Trade and Commerce in Banmaw District (1886- 1942)

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Abstract

Banmaw is derived from Shan language. "*Man Mo*", "*Ma*n" means village and "Mo" means pot in Shan language. "*Ma*n" means village and "*Mo*" means pot in Shan language. So, "Man Mo" is now called Banmaw. Banmaw is situated in the northern part of Myanmar. It is also located on the southern edge of the Kachin State. Banmaw District was annexed by the British after the third Anglo-Myanmar War of 1885. The British government encouraged the trade and commerce of Banmaw District.

Introduction

Myanmar came under British colonial rule after waging three wars with the British. Upper Myanmar was occupied by the British after the third Anglo-Myanmar War in 1885. Lord Dufferin, the Viceroy of British India Government, formally announced that the whole of Myanmar was annexed by the British. Myanmar was designated as a province of India.

Banmaw District was also captured by the British forces headed by Brigadier General Norman on 28 December 1885. Banmaw District was a strategically well-known area, and situated as a gateway from northern to central Myanmar. It was also on the trade route from China. So, the British government stimulated and encouraged the trade and commerce of Banmaw District both external and Internal.

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Location

Banmaw District is located in the northern part of Myanmar. It is also situated on the southern edge of the Kachin State. It comprised an area of 4,146 square miles, and located between 23 71' and 24 52' North and 96 34' and 97 46' East. Until the year 1895, the present Banmaw and Myitkyina districts were formed a single charge, with its headquarters at Banmaw. When the separation took place the Banmaw District consisted of two subdivisions-----Banmaw and Shwegu and four townships, namely, Banmaw, Sin-Khan, Kaungtone, and Shwegu.

Boundary

The Banmaw District is bounded on the North by Myitkyina, on the East by China, on the South by the Shan State of *Mongmit* and on the West by Katha. On the eastern part, the boundary between Banmaw District and China was demarcated by a joint commission in the year 1897-98 and agreed with the boundary described in article 1 of the Agreement of 1897. The *Namwan* Assigned Tract, or "Triangle", was the Agreement of 1891 recognized as belonging to China. The administration and control this tract was however, entirely conducted by the British government, who held it on a perpetual lease from China. The boundaries of this tract, administered as part of the Banmaw District, were *Namwan*, *Nam Mak*, and Shweli rivers.

River Transportation

The most important rivers are the Ayeyarwady and Ta-ping. The Ayeyarwady River flowed throughout the district, in the mid, it forms the first defile in the north and the second defile in the south. Except the Ayeyarwady River, other is not so necessary for the transportation in Banmaw District. The Ta-ping river is too shallow for ships and large size boats. So, small boats sail only in the rainy season. The Ayeyarwady River, the Ta-ping river, and Mo-Le stream are important for transportation and trading local crops and wood products.

Nan-Saree, *Thein-Lin*, *Moe-Yu*, and La-Bai-Din streams are useful for irrigation and local trade.

Land Transportation

Since Banmaw was only 54 miles away from Chinese border. In the past it was a key place to trade with China. The traders could stay in contact with Chinese by land routes. The Banmaw-Myitkyina road, the Banmaw- *Namkhan* road, the Banmaw-*Momeik* road, and the Banmaw-Shwegu-Tagaung-Mandalay road were the main land routes. After the annexation, the situations of Banmaw District became complicated and the transportation became worse. The British government made Banmaw as the headquarters of District and tried to regain its prosperity and transportation but it did not develop as before.

Headquarter

The headquarters of the district was Banmaw. It was situated on the left bank of the Ayeyarwady River, 687 miles from the sea, and had in 1901, a population of 10,734, including the cantonment. It was established as the chief town of the district and the emporium of the Chinese trade dated probably from the 17th century. The old town of Banmaw was located on the right bank of the Ta-ping river between Sikaw and Sihet, and was founded as an ancient capital called *Sanpenago*. It was probably established by the Shans. The site of *Sanpenago* was now occupied by the village of Shwekyina and a maze of ruined pagodas and the remains of the old fort-wall testify to its former greatness.

Subdivisions

The area of Banmaw subdivision, including the hill tracts, was 1,720 square miles, and its population in 1901 was could be estimated at about 25,000. The area of the Shwegu subdivision, including the hill tracts, was 2,432 square miles and its population in 1901 was 21,943. The Banmaw District was sparsely populated. At that time, the population of the whole district was less than twenty in a per square mile.

Nationalities

The nationalities living in the Banmaw District were Banmar, Hkamti-Shan, and Kachin. Among them, Kachin nationals were small majority. The only other race was Palaungs who were ousted from the hills by the Kachins. Indeed, they were descendants of Mon-Khamar tribes, Tibeto-Burman tribes, and Sino-Tai tribes which were originated from Mongoloid family.

The Main Businesses

The majority of the people living in Banmaw District were farmers and they depended on the cultivations and the forest products. The main business crops of Banmaw District were paddy, wheat, millet, groundnut, sesame, corn, sunflower, soya-bean, green pea, sugar-cane, potato, garlic, onion, water melon and vegetables.

At that time, the main business of Banmaw District was agriculture. The forest products were also the main business works there. In the Banmaw District, there were also mining such as gold, copper and coal etc. Under the British administration, there were also the drug smugglers. Along the bank of the Ayeyarwady River, where cultivated land was scarce fishing took its place as the stable business work. Fishing had been conducted on an extensive scale. The fishery was blocked with a yin or screen of bamboo. The bulks of the fish were also made into *ngapi* or fish paste. The river-bank villages depended almost entirely on the fisheries.

Households Manufacture

A few households manufacture of earthen utensils from locally-obtained clay were found in Shwegu. They were the water-pots, glass, cup, and saucer. They were sold both in the district and in river-bank villages. The cotton-weaving workshops were manufactured *longyis* for both men and women. They were found in most houses. A considerable quantity of silver-ware was also imported from the Shan State.

Timber Trade

The felling and dragging of timber and the cutting of bamboo were done by the early dwellers in or near the forests and a small town population who were engaged in petty trade. The introduction of the purchase-contract system had been started to improve the timber trade. Elephants and buffaloes were used for dragging the timbers to the floating streams. The main trade products of the forest were the timber, bamboos and canes. The principal timbers were teak, *ingyin, kanyin, letpan* and *didu*. A few hundred rupees were realized annually on *indwe* and *pwenyet*. Lac, honey and wax were exported to abroad pass through Banmaw. Large trading business was also done in bamboos. Different kinds of basket and tray made of cane and bamboo were also manufactured, some of which were dedicate workmanship and of some artistic value.

Trade Registration

Banmaw District was an important trade centre. Because its position was the distribute trade centre. Trade with Yunan and the Kachin-hills was registered at Banmaw. The system of trade registration was in a more or less experimental and progressive state until 1892, when it was thoroughly revised, and trade registration department was placed under the Director of Land Records and Agriculture and rendered more simple and uniform. The trade between Myanmar and China was registered at Banmaw and Myothit in the Banmaw District. The trade between Upper Myanmar and the Northern States was registered at Banmaw, Myothit, and *Sawad*i.

Exports and Imports

For a long time raw cotton was the only export from Banmaw to China, but later woolen piece goods and twist and yarn were also added. The import trade consisted of ponies and mules, horns, hides, and raw silk. Large quantities of treasure, both species and bullion were imported and exported, but the amounts were not nearly equal.

In March 1896, the percentage of increase of the trade with China was13.61percent; the increase in imports was 23.07 percent; and in export was 84.29 percent. The trade in 1895-96 was only twenty-two lakhs against thirty-two lakhs in 1894-95 and twenty-seven lakhs in 1893-94, owing to the Sino-Japanese War. The most noticeable decrease in imports was under raw silk, gold, and silver, and in exports under raw cotton, European cotton piece-goods, and silver.

The trade between Upper Myanmar and the Northern States, the merchandise trade of 1895-96 amounted to thirty-five lakhs against thirty-eight lakhs in 1893-94 and forty lakhs in 1894-95. During the three years from 1893-1896 in Myanmar showed the percentage of increase under imports and exports being 20.03 and 45.09 respectively. The most marked increase in articles imported occurred under the heads of precious stones and foreign tea, in articles exported under the heads of Indian twist, cotton piece-goods and salted-fish. There was a decrease under the heads of ponies, rice, and cigar-wrappings.

To foster the export trade a rebate of seven-eight of the custom duty levied in Yangon was allowed on goods consigned to China. For this purpose, a custom-house was established at Banmaw in December 1904. The goods were repacked and the rebate was paid on production of a pass counter-signed by the custom officials at *Tengyueh*.

The trade with China and the Northern States was carried by the Irawaddy Flotilla Company which had been increased double in 1903-04 while imports were valued at 29 lakhs and export at 39 lakhs. The aggregate sums paid as rebate in the three years, the establishment of the bonded warehouse were Rs. 9, 717, Rs.12, 314 and Rs.13, 333 respectively. The disproportion between imports and exports of Banmaw would show as the following table.

Table-I

Export and Import with China

	1905- 06	1906- 07	1907- 08
	Rs.	Rs.	Rs.
1. Imports, including treasure …	29, 38, 377	31, 09, 985	32, 97, 317
Treasure …	16, 74, 527	17, 37, 162	19, 27, 849
2. Exports, including treasure …	33, 63, 655	38, 13, 076	42, 02, 931

Treasure …	2, 56, 164	3, 99, 625	3, 05, 890

This table indicated that both the imports and exports with China through Banmaw were increased during the early colonial times. It was due to the construction of a series of roads connecting the new posts with Banmaw and other places.

Trans Frontier Trade with China

Myanmar's new economic was deteriorated due to the word depression of 1930. Even though the events were thousand of miles away from Myanmar, the people had to face the great problems such as paddy price fell and livings were adversely affected. Myanmar's frontier was not crossed until 1939 by any modern means of communication. The old caravan trails to China had never carried a significant volume of goods. Hence nearly all of Myanmar's trade took place through Yangon. Nevertheless, Myanmar's trans-frontier trade with China was still until 1942.

As the result of the Japanese's aggression, all the ports of China's eastern seaboard were closed. But the trade with China was never stopped. The years 1937-1939 therefore saw Myanmar actively involved with Britain and America in supporting China, but observing neutrality with Japan.

Table-II

Myanmar's Trans Frontier Trade with China

	1938- 1939 April to March	1939- 40 April to March	1940- 41 April to March
	Rs.	Rs.	Rs.
Exports to China via Banmaw	14, 09, 166	43, 69, 700	71, 14, 108
Imports from China via Banmaw	63, 94, 335	19, 49, 171	17, 42, 343
Foreign merchandise re- exported by Myanmar to China by Burma- Yunnan Road and other routes	…	3, 10, 92, 338	9, 05, 06, 286

Caravan Traffic

At first, the animal-dealers could travel in combine with other merchants to sale their animals which included at least five hundred to one thousand for their caravan's security. They used the ponies, mules, bullocks and cats as the means of transportation. Before the annexation, the trade of Banmaw District had been almost entirely with both internal and external, Upper Myanmar and China. Shortly after the second Anglo-Myanmar War of 1852, the *Panthay* rebellion broke out in *Yunan*. So, the caravan traffic was brought to a stop by accident.

River Traffic

The traffic on the Ayeyarwady River soon regained important. The river trade was largely in the hands of the Irawaddy Flotilla Company. After the annexation, the Company's operations were largely increased and the boat traffic soon also resumed. The following table contained the statistics of the river traffic during the years before and after the annexation:

Table—III

The River Traffic on Ayeyarwady River before and After Annexation

Year	Up		Down		Total	
	Number	Tonnage	Number	Tonnage	Number	Tonnage
1884- 85	7, 120	80, 542	7, 135	81, 638	14, 255	162, 180
1885- 86	7, 405	82, 276	5, 949	65, 802	13, 354	148, 078
1886- 87	4, 433	45, 703	4, 638	45, 091	9, 071	90, 794
1887- 88	5, 862	72, 178	6, 550	73, 922	12, 412	146, 100

The river traffics from Banmaw to China were followed two main routes. These routes were the northern river route called the Ta-ping river route and the southern river route called the Shweli river route. The Kachin nationals had always been brought to use the trade through these two main river routes until the annexation. The former was proceeded by *Sikaw* (*Manmaw*) and *Manwaing* (*Manyun*) to *Tengyueh* (*Momein*) and the latter by *Sawadi* and the Shan State to *Yungchang* through the way on the Shweli river. The nationals demanded a toll of three annas for every baggage animal passing between *Sikaw* and *Tengyueh*. There was standing committee of Chinese trades at *Manwaing*, whose business it, was to make arrangements with the traders for the safe conduct of each caravan, to investigate complaints, and to deal with questions arising out of attacks on trading groups.

Before the turn of the century, the British government decided to continue their commissariat steamer services on the Upper Ayeyarwady River and Chindwin River. The railway to Myitkyina was opened in 1899, and the concession to run between Banmaw and Myitkyina enjoyed by the Irawaddy Flotilla Company was withdrawn, but the trade became only the land route and this was not great loss.

Airway

In 1937, the Banmaw route into China came on the scene again. The mule caravans were still there on the trail to *Tengyueh*, but the new transport was developed there. It was airway line from Yangon to Banmaw.

Road Constructions

The construction of the roads was carried out by the Public Works Department under the supervision of Assistant Superintendent. With the arrangements of the Public Work Department, the Assistant Superintendent had to work on the construction of the roads every year. According to the village jurisdictions, he would divide the roads into sections, get the work done and divided and received money from Public Work Department.

In the district, the Public Work Department staff had been undermanned that the construction works could not complete and the standard of roads were bad and they tried to repair impossible. So, the Commissioner of Mandalay Division, H.A. Thornton, had given proposal that the Assistant Superintendent could be undertaken the works with local labour

forces. According to his report, the Public Work Department had to permit the arrangement. Under the Assistant Superintendent's management there would be little difficulty in securing a supply of labour for roads.

Cart and Mule Traffic

Before the construction of the roads, the District Public Work Department started to repair the cart roads and mule-tracks. In the Sin-Khan area, the mule- tracks were repaired about 21 miles from *Kulonghka* to *Manwaing* plain, near the Chinese frontier. And then, the Chinese frontier road along the left bank of the Ta-Ping, the cart-road about 13 miles was opened. All the cart-roads were opened throughout the year with the exception of the sections between Banmaw and *Sawadi* and *Nanhlaing*, which were flooded during the rains.

According to the report of 1915, Rs. 3472 were spent on roads in the *Sinlum* Hills. The Reverend Father Gilhodes supervised the supervised the construction of a useful mule-track connecting *Mahtang* with *Mongloi* and the Reverend Father Juery made the construction of an excellent mule-track from *Mongloi* to *Lapyehka*. The former road cost Rs. 400, the latter, 9 miles in length, was constructed at a cost of just over Rs. 700 which sum covered also the cost of a dozen substantial bridges.

The transport used on the border and in Yunan was chiefly mules and bullocks, the former was used by Chinese, and the latter by Shans, and to a lesser extent by Kachins. Elephants did not exist in China. They were probably obtained from Myanmar, but did not use in an expedition into Yunan. A large numbers of mules and bullocks were used on the whole year.

Mules were very plentiful among the Chinese throughout *Yunan*. During the year 1893, 20,000 loaded mules came to Banmaw. Among them had made the journey to Banmaw and back several times in the year. The majority of them came from *Momein* and other places to the west of the Thanlwin River, though some were from Yungchanfu, Talifu. Taking 15,000 mules did the journey backwards and forwards into Myanmar from the west of the Thanlwin River. But all the mules did not go into Banmaw and they went to eastern Yungchanfu and Talufu, northern Likiang, western Jade Mines and Hukong valley.

During 1893, 16,000 bullocks arrived in Banmaw from the Kachin hills and the Northern Shan State. Those from the Northern Shan State were more numerous than those from the Kachin hills. So taking 9,000 came from the Shan State and each bullock came nine times within the year, and would be 1,000 bullocks. They were almost all from the Namhkam

Valley and the return trade. They probably came from the Sino-Shan State of Mong Mow. In the return for the year, a single bullock was not shown as coming by the Sawadi route from China. A thousand separate bullocks had to be taken as the large numbers which probably came from *Mong Mow-Namhkam Valley* in a year. It estimated that at least 1,000 pack bullocks came from *Mong Mow*, *Nqamhkam*, and *Selan*.

In the *Mong Wan* plain, only 670 bullocks came from China to Banmaw in 1893. Probably nearly all these were from Mong Wan Shans. But, there were not so many bullocks in the *Mong Wan* Valley. In many of the Kachin villages in the southern Ta-ping river near the trade route between Banmaw and China, there were a large numbers of bullocks, and one could take them by an 8 days. With regard to drivers for the bullocks were probably the Sino-Shans who settled from *Mong Mow* and *Mong Wan*. But they did not love for the Chinese.

Bridge Constructions

The constructions of the roads and bridges were developed simultaneously by the District Public Work Department in Banmaw District. In 1906, the suspension bridge of Ta-ping river was completed at a cost of Rs. 20,000. a similar bridge spanned the Mole river at Kadon and established connection with the most northerly outpost at *Nalon*. These bridges were constructed using the revenue derived from tributes.

In the road from *Sinlum* to *Wahtang*, under the supervision of the Assistant Superintendent two Chinese stone arched bridges, 50 feet and 20 feet long, were constructed at a cost of Rs. 3,960 and Rs. 1,750 respectively, and used from only district funds. These Chinese arched bridges were an experiment and later, if successful it was proposed gradually to replace with similar bridges over all the larger streams crossed by district roads.

In the road from *Sinlum* to *Longkha*t, five masonry bridges were erected. The works were done by experienced Chinese contractors and supervised by the Assistant Superintendent, *Sinlum*. The total expenditure on five masonry bridges was Rs. 12,137-5-9. The Superintendent Engineer saw and reported that one of these bridges was very favourably on it.

A 42 feet arch masonry bridge over the *Nawje Kha* on the *Sinlum-Loilaw* road was commenced and completed in 1919. And a stone arch bridge over the *Nansai Kha* on the Sinlu*m-Loilaw* road was completed at a cost of Rs. 4,800. A similar bridge over the *Paga Kha* on the *Prang-Hutong-Kalekyet* road was completed at a cost of Rs. 3,570.

In the S*inlum*-Kachin Hill Tracts, 10 feet two stone bridges, over the *Namli* and *Kahpra* streams and 46 feet stone culverts on the Silum-Lailaw road, were constructed at a cost of Rs. 4,455 from district funds.

Road Constructions

The road from Banmaw to Lweji and Panghkham were completed, and constructed by Kachin national labours. *Sikaw* in 1900-1901, and in the Sin-Khan valley, was connected with the headquarters in 1901, and in 1904, over half a lakh of rupees were spent in the construction of roads. The Chinese frontier road along the left bank of the Ta-ping river was undertaken in 1906, the *Yunan* government contributed to the cost. It was metalled for 171/2 miles, and for 13 miles was opened for cart road. From *Kulonghka* to frontier, a distance of 21 miles, and the alignment of the road was carried through to the *Manwaing* plain, aS distance of 79 miles from Banmaw. The cost of this road was about 311/4 lakhs of rupees. Thus the district had 31/4 lakhs of rupees. Thus the district had 31 miles of metalled and 100 miles of unmetalled cart-roads and 469 miles of bridle-roads.

According to the report of 1915, Rs. 3472 were spent on roads in the *Sinlum* Hills. In the Shwegu Hills where owing to the very sparse population the expenditure of District Fund on roads was hardly justified, the Civil Officer had continued to get communications improved by the people themselves. Seven villages combined to open out a road of seven miles between *Khataun*g and *Khashi*n. So, they got the rewards for their efforts. And another roads was opened out under the supervision of the *Tangte Taungok* from *Khataung* and thence to the *Sin-Khan-Sikaw* road.

The road from *Sinlum* to *Wahtaung*, which made Sinlum accessible from south, was carried another six miles at a cost of Rs. 1,100 and Rs. 2,500 was spent on the repair of existing roads. In the *Shwegu* hills no district fund was spent on roads, but Mr. Davis paid mush attention to get the villagers to keep inter-village roads in good condition.

The road from *Sinlum* to *Longkhat* was continued as far as *Bunkaiwaing* and thence to the 35 miles on the Banmaw-*Namkham* road. a new road was opened joining the China frontier road and *Sinlum*. It had only 17 miles. Another new road was partially made from *Watangyang* to *Lazao* to improve the communications for the *Taungok* . For the improvement of communications in the numerous district roads which existed in the hills was started there according to the programme of Assistant Superintendent, *Sinlum*. According to the

programme, the villages could and should be required to maintain all minor roads and only bridge work and heavy embankment. It was paid by district funds. So, the district scheme had accordingly been prepared on this basis.

The following roads were carried out by the Assistant Superintendent under the supervision of District Public Work Department:

(1) *Momauk-Sinlum*;

(2) *Sinlum-Lweji*;

(3) *Sinlum-Warabum*;

(4) *Warabum-Khuli Kha*; and

(5) *Mansi-Pangkham*.

Arrangement with the District Public Work Department, the Assistant Superintendent worked on these roads every year. According to the arrangement, he would divide the roads into sections and work done among the villages and divide the funds received from District Public work Department. This was the best arrangement. And then the cleaning and repairing in the jungle, where necessary, were carried out by the villagers in the Shwegu Hill Tracts. The road from *Mongloi* to China was improved at a cost of Rs. 425. It had only 17 miles. Twenty-five villages had to receive funds at about Rs. 1,090-8-0 as rewards for good works. The Assistant Superintendent, *Sinlum* appointed an impress holder. He would be to arrange for a supply of labour of such repairs as if involved no great technical skills.

With the exception of the Banmaw-*Tengyueh* and Banmaw-*Pangkham* road, all work on the District public Work Department roads were carried out by Kachin nationals under the supervision of the Assistant Superintendent of *Sinlum*, at the total cost of Rs. 7,664-12-0 which was received from the District Public Work Department. The District Public Work Department improved the Banmaw-*Tengyueh* road. It was to be in excellent conditions.

In the Shwegu Hill Tracts, good well-aligned roads had been and were being made by District Forest Department. In the villages, the Kachin nationals had to repair the village roads but they started work late in the season and had not done enough to merit remission of tribute. In some places, wild elephants damaged the village roads, but finally, they would be carried out there.

Manual Workers

If transport failing, it might be necessary to employ manual workers called collies. During the cold seasons, a large numbers of Sino-Shans and Kachins who living in Banmaw District had to work as collies. They were at least probably 200 or 300 men. From the *Namhkam*, *Selan*, and *Mong Mow* states, at least about 500 to 1,000 Shan coolies were recruited. Among them, at least about 200 to 300 men came from Mong Wan.

Conclusion

Banmaw District was a strategically well-known area and also on the trade route from China. So, during the colonial period (1886-1942), the British government attempted to improve trade and commerce between Banmaw District and China. In order to upgrade the trade and commerce, the British government had to construct a series of roads, and bridges and repair the old roads and bridges. In deed, the aim and objective for the construction was for more effective administration and economic development. The economy of Banmaw District was developed from feudalism to capitalism. But, it was only benefits to British not for natives. The native people of Banmaw District had to face the economic and social problems. They had to suffer severely from the yoke of imperialism.

References

- *Banmaw Myo Nai Hmat Than* (*Records on Banmaw Township*), Burma Socialist Programme Party, Party Press.
- *Banmaw Hka Yaing Hmat Than* (*Records on Banmaw District*), District Planning Department, 1992.
- *Burma Gazetteer*, *Bhamo District*, Vol. B, No. 27, Rangoon, Office of the Superintendent, Government Printing Press, 1913.
- Dawson, G.W., *Burma Gazetteer*, *Bhamo District*, Rangoon, Superintendent, Government Printing Press, Reprint, 1960.
- Furnivall, J.S, *Burmese Economic Life*, Bombay, Oxford University Press, 1946.
- *Kachin Pyi Ne Hmat Than* (*Records on Kachin State*), Burma Socialist Programme Party, Party Press,1985.
- Min Kaung Oo, *Theinganadi Myan Pyi Myaut Phar Tot* (*Toward Northern Myanmar*, Theinganadi) Yangon, Burma Socialist Programme Party, Party Press, 1983.

- *Myanmar Sawe Sone Kyann* (*Myanmar Encyclopedia*), Vol, III, Yangon, Sarpay-Beik-Hman Publishing House, 1956.
- *Myanmar Sawe Sone Kyann* (*Myanmar Encyclopedia*), Vol, IV, Yangon, Sarpay-Beik-Hman publishing House, 1957.
- Naw Anglene, *Kachin Taungthan Deta Ok Choke Ye* (*The Administration of Kachin Hills*), M.A. Thesis, Mandalay, Mandalay University, History Department, 1979.
- *Report on the Administration of Upper Burma, for the year 1886*, by H.Thirkell White, Secretary of Upper Burma, Mandalay, Reel No. 156, Acc: No. 156, IQR, NAD, dated15 December, 1886.
- *Report on the administration of Burma, 1890-1891*, Rangoon, Superintendent, Government Printing Press, 1891.
- *Report on the Administration of Burma, 1892-1893*, Rangoon,Superintendent, Government Printing Press, 1893.
- *Report on the administration of Burma, 1899-1900*, Rangoon, Superintendent, Government Printing Press, 1900.

- *Report on the Administration of Burma, 1900-1901*, Rangoon, Superintendent, Government Printing Press, 1901.
- *Report on the Administration of Burma, 1902-1903*, Rangoon, Superintendent, Government Printing Press, 1903.
- *Report on the Administration of Burma, 1903-1904*, Rangoon, Superintendent, Government Printing Press, 1904.
- *Report on the Administration of Burma, 1921-1922*, Rangoon, Superintendent, Government Printing Press, 1922.
- *Report on the Administration of Burma, 1923-1924*, Rangoon,Superintendent, Government Printing Press, 1924.
- *Report on the Administration of Burma, 1925-1926*, Rangoon,Superintendent, Government Printing Press, 1926.
- *Report on the Administration of Burma, 1929-1930*, Rangoon, Superintendent, Government Printing Press, 1930.
- *Report on the Administration of Burma, 1932-1933*, Rangoon, Superintendent, Government Printing Press, 1933.

- *Report on the Administration of Burma, 1932-1933*, Rangoon, Superintendent, Government Printing Press, 1933.
- *Report on the Administration of Burma, 1933-1934*, Rangoon, Superintendent, Government Printing Press, 1934.
- *Report on the Administration of Upper Burma, 1886-1888*, Rangoon, Superintendent, Government Printing Press, 1888.
-*Report on the Kachin Hills Northeast of Bhamo* by Captain G.H.H. Couchman, Rangoon, Superintendent, Government Printing Press, 1892.
- *Report on the Part of Yunan between the Bhamo Frontier and Salween*, by H.R.Davies, Rangoon, Government Printing Press, 1896, S.R. 772, UHRC.
- Scott, J. George and Hardiman, J.P, *Gazetteer of Upper Burma and Shan States*, Vol.I, Part, I, Rangoon, Superintendent, Government Printing Press, 1900.
- Scott, J. George and Hardiman, J.P, *Gazetteer of Upper Burma and Shan States*, Vol.I, Part, II, Rangoon, Superintendent, Government Printing Press, 1900.
- Scott, J.George and Hardiman, J.P, *Gazetteer of Upper Burma and Shan States*, Vol, II, Part, II, Rangoon, Superintendent, Government Printing Press, 1901.
- *Tainyintha Yinkywemu Yoeyar dalayt Htonezan Myar*, *kachin* (*Custom and Tradition of* Kachin), Burma Socialist Programme Party, Party Press, 1967.

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Professor's Recommendation on the Project Paper

The project paper titled "Trade and Commerce in Banmaw District (1886-1942)" submitted and described by Myo Naing, lecture, is well organized and structured. The researcher's presentation and performance are satisfactory. I surely recommend this project paper should be effect and support for students who interest in Myanmar history especially Banmaw District.

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Professor's Recommendation on the Project Paper

The project paper titled "The Administration of Banmaw District (1886-1942)" presentation and submitted by Dr. Myint Myint Htay, Lecturer, is good structured and organized .The researcher's designation on her project is not well but she must be try the best. I satisfyingly recommend this project paper should be accepted for the students who study in this field especially Banmaw University.

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References

1. Amar, Daw; *Bawa- Chin- Matu- Thi- Tayoke- Pyi (Trs)* Mandalay. Kyee Pwar Ye Press, 1966.
2. Amar, Daw; *Communist- Tayoke- Pyi- i- In- Ah- Pyaing- Bwe (Trs)* Mandalay. Kyee Pwar Ye Press, 1949.
3. Amar, Daw; *Taw- Lan- Ne- Dai- Tayoke- Pyi Kyun- Taw- Hmat- Mi- Thamya (Trs)* Mandalay. Kyee Pwar Ye Press, 1979.
4. Aung Zan; *Chou En- Lai*. Yangon. Thitsar Sarpay, 1977.
5. Ebery Patrica Buckley; *Cambridge Illustrate History of China*. Cambridge University Press, 2000.
6. Faust, John Ran Juidith F. Karnberg; *China in World Politics*. London. Lynne, Reinner Publisher Press, 1995.
7. Garnett, Sherman W; *Reapproachement or Rivalry ? Russia- China Relations in Changing Asia*. Washington D.C. The Brooking Institution Press, 2000.
8. Ko Ko Gyi, (Taung Twin Gyi); *Tayoke- Pyi- Thamai A Kyin- Choke (" Abstract* of *the History of China, 1840- 1915 "*) Yangon. Ahtauk- Taw Press, 1966.
9. Odd, Arne Wested; *Brothers in Arms, The Rise of Fall of the Sino- Soviet Alliance (1955- 1963)* California. Stanford University Press, 1998.
10. Ohm Myint, (M. A); *Pyang- Lei- Toe- Tet- Lar- Thaw- Tayoke- Russia- Hset- hsan- Ye- nint- Mahar- byu- har- Aye- Parlar- naing- hmmu- Alar- Ala (" Changing Sino- Russia Relations and the future of the Significance of the Strategy ")* Yangon. Lan- San News Press, 2003.

11. Sein Tin, Tet- Ka- Tho; *Soviet Union Pyo- Kwei- Khin (" Union of Soviet Socialist Republic ")* Yangon. Yaw Mingyee Sarpay, 1995.

12. Shih- Chih- Yu; *China's Fast World, The Morality of Chinese Foreign Policy.* London. Lynne Reinner Publisher Press, 1993.

13. Taw Kaung Min; *Tayoke- Pyi- Ko Pyaung- Lei- Khe- Thu (" The Man Who Changed China ") Yangon*. Thiha Yadanar Sarpay, 2008.

14. Tin Htwe; Tayoke- Pyi- Paw- Ka- Kye- Ni (Trs) yangon. Pimma Ye-Si, 1964.

15. Wan Tha, Maung; *Khit- Pyaing Ka- Bar- Ye- Yar- Abid- Dan (" Dictionary of Contemporary World Affairs ")* Yangon. Bawa- Tetkatho Sarpay, 1982.

16. Win Sein, U;(B.A, B.L); *A HISTORY OF THE FAREAST (MODERN PERIOD)* Rangon, Thidar- Aye Press, 1954.

The Administration of Banmaw District (1886- 1942)

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Abstract

In Banmaw had been administered by the Magistrates and Sawbwas since the Bagan period. Under the Bayinnaung who had established the Second Myanmar Empire demarcated the Myanmar into eight divisions and Banmaw was located in *Seintain*. Banmaw was a subordinate of the Moemaik too. The English, government was formed and governed for the Upper Myanmar after the Third Anglo- Myanmar War. Then the Upper Myanmar had divided into seventeen districts and the four divisions and charged each commissioner. Banmaw districts had been included in the Northern Division among these four divisions. Banmaw Town, Shwegu Town, Sinkin Town and Kaungton Town were contained in the Banmaw district administrative region. The Banmaw District had

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also divided into the sub- divisions there. There were six departments. The hill tracts had been divided into five parts.

Keywords: Myanmar Kings, Administration, Government Staff

Introduction

After the annexation of the *Yadanarbon* Royal City by the English armies in 1885, the English assumed that it required to strong station in Banmaw because it was on the main military road and seized like Mandalay. Therefore, on 19th December 1885 General Prendergast led and marched to Banmaw. Brigadier Norman was given the responsibility to control Banmaw column and Ademin and Stivinrin followed for the administration. The British army arrived to Banmaw on 28 December 1885.

In that time U Phoe Hla, *Hluttaw Wundauk* (Assistant Minister of Hluttaw) had been served as *Wundauk* in Banmaw. After the arrival of Prendergast to the Banmaw, it had been occupied by the British Army on 30 December 1885. However, the national revolted against the British in *Banmaw, Myothit, Siin, Sinkhan, Sarwati* and *Chaungtauk* regions until 1897. But these rebellions were not wiped- out completely by the British.

After the annexation of British, the Upper Myanmar was included in British India Empire apart from the Shan States. Then, the Upper Myanmar became the Scheduled Districts on 1st March 1886. The Upper Myanmar was divided into twelve districts, Mandalay, Shwebo, Banmaw, Kathar, Innwa, Sagging, Chindwin, Kyaukse, Myingyan, Minbu, Bagan and Ninkyan Districts. Then Ye- U district and Yamethin district were added into administrative areas. So, these were totally seventeen districts. These districts were under the four Divisions, which had been controlled by four Commissioners of Division. They were Eastern Division, Northern Division, the Central Division and the Southern Division.

Banmaw contained in the Northern Division with Kathar, Shwebo, Padamyamyay called Moguke and Mandalay. The Northern Division was administered by the minister G. D., Burgess, Commissioner of the Northern Division in 1886. It headquarter was at Mandalay. The Northern Division renamed as the Mandalay Division in 1897. So, Banmaw was included in Mandalay with Mandalay, Myitkyina, Kathar and Padamyamyay.

Banmaw under the Myanmar Kings

Sawbwa, *Thou Liynbwa*, who was the chief of Shan, ruled Banmaw under the reign of the King Anawrathar of Bagan. At that time, Banmaw was controlled by the total of twenty-three *Sawbwas* and *Myou- wun*. According to the records of Myanmar was demarcated into eight divisions under the king of Bayinnaung, the Second Myanmar Empire. They were:

(a) *Sunarparantatain*
(b) *Tambadipatain*
(c) *Sirikettaramatain*
(d) *Jeyyawandunnatain*
(e) *Ramanyatain*
(f) *Suwannabummitain*
(g) *Kambojatain and*
(h) *Seintain*

Eight Divisions

The *Sunarparantatain* contained the northern and western parts of Ayeyawaddy River. The *Tambadipatain* contained the southern and eastern parts of Ayeyarwaddy River. The *Sirikettaramatain* included the part of *Siriksetra*. The *Jeyyawadunnatain* included the part of *Ketumat*i, Taungoo. The *Ramanyatain* contained the part of Pathein, Upekho, Mottama. The *Suwannabummitain* contained the region of fifty-seven Shan cities including the *Suwunna*. The *Kambojatain* included the region of the *Moene* and *Nyaungsh*we. The *Seintain* included the part of Moemaik and Banmaw. Therefore, Banmaw was situated in the *Seintain* with the Moemaik in Myanmar times. At that time, Banmaw was under the Moemaik. So, the Banmaw paid to tribute the Moemaik during the reign of *Thohunbwa*.

Administrative Units

At that time, Banmaw had no administrative person. So the guardians of Banmaw requested to the Moemaik *Sawbwa*, they wanted to desire for the administrative officer. As a result of this action, the Moemaik *Amat* (high official of Moemaik) gave the responsibility person and limited the boundary of administrative unit of Burma. Therefore the boundary of Banmaw had as follows:

in the East, up- to *Moewun*

in the South, up- to *Hanhtet, Maing Khung, Kaungton*,

in the West, up- to *Kyaukyee* and

in the North, up- to *Kapmyo*.

Under Banmaw *Sawbwa*

Kachin, Mon, Palaung, Wa, and *Riann* were settled in the parts of east *Moewun*. The ruler of Banmaw did not collect the revenue. So, the Moemaik *Amat* once again demarcated the boundary with extension to the South. Therefore, the boundary of Banmaw was added up-to the South in *Hanhtet, Myitlepyin, Yinkethapyapin, Satkyar* stream in 1407. At that time, Banmaw paid the revenue, three hundred pots and three Kyattha (numerical classifier used in counting hundredths of a viss) to Moemaik. In return, Moemaik recognized Banmaw as a subordinate administration unit. In 1408, the Banmaw did not pay the revenue to Moemaik because they did not desire under the control of the Moemaik. And Banmaw desired to serve as a subordinate under the direct Myanmar King. At last, Banmaw and Moemaik had been seized by the Myanmar King. There were no *Sawbwa* and *Myou- wun* from 1410 to 1574. In 1574 about five *Pawhmines* and Shan *Amat* (the chief of Shans) administered in Banmaw. In 1576 *Savpukhan*, a nephew of Moemaik *Sawbwa*, was appointed as Banmaw *Sawbwa* to control Banmaw. Banmaw was rebuilt by *Suvpukhan* who became a Banmaw *Sawbwa* in 1577. The area of Banmaw was follows:

in the East, up to other *Kyaukpallin*, the boundary of *Moewun*,

in the West, up to other *Kyaukngamwar*, Kaungton, the boundary of the Moemaik,

in the North, up to *Banzaloute*, the boundary of Moekaung,

in the South, up to other bank of *Satkyar* stream, the boundary of *Mupat*,

Under Konbaung Period

There were thirty- one *Myou- wun* and *Sawbwa*, during the reign of Alaungmintaya (1752- 1760).

Location

Nowadays, Banmaw district was located in the southern kachin state, the north of Myanmar. The Banmaw district comprises an area of 759. 01 square miles, situated between 23˙ 37′ and 24˙ 52′ North, and 96˙ 34′ and 97˙ 46′ East. In the east, it connected with Moemout about 48 miles, Mansi about 34 miles. In the west, it connected with the Shwegu

about 45 miles. In the south, it connected with the Mansi town- ship about 15 miles. In the north, it connected with the Myitkyina about 20 miles. Banmaw was located in the east bank of Ayeyarwaddy and 385 feets above sea level.

The Beginning of British Administration

The Third- Anglo Myanmar War started on 14th November 1885. At the war, Myanmar was defeated again. King Thibaw being was dethroned on November 29. The Upper Myanmar was easily occupied by the English. Before the English, thief and dacoits rioted there. Besides that some regions had been rebelling for the politically. Therefore, the English gave the reason that the Myanmar was occupied by the English because of the people were very presented by the feudalism. After the annexation of Upper Myanmar, the British India army people were killed more than under the administration of king Thibaw and the British administration began to conduct the law and order.

After the annexation of Upper Myanmar, the English temporary government was formed for the Upper Myanmar administration. But *Myanma- Hluttaw* was continued. The cases of civil- administration, were charged by the Colonel E.B. Sladen. Besides, the Major General Harry North Dalrymple Prendergast, C.B., V.C., R. E. controlled the cases of military. They supervised the *Myanma- Hluttaw*.

The Chief Commissioner of Lower Myanmar arrived to Mandalay on 15th December 1885 for the purpose of abolishing the *Myanma- Hluttaw*. He decided to manage only by the British Deputy- Commissioner in the cases of Mandalay and vicinity his supervise. According to the order in 1st January 1886 the Upper Myanmar was added into the British Empire and it fell under the Viceroy and Governor- General of India. Then the Myanmar- Min- Hluttaw was abolished in 1st April 1886. Although in the new administrative machine continuing served to Kin- wun- mingyi, Taung- kwin- mingyi, Pin- Atwin- wun, Shwe- taik- Atwin- wun and Depayin- wun- htauk because of Kin- wun- mingyi was with regarded to the cases of regions, Taung- kwin- mingyi and Shwe- taik- Atwin- wun were with regarded to the cases of finance, Depayin- wunhtauk with respect to the English and French languages besides he was stayed in Europe.

At the beginning of 1st March 1886, the English regarded the Upper Myanmar as districts and governed. The total districts were seventeen in the Upper Myanmar. They had put under the four divisions, which had formed in June 1886 and had to charge by Commissioner. They had to supervise by the Chief Commissioner. Sir Herbert Thirkell White served as a

separate Secretary for Myanmar. All they had under instruction of the Dufferin who was a Viceroy and Governor- General of India.

The British Administrative Policy

The British basic administrative policy on the colonial states was to collect tax and conduct law and order. In the main places of the administration had to serve India covenant staff. The administrative area had been divided into districts and division and the Direct Rule System had been practiced. The British colonial administer said that the Direct Rule System was more just than traditional administrative system in accordance with liberalism. The Civil Administration System had been practiced in Myanmar. It had been firmly practiced in India. For convenience the administrative duties, Chief Commissioner was raised designation to Lieutenant Governor there.

Appointment of Staff

The Secretariat and other departments were established and, the heads of department were appointed. They were led by Deputy Commissioners. Moreover, law and order and collected the tax were the main duty of Deputy Commissioner. Under the Deputy Commissioner, there were three main sections. They were general section, justice section and revenue section. They were merely upgraded the base of administration.

With regard to appointment of staff Indians were appointed as the higher class, but Myanmar were served as the post of clerical staff and lower class. Commissioner, Deputy Commissioners, Director General of Education, Inspector- General of Police etc. were appointed by the Governor of India. Then the Burma Commission had been formed like, the other unsettled areas of the British Administration in India. The majority of the Burma Commission contained Indian Civil Service, called Indian covenant staff and minority. They served in the military department, the civil department, police department and so on. These members had responsible in the main posts of the British Burma colony. The staff was sent from India for the Medical Office and Construction Department. Therefore, until the end of the British Administration in some departments, Indian staff have been influencing than Myanmar. They served in the Account Department, Post and Telegraph Department, Public Work Department, Railway Department and Secretary Office and so on. In which they were

appointed as the high posts as well as lower posts. According to the British administration the English officers, many Indian staff served in Myanmar, they acted for the firmly developed the Colony Administration System.

Subordinate Staff

Wun (minister), *Myo- thu- gyi* (charge of city) who had been served under the Myanmar King and influenced over the people. Later, they were appointed as *Myook* by recommendation of the Commissioner. So, they joined with the British Colonial Government. Later educated persons were selected for the post of *Myook* by examination system. They were appointed as Sub- divisional officer. There were included the First Deputy Commissioner was appointed there in 1908. In the government administration, there were the sub- divisional officers and the sub- ordinate service men. The sub- divisional officer was appointed as a provincial service and *Myook* was served in sub- ordinate service.

By the order of 1926, the Myanmar regional government was given to power for the appointment of *Myooks*, Assistance *Myooks* etc., and later other institutions and technical staff were also appointed by the government.

By the India Act of 1919, Myanmar became a part of colonies of the British governed by a Governor. It was now called *Dyarchy* Scheme. Until the Government of Burma Act 1935, the Myanmar became a state of India under the Viceroy and Governor- General of India. According to the Act of 1935, Myanmar became a direct subordinate separate colonial state of the British Government. By that law, the Separate Civil Service Board was formed with one chairman and two members and the First Class Myanmar Staff were appointed there. By the Act of 1935, Governor- General was assigned power to command the Civil Services Board Rule and Regulation. The First Chairman was Mr. C.F Grant and members were U Thein Maung and U Ba Aye. The main duties of civil services board were:

1. To celebrate the examination of service; and
2. To lay the rules and regulations for services.

Administrative Department

In Banmaw District there were four townships: Banmaw, Shwegu, Sinkin (Sinkin village), Kaungton (Kaungton village). In Banmaw District, there was divided into two sub-divisions namely Banmaw sub division and Shwegu sub- division and two townships, Banmaw and Shwegu and Banmaw Hill Tracts. It headquarters was at Banmaw. Banmaw District was

controlled by a Deputy Commissioner. There were six main departments under the Deputy Commissioner. They were

1. Judicial Department,
2. General Department,
3. Revenue Department,
4. Land Records Department,
5. Treasury Department and
6. Departments of Registration.

Besides, the Police Department and Forest Department were also under the control of the Deputy Commissioner. But the District superintendent of Police and Divisional Forest Officer were given to separate powers there.

Judicial Department

The Judicial Department and General Department became under the direct control of the Banmaw Deputy Commissioner. Under the Deputy Commissioner, there were Assistant Commissioners or Extra Assistant Commissioners. The Superintendent of Land Records, Treasury Officer and Registering Officer were supervised by the Deputy Commissioners.

The Judicial Department was founded to act the court of Justice. The Judicial Commissioner was also appointed them. The Act of the Code of Criminal Procedure was passed.

The General Department and the Revenue Department

The General Department acted the promotion of Police officers, the collection of the district fund and revenues. The Revenue Department had to account to get other money for the government and manage land revenue. Besides which the Revenue Department also had responsibility for the control to improve agriculture and the collected the district fund. The Revenue Department was obliged by the Extra Assistant Commissioner.

The land Records Department

The Land Records Department worked the reservation of land records and collection tax on paddy land. The Treasury Department emphasized extraction and receiving money of the people. Besides, the Treasury Department responsible for trading opium and stamp too. The Treasury Department had been charged by the Extra Assistant Commissioner or *Myook*. Both they have also power in justice.

The Registration Department

The Registration Department, which tasks had made by the law of India Registration and the law of Upper Myanmar Registration. The Sub- divisional Officer acted as Registering Officer.

Deputy Commissioner

Although the Banmaw District administration was divided into main six departments, the important decisions and duties were in the hands of the Deputy Commissioner. Not only Banmaw Deputy Commissioner was given powers, but also are police officer was also appointed to help him. Military and Police forces were set to firm power of the Banmaw Deputy Commissioner. In the towns and villages, the Deputy Commissioner appointed the *Myook, Myothugyi* (Head man of town) and *Ywarthugyi* (Head man of Village).

At the end of the 1893 a Durbar was held to discuss on the administration of the Kachin Hills in which contained Banmaw. Banmaw and Myitkyina districts had been organized and founded a single charge, with Headquarter at Banmaw until 1895. However, in April 1895, Banmaw District took placed separation.

The Kachin Hills Regulation

The Kachin Hills Regulation was passed on 16th February 1895 and brought into operation on 1st July 1895. The hill portion of the Banmaw sub- division had made a separate charge under the Assistant superintendent in August 1897. The Assistant Superintendent stationed at *Sein- Loun- Ka- Ba*. In 1897, the Kaungton township had abolished, its area being absorbed in the Shwegu township. The Banmaw District therefore had been subdivided into three administrative charges, the Banmaw and Shwegu sub- divisions with township corresponding and the Banmaw Hill Tracts under the Assistant- superintendent. Later administered under the Kachin Hill Tracts Regulation, 1895 as also were the hill tracts of the Shwegu sub- division.

Kachin Hills Administration

For the convenience, administration in the hills had been divided into five tracts, and each had been charged by a *Taungok* (charge in hill) with the powers of a headman over the village of tract. The *Taungok* disposed of petty cases, collected tribute and maintained order

with the help of few village police. The subdivision and township officer in the plains dealt directly with the headman of village except in certain backward tracts where the headman was for the most part illiterate and the villager scattered. There were also *Khayaingoks*, who exercise a sort of general control. They received a regular salary and were invested with magisterial powers. There were four *Khayaingoks*;

Taping (*Myothit*)
Mole (*Theinlin*)
Ahtet- Sinkan (*Sikaw*) and
Moempin (Thinbawin).

The *Namawun* Agreement

The *Namawun* Assigned Tracts was concluded between China and Banmaw in 1897. Under the *Namawun* Agreement of 1897, the fifth *Khayaingok* was appointed there. He was also given to act with similar functions but without magisterial powers.

Headmen

All headmen draw the commission of ten percent allowed on their collections of revenue, and their authority in village matters had not been affected by the existing of *Khayaingoks*. Small cases of a civil or criminal had been dealt with by the headman who was the direct representative of the village with the officer of covenant. They were well known as *Tamon, Thugyi, Pawhmaing*. They were just like *Thugyi* in Myanmar village.

Myothugyi

In some places, there were *Khayaingok, Chaungok or Taikok*. The *Khayaingok* received no remuneration but he was exempted from the *Thathameda* (one ten of income or paddy). He had nothing to do with the collection of taxes. He was usually responsible to collect taxes such as paddy, rice, salt etc under his charge. In the southern part of the district, namely, Kaungton, Shwegu and Moenyin, there were *Myothugyis*, *Myodeins* and *Myosayays*. The *Myothugyis* received ten percent of the *Thathameda* and paid a certain portion of this percentage to the *Tamons* and *Thugyis* under him. The *Myothugyi* had civil powers and the fees levied there formed part of his remuneration. The *Myothugyi* had no criminal powers especially special cases.

Upper Myanmar Village Regulation

The Banmaw Deputy Commissioner who administered Banmaw, Myitkyina and Katha Districts had the same authority as that of Deputy Commissioner of other districts of Myanmar. He had to take the responsibility of Justice and revenue administration in their respective places. He served also session Judges according to the Upper Myanmar Village Regulation of 1887. To perform the tasks of promoting stability of the power of the British Colonial Government, the Deputy Commissioner went to tour the Kachin Hill Tracts and had to prevent any border crisis especially with regard to the Chinese- Myanmar border, had to collect revenue and had to task the administration.

If someone unjustly maltreated, a villager or a member of a tribe, the Banmaw Deputy Commissioner could give an order to the tribe or the village concerned to expose the defendant. If the defendant could not be exposed, the Banmaw Deputy Commissioner could charge a five in money or compensation from the guilty village or tribe concerned.

Duwas

Under the Deputy Commissioner there were *Duwas* or indigenous Kachin Chiefs, *Taungoks* and *Salanwas* or village *Thugyis*. That hereditary structure of administration in the Kachin Hills Region was the same as in other districts of Myanmar. *Duwas*, *Taungoks* and *Salanwas* were appointed by the Deputy Commissioner, they had governed by customary law and their influence and authority was greater than of *Thugyi* in other parts of Myanmar. There were also traditional Kachin headmen who called as *Akyiwa*. The position of *Akyiwa* was generally similar to that of *Ywagaung* and *Se- eingaung* of Myanmar village.

Sub- divisional Officers

The Sub- divisional officers of Banmaw and Shwegu were Judges for both of the Sub-divisional and Township Courts, and the *Akunwun* and the Assistant Superintendent of *Sein-loun- ka- ba* were additional judges of Banmaw Township Court. The Township Courts had jurisdiction in suits up to the value of Rs. 500 and Sub- divisional Court up to Rs. 3, 000. Appeals from both lay to the District Court, which had jurisdiction in regional suits without pecuniary limit.

Judicial Commissioner

The Judicial Commissioner was appointed and acted the various degrees of the courts in Upper Myanmar. There were Cantonment, Magistrates at Mandalay, Meiktila, Myingyan, Shwebo, Banmaw and Maymyo.

District Court

While the District Court did not accept to appeal in District Court some cases. The Judicial Commissioner had to receive and decide these cases. In the Kachin Hills, headmen were empowered to decide civil suits without restriction under their own jurisdiction. The Assistant Superintendent of *Sein- loun- ka- ba* and the sub- divisional officer of Shwegu, decided other hill cases between the different tribes and Kachin, but was no appeal.

Assistant Commissioners

By the Commissioner order of 1895, the Deputy and Assistant Commissioners had to exercise jurisdiction in the Kachin Hills regions. The value of litigation in Banmaw District had always been small, and the yearly variations had little significances. There had been a slight upward tendency in the value of suits instituted, but a single valuable case had a disproportionate effect on small figures, and for the most part litigations had confined to the towns and had concerned with petty cases for the recovery of money.

Public Works

As the public works, the new Court- house had provided at Shwegu in 1899 and *Sin- loun- ka- ba* in 1904. Quarter have also provided at these stations for the Civil Officers. Following the delimitation of the international boundary, Military Police Posts have erected between 1901 and 1908. Opium shops have opened at Banmaw and Shwegu in1904, and Customs building have built at Banmaw in December 1904 to deal with the system of rebate on goods in transit to China. A school for the Kathin at *Sein- loun- ka- ba* had built in that year.

The Registration Department

The registration of documents innovation property was compulsory in the town of Banmaw and Shwegu. The former Sub- divisional Officer and the Treasury Officer were joint Registering Officers and in Shwegu the Sub- divisional Officer was in charge of the Office. The sales and mortgages of house- sites, The Deputy- Commissioner supervised.

District Police Force

After the establishment of a District Police Force, twenty Chinamen with two Sergeants had employed under the Superintendent for the protection of traders in Banmaw and on the Road. A lock- up for under trials and short- term prisoners had established in the following year, and a defensible police station had built in 1889. Another outpost had built in 1890 at the south end of the town. Various modifications have been made in the strength. It was recognized in 1907 with one District Superintendent, three Inspectors, ten sub- Inspectors, fourteen Head Constables and 135 Constables. The forty- nine irregular or village police had employed to maintain communications with the distant parts of the district, to collect information and arrest offenders. Guard at Banmaw and Shwegu Police Station had been provided by the Military Police, who also provided treasure escorts. There were regular Civil Police patrols in the towns and periodical visits had been paid by beat constables to outlying villages.

Civil Police

The greater part of the Civil Police had armed. A number of native of India had been employed in Banmaw, but the bulk of the force consisted of Shan- Myanmar and Kachins. A regular training school had been established at the headquarters of every district. Every recruit had first been sent to this school and had been kept there for six months or until he had passed an examination showing that he had quartered a fair knowledge of his duties. The whole district force moreover had brought into the headquarters school in batches for a mouth's training in each year.

Criminal Cases

The annual average of persons convicted for various crimes in Banmaw District was 166 in the years 1901- 1905 and 156 in the years 1916- 1920. Of the various types of crimes, cases of rioting and unlawful assembly especially decreased. In Banmaw District, the number of persons convicted for rioting and unlawful assembly was 86 in the years 1909- 1914 and there no convictions at all for those crimes after 1916. However, the increased in crime had attributed to the illegal opium trade 1934- 1935 at Banmaw.

Civil Cases

There had no separate civil code of law for the Kachin Hills, where civil cases had decided in accordance with the Kachin Hill Tribes Regulation. In the administration of civil justice, there were under the office of the Banmaw Deputy Commissioner, the office of the Assistant Deputy Commissioner, *Myook* , *Thugyi*, *Taungok* and *Duwa*. Just like the Deputy Commissioner, the Sub- divisional officers and the Assistant Deputy Commissioner had the authority to decide civil cases.

Military Police

In Military Police, on 1st January 1888, the Banmaw Battalion consisted of eighteen native officers and 883 non- Commissioned officers and soldiers. The battalion occupied six pots in 1887 and a moveable column of seventy- five men was organized. The headquarters of the Battalion were, however, at Mogaung, and for some years after the occupation of regular Military garrison of Banmaw carried out all the local operation, which had undertaken.

Battalion

In March 1892, a separate battalion had formed at Banmaw, with the strength of nine companies. In 1896, the Katha Battalion had absorbed raising the strength of the Banmaw Battalion with fifteen companies. By 1897, it had been reduced to eleven, but in that years a notable departure had been made by the enlistment of a company of Kachins, a second being raised three years later. In 1892, four outposts; *Nempaung*, *Thuyetta*, *Sikaw* and Shwegu had been occupied by Military police.

Cantonment Area

After the period of the great sickness among the troops, Sir F. Roberts visited Banmaw in 1887, selected sites for three forts, of which fort A to the north had now been occupied by the Military Police and fort B to the east had abandoned. Fort C had to be the main entrenched position. The boundaries of the cantonment had been agreed on about the same time and had slightly been modified since.

Under BIA

Banmaw had been occupied by the BIA in 1942, when the BIA (Burma Independence Army) contingent entered Myanmar with the Japanese army. The invading Japanese army had exerted all their efforts to win the war in spite of administering the occupied areas. Since anarchism developed in the whole country, the BIA in January 1942 started to form the local administrative body at the towns and villages on their route of marching.

In organizing BIA administrative bodies throughout the country, men of all strata including teachers, BIA officers, ex- police officers, students, pleaders, clerks, participated in the administrative body. Although, BIA administrative bodied had special capabilities Japanese Military authorities had already decided to place the country under Japanese Military Administration. Hence, the Central Administration had dissolved and the Japanese Military Administration had established on 2nd May 1942 under Colonel Magasaki.

At the beginning, the Japanese Army had consciously followed the British pattern of separating the hill areas from Myanmar proper. The Shan, *Karenni* (Kayar) and Wa State, the *Arankan* (Rakhine), Chin, Kachin and Naga hill tracts were outside of Myanmar Jurisdiction. For military reason, most of Myitkyina, Banmaw and Katha Districts had been excluded from Myanmar's control. Although the Myanmar government gained formal jurisdiction over the *Karenni*, Wa and most of the Shan States on December 23rd, 1943, it never exercised control there. Thus, during the Japanese Military Administration period, Banmaw was a district and it was under the Katha Branch Office, which was within the jurisdiction of Mandalay Regional Office in Upper Myanmar.

Conclusion

In conclusion, although the Banmaw district administration between 1886 and 1942 was able to smooth the colonial administrative system, the Myanmar indigenous people have not benefited. The British administration in the Upper Myanmar was purely bureaucracy. By which the Upper Myanmar was divided into four divisions and seventeen districts had been administered by each Deputy- Commissioner. The Banmaw District was included in the Northern Division, later in Mandalay Division. The Banmaw Township and the Shwegu Township had been administered by the English sub- divisional officers. Banmaw Town, Shwegu Town, Sin Khan Town and Kaungton Town were charged by the Myanmar *Myook* and *Myothugyi* (circle headman). The villages had been kept by the village Headman. The Banmaw hills had charged by the English Extra Assistant Commissioner. Under then was the *Taungok* (in-charge of hills). In the Districts, the Deputy Commissioner was the most power-full. The colonialists monopolized in administrative department for their interests.

I. INTRODUCTION

Water is a basic nutrient of the human body and is critical to human life. It supports the digestion of food, adsorption, transportation, use of nutrients, the elimination of toxin and wastes from the body. Water is a clear, odorless, tasteless inexpensive and versatile liquid made by combing two parts hydrogen and one part oxygen. Water is a principle component of every fruit and vegetables as well as making up a large portion of living things.

Water is essential as a medium for preparation food. Water is a nature's solvent and may contain minerals from the soil through which it has percolated sodium chloride, magnesium and iron are among the minerals most frequently found in water.

So, water is the source of life. It plays a vital role for the existence of human beings.

In this research, the water sample is collected from Nanpha In (Lake), Banmaw Township, Kachin State.

Nanpha In (Lake) in Banmaw Township

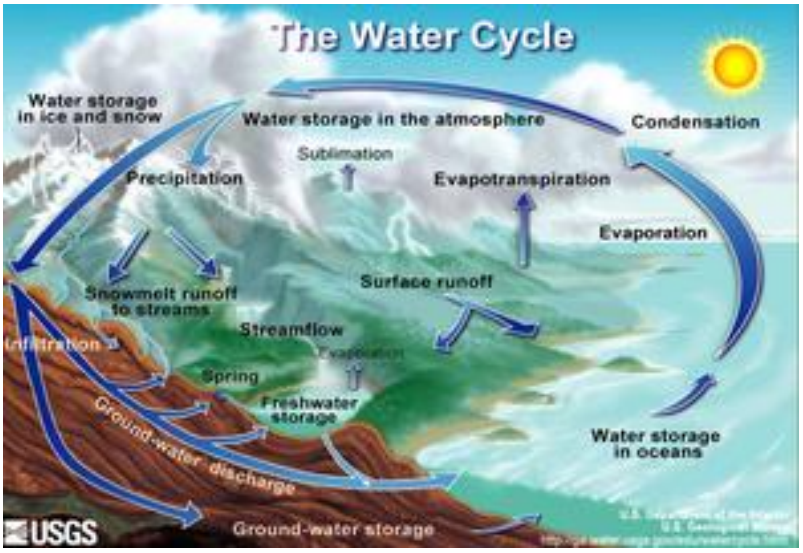
1.1 Natural Source of Water

Water is a ubiquitous chemical substance that is composed of hydrogen and oxygen and is vital for all known forms of life.

Water on Earth moves continually through a cycle of evaporation or transpiration (evapotranspiration), precipitation, and runoff, usually reaching the sea. Over land, evaporation and transpiration contribute to the precipitation over land.

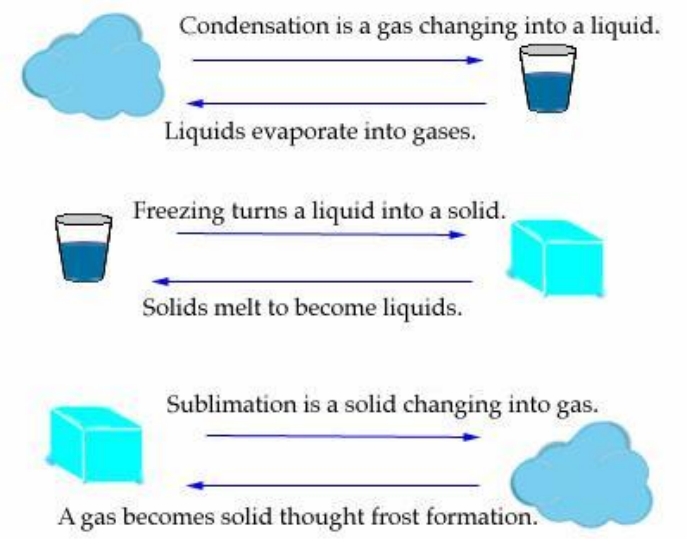
Water in three states: liquid, solid (ice), and (invisible) water vapor in the air. Clouds are the accumulations of the droplets, condensed from vapor-saturated air.

The representation of the main processes in the water cycle



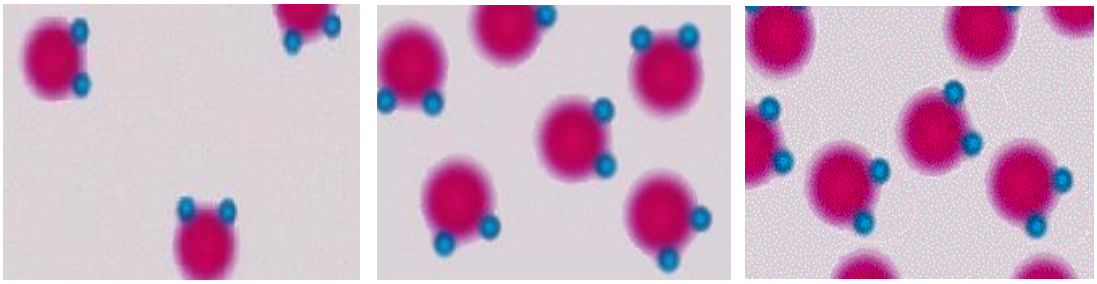
1.2 Water Properties

The States of Water



Water has three states. Below freezing water is a solid (ice or snowflakes), between freezing and boiling water is a liquid, and above its boiling point water is a gas. There are words scientists use to describe water changing from one state to another. Water changing from solid to liquid is said to be *melting*. When it changes from liquid to gas, it is *evaporating*. Water changing from gas to liquid is called *condensation* (An example is the 'dew' that forms on the outside of a glass of cold soda). *Frost formation* is when water changes from gas

directly to solid form. The process of water changes directly from solid to gas is called *sublimation*.



Gas **Liquid** **Solid**

Water is found on Earth in all three forms. This is because Earth is a very special planet with just the right range of temperatures and air pressures.

1.3 Water Treatment

Water treatment describes those processes used to make water more acceptable for a desired end-use. These can include use as drinking water, industrial processes, medical and many other uses. The goal of all water treatment process is to remove existing contaminants in the water, or reduce the concentration of such contaminants so the water becomes fit for its desired end-use. One such use is returning water that has been used back into the natural environment without adverse ecological impact.

The processes involved in treating water for drinking purpose may be solids separation using physical such as settling and filtration, chemical such as disinfection and coagulation.

Biological processes are also employed in the treatment of wastewater and these processes may include, for example, aerated lagoons, activated sludge or slow sand filters.

Appropriate technology option in water treatment include both community-scale and household-scale point-of-use (POU) designs.

The combination of following processes is used for municipal drinking water treatment worldwide:

- Pre-chlorination - for algae control and arresting any biological growth
- Aeration - along with pre-chlorination for removal of dissolved iron and manganese
- Coagulation - for flocculation
- Coagulant aids also known as polyelectrolytes - to improve coagulation and for thicker floc formation
- Sedimentation - for solids separation, that is, removal of suspended solids trapped in the floc

- Filtration - for removal of carried over floc
- Disinfection - for killing bacteria

There is no unique solution (selection of processes) for any type of water. Also, it is difficult to standardise the solution in the form of processes for water from different sources. Treatability studies for each source of water in different seasons need to be carried out to arrive at most appropriate processes.

The above mentioned technologies are well developed and generalised designs are available which are used by many water utilities (public or private). In addition to the generalised solutions, a number of private companies provide solutions by patenting their technologies.

II. MATERIALS AND METHODS

2.1 Physical Examination

2.1.1 Estimation of Conductivity

Method : Direct Measurement Method using Hach DREL / 5 Instrument.

Principle

Conductivity is a measurement of water's capacity for conveying electrical current and is directly related to the concentrations of ionized substances in water. The method of measurement used in the following procedure is by direct measurement with Hach Conducitivity Meter having a range of 0 to 20,000 micromhos/cm. With sample dilution, higher levels of conductance can be determined.

Apparatus

(a) Spectrophotometer: DREL / 5 Hach Spectrophotometer (Hach Company)

(b) Hach Conductivity

(c) Beaker

Reagent

A sodium chloride standard solution, 1000 mg/l (1990 micromhos/cm) was used from Hach to check the accuracy of the instrument.

Procedure

The conductivity meter scale was inserted into the meter and the cond slect witch was pressed. The highest range was selected. The probe was connected assembly to the probe input on the spectrophotometer panel. The probe was immersed in a beaker containing the sample solution. The depth of the solution must be sufficient to allow the probe to be immersed to the vent holes. The probe or tap was agitated it on the beaker to free any bubbles in the electrode area. The appropriate range was selected, beginning with the highest range and working down. If the reading is in the lowest 10% of the range, switch to the next lower range. The micromhos/cm on meter scale was read.

2.1.2 Estimation of Turbidity

Method : Absorptiometric Method

Principle

This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher, the turbidity. Formazin polymer is used as the reference suspension. The turbidity of a specified concentration of formazin suspension is defined as 40 nephlometric unit (NTU).
This suspension has an approximate turbidity of 40 jacken units (JTU) when measured on the candle trubidimeter.

Apparatus

Hach Spectrophotometer, DREL / 5

Procedure

The turbidity of 25 ml sample was directly measured at 450 nm against colorless distilled water blank.

2.2 Determination of Metals

2.2.1 Estimation of Calcium

Method : EDTA Titrimetric Method

Principle

When EDTA (ethylenediamine tetraacetic acid or its salt) is added to water containing both calcium and magnesium, it combines first with calcium. Calcium can be determined directly with EDTA, when the pH is made sufficiently high so that the magnesium is largely precipitated as the hydroxide and an indicator is used that combines with calcium only. Several indicators such as murexide, Eriochrome Blue Black R give a color change when all of the calcium has been complexed by the EDTA at a pH of 12 to 13.

Apparatus

(a) Burette

(b) Pipette

(c) Conical Flasks

Reagents

(a) Sodium hydroxide solution, 1 N

(b) Solid indicator mixture : 100 g NaCl and 0.2 g murexide were ground to 40 to 50 mech.

(c) EDTA titrant 0.01 M

(3.723 g dry disodium ethylenediamine tetra-acetate dihydrate per 1 L distilled water).

Procedure

25 ml sample was mixed with 25 ml distilled water 50 ml of distilled water was taken as color comparison 2 ml of NaOH solution and 0.2 g of murexide indicator were added to the sample and blank. 2 or 3 drops of EDTA titrant were added to the blank to produce an unchanging color.

The sample was titrated immediately with EDTA solution until the color changed as blank.

Calculation

mg Ca / L = a × b × 400.8/ml sample

(or)

Ca hardness as mg $CaCO_3$ / L = a × b × 400.8/ml sample

Where :

a = ml titrant for sample and

b = mg $CaCO_3$ equivalent to 1.00 ml EDTA titrant at the calcium indicators end point.

2.2.2 Estimation of Magnesium

Method : Calculation Method

Magnesium can be calculated by the following formula.

mg Mg / L = [Total hardness as $CaCO_3$ / L - Ca hardness as $CaCO_3$ / L] * 0.244

2.3 Estimation of Total Hardness

Method : EDTA Titrimetric Method

Principle

EDTA can form a soluble chelated complex with certain metal ions. If a small amount of dye such as Eriochrome Black T or Calmagite added to an aqueous solution containing Ca and Mg ions at a pH of 10.0 ± 0.1, the solution becomes wine red. If EDTA titrant is added, Ca and Mg will be complexed and when all of the Ca and Mg ions has been complexed, the solution turns wine red to blue. Mg^{2+} ion must be present to yield a satisfactory end point. So, a small amount of complexometrically neutral magnesium salt of EDTA is added to the buffer solution. If a given metal ion is titrated with EDTA at a high pH, the principal titration reaction will be the complexation between the ion and the tetra-anion.

$M^{2+} + Y^{4-} \rightleftharpoons MY^{2-}$

Apparatus

(a) Pipette (25 cm^2)

(b) Burette (50 cm^2)

(c) Conical flask (250 cm^3)

Reagents

(a) EDTA, 0.01 M titrant

Dry disodium ethylenediamine tetra acetate dehydrate (2.723)g was dissolved in I dm^3 of distilled water.

(b) Buffer Solution

Ammonium chloride 16.9g was dissolved in 143 cm^3 of concentrated ammonia, then 1.179 g of EDTA and 0.78g of $MgSO_4.7H_2O$ were dissolved in 50 cm^3 of distilled water. The two solution were mixed and diluted to 250 cm^3 with distilled water.

(c) EBT indicator

The dye Eriochrome Black T is the salt of (1, 1-dihydoxy 2-napthylazo -5- nitro - 2-napthol - 4 - sulphuric acid) 0.5 gram of the dye was mixed with 4.5 gram of hydroxylamine hydrochloride and this mixture was dissolved in 100 cm^3 of 95 percent ethanol.

Procedure

The water sample 50 cm^3 was taken in a conical flask and 2 cm^3 of buffer solution was added. After adding the buffer solution, the sample was titrated with EDTA titrant using one to two drops of EBT indicator. The titration was carried out by adding the titrant slowly with continuous stirring until the color turns from wine red to bright blue.

(50 cm^3 of distilled water was used as a blank for color comparison)

Calculation

$$\text{Total hardness as } CaCO_3 \text{ mg/l} = \frac{1000 \times V_1}{V_2}$$

V_1 = Volume (cm^3) of standard EDTA solution

V_2 = Volume (cm^3) of sample

2.4 Determination of Inorganic Non-Metallic Constituents

2.4.1 Estimation of Alkalinity

Method : Titrimetric Method

Principle

Hydroxyl ions present in a sample as a result of dissociation or hydrolysis of solutes react with addition of standard acid. Alkalinity thus depends on the pH of end point. Alkalinity can be determined by neutralizing OH^-, $CO_3^=$ and HCO_3^- with standard H_2SO_4. Titration at pH 8.3, i.e., decolourizatione of phenolphthalein indicator will show complete neutralization of OH^- and ½ of $CO_3^=$, while at pH 4.4 or sharp change from yellow to pink of methyl orange indicator will indicate total alkalinity, i.e., OH^-, and $CO_3^=$ and HCO_3^-.

Apparatus

(a) Burette (50 cm^3)

(b) Pipette (20 cm^3)

(c) Conical flask (250 cm^3)

Reagent

(a) Standard Sulphuric acid, 0.05 N

(b) Methyl orange indicator solution

Procedure

The water sample 20cm^3 was taken in a conical flask and two drops of orange indicator was added into the flask. This solution was titrated with 0.05 N standard H_2SO_4 solution until the colour change from yellow to faint red range.

Calculation

$$\text{Total alkalinity, T mg } CaCO_3/l = \frac{A \times 1000}{cm^3 \text{ sample}}$$

A = cm^3 acid used in titration

2.4.2 Estimation of Chloride

Method : Argentometric Method

Principle

In a neutral or slightly alkaline solution, potassium chromate can indicate the end point of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chlorite is formed.

Apparatus

(a) Pipette

(b) Burette

(c) Conical flask

Reagents

(a) Potassium chromate indicator:

50 g K_2CrO_4 was dissolved in little water and $AgNO_3$ titrant was added until a definite red precipitated was formed. The solution was allowed to stand for 12 hours, filtered and diluted to 1 L.

(b) Standard silver nitrate titrant, 0.0141 M.

(2.395 g $AgNO_3$ in 1 L distilled water)

($AgNO_3$ titrant was standardized against 0.0141 M NaCl solution)

Procedure

10 ml of sample was mixed with 90 ml of distilled water. 1 ml of K_2CrO_4 indicator solution was added and titrated with standard $AgNO_3$ solution to a pinkish yellow end point. 100 ml of distilled water was treated as above and used as color comparison blank.

Calculation

To get the concentration of chloride in a sample, use the following formula:

$$\text{Chloride concentration} = \frac{\text{mgCl}}{\text{L}} = \frac{(\text{A}-\text{B})\text{mL} * \text{M}\,\frac{\text{mmol}}{\text{mL}} * 35.5\,\frac{\text{mgCl}}{\text{mmol}}}{25\text{mL} * \frac{1\text{L}}{1000\text{mL}}}$$

Where :

A = mL titrant for sample

B = mL titrant for blank and

N = molarity of silver nitrate

2.4.3 Estimation of Sulfate

Method : Gravimetric Method

Principle

Sulphates in the samples are precipitated by barium chloride and the precipitate weighed as barium sulphate.

Apparatus

Beaker

Reagents

(a) Concentrated hydrochloric acid

(b) Barium chloride solution (approximately 10 percent W/v)

Procedure

Concentrated HCI was added drop by drop to 100 ml of the sample (filtered if necessary) contained in a beaker until justr acid, three drops was added in excess and evaported to about 50 ml. The solution was filtered if necessary and the filter paper was washed with distilled water, collecting the washings together with the filtrate. The soultion was boiled and boiling barium chloride solutin was added until all the sulphate was precipitated. Addition of excess barium chloride solution was avoided. It was digested on a hot water-bath until the precipitates settle, or preferably kept over night, it was filtered through a filter paper (Whatman No. 44 or its equivalent) or through a crucible, and was washed with hot distilled water until washings are free from chloride. The precipitate was ignited and weighed.

Calculation

$$\text{Sulphates (as } SO_4^{2-}\text{), mg/l} = \frac{412000\ W}{V}$$

W = Weight in g of the precipitate

V = Volume in ml of the sample taken for the test

2.5 Estimation of Total Dissolved Solids

Principle

Dissolvred solids may be determined by any of the thre methods, namely, gravimetric method, electrical conductivity method or density method.

For water containging a given mixture of mineral salts, the electrical conducance is closely proportional to the dissolved solids. This is the most convenient method for measuring total dissolved solids.

Where an apparatus for measuring electrical conductance is not available, reasonably reliable can be obtained by density method, particularly when quick results are required. The method is not very accurte but it is found satisfactory for controlling the permissible maximum concentration in the boiler water.

Procedure

A clean and dry porcelain basin of about 20 cm^3 capacity was heated to redness and cooled in a desicator, and the basin was weighed. Alternatively a nickel or silica dish may be used, in which case it was dried at about 105°C for 30 minutes and then cooled to room temperature. 20 cm^3 of water sample was added into the basin and evaporated to dryness and the total dissolved solid residue was weighed.

The water sample was also determined as above.

Calculation

$$\text{Total solid mg/l} = \frac{W \times 10^6}{V}$$

W = Weight in g of residue obtained

V = Volume (cm^3) of the sample taken

III. RESULTS AND DISCUSSION

The principal factors that are taken into consideration water qualities are turbidity, acidity, alkalinity, trace elements, alkali metals, calcium, magnesium and dissolved oxygen content. In this investigation, some parameters such as turbidity, color, pH, hardness, alkalinity, TDS and some trace elements were determined. The results showed that the values of TDS and sulphate are lower than the W.H.O standard. Iron content was not detected.

The results obtained from the treatment of Nanpha In (Lake) water are shown in this Table.

Test		Result	W.H.O standard	
			Highest desirable level	Maximum permissible level
Appearance		Clear		
Colour (Platinum, Cobalat Scale)		5	5 Units	50 Units
Turbidity (Silicada Scale Unit)		-	5 NTU	25 NTU
pH value		7.2	7.0 to 8.5	6.5 to 9.2
Total Solids	p.p.m(mg/l)	350	500 mg/l	1,500 mg/l
Total Hardness (as $CaCO_3$)	p.p.m(mg/l)	40	100 mg/l	500 mg/l
Total Alkalinity (as $CaCO_3$)	p.p.m(mg/l)	130	600 mg/l	450 mg/l
Calcium as Ca	p.p.m(mg/l)	12	75 mg/l	200 mg/l
Magnesium as Mg	p.p.m(mg/l)	12	30 mg/l	150 mg/l
Chloride as Cl	p.p.m(mg/l)	30	200 mg/l	600 mg/l
Sulphat as SO_4	p.p.m(mg/l)	69	200 mg/l	400 mg/l
Total Iron as Fe	p.p.m(mg/l)	Nil	–	–

IV. CONCLUSION

The quality of Nanpha In (Lake) water in Banmaw Township was found to be good and fit for domestic and industrial purposes.

The water is physically clear and colorless. It possesses agreeable taste and odour. The pH and alkalinity value may indicate the low corrosive property. The values of conductivity and total dissolved solid indicate that the water has fairly low mineral contact.

The toxic chemical substance were not detected and the heavy metals were also absent. Therefore, the samples cannot cause disease in humans.

However, the experimental values are not beyond the standard limits. Generally, Nanpha In (Lake), Banmaw Township, Kachin State is suitable for drinking and domestic purposes after giving proper treatment.

ACKNOWLEDGEMENTS

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REFERENCES

1. Yu May, "Analysis of water of Inlay Lake (From some Selected Region)", M.Sc Project, 2000.
2. Aye Ko, "Study of the Quality of Myitnge River Near Paleik, Singaing Township", M.Sc Thesis, 1996.
3. Khin Khin Latt, "Determination of Some Characteristics Water from Inlay Lake", B.Sc.(Hons.), 2002.
4. http://www.madsci.org/posts/archives/2000-01/947-987963.ch.r.htm/
5. http://enivonmentalet.org/env1221/titrations.htm
6. http://en.wikipedia.org/wiki/water

7. http://www.recipezaar.com/libraray /water-459
8. http://www.ecs.umass.edm/cee/reckhow/courses/572/572bk15/572Bk15/htm
9. http://en.wikipedia.org/wiki/water_treatment
10. http://cigmat.cive.uh.edn/content/conf-exhib/99-poster/4.htm
11. http://www.atmosphere.mpg.de/enid/1vb.html
12. http://science.howstuffworks.com/environmental/earth/geophysics/h2o.htm

1. INTRODUCTION

The carbohydrates are an important class of naturally occurring organic compound include glucose (grape sugar), fructose (honey), sucrose (cane sugar), starch (potatoes) and cellulose (wood). They are all composed of C, H and O. In general, carbohydrates can be represent formula $C_n(H_2O)_m$.

They are widely distributed in plants and animals, where they fulfill both structural and metabolic roles. In plants, glucose is synthesized from carbon dioxide and water by photosynthesis and stored as starch or is converted to the cellulose of the plant framework. Animals can synthesize some carbohydrate from fat and protein, but the bulk of animal carbohydrate is derived ultimately from plants.

Glucose is the most common and abundant of all of the carbohydrate molecules and plays a key role in the carbon cycle and in all life processes. The monosaccharide and oligosaccharides are soluble crystal substances having a sweet taste. They are collectively known as sugars. Polysaccharide other hand are insoluble amorphours substances and are called non-sugars. The sugar are divided into two families the D-family and L-family, taking the configuration glyceraldehydes as standard.

Sugars configurationally related to D-glyceraldehydes are members of the D-family, those related to L- glyceraldehydes are in the L-family. Most naturally occurring sugars are D-family sugars. The L-form of a sugar is the enantiomer of the D form.

Sugars have large number of stereoisomers because they contain several asymmetric carbon atoms. Sugars which reduce Fehling's reagent and Tollens’ reagent are called reducing sugars and those which do not, non-reducing sugars.

1.1 Classification of Carbohydrates

The carbohydrates are divided into three major classes depending on the number of simple sugar present in their molecule.

1.1.1 Monosaccharide (Simple Sugars)

These are single unit carbohydrates, polyhydroxy aldehydes or polyhydroxyl ketones that cannot be broken into simpler carbohydrates hydrolysis. Glucose and fructose are the example.

$$C_6H_{12}O_6 + H_2O \xrightarrow{H^+} \text{NO reaction}$$

Glucose or Furctose

1.1.2 Oligosaccharides

They are made of 2 to 10 units of monosaccharide or simple sugars, The saccharides containing two monosaccharides units are called disaccharides. Thus sucrose $C_{12}H_{22}O_{11}$ is a disaccharide because on hydrolysis it gives molecule of glucose plus one molecule of fructose.

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{22}O_6 + C_6H_{12}O_6$$

Sucrose Glucose Fructose

On the other hand raffinose, produces three simple sugars on hydrolysis and is designated as a trisaccharide.

$$C_{18}H_{32}O_{16} + 2H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6 + C_6H_{12}O_6$$

raffinose Glucose Fructose Galactose

1.1.3 Polysaccharides

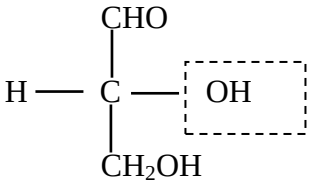
They contain more than ten monosaccharide units in the molecule. Thus molecule of starch or cellulose upon hydrolysis yield a very large number (n) of glucose units.

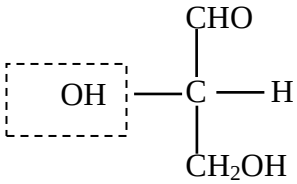
$$(C_6H_{10}O_5)_n + nH_2O \xrightarrow{H^+} nC_6H_{12}O_6$$

Starch or Cellulose Glucose

1.2 The D and L Families of Sugars

Glyceraldehydes contains a central asymmetric carbon atom. Therefore it exists in two continue (or mirror image isomers) represented by the Fischer projection formulas (1) and (2).

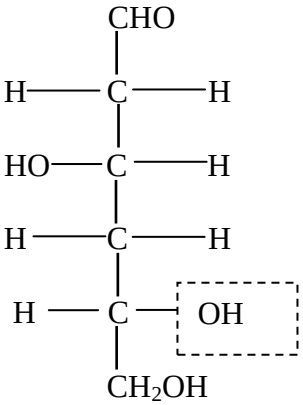


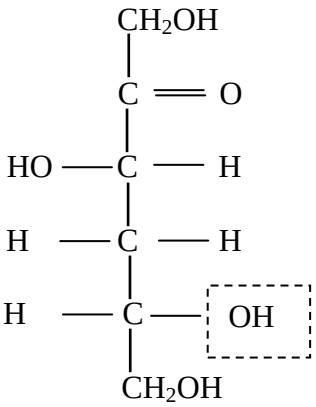


D(+) Glyceraldehyde (1) **L (–) Glyceraldehyde (2)**

The enantiomer which rotes the plane of polarized light to the right is written as (+) glyceraldehydes. The other enantiomer that rotates the plane to the left is (–) glyceraldehyde. The (+) and (–) while they specify the direction in which each enantiomer rotates the plane of polarized light, gives indication as to how the OH and H are arranged about the asymmetric carbon atom.

In 1960 Rosanoff decided arbitrarily that the enantiomer (1) with OH to the right may be designed as D-glyceraldehyde and the enantiomer (2) with OH to the left as L-glyceraldehyde. It has shown by the modern X-ray diffraction technique that Rasanoff's D-glyceraldehyde was actually glyceraldehydes and that its absolute configuration was the same as indicated in formula (1).





D (+) Glucose **D (–) Fructose**

1.3 **Botanical Aspects of Watermelon**

Family	-	Cucurbitaceace
Genus	-	Citrullus
Scientific name	-	*Citrullus vulgrais* Schard
English	-	Watermelon
Myanmar name	-	Hpa-ye

Watermelon is a member of the ground or cucurbitaceace family along with cucumber and pumpkim.

Watermelon flesh contains nutrients such as Vitamin C and A, thiamin, potassium, magnesium, pyridoxine and antioxidants. The seeds of watermelon are also located with potent nutrients such as protein, Vitamin B, manganese, zinc, copper and omega 6, fatty acid. These potent nutrients are what give watermelon its medical properties.

Watermelon is 92% of water and 6% sugar. Although temporarrly quenches thirsts while eating, watermelon ultimately dries the body because of high levels of potassium a diuretic. The cooling anti-inflammatory effects of Beta-carotene, combined with diuretic help watermelon flush inflammatiny from the urinary tract. Its low calorie count, drying quality and ability to reduce insulin resistance are ideal for kapha dosha. Watermelon digest very quickly and should never be combined with other foods, even other fruits.

The reason why everyone should eat watermelon all years round and not just in the summertime is because it helps fight fatigue, regulate blood pressure, stabilize blood sugar

levels, prevent heart disease, lower high cholesterol and relieve server asthma. The types of cancers watermelon can help you prevent simply by eating a few slices every day are prostate, colon, stomach, lung and skin. Those whose suffer from information disease. For those of you at an increase change of having a stoke or heart attack can decrease your chance by simply consuming some watermelon each day as a healthy snack instead of a fatty one. Watermelon is one of the safest foods you can eat with many medicinal benifits. Watermelon do not cause any really side effects at all.

1.4 Botanical Aspects of Apple

Botanical name	-	*Pyrus malus* Linn
Family	-	N.O. Pomaceae
English name	-	Apple
Myanmar name	-	Pan – thee

Apples are great source of fiber pectin. An apple has five grams of fiber. Apples are fat, sodium and cholesterol free. A medium apple is about 80 calories. The apples is the best fruit to tone up a weak and run-down patient. It removes deficiencies of vital organs and makes the body stout and strong. It tones up the body and brain as it contains more phosphourous and iron than any other fruit or vegetable. The skin of apple contain more vitamin C than inner flesh. The vitamin content decreases gradually towards and the center of the fruits. The skin also contain five time more vitamin A than the flesh.

Iron contained in the apple helps in formation of blood. Raw apples are good for diarrhea. Apples have been found useful in acute and chronic dysentry among children. Ripe

and sweet apples should be crushed into pulp and given to the child several time a day. Apples are special value to heart patients. They are rich in potassium and phosphorous but low in sodium. It is also useful for patient of high blood pressure. Apple is also said to be benificial to gout patients caused by crease of uric acid in blood. The apple peels water is an excellent medicine for the inflamed eyes as an eye wash. The over-ripe apples are useful as a poultic for sore eyes. The pulp is applied over the close eye. Tooth decay can be prevent by regular consumption of apples as they possess a mouth cleansing property.

1.5 **Botanical Aspects of Orange**

Family	-	Rutaceae
Genus	-	Orange
Scientific name	-	*Citrus aurantium* Linn
Myanmar name	-	Lein – maw – thee

Oranges are widely grown in warm climates worldwide, and the flavours of oranges vary from sweet to sour. The fruit is commonly peeled and eaten fresh, or squeezed for its juice. It has a thick bitter rind that is usually discarded, but can be processed into animal feed by removal of water using pressure and heat. The peel of an orange has higher values of vitamin C and more fiber. Most of the vitamin C is located in the zest rather than the pith.

Orange oil is a by-product of the juice industry produced by pressing the peel. It is used a flavouring of food and drink and for its fragrance in perfume and aromatherapy. Orange oil consists of about 90% d-limonene, a solvent used in various household chemicals, such as to

condition wooden furniture, and along with other citrus oils in grease removal and as a hand-cleansing agent. It is an efficient cleaning agent which is promoted as being environmentally friendly and preferable to petroleum distillates.

Orange blossom essence is an important component in the making of perfume. Orange peel is used by gardeners as a slug repellent. Orange leaves can be boiled to make tea.

2. MATERIALS AND METHODS

2.1 Sample Collection

Firstly, we chose the seasonal fruits cultivated in Banmaw Township, Kachin State. Watermelon was collected in summer, apple was collected in rainy season although it can be obtained in three seasons. Orange was collected in cold season.

2.2 Determination of Carbohydrates by Phenol-Sulphuric Colorimetric Method

The sugar contents of water melon, apple, orange were determined by phenol-sulphuric acid colorimetric method. The phenol-sulphuric acid method was first applied at the University of Minnesota. This method is sensitive, rapid, accurate, specific for carbohydrates and widely applicable. It is an excellent method for determining sugar eluted from spots and paper chromatogram because the usual chromatographic developing solvents do not interfere. Under proper conditions, the phenol-sulpuric acid method is accurate to ± 2%.

Apparatus

WTAF – 104D UV – VIS Spectrophotometer.

Reagents

(1) 5% phenol solution (5g of redistilled phenol was dissolved in water and diluted to 100ml)

(2) Sulphuric acid (96% reagent grade)

2.2.1 Preparation of Sample Solution

For Water melon

Water melon (10" (length) – (18" (width) was selected and cut the slices. From three slices pulps were taken and weighed. These three slices were pressed and decanted the juice.

20 ml of hot water was added to the residue. It was stirred and stood for 15 minutes and decanted the juice. This procedure was repeated still the solution became clear. The decanted juices were combined and the total volume were measured. It was found that the total volume of water melon was found to be 383 ml.

Table 2.1 Weight of the Slices of Water Melon

No.	the slices of water melon
1.	46.90
2.	45.37
3.	48.02

One ml of these sample solutions were diluted to 50ml with distilled water and stirred thoroughly. These solutions were taken as the sample solutions. All fruits are not equal in sugar content.

For Apples

Three apples were taken, removed the skin and weighed. Among these apples without skin, one slice from each was out and weigh again. These three slices were pressed and decanted the juice. Stood for 15 minutes and decanted the juice. This procedure was repeated still the solution became clear. The decanted juices were combined and the total volume were measured. It was found that the total volume of apple juice was found to be 270ml.

Table 2.2 Weight of Apples and Slices

No.	the slices of Apple (g)	Slices (g)
1.	172.46	23.02
2.	170.42	22.35
3.	175.32	21.77

For Orange

Three oranges were taken and peels were removed. Then they were weighed. Among these peel-off three oranges, one segment from each was selected and weigh again. These three segments were pressed and decanted the juice. 20ml of hot water was added to the residue and then stirred, stood for 15 minutes and decanted the juice. This procedure was repeated still the

solution became clear. The decanted juices were combined and the total volume were measured. It was found that the total volume of orange juice was found to be 106.8ml.

Table 2.3 Weight of Segments of Oranges

No.	the segments of oranges (g)	Wt. of segment (g)
1.	115.20	11.20
2.	100.35	10.01
3.	111.75	11.12

2.3 Preparation of Standard Sugar Solutions

100 mg of glucose was exactly weighed and dissolved in 100 ml of distilled water. 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24 and 26 ml of this solution were drawn out and put in each 100 ml volumetric flask. Then it was diluted to the mark with distilled water. These solutions contained 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240 and 260µg of glucose per ml respectively.

1 ml of sample solutions and thirteen standard solutions containing 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240 and 260 µg of glucose per ml were put in each test tube. 1ml of 5% phenol solution was also added to each test tube and mixed. 5 ml of 96% sulphuric acid was again added to each tube so that the stream hit the liquid surface directly to produce good mixing. Each tube was agitated during the addition of acid. After 10 minutes, the tubes were reshaken and placed in water bath at 25° - 30°C for twenty minutes. The yellow orange color was stable for several hours. A black was also prepared with 1 ml of distilled water instead of sugar solution.

3. RESULTS AND DISCUSSION

We chose the maximum wavelength for the standard solution of glucose using spectrophotometer by applying 100µg per ml glucose solution as a standard. Firstly, maximum wavelength intervals (50 nm difference) were determined starting 350 nm to 750 nm and the results were described in table 3.1 and figure 3.1.

Table 3.1 Absorbance for maximum wavelength interval

No.	Wavelength	Absorbance
1.	350 nm	0.29
2.	400 nm	0.38
3.	**450 nm**	**0.50**
4.	**500 nm**	**0.54**
5.	**550 nm**	**0.46**
6.	600 nm	0.44
7.	650 nm	0.41
8.	700 nm	0.40
9.	750 nm	0.39

(maximum wavelength interval)

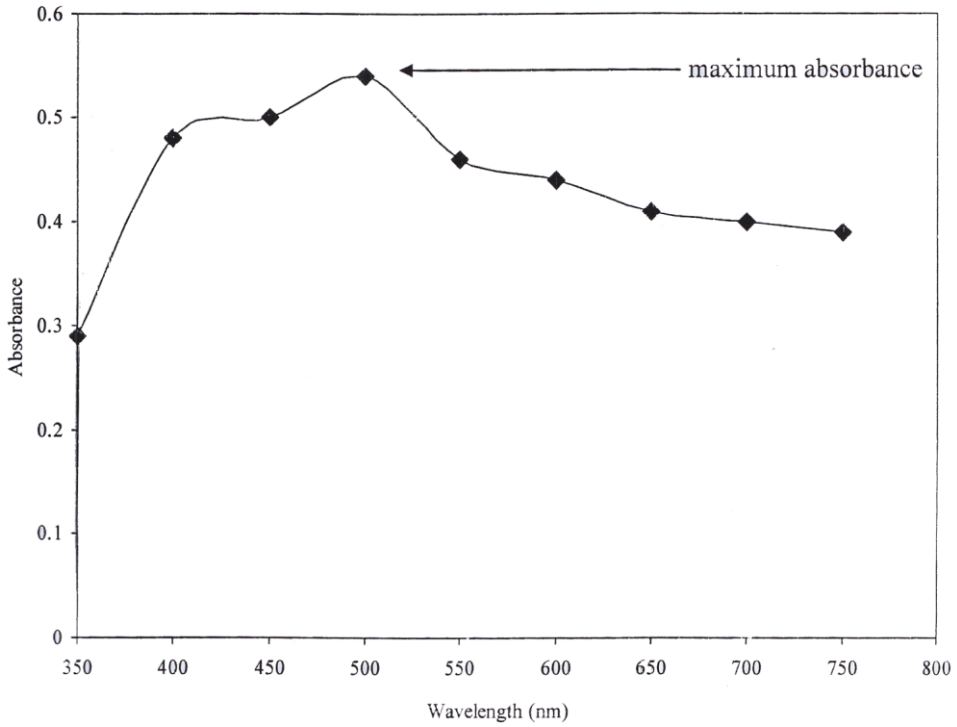


Fig 3.1 Calibration Curve for the Determination of Maximum Wavelength Interval.

From Table 3.1, it can be seen that the standard solution shows the maximum absorbance at 450 – 550 nm wavelength intervals. Therefore, we choose again the exact maximum wavelength bewteen these intervals, determined and the results were shown in table 3.2 and figure 3.2.

Table 3.2 Dtermination of maximum wavelength

No.	Wavelength	Absorbance
1.	450 nm	0.50
2.	160 nm	0.51
3.	170 nm	0.53
4.	480 nm	0.53
5.	450 nm	0.53
6.	**500 nm**	**0.54**
7.	510 nm	0.51
8.	520 nm	0.48
9.	530 nm	0.48
10.	540 nm	0.45
11.	550 nm	0.40

maximum wavelength

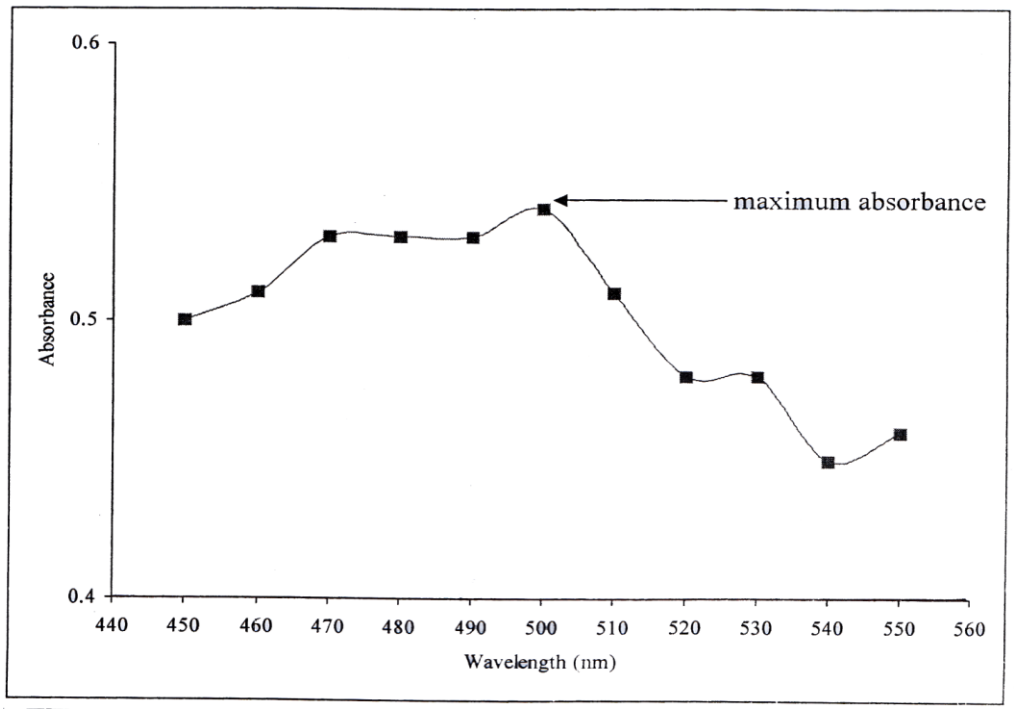


Fig 3.2 Calibration Curve for the Determination of Maximum Wavelength

According to table 3.2 maximum wavelength was for found to be 500 nm. A standard curve was plotted by absorbance of the standard solution against the concentration in μg per ml. Using this standard curve, the concentration of glucose in the sample was calculated.

Absorbance of standard glucose solutions and sample solutions were measured at maximum wavelength 500 nm and the results were described in table 3.3 and figure 3.3.

Table 3.3 Absorbance of Standard Glucose Solutions

No.	Concentration of glucose (μ g/ml)	Absorbance at 500 nm
1.	0	0
2.	20	0.12
3.	40	0.22
4.	60	0.33
5.	80	0.44
6.	100	0.54
7.	120	0.65
8.	140	0.78
9.	160	0.86
10.	180	0.96
11.	200	1.08
12.	220	1.18
13.	240	1.28
14.	260	1.38

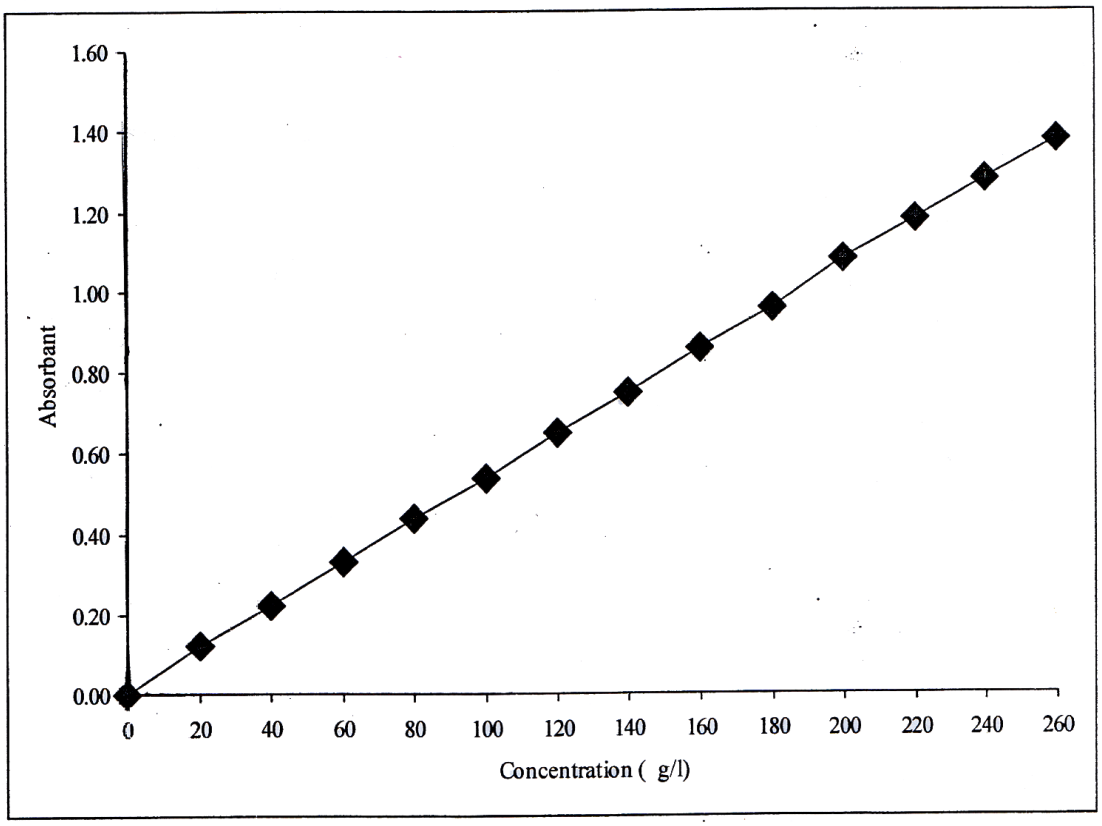


Fig 3.3 Calibration Curve for the Standard Glucose Solution

For Water Melon

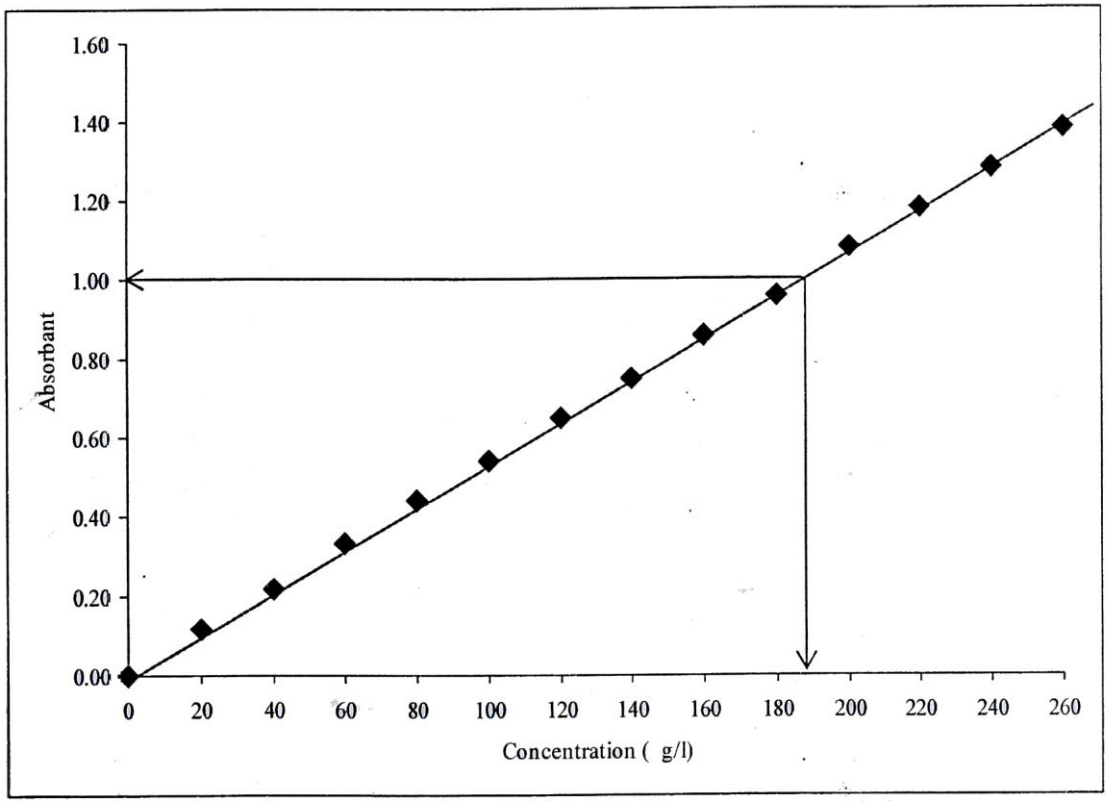


Fig 3.4 Calibrate Curve for Glucose Containing in Water melon Sample Solution

From the standard curve it was found that the concentration of water soluble carbohydrate as glucose in water melon sample solution was 192 µg/ml. The amount of water soluble carbohydrate as glucose in water melon sample was calculated as follows.

1 ml sample of solution contains	=	192µg of glucose
50 ml of sample solution contains	=	192 × 50 µg glucose
383 ml water melon juice contains	=	192 × 50 × 383 µg glucose
	=	3.6768 g glucose
141.60 g water melon contains	=	3.6768 g glucose
1 g water melon contains	=	0.02597 g glucose

For Apple

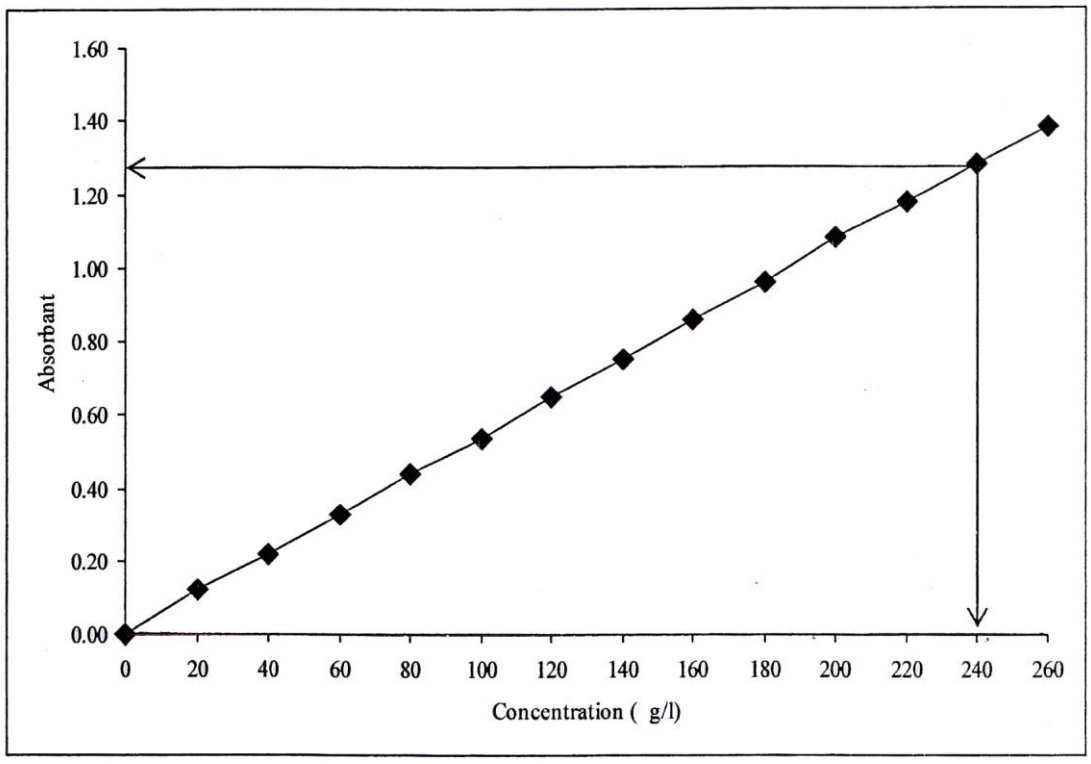


Fig 3.5 Calibrate Curve for Glucose Containing in Apples Sample Solution

From the standard curve it was found that the concentration of water soluble carbohydrate as glucose in apple sample solution was 238 µg/ml. The amount of water soluble carbohydrate as glucose in apple sample was calculated as follows.

1 ml sample solution contains	=	238µg of glucose
50 ml of sample solution contains	=	238 × 50 µg glucose
270 ml apple juice contains	=	238 × 50 × 270 µg glucose
	=	3.231 g glucose
66.99 g apple contains	=	3.231 g glucose
1 g apple contains	=	0.04796 g glucose

For Orange

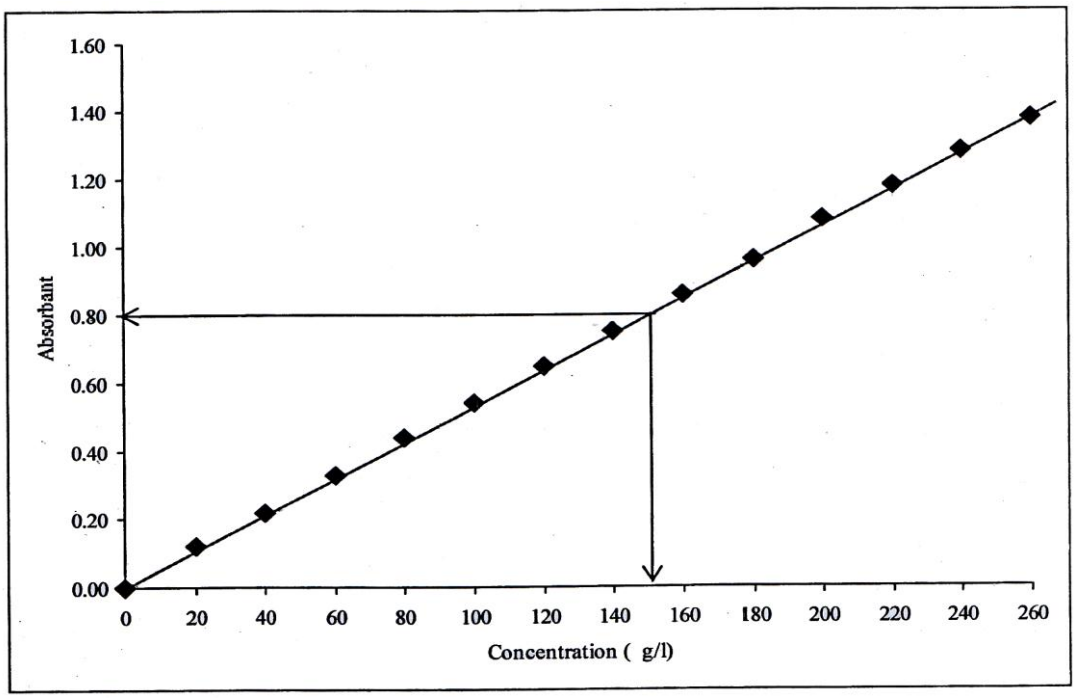


Fig 3.6 Calibrate Curve for Glucose Containing in Oranges Sample Solution

For the standard curve it was found that the concentration of water soluble carbohydrate as glucose in orange sample solution was 147 µg/ml. The amount of water soluble carbohydrate as glucose in orange sample was calculated as follows.

1 ml sample solution contains	=	147 µg of glucose
50 ml of sample solution contains	=	147 × 50 µg glucose
106.8 ml orange juice contains	=	147 × 50 × 106.8 µg glucose
	=	784980 µg glucose
	=	0.784980 g glucose

33.77 g orange contains = 0.784980 g glucose

1 g orange contains = 0.02324 g glucose

Determination of Sugar Contents of Three Selection Fruits

The sugar content of water melon, apple and orange was determined and the results were described in Table 3.4.

Table 3.4 Glucose Content of Three Selected Fruits (in juice 1g)

No.	Fruit	Glucose content (g)	Sugar content (observed)	Sugar content (literature)
1.	water melon	0.02597	0.05194	0.06428
2.	apple	0.04796	0.09592	0.1031
3.	orange	0.02324	0.04648	0.0375

According to Table 3.4, it can be seen that the observed sugar content of three selected fruits are nearly same as literature value.

4. CONCLUSION

Firstly, we selected water melon, apple, and orange, as seasonal fruits from Banmaw Township, Kachin State. The water soluble carbohydrate as glucose and sugar content of three seasonal fruits were determined by phenol-sulphric acid colourimetric method using sophisticated spectrophotometers. The maximum wavelength interval was determined and the maximum wavelength that can be used for the measurement of absorbance of sample solutions and standard solutions was found to be 500 nm. From the measurement, 1 g water melon sample contains 0.02597 g glucose and 0.05194 g sugar. 1 g apple sample consists of 0.04796 g glucose and 0.09590 g sugar. 1 g orange sample contains 0.02342 g glucose and 0.04648 g sugar.

From the above resulting data, it can be seen apple giving the higher sugar content although orange containing the lowest sugar content among these three selected seasonal fruits. These sugars are not harmful as these are natural sugar, and not a man made one. On the contrary, the sugar present in fruits can give instant energy to people. Therefore, seasonal fruits should be eaten for sugar supplement.

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REFERENCES

1. T.G Solomons, "Organic Chemistry", John Willey & Song, Inc. 1976.
2. R.K Murray and D.K. Granner and P.A. Mayes and V.W. Rodwell, "Harper's Biochemistry", twenty fifth editions.
3. http://www. Online Gardenertips. com/Hydroponics/ Index.html "Grams of Sugar in an apples", 2010.
4. http://www. Stacker & Sugarstacks.com "Sugar Stacks", 2009.
5. http://www. dietary fiber food. com "Sugar content in fruits and alcoholic drinks" March 2009.
6. http://en. Wikipedia.org / wiki / Water melon.
7. http://en. Wikipedia.org / wiki / Apple.
8. http://en. Wikipedia.org / wiki / Orange.

INTRODUCTION

1.1 Ferroelectric Materials

Recently, there has been growing interest in ferroelectric materials for nonvolatile memory applications. Ferroelectric materials, once electrically polarized, remain polarized even in the absence of an electric field. The name ferroelectric was chosen by analogy with ferromagnetic materials, which exhibit a spontaneous magnetization even in the absence of a magnetic field. This is due to the hysteresis in the polarization response of the ferroelectric material to the electric field. The model of ferroelectric materials should include the effects of a time-dependent electric field and the sweep direction of the polarization. Ferroelectric materials exhibit high dielectric permittivity and strong piezoelectric and pyroelectric effects. While there are limitations to the applications of ferroelectric materials in bulk form owing to the high operating voltages required, advances in thin-films fabrication technology along with parallel developments in integrated-circuitry and electro-optic technologies have led to an explosion of interest in the ferroelectric thin film.The common and defining feature of all ferroelectrics is the presence of a field reorientable spontaneous polarization. Exactly which crystals belong to this group is an empirical distinction, but many ferroelectrics are characterized by structure in corporating oxygen polyhedra. The most important of these is the perovskite structure $A^{2+}B^{4+}O_3$, shows in Fig. 1.1.

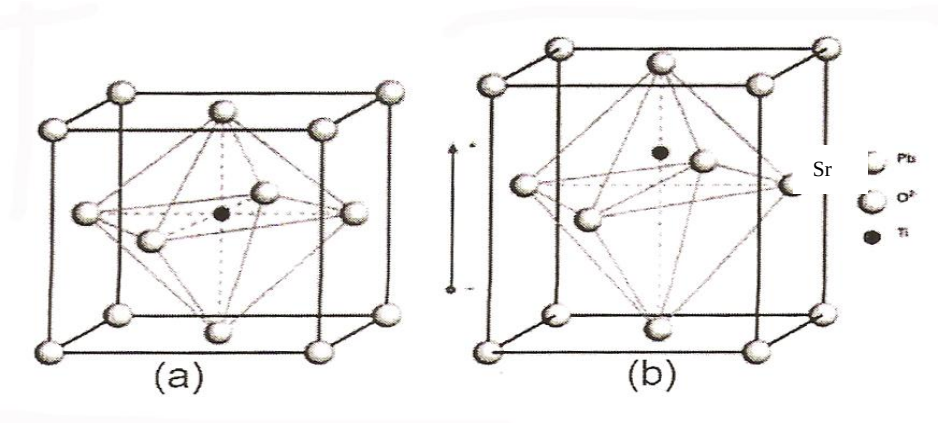


Fig. 1.1 Unit cell of perovskite structure $SrTiO_3$ (a) cubic structure at paraelectric state; (b) tetragonal structure at ferroelectric state

1.2 Ferroelectricity

Ferroelectricity is a physical property of a material where by it exhibits a spontaneous electric dipole moment, the direction of which can be switched between equivalent states by the application of an external electric field. Ferroelectrics are key materials in microelectronics. Their excellent dielectric properties make them suitable for electronic components such as

capacitors and filters etc. The term ferroelectricity is used in analogy to ferromagnetism, in which a material exhibits a permanent magnetic moment. Ferromagnetism was already known when ferroelectricity was discovered in the late 1800s. Thus, the prefix "ferro", meaning iron, was used to describe the property despite the fact that most ferroelectric materials do not have iron in their lattice.

The combine properties of memory, piezoelectricity and pyroelectricity make ferroelectric capacitors some of the most useful technological devices in modern society. Ferroelectric capacitors are at the heart of medical ultrasound machines (the capacitors generate and then listen for the ultrasound "ping" used to image the internal organs of a body), high quality infrared cameras (the infrared image is projected onto a two dimensional array of ferroelectric capacitors capable of detecting temperature differences as small as millionths of a degree Celsius), fire sensors, sonar, vibration sensors, and even fuel injectors on diesel engines. Engineers use the high dielectric constants of ferroelectric materials to concentrate large values of capacitance into small volumes, resulting in the very tiny amount capacitors, compact laptop computers and cell phones simply would not be possible.

As well, the electro-optic modulators that form the backbone of the Internet are made with ferroelectric materials. Ferroelectric crystals often show several transition temperatures and domain structure hysteresis, much as do ferromagnetic crystals. The nature of the phase transition is some ferroelectric crystals is still not well understood.

Ferroelectricity is characterized by a spontaneous polarization in the absence of an electric field. The spontaneous polarization can be switched by applying an external electric field. Ferroelectric materials undergo a structural phase transition from a paraelectric phase to a ferroelectric phase upon cooling through the Curie temperature, T_c. Above T_c, the crystal has a centrosymmetric structure and has no spontaneous polarization. Below T_c, the crystal exhibits ferroelectricity and a structure resulting from a change in the symmetry of the unit cell. As a perovskite ferroelectric is cooled below T, the central ion in the unit cell displaces from its equilibrium position to create a spontaneous polarization. Consequently, a perovskite ferroelectric material transform from a paraelectric Centrosymmetric structure into a ferroelectric non centrosymmetric structure which is often tetragonal or rhombohedral. Below the phase transition temperature, there are least two directions along which the spontaneous polarization can exit in a stable state. The spontaneous polarization in Pb(Zr,Ti)O, for example, lies along <100> directions in the tetragonal phase and <111> directions in the rhombohedral phase

1.3 Polarization Electric Field Hysteresis Loops

Upon application of a DC electric field in the horizontal direction of Fig. 1.3, the dipoles which were already aligned in the field direction will remain aligned but those which are anti parallel will have a tendency to reorient themselves in the direction of electric field. Upon application of sufficiently large electric field their dipoles will be able to align themselves in the direction of applied field. This phenomenon of polarization reversal takes place by way of nucleation of favorably oriented domains and domain wall motion. If we assume that our hypothetical crystal has an equal number of positive and negative domains then the net polarization of the crystal will be zero. Upon application of an electric field E, initial polarization P increases linearly with the increasing electric field and the crystal behaves like a dielectric because the applied field is not large enough to switch any of the domains oriented opposite to its direction. A plot between P and E is shown in Fig. 1.3 and this linear region is shown as AB. Upon further increasing the electric field, oppositely oriented domains start to reorient themselves and polarization starts increasing rapidly (BC) until all the domains are aligned in the direction of the electric field i.e reach a single domain state (CD) when polarization saturates to a value called saturation polarization (P_S). Upon decreasing the electric field, the polarization generally does not return to zero but follows path DE and at zero field some of the domains still remain aligned in the positive direction and crystal exhibits a remanent polarization (P_r). To bring the crystal back to zero polarization state, a negative electric field is required (along the path EF) which is also called the coersive field (E_c). Further increase of electric field in the negative direction will cause complete the path GHD. This relation between P and E is called a ferroelectric hystersis loop which is an important characteristic of a ferroelectric crystal. The principle feature of a ferroelectric crystal is not only the presence of spontaneous polarization but also the fact that this polarization can be reversed by application of an electric field .

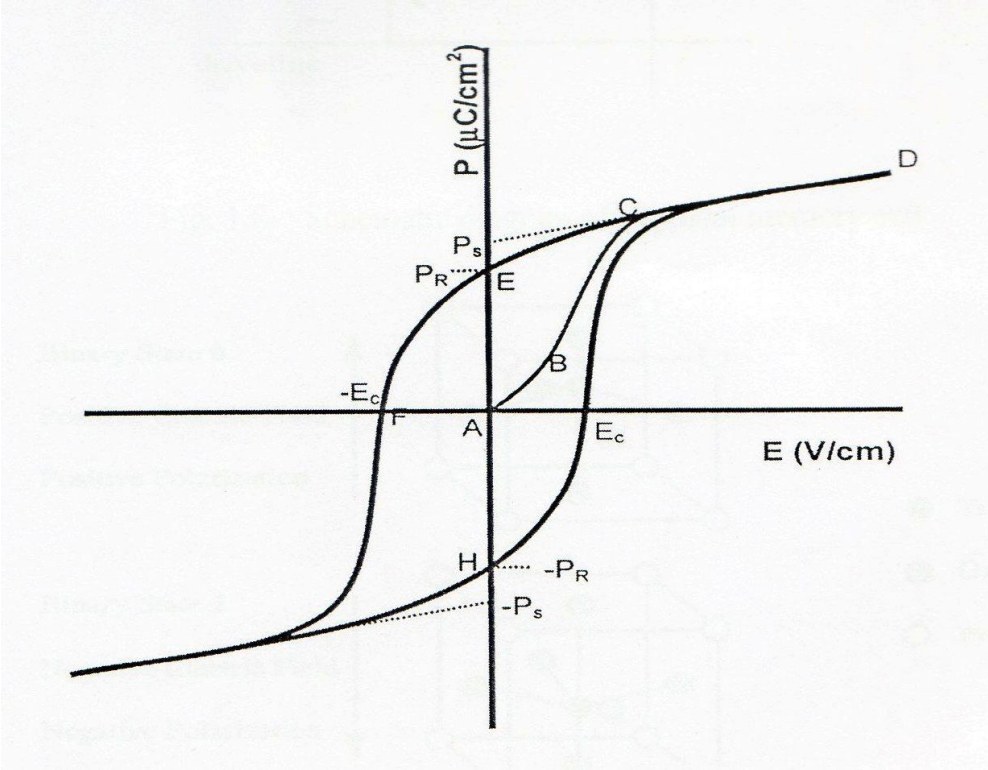


Fig.1.3 Characteristic hysteresis loops of a ferroelectric materia

1.4 Applications of Ferroelectric

Ferroelectric materials typically exhibit large values of dielectric permittivity. Therefore, they are suitable for the application as high-k material in capacitor structures, such as multilayer thin-film capacitors and decoupling capacitors in microwave monolithic integrated circuits. They are also used as cell dielectric in dynamic random access memory (DRAM) devices, or as gate oxide material in field effect transistors. The pyroelectric properties are used for temperature sensing and infrared-radiation detection, which is a basis for infrared imaging also . The piezoelectric properties are not only used for simple electric actuators. They are also one of the basic ingredients in microelectromechanical systems (MEMS). Applications of MEMS cover for instance piezoelectric micromotors and pumps, air-bag accellerometers, actuating cantilevers, chemical micro-sensors, and micro-mirror displays. MEMS are also applied for surface-acoustic-wave (SAW) filters, pyroelectric IR microsensors, and ultrasonic high-frequency imaging .

The most propagated one is information storage either in nonvolatile memory cells such as ferroelectric random access memories (FRAM) or in nanoscopic mass data storage devices .Nevertheless, the growing interest in smart materials and structures and integration of more

complex functionalities will push this field of applications further. Placing a ferroelectric material between two conductive plates creates a ferroelectric capacitor. Ferroelectric capacitors exhibit nonlinear properties and usually have very high dielectric constants. The fact that internal electric dipoles can be forced to change their direction by the application of an external voltage gives rise *to* hysteresis in the "polarization vs voltage" property of capacitor. In this case polarization is defined as the total charge stored on the plates of capacitor divided by the area of the plates. Hysteresis means memory and ferroelectric capacitors are used to make ferroelectric RAM for computes RFID cards. Ferroelectric materials can be used in different ways in memory designs. Another class of memory applications is the electrical write with optical read storage element .

1.5 Dielectric Properties of Ferroelectric

Dielectric materials usually have very high resistance. Because the electrical current can not flow through it easily, dielectric materials can prevent the leakage of an electrical current or electrical free charges moving inside its body. Dielectric material is distinctly different from the electrical conductor which provides the path for free charges moving inside its body when applied electric voltage or electric field. Even the dielectric materials do not provide the path for electrical charges to pass through its body, when an electric field was applied on its body, a phenomenon called Polarization will occur inside the body, in which the bonded charge particles align with the applied electric field. This alignment of the bonded charge particles will produce additional electric field to compensate the applied electric field. The fundamental basis of the phenomena is the interaction of the dielectric material with the applied electric field, and this interaction could be characterized by the dielectric constant. The permittivity (also called dielectric constant when comparing to free space), loss tangent, and conductivity are three important properties for dielectric materials.

The two-parallel-plate capacitor structure is a practical and popular structure to characterize the dielectric materials. The two plates are separated by a distance h under an applied voltage V. Because of the applied voltage, charges will accumulate at the external surface of the two plates which have an area of A square meters.

As shown in Fig. 1.4, the space between the two plates are free space, the electric field is expressed as

$$E = \frac{V}{d} \qquad (1)$$

The free charge accumulated at one of the internal surfaces of the two plates equals to Q_0

where $Q_0 = C_0 V$ (2)

Where the capacitance of the two parallel-plate capacitor is

$$C_0 = \frac{\varepsilon_0 A}{d} \qquad (3)$$

As shown in Fig. 1.4, the space between the two plates is filled with dielectric materials with a dielectric constant of ε_r, and the capacitance of the two parallel-plate capacitor becomes

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d} \qquad (4)$$

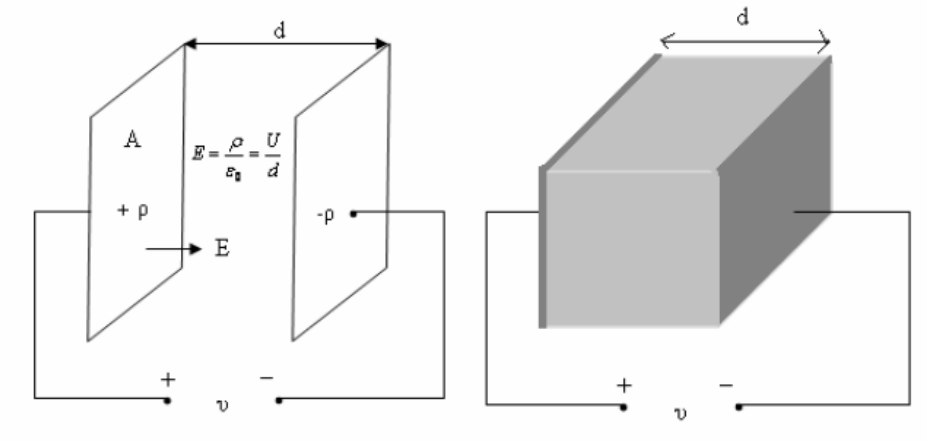
The free charge that is accumulated at one of the external surfaces of the two plates equal to Q

where $Q = CV$ (5)

The electric field is normal to the inner surface of the parallel plates, especially at the center of the plates. As the location approaches to the edge of the plates, the electric field may not be normal to the surface of the plates. Fortunately, dimension of the plates becomes much larger than the distance, d, this fringe effect can be ignored.

The terms discussed above are the dielectric constant and permittivity under applied static electric field. Even through the dielectric materials has large resistance, there are still some free carriers inside. The moving free carriers will contribute to the leakage current and consume the electric energy, which can be termed as the loss tangent of power consumption. For ideal capacitors, when an alternative electric field is applied, the electrical energy is stored as potential energy through charge accumulation at the surface in positive half circle, and then the charge cumulated are discharge to give off energy in the negative half circle, and there is no energy dissipated within the dielectric materials. In reality, when an alternative electric field is applied, there will be free charges escaped which will be able to move around and consume the

electric energy. For the parallel-plate capacitor, the ratio of the energy consumed to the energy stored in the capacitor is the loss tangent of the power consumption.



(a) (b)

Fig. 1.4 Schematic diagrams of two parallel-plates capacitor.

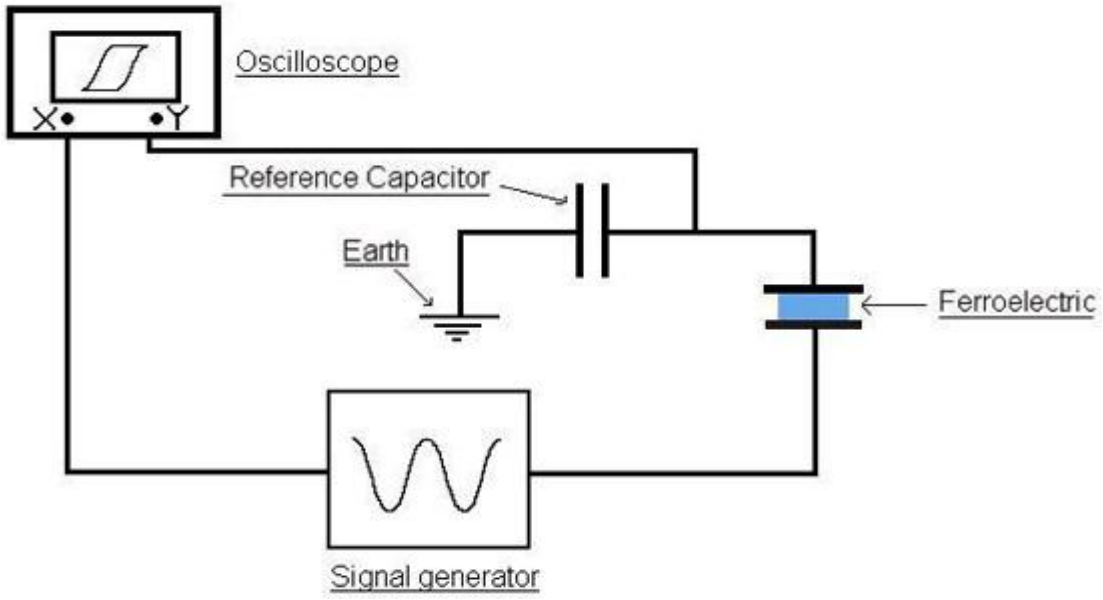


Fig. 1.5(a) Schematic diagram of Sawyer-Tower circuit

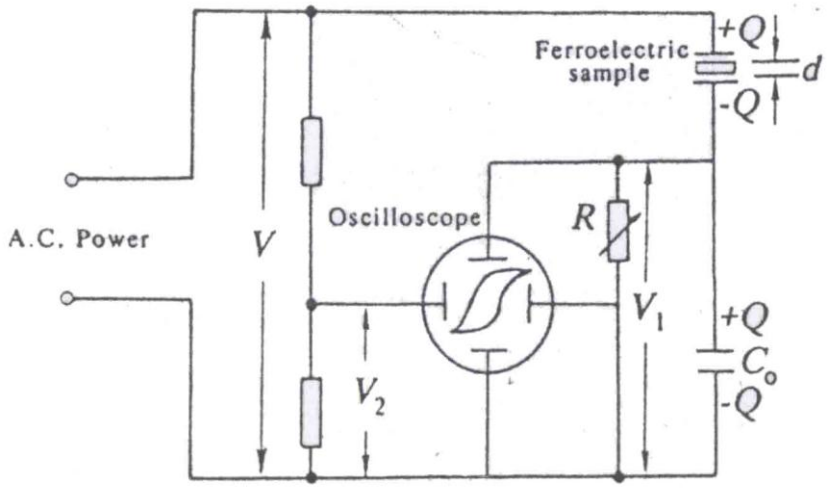


Fig. 1.5(b) Sawyer-Tower Circuit

Experimental Procedure

Barium Carbonate is heated at 1200°C for 1h. Barium oxide is obtained. Barium oxide (BaO), titanium dioxide (TiO_2) and Strontium oxide (SrO) were mixed with different molar ratios to get the chemical formula $Ba_{(1-x)}Sr_xTiO_3$. Firstly the raw material of BaO, TiO_2 and SrO were weighed by digital balance. The three powder were mixed and ground by an agate mortar for 1h to obtain homogenous powder. Acetone solvent was added into the mixed powder and stirred with magnetic stirrer for 3h. And then, it was dried at room temperature. Ball-milling was performed to get homogeneous powder. This powder was operated by air-jet milling to get ultra-line powder. Some powder was sieved with (100 mesh, 250 mesh, 400 mesh) to get uniform particle size powder. The mixture powder is heated at 800°C for 1h . To get $BaSrTiO_3$ pellet, the powder was with PVA and mould press with 10 ton. The BST pellet was annealed at 600˚C, 700˚C and 800˚C for 1h each respectively. X-Diffraction and Scanning electro microscope (SEM) analysis was carried out for the BST samples of sieving powder and pellet. DT-TGA analysis was carried out to study thermal decomposition. Dielectric properties of BST ceramics were also studied. Ferroelectric properties of BST samples were characterized by P-E characteristics. Schematic diagram of BST sample preparation and characterization was shown in Fig. 2.5.

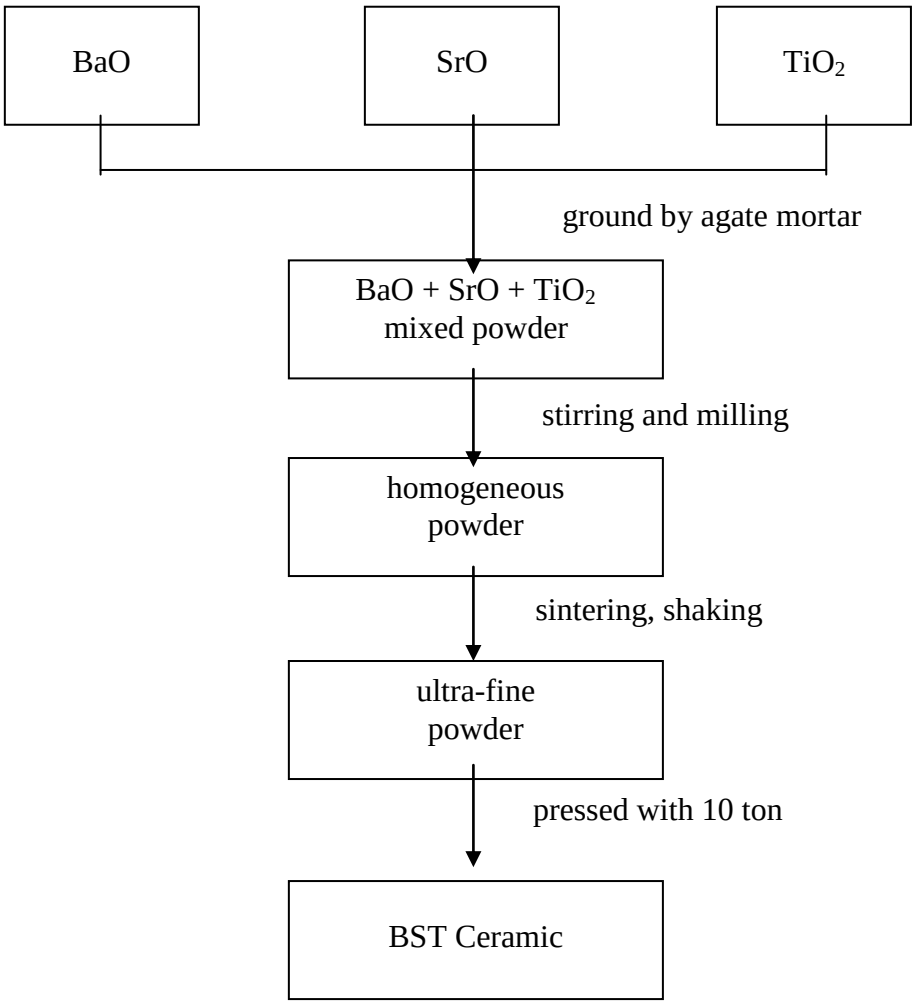


Fig. 2.5 Schematic diagram of BST sample preparation

RESULTS AND DISCUSSION

1. Crystallographic Investigation of BST Ceramic

The Sr-doped $BaTiO_3$(BST) was thus obtained and XRD technique was used to examine toward studying phase analysis, crystallographic investigation and lattice parameters. The phase analysis of BST powder was determined by using a diffractormeter (RIGAKU RINT 2000). XRD was performed using monochromatic Cukα radiation ($\lambda = 1.54056$Å) operated at tube voltage of 40 kV and tube current of 40 mA. Sample was scanned with diffraction angle 2 θ value range of 10° to 70°.

The XRD images of BST ceramic with different process temperature were recorded and shown in Fig. 3.1(a ~ c). From the profile, it was clean that all XRD profile of BST at 600° C, there

were 7 reflection peaks on the pattern were agreed with typical $BaTiO_3$ pattern. XRD profile of BST at 700° C, there were 7 reflection peaks were consistent with standard $BaTiO_3$. At 800° C, 10 reflection peak of XRD patterns were agreed with standard $BaTiO_3$ peak. The intenstiy of (100) reflection was much stronger than other of BST sample.

The average grain size, G was also estimated from the half-width of X-ray diffraction peaks using Debye-Scherrers formula.

$$G = \frac{k\lambda}{\beta \cos\theta_B} \qquad (3.1)$$

Where

G = crystallite size

k = the sharp factor (0.899)

λ = wavelength of Cuk radiation

θ_B = Bragg's angle

β = half – maximum line breeth

The calculated value of crystallite size for BST ceramics with different process temperature were listed in Table 3.1.

Table (1) The calculated value of crystallite size for BST ceramics with different process temperature

Process temperature(˚C)	G(nm)
600	29.1
700	37.4
800	41.2

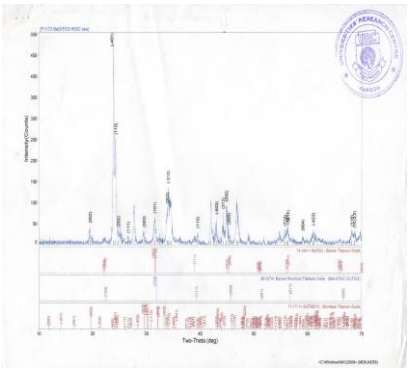


Fig. 3.1(a) XRD profile of BST sample at 600˚C

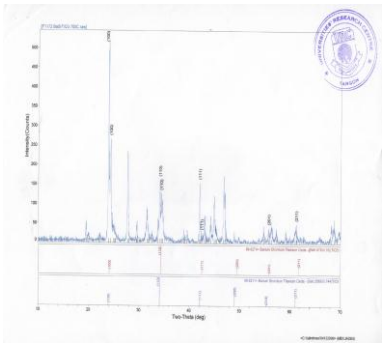


Fig. 3.1(b) XRD profile of BST sample at 700˚C

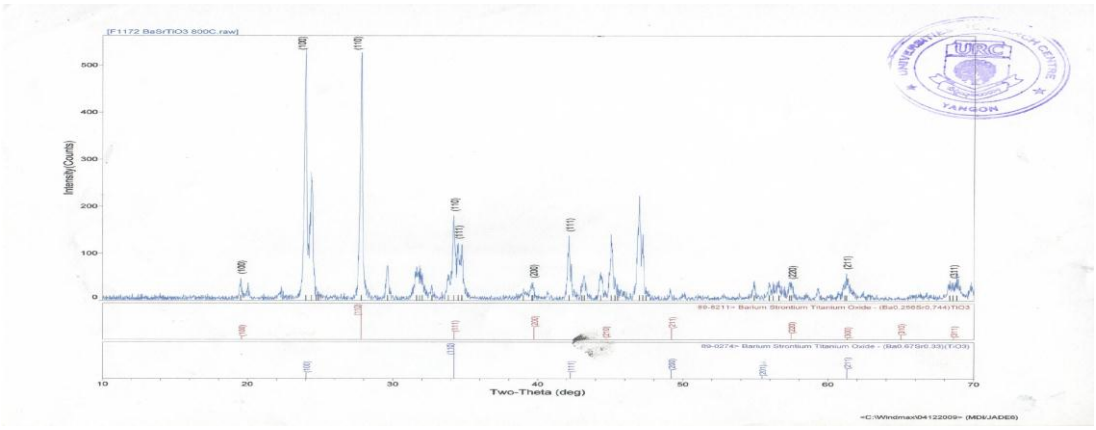
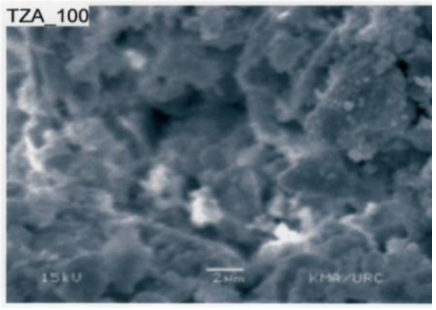


Fig. 3.1(c) XRD profile of BST sample at 800˚C

3.2 SEM Results

The microstructurals of SEM images were shown in Fig. 3.2(a~c) with different mesh sieving. In these figure all of SEM image were quite different. At 100 mesh SEM image, it could be seen that the irregular grain distribution. The surface morphology was dense and non homogeneous. At 250mesh and 400mesh SEM images, bubble like morphology was found. Grain growth pattern was observed and average grain size was 1.32 µm for BST powder for 250mesh and 1.09µm for BST powder with 400mesh. Particle orientation of all BST powder was right.

SEM graph for BST pellet was also shown in Fig. 3.2(d). In this figure, we could clearly seen that it was non-uniform and dense. But the surface of BST pellet was non-crack. Cauliflower like shape was also found and grain size was 1µm.



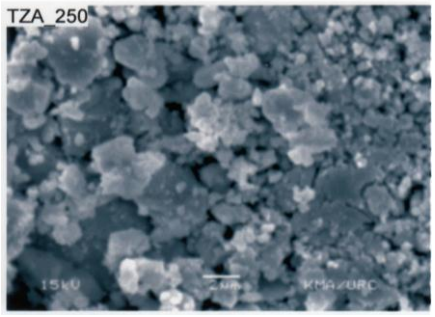
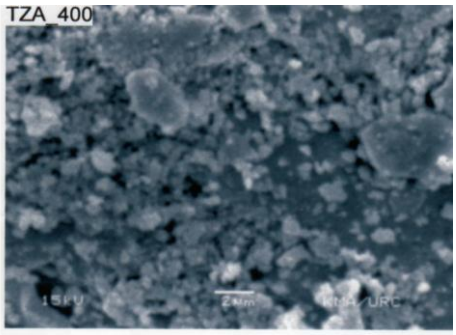


Fig. 3.2(a) Micrograph of BST powder at 100mesh sieving Fig. 3.2(b) Micrograph of BST powder at 250mesh sieving



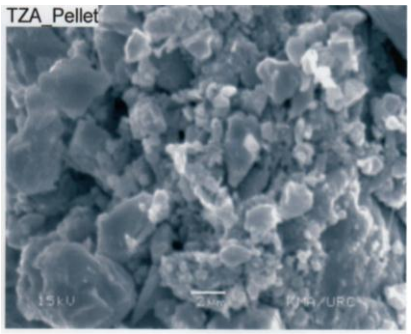


Fig. 3.2(c) Micrograph of BST powder at 400mesh sieving Fig. 3.2(d) Micrograph of BST pellet

3.3 Thermal Analysis

Thermal analysis was used to measure physical and chemical properties of material as a function of time by controlling of temperature. There are various thermal analysis. Among these, TGA-DTA analysis was simultaneous analyze system. TGA and DTA results can obtain by just one analysis. Thermal properties such as transition temperature, melting point an reaction temperature can be measured. At the same time, weight changes which occur during same thermal changes, may also be measured.

DT-TGA curves of BST sample with different process temperature were shown in Fig. 3.3(a ~ c). Two exothermic peaks at 270.65° C and 425.93° C were observed in thermograph of BST ceramic at 600° C. These DTA peaks were associated with TGA weight loss. This facts indicated that combustion step. But no distinct DTA peak and TGA weight loss step were appeared in BST ceramic at 700° C. At 800° C, two endothermic peaks were observed in BST ceramic thermogram. These endo peaks were also associated with TGA weight loss. The first endo peak at 118.21° C was due to decomposition. At 299.46° C, the weight loss step was completed.

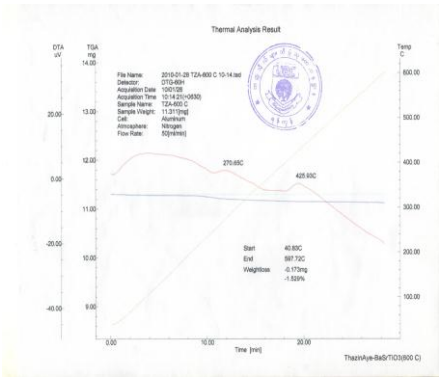


Fig. 3.3(a) Thermogram of BST sample at 600˚C

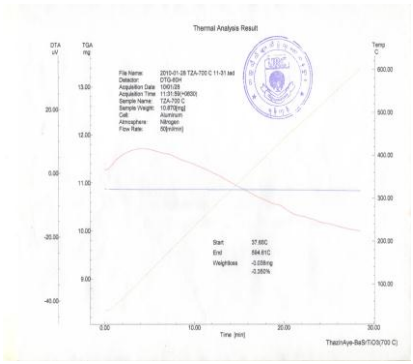


Fig. 3.3(b) Thermogram of BST sample at 700˚C

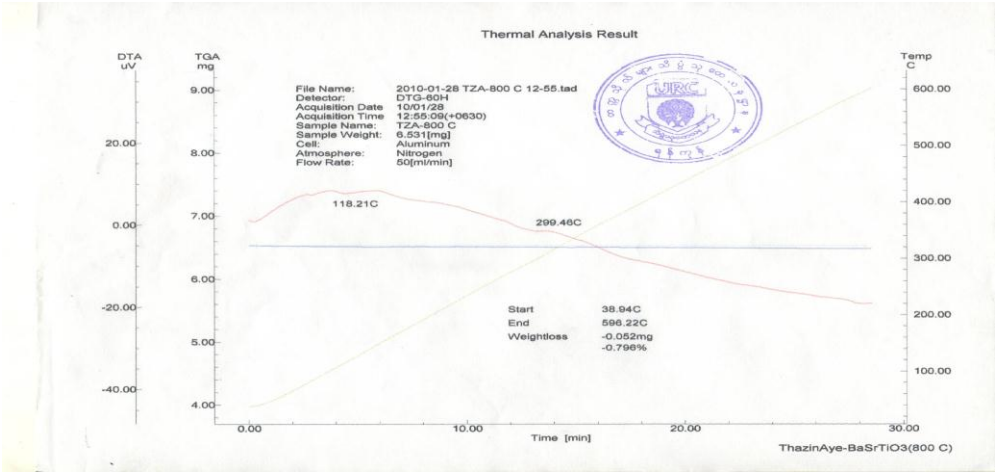


Fig. 3.3(c) Thermogram of BST sample at 800˚C

3.4 Relative dielectric constant-Frequency (ε_r-f) Characteristics

Dielectric properties of BST ceramic were studied by C-f measurement. Firstly C-f measurement was done by using LCR meter. And then relative dielectric constant was calculated by using capacitance and dielectric relation. Frequency dependence of relative dielectric constant for BST ceramics at different process temperature were displayed in Fig. 3.4(a). All of ε_r-f graphs were not remarkably different. In these figure, one-step like dispersion was observed. Linear state was found on low frequency region and saturated state on height frequency.

Dielectric lose (tan δ) and frequency variation was also shown in Fig. 3.4(b). Dielectric lose (tan δ) values were decreased with the increasing of applied frequency in all figure. The values of C, ε_r and tan δ with different applied frequency were listed in Table 3.2.

Table 3.2 The values of C, ε_r and tan δ with different applied frequency for BST samples

	600˚C		**700˚C**		**800˚C**	
f(kHz)	**ε_r**	**tanδ**	**ε_r**	**tanδ**	**ε_r**	**tanδ**
1	107.88	0.142214	67.99	0.158759	39.29	0.563146
10	59.17	0.046699	41.99	0.043644	22.75	0.166629
20	54.07	0.027862	37.79	0.028452	20.19	0.110901
50	47.58	0.016917	30.48	0.023478	17.87	0.060929
100	42.46	0.013997	25.63	0.023843	16.63	0.039994

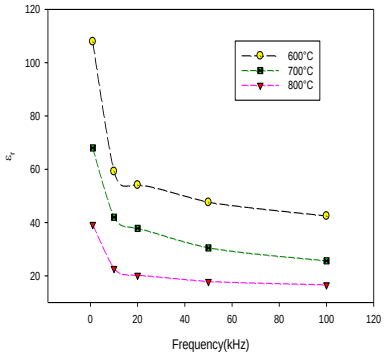


Fig. 3.4(a) ε_r-f graphs of BST ceramic at different process temperature

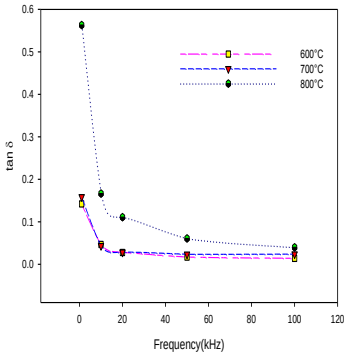
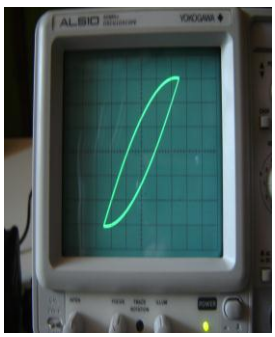


Fig. 3.4(b) tan δ-f graphs of BST ceramic at different process temperature

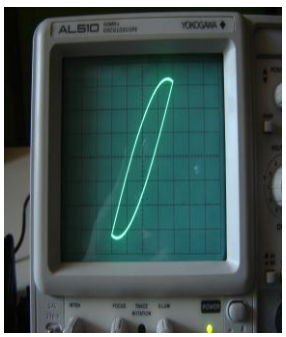
3.5 Hysteresis Loop Measurement

Hysteresis loop of BST powder with different process temperatures range of 600°C, 700°C and 800°C were measured by Sawyer-Tower circuit. The applied frequency of 100 kHz was used. The applied voltage was changed in this work were 2V, 4V, 6V, 8V and 10V respectively. The operating frequency was 100 kHz. Non-linear P-E hysteresis loops of BST sample were shown in Fig. 3.5(a ~ c). From the loop, it was found that non-linear P-E loop was observed for all samples. Hysteresis parameters such as remanent polarization (P_r), spontaneous polarization (P_s) and coercive field (E_c) were calculated by taking the horizontal and vertical values of loop. The polarization was zero when the maximum field was applied where as polarization reached its maximum value when the absence of electric field. From the loop, it was found that the ferroelectric behavior of BST sample.

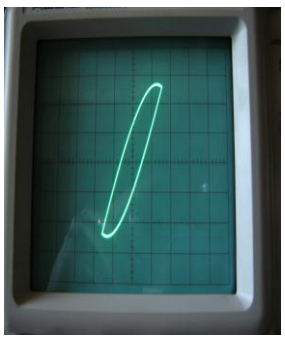
Fig. 3.5 Ferroelectric hysteresis loop of BST ceramic with the applied voltage of 10V and frequency at 100kHz



(a)at 600˚C.



(b) a t700˚C



(c) at 800˚C

3.6 Saturation Properties

To know working voltage (or) saturated voltage of BST sample, $2P_r$-V characteristics were measured. The variation of $2P_r$-V characteristics of BST sample with different process temperature were shown in Fig. 3.6(a). In this Fig, two different states such as linear and saturated were observed. P_r values were linearly increased in low voltage region and reach its constant value after transition voltage. The transition voltage changed from linear region to constant region was defined as working voltage (or) saturated voltage of BST sample. It was found to be about 6 V. Variation of hysteresis parameters of BST sample with different process temperatures were shown in Fig. 3.6 (b~g) and the value were collected in Table 3.3.

Table 3.3 Hysteresis parameters of BST sample with different process temperatures

Temperature(˚C)	V(V)	$P_r(\mu Ccm^{-2})$	$P_s(\mu Ccm^{-2})$	$E_c(kVcm^{-1})$	$MW(kVcm^{-1})$
600	2	0.2650	0.652	0.0020	0.0040
	4	0.6730	1.182	0.0370	0.0740
	6	1.0190	1.589	0.0500	0.1000
	8	1.0490	1.875	0.0660	0.1320
	10	1.1200	2.058	0.0800	0.1600
700	2	0.3464	0.774	0.0025	0.0050
	4	0.6930	1.059	0.0350	0.0700
	6	0.9780	1.997	0.0530	0.1060
	8	1.0390	2.079	0.0610	0.1220
	10	1.0802	2.222	0.0750	0.1500
800	2	0.3060	0.611	0.0018	0.0036
	4	0.6600	1.121	0.0290	0.0580
	6	0.9370	1.651	0.0480	0.0960
	8	1.0190	1.956	0.0560	0.1120
	10	1.0490	2.283	0.0690	0.1380

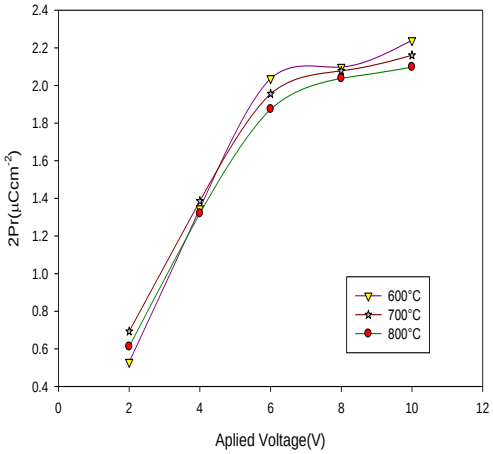


Fig. 3.6(a) $2P_r$ versus applied voltage for BST sample at different process temperatures

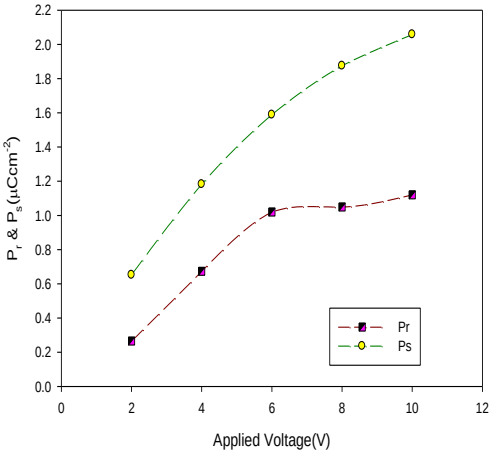


Fig. 3.6(b) P_r & P_s values with respect to applied voltage for BST sample at 600˚ c

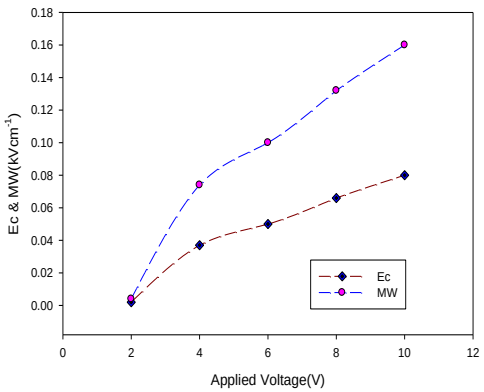


Fig. 3.6(c) E_c & MW values with respect to

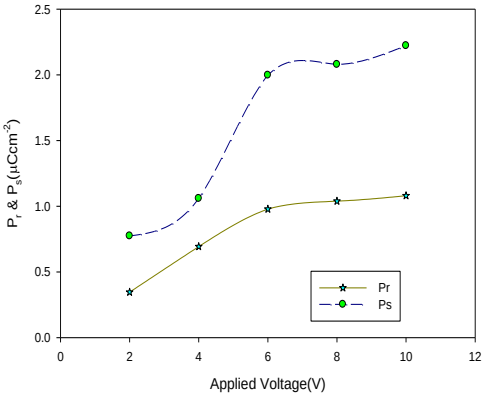


Fig. 3.6(d) P_r & P_s values with respect to

applied voltage for BST sample at 600˚C applied voltage for BST sample at 700˚C

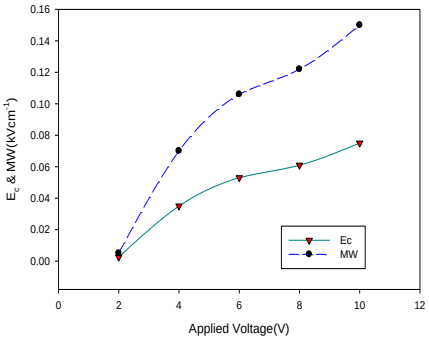


Fig. 3.6(e) E_c & MW values with respect to applied voltage for BST sample at 700˚C

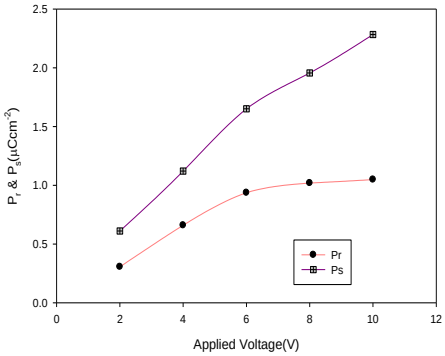


Fig. 3.6(f) P_r & P_s values with respect to applied voltage for BST sample at 800˚C

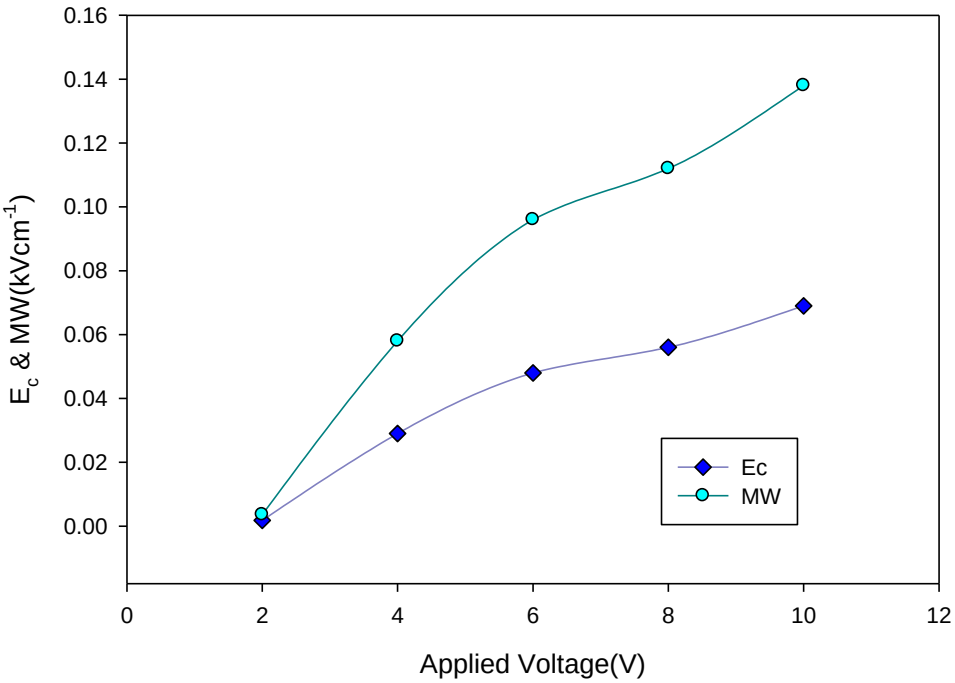


Fig. 3.6(g) E_c & MW values with respect to applied voltage for BST sample at 800˚C

CHAPTER IV
CONCLUSION

$BaSrTiO_3$(BST) ceramic was successfully fabricated by using solid state oxide route. All reflection of XRD spectra were found to be well-consistent with the peaks on XRD pattern of standard. From the XRD results, pseudo cubic phase of BST sample was observed. Uniform grain growth pattern was observed on microstructural of SEM image. The smallest grain size was 1 μm. From the DT-TGA results it was found that the weight loss step was completed about 300˚C. In ε_r-f graphs, significant dispersion was observed. The highest ε_r value was found at the process temperature of 600˚C. Non-linear P-E hysteresis loops of BST sample were observed. From the loop, it was found that the ferroelectric behavior of BST sample. The transition voltage changed from linear region to constant region was defined as working voltage (or) saturated voltage of BST sample. It was found to be about 6 V. Therefore, fabricated BST sample was quite promising candidate for memory device application.

CHAPTER 1

INTRODUCTION

Fire is among the most serious dangers we face. The easiest way to detect a fire at residential places is using the smoke detectors or any other similar sensors, which are usually sensitive to ionization or obscuration.

Smoke detectors are devices mounted on the wall or ceiling and automatically sound a warning when they sense smoke or other products of combustion. There are many types of smoke detector devices; they are classified according to their principle technique of detection. One of the more reliable detectors is the photoelectric smoke detector. The smoke detector with alarm system is important for prompt extinguishing and reducing damages and life losses. To detect fire, one or a combination of sensors and a detection algorithm are needed. Smoke detector is one of the common devices in a house security system.

This research will demonstrate how microcontroller will read the smoke detector and react when the smoke detector detects smoke. The constructed system is improved for transmitting the alarm signal by using PIC microcontroller and the signal can be received easily by using buzzer.

The photograph of PR13 wireless smoke detector is shown in Fig. (1.1). This is the development of Cytron Technologies, Malaysia. This system used PIC16F876A and smoke detector to detect smoke and sound a buzzer when smoke detected.

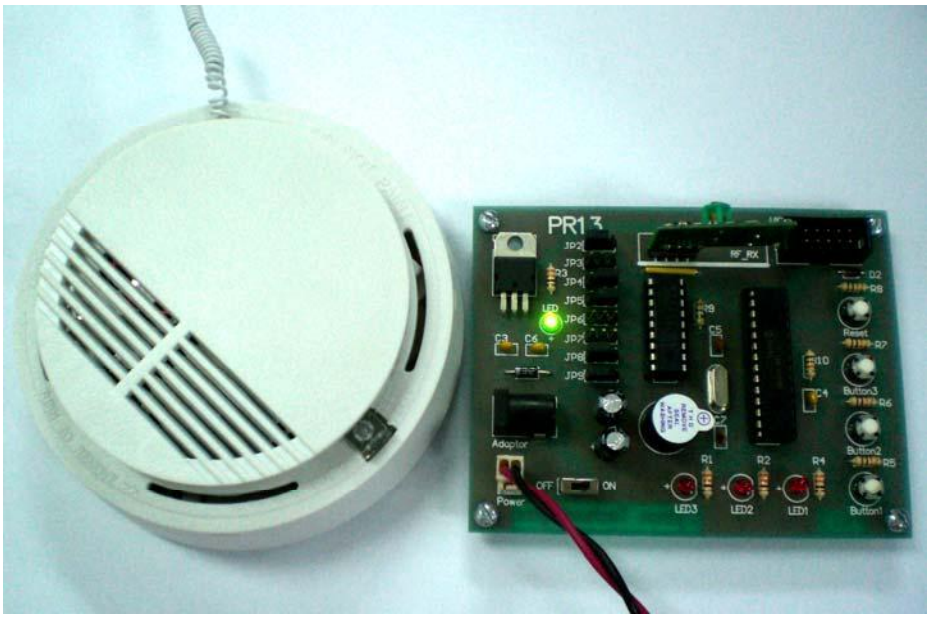


Fig (1.1) Photograph of PR13 wireless smoke detector

CHAPTER II

GENERAL DESCRIPTION OF CONSTRUCTED SYSTEM

2.1 Block Diagram of the Constructed System

The block diagram of the constructed smoke detector with alarm system is shown in Fig. (2.1). The constructed system includes four main units and they are smoke detector, main control unit, alarm unit and power supply unit.

The function of smoke detector is to detect the smoke and to transform the smoke into electrical signal. The functions of main control unit are to receive the electrical signal from the output of smoke detector, to drive alarm unit. The function of alarm unit is to produce alarm sound when the smoke detector receives the smoke. The function of power supply section is to provide regulated +5 V for other units.

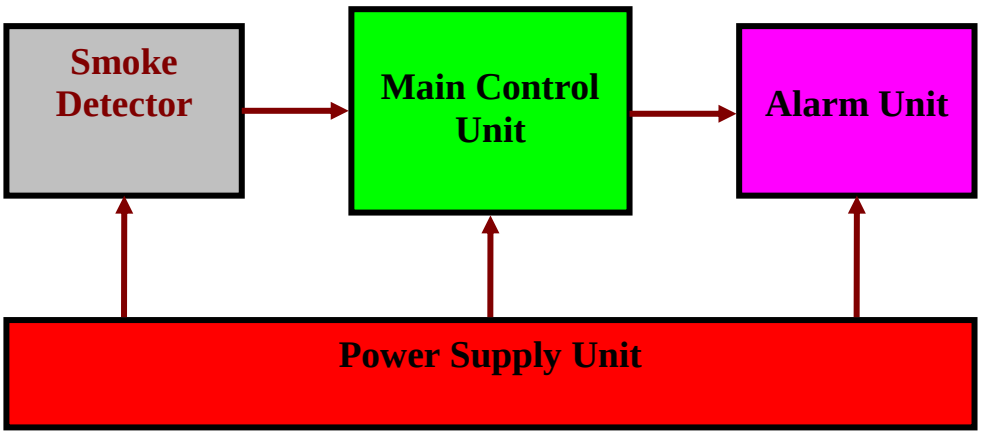


Fig (2.1) Block diagram of constructed smoke detector with alarm system

2.2 PIC16F84A Microcontroller

There are three classes of PIC, low middle and high end. They can be categorized by number of I/O pins, program memory amount and other optional features. There are three series of PIC, with 12, 14 and 16 bit wide program memories. In this research work, PIC16F84A microcontroller is used. The PIC16F84A is type of middle class PIC and has 18 pins, 13 I/O pins, 68 bytes of RAM (Radom Access Memory) and 64 bytes of Data EEPROM. The pin diagram of the PIC16F84A (Peripheral Interface Controller) is shown in Fig (2.2). The photograph of the PIC16F84A is also shown in Fig (2.3).

2.2.1 General Feature of PIC16F84A Microcontroller

The PIC16F84A microcontroller is a high performance RISC (Reduced Instruction Set Computer) processor. It has only 35 single word instructions. The operating speed is DC-20MHz clock input and DC-200ns instruction cycle. The PIC16F84A uses CMOS technology and it has low power, high speed FLASH/EEPROM technology. The PIC16F84A has two ports, PORTA and PORTB. The PIC of PORTA is a 5 bit wide bidirectional port. TRISA registers which can configure these pins are as output or input. PORTB is an 8 bit wide bidirectional port. The corresponding data direction register is TRISB. The PIC16F84A can be operated in four different oscillator modes.

They are LP (Low-Power Crystal), XT (Crystal/Resonator), HS (High-Speed Crystal/ Resonator) and RC (Resistor-Capacitor). In XT, LP or HS modes, a crystal or ceramic resonator is connected to the OSC1/CLKIN and OSC2/CLKOUT pins to establish oscillation. The PIC16F84A oscillator design requires the use of a parallel cut crystal.

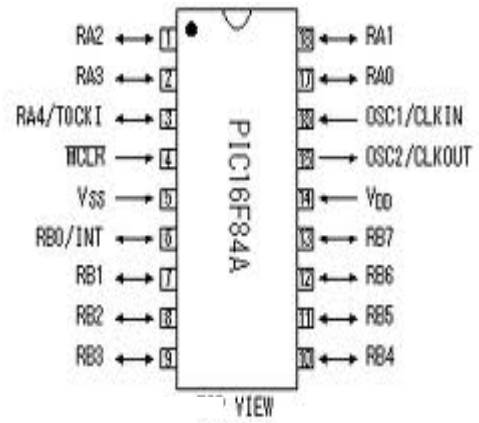


Fig (2.2) Pin diagram of PIC16F84A microcontroller

Fig (2.3) Photograph of PIC16F84A microcontroller

2.3 Light Dependent Resistor (LDR)

A Light Dependent Resistor (LDR) is a component that has a resistance that changes with the light intensity that falls upon it. It has a resistance that falls with an increase in the light intensity falling upon the device. The symbol and photograph of LDR are shown in Fig (2.4) and Fig (2.5) respectively.

The LDR is special type of resistor that reacts to changes in light level. The resistance of the LDR changes as different amounts of light falls on the top window of the device. This allows electronics circuits to measure changes in light level. The experimental resistance values of LDR used in this research is shown as follow.

For sun light, the resistance of LDR is 180Ω .

For table light, the resistance of LDR is 900Ω.

For dark light, the resistance of LDR is 2MΩ.

2.4 Light Emitting Diode (LED)

The light emitting diode (LED) is a diode consisting of layers of semiconductor material. Light is generated when electrical current is driven through the LED. A current of 20mA to 40mA is a good range for LEDs. They have a positive leg and a negative leg just like regular diodes. Different doping materials in the semiconducting material produce different colors of light. Most white LEDs are really blue LEDs with a coating of a single phosphor compound that absorbs the blue light and reradiates it as broad spectrum white light. The symbol and photograph of light emitting diode are shown in Fig (2.6). In this research, blue LED is used in the smoke detector circuit because blue LED is the most sensitive in smoke detection.

2.5 LM339 Comparator

The LM339 series consists of four independent precision voltage comparators, with an offset voltage specification as low as 2.0 mV max for each comparator. They are designed specifically to operate from a single power supply over a wide range of voltages. The pin diagram and photograph of LM339 comparator are shown in Fig (2.7) and Fig (2.8) respectively.

Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common mode voltage range includes ground, even though they are operated from a single power supply voltage.

The LM339 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM339 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

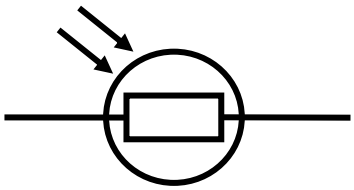


Fig (2.4) Symbol of LDR

Fig (2.5) Photograph of LDR

Fig (2.6) Symbol and photograph of light emitting diode

2.6 Alarm Buzzer

The audible alarms also known to be called buzzers have become a part of our everyday life. Buzzer is a sound producing device and there are two main types of buzzer. One has active components inside the casing and only requires a DC supply to produce sound. The frequency of sound produced from this type of buzzer cannot be changed and they are fixed by the internal circuitry. This type of buzzer is used in this project. The other type of buzzer consists of a sound producing diaphragm. This type of buzzer requires a signal to be delivered to it for producing the sound signal.

In some applications such as in a smoke detector or medical equipment, a person's life may depend upon the audible warning sound. In all cases, the equipment designer should consider the desired characteristics of the audible alarm at the initial design planning phase to obtain satisfactory performance and avoid costly redesign. The first characteristic for a designer to consider is the type of sound such as a continuous, intermittent, or specialty sound. Other critical conditions include sound level, frequency, current draw, quality, mounting configuration, cost, and availability.

The buzzer consists of a plastic housing with a metal diaphragm that is flexed by an electromagnet. The main benefit of this design is the ability to obtain low frequencies in a small package. The photograph of buzzers is shown in Fig (2.9).

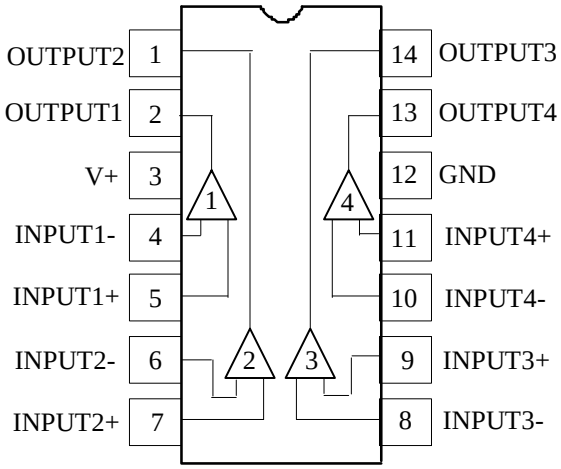


Fig (2.7) Pin diagram of LM339 comparator IC

Fig (2.8) Photograph of LM339 comparator IC

Fig (2.9) Photograph of buzzers

CHAPTER III

CIRCUIT CONSTRUCTION OF THE WHOLE SYSTEM

3.1 Smoke Detector Circuit

The smoke detector circuit is constructed by using LM339 comparator, a light dependent resistor (LDR), a light emitting diode (LED) and some resistors. In this circuit, blue LED is used as a light source and applied +5 V via 220 Ω current limiting resistors. The resistor 39kΩ is applied by +5 V and connected to the ground via LDR. The inverting input of comparator is applied with a reference voltage of 1V and therefore the output of the comparator is initially at the LOW state. The series combination of 39kΩ resistor and LDR is connected to non-inverting input of comparator. The output of comparator is also applied +5 V via 1 kΩ pull-up resistor for digital threshold output of HIGH state. The output (Signal) of smoke detector circuit is also connected to the RA2 of PIC16F84A microcontroller and that pin is used as digital input. If the smoke reaches between LED and LDR, the output of comparator is HIGH. In this way, the smoke detector circuit senses the smoke and also to generate digital signal for PIC microcontroller. The circuit diagram of smoke detector is shown in Fig (3.1).

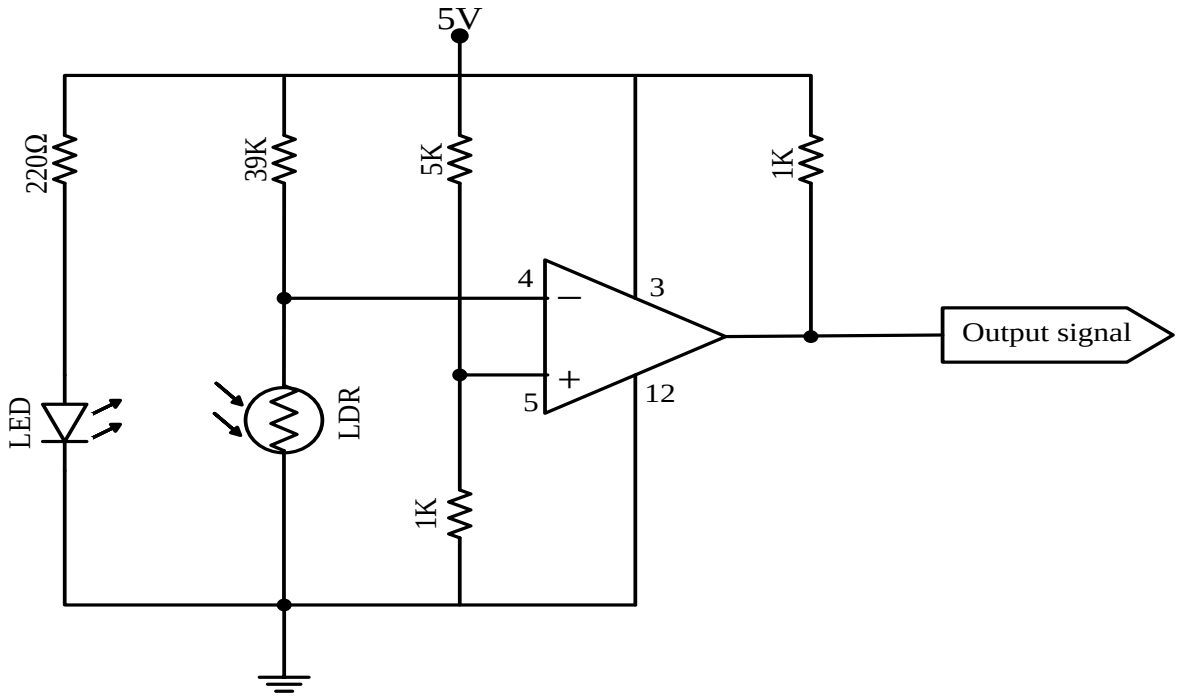


Fig (3.1) Circuit diagram of smoke detector

3.2 Main Control Circuit

In this circuit, the main control device is PIC16F84A microcontroller. To produce alarm sound, the buzzer driver circuit is constructed by using buzzer, H1061 transistor and other required components. In this circuit, a 4 MHz crystal is used as the oscillator circuit of PIC16F84A microcontroller. RA2 of PIC microcontroller is used as digital input to receive the signal from the smoke detector output. Therefore, bit 2 of TRISA is configured as set. RB3 of PIC16F84A microcontroller is used as digital output to drive the buzzer and that pin is connected to the base of H1061 transistor with via 1 kΩ resistor. Therefore, bit3 of PORTB is required to be cleared. The emitter of H1061 transistor is directly connected to the ground. The collector is connected to the negative end of the buzzer and the positive end of buzzer is connected to the applied +5V. This control circuit generates the alarm sound signal. The circuit diagram of main control unit is shown in Fig. (3.2).

3.3 Power Supply Circuit

In this research, +5 V regulated power supply circuit is constructed by using step-down transformer, filter capacitors, and 7805 regulator IC. The circuit diagram of the regulated power supply is shown in Fig (3.3). The secondary output of transformer is full-wave rectified by diodes connected in the form of bridge circuit, then smoothed by filter capacitors of capacitances 1000 µF and 100 µF. The positive output of the bridge rectifier is fed to the pin 1 (input terminal) of the 7805 IC. Pin 2 is connected to the ground. Pin 3 (output terminal) of the 7805 IC is also filtered by a 0.1 µF capacitor for stabilized +5 V output voltage. The circuit diagram of the power supply unit is shown in Fig (3.3).

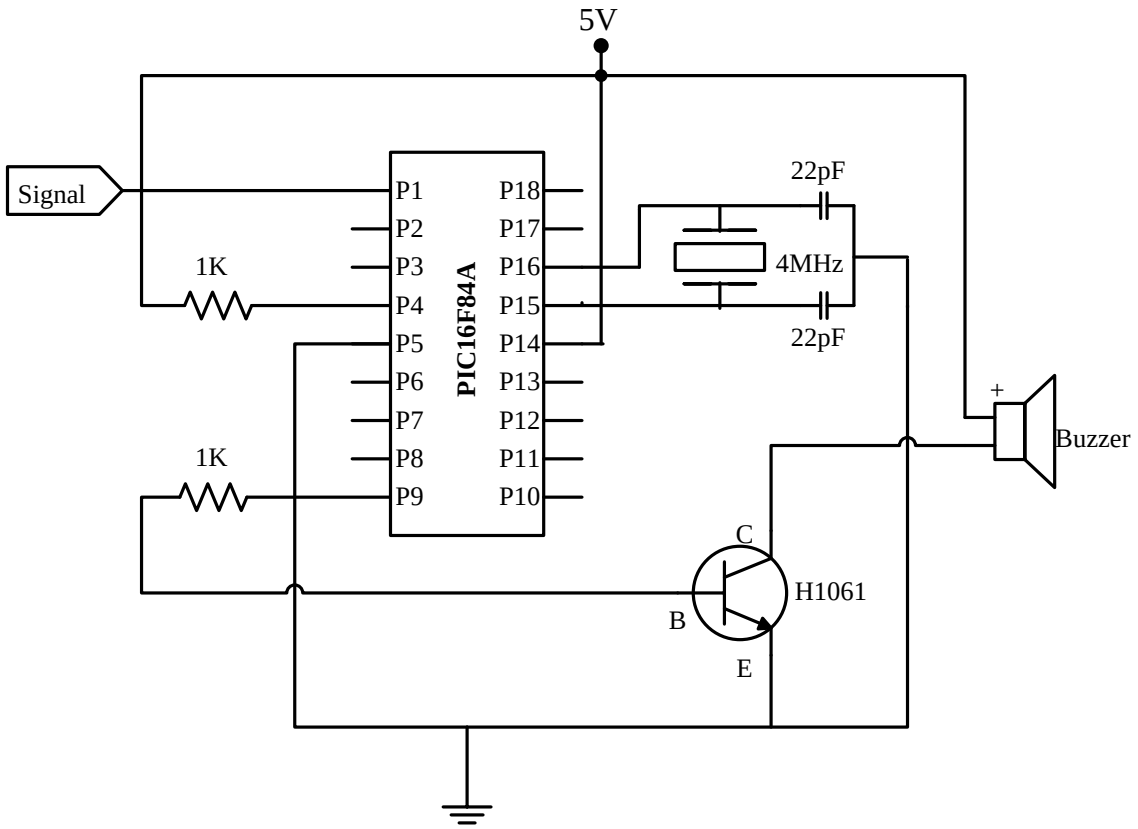


Fig (3.2) Circuit diagram of main control unit

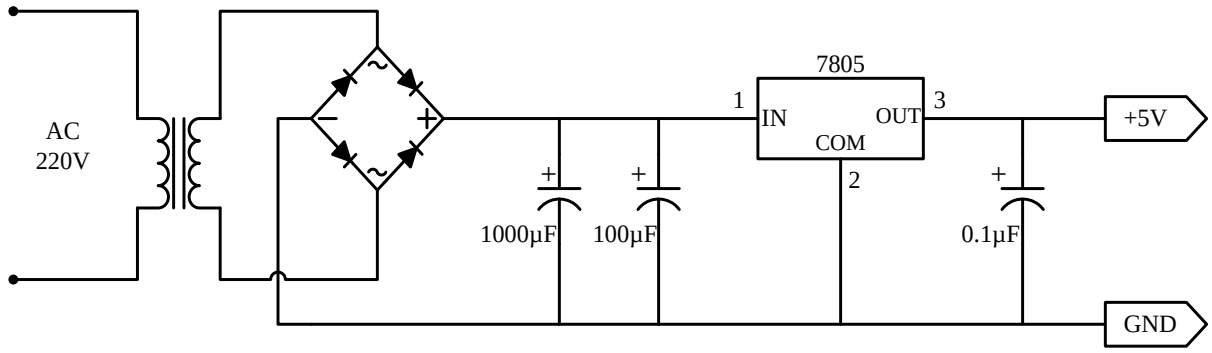


Fig (3.3) Circuit diagram of the power supply unit

3.4 Complete Circuit of the Whole system

The smoke detector circuit, main control circuit and regulated power supply circuit are fitted together to form the complete circuit of the whole system. In this research, a pair of LED and LDR is used as the main operating circuit for smoke detector. The output of smoke detector circuit is initially LOW state. If the smoke reaches into the smoke detector, the output of comparator becomes HIGH state. This is used to trigger the RA2 of PIC16F84A microcontroller. When RA2 of PIC is HIGH, RB3 of PIC microcontroller also generates the alarm sound signal. To produce alarm sound signal, RB3 of PIC16F84A microcontroller is also used as digital output and therefore bit 3 of TRISB must be cleared. The circuit diagram of the whole system is shown in Fig (3.4).

3.5 Programming and Downloading

First of all, the desired programs .asm are developed in MPLAB software. The resultant .hex files of corresponding .asm codes are downloaded from the USB port of the personal computer to the PIC16F84A microcontroller via JDM programmer board.

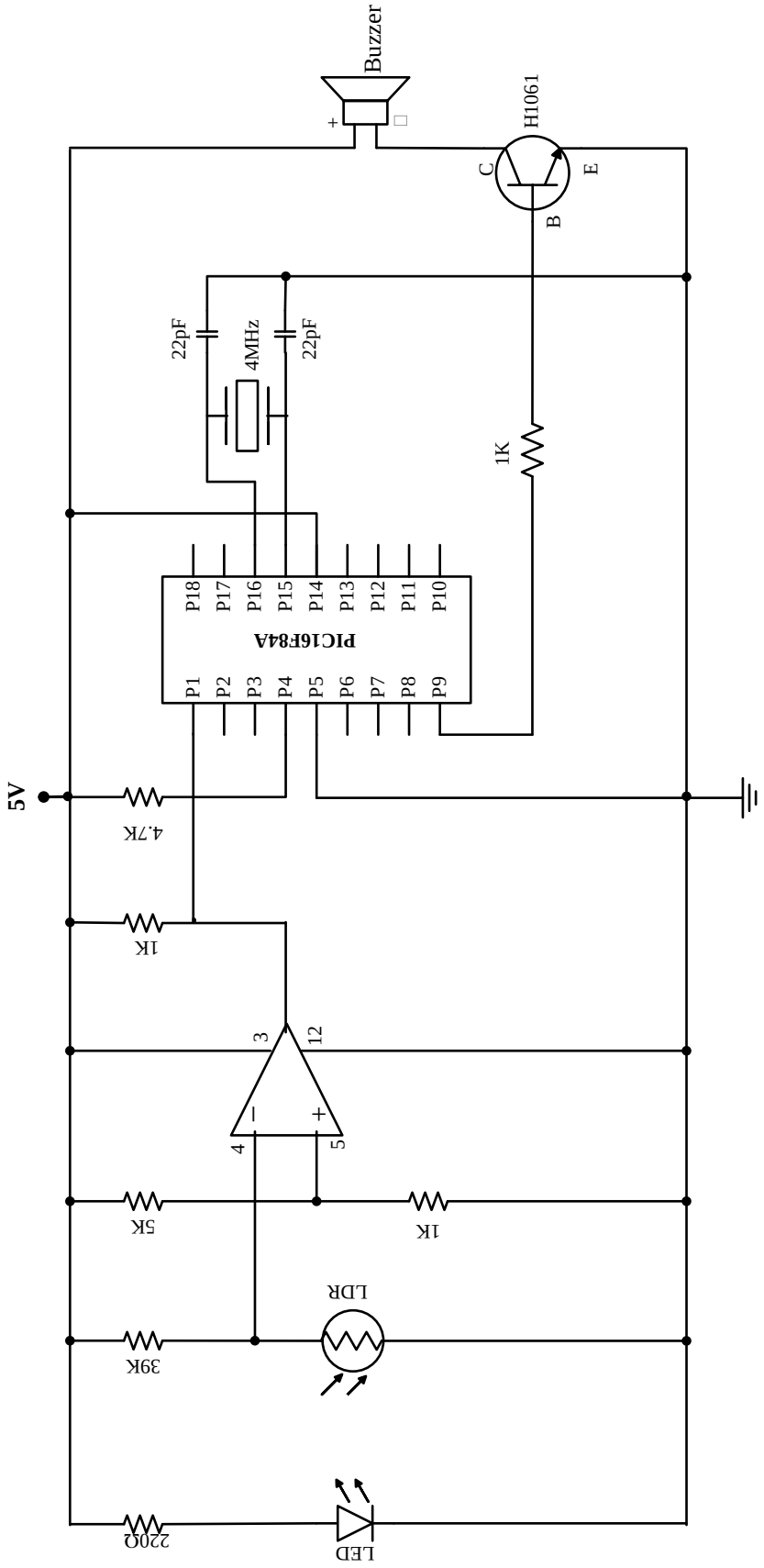


Fig (3.4) Complete circuit of the whole system

CHAPTER IV

RESULT AND DISCUSSION

4.1 Discussion and Operation of the Whole System

In this research, smoke detector with alarm system is designed and implemented by using PIC16F84A microcontroller, LM339 comparator and available electronic components. A light obscuration smoke detector type is used in the smoke detection system. This system employs a blue LED light source and a LDR which is photosensitive receiving device. When the power switch on the system is opened, the PIC16F84A microcontroller always waits the output of comparator which is initial LOW state. When the smoke particles partially block the light beam, the reduction in light reaching the photosensitive device alters its output. When the output of the photosensitive crossed by the detector threshold the comparator output becomes HIGH state, and the microcontroller to produce sound signal with buzzer. The flowchart for the operation of the whole system is shown in Fig (4.1).

4.2 Conclusion

The standard smoke detector is not designed for the hearing impaired. Also in case of there is no any person in the place of the detector, will not hear the alarm and therefore there is no fast action. Standard smoke detectors are inadequate in all these cases. In this research work, the smoke detector was enhanced by connecting it with PIC16F84A microcontroller. Therefore, the constructed system enhanced the standard smoke detector to save lives of people. This instrument can be made with very low price and minimum hardware requirements. We hope that our developed system can be applied at the University, Home, Office, and so on.

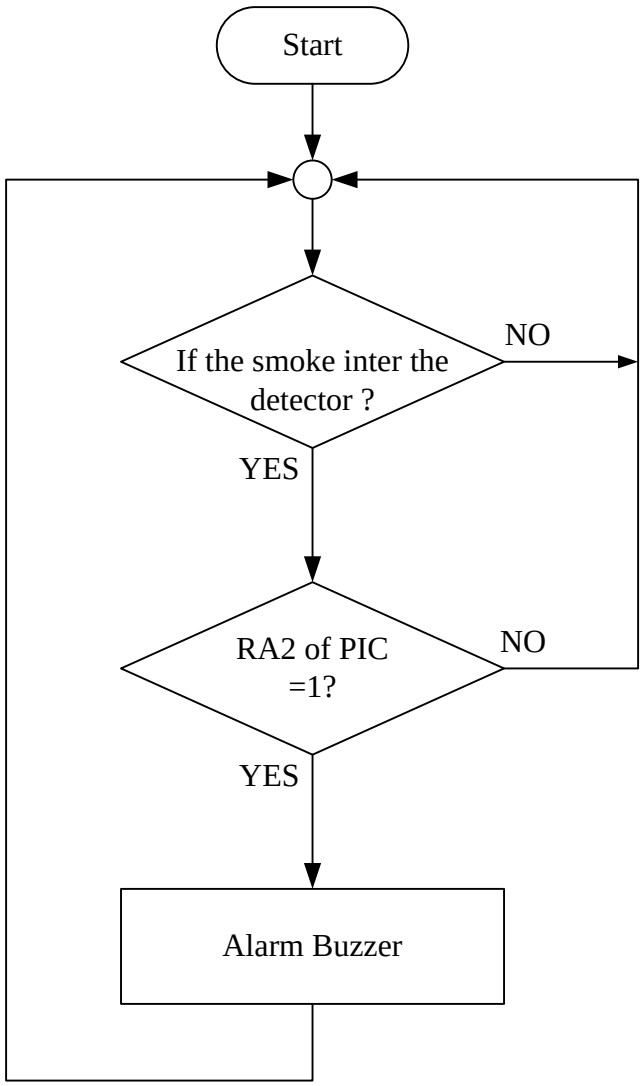


Fig (4.1) Flowchart for the operation of the whole system

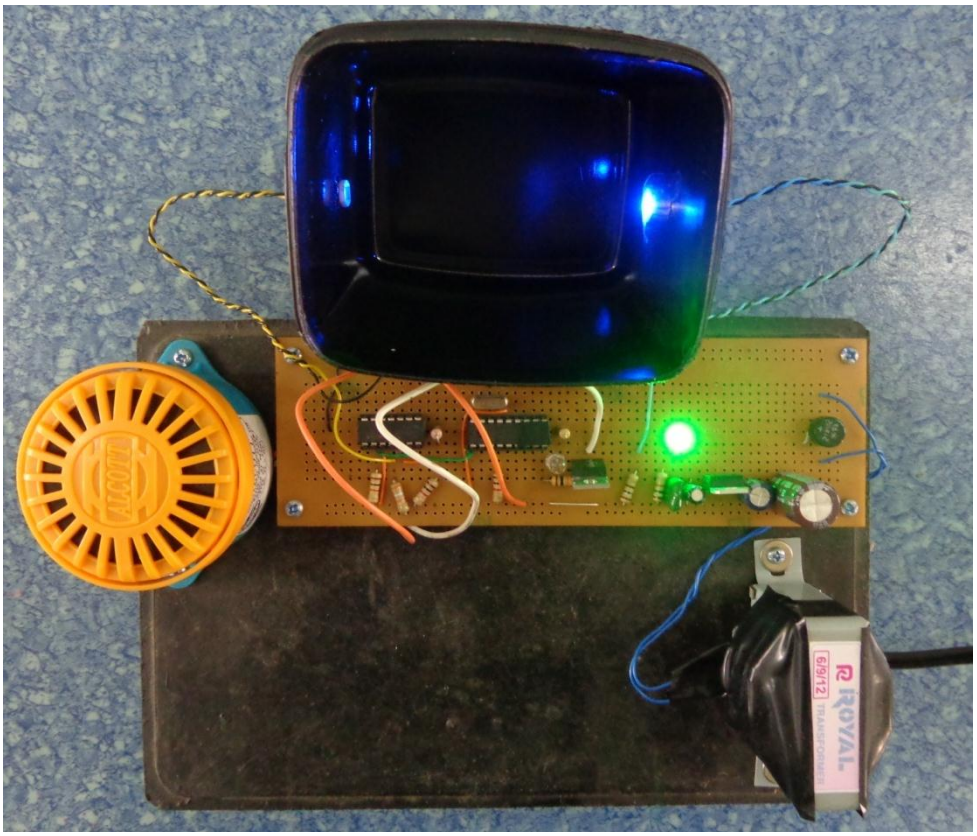


Fig (4.2) Photograph of Smoke Detector with alarm System

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude to Dr Kyi Shwin, Rector, Banmaw University for his encouragement to submit this project. Further I wish to thank to Dr Phone Myint Aung, Pro- rector, Banmaw University, for his valuable suggestion.

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REFERENCES

[1] Microchip Technology Inc., (2004), "PIC16F84A Data Sheet, 18-pin CMOS FLASH Microcontrollers", United State of America.

[2] RS Components, "Light dependent resistors Datasheet", (1997).

[3] Cytron Technologies, "Alarm System: Wireless Smoke Detector", Johor, Malaysia, (2008).

[4] Philips Semiconductors and Philips Electronics North America Corporation, "LM139/239/239A/339/339A/LM2901/MC 3302 Datasheet", United State of America (2007).

[5] Bates. M., (2006), "Interfacing PIC Microcontrollers Embedded Design by Interactive Simulation", United State of America.

INTRODUCTION

The insects are the dominant group of animals on the earth today. They far surpass all the other terrestrial animals in number, and they occur practically everywhere. Several hundred thousand different kinds have been described and some authorities believe that the total number of different kinds may approach 30 million (Borer, Triplehorn and Johnson, 1992).

An almost endless variety of structural and physiological pecularities and adaptations to different living condition is to be found among these animals. A great many insects are extremely beneficial to man and a few insects are harmful and cause enormous losses each year in agricultural crops, stored products and health of man and animals.

Insects are so important to the continued working of the global ecosystems that, as long as the well-being of insects is safeguarded, the Earth should remain habitable for humans (Berenbaum, 1995). This is not overstating the case. As herbivores, predators, parasites and as a food source for countless species, insects are fundamental in all terrestrial and aquatic food chains. Put simply, without insects, global ecosystems would disintegrate. Insects pollinate more than a quarter of a million species of flowering plant. Even from a purely anthropocentric view, without pollinators we would lose one third of all the food we eat. Insects recycle nutrients, enrich soils and dispose of carcasses and dung. Insects provide us with silk, honey, waxes, medicines and dyes. We use them to control pests (mostly other insects) and weeds. Insects have been revered as sacred, celebrated in art and literature and eaten as human food (McGavin, 2007).

The class insecta is divided into orders on the basis of the structure of wings and mouth parts, the metamorphosis and on various other characters. There are 28 insect orders. Out of 28 orders, six orders were collected from Banmaw University campus. The order Odonata comprises two well defined suborders Zygoptera (damselflies) and Anisoptera (dragonflies).

Damselflies are distinguished by the eyes that well separated, and the fore and hind-wings are of the same shape and breadths approximately. Dragonflies, have eyes that are usually confluent across the middle line or at the most very slightly separately and with fore and hind wings which are of variable shape, the hind usually considerably broader at the base than the fore. The thorax is relatively small compact, and the abdomen is long and slender. The immature stages are aquatic, and the adults are usually found near water. All stages are predaceous and feed on various insets and other organisms and, from man point of view, are generally very beneficial; the adults are harmless to man. The thorax is relatively small compact, and the abdomen is long and slender (Borror and Delong, 1964).In the present study, two families, Libellulidae and Calopterygidae were recorded.

The order Orthoptera contains a great many large and well known insects. These insects are slightly flat in shape, with rounded heads, long, thread-like antennae and the wings are folded flat over the body. Most of the Orthoptera are plant feeders, and some are very destructive to vegetation. Only the family Gryllidae confined to the order Orthoptera was studied in the present work.

One of the most distinctive features of the Hemiptera is the structure of the front wings. In most of the Hemiptera, the basal portion of the front wing is thickened and leathery, while the apical portion is membranous; this type of wing is called a hemelytron. The hind wings are entirely membranous and are highly shorter than the front wings. Hemiptera are sometimes called the" true" bugs to distinguish them from the occasional insects in other orders to which the term" bug" and is applied(Borror and Delong, 1964).Three families, Pyrrhocoridae, Alydidae and Pentatomidae were represented in this work.

The order Homoptera contains a large diverse group of insects closely related to the Hemiptera. All the Homoptera are plant feeders, and many species are serious pests of cultivated plants; some species transmit plant diseases. A few Homoptera are beneficial and serve as a source of shellae, dyes, or other materials (Borror and Delong, 1964). In this work, only the family Cicadidae was recorded.

The order Coleoptera is the largest order of insects and contains about 40 percent of the known species in the class insecta (Borror and Delong, 1964). These insects are commonly known as beetles. The beetles vary considerable in habits, and are to be found almost in everywhere, many are of great economic importance.

Beetles are extremely diverse not only in size and colour, but also in body shape, sculpture of external cover, presence of various outgrowths, etc. and can range from 0.4 to

about 80 millimetres in length(Bellamy, 2000). The Coleoptera is divided into three suborders, Archostemata, Adephaga and Polyphaga. In the present study, only the family Carabidae confined to the suborder Adephaga was recorded. Under the suborder Polyphaga, eight families; Buprestidae, Coccinellidae, Meloidae, Scarabaeidae, Lucanidae, Cerambycidae, Curculionidae and Chrysomelidae were represented.

The order Lepidoptera, butterflies and moths are common insects and well known to everyone. They are readily recognized by the scales on the wings. The Lepidoptera are of considerable economic importance. The larvae of most species are phytophagous, and a few feed in store grain or meal. On the other hand, the adults of many species are beautiful and are much sought after by collectors, and many serve as the basis of art and design. Natural silk is the product of a member of this order (Borror and Delong, 1964). In this work, four families: Papilionidae, Pieridae, Nymphalidae and Saturniidae were studied.

The environment of Banmaw University Campus is a favorable habitat for most insects because it is rich in vegetations and near the cultivated fields . So, the present study has been undertaken on the 34 species belonging to 20 families under the 6 orders of insects from Banmaw University Campus.

The objectives of the present work are -

- to identify and record the insects species that thrive in Bamaw University Campus .
- to provide the basic information about the insects for those who will be pursuing in the fields of entomology.

MATERIALS AND METHODS

Study Area

The study area was fixed in the Banmaw University Campus. (Fig. 1)

Study Period

The present study lasted from March to November, 2013.

Collection of Specimens

The specimen collections were made weekly during the study period. The specimens were collected while resting or feeding on plants and low vegetations. They were picked up by hand or by forceps. Some were collected from plants and trees while some were collected

during night under electric lamps. Some specimens were caught by using an ordinary insect net with a long handle. List of recorded species was given in Table 1.

Preservation of Specimens

The collected specimens were killed in the plastic boxes containing some cotton soaked with a few drops of chloroform. After they were killed, the specimens were pinned down and mounted in insect boxes. Under each specimen, there is a label bearing the name of species, locality and date of bearing the name of species, locality and date of capture were also attached for future reference. To avoid any fungal attack, the insect boxes were thoroughly applied with creosote and nepthalene balls were introduced for long time preservation.

Identification of Specimen

The species were identified under a binocular microscope and classified according to the fauna of British India including Ceylon and Burma (Arrow, 1910; 1917; 1931), (Fraser, 1933; 1934) , A Field Guide to Insects (Donald J. Borror and Richard E. White, 1970) and Insects spiders and other terrestrial arthropods (McGavin, 2000).

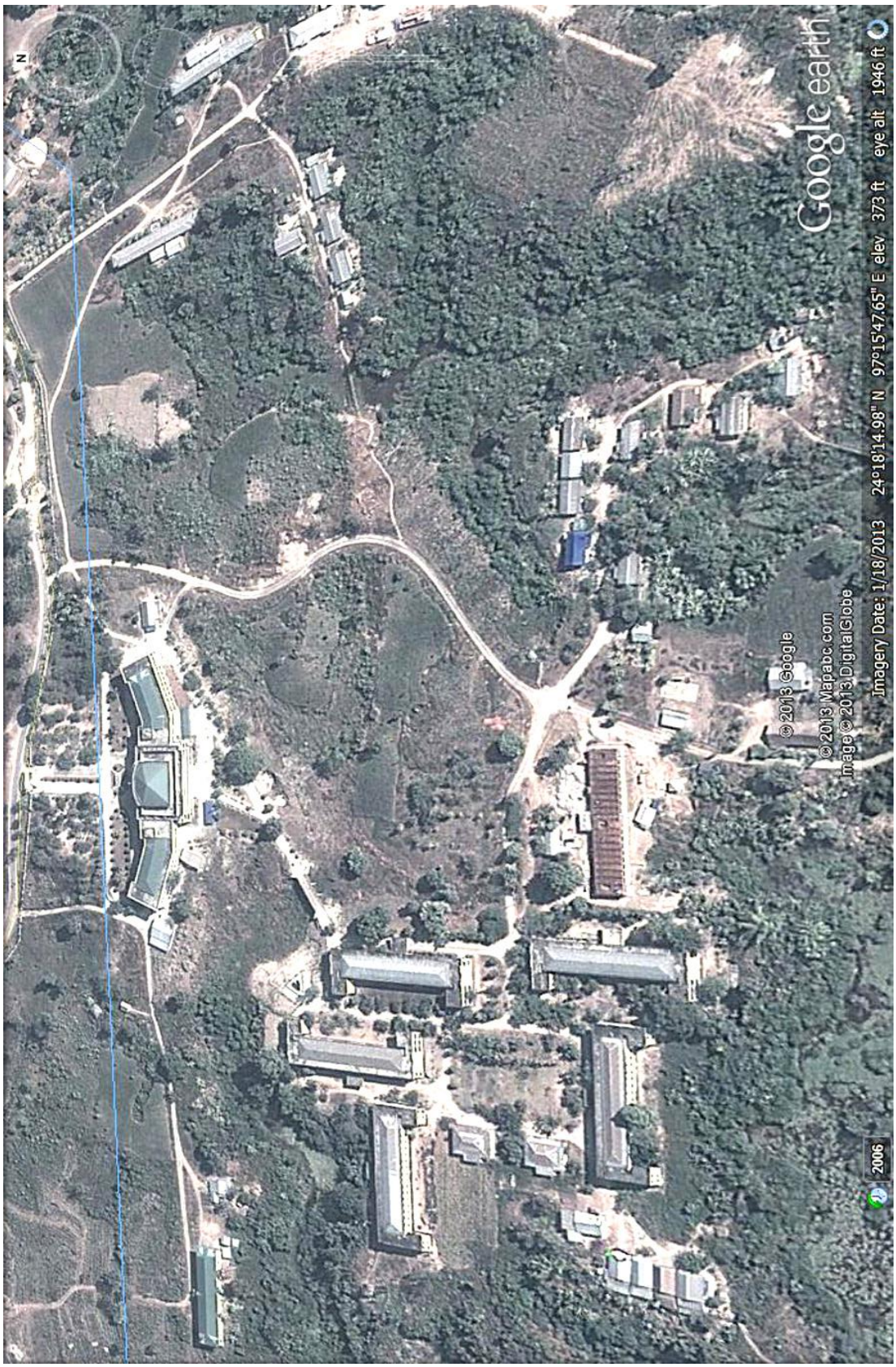


Figure 1. Study Area of Banmaw University Campus (Source from Google)

Table 1. List of insect species recorded from Banmaw University Campus

Phylum	**Class**	**Order**	**Family**	**Genus**	**Species**
Arthropoda	Insecta	Odonata	Libelluidae	*Brachythemis*	*B. contaminate* (Fabricius, 1793)
				Crocothemis	*C. servilia servilia* (Drury, 1773)
				Tholymis	*T. tillarga* (Fabricius, 1793)
				Orthetrum	*O. sabina* (Drury, 1770)
			Calopterygidae	*Veslalis*	*V. amoenas* (Selys, 1853)
		Orthoptera	Gryllidae	*Brachytrupes*	*B.potentosus* (Fabricius, 1775)
		Hemiptera	Pyrrhocoridae	*Dysdercus*	*D. singulatus* (Fabricius, 1775)
			Alydidae	*Alydus*	*A. calcaratus* (Linnaeus, 1758)
			Pentatomidae	*Nezara*	*N. viridula* (Linnaeus, 1758)
				Halymorph	*H. halys* (Stal, 1855)
		Homoptera	Cicadidae	*Cicadas*	*Cicadas sp*.(Linnaeus, 1767)
		Coleoptera	Carabidae	*Cicindela*	*C.sexguttata*(Fabricius, 1775)
				Scarites	*S. parvus* (Wiedemann,1823)
				Calosoma	*C. sycophanta* (Linnaeus, 1758)
			Buprestidae	*Chrysochlora*	*C. vittata* (Fabricius, 1774)
			Coccinellidae	*Coccinella*	*C. transversalis*(Fabricius, 1781)
			Meloidae	*Mylabris*	*M. pustulata* (Thunberg, 1821)
			Scarabaeidae	*Chrysina*	*C. gloriosa* (Le Conte, 1854)
				Heliocorpis	*H. bucephalus* (Fabricius, 1775)
				Catharsius	*C. molossus* (Linnaeus, 1758)
				Oryctes	*O.rhinoceros* (Linnaeus, 1758)
				Xylotrupes	*X. gideon*(Linnaeus,1767)
			Lucanidae	*Prosopocoilus*	*P.biplagiatus*. (Westwood, 1855)
			Cerambycidae	*Batocera*	*B.titana* (Thomson, 1859)
			Curculionidae	*Hypomeces*	*H. squamosus* (Fabricius, 1742)
			Chrysomelidae	*Cassida*	*C.circumdata* (Herbst, 1799)
				Aulacophara	*A.foveicollis* (Lucas)(Baly,1879)
		Lepidoptera	Papilionidae	*Papilo*	*P. memnon agenor* (Linnaeus, 1758)
				Papilo	*P. polytes* (Linnaeus, 1758)
				Chilasa	*C. clytia clytia* (Linnaeus, 1758)
			Pieridae	*Catopsilia*	*C. pomona pomona*(Fabricius, 1775)
			Nymphalidae	*Danaus*	*D. limniace leopardus* (Butter, 1866)
				Junonia	*J.hierta hierta* (Fabricius, 1798)
			Saturniidae	*Attacus*	*A. atlas* (Linnaeus, 1766)

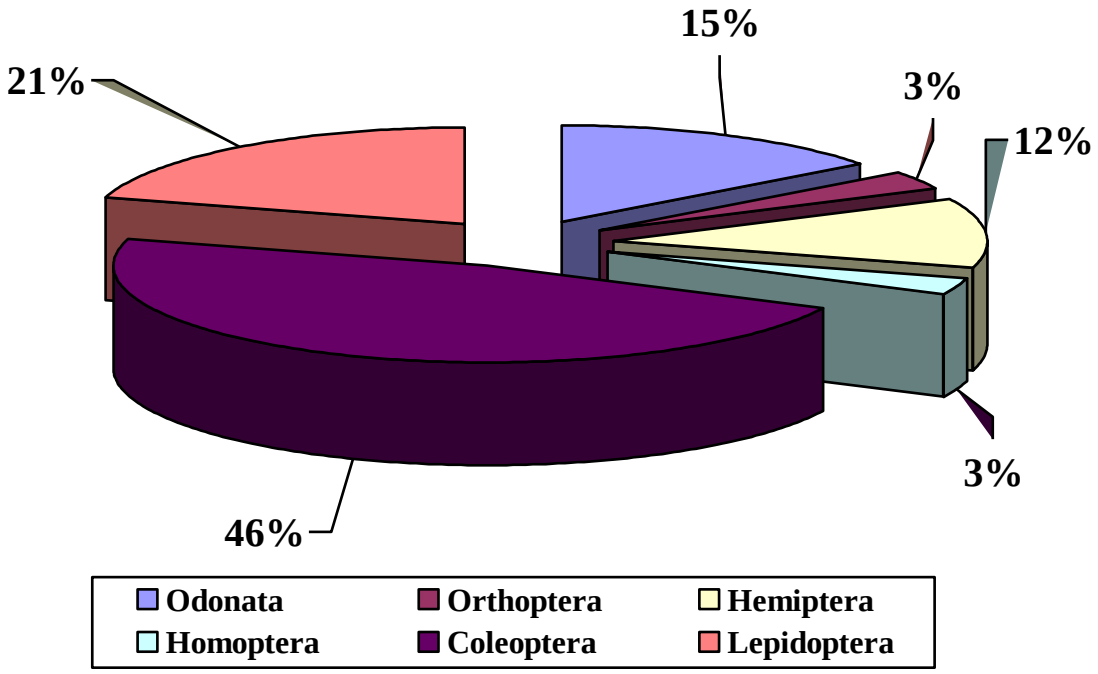


Figure 2. Occurrence of insect species percentages in different Orders from Banmaw University Campus

RESULTS

Systematic Position of Recorded Species

Phylum	-	Arthropoda
Class	-	Insecta
Subclass	-	Pterygota
Order	-	Odonata
Suborder	-	Anisoptera
Family	-	Libellulidae
Subfamily	-	Libellulinae
Genus	-	*Brachythemis*
Species	-	*B. contaminata* (Fabricius, 1793)
Genus	-	*Crocothemis*
Species	-	*C. servilia*
Subspecies	-	*C. servilia servilia* (Drury, 1773)
Genus	-	*Tholymis* Hagen,1842
Species	-	*T. tillarga* (Fabricius, 1798)

Genus - *Orthetrum*
Species - *O. sabina* (Drury, 1770)
Suborder - Zygoptera
Family - Calopterygidae
Genus - *Veslalis* Selys (1853)
Species - *V. amoena* (Selys,1853)
Order - Orthoptera
Suborder - Ensifera
Family - Gryllidae
Genus - *Brachytrupes*
Species - *B. potentosus* (Fabricius, 1775)
Order - Hemiptera
Suborder - Gymnocerata
Family - Pyrrhocoridae
Genus - *Dysdercus*
Species - *D. cingulatus.* (Fabricius, 1775)
Family - Alydidae
Genus - *Alydus*
Species - *A. calcaratus.* (Linnaeus, 1758)
Family - Pentatomidae
Genus - *Nezarza*
Species - *N.viridula* (Linnaeus, 1758)
Genus - *Halyomorph*
Species - *H. halys* (Stal, 1855)
Order - Homoptera
Suborder - Auchenorrhyncha
Family - Cicadidae
Species - *Cicadas* (Linnaeus, 1767)
Order - Coleoptera
Suborder - Adephaga
Family - Carabidae
Genus - *Cicindela*
Species - *C.sexguttata*(Fabricius, 1775)
Genus - *Scarites*

Species - *S. parvus* (Wiedemann, 1823)
Genus - *Calosoma*
Species - *C.sycophanta* (Linnaeus, 1758)
Suborder - Polyphaga
Family - Buprestidae
Genus - *Chrysochlora*
Species - *C. vittata* (Fabricius, 1774)
Family - Coccinellidae
Genus - *Coccinella*
Species - *C.transversalis* (Fabricius, 1781)
Family - Meloidae
Genus - *Mylabris*
Species - *M. pustulata* (Thunberg,1821)
Family - Scarabaeidae
Genus - *Chrysina*
Species - *C. gloriosa* (Le Conte, 1854)
Genus - *Heliocopris*
Species - *H. bucephalus* (Fabricius, 1775)
Genus - *Catharsius*
Species - *C. molossus* (Linnaeus, 1758)
Genus - *Oryctes*
Species - *O. rhinoceros* (Linnaeus, 1758)
Genus - *Xylotrupes*
Species - *X. gideon* (Linnaeus, 1767)
Family - Lucanidae
Genus - *Prosopocoilus*
Speices - *P.biplagiatus* (Westwood, 1855)
Family - Cerambycidae
Genus - *Batocera*
Species - *B. titana* (Thomson, 1859)
Family - Curculionidae
Genus - *Hypomeces*
Speices - *H. squamosus* (Fabricius, 1792)
Family - Chrysomelidae
Genus - *Cassida*
Species - *C. circumdata* (Herbst, 1799)

Genus	-	*Aulacophara*
Species	-	*A.foveicollis* (Lucas) (Baly, 1879)
Order	-	Lepidoptera
Family	-	Papilionidae
Genus	-	*Papilio*
Species	-	*Papilio memnon agenor* (Linnaeus, 1758)
Species	-	*Papilio polytes* (Linnaeus, 1758)
Genus	-	*Chilasa*
Species	-	*Chilasa clytia clytia* (Linnaeus, 1758)
Family	-	Pieridae
Genus	-	*Catopsilia* (Hubner, 1816)
Species	-	*Catopsilia pomona pomona* (Fabricius, 1775)
Family	-	Nymphalidae
Genus	-	*Danaus*
Species	-	*Danaus limniace leopardus* (Butter, 1866)
Genus	-	*Junonia*
Species	-	*Junonia hierta hierta* (Fabricius, 1798)
Family	-	Saturniidae
Genus	-	*Attacus*
Species	-	*Attacus atlas* (Linnaeus, 1766)

Description of recorded species

***Brachythemis contaminata* (Fabricius, 1793) (Plate I)**

Common name	-	Ditch Jewel, Orange Skimmer
Sex	-	Male
Head	-	Labium, labrum and face is olivaceous; occiput brown; eyes olivaceous brown above, bluish grey below
Thorax	-	Olivaceous brown to reddish brown above with two reddish brown lateral stripes
Legs	-	Dark brown in colour
Wings	-	Transparent with reddish venation, a broad bright orange patch extending from wing base to pterostigma in fore wing and hind wings, pterostigma red
Abdomen	-	Bright red
Anal appendages	-	Bright red, shortly conical

Measurement

Fore wing	-	23 mm
Hind wing	-	24 mm
Abdomen	-	20 mm

***Crocothemis servilia servilia* (Drury, 1773) (Plate I)**

Common name	-	Ruddy Marsh Skimmer, Greater Red Skimmer
Sex	-	Male
Head	-	Labium ferruginous, labrum and face blood red; occiput bright orange; eyes blood red above, purple on the sides
Thorax	-	Blood red to bright orange
Legs	-	Ochreous, rather short, robust, hind femora with numerous small spines and a larger one at distal end
Wings	-	Transparent, long and narrow, pointed at apices, base marked with rich amber-yellow, pterostigma dark brown
Abdomen	-	Blood red, segments 8 and 9 with dorsal carina blackish, depressed, moderately broad at base and tapered gradually to the end
Anal appendages	-	Blood red, superior anal appendages strongly curved, the apex tipped with black
Measurement		
Fore wing	-	30 mm
Hind wing	-	31 mm
Abdomen	-	25 mm

***Tholymis tillarga* (Fabricius, 1978) (Plate I)**

Common name	-	Coral-tailed cloud wing
Sex	-	Male
Head	-	Face is rusty brown with a crimson flush. Eyes brown capped with reddish olivaceous below.
Thorax	-	Reddish above golden yellow or olivaceous on side.
Legs	-	Rusty brown.
Wings	-	Transparent with a broad fan shaped golden brown patch on The hind wing. This is bordered by a milkey white patch. Wing spot reddish brown.

Abdomen	-	Broad at base tapered gradually from three to the end, bright rust-red, especially on dorsum paler at sides of basal segments, but olivaceous-brown in female.
Measurement		
Fore wing	-	33 mm
Hind wing	-	31 mm
Abdomen	-	33 mm

***Orthetrum sabina* (Drury, 1770) (Plate I)**

Common name	-	Green Marsh Hawk, Green Skimmer, Slender Skimmer
Sex	-	Male
Head	-	Labium, labrum and face yellow; occiput black; eyes green mottled with black
Thorax	-	Greenish yellow with black tiger like stripes
Legs	-	Black, inner side of anterior femora is yellow, moderately long
Wings	-	Transparent, inner edge of hind wing tinted with yellow, the hind wing moderately broader than forewing, pterostigma black with reddish brown
Abdomen	-	Slender, greenish yellow, marked with black, segment 1 to 3 finely black, segment 4 to 6 a broad dorsal black spot and distinctly swollen at base
Anal appendages	-	Creamy white in colour, a row of very small black spines below superior appendages
Measurement		
Fore wing	-	33 mm
Hind wing	-	34 mm
Abdomen	-	36 mm

***Vestalis amoena* (Selys, 1853) (Plate I)**

Common name	-	Clear-winged forest Glory
Sex	-	Male

Head	-	Broad and large, labium yellow, clouded with black, labrum black and rest of head dark metallic green. Eyes globular and large, blackish brown above and paler below.
Thorax	-	Iridescent emerald green above, yellowish beneath.
Legs	-	Dark brown to black, posterior femora paler or brown towards proximal end.
Wings	-	Wings of both sexes rounded at apex, wing spot; pale yellowish green tinge in forewings and hind wings.
Abdomen	-	Very long and cylindrical, coloured metallic green. Segments with a dorsal keel.
Measurement		
Fore wing	-	40 mm
Hind wing	-	33 mm
Abdomen	-	27 mm

***Brachytupes potentosus* (Randell, 1964) (Plate I)**

Common name	-	House cricket
Head	-	relatively large, approximately rectangular in shape, a pair of small of spherical compound eyes, a pair of long slender antennae which are longer than body.
Thorax	-	Three segments, The chitin is covering each of three thoracic segment dorsally and ventrally, is especially thickened to form a tergum and a sternum.
Legs	-	Two pairs of forward legs arising from the pro and meso thorax are shorter and approximately equal in size. The third pair of legs arising from the meta thorax is longer and larger in size. The tibea is provided with a series of tibia spurs.
Wings	-	The hind wings are thin and membranous . At rest these wings are folded like a fan and covered by the fore wings. The fore wing is dark, thick and opaque and is not used for flight at all.
Abdomen	-	Nine segments in males and only eight in the females, each bdominal segment is rather thin and flexible and consists of a dorsal tergum

and a ventral sternum plates. The eight sterna plates male are the narrowest while the seventh sterna plate in female is the largest. In both sexes a pair of many segmented anal cerci arise from the ventrolateral aspect of the hider abdominal region.A long ovipositor is present the terminal end of the broad flat abdomen.

Measurement - Length-7mm

***Dysdercus cingulatus*(Fabricius, 1775) (Plate II)**

Common name - Red cotton bug

Head - Red or reddish - orange with a white prothoracic collar, Their antennae are more than two thirds of the body length and the rostrum is folded beneath the body to reach to or beyond the second abdominal segment.

Wings - Reddish and each has a black spot or bar near the middle. On the broadest part of the forewings, The hemelytral membrane is dark and has numerous reticulating veins.

Measurement - length 13.5 mm, width 5.4 mm

***Alydus calcaratus* (Linnaeus, 1758) (Plate II)**

Common name - Broad-headed bug

Body - Slender, elongate to oval , fairly hard body

Colour - Yellowish brown or black.

Head - Nearly as wide and long as pronotum. Four- segmented antennae, characteristic curve in fourth antennal segment

Legs - Long, spines on hind femur.

Measurement - Length-18mm

***Nezara viridula*(Linnaeus, 1758) (Plate II)**

Local name - Jabo - sein

Common name - Green stink bug

Body - The adults are shield shaped with fully developed wings, oval.

Colour - Apple or jade green

Head - The eyes are black and antennae five jionted green three spots at base of head, three spots on posterior area of pronotum

Wings	-	Completely covered the abdomen., three basal and an apical spot to scutellum, and a discal spot on apical area of corium.
Abdomen	-	More or less distinctly spindle at base, with small black dots along sides.
Measurement	-	length 15 mm, width 8 mm

***Halyomorph halys* (Stal,1855) (Plate II)**

Common name	-	Brown Mamorated stink bug
Colour	-	Commonly green or brown, some are brightly coloured.
Body	-	Broadly oval and somewhat shield shaped scutellum large and Triangular but not longer than corium and not reaching apex of abdomen. Square pronotum with sharp point at each side. Side of abdomen banded black and white
Head	-	Front of head rounded. They have five-jointed antennae and long, piercing-sucking mouthparts.
Legs	-	Tibea with weak or no spines.
Measurement	-	Length-7mm

***Cicada* (Linnaeus,1767) (Plate II)**

Colour	-	Blackish usually greenish markings.
Head	-	Broad, having lateraled well developed reddish compound eyes, short and bristle like antennae. Piercing sucking mouth parts.
Wings	-	The fore wings are larger thanthe body, membranous. Lens-shaped, glistenining, prominently veined.The hind wings half is long. The wings at rest are usually held roof like over the body, with the inner margins overlapping slightly at the apex.
Abdomen	-	Elongated and to segments and tapering rapidly behind. The sound is produced by a pair of organs located on the ventral scale of the basal abdominal segment.
Measurement	-	Length- 50 mm

***Cicindela sexguttata* (Fabricius, 1775) (Plate II)**

Common name	-	Six-spotted Tiger beetle
Body	-	Long ,slightly flat.

Colour	-	Black, brownish or green often patterned and some iridescent and very coloured, with more or less distinct metallic reflections in parts, the base of the antennae, the ccutellum, the base and suture of the elytra being usually bright coppery or greenish .
Head	-	Head at eyes as wide as or wider than pronotum. Antennae inserted above base and mandibles.
Elytra	-	The small six white spots on the elytra.
Legs	-	Long, slender, metallic, femora mostly coppery; underside golden and coppery, with the sides throughout furnished with thick and long white pubescence.
Measurements	-	Length - 11 mm

***Scarites parvus* (Wiedemann, 1823) (Plate III)**

Common name	-	Ground beetle
Body	-	Long ,slightly flat.
Colour	-	Black and shiny or dark, sometimes brightly coloured, often with metallic sheen.
Head	-	Head at eyes nearly narrow than pronotum. Antennae inserted between eyes and base of mandibles, threadlike. Huge-slicing sickle-shaped are present.
Elytra	-	Usually have obivious striations, moderately convex, slightly dilated and a little pointed at apex.
Legs	-	Protibiae with two denticulation above upper tooth, mesotibiae with a single fine sharp spur.
Measurements	-	Length - 50 mm Breadth - 13 mm

***Calosoma sycophanta* (Linnaeus, 1758) (Plate III)**

Common name	-	Ground beetle, Forest caterpillar hunter
Body	-	Long , flat, large.
Colour	-	Black and shiny or bright green, sometimes brightly coloured, often with metallic sheen.

Head	-	Head at eyes nearly narrow than pronotum. Antennae inserted between eyes and base of mandibles, threadlike.
Abdomen	-	Six or fewer segments.
Elytra	-	Usually have obivious striations.
Legs	-	Protibiae with two denticulation above Long and slender, tarsi 5-5-5,
Measurements	-	Length - 28 mm Breadth - 9 mm

***Chrysochlora vittata* (Fabricius, 1774) (Plate III)**

Common name	-	Metallic wood boring beetle
Body	-	Elongated, depressed, very smooth.
Colour	-	Shining with green reflexions or brilliant green.
Head	-	Deeply and widely excavate; eyes prominent, shining black; antennal serrated and eleven segmented.
Thorax	-	Prothorax not very convex; coarsely punctured with firey red, nearly triangular in shape; a strong lobe in the middle of posterior margin.
Elytra	-	Truncate at shoulder, apex constricted, truncate bidentate; four costae on each elytron approaching each other towards apex.
Legs	-	Broad, stout with metallic green; tarsi segments flatten, five segment.
Abdomen	-	Five segmented, shining medianly with dense yellow pubescence at side.
Measurement	-	Length - 47 mm Breadth - 16 mm

***Coccinella transversalis* (Fabricius, 1781) (Plate III)**

Common name	-	Ladybird beetle
Body	-	Small, broadly oval, convex, nearly flat ventrally.
Colour	-	Brightly coloureed, yellow, orange, or reddish, often with blacking marking.
Head	-	Partly or completely concealed by pronotum. Antennae short, clubbed, 3 to 6 segmented.
Elytra	-	Yellowish or reddish, often with black spots on each elytron.

Legs	-	Tarsi 3-3-3, 3rd segment minute, short, with three tarsal segments with claws.
Measurements	-	Length - o.8 mm Breadth - 1 mm

***Mylabris pustulata* (Thunberg,1821) (Plate III)**

Common name	-	Blister beetle
Body	-	Soft, often leathery, elongate, slender onvex, a few are oval or round.
Colour	-	Black or brown with red or yellow marks, sometimes usually brightly coloured. Some are metallic.
Head	-	Broad, usually wider than pronotum, eyes small; antennae threadlike or beadlike, intermediate segments sometimes modified.
Thorax	-	Pronotum narrow than fore wing.
Elytra	-	Vary in length, covering abdomen, rarely shortened.
Legs	-	Long, slender, tarsi 5,5,4.
Measurement	-	Length - 26mm Breadth - 10 mm

***Chrysina gloriosa* (Le Conte,1854) (Plate III)**

Common name	-	Shining leaf chafers
Body	-	Convex, moderately elongate and cylindrical.
Colour	-	Dark metallic green coppery above and beneath, or pitchy beneath.
Head	-	Clypeus densely granulated, with the margin rounded and strongly reflexed, the forehead finely and closely punctured Antennae red.
Thorax	-	Pronotum finely and coarsely punctured, very closely at the sides, the lateral margins rounded without a medium groove.
Elytra	-	Rather less finely but rather closely, and with the linear arrangement almost obliterated, the intervals being extremely minutely punctured.

Legs	-	The front tibia armed with three teeth; the larger claw of front and middle leg with cleft.
Abdomen	-	The entire sternum clothed with rather short grey pubescences, the abdominal segments with bands of short golden hairs at the sides; pygidium rather closely punctured, exposed.
Measurement	-	Length - 25 mm Breadth - 14 mm

***Heliocopris bucephalus* (Fabricius, 1775) (Plate IV)**

Common name	-	Dung beetle
Body	-	Broad, somewhat quadrate in shape and not very convex.
Colour	-	Black, not very luster, lower surface usually deep red.
Head	-	Rather small but the clypeus broad, concave and vertex transversely strigose; eyes small; antennae lamellate and nine segmented.
Thorax	-	Pronotum granulate, very unevenly rugose or reticulate, with a slight depressed area in the middle of the basal part; scutellum invisible.
Elytra	-	Very lightly striate with the intervals sparsely punctured and flat.
Legs	-	Clothed with erect and red hairs, the front tibia armed with three strong teeth and the hind tibia serrated, tarsi five segmented.
Abdomen	-	Six-segmented, very short, convex and shining; pygidium unevenly rather shallowly and punctured.
Measurement	-	Length - 50 mm Breadth - 30

***Catharsius molossus* (Linnaeus, 1758) (Plate IV)**

Common name	-	Horned beetle
Body	-	Broadly oval, very convex.
Colour	-	Black and opaque, partially clothed with reddish hair beneath.
Head	-	Broad with front margin almost imperceptibly excised in the middle, clypeus closely transversely rugulose; ocular lobes densely

granular; a conical median horn broad and a little flattened behind at the base, sharp pointed at the tip in male, a very short pointed horn in female; eye small; antennae lamellate, nine segmented.

Thorax - The pronotum with densely fine round granules in male, prothorax with a steep declivity in front, a sharp ridge feebly convex in the middle, with its extremities curving forward; in female, a nearly straight ridge at the upper edge of prothorax, the sides rounded, the front angles broadly truncate.

Elytra - Very convex, finely and lightly striate, elytral sutures distinct carina at the sides, the hind angles nearly rounded.

Legs - Short and stout, front tibiae with three external teeth.

Abdomen - Six segmented, convex, very short; scutellum absent; the pygidium finely punctured in the middle.

Measurement - Length - 54 mm
Breadth - 28 mm

***Oryctes rhinoceros* (Linnaeus, 1758) (Plate IV)**

Common name - Rhinoceros beetle

Body - Stout, massive, cylindrical in shape and moderately convex.

Colour - Brownish black or chestnut red.

Head - Small, armed with horn in both sexes, apical part with tuft brownish hair; the cephalic horn compressed and tapering to a blunt point; eyes large and yellowish; antennae nine segmented and lamellate.

Thorax - Slightly broader, the apical margin of pronotum crown shaped at the central area and concave in the middle area with unevenly wrinkled, crown shaped area and apical angles wrinkled but the rest smooth; scutellum triangular.

Elytra - Roundly rectangular, strongly smooth, closely fine punctured, with a juxta-suture line; the striae indistinct.

Legs - Short and stout with reddish hairs; the front tibia with three external teeth, the middle and hind tibiae digitated at the end; tarsi long, slender, five segmented; claws equal.

Abdomen - Six segmented, short and punctured; pygidium very short.

Measurement	-	Length - 43 mm
		Breadth - 25 mm

***Xylotrupes gideon* (Linnaeus, 1767) (Plate IV)**

Common name	-	Elephant beetle
Body	-	Ovate, elongated and moderately convex, larger in male than female in size.
Colour	-	Chestnut red or red brown with the head, the pronotum and legs generally darker.
Head	-	Armed with the cephalic horn in male which projecting forward and upward, ending in two diverging points curving backwards. In female very rugose, smaller and no horn; eye small; antennal dark brown, lamellate, ten segments, the last three segments club-shaped.
Thorax	-	Pronotum conical, gently curved, the thoracic horn bifid at the extremity and reach cephalic horn in male. In female prothorax strongly, coarsely, punctured and no horn.
Elytra	-	Convex, broad, not very smooth, punctured, strong.
Legs	-	Short, stout; tibiae blackish-brown the front tibiae with three external acute teeth; tarsi black, five tarsal segments; claws equal.
Abdomen	-	Six segmented, pygidium with tuft reddish pubescences.
Measurement	-	Length - 48 mm
		Breadth - 28 mm

***Prosopocoilus biplagiatus* (Westwood, 1855) (Plate IV)**

Common name	-	Stag beetle
Body	-	Elongate-robust, large shiny body.
Colour	-	Black or reddish brown.
Head	-	Eyes at sides of head. Antennae elbowed, club 3or4 segmented, segments of club not capable of being held together in a tight ball. Mandibles of male very, sometime branched.
Thorax	-	Pronotum without a medium groove.
Elytra	-	Usually smooth.
Legs	-	Long, slender, tarsi 5,5,4.
Measurement	-	Length - 29 mm
		Breadth - 10 mm

***Batocera titana* (Thomson, 1859) (Plate IV)**

Common name	-	Mango-tree longicorn borer
Body	-	Cylindrical, stout, not very convex.
Colour	-	Brown with pale yellowish pubescence, two kidney shaped orange spots on prothorax; blackish points with orange spots at basal elytra.
Head	-	Slightly short behind the eyes, with a distinct medium line between the antennae; eye large; antennae serrate, eleven segmented; longer than body, first antennal segment brownish black, stout, with acute apical edge.
Thorax	-	Prothorax with a median acute spine on each side; a broad collar on each either anterior edge or posterior edge; scutellum large, heart shaped yellow.
Elytra	-	Broad, constricting apically, anterior parts with coarsely prominences; the shoulders with short spine; apices truncate and feebly spined at sutural border.
Legs	-	Long, stout, the tarsi four segmented with the third segment bilobed, the last segment with two spurs.
Abdomen	-	Five segmented; pygidium truncate and hollow.
Measurement	-	Length - 48 mm Breadth - 18 mm

***Hypomeces squamosus* (Fabricius, 1792) (Plate V)**

Common name	-	Gold-dust-Weevil, Snout beetle
Body	-	Fusiform, long and slender.
Colour	-	Black with uniform dense glittering metallic green or blue green scaling or else with the green scaling replaced by pale grey, pearly brownish or dull coppery scaling.
Head	-	Plane on each side of the control furrow, rostrum gradually rarred from base to apex.
Thorax	-	Prothorax broadest at the base, much narrower at the apex.
Elytra	-	Sinuate in the middle of the base, broadest at the shoulders and gradually narring behind.
Legs	-	the femora clavate, the tibiae almost straight
Measurement	-	length 13 mm, width 5.5 mm

***Cassida circumdata* (Herbst, 1799) (Plate V)**

Common name	-	Tortoise beetle
Body	-	Ovate, yellow-brown, sometimes with a greenish tinge; along the middle of each elytron a broad black stripe meeting its fellow posteriorly at the suture, forming a U-shaped markings, suture black to the middle.
Head	-	The clypeus flat, smooth and impunctate, the antennae not very long, passing beyond the lateral angles of the prothorax.
Thorax	-	Pronotum almost as long as broad, narrower than the elytra at the base, with the lateral angles narrowly rounded, the basal margin oblique, scutellum triangular, smooth and impunctate.
Elytra	-	convex, punctate - striate; the triangular area just behind the scutellum slightly compressed, apex with the highest point on the surface, on each elytron with ten rows of round distant punctures.
Legs	-	Claws apendiculate.
Abdomen	-	The underside shining, pygidium not exposed.
Body length	-	4 mm
Body width	-	5 mm

Aulacophora foveicollis **(Lucas) (Baly, 1879) (Plate V)**

Common name	-	Cucumber beetle
Body	-	Elongate - ovate, the fresh examples with colour orange red or dark orange colour, the dorsal and ventral aspects moderately shining.
Hea	-	Clypeus and labrum very thinly covered with fine hairs; antennae extending somewhat beyond the middle of elytron, third segment equal to fourth.
Thorax	-	Prothorax slightly broader than long; the anterior region is more convex than the posterior. Scutellun is two, small, not conspicuous.
Elytra	-	Uniformly covered with fine puncture; brownish coloured, the anterior margin is slightly broader than behind and smooth.
Legs	-	Slender; tibia often with a small apical spine; claw-segment of tarsus long, claws bifid.
Abdomen	-	Slightly swollen, darkish-brown coloured, along the middle is more convex than the lateral margin.

Body length - 6 mm
Body width - 4 mm

***Papilio memnon agenor* (Linnaeus, 1758) (Plate V)**

Common name - The Great Mormon
Wingspan - 180 mm
Antennae deep black, head, thorax, abdomen and palpi are black and beneath yellow with black.
Upperside - Tail butterfly. Forewing basal part of the cell red and the basal area below the black. Hind wing basl part of the cell black and cell apex is white. White stripes radiating from the periphery of the cell are short and are limited to the discal areas 1 to 7. A series of marginal red spots.
Underside - Forewing similar to the upperside, but paler than the upperside. Hind wing similar to the upperside character.

***Papilio polytes* (Linnaeus, 1758) (Plate V)**

Common name - The Common Mormon
Wingspan - 87 mm
Antennae deep black, head and abdomen dark reddish, thorax black, palpi pale reddish, abdomen red colour with black segment stripes.
Upperside - Dark tail butterfly. Forewing with a series of rather large pale yellow oval. The series of a few white spots from space 2 to 7. Hind wing a few white small spots on the central band. A total red spot at the apex of a black ocellus.
Underside - Forewing similar to the upperside, but the vein is clearly stripes. paler than the upperside. Hind wing series of red submarginal lunules, often incomplete and another series of white marginal spots.

***Chilisa clytia clytia* (Moore) (Plate V)**

Common name - The Common Mine

Wingspan - 98 mm

Antennae dark brown,head black with spot, head, thorax black, abdomen anterior black posterior black with white spot, palpi and thorax beneath black with white spot.

Upperside - Tail butterfly. Forewing similar to the male; Hind wing but more deep dark brown.

Underside - Forewing similar to the male; Hind wing but more prominent characteristics on the underside.

Catopsila pomona pomona **(Fabrius, 1775) (Plate VI)**

Common name - The Lemon Emigrant

Wingspan - 53 mm

Antennae red, thorax black, abdomen creamy white.

Upperside - Forewing the base is greenish-white, costal margin, apex and half of the termen with narrowly black. Hind wing: similar to the forewing, but costal and apex not black.

Underside - Forewing similar to the upperside, except coastal margin. Hind wing similar to the underside.

Danaus limniace leopardus **(Butter, 1866) (Plate VI)**

Common name - The Bule Tiger

Wingspan - 84 mm

Antennae thorax, black, head brown with white, palpi black with white band. thorax and abdomen beneath brown with white spot.

Upperside - Forewing black with bluish-white semi-hyaline spots and streaks. The interspace 1 with two streaks; cells is a streak from the base and on outwardly intented spots at its apex; subterminal and terminal series of spots; the latter smaller. Hind wing interspace 1s, 1b, and 2 with streaks from base, cell with a forked broad streak and scattered unequal subterminal and terminal spots.

Underside - Forewings similar to the upperside, but more paler than the upperside.

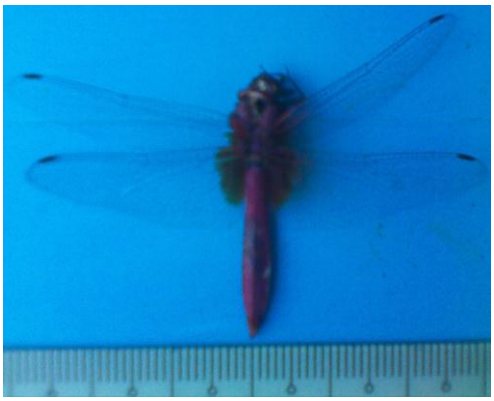
***Junonia hierta hierta* (Fabricius, 1798) (Plate VI)**

Common name	-	The Yellow Pansy
Wingspan	-	54 mm
		Antennae anterior black and posterior yellow, head brownish yellow, palpi white, thorax and abdomen black and beneath pale yellow.
Upperside	-	Tail butterfly. Forewing a large irregular shaped yellow patch bordered with black which is broken by a small white subapical spots. Incomolet series of submarginal spots from the apex to space 4. Hind wing a large yellow patchs space 1 a to 3, costal and outer margin black with subdiscal on blue central spot.
Underside	-	Forewing brownish yellow black ocelli present in space 3 and 6, small black 5 bars transverse in the cell. The distinct black transverse line present in the apex of the cell. Hind wing brownish yellow, no distant ocelli.

***Attacus atlas* (Linnaeus, 1766) (Plate VI.)**

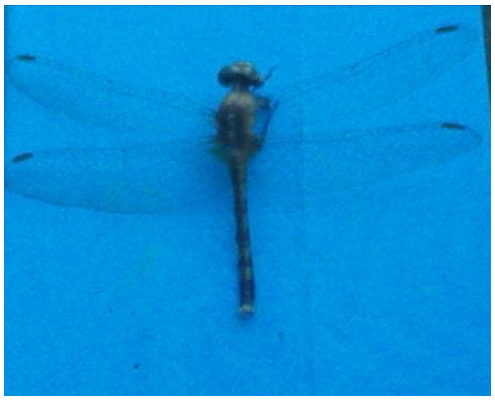
Common name	-	Atalas moth or Royal moth
Wingspan	-	254 mm
		Antennae fearthy, less feathery in female. Body medium sized to large, yellowish and brown
Upperside	-	Curved wing-tips on fore wing, black wavy line on wing margins, large triangular translucent patches on fore-and hind wings, red line continues from forewing to hind wings. Hind wing similar to fore wing; the intermedial line nearly straight; no streak above the hyaline triangular mark; a series of black spots within the black submarginal line which is less wavy.
Underside	-	Thorax and abdomen red- brown; the basal segment and abdomen pale and each segment with a pale fringe; legs brown.

Brachythemis contaminida



Crocothemis servilia

Tholymus tillarga

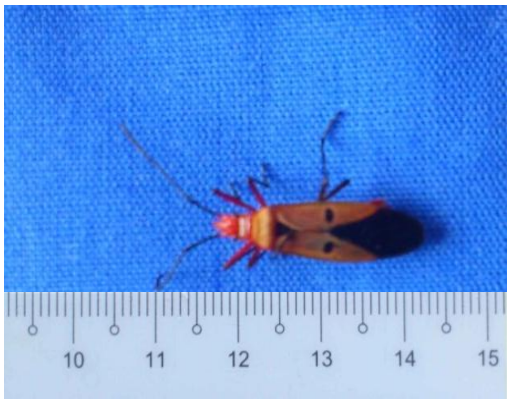


Orthetrum sabina

Veslalis amoena

Brachytrupes potentosus

Plate I. Recorded species of insects



Dysdercus cingulatus

Alydus calcartus

Nezarza viridula

Halyomorpha halys

Cicadas

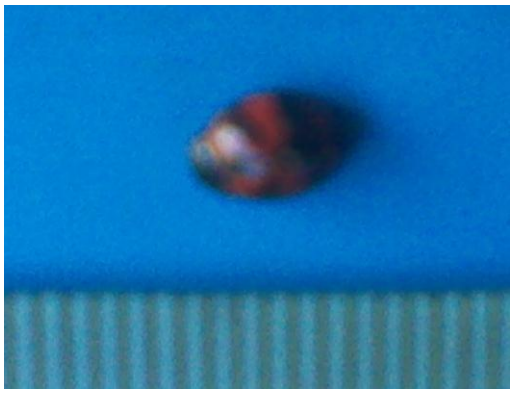
Cicindela sexguttata

Plate II. Recorded species of insects

Scarites parvus

Calosoma sycophanta

Chrysochlora vittata



Coccinella transversalis

Mylabirs pustulata

Chrysina gloriosa

Plate III. Recorded species of insects

Heliocopris bucephalus

Catharsius molosus

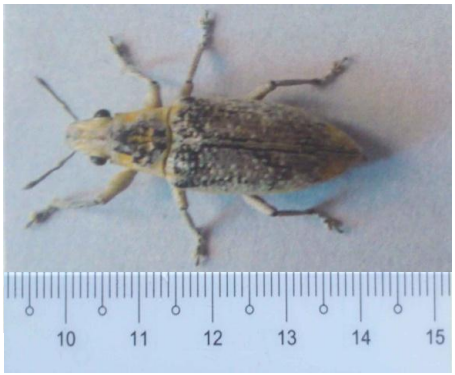
Oryctes rhinoceros

Xylotrupes gideon

Prosopocoilus biplagiatus

Batocera titana

Plate IV. Recorded species of insects



Hypomeces squamosus

Cassida circumdata

Aulacophara foveicollis

Papilio memnon agenor

Papilio polytes

Chilasa clytia clytia

Plate V. Recorded species of insects

Catopsilia pomona pomona

Danaus limniace leopardus

Junonia hierta hierta

Attatcus atlas

Plate VI. Recorded species of insects

DISCUSSION

Altogether 34 species of insects, confined to 33 genera and distributed among 20 families and 6 orders were collected and identified during the present work which was commenced from March, 2013 to November 2013(Table 1).

The order Odonata is represented by 5 species of insects confined to 5 genera, a single subfamily and 2 families. In the present work, *Brachythemis contaminata, Crocothemis servilia, Tholymis tillarga and Orthetrum sabina* confined to the family Libellulidae and *Veslalis amoena* belonging to the family Calopterygidae which are predaceous were collected. Adult dragonflies are of great ecological values. They feed on noxious flies, mosquitoes, small beetles, butterflies and moths which are regarded as agricultural pests (Fraser,1933). Thus, the odonates may be assumed as beneficial insects since nymphs and the adult prey on mosquito some of which are vectors of certain human diseases.

The Grylloidea or crickets have a worldwide distribution and are particularly plentiful in the tropics. No less than 355 species are known to occur in India, Sri Lanka and Myanmar, out of which 51 species are from Myanmar alone (Chopard, 1969 cited by Tin Maung Oo 1976). In the present study, a single species, *Brachytrupes potentosus* confined to family Gryllidae under the order Orthoptera was collected. McGavin, (2000) recorded that the *Brachytrupes* species included some damaging pests, which can attack the seedling of valuable crops such as tea, tobacco and cotton. Therefore, it may be assumed that the species of family Gryllidae are agricultural pests.

Four species of insest, *Alydus calcaratus*, (family Alydidae), *Nezara viridula, Halyomorph halys* (family Pentatomidae) and *Dysdercus cingulatus* (family Pyrrhocoridae) belonging to the order Hemiptera were recorded during the present

study. *A.calcaratus*, broad-headed bugs are plant feeders and are usually found on vegetation. The species of pentatomids are commonly known as stink bugs. For instance, *N. virdula* and *H.halys* feed on the juice of the leaves and pod from crops. Both nymphs and adult bugs suck plant juice throughout their life. The former is serious pests (Ghosh, 1940). *N. virdula* has a worldwide distribution occurring throughout the tropical and subtropical regions of the world.

The only species Cicadas confined to the family Cicadidae under theHomoptera was recorded in the present work. Johnson *et al*, (2008) described that male cicadas make a piercing, high-pitched sound. The most significant damage is from females who puncture limbs and twigs of ornamentals when laying eggs. Twigs and small branches will wilt, and may die and break off. Nymphs cause minor damage by feeding on roots and removing nutrients, but

adults do not feed at all. Thus, it may be regarded that the members of the order Homoptera are serious pests of cultivated plants, causing damage by feeding.

The largest number of species collected and identified during the study period is confined to the order Coleoptera, represented by 16 species distributed among 16 genera and 10 families. The three species, *Cicindela sexguttata, Scarites parvus* and *Calosoma sycophanta* confined to the family Carabidae and only one species *Chrysocholora vittata* belonging to the family Buprestidae were presented in the present study. According to Borror and White,(1970) adults and larvae of family Carabidae nearly always predaceous and many are very beneficial; they feed on our worst pests, including Gypsy Moth larvae cankerworms and cutworms while many species of family Buprestidae are stem miners and some produce galls on certain plants. Therefore, it may be regarded that Carabids are beneficial insects but Buperstids are serious pests. Adults feed on foliage and bark or are attracted to flowers.

Under the family Coccinellidae, a single species, *Coccinella transversalis* namely ladybird beetle was collected during the present work. Ladybird beetles are predaceous, as both larvae and adults feed chiefly on aphids. So, we may consider that the species of the family Coccinellidae are useful in agriculture. *Mylabris pustulata* commonly called blister beetle confined to family Meloidae was recorded in the present work. Borror and White,(1970) recorded that adult blister beetles are plant feeders, and some are serious pests of potatoes, tomatoes, beets, clover, and other plants. They may completely defoliate a plant. Larvae are parasitic and generally beneficial; they usually feed on grasshopper eggs.

In the family Scarabaeidae, five species of *Chrysina gloriosa*, *Heliocopris bucephalus, Catharsius molossus*, *Oryctes rhinoceros* and *Xylotrupes gideon* were collected in the study area. The Scarab beetles are heavy-bodied, oval or elongate, usually convex. The scarabs vary considerably in habits. Many are dung feeders or feed on decomposing plant materials, carrion. Many feed on plant materials such as grasses, foliage, fruits and flowers. Some of these are serious pest of various agriculture crops.

The presence of horns is diagnostic character of male and female. Dung beetles are of worldwide in distribution, particularly found in warm regions. They are common in pasture lands (Arrow, 1910 & 1917). Rhinoceros beetle, *Oryctes rhinoceros* and *Xylotrupes gideon* were hosted in coconut palms (Hill, 1983).Under the family Lucanidae, only a single speices *Prosopocoilus biplagiatus* was presented in the present work.

Under the family Cerambycidae, Long-horned beetle, *Batocera titana*, was recorded in study area. Most of the long horns are elongate and cylindrical. The beetles of family

Cerambycidae, having long antennae are also called longicorn beetles based on this feature. They are all phytophagus. *Batocera titana*, Mango-tree longicorn borer is a serious pest and heavily attacked trees. Most adult cerambycids are usually not brightly coloured, nocturnal in habit and during the day may be found under bark or resting on trees or logs (Borror and White, 1970).

During the study period, only a single species *Hypomeces squamosus*, the leaf-damaing weevils under the family Curculionidae was collected. *H.squamosus* feed on the leaves, making the leaf marging damage. They are minor pest and feed on developing foliage (Ghosh, 1940).

In the present study, 2 species of Chrysomelid leaf beetles belonging to 2 genera, 2 subfamilies under family Chrysomelidae were recorded. Under the subfamilies Cassidinae, *Cassida indicola*, tortoise beetles, was recorded. The species was annually occurred in Kanzun, Hnin-nu-new and pumpkin plants. The species was also seen attacking its host plants throughout the study period. Gallerucinae are commonly known as cucumber beetles which without exception live on green plants. These beetles are soft bodied, mostly with shining colours. As the names implies, they feed on cucumbers, and related plants and doing serious damage to cucurbits. They are as pest of the cultivated plants (Maulik, 1919). The species of the subfamily Gallerucinae, *Aulacophora foveicollis* were abundantly observed in cucumber and bu plants during the study period. These species have been reported by Azim (1966) as the most destructive insect pest of cucurbitaceous vegetables. Thus, these species were assumed that as pest of these plants. It is evident that the polyphagous species of coleopteran are capable of damaging practically vary parts of the economic important crops, plants, trees and stored product which are used as host plant and habitat.

The order Lepidoptera has 7 represented species, confined to 6 genera and 4 families. *Papilio memnon agenor, Papilio polytes* and *Chilisa clytia clytia* belonging to family Papilionidae, only one species *Catopsilia pomona pomona* under the family Pieridae, *Danaus limniace leopardus* and *Junonia hierta hierta* confined to family Nymphalidae were collected during the study period. Only a single species, *Attacus atlas* called atlas moth belonging to family Saturniidae was recorded in the present study.

Percentage of the recorded insect species in different orders as shown in Fig 2 reveals that 15 % in Odonata, 3 % in Orthoptera , 12 % Hemiptera, 3 % in Homoptera,4 6 % in Coleoptera , and 21 % in Lepidoptera respectively.

The overall results of this study clearly indicated that the order Coleoptera is with the largest number (16) species representatives of the total number of species recorded. Moreover,

in terms of the number of genera, family is also ranked the top. Thus the results revealed that the Coleroptera insects are predominant in the study area. The abundance of insect fauna in Banmaw University Campus suggests that there is a great need for the identification of the insect species which are of economic importance. It is hoped that the result of this observations could provide the basic information for ' 'ho are pursuing in entomology.

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REFERENCES

Arrow, G. J. (1910). *The Fauna of British India including Ceylon and Burma.* Taylor and Francis, Red Lion Court, Fleet Street, London. pp281-292

Arrow, G. J. (1917). *The Fauna of British India including Ceylon and Burma.* Taylor and Francis, Red Lion Court, Fleet Street, London. 387pp

Arrow, G. J. (1931). *The Fauna of British India including Ceylon and Burma.* Taylor and Francis, Red Lion Court, Fleet Street, London. 428pp

Azim, M. I. I (1966) Studies on the biology of red pumpkin beetle, *Anlacophora foveicollis* (lucas) (Chrysomelidae: Coleoptera) in East Pakistan. M.Sc Thesis. Department of Entomology. Bangladesh agricultural University, Mymensingh. pp. 1-95.

Bellamy, C. (2000). http://en.wikipedia.org/wiki/Beetle.

Berenbaum, M.R. (1995) *Bugs in the system: insects and their impact on humanaffairs*. Addison Wesley.

Borror, D. J. & Delong, D.M., (1964). *An Introduction to the study of Insects.* Holt,Richard and Winston, N. Y. 819pp

Borror, D. J. & White, R.E., (1970). *A Field Guide to Insects.* Printed in the United States of America. 404pp

Fraser, F. C., (1933)*The Fauna of British India including Ceylon and Burma,Odonata.* Vol. II. Taylor and Francis, Red Lion Court, Fleet Street, London.448pp

Fraser, F.C.,(1934). *The Fauna of British India including Ceylon and Burma, Odonata* Vol.III. Taylor and Francis, Red Lion Court, Fleet Street, London.461pp

Ghosh, C. C. 1940. *Insect Pest Of Burma.* Supd. Govt. Printing and Stationary, Rangoon. 214 pp

Hill, D. S. (1983). *Agricultural insect pests of the tropics and their control.* (2nd edition). Cambridge University press, London. New York. 746pp

Johnson, W. S., J. Graham, and R. S. Strom(2008). *Identification of Common Landscape Pests and Beneficial Organisms in Nevada.* University of Nevada Cooperative Extension. 128pp

Maulik (1919) *The Fauna of British India, including Ceylon and Burma*. Coleoptera; Chrysomelidae (Hispinae and Cassidinae) Taylor and Francis, London. 411 pp

McGavin, G. C., 2000. *Insects spiders and other terrestrial arthropods.* Dorling Kindersley Limited, London. 255pp

McGavin, G. C., 2007. *Expedition Field Techniques Insects and other terrestrial arthropods.* Kensington Gore, London. 96pp.

Tin Maung Oo, 1976. Taxonoimic Studies of Some Grylloidea of Burma. *M. Sc. Thesis,* Arts and Science University, Mandalay.