that majority of samples plot within the active continental margin. The samples falling in the ACM reveal that the sediments are delivered from mixed sources and stored on or adjacent to active plate margins and in strike-slip setting (Roser and Korsch 1986). The geochemical characteristics of red sandstones unit strongly suggest deposition in alluvial fans, lacustrine to fluvial environment.

Conclusion

The geochemical analysis of the sandstone of Red Bed Unit is employed to reveal weathering, the natures of the source rocks provenance and tectonic setting of inferred source areas. These sandstones were classified as of arkosic and subarkosic sandstones based on major oxide composition. Studies have shown that the CIA and CIW values reflect a low to moderate degree of chemical weathering at the source area. The average ICV values suggest immature sediments deposited in tectonically active settings. The geochemical characteristics of red sandstones unit strongly suggest deposition in alluvial fans, lacustrine to fluvial environment.

Acknowledgements

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APPENDIX

Weathering Indices

CIA - chemical index of alteration (Nesbitt and Young, 1982): it is calculated as follows:

$$CIA = \left\{ \frac{Al_2O_3}{(Al_2O_3+CaO+Na_2O+K_2O)} \right\} \text{ x } 100$$

CIW—chemical index of weathering (Harnois, 1988): it is calculated as follows:

$$CIW = \left\{ \frac{Al_2O_3}{(Al_2O_3+CaO+Na_2O)} \right\} \text{ x } 100$$

ICV – Index of compositional variability (Cox *et. al.*, 1995): it is calculated as follows:

$$ICV = \left\{ \frac{(Fe_2O_3+K_2O+Na_2O+CaO+MgO+MnO+TiO_2)}{Al_2O_3} \right\} \text{ x } 100$$

Provenance Discrimination

Discriminant functions (DF) of Roser and Korsch (1988) used in the text is given as:

DF1 = 30.638TiO2/Al2O3 – 12.541Fe2O3(Total)/Al2O3 + 7.329MgO/Al2O3 + 12.031Na2O/Al2O3 + 35.402K2O/Al2O3 – 6.382

DF2 = 56.500 TiO2/Al2O3 –10.879Fe2O3(Total)/Al2O3 + 30.875MgO/Al2O3 – 5.404Na2O/Al2O3 + 11.112K2O/Al2O3 – 3.89

Minerals Paragenesis of Precious and Base Mineral in Kantaung Area, Singu Township, Mandalay Region

Aung Zaw Oo[1]

Abstract

The research area is located within one inch topographic map of 93 B/2. This area is coincided by Mogok Metamorphic Belt (MMB) consisting of marble, calc-silicate rocks and gneiss. The older rocks areintruded by Kabaing granite. The auriferous quartz veins are mainly hosted in marble and gneiss. The veins are generally characterized by banded, cockscomb, breccia and vuggy textures. They are structurally controlled by Sagaing fault which west of the research area. The vein is altered by silicification, sericitization and chloritization from inner to outer. The mineralogy of ore vein can be recognized into three paragenectic stage. Sericite and adularia are the gangue minerals. These two minerals are principal mineral of hydrothermal deposits. Base on mineral paragenesis, alteration, host rock lithology and geologic setting, the ore deposite of research area indicatesepi- to mesozonal hydrothermal deposite and might have been formed at the end of Tertiary period.

Key words: Mogok Metamorphic Belt (MMB), Kabaing granite, adularia, hydrothermal deposit

Introduction

The investigated area lies between vertical grids 74 to 81 and horizontal grids 11 to 18 in one-inch to one-mine scale topographic maps 93 B/2. The study area is the part of the locally well known gold mining area trending N-S linear belt and situated in Singu township on the Mandalay-Mogok car-road. In view of the geological setting, the study area lies within the northern part of the Medial Metamorphic Belt of Mitchell et al (1999), which is roughly equivalent to the Mogok belt of Searle and Haq (1964).The major objective of this research is to know the ore mineral and gangue mineral paragenesis of the base metal in Kaungtaung area.

Method of Study

Ore and rock samples were collected from both surface and underground. Depths of the veins were also noted. In hand specimens, recognition of ore minerals are very difficult because of fine-grained and coated with tarnishing film. For these reasons, careful study of ore minerals is necessary in order to interpret correctly. Therefore, making thin sections and polished sections of mineralized rock and ore samples from veins and associated rocks were prepared following the techniques of Craig and Vaughan (1981) and Oelsner (1966).

General Geology

In the study area, two main rocks − igneous and metasedimentary, are exposed over the area. Igneous rocks of the study area are mainly biotite micro-granite, leucogranite and syenitic rocks. Metasedimentary rocks are gneisses and marble units. Vein and dykes of pegmatite and aplite commonly occur. The eastern part of the study area is covered with the igneous rocks and the rest is comprised by the metasedimentary rocks. Calc-silicate rocks are

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scarcely exposed. The general stratigraphic trend is trending N-S and dipping east. The major rock sequence of the study area is shown in the Table (1), based on the stratigraphic position. Geological map of the study area is shown in Fig (1).

Table (1) Stratigraphic succession of the research area

Rock Units	Ages
Igneous Rocks	
Basalt	Pleistocene
Granitic Rocks (biotite micro-granite, leucogranite, syenitic rocks)	Upper Miocene
Metasedimentary Rocks	
Calc-Silicate and Skarn rocks	Upper Paleozoic to Mesozoic
Marble	Upper Paleozoic to Mesozoic
Biotite gneiss	Precambrian
Hornblende gneiss	Precambrian

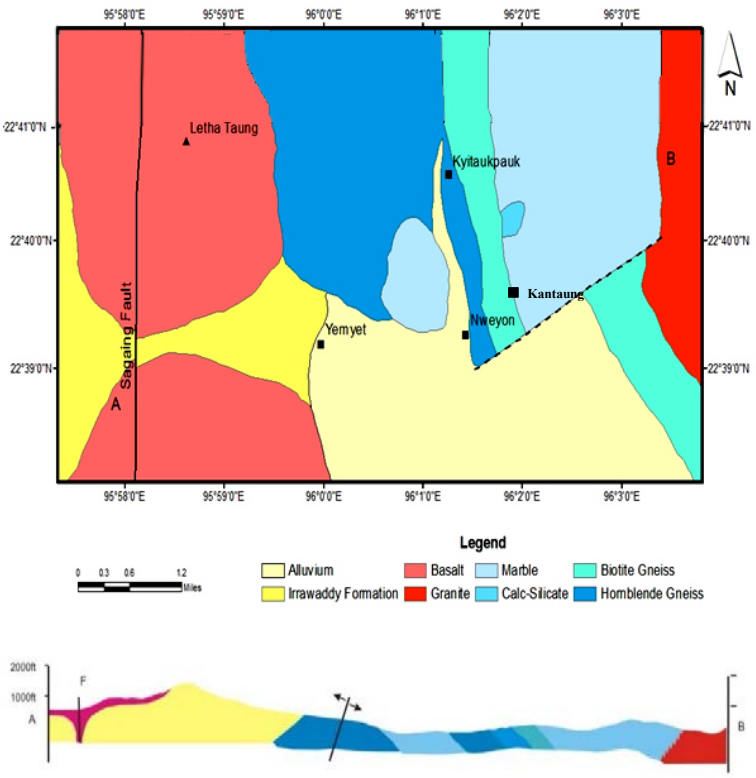
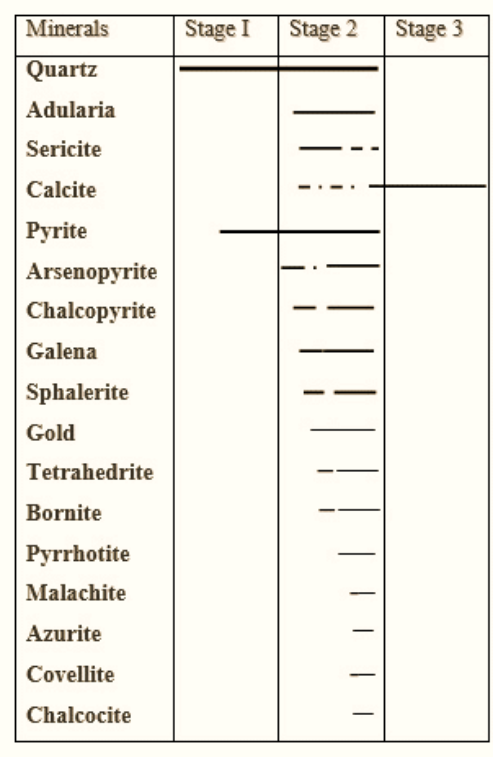


Fig. (1) Geological map of the Kantaung area. (Modified From Tin AungMyint, 2009)

Mineral Paragenesis of Precious and Base Metal

The gold bearing quartz veins are characterized by banded, cockscomb, breccia and vuggy textures. The vein-related alteration aresilicification, sericitization, and chloritization from inner to outermost zones. The mineralogy of the vein at the Kantaung area is relatively simple and can be recognized into three paragenetic stages (table 2).

Table (2) Generalized paragenetic sequence of the vein minerals. (Width of lines corresponds to abundance)



Stages I and II are main mineralization stages, and stage III is post-ore carbonate stage. In stage I, gangue minerals and base metals are precipitated and then precious and base metals were principally precipitated during stage II. Clear to white crystalline quartz is the most abundant gangue in stages I and II. In stage III, precious and base metals are obstructing by the abundance precipitation of the carbonate minerals. The width of the stage I veining is too small (about 2cm – 10cm) in comparison with stage II. So, stage II is the more important paragenetic stage than the stage I. Stages I and II were terminated by the onset of fracturing and brecciation event and overprinted by calcite veins. In some place, these stage III veins cut across the former veins. In this stage, the veins could not carry the mineralized fluid. Generalized paragenetic sequence of the vein minerals of the study area is shown in Table (2).

Gangue Mineralogy

In the study area, vein-forming minerals such as clear quartz, milky quartz, chalcedonic quartz, adularia, sericite, bladed calcite, metallic minerals, are filling in the fractures which were formed before the mineralization. Bladed quartz, banded quartz (Fig. 2), cockscomb quartz, drusy and vuggyquartzs are common. Adularia is the widespread mineral together with quartz. It is found as idiomorphic clustered crystals intergrowth with quartz (Fig. 3). Locally it alters to sericite. Vein adularia is one of the mineralogical indicators for boiling (Henley, 1985). Sericite occurs as the most common phyllosilicate and as widespread dustings. Under microscope, adularia is more common than sericite.

According to the gangue mineral assemblage, the common occurrence of adularia associated with minor amounts of sericite in the study area indicates that the pH of the fluid during mineral deposition was nearly neutral condition, as suggested by the following feldspar hydrolysis reaction of Barton *et al.*, 1977 (in Min Aung, 2004).

$$3 \text{ K- feldspar} + 2 H^{+} = \text{K mica} + 6 \text{ quartz} + 2 K^{+}.$$

Calcites commonly occur in the study area. Calcite is marked by its rhomboheral cleavages. Bladed calcite and platy calcite are also one of the mineralogical indicators for boiling. It principally occurs as vein filling form along some fractures. Sometimes, it is observed along grain boundaries of some quartz grains. It is noted that calcite veinlets are passing through the previously formed minerals. There may be two generations of calcite – the larger grained calcite crystals are possibly of stage I and the small veinlets forming calcite are of last stage.

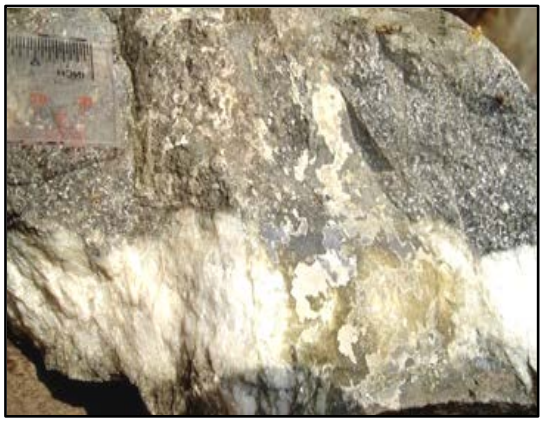


Fig.(2) Quartz vein with banded nature in Nweyon area.

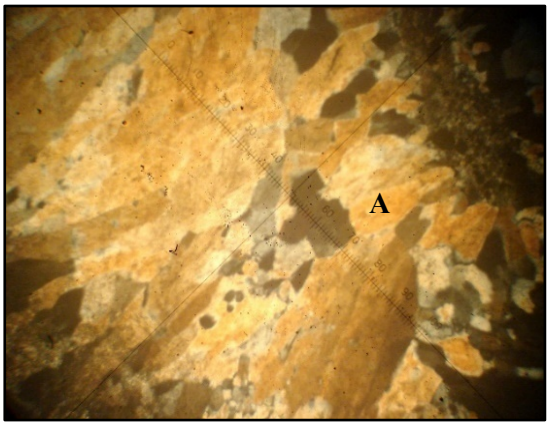


Fig.(3) Adularias as idiomorphic clustered crystals intergrowth with quartzs.

Wall - Rock Alteration

In the field, the mineralized vein system is enclosed by the zones of alteration with variable intensity and thickness. The following are the general characteristics of these zones.

1. Wall-rock alteration can be characterized by hydrothermal alteration minerals such as quartz, adularia, sericite, calcite and chlorite.
2. The alteration patterns of the study area are not yet well-defined, due to the lack of detailed alteration studies. In general, present deposits are characterized by the sericitic alteration that sometimes borders a silicified zone near the vein. Also near the vein, fine-grained potassium feldspar and/or chlorite are often disseminated in the wallrock.
3. Therefore, the vein related alteration is generally characterized by silicification, sericitization and chloritizaion from inner to outermost zones. In some places, an argillic zone between the sericite and propylitic zone is sometimes present. Propylitization appears to be formed prior to the ore deposition and may be unrelated to the ore-forming hydrothermal system (Evans, 1998)
4. Once silicified, the rocks were more brittle, allowing the apparently late emplacement of the massive auriferous quartz – sulfide veins.

5. It is found that visible alterations of gneisses to khaki to pale yellow color, marble to white color, impure marble to green and buff color and calc-silicate rock to green color are present but graphite or carbonaceous rocks resist these color changes.
6. In some places, disseminated auriferous pyrite and arsenopyrite mineralization occurs in alteration zone adjacent to ore veins.
7. Vein system locally exhibits iron oxide stains in the field as well as under microscope.
8. Generally there are two phases of silicification. The younger phase is marked by fine- quartz veinlets, cutting across the older phase of coarse- white quartz locally. It is found that coarse quartz contains a rare amount of gold relative to the fine quartz veins which sometimes carry a fair amount of gold.
9. Most of the alteration processes in the study area are sericitization, chloritization, silicification, pyritization, and some clay alteration.
10. There is no consistent relation between the size of ore body and the size of the alteration envelope in many places

Ore Mineralogy

To determine the mineral paragenesis and origin of mineralization, the mineral association and textural relationship under the reflected microscope are identified. Under ore microscope, some ore minerals generally display euhedral form but others are of irregular in shape and anhedral form. Besides, subhedral and long prismatic forms also occurs.

Studies on the sequence of mineralization have shown that pyrite occurs over the whole period of mineralization and is associated with other sulfides. Among the sulfides, pyrite is the most commonly observed mineral. It occurs as large euhedral grains (Fig. 3) as well as finely crystalline aggregates almost throughout the mineralization processes. The occurrence of pyrite indicates several generations. Coarse pyrite is commonly fractured and cemented by gangue quartz and some sulfides such as galena. In some places, pyrite occurs as relic crystals in quartz cavities. Pyrite is also found as small disseminated grains throughout the vein and as aggregates of small cubes.

Oriented small grains and rods of chalcopyrite (chalcopyrite diseases or exsolution texture) (Oelsner, 1966) are sometimes found in sphalerite (Fig. 4). This is due to the chalcopyrite resulted either by epitaxic growth (overgrowth) during sphalerite formation or by replacement of copper rich fluid reacting with the sphalerite after formation (Barton and Bethke, 1979) (in Cring and Vaughan, 1981).

Curved cleavage pits occur in galena indicated the deformation which is form after the deposition of these minerals. It commonly replaced by sphalerite along irregular cracks and grain boundaries (Fig. 5).

Gold occurs together with silver in the form of electrum. Electrum is essentially observed as disseminated specks within pyrite, chalcopyrite, sphalerite and galena. Some of the electrums are rimmed by galena (Fig. 6) and vice versa. Electrum locally occurs together with galena within pyrite (Fig. 7). Ellipsoidal grains of electrum are intimately associated with some sulfide ores such as pyrite, chalcopyrite, sphalerite and galena. This fact indicate that galena is a little earlier than electrum in paragenesis. With increasing Ag content, the color of electrum becones whitish yellow.

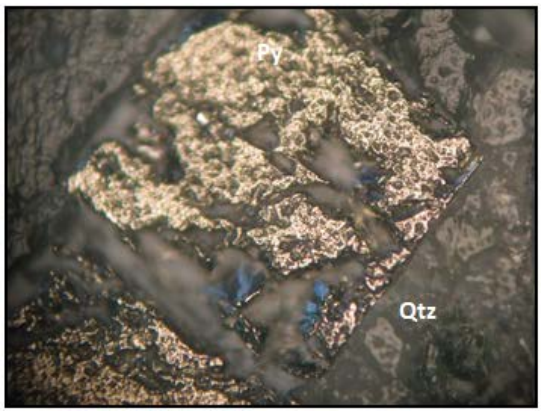


Fig (3) Euhedral pyrite (Py) crystal in gangue quartz. 30X

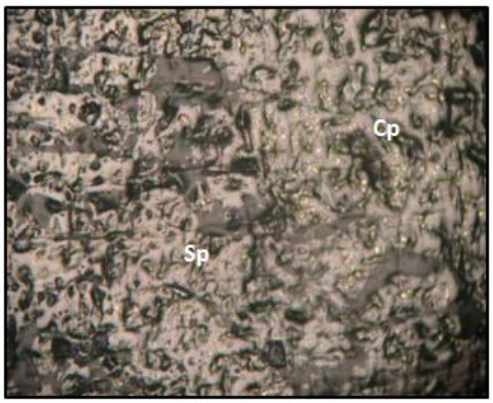


Fig (4) Chalcopyrite (Cp)diseases in sphalarite (Sp). 20X

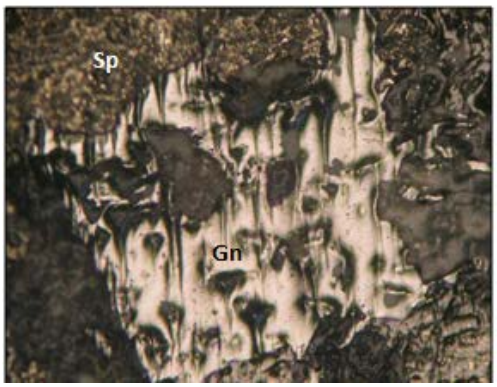


Fig (5) Sphalerite (Sp) replaced along grain boundary of galena (Gn) 30X

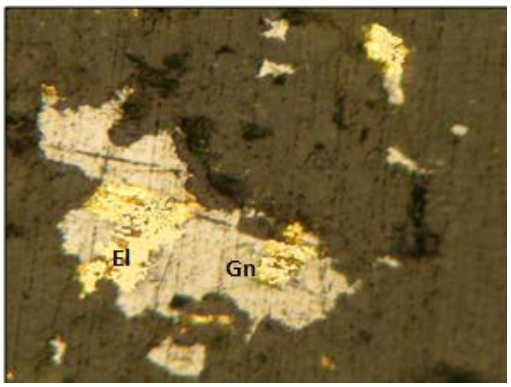


Fig (6) Electurm (El) in galena (Gn). 40X

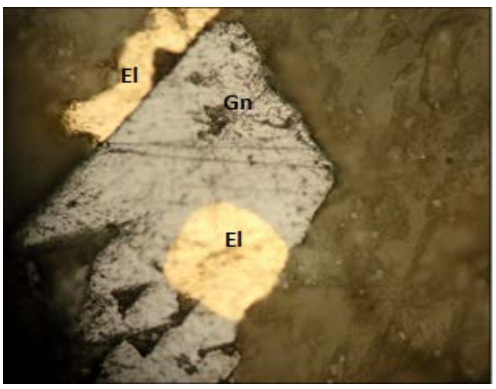


Fig (7) Galena (Gn) replaces along the boundary of electrum (El). 40X

Interpretation

Mineral paragenesis of study area is determined by microscopic mineralogical and textural features of ore and gangue minerals using ore microscope and polarized microscope. The mineral assemblage and related paragenetic sequence of the vein systems of the study area is three stages. The mineralization is mainly characterized by Au –Ag bearing pyrite–chalcopyrite dominant sulfide assemblage along with gangue mineral assemblage consisting mainly of quartz, adularia, sericite and calcite.

Precious metals and associated base metals of study area are considered to have been formed by deposition from the hydrothermal solution (mainly epithermal mineralization) related to igneous intrusion. The presences of a minor amount of pyrrhotite and chalcopyrite diseases are undeniable evidences for mesothermal mineralization in some places. Moreover, the shape of the individual crystals (euhedral) in fractures indicates that the mineralization is of fracture filling vein deposits.

Small amounts of marcasite and hematite occur in veins. These mineralogical characteristics reflect the moderate activity of oxygen, neutral pH condition and low sulfur content of hydrothermal fluids at the site of mineralization (Izawa, 1995), suggesting the study area to be a low sulfidation style epithermal deposit.

Judging upon gangue mineralogical assemblage, it is found that adularia is a morphological distinctive variety of K-feldspar. This mineral is typical of low-temperature, hydrothermal environments (Dong *et al.*, 1995). In other words, adularia is the only common feldspar in hydrothermal veins at epithermal temperature. The mineral occurs as typical and distinctive gangue phase of the so-called adularia– sericite type deposit of Heald*et al.*, (1987) and is not found in other category of epithermal deposit known as acid- sulfate (Kaolinite–alunite) or high sulfidation type.

Sericite also known as fine-grained white mica, hydromica, hydromuscovite, hydrothermal illite etc., (e.g. Hedenquist and Browne, 1989) is also a common gangue mineral together with quartz, adularia and calcite.

Conclusion

In research area, gold forming veins are mainly hosted in marbles rather than in gneisses. This is due to that the permeability and porosity of marble units may also favor than that of gneisses. The mineralized veins are striking parallel with the regional structural features which serve as channelization for ore bearing hydrothermal solutions. The veins are characterized by banded, cockscomb, breccia and vugg textures. Adularia andsericite are the gangue minerals, suggesting the low temperature and hydrothermal environments. Base on Au/Ag rations, ore and gangue mineralogy, alteration, host rock lithology and geologic setting of the Kantaung area, the present precious and base metal mineralization is epithermal to mesothermal hydrothermal origin. Base on time of mineralization is probably at the end of Tertiary period after the intrusion of granite.

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