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CONTENTS Page

DFT/B3LYP THEORETICAL STUDIES OF SOME QUATERNARY AMMONIUM TRIBROMIDES TO EXAMINE THE DYNAMICS OF THE N-BR BOND

Reviewed

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Abstract: DFT/B3LYP theoretical studies of some quaternary ammonium tribromide reagents namely TMATB, TEATB, TBATB and TPATB have been performed in order to assess the feasibility of the reaction. The optimized geometries obtained at the DFT/B3LYP level using the 6-31g* basis set shows that the compound TBATB is most stable among the four tribromides with a bond dissociation energies in the following order BDE (TBATB) <BDE (TPATB) < BDE (TEATB) <BDE (TMATB).

Keywords: Quaternary ammonium tribromide, Guassian09, Gauss view, DFT/B3LYP.

Introduction

Organic tribromides have gained enormous attention in recent years as solid bromineless brominating agents with remarkable ease in maintenance of their desired stoichiometry and the ease in storage, transportation and handling. They have, up to a great extent, replaced the use of the toxic molecular bromine in organic bromination reactions and have been found to be attractive reagents in various organic transformations such as bromination of organic substrates, oxidative cyclization reactions, in the construction of heterocycles, acylation reactions, etc (Madhudeepa *et. al*., 2012*)*. With the advent of faster and more powerful computational resources today, the quantum chemical approach provides substantial knowledge of chemical structure and chemical reactivity where experimental science or empirical approaches are insufficient or at least difficult and limited in scope. Much of the value of theoretical and computational study lies in the observation that many facets of the chemistry of unstable reaction intermediates and transition state are currently inaccessible to experimentalist due to the extremely short life of the species. These, however, can be easily studied by computational chemist who employ theoretical models on the computer. This paper makes use of the DFT methods called B3LYP (Becke *et. al*., 1997; Lee *at. al*., 1988) due to its success in handling a wide range of chemical systems. Unfortunately, we have taken note that computational models for these industrially important reagents are almost non-existent and therefore for a complete understanding of the reactivity of this important class of reagents, we have performed DFT/B3LYP studies of some selected QATBs, namely tetramethyl ammonium tribromide (TMATB), tetraethylammonium tribromide (TEMATB), tetrabutyl ammonium tribromide (TBATB) and tetrapropyl ammonium tribromide (TPATB) and the results have been summarised herein.

Experimental

Material and method

The Guassian 09 software was used for this study. Structures of Me_4N^+, Et_4N^+, n-$Pr_4N^+$and n-Bu_4N^+ were calculated using quantum mechanical HF and DFT methods together with the PCM solvent model using

acetonitrile solvent system for studying the structures (Pople *et. al.*, 1999).

Computational method

All the molecular structures were constructed by Guass view. The geometry optimizations were carried out by using the density functional theoretical (DFT) methods at the B3LYP/6-31G* level in solvent phase. Vibrational frequencies at the B3LYP/6-31G* level were used to characterize stationary points as minima (no. of imaginary frequencies=0) and to evaluate zero point vibrational energies (ZPE) which were scaled by a factor of 0.977. The Gaussian 09 program was used for all calculations (Allen *et. al.*, 1987).The dissociation energy (ΔH_d) was calculated by the following equations:

$$R_4N^+Br_3^- \rightarrow R_4N^+ + Br_3^- + \Delta Hd \ldots\ldots 1$$

$$\Delta Hd = Et(R_4N^+) + Et\,(Br_3^-) - Et\,(R_4N^+Br_3^-) \ldots. 2$$

$$R_4N^+Br^- + Br_2 \rightarrow R_4N^+Br_3^- + \Delta H_f$$

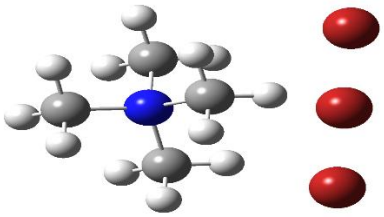
$$\Delta H_f = Et\,(R_4N^+Br_3^-) - Et(R_4N^+Br^-) - Et(Br_2) \ldots 3$$

The change in Gibb's free energy are also calculated using the above equations.

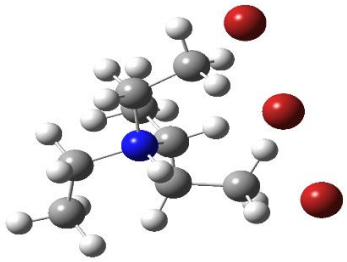
Results and Discussion

Molecular geometries were obtained by the B3LYP method using 6-31G* basis set. Optimized B3LYP geometries of the four quaternary ammonium complex compounds are depicted in figure 1 below as Gauss View representations (where blue, red, white and grey circles stand for N, Br, H and C atoms respectively).

Structures of the four quaternary ammonium complex compound



TMATB



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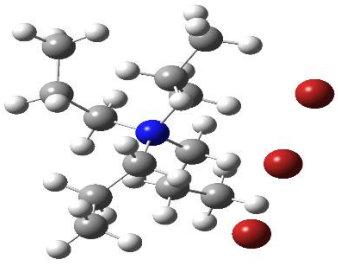
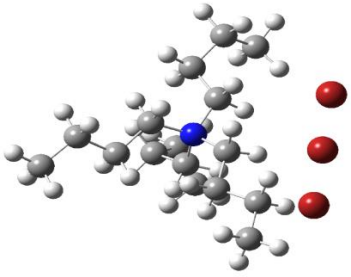


TPATB



TBATB

Figure 1. Optimized structures of TMATB, TEATB, TPATB and TBATB using B3LYP method.

Table 1: B3LYP/6-31g* values of geometry parameters

Tribromide	Bond distance N-Br1	Bond angle N-Br1-Br2	Bond angle Br1-Br2-Br3	Dihedral angle N-Br1-Br2-Br3
TMATB	4.798	87.52	178.27	-0.89
TEATB	4.248	89.12	178.85	8.50
TPATB	4.023	92.21	179.55	-6.65
TBATB	4.000	90.45	180.0	-19.1

* Bond lengths in Angstrom and angles in degrees.

Table 1 shows that the distance between N and Br1 increases in the following order TBATB<TPATB< TEATB<TMATB. This result is reasonable because the bond length depends on the interaction force between groups within a molecule. From table 1, the distance between N and Br1 of TBATB is lowest. From thermodynamic point of view it is known that when atoms are held firmly, it results in more energy being required to break the bond. Again, therefore more energy that is required to break a bond, the more stable the compound will be. Computationally too, by calculation of the bond dissociation energies (Blanksby *et. al*., 2003) and N - Br1 distances (Allen *et al*., 1987) of each geometry optimized molecule, we observed a relationship between bond distance and energy, *i.e*., stronger the bond higher the bond dissociation energy (Nicholas *et. al.,* 2014).

In Table 1, TBATB shows a linear structure with bond angle <Br1-Br2-Br3=180^0. Although the bond angle of TMATB is 178.27, TEATB is 178.85 and TPATB is found to be 179.55 which is close to linearity, This results are also supported by experimental data as reported from XRD (Bora *et. al*., 2001).

The dissociation energy of the four quaternary ammonium complexes compound *viz.*,tetramethylammonium tribromide (TMATB); tetraethyl ammonium tribromide (TEATB); tetrapropylammonium tribromide (TPATB) and tetrabutylammonium tribromide (TBATB) were studied by the B3LPY/6-31G* method and all the calculations were carried out by density functional (DFT) method. Table 2 presents the calculated values of bond dissociation energy and formation, as well as change in Gibbs-free energy of formation and dissociation.

Table 2: B3LYP/6-31g* values of energy parameters

Tribromide	ΔH_d	ΔH_f	ΔG_d	ΔG_f
TMATB	153.50	71.01	137.97	81.77
TEATB	155.02	-23.59	132.16	-14.49
TPATB	156.13	-24.42	145.76	-12.82
TBATB	156.64	-26.58	85.72	-11.89

* Energy terms in kcal/mol

From thermodynamic point of view, the B3LYP values of bond dissociation energy (ΔH_d) predict that it is endothermic for all the four tribromides, with ΔH_d ranging from 153.50 - 156.64 kcal/mol.

The B3LYP values of the change in enthalpy of formation (ΔH_f) predict that it is exothermic for the three bromides with ΔH_f ranging from -23.59 to -26.58 kcal/mol, except in the case of TMATB where ΔH_f is 71.01. The TBATB has the least ΔH_f value which means it is most stable whereas TMATB the highest.

Similarly, the change in formation of Gibb's free energy (ΔG_f) value from the table predicts that the reactions are more feasible in the case of the three tribromides ranging from -11.89 to -14.49 except in the case of TMATB where ΔG_f is 81.77. A negative Gibb's free energy (ΔG) is thermodynamically favourable and often spontaneous, hence the reactions of the three tribromides viz. TEATB, TPATB and TBATB are feasible.

Conclusion

A good number of synthesis of bromoorganic compounds have been reported but no work on computational chemistry has been done so far except one of the work which has been performed by our group and recently accepted by Chemical Physics Letter (Elsevier). Therefore, a study on the methods of computational quantum chemistry was performed in order to investigate the stability and feasibility of the four quaternary ammonium tribromides viz., TMATB, TEATB, TPATB and TBATB respectively. From the result it was observed that among the four tribromides TBATB was the most stable. This study consistently employs on solvent phase (acetonitrile) environment for the computational understanding of the structures. This may be defended on the ground that in experimental analysis, acetonitrile was used as a solvent, hence the full interpretation of the result of these calculation is applied primarily only in solvent phase context.

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LOCALLY PRODUCED CROPS YIELD GREATER MONETARY RETURN: A VALUE CHAIN ANALYSIS IN KOHIMA, NAGALAND

Reviewed

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Abstract: A comparative case study was conducted between local and non-local sources of king chilli, ginger, orange and pineapple in Kohima, Nagaland. The objectives of this study were to evaluate the value chain at marketing and consumer demand stages. The results showed that locally produced ginger had a greater net benefit comparing to non-local products. Although, not statistically significant local king chilli and orange had a greater net gain margin. Pineapple was found to be procured solely from local source. Consumer demand survey indicates substantial daily intake of king chilli, ginger and orange which is worth considering for marketing.

Key words: King chilli, Ginger, Orange, Pineapple, Value chain.

Introduction

Nagaland produces several crops with high commercial potential for local market and even export. However, the marketability of the locally produced crops having high consumer demand is seldom been evaluated. It is important to identify these locally produced crops that can benefit both growers and consumers. With the help of value chain analysis (VCA) it is possible to identify the value of a particular crop (Grant, 2010). A value chain can be defined as a chain of activities required to bring a product or service from production through delivery to final consumer (Porter, 1985, Kaplinsky and Morris, 2001). Studying horticultural and agricultural crops of Nagaland using VCA has specific relevance because of differences with other regions in environmental condition that influence quality of the crops and seasonality of crop production. A case study of VCA on marketability and consumer demand survey was conducted around Kohima for four crops, king chilli (*Capsicum chinense* Jacq.), ginger (*Zingiber officinale* Rosc.), orange (*Citrus reticulate* Blanco), and pineapple (*Ananas comosus* L. Merr.). The objectives of this study were to evaluate the marketability of these crops, compare the performance between local and non-local crop products, gender participation in marketing and to find a localized estimate of consumer demand of the above crops.

King Chilli is traditionally cultivated in Assam, Nagaland, Manipur and other North-Eastern states of India (Baruah *et. al*., 2014). It is locally known as bhut jolokia (Assam) and Naga king chilli (Nagaland), named after the large pod size. It is grown as summer crop in Nagaland. King chilli is seeded as intercrop in paddy fields around February to March and harvested by August to September (Bhagowati and Changkija, 2009). Ginger is an important cash crop in North-East region of India. The climatic and environmental conditions in this region favors production of high quality ginger (Yadav *et. al.*, 2004). In Nagaland ginger is

cultivated in jhum fields, Zabo system, and terraced lands and in plains as intercrop or monocrop (Rahman et al, 2009). It is planted between February to April and harvested by November to January. The traditional approach of organic ginger production is considered as one of the best quality ginger with high commercial value.

Orange is one of the top citrus fruits having great economic importance due to its wide range of uses and benefits. This fruit is rich in vitamins A, B, C and phosphorus. The fruit size of Nagaland orange is smaller (8-10 Nos per kg) as compared to orange from Punjab (5-6 Nos per kg), one of the major source of orange import in Nagaland. An advantage of orange cultivation is that fruits are harvested during January to March when there is limited supply of other fruits in the market (Sashimatsung, 2013). Pineapple production in Nagaland is a government supported horticultural crop (Sema *et. al.*, 2009). Although yield is low, Nagaland produce organically grown high quality pineapple with good potential for market competition.

Materials and Methods

Methodology for value chain analysis was formulated based on availability of crop variety at the time of performing this experiment. This case study was conducted from December 2017 to April 2018. Mao market, P. R. Hill, Kohima, Nagaland was selected for this study. Location for data collection was identified based on easy accessibility and frequency of consumers to this market. The consumer demand survey was conducted at Dzuvuru, Poterlane colony, Kohima. Primary data were collected at wholesale, retail and consumer demand stage for each crop. Throughout the initial stages of this study a literature review was conducted looking at previous horticulture research in Nagaland, in particular with king chilli, orange, ginger and pineapple (Anonymous, 1999; 2014).

Data collection

A. *Interviews with retailers at the Kohima town*

Interviews were conducted to gather information on wholesale and retail aspects of the four crops from 40 retail vendors (10 for each studied crop). The selection of retailers was performed by random sampling of shops around the main street of Mao market near the bus parking at P. R. Hill, Kohima. The retailers include five vendors who trade with local producers and five vendors dealing with non-local producers. Interviews were conducted between 10:00 – 12:00 hrs, which is the beginning of the normal business hours in Kohima. Questions were ask to identify the location from where the crops were procured, the wholesale and selling price of the crops, and gender of the retailers were noted.

B. *Interviews with members at Dzuvuru colony, Kohima*

A localized consumer demand survey was conducted in Dzuvuru, Poterlane colony, Kohima. The survey questionnaire was asked on quantity of each studied crop purchased by a family on a weekly or monthly interval. These interviews formed the primary data gathering process.

Data analysis

The data analyses were performed using independent *t*-tests at $P \leq 0.05$ in Microsoft Excel. The *t*-test was used to compare means of wholesale, selling and net gain prices between local and non-local source

for king chilli, ginger and orange separately. Pineapple data was solely procured from local producers and means of sample collected was used to determine wholesale, selling and net gain prices. The consumer demand survey was determined by using means of the collected samples for each crop.

Results and Discussion

Price comparison between local and non-local crop product

1. King Chilli

The *t*-test for wholesale and selling price was significant between local and non-local king chilli but net gain was not significant (Table 1). However, the net gain price was ₹ 24 greater for local king chilli than non-local king chilli and the wholesale price was lesser by ₹ 164 for local than non-local source. The selling price of local king chilli was lesser by ₹ 142 than non-local product. The local king chilli were from Jalukie, Phek district and non-local product from Manipur.

2. Ginger

The wholesale and net gain prices of ginger between local and non-local were significantly difference (Table 1). The net gain price was significantly greater by ₹ 9 for local ginger than non-local ginger and the wholesale price was lesser by ₹ 9 for local than non-local. There was no difference in selling price between local and non-local ginger. The local ginger source was from Phek district and non-local from Assam.

3. Orange

The wholesale and selling prices of local orange were significantly lesser by ₹ 30 and ₹ 20, respectively for local than non-local products (Table 1). Although the net gain price was not significant, the price was ₹ 10 greater for local orange than non-local orange. Local product of orange was from Wokha district and non-local product from Arunachal Pradesh and Punjab.

4. Pineapple

There were no non-local pineapple vendors available and only the local product was evaluated. The mean wholesale price of local pineapple was ₹ 22.5 per piece and selling price was ₹ 45 per piece with a net gain of ₹ 22.5 per piece (Table 1). The local pineapple source was from Molvom Jharnapani, Dimapur district.

Assessment of market potential of local and non-local crop products

The wholesale and selling prices were greater for non-local compared to local products for all studied crops except ginger with equal selling price for local and non-local sources (Fig. 1). There was a greater net gain for local than non-local products for all crops. This greater net gain is indicative of a tighter price range of each product when it comes to fixing a selling price. This may also be reflective of consumer willingness to pay for a particular crop and the quality of the product when it reaches the market. Some vendors commented on a greater customer preference for local king chilli compared to non-local produced because of its stronger pungency and flavor. The quality of crops is influenced by the growing environment and climatic condition of a particular location. The North-East India including Nagaland is often identify as having conducive environment for production of high quality king chilli, ginger and pineapple (Bhagowati and Changkija, 2009; Kanjilal *et.*

Table 1: Means comparison using *t*-test for wholesale, selling and net gain prices between local and non-local crop products at Mao markets, P. R. Hill Kohima, Nagaland.

Crop	**Price**	**Local**	**Non-local**	***P* value**
		——— ₹ kg^{-1} ———		
King chilli	Wholesale	136	300	0.001*
	Selling	218	360	0.001*
	Net gain	84	60	0.074ns
Ginger	Wholesale	27	36	0.005*
	Selling	54	54	
	Net gain	27	18	0.001*
Orange	Wholesale	68	98	0.000*
	Selling	106	126	0.004*
	Net gain	38	28	0.083ns
Pineapple		—— ₹ $piece^{-1}$ ——		
	Wholesale	22.5		
	Selling	45		
	Net gain	22.5		

ns not significant; * significant at $P \leq 0.05$

al., 1997; Sema *et. al.*, 2009; Yadav *et. al.*, 2004). Additionally, non-local products have to account for the cost of transportation and maintaining the quality during transit. The price comparisons of all studied crops showed a greater benefit margin for locally produced crops than non-local products. Considering the cost and benefit of the crops in this study, local products indicate a better market response in the value chain analysis.

King chilli showed the largest price difference between local and non-local products and also the greatest net income compared to other crops in this study. This suggests a potentially greater trade value of king chilli than the other crops. King chilli has been documented to have several medicinal values and potential for increased commercial interest at the international market has been anticipated (Baruah *et. al.*, 2014). Absence of difference in selling price

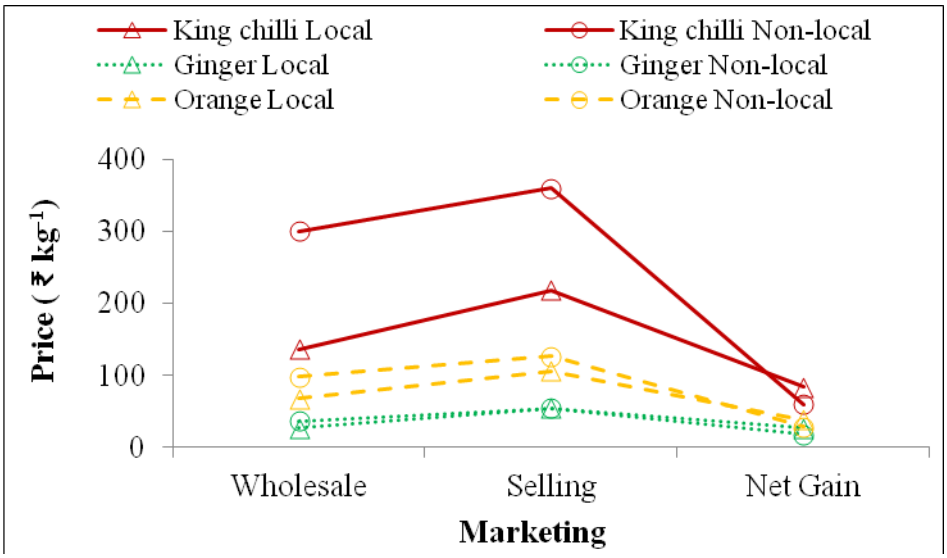

Fig. 1: A comparative study of market potential between local and non-local crop products, conducted around Mao market, P. R. Hill, Kohima, Nagaland.

of ginger between local and non-local source is indicative of a greater market value of local produced and perhaps a potential commercial competitor with non-local source, worth paying attention for local production. However, this study did not estimate the overall production and consumption of each crop and therefore caution should be taken while interpreting this result for other location in the overall value chain study.

Evaluation of gender participation in marketing

In this study total number of female vendors was twenty-three compared to seventeen male vendors (Fig. 2). The gender participation in marketing of king chilli and oranges was equal. There were more female participants in ginger and pineapple marketing. Having more female vendor is indicative of an important role of female in commercial activities of crops. The participation of female in marketing likely contribute to increase family income, better livelihood for female and the additional income may contribute to household management. Producing and vending local crops can help Naga women to be economically independent and self-reliant. Thus, vending of local crops may act as an important economic activity for Naga women. Further assessment is needed to understand the impact of gender participation in socio-economic aspect and value chain of different crops.

Consumer demand survey in Dzuvuru, Poterlane colony, Kohima

Table 2: Average weekly consumption of crops at Dzuvuru, Poterlane colony, Kohima, Nagaland.

Crop	Consumption
	kg week^{-1} family^{-1}
King chilli	0.57
Ginger	0.30
Orange	2.32

A total of 10 families in Dzuvuru, Poterlane colony, Kohima were interviewed for weekly consumption of each studied crop, except pineapple which was excluded from this study because of small sample size. The average weekly consumption per family was 0.57, 0.30 and 2.32 kg for king chilli, ginger and orange, respectively. Consumer demand survey found that orange consumption was more in comparison to spices. A reason for this could be because fruits are consumed in larger quantity compared to spices on a daily basis. This result is a localized assessment and is not representative of a large area but it gives and understanding that these crops are in demand by consumers. Therefore, a consideration to study the marketing prospect of these crops is important. A more detail study on consumer demand survey of different crops can provide valuable information for accurate estimation of crop supply and demand for greater economic benefit to both suppliers and consumers.

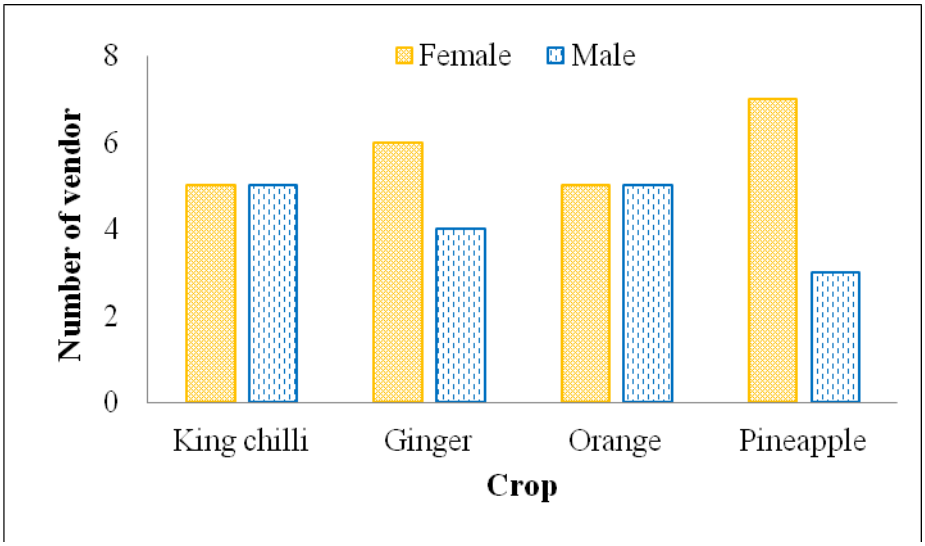

Figure 2: Gender distribution for marketing of crops around Mao market, P. R. Hill, Kohima, Nagaland.

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DEVELOPING BISHNUPRIYA MANIPURI CORPUS FOR MULTILINGUAL DICTIONARY

Reviewed

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Abstract: This paper discusses about the corpus and its requirements during building a multilingual dictionary of Bishnupriya Manipuri language. Due to the lack of awareness like other Indian languages, this language is studied less frequently. As a result the language still lacks a good corpus and basic language processing tools. This paper discusses about the different types of corpus, methods and methodology of being develop the corpus for Multilingual Dictionary. The paper also analyzes the applications areas of corpus and in brief the Tagging process of corpus in NLP and computational linguistics areas.

Keywords: Bishnupriya Manipuri, Corpus, NLP, Multilingual

Introduction

The term corpus, derived from Latin, usually refers to a body of texts (collection of linguistics data) either in written or spoken form (transcribed recorded speech). It is a representative sample of different varieties of language preserved in machine readable form which can be used as a starting point of linguistic description or a means for verifying hypotheses about a language (Crystal 1980). According to Sinclair (1996) corpus is a collection of pieces of language that are selected and ordered according to explicit linguistic criteria in order to be used as a sample of language. A corpus, designed methodically, should have the following characteristics features.

- It should be large in size containing a healthy amount of language data.
- It should be authentic and reliable in representation of language.
- It should consist of structured collection of text specifically compiled.
- It can be either a simple plain text or a text with annotation
- It should be user-friendly for easy handling.
- It should be properly and systematically documented
- It should have authentic referential value

Bishnupriya Manipuri language

The Bishnupriya Manipuri Language comes under the group of Indo-Aryan languages. The structure of the language is undoubtedly of Indo-Aryan origin, but it also retains some older sounds of medieval Meitei. The vocabulary is influenced by many Indo-Aryan and Tibetan-Burmese terms. There are two dialects in the Bishnupriya Manipuri language, namely, the Madai Gang dialect or

the dialect of the village of the queen and the Rajar Gang dialect or the dialect of the village of the king. The Madai Gang dialect is also known as Leimanai and the Rajar Gang dialect as Ningthaunai. The term Leimanai is derived from Leima (queen)+(ma) nai (attendant), meaning the attendants of the queen, and the word Ningthaunai, from ningthau (king)+(ma) nai (attendant) meaning the attendants of the king. Unlike the dialects of other tribes, these dialects of Bishnupriya are not confined to distinct geographical areas; they rather exist side by side in the same localities

Thirty-five principal phonemes present in Bishnupriya Manipuri of which eight vowel sounds, such as i, e, ɛ, a, ɑ, ∂, ò and u; twenty-five consonant sounds such as h, p, b, t, d, ʈ, ɗ, ʔ, ph, th, ʈh, kh, cʃ, ʃδ, m, n, ɳ, l, r, φ, s, ʃ, ĥ and ɧ and two semi vowels ŏ and ĕ. The vowel sounds can be represented in a tabular form as follows:

	Front	Back
Close (High)	i	u
Half-Close (High-mid)	e	ò
Half-Open (High-mid)	ɛ	∂
Open (Low)	a	ɑ

The consonant sounds can be represented in a tabular form as follows:

	Bilabial	Dental	Alveolar	Palato-Alveolar	Palatal	Retroflex	Velar	Glottal
Plosive	p,b	t,d				ʈ, ɗ	k,g	ʔ
Aspirate	ph	th				ʈh	kh	
Plosive with glottal	b'	d'				đ	ġ	
Affricate				cʃ, ʃδ				
Affricate with glottal				ʃδ'				
Nasal	m			n			ɳ	
Lateral				l				
Flapped				r				
Fricative	φ	s			ʃ			h,ɧ
Semi-vowel	ŏ(w)					ĕ (y)		

The voice aspirates, such as as, bh, dh, gh and jh never occur in this language. They are replaced by four stops and an affricate with glottal closure, such as h, b',d',g', z' etc. The -ch- sound is also not found and it is pronounced as -s-.We have analysed the word structure of the Bishnupriya Manipuri language from the data of the corpus. Some portions of our result are shown below

Nouns

Bishnupriya Manipuri nouns that denote male and female beings are sometimes distinguished by suffixation or through pairs of lexically differing terms. the word মুনি (muni) and জজলা (ʤela) are used before the word to indicate masculine and feminine genders respectively .

E.g. –মুনিমানু (munimanu : man),
জজলামানু (ʤelamanu : woman)

The feminine gender is generally indicated by the use of the word জজলা (ʤela) after the words indicating common gender.

Feminine gender is formed by adding the following suffixes to the masculine forms of words:

i) ী খুড়া (kʰuɹa : father's younger brother) -> খুড় (kʰuɹi : the wife of father's younger brother), জজঠাবা (ʤetʰaba : father's elder

brother) -> জজঠ মা (ʤʰima : the wife of father's elder brother)
ii) ী◌া◌ি (ani): চাকর (sakɔɹ : servant) -> চাকরা◌ি (sakɔɹani : maid servant) iii) ি◌ (ni): চামার (samaɹ : cobbler) -> চামারি (samaɹani : female cobbler)

Being an agglutinative language, Bishnupriya Manipuri has the capability of generating hundreds of words from a single noun and verb root.
For example,

The root word মানু (manu: man) may form different inflected words.

1. মানু◌ে◌য় (manuje) → মানু (manu) + ◌ে◌য় (je) → Noun + NCM
2. মানুহা◌ি◌ব (manuhabi) → মানু (manu) + হা◌ি◌ব (habi) → Noun + Pl
3. মানু◌ে◌র (manuɹe) → মানু (manu) + ◌ে◌র (ɹe) → Noun + ACM
4. মানুগেয় (manugɔje) → মানু (manu) + গ (gɔ) + ◌ে◌য় (je) → Noun + DM + NCM
5. মানুহা◌ি◌বেয়েহ(manuhabijehe)→মানু(manu) +হা◌ি◌ব(habi)+◌ে◌য়(je)+◌ে◌হ(he) → Noun + Pl + NCM + EM A

Basic principles of corpus building

A Corpus is considered as a building block for any language processing tasks and few principles for building corpus are as follows:

- The contents of a corpus should be selected without regard for the language they contain, but according to their communicative function in the community in which they arise
- Corpus builders should strive to make their corpus as representative as possible of the language from which it is chosen.
- Only those components of corpora which have been designed to be independently contrastive should be contrasted.
- Criteria for determining the structure of a corpus should be small in number, clearly separate from each other and efficient as a group in delineating a corpus that is representative of the language or variety under examination.
- Any information about a text other than the alphanumeric string of its words and punctuation should be stored separately from the plain text and merged when required in application.
- Samples of language for a corpus should wherever possible of entire document or transcription of complete speech events, or should get as close to this target as possible. This means that sample will differ substantially in size.

Types of corpus

- **Sample corpus:** A fixed sample of text, often used as a reference corpus for comparing.
- **Monitor Corpus:** A corpus which develops and is added to or filtered depending on the researchers needs**.**
- **Mini-Corpus:** a small corpus (e.g. to be compared with a reference corpus)
- **Multilingual Corpora:** Corpus in a variety of language.
- **Comparable Corpus:** Text in two language or two language varieties but not matched up.
- **Parallel Corpus:** Text are translation of each other, e.g. Canadian Hansard, Corpus of Version of Plato, Bible.
- **Translation Corpus:** two or more set of text classified as either originals or transition, the purpose being to identify features of translation (Manchester: Baker)

- **Diachronic Corpus:** Helsinki, LOBA V. FLOB
- **Learner Corpus:** Texts are written by language learner.

Methods of data input

Data from electronic sources: In these process texts from newspapers, journals, magazines, books etc. are included if these are found in electronic form But unfortunately BISHNUPRIYA Manipuri are not available in UNICODE standard.

Data from the websites: This includes texts from web pages, web sites, and home pages, same problem as we have no web pages available in BISHNUPRIYA Manipuri in proper UNICODE format.

Data from e-mails: Electronic typewriting, e-mails, etc. are also used as source of data. People of Manipur used the current trends of technology but still we cannot used our script for such works as due to the above said problems.

Machine reading of text: It converts printed texts into machine-readable form by way of optical character recognition (OCR) system. Using this method, printed materials are quickly entered into a corpus. Here printed or written materials are available but it will be a hard work to convert the scripts in electronic text, mainly in financial.

Manual data input: It is done through typing texts in computer. This is the best means for data collection from hand-written materials, transcriptions of spoken texts, and old manuscripts. The process of data input is indirectly based on the method of text sampling.

Algorithm

STEP 1 Find each BISHNUPRIYA Manipuri string which occurs more than once in corpus C. Record and its frequency of occurrence F in an entry in MayBe database.

STEP 2 For each in the entries in MayBe. Find , the strings in MayBe with one more character than , where is a sub-stringof .Compute F = $\sum^{F}$. 1⁄ Compute F2 = $\sum^{F}$, where is the first two entries and in , where is , the first L characters of , and where is the last L characters of .Compute N =F -F1 +F2. We extract each entry whose net frequency of occurrence is more than one as a CFS.

Corpus cleaning

The corpora have to be cleaned from such unintended error as –typos, wrong splits, foreign characters, which may have been introduced while keying the text i.e in the process of digitization. For example, some of these corrections include, removal of '-', '~', '_' etc. which are introduce to break words at the end of lines while keying in the text. Sometimes the conversion of corpus text from one standard format to another may have introduced viz. alt, control characters (^C, ^M, ^Z etc.,.) are also removed. The resulting text is free from all such errors. Finally, the entire Language corpora shall be converted to case sensitive roman notations in wx- scheme.

Generally, five types of error may occur at the time of manual data

- Omission of character,
- Addition of Character,
- Repetition of Character,
- Substitution of character, and
- Transposition of character

To remove spelling errors, we need to thoroughly check the corpus and compare it with the actual physical data source, and do manual correction. Care has to be taken to ensure that the spelling of words used in the corpus must resemble with the spelling of words used in the source texts. Also, it has to be checked if words are changed, repeated or omitted, punctuation marks are properly used. Lines are properly maintained, and separate paragraphs are made for each other.

Besides error correction, we have to verify the omission of foreign words, quotations, dialectal forms, etc. after generation of a corpus. The naturalized foreign words are, however, allowed to enter into the corpus. Others should be omitted. Dialectal variations are allowed. Punctuation marks and transliterated words are faithfully reproduced. Usually, books on natural and social sciences contain more foreign words, phrases and sentences than books of stories or fiction. Similarly, quotations from other languages, poems, songs, mathematical expressions, chemical formulae, geometric diagrams, images, tables, pictures, figures, flow-charts and similar symbolic representations of the source texts are not entered into corpus. All kinds of processing and reference works become easier and authentic if corpus is properly edited and errors are removed. For cleaning corpus we used Perl program to clean the raw corpus.

Applications

The purpose of corpus is not merely to gather a big file of different texts and store it on the computer, but rather to prepare the texts and put them in a certain format so that they can be used by search tools and the results of the search can be displayed in a way that is meaningful and useful to the linguist, teacher and learner especially at the advanced level. For example, scholars, teachers and learners can explore the use of a word in different types of texts to see how frequently this word is used, how many meanings it has, what syntactic environment it occurs in, whether the word has the same frequency of occurrence in all types of texts. Teachers can identify the most frequent words and select them as a basis for their material. There is also the study of syntactic structures and analysing the distribution of competing structures. For example, the uses of verb–subject vs. subject–verb word order in Bishnupriya Manipuri: which word order is more preferred in children's stories, interviews, and scientific documents? The MMD corpus is to be annotated with XML mark-up which includes information about the text, author, and source; this gives the opportunity to conduct empirical analyses which control extra-linguistic factors (such as age, sex, region, social class, and education level) and examine the accompanying linguistic variations. We hope our corpus would be further enriched with other information such as tagging which signifies information on word classes. This would make retrieval of useful information qualitatively and quantitatively much richer and easier to handle.

Corpus as knowledge resource: corpus is used for

- developing multilingual libraries,
- designing course books for language teaching,
- compiling monolingual dictionaries (printed and electronic),
- developing bilingual dictionaries (printed and electronic),
- multilingual dictionaries (printed and electronic),

- monolingual thesaurus (printed and electronic version),
- various reference materials (printed and electronic version),
- developing machine readable dictionaries (MRDs),
- developing multilingual lexical resources,

Corpus for translation support systems: corpus is used for

- Language resource access systems,
- Machine translation systems,
- Multilingual information access systems, and
- cross-language information retrieval systems etc.

Corpus in speech technology: Speech corpus technology is used to develop general framework for

• Speech technology, • phonetic,• lexical, • pronunciation variability in dialectal versions, automatic speech recognition, • automatic speech synthesis, • automatic speech processing, • speaker identification, repairing speech disorders, and • forensic linguistics, etc.

Conclusion

In this paper we provided an extensive survey how corpus can develop for Multilingual Dictionary, mainly based parallel corpora and mono corpora. We envisage that not only would this corpus fill a gap in the general field of corpus linguistics but it would also have a role in providing authentic material for teaching Bishnupriya Manipuri as a foreign language. In future, we will further increase the size of this corpus and will add more sections to the corpus. We are also planning to develop language processing tools on this language.

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ENVIRONMENTALLY BENIGN SYNTHESIS OF ISOTHIOCYANATES AS POTENTIAL PRECURSOR FOR ANTICANCER DRUG

Reviewed

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Abstract: Docking studies of different derivatives of isothiocyanates showed potential activity against cancer. Here the main enzyme responsible for inhibition is Aromatase. The aim of the study is to find aromatase inhibitor potential from isothiocyanates through binding free energy analysis into aromatase using molecular docking. Docking simulation was conducted to five isothiocyanates derivatives as ligands into aromatase as the receptor. The result was interesting as majority of the compounds synthesised turned up with favourable molecular interaction and binding affinity as evidenced from the docking score.

Keywords: Isothiocyanates. Docking, Anti-cancer

Introduction

Isothiocyanates are a family of small organic compounds that occur in a wide variety of plants that are formed from glucosinolate of cruciferous vegetables and are potent cancer chemopreventive agents in animals (Newman *et. al*., 2012; Higdon *et. al.,* 2007). Many isothiocyanates, both natural and synthetic, displays anti-carcinogenic activity since they reduce activation of carcinogens and increase their detoxification (Franca *et. al*., 2004; Sandi *et. al*., 2011; Parul *et. al*., 2014). Isothiocyanates have gained a great deal of interest as important precursors for the construction of pharmaceutically active heterocycles such as thiohyantoins, thiopyrimidones, thioquinazolones, mercaptoimidazoles, thioamidazolones, pyridinethiones, pyrrolidine and benzothiazine (Mukherjee *et. al.*, 1991). In addition, several isothiocyanates are also used in the synthesis of agrochemicals that have antifungal and anthelmintic activities (Kim *et. al.,* 1997). They are important reagents for amide ligation (Crich *et. al*., 2009) and widely applied as chemoselective electrophiles in biconjucate chemistry because of their tolerance toward aqueous reaction condition (Fernandez *et. al.*, 1995). Synthetic isothiocyanates have been proved to have some biological activity, such as antiproliferatives (Nastruzzi *et. al*., 1995), anticancer properties (Bommareddy *et. al*., 2009; Xiao *et. al*., 2006), enzyme inhibitors for the HIV virus (Edman *et. al*., 1949), reagent in Edman peptide sequencing (Heckl *et. al*., 2008), and other biological assays of DNA and proteins (Meng *et. al*., 2008; Dyer *et. al.,* 1932). Knowing the importance of ITC studies on the biological activity of five different ITC compounds was performed by molecular docking. Docking simulation was conducted to isothiocyanates as ligands into aromatase as the receptor. Human cytochrome p450 aromatase catalyses the biosynthesis of estrogens from androgens with high specificity and the inhibition of the biosynthesis paved the way the treatment for postmenopausal estrogen-dependent breast cancer (Ghosh *et. al.,* 2012). The interaction and binding of ligands – protein were done and visualized using software Molegro Virtual Docking(MVD) and predicted that isothiocyanate compounds has potency as lead compound for possible therapeutic agents.

Experimental

Materials and methods

Molegro Virtual Docker software was use for docking studies.

Chemical structures

The 2D structure of isothiocyanates (NUCHEM 1,2,3,4 and 5) were generated with Chemoffice 2010. The energy of these compounds were further optimized using MM2 force field method and saved as sybyl mol2 (three dimensional) file format using ChemBioDraw Ultra 12.0. The compounds were checked by applying Lipinski rule of five and all the isothiocyanates understudy falls within the set rule making the compounds for potential drug development (Pathak *et. al*., 2016).

Protein preparation

The 3 dimensional (3D) structure of human placental aromatase cytochrome p450 [CYP19A1] (PDB ID: 3S79) was downloaded from the Protein Databank Bank (http://www.rcsb.org/) having a resolution of 2.75 Å, structural weight of 59143.26 Da, amino acid length of 503 and contains only a single chain (Chain A). The enzyme was then imported in the Molegro Virtual Docker (MVD) and all the water molecules were removed during the docking simulation as they were not taken into consideration during the scoring function (Vinoda *et. al*., 2016).

Docking computation

Docking studies of isothiocyanate compounds against aromatase was performed using MVD software. The 3 dimensional (3D) structure of human placental aromatase cytochrome p450 (PDB ID: 3S79) was then imported into the MVD and the cavities or binding sites were predicted. By using MVD five cavities were predicted and the one with the highest volume (304.128 Å) was selected for consideration (Kusumaningrum *et. al*., 2014). The grid was set inside a restriction sphere of radius 10Å (X 88.58, Y 51.09, Z 43.73) surrounding the region of interest (active binding site) in the aromatase. The isothiocyanate compounds were docked against aromatase and 20 independent runs were performed for each of the isothiocyanate compounds with maximum number of five poses returned based on a differential evolution search algorithm. The docking energy scoring function was based on the modified piecewise linear potential (PLP) with new hydrogen bonding and electrostatic terms included (Thomsen *et. al.,* 2006). The best pose of each compound with the highest moldock re-rank score was selected for subsequent ligand-protein interaction energy analysis. [Table 1]

Results and Discussion

Molecular docking simulation was carried out using the MVD. The binding cavity used in the present molecular docking simulation is shown in Fig.1. The docking scoring function, EScore, is defined by the following energy terms:

$$EScore=E_{inter}+E_{intra}$$

Where, E_{inter} is the ligand-protein interaction energy, E_{intra} is the internal energy of the ligand

The docking scoring results are shown in Table 1. The interaction energy of NUCHEM1, NUCHEM2, NUCHEM3, NUCHEM4 and NUCHEM5 is -92.20kJ/mol, -87.61kJ/mol, -86.71kJ/mol, -83.97 kJ/mol and -77.59 kJ/mol respectively.

	Table 1: Molecular docking score of the isothiocyanate compounds						
Ligand	**Code**	**Rerank Score**	**Interaction**	**Internal**	**HBond**	**LE1**	**LE3**
1	NUCHEM1	-71.21	-92.20	11.13	-5.00	-6.24	-5.48
2	NUCHEM2	-70.17	-87.61	7.68	-5.20	-6.15	-5.40
3	NUCHEM3	-69.76	-86.71	3.73	-6.97	-6.92	-5.81
4	NUCHEM4	-62.02	-83.97	7.69	-13.29	-6.36	-5.17
5	NUCHEM5	-61.59	-77.59	7.22	-4.88	-6.40	-5.60
	Rerank Score:The rerank score is a linear combination of E_{inter} (steric, Van der Waals, hydrogen bonding, electrostatic) between the ligand and the protein and E_{intra} (torsion, sp2-sp2, hydrogen bonding, Van der Waals, electrostatic) of the ligand. ***Interaction***:The total interaction energy between the pose and the protein (kJ/mol). ***Internal***: The internal energy of the pose. ***HBond***: Hydrogen bonding energy (kJ/mol). ***LE1***: Ligand efficiency 1: MolDock score divided by heavy atoms count. ***LE3***: Ligand efficiency 3: Rerank score divided by heavy atoms count.						

Table 2: **Molecular interaction analysis of NUCHEM1, NUCHEM2, NUCHEM3, NUCHEM4 and NUCHEM5 at the active site of aromatase**						
Sl.no	**Compound name**	**Interaction (protein-ligand)**	**Interaction energy (**kJ/mol**)**	**Interaction Distance (Å)**	**Hybridization (protein atom)**	**Hybridization (ligand atom)**
1.	Nuchem1	Val370(N)----N(10)	-2.5	3.08	Sp^2(donor)	Sp^2(acceptor)
		Val369(N)----N(10)	-2.5	3.09	Sp^2 (donor)	Sp^2(acceptor)
2.	NUCHEM2	Ser314(OG)---O(8)	-1.39	3.32	Sp^3 (both)	Sp^3(acceptor)
		Val369(N)----N(7)	-0.36	3.33	Sp^2(donor)	Sp^2(acceptor)
		Val370(N)---N(7)	-2.5	3.06	Sp^2(donor)	Sp^2(acceptor)
3.	NUCHEM3	Ser314(OG)---O(6)	-2.5	2.88	Sp^3(both)	Sp^3(acceptor)
		Val369(N)---N(9)	-1.97	3.21	Sp^2(donor)	Sp^2(acceptor)
		Val370(N)---N(9)	-2.5	2.97	Sp^2(donor)	Sp^2(acceptor)
4.	NUCHEM4	Arg145(NH1)---O(10)	-2.5	3.05	Sp^2(donor)	Sp^2(acceptor)
		Trp141(NE1)---O(10)	-2.5	2.94	Sp^2(donor)	Sp^2(acceptor)
		Arg115(NH2)---N(6)	-0.55	2.81	Sp^2(donor)	Sp^2(acceptor)
		Arg115(NH2)---N(9)	-1.13	3.37	Sp^2(donor)	Sp^3(acceptor)
		Arg115(NH2)---O(11)	-0.90	2.72	Sp^2(donor)	Sp^2(acceptor)
		Arg115(NE)---O(11)	-1.45	3.03	Sp^2(donor)	Sp^2(acceptor)
		Arg435(NH2)---O(11)	-1.59	3.15	Sp^2(donor)	Sp^2(acceptor)
		Arg435(NE)---O(11)	-2.5	2.67	Sp^2(donor)	Sp^2(acceptor)
		Arg435(NE)---N(9)	-0.79	3.44	Sp^2(donor)	Sp^3(acceptor)
5.	NUCHEM5	Val369(N)----N(6)	-2.24	3.12	Sp^2(donor)	Sp^2(acceptor)
		Val370(N)---N(6)	-2.5	3.05	Sp^2(donor)	Sp^2(acceptor)

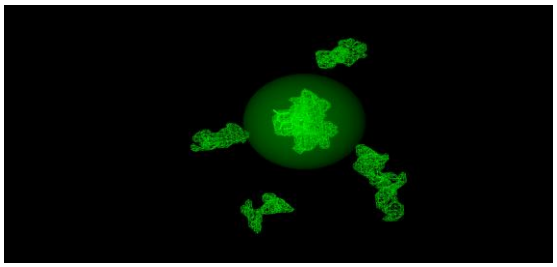
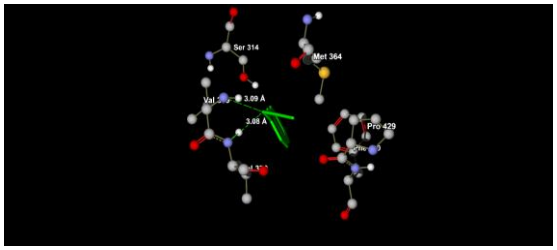
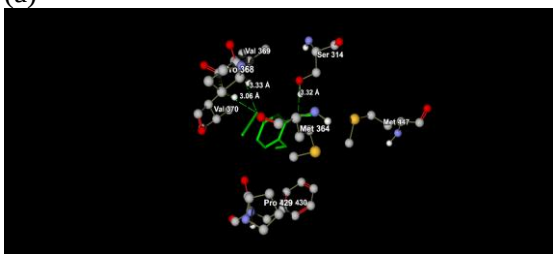


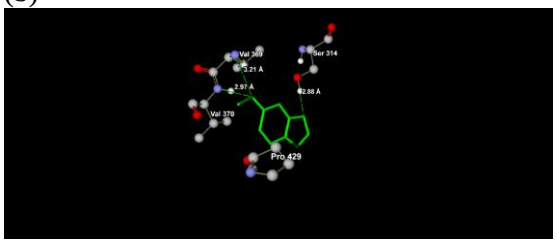
Fig. 1: The potential ligand binding cavity of Aromatase (PDB ID: 3S79) predicted using MVD.



(a)



(b)



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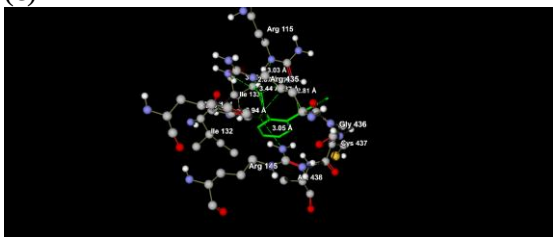

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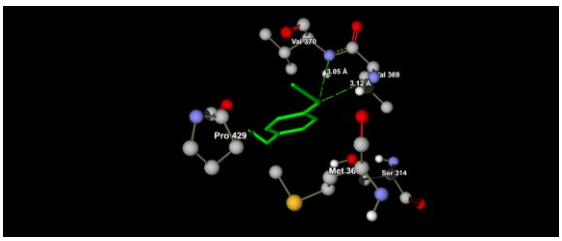

(e)

Fig. 2 Molecular interaction of (a) NUCHEM1, (b)NUCHEM2, (c)NUCHEM3, (d)NUCHEM4 and (e)NUCHEM5 at the active site of Aromatase

Additionally, the molecular interaction analysis for the ligand-protein interaction is shown in Table 2. The average molecular interaction energy of NUCHEM1 is -2.5 kJ/mol, while that of NUCHEM2 is -1.42 kJ/ mol, NUCHEM3 is -2.32 kJ/mol, NUCHEM4 is -1.55kJ/mol and -2.37kJ/mol for NUCHEM5. The snapshots of ligand-protein interaction depicting the binding mode of isothiocyanates are shown in Fig.2 a, b, c, d, and e. NUCHEM1 showed molecular interaction with Val370 and Val360 residues of Aromatase while NUCHEM2 established molecular interaction with Ser314, Val369 and Val370 residues of Aromatase , NUCHEM3 had molecular interaction with Ser314, Val369 and Val370 residues of Aromatase, NUCHEM4 showed molecular interaction with Arg145, Trp141, Arg115 and Arg435 residues of Aromatase and NUCHEM5 showed molecular interaction with Val369 and Val370 residues of the Aromatase enzyme . The docking hits showed common molecular interaction with Val369 (N) and Val370 (N). From the interaction analysis, isothiocyanates showed binding affinity towards the active site of Aromatase. Thus, isothiocyanate compounds may serve as lead molecule or a potent inhibitor of Aromatase.

Conclusion

In conclusion, these compounds appear to have many favourable properties that make them attractive for further development as chemopreventive agents for human cancer. From the results it shows that isothiocyanates fit and also interacts with the residues in the active site of the Aromatase as the active site is required for the biological activity that is for the synthesis of estrogen which is required for growth of breast and ovarian cancers. Therefore, isothiocyanates can be a potential inhibitor of Aromatase and might be designed as an anti-cancer drug.

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HYDROGEOCHEMISRTY AND GROUNDWATER QUALITY IN AND AROUND DC COURT, DIMAPUR TOWN, NAGALAND

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Abstract: The study area (in and around DC Court) falls under Dimapur town, Nagaland and lies between N25°55.0' and N25°53.0' latitude and E93°42.306' and E93°41.689' longitude and is incorporated in the survey of India Toposheet No. 83G/9, an area of about 173 sq km. Hydro-chemical parameters include turbidity, pH, total hardness, iron, chloride, total alkalinity, nitrate and fluoride are estimated by using Field Testing Kit (FTK) and the results obtained were compared with the standards of BIS(2012) to assess quality of groundwater and its suitability for drinking purpose. Most of the physico-chemical parameters of water samples from the study area are found to be within permissible limit. However, some parameters like pH vary from 6.4-7.4 indicating 50% acidic, 40% neutral and 10% basic. The concentration of iron varies from 0.1 to 1.2 indicating 40% desirable, 50% permissible and 10% above permissible.

Keywords: Hydro-geochemistry, Groundwater Quality, DC Court, Dimapur town, Nagaland.

Introduction

Water is one of the principal elements of life and many functions depend on it. On the planet Earth water exists in substantial quantity i.e. 97% saline water and 3% fresh water bodies. Out of the total fresh water available, 68.7% are found as icecaps and glaciers, 30.1% as groundwater and 1.2% as surface and other freshwater. Groundwater is used for drinking, domestic, industrial and agricultural purposes in most parts of the world as it is a replenishable resource and advantageous over surface water. Groundwater acts as a reservoir by virtue of large pore space in earth material, as a waterway which can transport water over a long distance as a mechanical filter which improves water quality by removing suspended solids and bacterial contamination (Sharma, 2001).

The quality of groundwater is very important for human beings mainly for drinking purpose. Now a days, the groundwater potential and its quality is getting deteriorated in many cities and urban areas including Dimapur town due to population explosion, urbanization, industrialization (Bathusa and Saseetharan, 2010). Todd (1980) stressed the importance of quality of groundwater as well its quantity. The hydro-chemical study reveals whether the quality of water is suitable for drinking, agriculture or industrial purposes, (Karanth, 1997). This paper intends to assess the groundwater quality for drinking purpose.

Location of study area

The study area (in and around DC Court) falls under Dimapur town, Nagaland and lies between N25°55.0' and N25°53.0' latitude and E93°42.306' and E93°41.689' longitude and is incorporated in the survey of India Toposheet No. 83G/9, with altitude varying from 147m to 205m above MSL having an area of about 173 sq km. The area is well bounded by the state of Assam on the north and west, Kohima district to the east and Medziphema to the south. Dimapur is declared as the commercial centre of the state and is

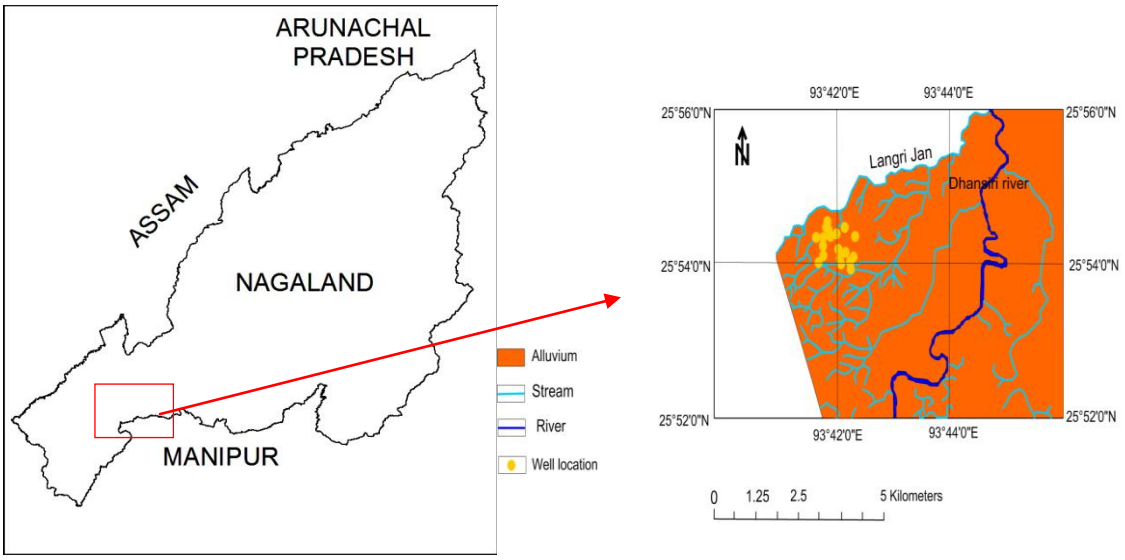

Fig 1: Location map of the study area

well connected by roads, Railways and Airways (Fig. 1).

Geological setting

Dimapur is exposed on the North-western side of the outermost belt of Schuppen known as the "Naga Thrust" having strike in NE-SW direction and the remaining part of the Dimapur district lies within the belt of Schuppen. The rock formations belong to Tertiary and Quaternary periods.

During the late Cretaceous, tertiary sediments were deposited in Assam-Arakan Basin. The Disangs were deposited as flysch sediments in a Mio-geosyncline and the Burmese plate served as the provenance for these sediments. Barail group of rocks are formed under marine and estuarine environments. Distinct break in sedimentation and denudation represents conglomerate at the base of Bhuban formation after Renji. Primary sedimentary structures in Surma and Tipam group of rocks indicate fluvial condition of deposition. Subduction of the Indian plate is manifested as spongy shortening and migration of different thrust sheets to form the belt of Schuppen.

The Belt of Schuppen is a long belt of thrusted hills 10-20km wide running along the entire NW portion of the state. Mathur and Evans (1964) defined the belt of Schuppen as a narrow linear belt of imbricate slice which follows the boundary of Assam alluvium plain for a distance of 350 km along the margin of Naga Hills.

The outermost part of Schuppen is called the Naga Thrust marked by sudden elevation near Chumukedima which is located at old Nichuguard gate, though the Naga Thrust is not visible as it is covered by sediments. However, deep tube wells drilling water carried out by the ONGC, the presence of Naga Thrust is inferred and the inner most thrust is by the Haflong-Disang Thrust. Sedimentary structures like ripple marks, load casts, cross bedding and convolute bedding are common in Surma group of rocks and Tipam sandstone formation.

Further, the soils in Nagaland have been divided into four main orders. They are: Alfisols, Entisols, Inceptisols and Ultisols. Alfisols occur in Dimapur plains and

Medziphema valley, inceptisols in moderate hills, ultisols and inceptisols in higher regions and entisols in Niuland area.

Methodology

The methodology adopted in the present study has been grouped into two components, viz. field investigation and laboratory investigation.

Field investigation

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Detailed field study was carried out in and around DC Court areas during pre monsoon (March 2017) for assessment of water quality with special reference to drinking purpose. A total of 20 samples were collected from various wells in and around DC Court and the location of the water samples are listed below in Table 1.

Table: 1

Wells	Latitudes	Longitudes	Elevation	Depth
Well 1	N25°54.396’	E93°42.306’	142m	60ft 7inches
Well 2	N25°54.105’	E93°42.272’	159m	60ft
Well 3	N25°54.166’	E93°42.156’	179m	52ft
Well 4	N25°54.042’	E93°42.200’	176m	40ft
Well 5	N25°54.091’	E93°42.142’	143m	30ft
Well 6	N25°55.090’	E93°42.148’	148m	35ft 4inches
Well 7	N25°54.069’	E93°42.069’	132m	29ft
Well 8	N25°54.118’	E93°42.065’	133m	21ft
Well 9	N25°54.112’	E93°42.060’	135m	30ft
Well 10	N25°54.068’	E93°42.246’	140m	35ft
Well 11	N25°54.453’	E93°41.866’	168m	30ft 7inches
Well 12	N25°54.402’	E93°41.717’	157m	55ft
Well 13	N25°54.368’	E93°41.689’	160m	45ft
Well 14	N25°54.296’	E93°41.725’	164m	50ft
Well 15	N25°54.285’	E93°41.749’	164m	40ft
Well 16	N25°55.290’	E93°41.806’	169m	65ft
Well 17	N25°54.393’	E93°41.737’	178m	65ft
Well 18	N25°54.474’	E93°41.746’	162m	30ft
Well 19	N25°54.473’	E93°41.821’	164m	30ft 7inches
Well 20	N25°54.443’	E93°41.854’	165m	25ft 8inches


Laboratory work

The water samples collected from various locations in the study area. Physical and chemical parameters of groundwaters include colour, odour, temperature, pH, total hardness, total alkalinity, iron, nitrate, chlorides and fluoride were carried out by using ORLAB -Multi Parameters Field Water Testing Kit (MFTK), (figs above).

Results and Discussion

A total of 20 samples were collected from various wells in and around DC Court area of Dimapur town. The location of the water samples, physical and chemical parameters of groundwater are given below for discussion.

Table 2: Hydro-chemical parameters of water samples from study area

Sample	Temperature °C	pH	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Chloride (mg/l)	Iron (mg/l)	Nitrate (>mg/l or <mg/l)
Well 1	24	7.4	40	256	89	0.4	>1.0
Well 2	25	6.5	50	340	86	0.6	<10.0
Well 3	22	6.4	80	300	80	0.9	>1.0
Well 4	26	6.6	20	360	70	0.11	>10.0
Well 5	23	6.7	30	252	65	0.8	>1.0
Well 6	21	7	40	272	61	0.7	>1.0
Well 7	23	7	20	224	82	1.2	<10.0
Well 8	23	6.5	40	112	45	0.12	>1.0
Well 9	22	7	60	368	75	0.3	<10.0
Well 10	24	7	50	280	71	0.3	>1.0
Well 11	24	7.4	40	256	89	0.4	>1.0
Well 12	25	6.5	50	340	86	0.6	<10.0
Well 13	22	6.4	80	300	80	0.9	>1.0
Well 14	26	6.6	20	360	70	0.11	>10.0
Well 15	23	6.7	30	252	65	0.8	>1.0
Well 16	21	7	40	272	61	0.7	>1.0
Well 17	23	7	20	224	82	1.2	<10.0
Well 18	23	6.5	40	112	45	0.12	>1.0
Well 19	22	7	60	368	75	0.3	<10.0
Well 20	24	7	50	280	71	0.3	>1.0

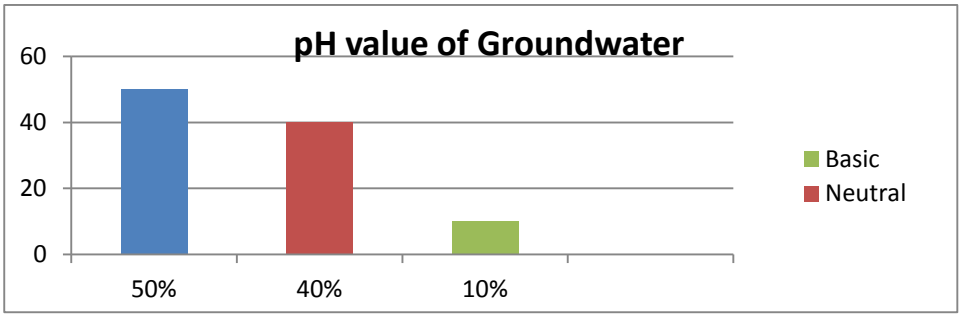

Fig: 2. pH value of groundwater

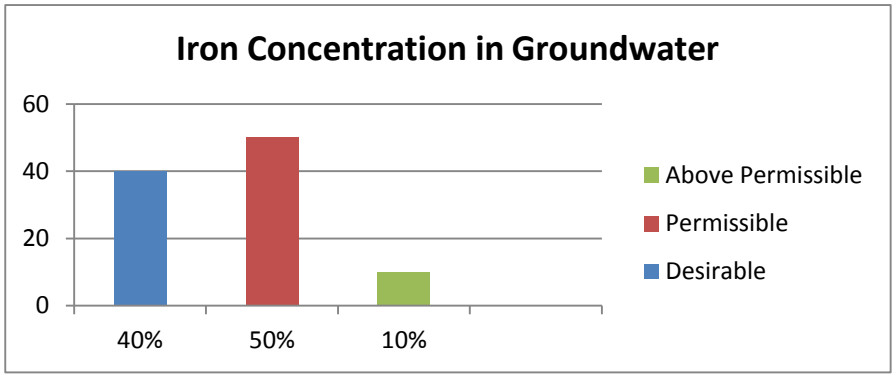

Fig: 3. Fe concentration of groundwater

The pH of water is very important as it provides information in many types of geo-chemical equilibrium or solubility calculations (Hem, 1985). In the study area, the pH values vary from 6.4 to 7.4 indicating acidic, neutral and basic nature. 50% of the water samples in the study area is acidic, 40% is neutral and 10% basic.

Total hardness denotes the concentration of magnesium and calcium ions, both expressed as calcium carbonate. Total hardness in the study area comes under the acceptable limit (200 mg/l) as per the BIS (1998) guidelines.

Alkalinity in neutral water is due to the presence of salts of carbonates, borates, silicates and phosphates along with hydroxyl ions in the free salts. (Peseyie and B. V. Rao, 2017). All the groundwater samples with reference to alkalinity are desirable for domestic and drinking purposes.

Chloride is found in all natural water and it is present in igneous and sedimentary rocks due to weathering as well as anthropogenic activities. In the study area the concentration of chloride in groundwater are within the permissible limits.

Iron is one of the major constituents in rocks present in mostly oxide, carbonate and hydroxide in sandstone, shale and limestone. The concentration of iron in groundwater of the study area varies from 0.1 to 1.2 indicating desirable, permissible and above permissible. 40% of the water samples in the study area are desirable, 50% is permissible and 10% is above permissible.

In the study area the concentration of nitrate in water is found to be desirable and fluoride concentration is found to be zero in the study area.

Conclusion

Overall study reveals that the groundwater from the study area is largely suitable for drinking purposes, except few wells in respect of iron concentration is above permissible limits as per the Bureau of Indian Standards (BIS), which needs further treatment to bring it under the permissible limit. Further, the study has revealed that there is an immense scope for development of ground water in the region based on the presence of thick unconsolidated formations in most areas.

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ROUNDNESS ANALYSIS AND TEXTURAL MATURITY OF THE TERTIARY ROCKS OF CHANGKIKONG RANGE, MOKOKCHUNG DISTRICT, NAGALAND

Reviewed

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Abstract: Flanking the eastern limit of Changki valley, the NE – SW trending Changkikong range preserves well developed cyclic sequences of the Belt of Schuppen all along its eastern face. The Tertiary succession of Changkikong range comprises of coal bearing Tikak Parbat Formation of the Barail Group (Oligocene), the Changki Formation and Tipam sandstone Formation of the Tipam Group (Miocene) in ascending order. Roundness analysis of detrital quartz grains in each of the Formations have been attempted besides assessing the textural maturity semi – quantitatively. The texturally immature sediments of the Changikong range possess sub-rounded character. Storm events coupled with post-depositional diagenetic alterations seem to have caused textural inversion in all the three Formations.

Keywords: Roundness analysis, Textural maturity, Tertiary rocks, Changki Valley, Nagaland

Introduction

The study area forms a part of the Naga Hills – the northern extension of the north – south trending Indo Burma Range (IBR) stretching all along the Indo - Myanmar international border linking Himalaya to the north and Andaman Nicobar islands to the south (Brunnschweiler, 1974). Based on morphotectonic elements, the Naga Hills has been longitudinally divided from west to east into four distinct units, namely the Belt of Schuppen**,** Inner Fold Belt (IFB)**,** Naga Hills Ophiolite (NHO) and the Naga metamorphic complex (Ghose et al., 2010). The Belt of Schuppen, around which the present investigation is centred, is thought to have been occupied by eight or possibly more overthrusts along which Tertiary sediments of Naga Hills have moved northwest ward relative to foreland spur (Evans, 1964; Mathur and Evans, 1964).

The study area forms a part of the Belt of Schuppen situated well within the Chanki valley (Fig.1). It is bounded between North parallels of 94˚20′ and 94˚30′ and East meridians of 26˚24′ and 26˚30′ of the Topographic sheet No.83G/7 of Survey of India. The entire area can be approached from Changki village either by foot track or unmetalled roads, the Mariani (Assam) being the nearest rail head linking Chagki village through metalled road. The Changki valley flanked between two sub-parallel strike ranges – the Changkikong to the east and Japukong to the west, presents an immature topography. The outer Japukong range possesses an average elevation of 750 meters where as inner Changkikong range attains an average elevation of 1000 meters. The main

objective of the present investigation is to analyze the roundness and interpret the textural maturity of the Tertiary rocks of the Changkikong range in Mokokchung district of Nagaland.

Geological setting

The belt of Schuppen constituting western part of Nagaland state is the most prominent morpho-tectonic unit of Naga Hills. It is a 200 kilometre long NE-SW trending belt of overthrust masses varying in width from 10-40 kilometers. The lithology, structure and tectonostratigraphy of different geological Formations in the belt of Schuppen has been described in detail by various workers including Evans (1932, 1964); Mathur and Evans (1964); Ranga Rao, (1983), Bhandari et al. (1973), Nandy (2000).

The Changki Valley with its spectacular Tertiary sequences occupies the nothern part of the Belt of Schuppen (Fig.1). The preserved sedimentary sequences exhibit well developed cyclic pattern with normal order of superposition except for the western face of the Changkikong range where litho-units pose thrusted contact.

The Tertiary succession of the study area comprises of coal bearing Tikak Parbat Formation of the Oligocene Barail Group (Fig.2), the Changki Formation (Fig.3) and Tipam sandstone Formation of the Miocene Tipam Group (Fig.4) in ascending order. The regional litho- stratigraphy after Mathur and Evans (1964) and Agarwal and Ghosh, (1986) has been followed in the present investigation except for the Changki Formation which was introduced by Ganju et al. (1986) as an alternation of shale, siltstone and sandstone but modified by Ralimongla (1998) as a sequence of very coarse to pebbly sandstone, sandy shale and conglomerate containing wood fossils. By virtue of its position above Barails and below Tipams, the Changki Formation was assigned an age equivalent to Surma Group, i.e. Miocene.

Methodology

Roundness Analysis

Roundness analysis (Krumbein, 1941, Sahu and Patro, 1970) of about 200 detrital quartz grains in each of Tikak Parbat, Changki and Tipam Sandstone Formations was carried out following the method suggested by Powers (1953). Detritals were classified into six roundness classes and average roundness of detritus in each sample was calculated. If n_1, n_2, n_3, n_4, n_5 & n_6 are number frequencies corresponding to six roundness classes and m_1, m_2, m_3, m_4, m_5 and m_6 are the midpoints of respective roundness classe, then,

$$\text{Average Roundness} = \frac{n_1m_1+n_2m_2+\ldots.n_6m_6}{S_n}$$

Where, $S_n = n_1 + n_2 + n_3 + n_4 + n_5 + n_6$.

The roundness frequency distribution and mean average roundness for different Tertiary Formations are shown in Table-1 and Table-2 respectively.

Textural Maturity

The semi-quantitative method after Folk (1951, 1966) was employed in assessing the textural maturity of the sediments under

question. Textural maturity of sediment is expressed in terms of clay matrix percent, sorting and roundness. Clay-free sediments containing well sorted and well rounded clasts are classed as matured texturally.

Results and discussion

Roundness Analysis

The bivariate plot of mean size (M_z) versus mean average roundness (Figs. 5, 6 & 7) exhibit sinusoidal relationship in respect of all the three Formations of the study area. The detritus having sizes up to 2.25Ø show increasing degree of roundness with decreasing grain size (more prominent in Changki Formation, Fig.6) but with fine sizes (>2.25Ø), the relationship is proportional i.e. a decrease in roundness is associated with a decrease in clast size (more prominent in Barails and Tipam Sandstone Formations, (Figs. 5 & 7).The inverse size-roundness relationship signifies either a dual source of sediments (Pettijohn, 1975) or considerable reworking in the near-shore environments (Swett *et. al..*, 1971). The later appears to be more plausible in case of Changki Formation.

Textural Maturity

The Tertiary sediments in the study area pose immature character as clay matrix variation ranges from 5 to 6%, 7 to 8% and 6 to 7 % in Barail, Changki and Tipam sediments respectively. The sorting, on an average, is moderate; moderate to well sorted and moderately well sorted in respect of Tikak Parbat Formation, Changki Formation and Tipam sandstone Formation. The roundness of quartz grains in all the three Formations possess sub-rounded character. The bivariate plot of average roundness versus matrix content (Figs. 8, 9 & 10) depicts a prominent textural inversion in of all the three lithostratigraphic units, that may be attributed either to post depositional diagenetic changes or storm induced mixing of sediments in a near-shore-beach complex. (Pettijohn, Potter and Siever, 1987).

Conclusion

From the above discussion it may be concluded that the texturally immature Tertiary sediments of the Changikong range possess sub-rounded character owing to the possible supply of detritus from recycled orogenic provenance. Mixing of sediments under storm events coupled with post-depositional diagenetic alterations might have been responsible for textural inversion in all the three Formations.

Table 1: Roundness frequency distribution (in percent) of detrital quartz grains in different tertiary formations of Changki valley

*Roundness classes after Powers (1953): A (0.12-0.17)-very angular, B (0.17-0.25)-angular, C (0.25-0.35)-sub-angular, D (0.35-0.49)-sub-rounded, E (0.49-0.70)-rounded, F (0.70-1.00) - well rounded.

	*R O U N D N E S S			C L A S S E S		
Sample No.	A (0.12-0.17)	B (0.17-0.25)	C (0.25-0.35)	D (0.35-0.49)	E (0.49-0.70)	F (0.70-1.00)
TIKAK PARBAT FORMATION						
R94/388	0.00	9.80	3.92	58.82	27.45	0.00
R94/389	0.00	2.38	7.14	71.43	19.05	0.00
R94/391	0.00	2.40	7.15	72.00	17.00	1.45
R94/039	0.00	0.00	2.00	60.00	28.00	10.00
R94/392	0.00	5.26	5.26	56.14	31.58	1.75
R94/393	0.00	2.00	4.00	68.00	24.00	2.00
R94/394	0.00	1.76	3.19	69.00	24.18	1.87
CHANGKI FORMATION						
R94/365	0.00	0.00	11.00	61.00	27.00	1.00
R94/300	0.00	11.11	0.00	58.33	22.22	8.33
R94/301	0.00	9.09	3.03	54.54	30.30	3.03
R94/303	0.00	0.00	0.00	71.43	28.57	0.00
R94/304	0.00	0.00	10.15	61.16	25.87	2.82
R94/306	0.00	0.00	5.13	53.85	38.46	2.56
R94/307	0.00	0.00	0.00	69.23	30.77	0.00
R94/308	0.00	0.00	10.20	61.22	26.53	2.04
R94/309	0.00	9.10	3.03	54.87	31.67	1.33
R94/314	0.00	10.11	0.00	57.33	32.11	10.44
R94/378	0.00	0.00	4.65	74.42	20.93	0.00
R94/381	0.00	0.00	13.16	63.16	21.05	2.63
R94/383	0.00	0.00	8.16	63.26	24.49	4.08
R94/367	0.00	0.00	4.00	28.00	68.00	0.00
R94/379	0.00	0.00	8.00	64.00	24.00	4.00
TIPAM SANDSTONE FORMATION						
R94/276	0.00	3.12	21.87	59.37	15.62	0.00

R94/277	0.00	3.03	12.12	48.48	36.36	0.00
R94/278	0.00	2.13	6.38	68.08	23.40	0.00
R94/279	0.00	0.00	9.37	59.37	31.25	0.00
R94/333	0.00	2.38	7.14	54.76	33.33	2.38
R94/334	0.00	0.00	16.33	61.22	22.45	0.00
R94/332	0.00	0.00	11.90	59.52	28.57	0.00
R94/335	0.00	0.00	6.98	62.79	25.58	4.65
R94/336	0.00	1.19	7.06	58.77	29.45	3.53
R94/374	0.00	5.71	17.14	51.43	25.71	0.00

Table 2: Variation of average roundness values of the detrital quartz grains of different lithofacies of tertiary rocks in Changki valley

SAMPLE NOS.	MEAN AVERAGE ROUNDNESS	AVERAGE
TIKAK PARBAT FORMATION		
R94/388	0.44	
R94/389	0.44	
R94/391	0.44	
R92/039	0.51	0.46 Sub-rounded
R92/392	0.46	
R94/393	0.46	
R94/394	0.46	
CHANGKI FORMATION		
R94/365	0.46	
R94/300	0.47	
R94/301	0.46	0.47 Sub-rounded
R94/303	0.47	
R94/304	0.47	
R94/306	0.49	
R94/307	0.47	
R94/308	0.46	
R94/309	0.46	
R94/314	0.48	
R94/378	0.45	
R94/381	0.45	
R94/367	0.53	
R94/379	0.47	
TIPAM SANDSTONE FORMATION		
R94/276	0.41	
R94/277	0.46	
R94/278	0.45	
R94/333	0.48	
R94/334	0.44	0.45 Sub-rounded
R94/332	0.46	
R94/335	0.48	
R94/336	0.48	
R94/374	0.43	

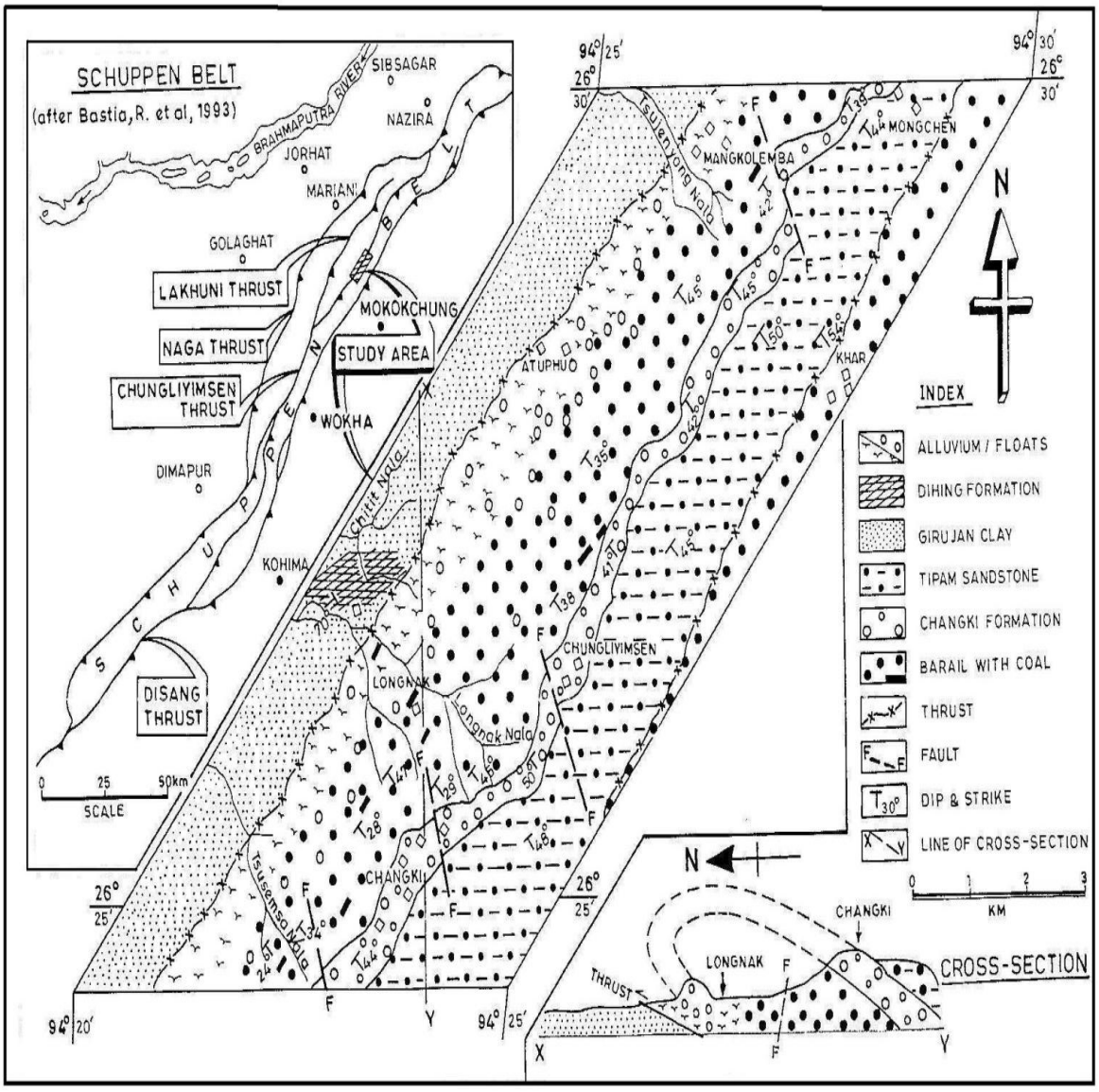

Fig.1. Geological map of Changki valley, Mokokchung District, Nagaland
(modified after Bastia *et. al.*, 1993)

Fig.2. Field photograph showing an outcrop of Tikak Parbat Formation (Barail Group). Height of the author is 5′5″.

Fig.3. Field photograph showing an outcrop of Changki Formation. Note lateral migration of small scale channels (arrow). Diameter of the Clinometer compass is 7.5 cm.

Fig.4. Field photograph showing an outcrop of Tipam sandstone Formation (Tipam Group). Note well preserved small scale ripples. Height of the author is 5′5″.

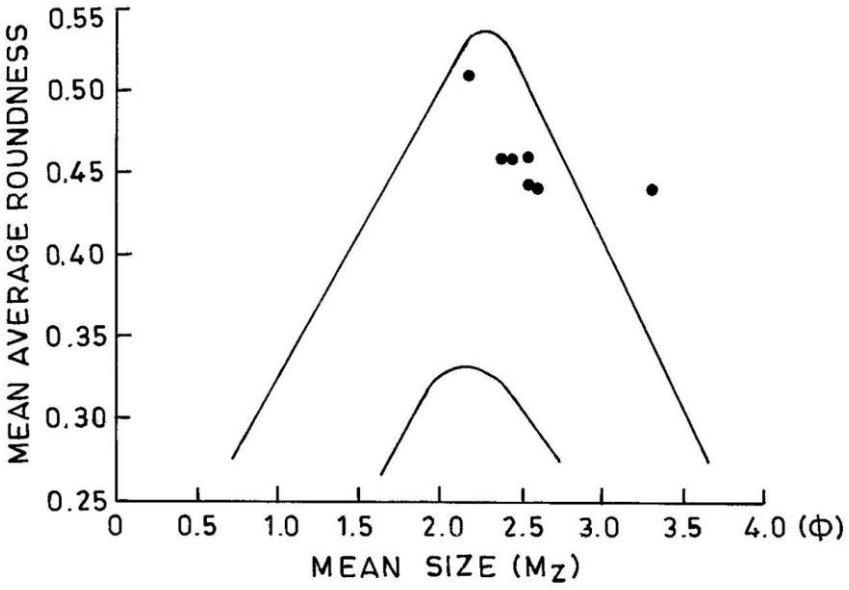

Fig.5. Mean average roundness versus Mean Size (Mz) plot of Tikak Parbat Formation

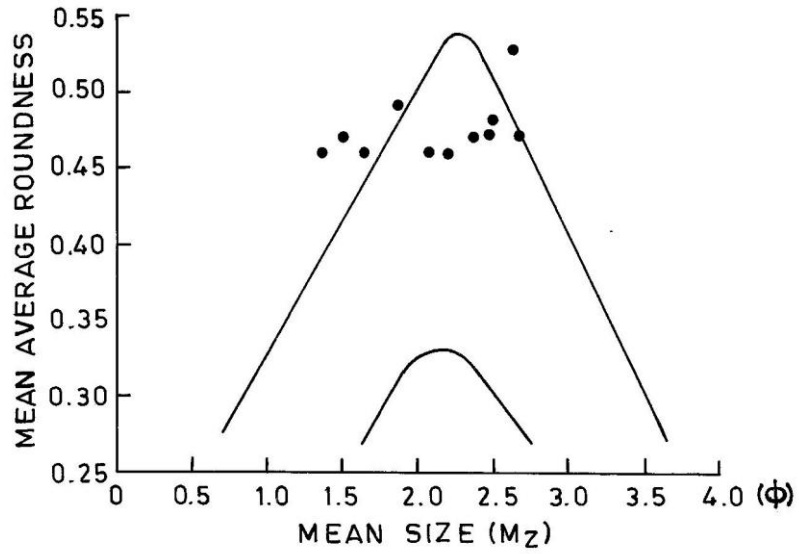

Fig.6. Mean average roundness versus Mean Size (Mz) plot of Changki Formation

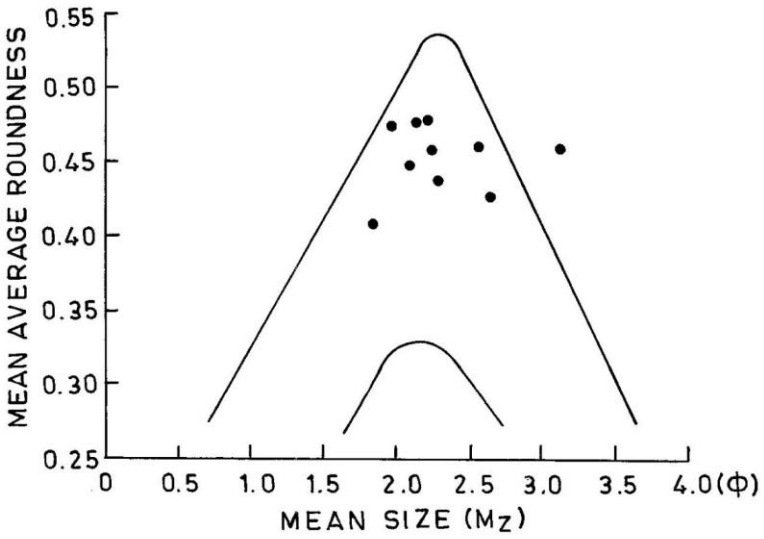

Fig.7. Mean average roundness versus Mean Size (Mz) plot of Tipam sandstone Formation

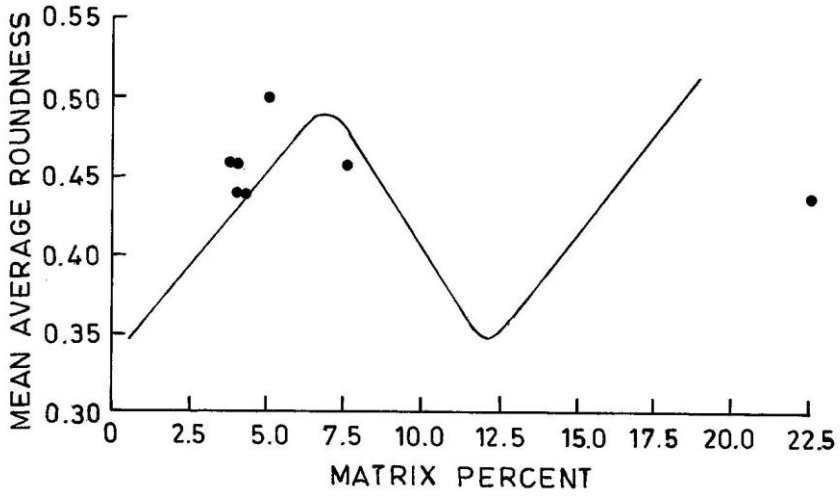

Fig.8. Mean average roundness versus Matrix percent plot of Tikak Parbat Formation

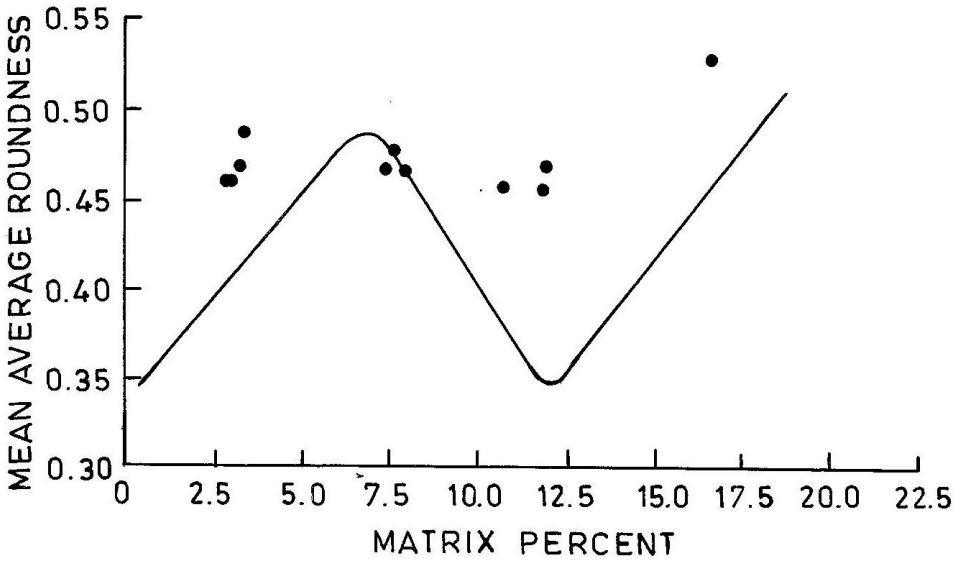

Fig.9. Mean average roundness versus Matrix percent plot of Changki Formation

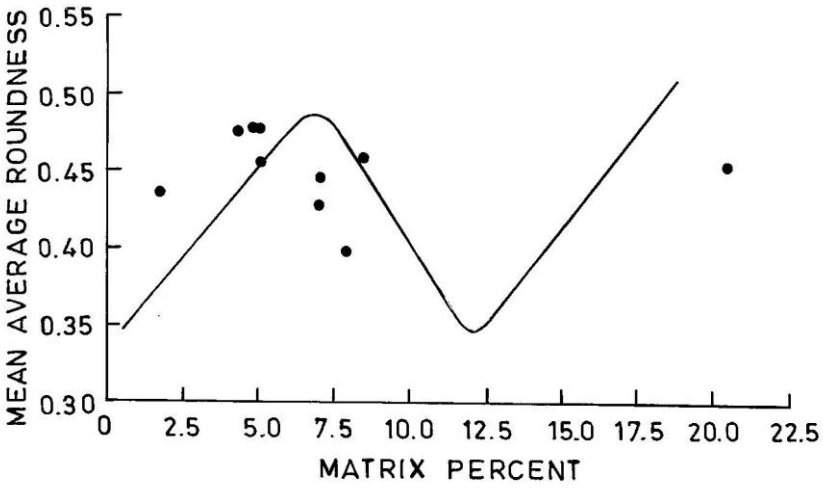

Fig.10. Mean average roundness versus Matrix percent plot of Tipam sandstone Formation

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PHYSICAL ENVIRONMENT OF PHEK DISTRICT, NAGALAND: A GEOGRAPHICAL PERSPECTIVE

Reviewed

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Abstract: Physical environment refers to the natural features such as mountains and rivers or the way in which the natural features of a place are arranged. Physical geography is an area of study that brings together and interrelate the important elements of man's physical environment (Strahler and Strahler, 1978). Phek district is a hilly district located in the southern part of Nagaland. The mountain summits are wooded with vegetation but the foot hills are deforested due to jhum cultivation. There are peaks exceeding 2000 m above msl while valleys are deep & narrow. The objective of this study is to provide geographical description on physical environment of Phek district. This study uses both primary and secondary data. Data collected were analyzed using statistical technique to explain the general physical environment of Phek district, Nagaland.

Key words: physiography, geomorphology, geology, drainage, climate.

Introduction

Environment refers to the sum total of conditions which surround man at a given point in space and time (Park, 1980). In the beginning, the environment of early man consisted of only physical aspects of the planet earth (land, air and water) and biotic communities but with the march of time and advancement of society, man extended his environment through his social, economic and political functions (Singh, 2009). Generally speaking, the environment is equated with nature wherein physical components of the planet earth viz. Land, air, water, soils etc. support and affect life in the biosphere. Physical elements are space, landforms, water bodies, climate, soils, rocks and minerals and these elements determine the variable character of the human habitat, its opportunities as well as limitations. Thus, physical environment is the circumstances and conditions (physical conditions) that surround and affect an organism or group of organisms (Singh, 2009). The physical environment may also be viewed in terms of climatic conditions providing certain suites of habitat for the biological communities including man viz., tropical environment, temperate environment etc. It is an established fact that different processes work in different climatic regions and with climatic variations there is also variability in the nature and mode of influences of climatic parameters which affect denudational (Weathering and erosion) processes. Temperature and humidity have emerged as the most significant climatic parameters of the control of geomorphological processes in different climatic regions.

- Location: Latitudes 25˚30'20"N to 25˚51'45"N and longitudes 94˚11'25"E to 94˚54'35"E.
- Area: 2026 sq.km and Population: 163294 (Provisional Census 2011).
- Important mountains peaks/ranges: Zanibu (2426 m), Mukhupusu (1873 m), Zipu (2074 m), Thurubophe (2288m) and Kapamedzu (2553 m).
- Important Rivers: Tachole Ru, knoba Ru, Lanye, Tizu, Tusuru, Arachu Nadi, Thetsi and Sedzu.

The study Area

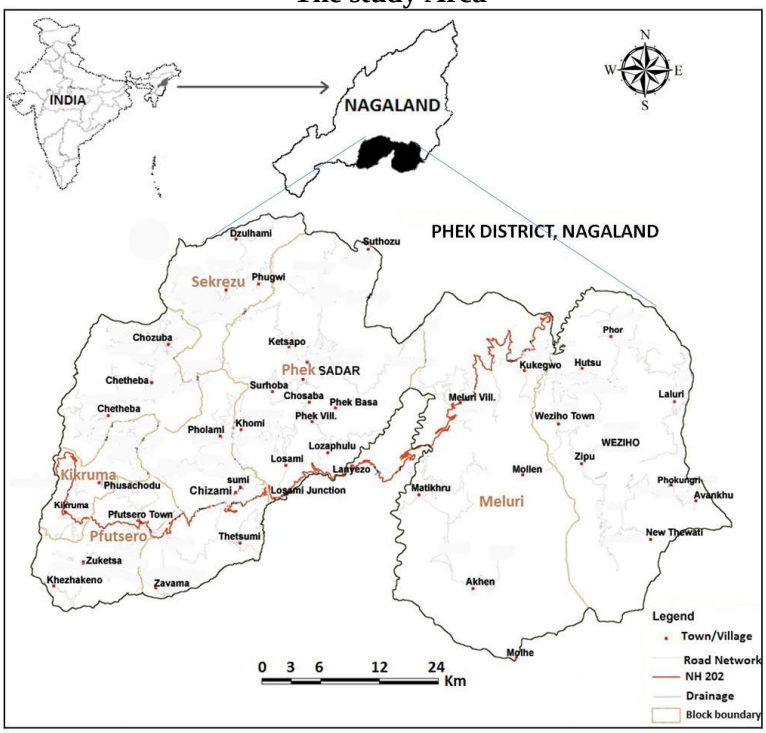

Fig.1: Location map of the study area viz., Phek District of Nagaland.

- Protected forest: 20731.77 ha land while land under shifting agriculture annually is about 15194 ha (SJLS Report 2005-06).

Objectives

The objective is to describe physical environment of Phek district and to highlight the degradation of the physical landscape due to the human activities. It also aims at providing information to those who yearns to learn about physical geography of the area as little research has been done in this area so far till date. It incorporates the following specific aims associated with the objectives.

1. To obtain detailed geomorphic information on drainage morphometry and relief Morphometry of the district.
2. Identification of various landforms, mass wasting processes and their control on land, water and forest resources.

Materials and methods

The data used in this study is both primary and secondary. Physiographic study was done through simultaneous field check and use of Toposheet 83k/2, 83k/6 and 83k/10 covering parts of Phek district of Nagaland. Geological information were

collected from NBSS&LUP-ICAR, Nagpur-440010. Meteorological data were collected from the Department of Soil and Water Conservation, Nagaland. Other socio-economic data, etc. were collected from Directorate of Census, Directorate of economics & Statistics, Nagaland and other sources. Data collected were analyzed using statistical technique to explain the general physical environment of Phek district, Nagaland.

Physiography

The Physiographic unit of the NE India consists of hills and mountainous stretches from Bhutan Himalayan, covering the Northern part of the N-E India then turning Southward, covers its Eastern and Southern parts. Starting from the Dibang valley and Lohit region of Arunachal, the Eastern hills cover South-Eastern Arunachal, Nagaland, North Cachar hills of Assam, a major part of Manipur, Mizoram and the eastern parts of Tripura. Phek district of Nagaland falls under (southern Patkai-Purvanchal) Hilly region. The ranges are raised during the late Himalayan orogeny. They are made up of tertiary sandstone, mudstone, shale and occasional limestone. The highest range, i.e., Patkai Bum has a height of 2000 m-3000 m. It is a synclinal range and made of hard sandstone. The highest peak is Saramati (3826 m) lying at Nagaland-Myanmar border. The hills and mountains are seismically unstable and said to be still rising. Earth quake occur frequently. Phek district can be divided into the following physical divisions (Fig. 2 & Table 1).

1. High hill slope.
2. Low hill slope.
3. Denudational hill slope.
4. Narrow valley.

High hill slope: High hill slope include Zanibu-Thurubophe and its associated ranges, kepamedzu, chozudzulu and the hills of Zipu-Terapimutu on the eastern border of the district with Myanmar. Zanibu Hill is one of the longest high hill (ranges) slopes which extend from northern part of Tuensang district. This hill slope starts from north western part of Phek district as Zanibu and extends north eastern up to the north of Tuensang and from there it bent southward down to the north of Phek as Chozudzulu hill slope. Kapamedzu hill slope extends from northern part of Manipur state and passes through the district from the south separating as a major watershed between Pfutsero circle on the west and Chizami circle on the east. Kapamedzu peak is found just few kilometers North West of Zavema Village. Another high Hill slope runs parallel to the river Cheche east of Tuhephu across Athumzu protected forest, down to Kotisumi village and curve northward towards Tuzatsi village and continue towards north east till the boundary with Zunheboto district near Natri and Tukhaki (or Khumutsa river sources (2481 m). High hill slope is also found from Lephori passing through Kanjang-Akhen and acts as a major water divide for streams to flow eastward and westward.

Low hill slope: These hill slopes are found on the western border of the district near Sedzu River and run northward up to north west of Tuensang district. These low hill slopes cover most part of western Chetheba, Chozuba and Sekrezu areas (Fig. 2).

Denudational hill slope: Denudational hill slopes are found in between High hill slopes and Low hill slopes (Fig. 2). Denudational hill slopes are denudated because of devotion of these hill slopes to Jhum cultivation. Jhuming is practiced in almost all the villages by the farmers in the district. Moreover, these hill slopes are suitable for shifting (jhuming) cultivation. Hence, they are denudated because of felling of trees for cultivation.

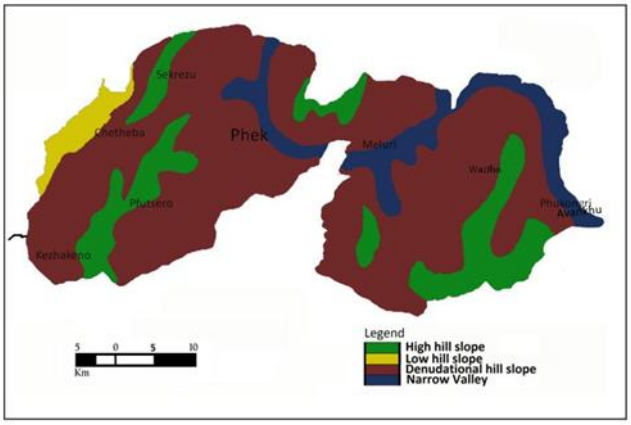

Fig. 2: Physiographic division of Phek District, Nagaland

Table 1: Area under different physiographic divisions of Phek district, Nagaland

Physiographic Divisions	Area (in sq.km)	Area (in %)
High Hill Slope	386.36	19.07
Low Hill Slope	59.36	2.93
Denudational Hill Slope	1318.72	65.09
Narrow Valley	261.56	12.91
Total	2026.00	100.00

Source: Based on National Bureau of Soil Survey & Land Use Planning, 2000

Narrow Valley: Narrow Valleys are found along the river courses of Tusuru-Tizu River and its tributaries in the north and east of Phek town; Tuphale-knoba-Lanye River east and south east of Lozaphuhu village and along Tizu-Arachu Nadi rivers and its tributaries in the east (south of Meluri) and north east along the boundary between Kiphire and Phek district. The shape of narrow valley belt in the district looks like letter "S" along Tizu river in Phek district (Fig.2).

Geomorphology

The Terrains of Phek district are rugged and slopes are generally steep. Streams and rivers are in the juvenile stages of cycle of erosion with deep & narrow V-shaped valleys indicating high erosive force and vertical erosion. Some of the significant erosional landforms resulting from fluvial processes are V-shaped valleys, waterfalls and rapids, pot holes, meanders, etc. The valleys are gradually widened due to lateral erosion in the lower section of river (Plate 1). But in general, the valleys found in Phek district are, by and large, narrow valleys. Slopes being steep, only few meandering types are formed in lower section of rivers where the valleys are relatively broader and the flow velocity of river is reduced. The important land forms formed by river deposition are Alluvial fans and cones, sand banks and small natural levees. Few natural levees are formed in broader valley plains where the river meanders and channel gradients are low. A breach in levees causes sudden overtopping of water in the adjoining wet paddy fields (Plate 1). Drainage networks

are dense with high dissection. Nearly two-third of the Geographical area is dissected land (Fig.3.). Primary surface processes responsible for most topographic features of Phek district of Nagaland includes weathering, mass movement/wasting, running water and to greater or lesser degree, tectonics and volcanism such as earthquakes. Phek district being nestled in a dense network of drainage with steep slopes (average slope=24°), fluvial morphology is the dominant landform process. Weathering naturally and through man induced activities like quarrying (activities for extraction of boulders for building), road and bridges construction and Mass movement such as landslides induced by anthropogenic activities are common. Block disintegration is an important physical weathering in Phek district. Disintegration of rocks due to freeze and thaw of water is a common occurrence in winter. Carbonation acting on limestone rocks is another weathering feature in the eastern parts of the district. Anthropogenic weathering on hill slopes by modifying the ground surface through deforestation and jhumming causes slope instability resulting slope failures and mass movement of materials down the slope in the form of landslides, and debris falls are common features. Landslides are most significant of all types of mass movements in the Phek district (Plate 2 & 3). Mountain range running from Kapamedzu from the South to Methocepi via Pfutsero-Chozuba-Suthozu form great watershed dividing rivers to flow either into Brahmaputra in the west in Assam or Chindwin in the East in Myanmar (Fig.6).

Surface forms: The Surface forms of Phek district are highly dissected. High hill slopes are associated with dissected landforms (Fig.3). Steep lands are found in the western part of the district near Sedzu river, also bordering Lanye and Tizu rivers. Rolling lands are found along the district boundary between Phek and Kiphire, near Ankhen and South of Kanjan, northwest of Chozuba adjoining Zunheboto district.

Geology

Geologically, Nagaland is a part of Assam-Myanmar geological province which itself was a portion of Tethy's sea. During the Paleozoic and Mesozoic eras this continued receiving sediments eroded from the Archean rock to form conglomerates, shales, sandstone and limestone. During the later period the region experienced orogenic movements accompanied by igneous

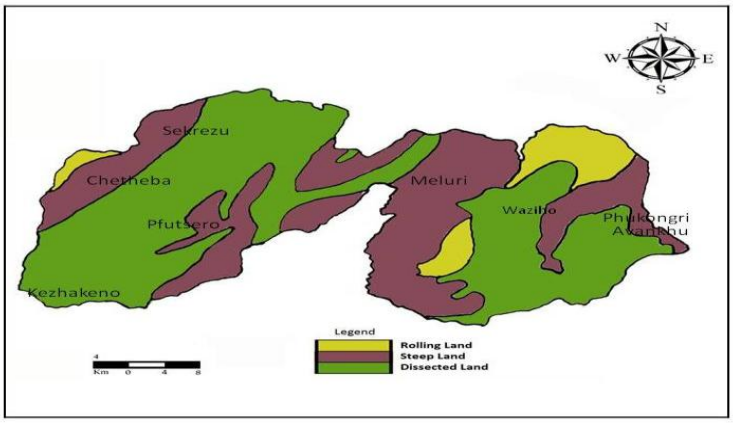

Fig. 3: Surface Forms of Phek District, Nagaland.

intrusions. The final orogenic phase in the early pliestocene age raised this area to its present height. In some parts folding has been so intense that the rock bed stand up vertically, resulting in bare hill sides. The region is very much unstable and falls within the seismic zone 1. It is also characterized by the presence of many faults. Nagaland is located in the northern extension of the Arakan Yoma ranges which are of Tertiary Cretaceous age and belong to fairly young mobile belt of the earth. The rock sequence is of the geo-synclinal fecies, represented by the Disang group (Lower and Middle Eocene, Upper Cretaceous), the Borail group (Upper Eocene and Oligocene), the Surma and the Tipam group (Miocene), the Namsang beds (Mio-Pliocene) and the Dihing group (Pliocene-Pleistocene) (Fig. 4).

The older alluvium comprising clay, coarse sand gravel and boulder deposits occurring at various levels cover the areas along the north-western flank of Naga-Patkai and parts of Manipur. The newer and low level alluvium comprising clay, sand, and silt covers vast areas bordering the Naga Hills (Fig. 4). Geologically, the terrain of Phek district of Nagaland is made up of tertiary rocks belonging to the Barail, Disang, and Tipam series of Miocene age. The Barails are composed of alternating sandstones and shales with carbon seams, where as the underlying Disang series represent unfossiliferous shales, slates and phylites. Certain ultra basic intrusions are also observed towards the south eastern flank of the Kohima and Phek districts. Kohima and Phek districts are governed by Disang and Barail Series but in Phek District, mostly by Barail in the West and Disang Series in the East. Ophiolite belt stretches from Manipur crosses the eastern part of the district (Fig. 5).

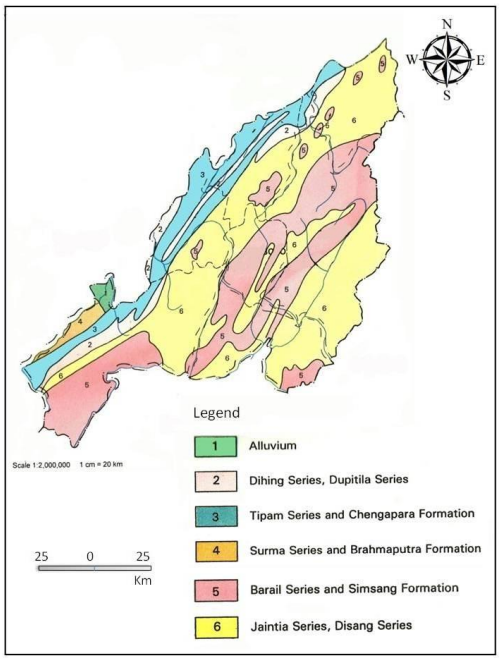

Fig. 4: Geological map of Nagaland
(Source: NBSS&LUP-ICAR, Nagpur-440010)

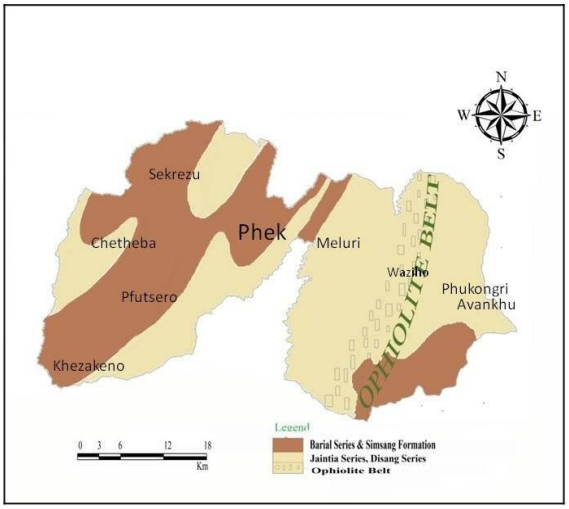

Fig. 5: Geological Map of Phek district, Nagaland

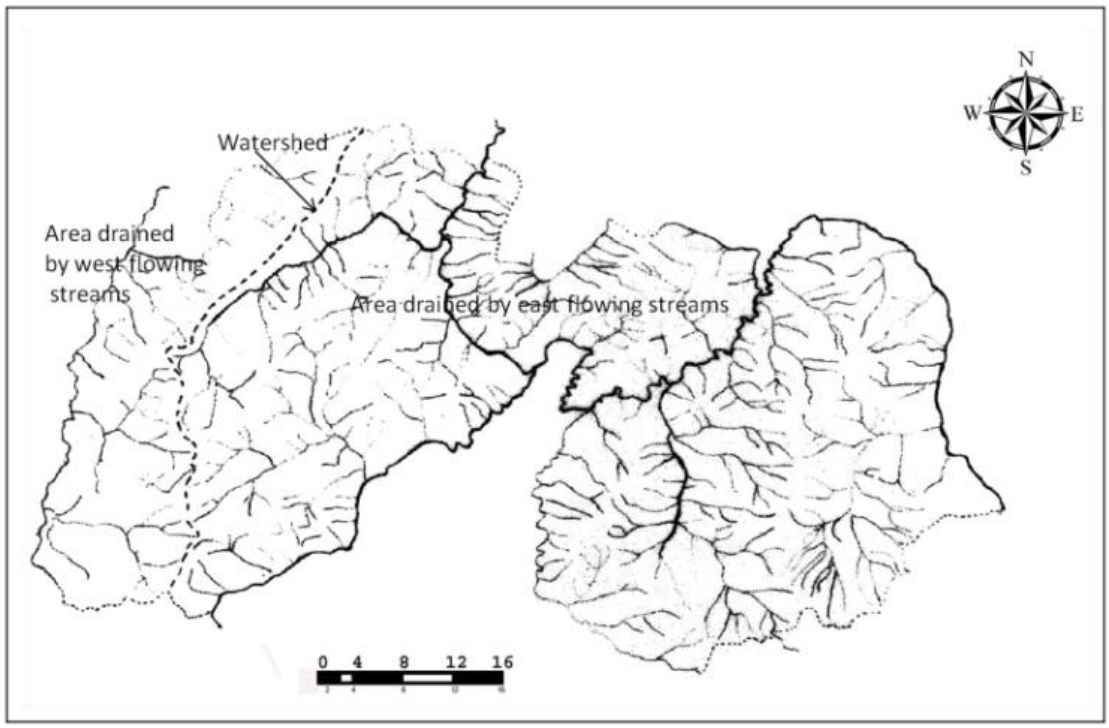

Fig.6: Drainage map of Phek district showing area drained by East and West flowing streams.

Drainage System

The drainage system of Phek district can be classified into two on the basis of either flowing into Bramaputra in the west in Assam or Chindwin in the East in Myanmar. The rivers which flow in to Bramaputra are Sedzu River and its tributaries. On the other hand, the rivers which flow in to Chindwin are Tizu-Lanye-Tusu ru-Thetsi Rivers and their tributaries. The great watershed which divides these rivers to flow toward East and West is the long mountain range that runs from Kapamedzu in the South to Methocepi and to Kumnuboto via Pfutsero-Chozuba-Suthozu (Fig. 6). Both Sedzu and Tizu rivers form a part of the natural boundary of the district with other districts. In fact the boundary of the district with others is made either by high mountain ranges or the rivers.

Climate

Climate is an aggregate weather condition of any region in long term perspective. Climate is one of the most important parts of the physical environment which is one of the two major sources of providing energy to regulate the (catchments) ecosystem. Temperature, pressure, wind, humidity, precipitation, cloudiness etc. are elements of weather and climate. The three principal elements of weather and climate i.e., temperature, humidity (R/humidity), precipitation (rainfall) have been selected for the study of climatic condition of Phek district. January is the coldest (11.82˚C) and August is the hottest month (23.1˚C). The average annual temperature (2001-2010) stands at 18.4 ˚C (Table 2.3). July is the month of heaviest rainfall (average 270.6 mm). About 62 percent of the total annual

rainfall is contributed by summer monsoon. The rainfall records show that it is a region of moderate rainfall where the average annual rainfall stands at 1500.5 mm. The district exhibit high humidity throughout the year (average R/H=75% Table 2.4). Elements of weather & climate data suggest that climatically Phek district falls within the sub-tropical to temperate climatic region. The district has, therefore, a typical monsoon climate with variations from subtropical to temperate conditions characterized by warm summer and mild winters with seasonal dry spells extending from November to April. The length of growing period ranges from 330-365 days and moisture index ranges from 140-160 %. The invigorating breeze and the temperate weather make life pleasant. The climate over the foothills is warm, subtropical and that over the hills is cool and temperate. The average summer and winter temperature oscillate between 11.7˚C to 23.1˚C. Over the hills, temperature is cool during winter and occurrence of frost is observed but snowfall is rare in the inhabited areas.

Table 2: Average Monthly and Annual Rainfall (in mm) for 10 years i.e., from 2001 to 2010 recorded at Phek Town

Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Jan	5	27.8	19.9	2.2	2.4	0.0	0.0	37.2	1.4	3.6	9.95
Feb	54.3	7.2	12.6	10.7	30.8	15.6	82.2	10.0	6.8	0.8	23.1
Mar	9.4	21.3	62.2	7.0	143.8	8.4	19.6	44.6	9.6	45.6	37.15
Apr	45.8	151.9	107.5	275.6	62.3	127.0	91.2	33.6	51.4	73.6	101.99
May	149.8	277.5	167.3	126.7	227.4	109.0	209.4	189.0	171.2	128.6	175.59
Jun	201.4	234.5	131.6	215.8	294.2	232.0	306.4	368.2	157.6	359.8	250.15
Jul	233.6	313.4	270.1	415.0	271.3	211.4	325.4	169.6	182.2	314	270.6
Aug	203.8	321.3	309.1	258.1	161.0	100.6	213.4	221.8	272	288	234.91
Sep	221.4	139.3	128.8	273.7	111.2	281.4	217.6	147.0	87.6	368.9	197.69
Oct	222.6	31.0	280.0	205.3	171.2	91.6	184.8	142.8	109.4	193	163.17
Nov	33.8	42.5	20.4	17.0	4.4	21.8	64.2	0.4	1.2	7	21.27
Dec	00	11.7	51.0	2.6	23.4	0.0	13.8	7.4	0.0	5.2	11.51
Year	**1380.9**	**1579.4**	**1560.1**	**1844.7**	**1503.4**	**1198.8**	**1728.0**	**1371.4**	**1050.4**	**1788.1**	**1500.5**

Source: Soil and Water Conservation Department, Govt. of Nagaland

Table 3: Average Monthly and Annual Temperature (°C) for 10 years i.e., from 2001 to 2010 recorded at Phek Town

Month (2001-2010)	**Average Max. Temp. (2001-2010)**	**Average Min. temp. (2001-2010)**	**Average temp. (2001-2010)**
Jan	18.35	5.29	11.7
Feb	20.49	7.9	14.1
Mar	23.6	11	17.3
Apr	24.9	13.6	19.2
May	25.7	15.8	20.7
Jun	26.4	17.9	22.1
Jul	26.6	18.6	22.6
Aug	27.6	18.6	23.1
Sep	26.8	17.79	22.2
Oct	24.48	15.1	19.7
Nov	21.6	10.1	15.8
Dec	18.49	6.4	12.4
year	**23.7**	**13.1**	**18.4**

Source: Soil and Water Conservation Department, Govt. of Nagaland

Table 4: Average Monthly and Annual Humidity (R/H in %) for 10 years i.e., from 2001 to 2010 recorded at Phek Town

Month	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Jan	63	68.7	69.9	74.5	69.1	75.1	69.3	71.5	62.4	60.8	68.4
Feb	64.1	66.0	65.9	11.6	59.9	68.6	75.5	69.1	54.7	57.8	**59.3**
Mar	56.7	58.4	66.6	67.6	71.4	55.2	62.0	69.2	54.5	53.1	61.4
Apr	57.2	75.0	66.6	81.3	63.2	68.0	66.0	59.2	59.1	65.2	66.0
May	74.1	77.5	75.6	73.5	75.5	71.8	74.2	73.4	68.3	79.7	74.3
Jun	80.6	76.6	83.1	82.8	77.4	81.8	82.2	85.2	75.2	87.4	81.2
Jul	82.3	85.7	84.5	85.4	83.4	82.7	84.7	83.6	77.4	88.3	**83.8**
Aug	82	83.5	82.0	83.3	82.9	78.2	83.1	86.1	84.6	85.4	83.1
Sep	83.4	81.2	85.8	87.2	80.1	82.2	81.0	82.9	78.6	88.3	83.0
Oct	86.1	80.9	84.9	81.8	84.9	77.6	81.0	83.4	85.5	86.1	83.1
Nov	86	84.8	82.3	82.8	78.3	76.1	78.8	71.9	76.7	81.9	79.9
Dec	75.7	76.2	80.3	78.1	76.9	75.0	77.8	77.8	73.3	76.3	76.7
Year	74.3	76.2	**77.3**	74.1	75.2	74.3	76.3	76.1	**70.8**	75.8	**75.0**

Source: Soil and Water Conservation Department, Govt. of Nagaland.

Plate 1: Meandering of River Dzuli

Plate 2: Road construction-induced landslide

Conclusions

Phek district falls under mountain hilly region with four distinct physiographic entities-high hill slope, low hill slope, denudational hill slope & narrow valley. The Terrains are rugged and slopes are generally steep with deep & narrow Valleys and Streams/rivers are in the juvenile stages of cycle of erosion. Most of topographic features are carved out through weathering, mass movement/wasting, running water and, to greater or lesser degree, tectonics and volcanism. Fluvial morphology is the dominant landform process. The Surface forms are highly dissected. The terrain is made up of tertiary rocks belonging to the Barail, Disang, and Tipam series of Miocene age with prominent Ophiolite belt in the eastern part of the district. The drainage system is such that the river either flows into Bramaputra in the west in Assam or Chindwin in the East in Myanmar. The district has a typical monsoon climate with variations from subtropical to temperate conditions characterized by warm summer and mild winters with seasonal dry spells. As a result of good soil and heavy rainfall there is luxuriant growth of forests mixed with herbs and shrubs. However many forest areas are being lost due to extensive jhumming and are replaced by degraded re-growth. The soil types found are Inceptisols, Ultisols and Entisols. Inceptisols is the dominant soil.

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TRACE FOSSILS OF THE BARAIL SEQUENCES AND THEIR PALAEOENVIROMENTAL SIGNIFICANCE AROUND JOTSOMA, KOHIMA DISTRICT, NAGALAND

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Abstract: Ichnofossils from Barail sequences around Jotsoma area are mixtures of domichnia and foodichnia belonging to *Skolithos, planolites, Arenicolites, Ophiomorpha,* etc., which were recorded both from mudstone and sandstone facies. Assemblages and sedimentological character of the sequence indicate temporal changes from shallow marine through deep marine depositional environments.

Key words: Ichnofossils, Barail rocks, Oligocene, Jotsoma area, Kohima District, Nagaland.

Introduction

Trace fossils are biogenic structures that are preserved on the bedding planes or within the beds, and are produced by the life activity of organisms. Trace fossils provide information about the life habits of fossil organisms and are useful in palaeoenvironmental studies (Savrda,1995).They are different from body fossil in the sense that they are formed by an animal's behavioral activities in response to the substrate and other palaeo-ecological factors rather than being a part of an animal's body. They are generally considered as good indicators of sedimentary environments as they provide information of hydrodynamic energy levels during deposition, substrate stability, salinity variations and oxygenation levels (Seilacher, 1967, 1977; Howard and Frey, 1984; Ekdale *et. al*., 1984; MacEachern *et. al*., 1992). Trace fossils distributions are indirectly controlled by bathymetry (Seilacher, 1967; Bromley, 1996). Direct parameters that have control on the trace makers could be substrate conditions (i.e. grain size, sorting, and substrate consistency), food availability, salinity, temperature etc. Trace fossil data mostly contribute to a better understanding of the sediments from the perspective of organism-substrate interactions (Uchman *et al*., 2004; Buatois and Mángano, 2002, 2011).

Many features like tool casts, flute casts, mud cracks, interference ripples, and deformation structures, cone in cone concretions, crystals and molds of body fossils are often misidentified as trace fossils. Trace fossils includes (i) footprints, tracks and burrows in unconsolidated sediments (ii) rasping, borings and etchings in rigid substrates (iii) faecal pellets, pseudo-facies and coprolites. Some geologists also include: (iv) plant root penetration structures, and even (v) algal-mate laminites and stromatolites.

Study area

The study area, Jotsoma, is a village panchayat located in the Kohima district of Nagaland state, India. The geo-coordinate of Jotsoma is N25°67' latitude and E94°06' longitude. The area under study is an Inner Palaeogene Fold Belt of Kohima Synclinorium. The surrounding nearby villages are Khonoma, Mezoma, Sechuma, Sechu-Zubza, Peducha, Thekrejuma & Dzulakema. Jotsoma is located around 4.7 km away from its district head quarter Kohima.

Trace Fossils have been collected along Jotsoma and Jotsoma-Khonoma road which criss-cross the study area, a few km's away from Kohima. The geological map (Fig-1) forms the basis of mapping of the study area on a scale 2cm=1km.

Objective

The objective of this study is to systematically describe the trace fossils of Barail sediments around Jotsoma area, Kohima District, Nagaland, and to interpret them in terms of depositional environment.

Methodology

The methodology employed in the present study has been divided into two major components viz, field investigation and laboratory investigation as mentioned below:

Field investigations: Collections of oriented and random samples in time and space, recording of trace fossils, and measurements and recording of lithologies.

Laboratory investigations: Identification of the trace fossils and their interpretation in terms of palaeo-environment and Palaeo-ecology.

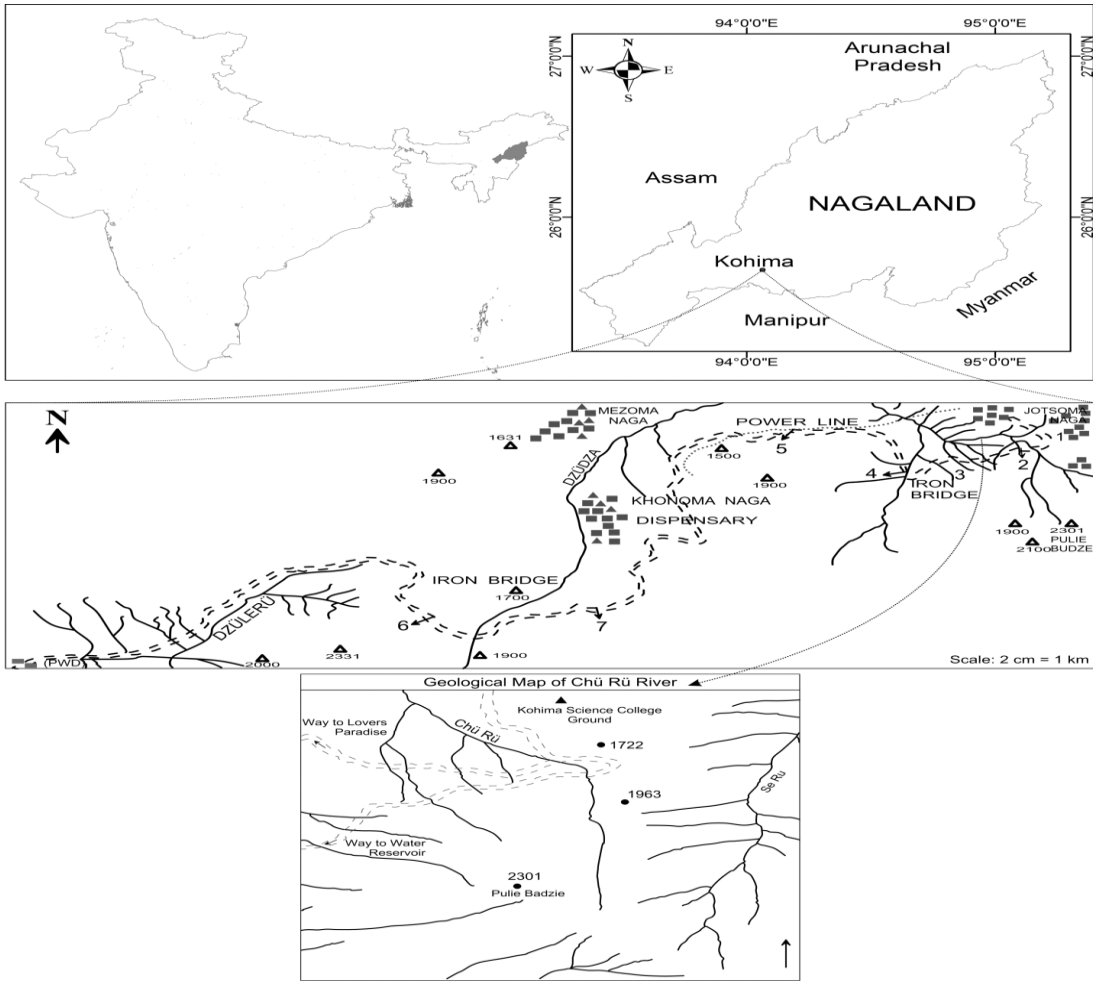


Fig.1: Location map of the study Area

Results

Identification and classification of the present ichnofossils, followed the Treatise on Invertebrate Paleontology (Häentzschel, 1962, 1975), classification scheme suggested by Simpson (1975) and Seilacher (1964, 1967). A total of ten specimens have been collected from the study area. Identification, name of author, systematic description, remarks and occurrence against each of the specimen are furnished in the following.

Ichnogenus: ***Ophiomorpha*** **Lundgren, 1891**
Ophiomorpha isp.
Description: Hypichnial, straight or slightly winding, branched, horizontal trace fossils, covered with poorly preserved knobs (1-3mm). It is elliptical in cross section and its diameter ranges from 7-35 mm. The cylinders are slightly winding. The length and diameter vary due to different burrow populations. They are covered with casts of scratch mark. *Ophiomorpha* is mud-lined and exhibits a "y-shaped" branching of smaller burrows of a larger main shaft (i.e. in sparsely bioturbated sandstone).
Remarks: This specimen is put in an open nomenclature due to its poor preservation. *Ophiomorpha* occurs predominantly in shallow water near shore deposits.
Occurrence: Sandstone- shale interbeds of the Barail Formation along Jotsoma-Khonoma road of Kohima district, Nagaland.

Ichnogenus: ***Ophiomorpha*** **Lundgren, 1891**
Ophiomorpha nodosa
Description: The burrow is vertical shaft, unbranched tunnels, consisting of regular distributed discoid pellets, and preserved as full relief. Diameter of burrows is approximately about 10 cm. The tunnels are filled with same sediments as the host rock.
Remarks: The main morphological features of the recorded burrow is very identical to *Ophiomorpha nodosa* Lundgren (1891) reported by Patel *et al* (2008).
Occurrence: Recorded from the grey Barail sandstone outcrops along Jotsoma-Khonoma road, Kohima

Ichnogenus: ***Gyrolithes*** **Saporta, 1884**
Gyrolithes isp.
Description: Spiral burrow with diameter of incomplete whorl up to 80 mm and diameter of burrow is ~17-19 mm. Surface of the burrow is smooth, slightly filled with small transverse ridges. The sediment fill is silty-sandy and coarser than the host rock.
Remarks: This specimen is questionably assigned to*? Gyrolithes isp*. Based on the dextral spiral nature of burrows preserved on the bedding plane. No vertical view is visible to observe the coiling pattern and number of circular helices which are diagnostic features of this Ichnogenus. *Gyrolithes* is a dwelling burrow of a suspension feeding organism and occurs in marginal marine setting. They are escape traces formed by surface-detritus feeder and passive carnivores' .*Gyrolithes* is known from Cambrian to Miocene.
Occurrence: Recorded from the sandstone beds near Chürü (near Sazolie college, Jotsom)

Ichnogenus: ***Planolites*** **Nicholson (1873)**
Planolites isp.
Description: *Planolites* occurs as hypichinial, straight to slightly winding ridges preserved in the sandstones. The burrows are predominantly horizontal, long, cylindrical, smooth-walled, unlined, unbranched and oriented more or less parallel to the bedding plane. They occur as a single isolated specimen. Their length is approximately around 8-9cm.They are preserved as positive epirelief.The burrow fill is surrounding the host sediments.
Remarks :The *Planolites* are actively filled and unlined and they are usually compared with *Palaeophycus.our* specimen resemble the

Planolites Montabus which are characterized by relatively small, curved to snake-like burrows and the filling materials consist of cleaner, better- sorted sediment than the host rock(Pemberton and Frey 1982).
Occurrence: Huge boulder beds of Barail sandstones, along Jotsoma, Kohima.

Ichnogenus: ***Chondrites*** **Sternberg, 1833**
Chondrites intricatus (Brogniart) Sternberg, 1833
Description: A ramifying system of branching tunnels(0.1-0.2 mm), arranged in a fan-shaped pattern on the shaly bedding plane, terminal branches deflected at intervals of 1-2mm and at an angle of 45°.the burrow tunnels are filled with lighter material than the host rock. The sample resembles with the *Chondrites intricatus* in branching pattern of tunnels.
Remarks: Fu (1991) suggested that the mode of branching pattern is the only taxonomic criterion for the classification of the *Chondrites*. However, Uchmen (1999) and Uchmen *et.al* (2012) suggested that the ratio of the burrow width for the radius of the burrow system should also be criteria for the classification. Using these classification criterions, the presently collected specimens are grouped under the *Chondrites intricatus* (brogniart, 1823) because of the morphological resemblance. *Chondrites* is considered to be made by deposit feeders during burrowing or made by chemo symbiotic organism which live in aerobic/anoxic interface, or are "cesspit" for fecal pellets produced by the excretory behavior of surface deposit feeders. This Ichnogenus is found in both anaerobic and oxic sediments and is used as a good indicator of anoxia condition.
Occurrence: Recorded from Barail Sandstone along Dzüna Rü (along Jotsoma-Khonoma road)

Ichnogenus: ***Thalassinoides*** **Ehrenberg, 1944**
Thalassinoides isp.
Description: Hypichinial to full-relief burrow and system of burrows. Burrow wall smooth and unlined regularly, few burrows exhibit Y and T-shaped branched structures. The range of branching angles varies from roughly 103° to 117°.one of the specimen is preserved as three dimensional horizontal network. The cylindrical burrows vary in diameter from 6-50 mm approx. and the length of individual branch varies from 21- 241 mm approx.
Remarks: Fürsich (1973) included *Thalassinoides* into the synonymy of *Spongeliomorpha.*we follow Seilacher (2007) who considered it as a separate Ichnogenus. Our specimen closely resembles in morphology with the *Thalassinoids Suevicus* as the burrow walls lack tubular lining, smooth, locally with poorly preserved longitudinal grooves or ridges, exhibiting swellings and are dichotomic Y and T-shaped bifurcation of burrows. *Thalassinoids* is a dwelling and feeding structure of decapods crustaceans and mostly occurs in shallow marine water to turbidite fans.
Occurrence: Barail Sandstone along Chürüzha Rü (along Jotsoma-Khonoma road)

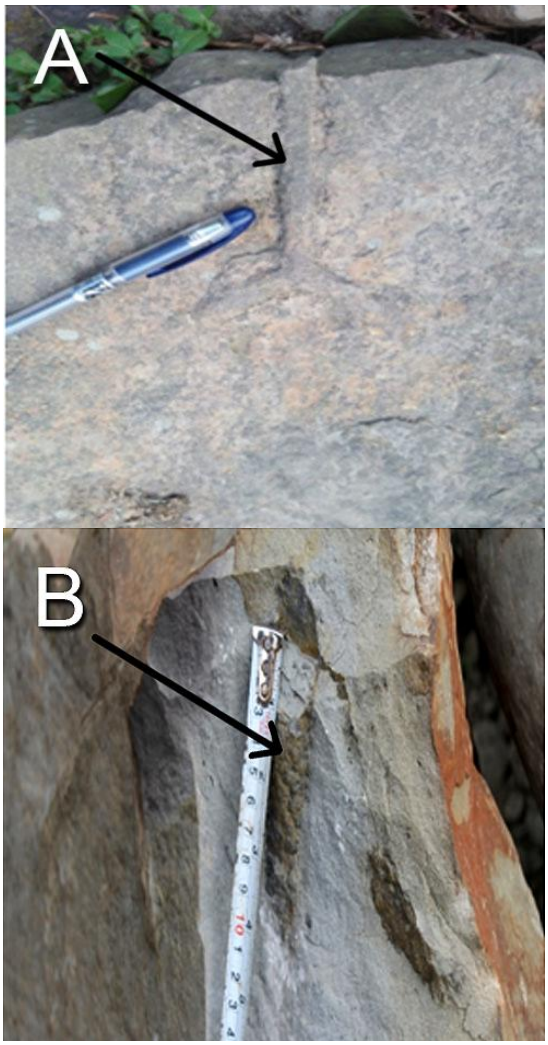
Ichnogenus: ***Skolithos*** **Haldemann (1840)**
Skolithos linearis
Description: Vertical or steeply inclined, unbranched, sub cylindrical, lined burrow perpendicular to the bedding plane with structure less fill. It occurs as closely spaced or isolated tubes on the bedding planes. The depths of the burrow vary in different burrow population and maximum depth observed is 35mm (approx.), it also appears as circular to sub circular outlines on bedding planes and standout as high relief burrow; infill material is different from the surrounding matrix and mostly seen as light color.
Remarks: Morphologically, this specimen clearly falls within the range of *Skolithos linearis* as described by Alpert (1974), Curran and Frey (1977) and Curran. Alpert (1974) and Pemberton and Frey (1982) suggested that

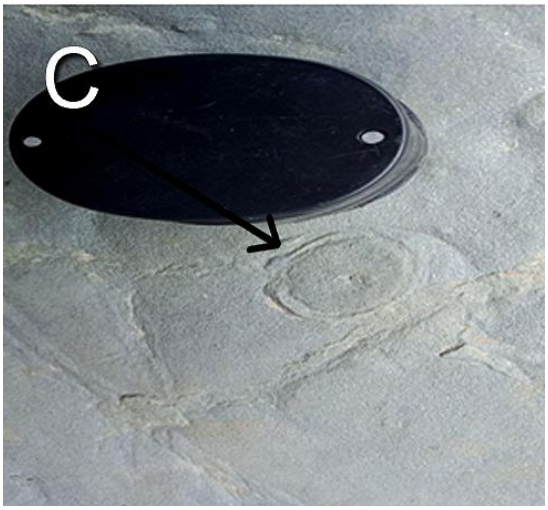
the *Skolithos* may have been dwelling burrows of suspension feeding polychaetes.
Occurrence: Sandstone, sandstone-shale interbeds and shale of Barail formations in Jotsoma, Kohima.

Ichnogenus*:* ***Palaeophycus*** **Hall, 1847**
Palaeophycus tubularis Hall 1847
Description: Unbranched, smooth, straight, cylindrical, horizontal burrows are preserved in the sandy and silty layers. These burrows are approx. 100-140mm long and 40-32 mm in diameter. The burrow fills are similar to the surrounding sediments.
Remarks: This Ichnogenus is a facies-crossing form (Pemberton and Frey, 1982). *Palaeophycus* may be referred to the activity of several unrelated vermiform deposit-feeders that produce active backfilling.
Occurrence: Barail Sandstone, Dzüna Rü (Jotsoma-Khonoma road)

Ichnogenus*:* ***Scolicia*** **de quatrefages, 1849**
Description: Horizontal, bilaterally symmetrical trial or burrow of negative epirelief, consisting of variable shaped, ridge-like, ribbed median axis.
Remarks: The behavioral pattern is locomotive or a feeding trace. Their environmental setting is Marine to continental. They are found in fluvial, alluvial to marine lacustrine conditions. They have a geological age range of Cambrian-recent
Occurrence : Barail Sandstone, Chürü (near Sazolie College)

Ichnogenus: ***Arenicolites*** **Salte (1857)**
Ichnospecies: *Arenicolites* isp.
Description: full relief, U-shaped, vertical, slender, small. They are circular in cross-section and are parallel to each other. Their infilling are different from the host rock, dwelling burrows of suspension feeding worm or worm-like animal. They are usually present in the littoral- bathyal zone. The burrows have funnel-shaped openings.
Remarks: Suspension feeding, dwelling, sound resonance (Wilson, 1971).Their environmental settings are usually in a marine, freshwater, lacustrine or fluvial condition. The possible trace makers of this isp. Are the worms, vertebrates, crustaceans, wasps, Mayfly larvae and beetles. The geological age range of this ichnofossil is Cambrian- recent (marine), carboniferous- recent (continental) Eagar 1985.
*Occurrence:*Barail Sandstone along Dzüna Rü (along Jotsoma-Khonoma road)

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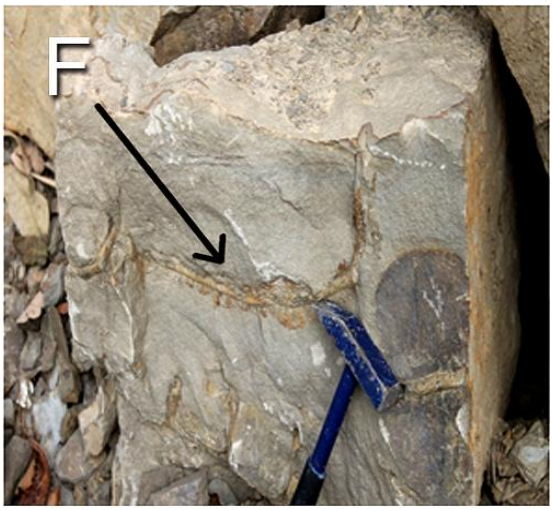
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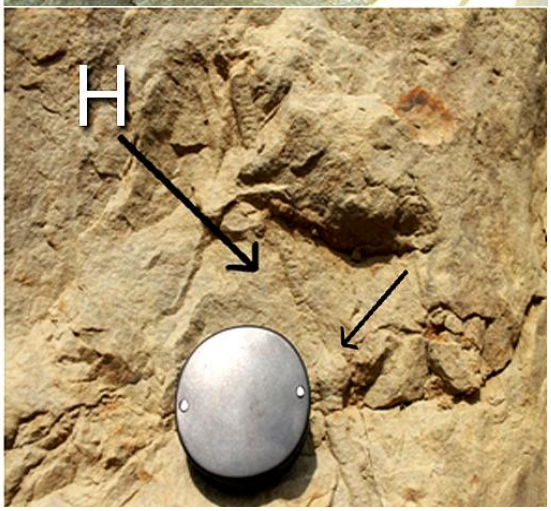
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Fig.2. (**A-J**): Trace fossils from Barail Sandstones around Jotsoma and Jotsoma-Khonoma area. **A**.*Ophiomorpha isp*. **B**.*Ophiomorpha nodosa*. **C**. *Gyrolithes isp*. **D**.*Planolites isp*. **E**.*Chondrites intricatus*. **F**.*Thalassinoides isp*. **G**.*Skolithos linearis*. **H**.*Palaeophycus tubularis*.**I.***Scolicia*.**J**.*Arenicolites isp*.

Conclusion

The recorded Ichnospecies of the study area are mixtures of domichnia and foodichnia. They belong to *Skolithos, planolites, Arenicolites, Ophiomorpha* etc. The most notable feature of the occurrence of trace fossils in these sediments is the presence of both shallow-water as well as deep-water traces. Traces were recorded from both mudstones and sandstone facies. The mudstones in the study area are highly bioturbated. Horizontal forms as well as vertical forms of trace fossils are seen in the area

While studying the Gurnigel and Schlieren flysch units (Palaeogene-Eocene) in Switzerland, Crimes *et. al*. (1981) demonstrated that the channelized inner fan facies contain the so-called shallow marine ichnotaxa (*Arenicolites, Skolithos*), but meandering and network forms are absent. Cummings and Hodgson (2011) considered the rations of pre-to post-depositional forms as the most powerful tool in the characterization of the trace fossil distribution in different parts of the depositional system in the late Cretaceous-Eocene deep sea fan sediments of the Basque Basin, Northern Spain. They concluded that higher diversity and intensity of bioturbation and domination of pre-depositional forms is typical of marginal parts of channel environment and lobes, while the axial part of the channel displays a lower diversity of trace fossil assemblages dominated by post depositional forms. In the axial part of the lobes, post-depositional forms exclusively occur with a dominance of *Ophiomorpha*. With increasing water depth and decreasing sediment grain size foodichnia such as *Palaeophycus* appears.

Presence of *Arenicolites* also suggests a quite environment. In the study area, that is, in Jotsoma and along Jotsoma-Khonoma road there is evidence that *Ophiomorpha isp*. dominates indicating that the area in the past has a marine setting and when the water level / palaeocurrent receded, the depositional environment sets in and in the process, trace fossils formed. Bivalve's impressions were also seen in the area. The region is therefore concluded from the study of trace fossils that it is a shallow marine to slightly

deep marine setting (rare e.g. *Scolicia, Palaeophycus*) with a high energy environment.

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IS MGNREGS A SIGNIFICANT REDEEMER FOR OUT-MIGRANTS OF LALGOLA BLOCK IN MURSHIDABAD DISTRICT?

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Abstract: The core of this article embodies that in earlier times many ethnic sects like the Karnary, the Rajputana, the Dutch, the French, the British, the Santhal, the Arab, the Turk, the Persian and the Jains migrated to Murshidabad district which has a fascinating history and ravenous attraction for making habitat. But in present day we are seeing the reverse picture i.e. day-by-day out migration from different parts of the same district for livelihoods is on rise even after the implementation of such beautiful flagship scheme, i.e. MGNREGS.

Keywords: Lalgola block, MGNREGS, migrants.

Introduction

Since time immemorial, Murshidabad has been the most attractive destination of the world for its natural beauty, healthy atmosphere, groves of delicious mango and litchi, bounty of resources, riverine landscape, and good communicational linkage. The Karnary, the Rajputana, the Karnat, the Jains, the Santhal, the Arab, the Turk, the Persian, the British, the French, the Dutch migrated to this district in different period. Nawab regime came into existence in Murshidabad during mughal period. Existence of Jains is still present in Jiaganj-Azimganj area. The name of Murshidabad bears the land of Nawab with aristocracy. It is the place where our ancient India lost her freedom in the Battle of Plassey and wore an unsavoury garland of slavery. After the Battle of Plassey propagation of many religions like Buddhism, Jainism, Islam and Christianity along with the culture of many races came into flourish here.

Objective and methodology

Lalgola Block of Murshidabad district in West Bengal has been chosen for undertaking this study. A critical attempt was made to study and analyse the performance of MGNREGS (Mahatma Gandhi National Rural Employment Guarantee Scheme) in reducing migration of Lalgola block. Of the 26 total blocks Lalgola have been implementing the scheme in spite of difficulties and malpractices recorded then and there. 152 households from three villages viz, Balarampur, Biswanathpur, Jhaubona of Lalgola block has been selected by adopting systematic sampling. Relevant information required for the study has been obtained during January-May 2018 from the informants personally with structured interview schedule. Books, reports, other periodicals have been referred for collating necessary secondary data required for strengthening the study further.

District Profile

The Murshidabad district lies between 23º43′30″ N and 24º50′20″ N latitude and 87º49′17″ E and 88º46′ E longitude in northern hemisphere with a total area of 5324 sq km. It is surrounded by Malda district in north, Bihar district in west, Jharkhand state & Birbhum district in south-west and Bangladesh to the east with 165 km international border. The river Bhagirathi divides the district in two portions; the eastern bank of Bhagirathi is said Bagri & western bank is Rarh.

Baharampur is the district headquarter of Murshidabad district which has been divided into 5 sub divisions, viz., Baharampur Sadar, Jangipur, Lalbag, Kandi, Domkol and Lalgola Block is under Lalbag sub-division.There are 7 Municipalities in the district viz, 1) Dhulia 2) Jangipur 3) Jiaganj 4) Azimganj 5) Murshidabad 6) Kandi 7) Beldanga and Baharampur constituting 22 assembly constituencies.

The population of Murshidabad is 7102430 (Census, 2011) with a population density of 1334 per Km^2 (W.B-1028, India-382). The population of Murshidabad places in the highest position that it comes under top 1 to10 among 640 districts of India.The share of Male-Female Population is almost halves to each other. The sex-ratio (number of women per 1000 men) of Murshidabad is 958 in 2011 showing continued improvement over time from the sex ratio of 952 in 2001 and far better than Country's average (940 in Census 2011) State's average (950 in Census 2011). Murshidabad's literacy rate (66.59%) is 4^{th} among 19 districts (low) which is really a matter of great concern and it is far below from State's average Country's average i.e. 76.26% & 74.04% respectively.

The history of Murshidabad is fascinating. The Pala and Gupta Period are involved in the history of Murshidabad. The relationship of Mughal with this district started after Sultanate period, Hussain Shahi Period. This is the place where the historical life of Murshid Quli Khan, Alivardi Khan, Nawab Siraj-ud Daula, Mir Jafar have been written. Murshidabad has been named after Murshid Quli Khan, earlier it was Maksudabad. The East India Company ruled over here for many years. In the year 1879, the final form of Murshidabad district came into existence through jurisdiction interchanges with Birbhum. So Murshidabad is a dignified and historical district.

Murshidabad is an important place of tourism in the history of Bengal, especially in historical aspect. Attractive places among the tourists are: Hazar Duari, Madina, Wasef Manzil, Imambara, Katra Masjid, Jafraganj Cemetery, Jahan Kosha Cannon, Khosbag, Nasipur Palace, Kathgola, Footi Masjid, Nimak Haram Deuri, Motijheel etc.

The entire district is plain with altitude varies from 10 to 50 metres above the mean sea level. Therefore this district is prone to floods during the monsoon season. Murshidabad district is full of Rivers, Bill and means of water bodies. There are many rivers flowing through this district. These are Ganga or Padma, Jalangi, Bhairab, Bansloi, Dwarka, Mayurakshi and so on. Bhagirathi is the main river of this district and it is a branch of Ganga which is the longest river in India. There are some large ponds and tanks locally known as Bils.

The main places of district are well connected by Railway, State and National Highway. Cheaper modes of transport are Buses, Tracker, Magic Van, *Bhotbhoti, Toto (locally they say Tuktuk), auto-rickshaws,*

tongas/ekka gari or horse-carts (available on some specific parts) are moving around the roads of Murshidabad. People use to cross the river by boat from one ferry ghat to other where there is no bridge among them.

The climate of Murshidabad district is oppressive hot summer with high humidity and well distributed rainfall occurs from the south east monsoon. Average rainfall of the district is about 1400 to 1700 millimetre and 74% of it falls between June to September. Generally flood occurs during the time. Monthly temperature varies between17 degree centigrade to 35 degree centigrade.

Many animals disappeared through passage of time, greenery had transformed into habitat in the district. So now only jackals and monkeys can be seen. Various species of birds are seen in the district, to mention a few are pigeons, crows, sparrow, doves, kites, maynas, ducks, vultures, cuckoos, woodpeckers, owls, herons and kingfisher.

Khadi and Muslin industry of this district occupies a very significant position. There also several small scales home based industries such as jute products, ornament making and manufacturing and polishing of brass and ivory products are effectively working. Murshidabad Silk is even today world famous. And the famous Baluchari sarees are made in the town of Baluchar in the district. Shola is used for making decoration and head wears of Bridal couple, head wears of God and goddess and Elephant Howdah and so on in the district. Various goods and utensil of bell metal and brass are manufactured in large quantities at Khagra, Berhampore, Kandi, Baranagar and Jangipur. Locks and betel-nut cutter are made at Dhulian and iron-chest at Jangipur. Though the products of bell metal and brass are manufactured in Murshidabad the raw material is not produced there.

There is a deficiency of heavy modernised industry in this area but there are many fertile agricultural lands. The cultivation of this area is the main source of livelihood and economic activity. The climate is congenial for cultivation. Rice and jute are the major crops of the district. Besides those, oil seeds, legumes, wheat, pulses, potato are some of the other important crops. Malda is famous for its Fajli mango but Murshidabad is famous for its taste & variety. Varieties of Mangoes (King of Fruits) are available in this district. It is said that King of earlier time used to preserve delicious mango sinking it within a pot filled with honey for future consumption during non available season.Every district has its own favourite & famous traditional sweets. Likewise Berhampore is famous for Chhanabora, Lalgola for ledikeni and Beldanga for Monohora, Jiagunje for Khirmohon.

Profile of Study Area

Lalgola block is situated along the international border with Bangladesh across the Padma to the north, Bhagwangola I block to the south, Bhagwangola II block to the east and Raghunathganj II block in the west. Lalgola block has 12 Gram Panchayats covering (Airmari Krishnapur, Bahadurpur, Bilborakopra, Dewansarai, Jasaitala, Kalmegha, Lalgola, Maiya, Manikchak, Nashipur, Paikpara and Ramchandrapur) 84 villages. One police station is there at Lalgola to maintain law and order through all over the block. In Lalgola Block, Jinda Kali Temple and Mukto Jail (Free Correctional Home or open jail where prisioners are not locked up) are the places of attraction. Lalgola often

makes news headline either on drugs & cow smuggling, human traffickings, transactions of fake currency, murder, river erosion, cross border business trouble or in mangoes and in jute production or recently sometimes early marriage has been postponed by Kanyasree Beneficiaries.

Table 1: Area, Population and Density of Population in Lalgola Block:

Name of Block	Area (Sq. Km.)	Population (Number)	Density of population (per Sq. Km.)	P.C. of population to district population
(1)	(2)	(3)	(4)	(5)
Lalgola	184.37	335831	1822	4.73

Source: District Statistical Handbook, Murshidabad, 2014

The total population of Lalgola block is 335831 which is 4.73 per cent of district population scattered around 184.37 sq km area.

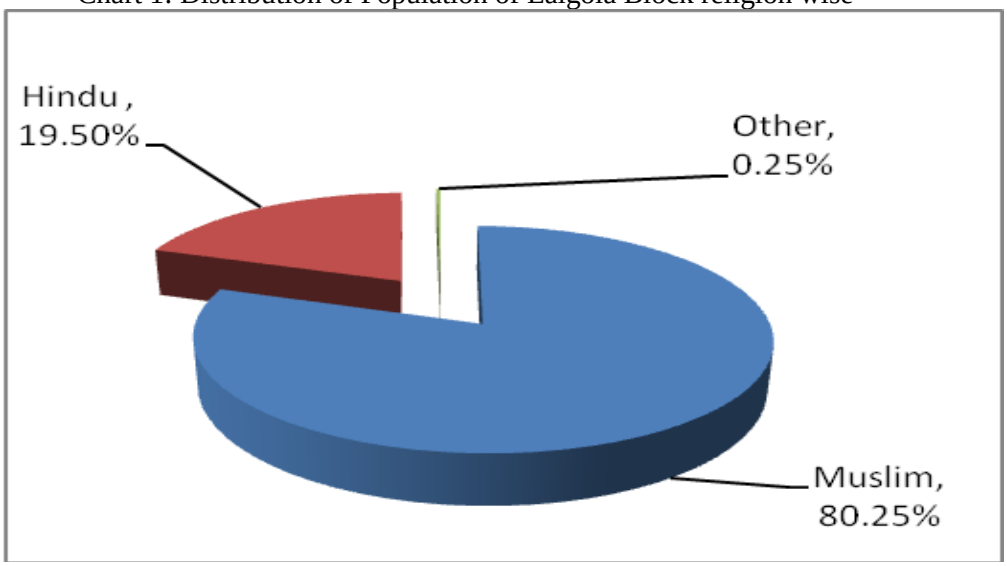
Table 2: Scheduled Caste and Scheduled Tribe Population by sex of Lalgola Block:

Name of Block	Scheduled Caste			Scheduled Tribe			SC%	ST%
	Male	Female	Total	Male	Female	Total		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lalgola	16092	15156	31248	96	72	168	9.30468	0.05003

Source: District Statistical Handbook, Murshidabad, 2014

It is clear from the above table that SC population constitutes only 9 per cent whereas ST population is very negligible with only 0.05 per cent.

Chart 1: Distribution of Population of Lalgola Block religion wise



Source: Census of India, 2011

Above pie diagram clearly depicts that Muslim population of Lalgola block is higher (80.25%) than any other population, it is quite high from district average (66.28%); Hindu population constitutes 19.50 per cent and other religion is only 0.25 per cent.

Overview of MGNREGS

The National Rural Employment Guarantee Act (NREGA), 2005 was passed unanimously by Parliament on 23rd August 2005 to ensure 100 days unskilled manual labour in rural areas as per the demand of rural poor. The Act was notified on Wednesday 7th September, 2005 for general information through Gazette of India after the assent and signature of the President of India on 5th September, 2005. Demand of work as per need & right to get the same demanded work is established by this Act. Under NREGA the National Rural Employment Guarantee Scheme (NREGS) was launched by the-then Hon'ble Prime Minister, Dr. Manmohon Singh on 2nd February, 2006. It was implemented in three phases. In Phase I (from 02/02/2006 to 31/03/2007) it covers 200 most backward districts all over the country. The scheme at Murshidabad started in Phase I. In Phase II (from 01/04/2007 to 31/03/2008) the scheme extended to 130 more districts. In Phase III on 01/04/2008 it extended to the remaining districts and covers the whole country except the districts that have cent percent urban population. (K. K. Bagchi, 2011). Following NREGA each state is bound to launch NREGS within six months from the date of effect of this Act. The law initially called the NREGA but was renamed as MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) on Gandhi Jayanti i.e. on 02/10/2009 subsequently NREGS as MGNREGS. Sometimes it is pronounced locally as Maha NAREGA, MG NAREGA, Mahatma Gandhi,

NAREGA, *Sou Din Ki Rojgar, Eksho Diner Kaaj,* 100 Days' Programme etc. This flagship scheme is mainly inspired by the success of the Maharashtra Employment Guarantee Scheme (MEGS, launched in 1975) which is implemented for over last 30 years in Maharashtra, without decline in the demand for unskilled wage work. The experiences gained in implementation of different wage employment programmes like National Rural Employment Programme (NREP: 1980), Rural Landless Employment Guarantee Programme (RLEGP: 1983), Jawahar Rozgar Yojana (JRY: 1989), Employment Assurance Scheme (EAS: 1993), Sampoorna Grameen Rozgar Yojana (SGRY: 2001), during the past two decades, have been taken into account while formulating the Act. The Government, through MGNREGA aims at removing poverty in the rural areas and thus improving infrastructure. MGNREGA guarantees 100 days of wage employment in a year to every household whose adult members are willing to do unskilled manual work. During the first year of implementation (Financial Year: 2006-07) in 200 districts 2.10 crore person days were generated. The performance of 12 years (2006-07 to 2017-18) since its inception: Persondays Generated (in Cr.): 2492.46, Total Expenditure (Rs. in Cr.) 437209.21. (Source NREGA Website as on 12/02/2018).

Objectives of MGNREGS

The short-term objective of MGNREGS is to enhance livelihood security of rural household by providing 100 days of employment in a financial year to every registered household whose adult members volunteer to do unskilled manual work at the minimum wage rate prescribed in the state so that they can meet their own day-to-day problem especially on poverty or we may say MGNREGS is a basically wage employment programme to enable unemployed rural households to earn additional income in lean season in view of guaranteeing food security.

Long-term objective of MGNREGS is to create durable/permanent assets and necessary infrastructure in rural areas. The scheme would employ people in developing infrastructure facilities in villages that would accelerate the process of agricultural and rural development in the country which would improve the quality of life of rural people. In this way in long-run it would lessen the dependency on Government as well as on Panchayat and would expand the livelihood opportunities for the poor and downtrodden rural people. In a word it may be said that long-term objective is poverty alleviation by creation of durable assets & generation of productive infrastructure in rural areas. Checking migration from rural to urban areas is one of the major endeavours of MGNREGS.

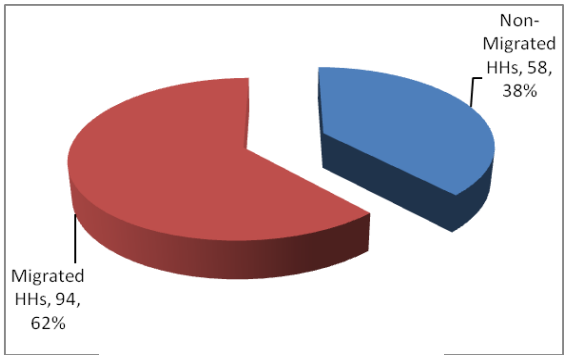
Migration-Analysis vis-à-vis Result

Migration is a process of people moving from one area to another with the intent of livelihood. Reason of migration is mainly because of Push Factor and Pull Factor and broadly classified by economic, social, political and environmental. Push factor are things that make people want to leave a place (i.e. natural calamities, political disturbances, war or conflict, crimes, flood, lack of jobs, lack of public amenities). Pull factors are things that make people to move to a place (i.e. Health Care, High alluring wages, good weather).

It has been observed that overall reason of out-migration are countless-insufficient job opportunities within the

district, low wage rate compared to wage rate of working area, abundance of unskilled or low skilled labour, low availability of agricultural land compared to present agricultural labour, easy accessible of network in which migrants get help to move to a place, vicious circle of poverty, low level of education, poor outlook towards self-development over and over rural development, lacunae in honest and earnest desire for educating child rather considering them as the source of income. Lack of mainstream education & Skill Based Education and high dependence on 'khariji' Madrasah not the Madrasah governed by WBBME (West Bengal Board of Madrasah Education) i.e., absence of mainstream education, Non-abundance of large scale industry, cottage industry like beedi-rolling & brick-making themselves are not enough to check out migration.

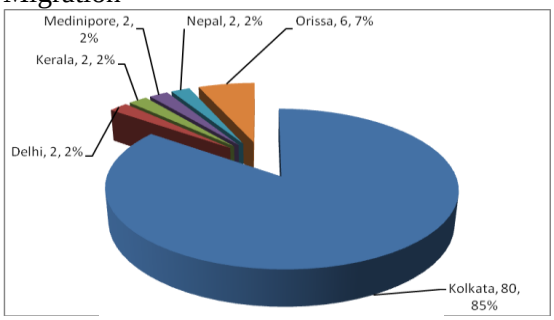
Chart 2: Distribution of Surveyed Household over Migration in Lalgola Block of Murshidabad district



Compiled from Primary Data

The above Pie diagram clearly reveals that any member or members from 62 per cent or 94 HHs out of 152 HHs of Lalgola block migrate outside for their livelihood whereas 38 per cent do not out migrate.

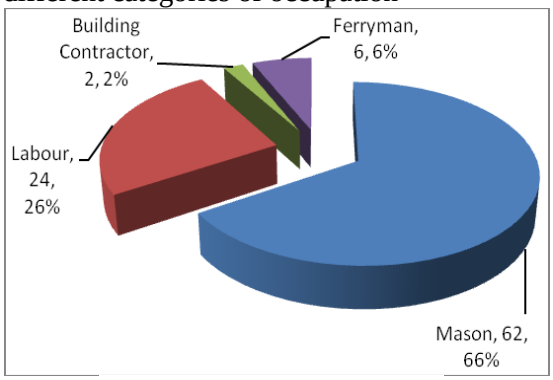
Chart 3: Distribution of Migrants over place of Migration



Compiled from Primary Data

People of Balarampur, Biswanathpur, Jhaubona of Lalgola block are used to go to Kolkata 85 per cent, then Orissa 7 per cent, other places Nepal, Medinipore, Kerala, Delhi 2 per cent each.

Chart 4: Distribution of Migrants over different categories of occupation



Compiled from Primary Data

Masons are available all over the district. In the study area 66 per cent migrants are doing masonry work, followed by labour 26 per cent, ferryman 6 per cent and building contractor 2 per cent.

Table 3: Distribution of Migrants over different categories of occupation

Places	Mason	Labour	Building Contractor	Ferryman
Kolkata	52	22	2	4
Delhi	2	0	0	0
Kerala	2	0	0	0
Medinipore	2	0	0	0
Nepal	0	2	0	0
Orissa	4	0	0	2
Total	62	24	2	6

Compiled from Primary Data

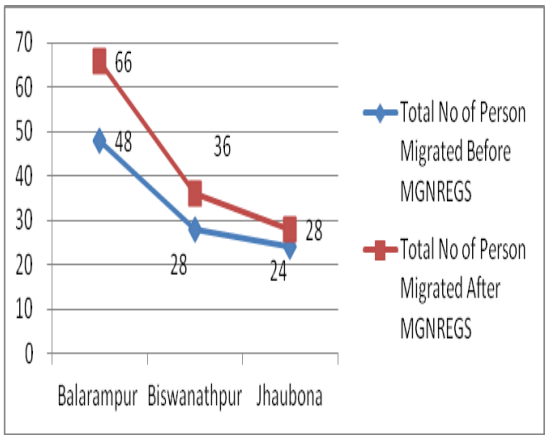
Most of the people have gone for work to Kolkata, 80 people out of 94 migrants are mostly for masonry work i.e., a total of 74 persons. 4 ferrymen went there for selling utensils and cloth. Orissa have also 2 ferrymen and 4 masons for their earnings. Migrants from Lalgola block are used to go Delhi, Kerala, Medinipore, Nepal mainly for masonry work, 2 migrants from each places went there.

Table 4: Comparison of Migration before implementation of MGNREGS & after implementation of MGNREGS

Name of the Village	HHs Surveyed	Total No of Person Migrated Before implementation of MGNREGS	Total No of Person Migrated After implementation of MGNREGS	% increased in Migration
Balarampur	56	48	66	37.50
Biswanathpur	40	28	36	28.57
Jhaubona	56	24	28	20.00
Total	152	100	130	30.00

Compiled from Primary Data

Chart 5: Double Line diagram for comparison of Migration before implementation of MGNREGS & after implementation of MGNREGS



The table 4 and Chart 5 clearly reveal that before implementation of MGNREGS the total migrants of Balarampur were 48 and after implementation of MGNREGS, the total migrants of Balarampur have been increased upto 66 i.e expansions is 37.5 per cent. In case of Biswanathpur and Jhaoubona, the expansions of migrants are 28.57 & 20 per cent respectively. The average expansion of migrants is 30 per cent even after implementation of MGNREGS and even after completion of 12 years. The destination places may vary but this is the picture of whole district. Kandi Block is famous for migrating people to Saudi Arab. MURSHIDABAD is industrially backward and agriculturally dependent - and hence because of the lack of opportunities in the region it would have to have a history of distress migration, mainly to urban areas as contract labour.

Snapshots of migrants of Murshidabad in different situations

Selfie taken by me at Seoraphuli Rail Station with a migrant of Murshidabad returning to home on occasion of Id festival

Picture showing three young migrants of Murshidabad at Seoraphuli Junction, a Rail Station waiting for Ganadevta Express Train in which they will return back to home on occasion of Id Festival

Picture showing Migrants who were from MURSHIDABAD heading towards Mumbai by Train for Marble Masonry after celebration of Muslim festival.

Picture showing labourer and migrants in luggage van of a Sealdah Bound Trains

Migrant from MURSHIDABAD going to bankura (a district of WB) for masonry work boarded from jangipur area, interviewed by me in SBSTC Bus

Picture showing a sugarcane Juice seller who came from MURSHIDABAD selling juice in front of State Bank of India, Suri Main Branch

Picture showing two contract labourers who came from Bhagwangola working household chores at Balarampur village of Lalgola GP


Safe Migration Card

নিরাপদ স্থানান্তরকরণ পত্র

(In case of any emergency please extend hand for all kind of help to the card holder)

Name of the Gram Panchayat - MIRZAPUR GRAM PANCHAYAT

Details of the Card Holder

Memo. No.

Date

Name

Father/Mother

Age

Own EPIC No.

Recent passport size photograph of the card holder

Duly attested by Panchayat Pradhan

Name

Father's Name

Address

P.O.- Block-Raghunathganj-I

Police Station - Raghunathganj, Pin Code - 742227,

Dist. - Murshidabad, State - West Bengal

Total Member of Family Members

Place of Migration

Purpose-Job/Others

If others write down

Total No of persons move with him / her

Expected date of Return

Card Issued by

Male Above 18 yrs | Female Above 18 yrs | Boys Below 18 yrs | Girl Below 18 yrs | Married | Unmarried

Please tick the appropriate box

See overleaf of some emergency help line and Important messages

Seal & Signature of the Gram Panchayat Pradhan

Safe Migration Card from Mirzapur GP (only Mirzapur GP of Murshidabad district provides this card to the Migrants as an Identity Card)

Despite being a source of employment, MGNREGS has not been able to check the migration. It is observed that out-migration is still present all over the district. Migration in search of better and more lucrative opportunities continues as before.

MGNREGS is unable to match the wages of labour in other sectors. Much more of the migration is of males due to 'pull' factors such as high wage rate on the other hand Women keep themselves into home in order to take care of the home, land and family.

Women and older people have a limited participation in labour migration and the enhanced dependence on migrant earnings increases male authority in the household, increasing dependence on men for cash and health care. In this case, migration may amplify gender inequalities.

Conclusion

"Gurudev found that the migration of rural people to towns was the main causes of breakdown of the village society."- Rabindranath Tagore on Rural Reconstruction, Sudhir Sen, Visva Bharati, 1943. The prudence of Gurudev was unrivalled. He himself understood the boundless importance of village life as India lives in villages & co-existence of cities, town as well as villages is necessary for the development of economic & socio-cultural ethos.

From social point of view we should give more attention to develop the social condition of the rural people in respect of educational status, health & sanitation. Because we know the improvement in literacy status will be helpful to remove the imbalanced in between the rural and urban area. We should give more attention in rural development. To stop out migration from rural area to urban area we should offer more public amenities for the rural people, otherwise these migrated rural people having no alternative employment opportunities in the urban area will undertake antisocial activities.

Whenever I travelled through any Murshidabad bound bus or Train, I came across lots of migrant either heading towards working place or returning to their home for festival or vacation. Most of them were for masonry work and very tiny amount of ferryman. It is really a matter of concern that in ancient time people made Mushidabad their destinations for earnings or habitat but now people use to migrate for better livings even after implementation of such a beautiful scheme like MGNREGS which cannot cope with the migration problem of Murshidabad.

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STUDY OF SOME MEDICINAL PLANTS USED BY THE ANGAMI NAGAS OF KIGWEMA VILLAGE, NAGALAND

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Abstract: This study was conducted to explore and document the plants used by the Angami Nagas of Kigwema village for treatment of various ailments. Through this study about 28 species belonging to 19 families were recorded. The details of the plants used and the various ailments for which it is used have been presented.

Keywords: Angamis, Medicinal plants, Ailments, Kigwema village

Introduction

Ethnobotany is an important branch that deals with medicine derived from plants and use of different parts in the treatment of various disease and ailments, based on indigenous pharmacopoeia, folklore, and herbal charms (Bhuyan *et. al.*, 2014). Vast ethnobotanical knowledge has existed since the advent of civilization. Since time immemorial men have been using plants as a source of food, shelter, clothing, etc (Singh *et. al.*, 2015). Tens of thousands of human cultures have existed in the past and a number of them exist even today. They contain knowledge system and wisdom about adaptations with nature, particularly with plant for their sustenance. Thus ethnobotanical information is vital for continuance of human life on the planet (Pullaih *et. al.*, 2017). People of the past have made use of a wide variety of plants for curing various ailments. This knowledge of medicinal plants has been developed through years of experience and observations and has been passed through generations (Islam, 2009).

India has one of the oldest, richest and most diverse cultural traditions associated with the use of medicinal plants. It presents a striking example of the intimate linkage between biodiversity and cultural diversity (Chaurasia *et. al.*, 2007). The earliest mention of the medicinal use of plants is found in the *Rig Veda*, perhaps the oldest repository of human knowledge, having been written between 4500 and 1600 B.C. (Chopra *et. al.*, 1956). India is endowed with a rich wealth of medicinal plants. It is the largest producer of medicinal herbs and is apparently called the 'Botanical garden of the world' (Chopra *et. al.*, 2007). It is a fertile area for ethnobotanical studies, mainly due to its rich floral diversity, large number of ethnic groups and dependency in bio-resources by large section of the society (Jain, 2016).

Nagaland is the 16 state of India (Jamir and Tsurho, 2016). It lies between 25°6′-27°4′N and 93°20′-95°15′E and has an area of 16,527km^2. The state of Nagaland in Northeast India is inhabited by 14 aboriginal tribes among which there exists rich plant folklore (Rao and Jamir, 1982). Due to conducive ecological and climatic conditions Nagaland serve as a rich reservoir of biodiversity including medicinal plants (Zhasa *et. al.*, 2015). It can be rightly termed as a state of true mega biodiversity (Jamir *et. al.*, 2012). Although modern culture have greatly influenced the life of Naga society today, they still have a culture rich with ethnobotanical and traditional folk practices and are widely

still dependent on nature for food, shelter and medicines (Changkija, 1999).

Kigwema village which falls under the foothills of Mt. Japfü is inhabited by the Southern Angami Nagas. The use of medicinal plants to cure diseases is deeply rooted in their culture which has been passed through generations. In recent years these valuable traditional knowledge are getting depleted. These traditional practices are now mostly confined to few ethnomedicinal men-local healers and village elders. The wealth of these medicinal plants is also in threat due to practice of shifting cultivation, deforestation, overexploitation of these plant resources, etc exploited (Chase and Singh, 2013). To conserve this indigenous knowledge a proper documentation of the plants is required. Hence, the need for exploration of these traditional medicinal practises arises (Pfoze *et. al.*, 2014).

Much of the ethnobotanical studies have been conducted in most of the states and districts of India (Salam *et. al.,* 2009). However, no work has been done in particular for this village. Therefore, this study aims at exploring the ethno medicinal plants used by the Angami Nagas of Kigwema village and to record all the available information. An attempt has been made to collect, compile and conserve this knowledge of medicinal plants stressing on the importance of its conservation.

Methodology

An extensive botanical survey was carried out in Kigwema village. The information on the traditional uses of ethnomedicinal plants were collected from the local people. The details on the parts of plants used its mode of use and the ailments for which it is used were collected. The plant specimens were collected and processed into herbariums.

Results and discussion

The present study documented 28 plant species belonging to 19 families used by the people of Kigwema village. From the study conducted, it was observed that the species of the family Asteraceae are widely used by the local people of the village. Asteraceae reported the highest number of species (5) followed by Lamiaceae (3 species) and Apiaceae, Hypoxidaceae and Solanaceae with 2 species while the other families are represented by one species each. The most commonly used part of the plant was the leaves. The plant parts were mostly used in the form of decoction. The plants have been used for a wide variety of ailments like include fever, toothache, gastritis, stomach problems, high blood pressure, low blood pressure, kidney problems, malaria, snakebites, headache, diabetes and as haemostatics.

The plants are presented in table 1 alphabetically along with their families, local Angami name, the parts used, its method of use and the disease for which it is used.

Conclusion

Through this study, it has been observed that the Angamis of Kigwema village still depend on forest resources for a wide variety of purposes including the knowledge on use of medicinal plant. There are many potential plants from herbs to trees which have medicinal values. . There will be definitely more plants and information that could be added after more thorough and detailed investigation. These plants can be wisely explored and judiciously utilized for the benefit of the local people. To ensure this, the people should be made to realize the value and benefits of preserving this valuable information. The need to conserve and preserve the rich plant resources should be instilled in the minds of the people so that they can conserve these resources and use them in a sustainable way.

Name	Angami name	Parts used	Methods of use	Disease
***Alnus nepalensis* (Betulaceae)**	Apo	Leaves	Leaves are crushed and applied on wounds	As Haemostatic
***Artemissia nilagarica* (Asteraceae)**	Pinah	Leaves	Leaves are applied on wounds or nose to control nose bleed	As haemostatic
***Bergenia ciliate* (Saxifragaceae)**	Pfiikhan-bathie	Leaves and stem	Boiled and the extract taken orally	Fever and gastric
***Bryophyllum pinnatum* (Crassulaceae)**	-	Leaves	Boiled and extract taken orally	Kidney stones
***Catharanthus roseus alba* (Apocynaceae)**	-	Leaves	Boiled and extract taken orally	Diabetes
***Centella asiatica* (Apiaceae)**	Gara	Leaves	Boiled or cooked	It helps to heal the wounds fast and helps in indigestion
***Crassocephalum crepididioides* (Asteraceae)**	Meyanha	Leaves	Boiled and extract taken orally	Diarrhoea
***Curculigo crassifolia* (Hypoxidaceae)**	Pharemi	Rhizome	Boiled and decoction of the rhizome is taken	Gastric
***Curculigo* (Hypoxidaceae)**	Pharemi	Rhizome	Boiled and decoction of the rhizome is taken	Gastric
***Elsholtzia blanda* (Lamiaceae)**	Ale	Leaves or shoots	Boiled and taken orally or leaves are crushed and applied	High blood pressure, dysentery and toothache
***Emblica officinalis* (Euphorbaceae)**	Lhesensi	Fruit	Juice is applied to the eyes	Eye infections
***Equisetum arvense* (Equisetaceae)**	Shiihie	Leaves or whole shoot	Boiled and taken orally	Kidney problems
***Eupatorium adenophorum* (Asteraceae)**	Keponhari	Leaves	Applied on wounds	Haemostatic
***Herpetospermum pedunculosum* (Cucurbitaceae)**	Yalii	Leaves	Boiled	Stomach problems

Houttuynia cordata **(Saururaceae)**	Gatha	Leaves and roots	Boiled or as salad	Cough, fever and blood purifier
Justicia adhatoda **(Acanthaceae)**	-	Leaves	Boiled or cooked	Stomach problems
Mentha spicata **(Lamiaceae)**		Leaves	Boiled or cooked or consumed raw	Headache
Nicotiana tabbacum **(Solanaceae)**	Khupi	Leaves	Leaves are roasted in fire, crushed and applied on affected part	Toothache
Occimum bacilicum **(Lamiaceae)**	Nyiipyoh	Leaves and flowers or whole shoot	Boiled or cooked	Headache ,fever and high blood pressure
Oenanthe javanica **(Apiaceae)**	Gakra	Leaves	Boiled or cooked	Low blood pressure
Passiflora edulis **(Passifloraceae)**	Bael	Leaves	Boiled and extract taken orally	High blood pressure and blood circulation
Paris polyphylla **(Trilliaceae)**	-	Rhizome	Decoction of rhizome, as paste or taken raw	Fever, inflammations, snakebites, cuts and wounds
Plantago major **(Plantaginaceae)**	Gapa	Leaves	Boiled or cooked	High blood pressure
Rhus semiliata **(Anancardiaceae)**	Tsemhesi	Fruits	Fruits are crushed and applied on the affected part or consumed orally	Allergy
Solanum sp **(Solanaceae)**	Kekhosi	Fruits	Consumed raw	Headache, sore throat and mouth ulcer
Sonchus wightianus **(Asteraceae)**	Yazii/ Gadzii	Leaves and root	Boiled and extract taken orally	Cough and stomach problems
Spilanthes acmella **(Asteraceae)**	Hyiithipi	Fruits	Fruits are kept on the affected part	Toothache
Thalictrum foliolosum **(Ranunculaceae)**	-	Roots	Decoction of root is taken orally	Stomach, gastric, malaria, boils and fever

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COMPARATIVE STUDY OF INTERROGATIVE AND NEGATIONS OF AO LANGUAGE

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Abstract: There are 16 tribes of indigenous Naga Tribes in Nagaland. Nagas are defined by the diversity of languages; each tribe has its own language. The total population of Nagaland, according to 2011 census is 19, 80,602. There are 11 districts and each district administration is headed by a Deputy Commissioner of the district. Mokokchung district is the home of Ao tribe. The language spoken by the Ao tribe is called Ao language. They have two division of spoken language viz. Chungli and Mongsen. The write up is conducted on Chungli of Ao language.

Key Words: Wh-question, Confirmation seeking questions and Negations.

Introduction

The data is collected from both primary and secondary. The primary data is collected from the native speaker of Wameken village under Mokokchung District. The informant, Shri Allen Imsong is a missionary cum social worker who is fully dedicated to social and mission works. At present, the Ao language is developing very fast and the grammatical development is growing very fast because of many dedicated writers. This writ up will be beneficial for the development of Ao language grammar for the upcoming researcher(s).

A. Wh-questions were given below:

1. na tenüng **shiba**?
   nʌ̄ tənəŋ ʃíbʌ́?
   you name who
   '**What** is your name?'
Ans. kü tenüng **John**
   kə tənəŋ ʤɔn
   my name John
   'My name is John.'

2. kichiba adena **kechi** ait?
   kitʃíbʌ̀ ʌ̄denʌ̄ kətʃi ʌ́it
   window through what came in
   'What came in through the window?'
Ans. kichiba adena **ozü** ait
   kitʃíbʌ̀ ʌ̄denʌ̄ ūzə ʌ́it
   window through bird came in
   'The bird came in through the window.'

3. nai **kechi** angu?
   nʌ̄ kətʃi ʌ́ŋù
   you what see
   'What did you see?'
Ans. ni **ozü** ka angu
   ní ùzə khʌ̀ ʌ́ŋù
   I bird one saw
   'I saw a bird.'

4. pa ya **komala** nisung?
   pʌ̄ jʌ̄ kūmʌlʌ̄ nisɔŋ
   he CASE what type person
   'What kind of a person is he?'
Ans. Pa ya nisung tajung
   pʌ̄ jʌ̄ nisɔŋ tʌ̄ʤoŋ
   He CASE person good
   'He is a good person.'

5. na **kong** alir?
   nʌ̀ kúŋ ʌlíəɹ
   you where live
   'Where do you live?'
Ans. ni **Kohima** nung alir
   nì kɔhimʌ̄ nūŋ ʌlíəɹ
   I kohima in live
   'I live in Kohima.'

6. na kidangi **kodang** aor?

nʌ kìtʌ̀ŋi kūtʌ̄ŋ ʌ̄wə́ʌ
you to home when going
'When are you going home?'
na **kodang** kidangi aor*?* (possible)
Ans. ni **asem ako** nung kidangi aor
ni ʌ̄səm ʌ́ko nɔŋ kìdʌ̀ŋi ʌ̄wə́ʌ
I three o'clock at home going
'I am going home at 3 o'clock.'

7. na **kechiba** delhi-i aor?
nʌ̀ kətʃíbʌ̀ delhi-i ʌ̄wə́ʌ
you why delhi-to going
'Why are you going to Delhi?'
na delhi-i **kechiba** aor? (possible)
Ans. ni delhi-i **tazüngi** aor
nì delhi-i tʌ́zəŋi ʌ̄wə́ʌ
I delhi-to to study going
'I am going to Delhi for my study.'

8. pa ya **shiba**?
pʌ̄ jʌ̄ ʃíbʌ́?
he CASE who
'Who is he?'
Ans. pa ya **John**
pʌ̄ jʌ̄ ʤɔn
he CASE John
'He is John.'

9. la ya **shiba**?
lʌ̄ jʌ̄ ʃíbʌ́?
she CASE who
'Who is she?'
Ans. la ya **mary**
lʌ̄ jʌ̄ mèʌi
she CASE mary
'She is Mary.'

10. na **koma** lir?
nʌ̀ kúmʌ̀? *líəʌ*
you how have
'How are you?'
Ans. ni **junga** lir
nì ʤūŋʌ̄ líəʌ
I fine have
'I am fine.'

11. nai ya **koda** yanglu?
nʌī jā kūdʌ̄ jʌŋ̄lo
you this how make
'How did you make this?'
Ans. **kü medemer teyari ajanga** ni ya yanglu
kə mədəmə́ʌ tijʌ̄i ʌ̀tʃʌ̀ŋʌ̀ ní jʌ̄ jʌŋ̄lō
my friend help through I this make
'I made this with the help of my friend.'
ni ya **kü medemer teyari ajanga** yanglu. (possible)

12. na **kwika** angu?
nʌ̀ kwî:kʌ̀ ʌ́ŋū
You how much get
'How much did you get?' (number)
Ans. ni **ana** angu
nì ʌ̀nʌ̀ ʌ́ŋū
I two got
'I've got two.'

13. na **kodaka** angu?
nʌ̀ kúdʌ̄kʌ̀ ʌ́ŋū
you how much get
'How much did you get?' (quantity)
Ans. ni **padaka ya** angu
nì pʌ́tʌ́kʌ̀ jʌ̄ ʌ́ŋù
I much this got
'I've got this much.'

14. library - ji **kopika**
lʌibɹʌʌi - tʃî kúpikʌ̀
library DET how far
'How far is the library?' (Distance)
Ans: librɪʌry - ji idak nungi talangka **masü**
lʌibɹʌ̄i - tʃi idʌk nūŋi tʌlʌùŋkʌ̄ mʌ̀sə̀
library DET here from far not
'The library is not very far from here'

15. nai laishiba **kwiben** züngdanger?
nāi lʌĩʃibʌ̄ kwípán zəŋdʌ̃ŋəɹ
You bible how many times read
'**How** many times have you read the Bible?'
Ans: ni laishiba **anaben** züngogo
ni lʌĩʃibʌ̄ ʌ̃nʌ̄pən zəŋɔgɔ
I bible two.time read
'I have read the Bible **two times**.'

16. item rongnong ya nedi **shiba**?
ítàm ʌūŋnūŋ jʌ̄ nədi ʃipʌ́?
among them DET your elder brother who
'Which one is your brother?'
Ans. **Tar talangsang-ji** kedi
tʌ́ɹ tʌ́lʌ̀ŋsʌ̀ŋ -ʤi kədi
the taller one-DET my elder brother
'The taller one is my brother.'

17. ne indang **koba** ?
nə indʌ̄ŋ kúbʌ́?
you yours which
'Which one is yours?'
Ans: **ya** kü indang.
jʌ̄ kə indʌ̄ŋ
this my mine
'This is mine.'

18. **kolen** **-ji** shitakba lemang?
kúlán -ʧi ʃitʌkbʌ̄ lemʌ̄ŋ
which way- DET right way
'Which way is the right way?'
Ans: **iba** **ya** shitakba lemang
ibʌ̄ jʌ́ ʃitʌkbʌ̄ lemʌ̄ŋ
this CASE right way
'This is the right way.'

19. na **koyimer** ?
nʌ̄ kūjímə́ɹ
you which village
'Which village is you belong to?'
Ans: ni **Wameken nunger**
ni wʌ̄məkən nūŋəɹ
I Wameken people
'I am Wameken.'

Conclusion

In Ao language there are 15 wh-question words. But there is no question marker.
The wh-question words in Ao language are:

1. Kechi /*kəʧi*/ :What
2. Komala /*kūmʌlʌ̄*/ :What kind
3. Kong /*kúŋ*/ : Where
4. Kodang /*kūdʌ̃ŋ*/ : When
5. Kechiba /*kəʧíbʌ̀*/ : Why
6. Shiba /*ʃíbʌ́?*/ : Who
7. Koma /*kúmʌ̀?*/ : How (human)
8. koda /*kūdʌ̄*/ : How (things)
9. Kwika /*kwî:kʌ̀*/ : How much (number, cost)
10. Kodaka /*kúdʌkʌ̀*/ : How much (quantity)
11. Kopiga /*kúpikʌ̀*/ : How far (distance, duration)
12. Kwiben /*kwípán*/ : How many times
13. Koba /*kúbʌ́?*/ : Which
14. Kolen /*kúlán*/ : Which (direction)
15. Koyimer /*kūjimə́ɹ*/ : Which (village)

B. Yes /No questions:

1. na onok den arur **asü**?
nʌ̄ únɔk tən ʌ́ɹūɹ ʌ̀sə̀
You us with coming Qmkr
'Are you coming with us?'
2. na delhi-i odanger **asü**?
nʌ̄ delhi-i ūtʌ̃ŋə́ɹ ʌ̀sə̀
You Delhi to been Qmkr
'Have you been to Delhi?'

3. na kari ali **asü**?
nʌ̄ kʌ̄i ʌ́li ʌ̀sə̀
You car buy Qmkr
'Did you buy a car?'

C. Questions seeking affirmation

4. na kari ali **ana** ?
nʌ̀ kʌ̄i ʌ́li ʌ̀nʌ́

you car buy Qmkr
'Did you buy a car?' (I heard that you bought a car?)

5. na yashi sentong nungto aten **ana**?
nʌ̄ jʌ́ʃi? *səntɔŋ nūŋtɔ ʌ́tən ʌ̀nʌ́*
you yesterday function attend Qmkr
'Did you attend the function yesterday?'

D. Tag questions:

6. ni skol-i moner. moner ato **na**?
nì iskūl-i múnəɹ. múnəɹ ʌ̄tū nʌ́
I school-to don't like go. Don't like go right Qmkr
'I don't like to go to school. Do I?'

7. na ya kaketshir tajung. Tajung ato **na**?
nʌ̄ jʌ̄ kʌ̄kətʃiəɹ tʌ̀ʤɔŋ. tʌ̄ʤɔŋ ʌ́tū nʌ́
you are student good. Good right Qmkr
'You are a good student. Aren't you?'

8. John arutsü. Arutsü ato **na**?
ʤɔn ʌ́ɹùtsə̀. ʌ́ɹùtsə̀ ʌ́tū nʌ́
John will come. will come right Qmkr
'John will come. Isn't it?'

E. Alternate questions:

9. John aru **asü maru**?
ʤɔn ʌ́ɹù ə̀sə̀ mʌ́ɹūʔ
John come or not.come
'Did John come or not?'

10. John ao **asü mao**?
ʤɔn ʌ́ɔ ʌ̀sə̀ mʌ́ū
John go or not.go
'Did John go or not?'

11. John chiyunger **asü mechiyong**?
ʤɔn tʃijūŋ-əɹ ʌ̀sə̀ mə-tʃijūŋ
John eat PRS or NEG eat
'Did John eat or not?'

Conclusion

In Ao language the confirmation seeking question has three markers : '**na**', '**ana**' and '**asü**'. '*na'* occurs in the tag questions as illustrated in sentences 6-8, '*ana'* occurs in affirmation seeking questions as illustrated in sentences 4-5. 'asü' occurred in Yes / No question as illustrated in sentence 1-3. Alternate questions do not carry any question marker.

NEGATIONS OF AO LANGUAGE:

Negative sentence:
1. ni skol -i **m**aor.
ni iskūl -i m-ʌ̄wəɹ
I school to NEG go
'I don't go to school.'

Declarative Sentence:
2. asenok Delhi -i **aotsü**.
ʌ̄sənɔk Delhi -i ʌɔ̄-tsə
we Delhi to go FUT
'We will go to Delhi'

Negative sentence:
3. asenok delhi -i **m**aotsü.
ʌ̄sənɔk delhi -i m-ʌɔ̄-tsə
we delhi to NEG go FUT
'We will not go to Delhi.'

Declarative Sentence:
4. ni yashih skol -i **ao**.
ni jʌ́ʃiʔ iskūl -i ʌ̄ū
I yesterday school to went
'I went to school yesterday.'

Negative sentence:
5. ni yashih skol -i **m**ao.
ni jʌ́ʃiʔ iskūl -i m-ʌ̄ū
I yesterday school to not go

'I did not go to school yesterday.'

Declarative Sentence:

6. tanursangi pa tedi dak **azük**.
tʌn̄ūrsʌŋ̄i pʌ̄ tədi tʌ̀k ʌ́zək
Child his elder brother DET hit
'The child hit his brother.'

Negative sentence:

7. tanursangi pa tedi dak **m**azük.
tʌn̄ūrsʌŋ̄i pʌ̄ tədi tʌ̀k mʌ́zək
child his elder brother DET NEG hit
'The child did not hit his brother.'

Declarative Sentence:

8. Parnoki **azüngba** agi tatidang nung **takok** angu.
pʌ́nɔki ʌzəŋbʌ̄ ʌ̀gi tʌt̄idʌŋ̄ nùŋ tʌ́kɔ́k ʌ́ŋò
they study because exam in passed got
'Because they study they passed in exam.'

Negative sentence:

9. parnoki **m**azüngba agi tatidang nung **tamakok** angu.
pʌ́nɔki mʌ́zəŋbʌ́ ʌ̀ki tʌt̄idʌŋ̄ nùŋ tʌm̄ʌ́kṓk ʌ́ŋò
they NEG study because exam in failed got
'Because they did not study they failed in exam.'

Declarative Sentence:

10. Kütsü -ah aru küyih -ah **aru**.
kə-tsə -ʌ̀ʔ ʌ́ʌ̀ù kə-yiʔ -ʌ̀ʔ ʌ́ʌ̀ù
my mother also came my sister also came
'My mother as well as my sister has come.'

Negative sentence:

11. kütsü – ah maru küyih -ah **m**aru.
kə-tsə -ʌ̀ʔ mʌ́ʌ̀ù kə-yiʔ -ʌ̀ʔ m-ʌ́ʌ̀ù
my mother also NEG come my sister also NEG come
'Neither my mother nor my sister come.'

Declarative Sentence:

12. shiti tain -to **asü**.
ʃiʔti tʌīn -tū ʌs̄ə
elephant old DET died
'The old elephant died.'

Negative sentence:

13. shihti tain -to **m**asü
ʃiʔti tʌīn -tū m-ʌs̄ə
elephant old DET NEG die
'The old elephant did not die.'

Declarative Sentence:

14. Parnok **aruogo**
pʌ́nɔk ʌ̄uɔgɔ
they come have
'They have come.'

Negative sentence:

15. parnok ano **m**aru
pʌ́nɔk ʌ́nùʔ m-ʌ́ʌ̀ù
they yet NEG come
'They have not come as yet.'

Declarative Sentence:

16. parnoki ya **inyaktettsü**
pʌ́nɔki jʌ̄ injʌ́ktəttsə
they this can do
'They can do this.'

Negative sentence:

17. parnoki ya **me**inyaktettsü
pʌ́nɔki jʌ̄ me-injʌ́ktəttsə
they this NEG can do
'They cannot do this.'

Declarative Sentence:

18. Parnoki ya **inyaktet**
pʌ́nɔki jʌ̄ injʌ́ktət
they this could do
'They could do this.'

Negative sentence:
19. parnoki ya **me**inyaktet
pʌ́ɹnɔki jʌ̄ me-injʌ́ktət
they this NEG could do
'They could not do this.'

Declarative Sentence:
20. Parnoki teti mapang nung **atonger**
pʌ́ɹnɔki təti mʌ̄pʌ̄ŋ nūŋ ʌ̄tɔŋəɹ
they always time on reach
'They always reached on time.'

Negative sentence:
21. parnoki mapang nung kodanga **m**atonger
pʌ́ɹnɔki mʌ̄pʌ̄ŋ nūŋ kūdʌ̄ŋʌ̄ m-ʌ́tɔŋəɹ
they time on never NEG reach
'They never reach on time.'

Declarative Sentence:
22. iba otsü ya parnok dang **shiang**
ipʌ̄ ūtsə jʌ̄ pʌ́ɹnɔk dʌ̀ŋ ʃi-ʌ̄ŋ
this story this them to tell IMP
'Tell them this story.'

Negative sentence:
23. iba otsü ya parnok dang **te**shi
ipʌ̄ ūtsə jʌ̄ pʌ́ɹnɔk dʌ̀ŋ tə-ʃi
this story this them to IMP.NEG tell
'Do not tell them this story.'

Declarative Sentence:
24. yimlibilema **arung**
jimlipiləmʌ̄ ʌ̀ɹɔŋ
please come
'Please come.'

Negative sentence:
25. yimlibilema **t**aru
jimlipiləmʌ̄ t-ʌ̀ɹɔ
please IMP.NEG come
'Please don't come.'

Drink:
Declarative Sentence:
26. ni anepdangshia süngo **ajemer**
nì ʌ́nəpdʌ̄ŋʃiʌ̄ səŋɔ̀ ʌ̄ʤəmə́ɹ
I everyday tea drink
'I drink tea every morning.'

Negative sentence:
27. ni anepdangshia süngo **m**ajemer
nì ʌ́nəpdʌ̄ŋʃiʌ̄ səŋɔ̀ m-ʌ̄ʤəmə́ɹ
I everyday tea NEG drink
'I don't drink tea every morning.'

Declarative Sentence:
28. ni tanü süngo **jemogo**
nì tʌ̄nə səŋɔ̀ ʤém-ɔ́gɔ̄
I today tea drink PST
'I have drink tea today.'

Negative sentence:
29. ni tanü süngo **ma**jem
nì tʌ̄nə səŋɔ̀ mʌ̄-ʤem
I today tea NEG drink
'I have not drink tea today.'
Declarative Sentence:
30. ni yashih süngo **jemogo**
nì jʌ́ʃiʔ səŋɔ̀ ʤə́m-ɔ́gɔ
I yesterday tea drink PST
'I drank tea yesterday.'

Negative sentence:
31. ni yashih süngo **ma**jem
nì jʌ́ʃiʔ səŋɔ̀ mʌ̄-ʤem
I yesterday tea NEG drink
'I did not drink tea yesterday.'

Declarative Sentence:
32. ni asüng süngo **ajemtsü**
nì ʌ́səŋ səŋɔ̀ ʌ̄ʤém-tsə́
I tomorrow tea drink - FUT
'I will drink tea tomorrow.'
Negative sentence:

33. ni asüng süngo **m**ajemtsü
nì ʌ́səŋ səŋɔ̀ m-ʌ̄ʤém-tsə́
I tomorrow tea NEG drink FUT
'I will not drink tea tomorrow.'

CRY:
Declarative Sentence:
34. ni anogoshia **ajeber**
nì ʌ̀nɔgɔʃiʌ ʌ́ʤēbə-ɹ
I everyday cry HAB
'I cry every day.'

Negative sentence:
35. ni anogoshia **m**ajeber
nì ʌ̀nɔgɔʃiʌ m-ʌ́ʤébə̄-ɹ
I everyday NEG cry HAB
'I do not cry every day.'

Declarative Sentence:
36. ni yashih **ajeb**
nì jʌ́ʃiʔ ʌ́ʤéb
I yesterday cried
'I cried yesterday.'

Negative sentence:
37. ni yashih **m**ajeb
nì jʌ́ʃiʔ m-ʌ́ʤéb
I yesterday NEG cry
'I did not cry yesterday.'

Declarative Sentence:
38. ni asüng **ajebtsü**
nì ʌ́səŋ ʌ́ʤéb-tsə̀
I tomorrow cry FUT
'I will cry tomorrow.'

Negative sentence:
39. ni asüng **m**ajebtsü
nì ʌ́sə̀ŋ m-ʌ́ʤéb-tsə̀
I tomorrow NEG cry FUT
'I will not cry tomorrow.'

Declarative Sentence:
40. ni tanü **jebogo**
nì tʌ́nə ʤeb-ɔgɔ
I today cry PRS PERF
'I have cried today.'

Negative sentence:
41. ni tanü **ma**jeb
nì tʌ́nə mʌ́-ʤéb
I today NEG cry
'I have not cried today.'

PLAY:
Declarative Sentence:
42. ni anogoshia football **asayar**
nì ʌ̀nɔgɔʃiʌ fútbɔ̄l ʌ̀sʌ̄jʌ̄-ɹ
I everyday football play HAB
'I play football every day.'

Negative sentence:
43. ni anogoshia football **m**asayar
nì ʌ̀nɔgɔʃiʌ fútbɔ̄l m-ʌ̀sʌ̄jʌ̄-ɹ
I everyday football NEG play HAB
'I do not play football every day.'

Declarative Sentence:
44. ni tanü football **asayaogo**
nì tʌ̄nə fútbɔ̄l ʌ̄sʌ̄jʌ̄-ɔgɔ
I today football play PRS PERF
'I have played football today.'

Negative sentence:
45. ni tanü football **m**asaya
nì tʌ̄nə fútbɔ̄l m-ʌ̄sʌ̄jʌ̄
I today football NEG play
'I have not played football today.'

Declarative Sentence:
46. ni yashih football **asayaogo**
nì jʌ́ʃiʔ fútbɔ̄l ʌ̄sʌ̄jʌ̄-ɔ́gɔ̄
I yesterday football play PST
'I played football yesterday.'

Negative sentence:
47. ni yashih football **m**asaya
ni jʌ́ʃiʔ fútbɔ̄l m-ʌ̄sʌ̄jʌ̄
I yesterday football NEG play
'I did not play football yesterday.'

Declarative Sentence:

48. ni asüng football **asayatsü**
nì ʌ́sə̀ŋ fútbɔ̄l ʌsʌjʌ̄-tsə́
I tomorrow football play FUT
'I will play football tomorrow.'

Negative sentence:
49. ni asüng football **m**asayatsü
nì ʌ́sə̀ŋ fútbɔ̄l m-ʌsʌjʌ̄-tsə́
I tomorrow football NEG play FUT
'I will not play football tomorrow.'

EAT:
Declarative Sentence:
50. ni anogoshia apple **achir**
nì ʌn̄ɔgɔʃiʌ̄ épə̀l ʌt̄ʃi-ɹ
I everyday apple eat HAB
'I eat an apple every day.'

Negative sentence:
51. ni anogoshia apple **m**achir
nì ʌn̄ɔgɔʃhiʌ̄ épə̀l m-ʌt̄ʃi-ɹ
I everyday apple NEG eat HAB
'I do not eat an apple every day.'

Declarative Sentence:
52. ni tanü apple **chiogo**
nì tʌn̄ə épə̀l tʃi-ɔgɔ
I today apple eat PRS PERF
'I have eaten an apple today.'

Negative sentence:
53. ni tanü apple **ma**chih
nì tʌn̄ə épə̀l mʌ̄-tʃiʔ
I today apple NEG eat
'I have not eaten an apple today.'

Declarative Sentence:
54. ni yashih apple **achih**
nì jʌ́ʃiʔ épə̀l ʌt̄ʃiʔ
I yesterday apple ate
'I ate an apple yesterday.'

Negative sentence:
55. ni yashih apple **m**achih
nì jʌ́ʃiʔ épə̀l m-ʌ́tʃiʔ
I yesterday apple NEG ate
'I did not ate an apple yesterday.'

Declarative Sentence:
56. ni asüng apple **achitsü**
nì ʌ́sə̀ŋ épə̀l ʌ́tʃĭ-tsə̀
I tomorrow apple eat FUT
'I will eat an apple tomorrow.'

Negative sentence:
57. ni asüng apple **m**achitsü
nì ʌ́sə̀ŋ épə̀l m-ʌ́tʃĭ-tsə̀
I tomorrow apple NEG eat FUT
'I will not eat an apple tomorrow.'

SEE:
Declarative Sentence:
58. ni anogoshia ohzü **angur**
ní ʌ̀nɔgɔʃiʌ̄ ɔ̀zə̀ ʌ́ŋú-ɹ
I everyday bird see PRS HAB
'I see a bird every day.'

Negative sentence:
59. ni anogoshia ohzü **m**angur
ní ʌ̀nɔgɔʃiʌ̄ ɔ̀zə̀ m-ʌ́ŋù-ɹ
I everyday bird NEG see HAB
'I do not see a bird every day.'

Declarative Sentence:
60. ni yashi ohzü ka **angu**
ní jʌ́ʃiʔ ɔ̀zə̀ khʌ̀ ʌ́ŋù
I yesterday bird one saw
'I saw a bird yesterday.'

Negative sentence:
61. ni yashi ohzü **katah mangu**
ní jʌ́ʃiʔ ɔ̀zə̀ khʌ̀-tʌ̀ʔ m-ʌ́ŋù
I yesterday bird one even NEG see
'I did not see a bird yesterday.'

Declarative Sentence:
62. ni tanü ohzü ka **angu**
ní tʌn̄ə̄ ɔ̀zə̀ khʌ̀ ʌ́ŋù
I today bird one seen
'I saw a bird today.'

Negative sentence:

63. ni tanü ohzü **katah** **mangu**
ní tʌn̄ə̄ ɔ̀zə̀ khʌ̀-tʌ̀ʔ m-ʌ́ŋù
I today bird one even NEG seen
'I did not see a bird today.'

Declarative Sentence:
64. ni asüng ohzü **angutsü**
ní ʌ́səŋ ɔ̀zə̀ ʌ́ŋū-tsə̀
I tomorrow bird see FUT
'I will see a bird tomorrow.'

Negative sentence:
65. ni asüng ohzü katah **mangutsü**
ní ʌ́səŋ ɔ̀zə̀ khʌ̀-tʌ̀ʔ m-ʌ́ŋū-tsə̀
I tomorrow bird one even not see FUT
'I will not see a bird tomorrow.'

WATCH:
Declarative Sentence:
66. ni anogoshia movie **repranger**
nì ʌ̀nɔgɔʃiʌ̄ mūvi ɹəpɹʌ̄ŋə́-ɹ
I everyday movie watch PRS HAB
'I watch a movie every day.'

Negative sentence:
67. ni anogoshia movie **me**repranger
nì ʌ̀nɔgɔʃiʌ̄ mūvi mə̄-ɹə̄pɹʌ̄ŋə́-ɹ
I everyday movie NEG watch PRE HAB
'I do not watch a movie every day.'

Declarative Sentence:
68. ni tanü movie ka **reprangogo**
nì tʌ́nə mūvi khʌ̀ ɹəpɹʌ̄ŋ-ɔ́gɔ
I today movie one watch PRS PERF
'I have watched a movie today.'

Negative sentence:
69. ni tanü movie **katah** **mereprang**
nì tʌ́nə mūvi khʌ̀tʌ̀ʔ mə̄-ɹə̄pɹʌ̄ŋ
I today movie one not even NEG watch
'I have not watched a movie today.'

Declarative Sentence:
70. ni yashi movie ka **reprangogo**
nì jʌ́ʃiʔ mūvi khʌ̀ ɹəpɹʌ̄ŋ-ɔ́gɔ̄
I yesterday movie one watch PST
'I watched a movie yesterday.'

Negative sentence:
71. ni yashi movie **katah** **mereprang**
ní jʌ́ʃiʔ mūvi khʌ̀tʌ̀ʔ mə-ɹəpɹʌ̄ŋ
I yesterday movie one not even NEG watched
'I did not watch a movie yesterday.'

Declarative Sentence:
72. ni asüng movie **reprangtsü**
nì ʌ́sə̀ŋ mūvi ɹəpɹʌ̄ŋ-tsə́
I tomorrow movie watch FUT
'I will watch a movie tomorrow.'

Negative sentence:
73. ni asüng movie **me**reprangtsü
nì ʌ́sə̀ŋ mūvi mə-ɹəpɹʌ̄ŋ-tsə́
I tomorrow movie NEG watch FUT
'I will not watch a movie tomorrow.'

Declarative Sentence:
74. ni anogoshia skol-I **aor**
nì ʌ̀nɔgɔʃiʌ̄ iskol-i ʌ̄ɔ̄-ə́ɹ
I everyday school-to go PRE HAB
'I go to school every day.'

Negative sentence:
75. ni anogoshia skol-I **m**aor
nì ʌ̀nɔgɔʃiʌ̄ iskɔl-i m-ʌ̄ɔ̄-ə́ɹ
I everyday school-to NEG go PRE HAB
'I don't go to school every day.'

Conclusion

In Ao language there was no independent/ separate negative word. But the word such as '*m*', 'ma', 'me' ,'t' and '*te*' were use to negate the verb by using prefixed

and infixed. The word *'m'* occurs in sentence 1, 3, 5, 7, 11, 13, 15, 21, 27, 33, 35, 37, 39, 43, 45, 47, 49, 51, 55, 57, 59, 61, 63, 65 and 75. *'ma'* occurs in sentence 29, 31, 41, and 53. *'me'* occurs in sentence 17, 19, 67,69, 71 and 73. *'t'* occurs in sentence 25. *'te'* occurs in sentence 23. The word *'ma'* which is also used in infixed were occurs in sentence 9.

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SPIN PERIOD OF FEW AXPS

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Abstract: Anomalous X-ray Pulsars are small class of pulsars which are highly magnetized and have spin period of several seconds. This paper presents the calculation of spin period of seven AXPs using Suzaku observations.

Key words: Neutron star, X-ray, spin period.

Introduction

Anomalous X-ray Pulsars (AXPs) are isolated young neutron stars having high order X-ray luminosity ($\sim 10^{34}$ ergs /s). They are called "anomalous" because they are neither rotation powered nor accretion powered X-ray pulsars. They are powered by a decaying ultra high magnetic field ($\sim 10^{13}$ -10^{15} gauss). AXPs have long spin period ranging from 5 -12 s. The X-ray luminosity of AXPs lies between 10^{33} to 10^{35} erg s^{-1}. Some of the AXPs also emit at optical and/or infrared wavelengths (Hulleman et al. 2000). The AXPs are also considered to be very young 10^{3} - 10^{5} years, some of which are associated with supernova remnants. There are currently 14 confirmed AXPs and 2 probable candidates {McGill SGR/AXP Online Catalogue}.

The survey of literature indicates that the first AXP discovered was 1E 2259+586 using the Einstein X- ray Observatory (Fahlman and Gregory, 1981). It was initially thought as a low mass X-ray binaries. After few years, Seward *et. al.* 1986, found ~ 6.44s pulsation in X-ray source 1E 1048.1-5937. Using the archival data of European X-ray Observatory, Isreal *et. al*. (1994) discovered ~ 8.7s pulsation in 4U 0142 +61. All these three sources showed the lack of massive companion. AXPs display different types of X-ray flux variability: from slow, moderate flux changes on timescale of months/years, to intense outbursts with short rise times (~ 1 day) lasting ~ 1 year. Some AXPs were found to undergo intense and drastic SGR like bursts activity on sub second time scales (XTE J 1810-197, 4U 0142+614, 1E 1048.1-5973, 1E 2259+586). The discovery of bursts from AXPs is strong evidence for their signature in favor of a common nature of AXPs and SGRs as young magnetars (Albano *et. al*. 2010).

Observations

For the present work, we used public data from Suzaku observations of various AXPs. The details about observation ID, date of observation, RA, DEC etc. are given in the table 1 and 2. Suzaku is Japan's fifth X-ray astronomy satellite mission with important US contributed instruments under collaboration with Institute of Space and Astronautical Science (ISAS) and the Japan Aerospace Exploration Agency (JAXA) (Mitsuda, *et. al*. 2007). It was launched on 2005 July 10. Its pre launched name was ASTRO-EII. It has a circular orbit at an altitude of 550 km with an inclination of 31^{o}. It covers the 0.2-600 keV energy range with three sets of instruments, X-ray imaging spectrometer (XIS) covering the soft X-rays in the energy range 0.2-12 keV, Hard X-ray detectors (HXD) covering the energy range 10-70 keV with PIN diodes and 40-600 keV with GSO scintillators and X-ray

spectrometer (XRS) to measure the high resolution spectra of X-ray source. Due to the loss of cryogen, the XRS is no longer working from the August 2005.

Table 1: Spatial parameters of AXPs

Name of Source	**RA**†	**DEC**†	**Distance*** **(kpc)**
CXOU J164710.2- 455216	$16^h\,47^m\,10.2^s$	$45^o52'16.9''$	5
1E 1547.0 -5408	$15^h\,50^m\,54.11^s$	$54^o18'23.7''$	3.9
1 RXS J 1708 -4009	$17^h\,08^m\,46.87^s$	$-40^o08'52.4''$	~8
1E 1841 -045	$18^h\,41^m\,19.34^s$	$-04^o56'11.16''$	~6.7
1E 1048.1-5937	$10^h\,50^m\,07.14^s$	$-59^o53'21.4''$	2.7
4U 0142 +61	$01^h\,46^m\,22.44^s$	$-61^o45'03.3''$	>2.5
1E 2259 +586	$23^h\,01^m\,08.29^s$	$-58^o52'44.4''$	3.0

† McGill SGR/AXP Online Catalog * Özel *et. al*. (2001)

Table 2: Observation details of AXPs used for present study

Source	ID	Date of observation	Exposure for XIS and PIN	Observation mode and window option of XIS
CXOUJ164710.2-455216	901002010	2006-09-23 10:44:58	38.68ks; 35.04ks	Pointing ; 1/8 i.e time resolution of 1s
1E1547.0 -5408	903006010	2009-01-28 21:34:12	10.69ks; 33.37ks	Pointing ; 1/4 i.e time resolution of 2s
1RXSJ 1708 - 4009	404080010	2009-08-23 10:25:08	50.91ks; 50.83ks	Pointing ; 1/4 i.e time resolution of 2s
1E 1841 -045	401100010	2006-04-19 10:51:40	96.97ks; 61.44ks	Pointing ; 1/8 i.e time resolution of 1s
1E 1048.1-5937	403005010	2008-11-30 23:02:01	85.02ks; 61.8ks	Pointing ; 0:off i.e
4U 0142 +61	404079010 402013010	2009-08-12 01:41:15 2007-08-13 04:04:13	82.66ks; 99.7ks 71.9ks; 10.1ks	Pointing ; 1/4 i.e time resolution of 2s Pointing ; 1/4 i.e time resolution of 2s
1E 2259 +586	404076010	2009-05-25 20:00:17	89.17ks; 10.25ks	Pointing ;1/4 i.e time resolution of 2s

Analysis and result

The data obtained from NASA's archive are into FITS (Flexible Image Transport system) format. The software used for this work is FTOOLS which is part of HEAsoft, which is developed and maintained by High Energy Astrophysics Science Archive Research Center (HEASARC) at GSFC, NASA. It is independent of the detectors on board various satellites and can be utilized for timing analysis.

The intensity of X-ray sources are highly variable. The variation in time can vary from few milliseconds to years. Timing analysis is study of such variabilities of different sources. A light curve is the starting point of timing analysis. A light curve is the plot between intensity of the source and the time. In ftools there is task called *efsearch* which also searches for periodicity in the given data. It folds the light curves with a large number of trial periods. Each folded light curve is fitted with a constant and hence χ^2 is determined. If the trial period is correct then χ^2 will be high and if the trial period is not correct then χ^2 value will be small. Thus, the trial period corresponds to maximum χ^2 represents the correct period in the light curve.

For all the sources used for this study, the following timing analysis procedure was adopted. At first, the barycentric correction was applied to the cleaned XIS by use of *aebarycen*. To find the most reliable period, first light curve of minimum time resolution were obtained for all XIS. Then, all XIS light curves for each source were combined. As the XISs have very low backgrounds, background subtraction from the light curves was not done. We generated the light curve for XIS 0, 1 and 3. We combined these light curves using the ftool task "lcmath". Using the *efsearch*, we derive the pulse period using the combined XIS light curves by searching for the maximum in the χ^2 versus folding period. The plot of χ^2 with folded period is shown is figure 1. The spin period obtained in the present study is found to be in good agreement (Table 3) with the period reported in the literature.

Table 3: Spin period reported and obtained using Suzaku data.

Source	**Spin period reported**	**Best period found**
CXOU J 164710.2 -455216	10.6107s	10.61058 ± 0.0001s
1E 1547.0 -5408	2.069s	2.07404 ± 0.0001s
1 RXS J 1708 -4009	10.99s	11.00545 ± 0.0001s
1E 1841 -045	11.775s	11.78298 ± 0.000s
1E 1048.1-5937	6.452s	6.45985 ± 0.0001s
4U 0142 +61 (Two observations)	8.688s	8.68893 ± 0.0001s 8.68879 ± 0.0001s
1E 2259 +586	6.979s	6.97914 ± 0.0001s

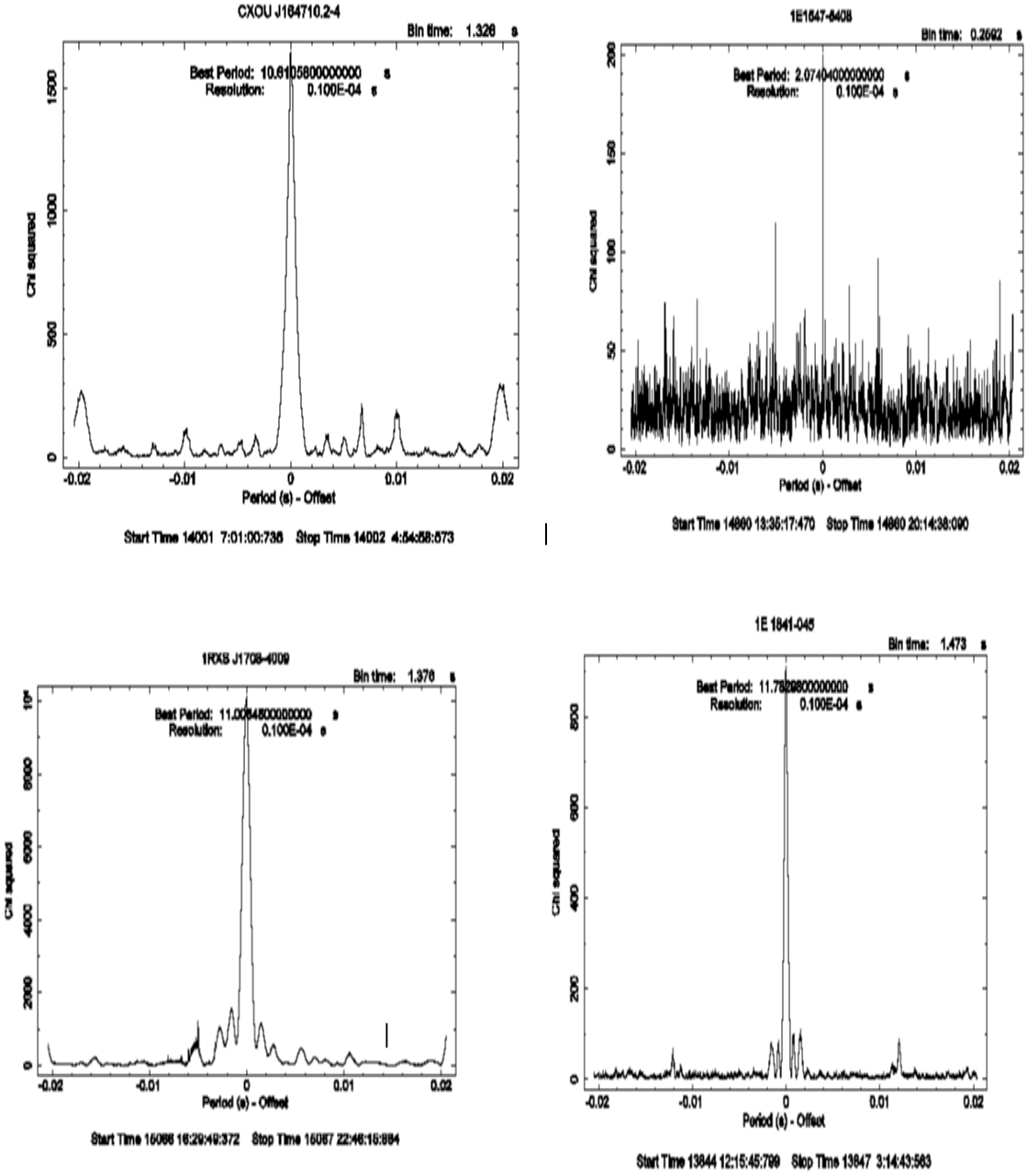

Fig. 1: The plot of of χ^2 with folded period for AXPs CXOU J 164710.2 – 45, 1E 1547-5408, 1 RXS J 1708-4009 and 1E 1841-045 respectively.

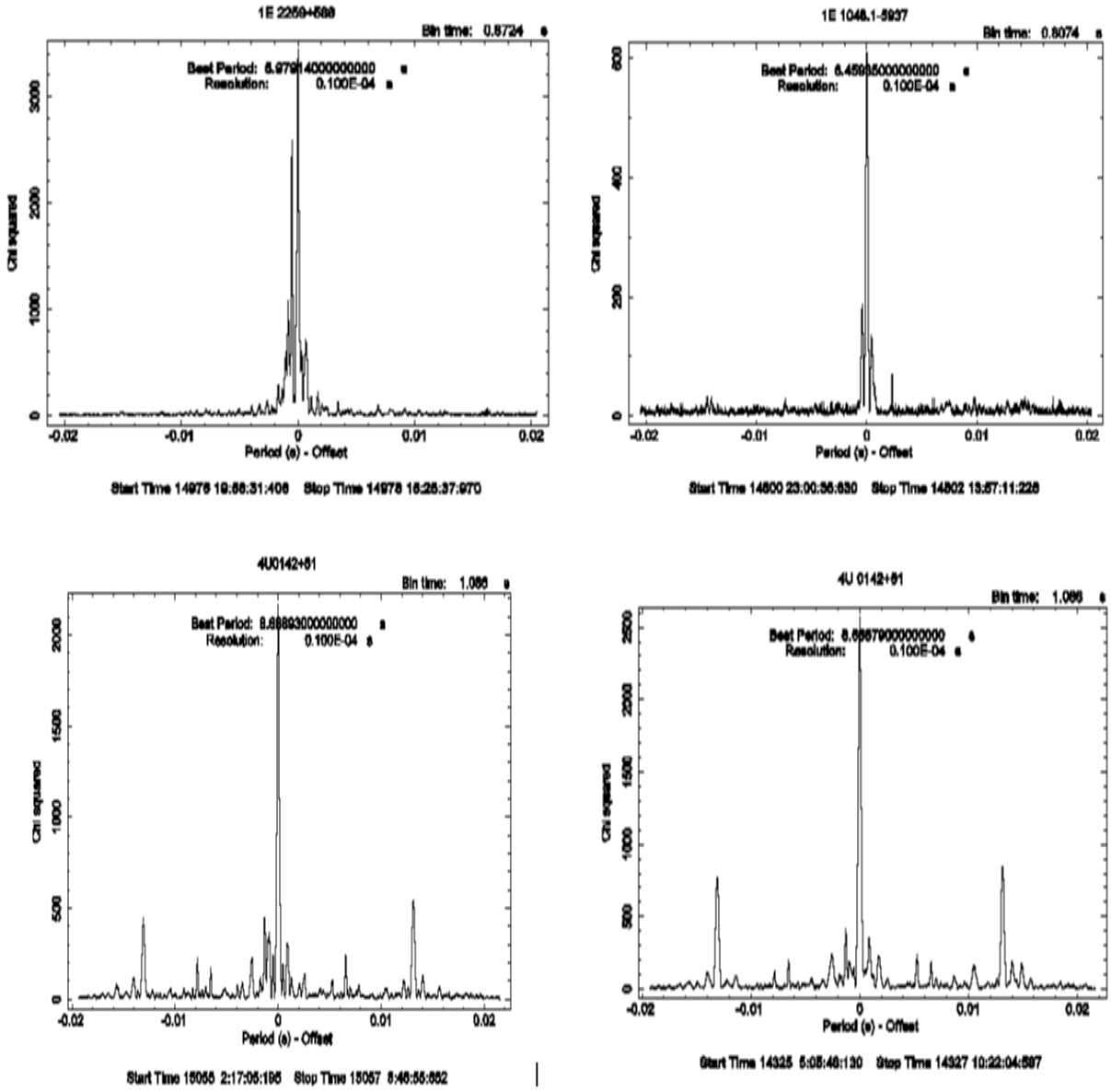

Fig 2: The plot of of χ^2 with folded period for AXPs 1E 2259+588, AXP 1E 1048-593 and the AXP 4U 0142 + 61 for two observations(ID and 404079010 and 402013010).

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A REVIEW ON CARBON NANO TUBES

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Abstract: Carbon nano tube is one of the emerging topics in nano technology with its unique properties. The historical development of carbon nano tubes, the methods for the production of carbon nano tubes and its applications are reviewed. Carbon nano tubes can be manipulated according to our requirements due to its unique property and is applied in many fields. However, the ill effects of carbon nano tubes have to be further investigated.

Key words: carbon nano tube, multi walled, single walled, synthesis.

Introduction

Nano science and Nano technology is one of the emerging fields for research in recent times. The word 'Nano' is derived from the Greek word 'Nanos' which means dwarf. Nano in physics denotes the prefix 10^{-9} which will amount to one billionth of a value. We can understand the application of the unique characteristics of nanoscience from different ancient works. The Egyptians used glasses that were colored with colloidal particles. The Romans also used to dye glass articles and cups. The Lycurgus cup used in the 4^{th} century used nanotechnology which makes the cup appears red in transmitted light and green in reflected light. Nanotechnology has revolutionized medicine, healthcare, energy, industries, computing, electronic gadget etc.
Carbon Nano Tube (CNT) is one of the interesting discoveries in the field of Nano science. Carbon nano tubes (CNTs) are allotropes of carbon with a nano structure. It has a unique property in terms of surface area, stiffness, strength and resilience.

Methodology

The materials in nano science and technology were initially investigated and later scaled down to carbon nano tubes. The historical background of carbon nano tubes, its classification, the properties and its uses were emphasized and later reviewed.

Historicial background

The report and study on structures similar to the structure of carbon nano tube started since 1952.

The report on the Soviet Journal of Physical Chemistry by Radushkevich and Lukyanovic (1952) discussed about a worm-like carbon formations. A vapor growth technique was used by Oberlin, Endo and Koyama (1976) to depict the existence of thin hollow carbon fibres. The 14th Biennial Conference of Carbon at Penn State University was remarkable with the presentation by John Abrahamson about the existence of carbon fibres produced from carbon anode. The studies on the structural characterization of carbon nano particles by some Soviet scientist (1981) showed the possibility of the production of carbon multi layer tubular crystals. There were different studies and report of this field till finally the first synthesis and charectisation of carbon nano tubes (CNTs) was reported by Iijima (1991) during the arc-discharge synthesis of fullerene.

Carbon nanotubes

Carbon is one of the most abundant elements in the universe by mass with an atomic number of six. Carbon nano tubes (CNTs) are allotropes of carbon and are known as buckytubes (Iijima *et. al*., 1993). The carbon nano tubes (CNTs) are cylindrical and the structure is tabular with thin diameter less than 100 nm and is the member of the fullerene family that was discovered by Kroto (Kroto *et. al.,* 1985). Buckyball is spherical fullerenes while carbon nanotubes are cylindrical.

The unique size, shape and physical properties of the CNTs are very challenging for researchers from various fields like physics, chemistry, biology, electronic, material science, energy management, medical etc.

The CNTs are observed to have a unique electrical, mechanical and thermal conductivity and can be manipulated to a large extend due to its unique chemistry. The carbon nano tubes have the unique property of behaving either as a conductor or a semi conductor depending on the manipulation of the axial direction and the unit vector describing the hexagonal lattice. CNTs are strong and stiff due to the covalent sp^2 bonds formed between the individual carbon atoms.
The Carbon nano tubes are classified as single walled carbon nano tubes (SWNTs), and multiple walled carbon nano tubes (MWNTs). Single walled carbon nano tubes are made of a single grapheme sheet rolled upon itself with a diameter of 1nm -2 nm while the multi walled carbon nano tubes consists of multi layers of graphene rolled upon it with diameters ranging from 2 to 50 nm (Ajayan PM., 2004). The comparison of some important properties between SWCNTs and MWCNTs is given in table 1.

SWCNTs	MWCNTs
Single layer of graphene	Multi layer of graphene
Poor purity	High purity
Easy for bulk synthesis	Difficult for bulk synthesis

Table 1: Comparison between SWCNTs & MWCNTs

The tensile strength of single walled carbon nano tubes (SWCNTs) and multi walled carbon nano tubes (MWCNTs) was found to be 5 -500 giga pascal (Gpa) and 10 - 60 Gpa respectively (Xie *et. al.,* 2005, Yu *et. al.,* 2000). The young's modulus of SWCNTs was calculated to be around 2.8 -3.6 terra pascal and that of MWCNTs as 1.7 – 2.4 terra pascal by Lourie and Wagner (1998). The CNTs were studied by researchers like Hamada *et. al.* (1992) and Saito *et. al.* (1992) that discussed about the dependence of electronic properties on the geometrical structure. The theoretical value of the thermal conductivity (Berber *et. al*., 2000) of CNTs is found to be around 6600 (W/m-K). The measured value of thermal conductivity for bulk single walled carbon nano tubes is around 200 Watts per meter Kelvin and individual multi walled carbon nano tubes is 3000 Watts per meter Kelvin (Hone, 2004). The investigation of optical properties of carbon nano tubes with the study of electronic transitions found that light emitting capacity is between conductor and semi conductors.

There are three different types of carbon nano tubes apart from the two different basic structures namely, arm chair carbon nano tubes, zigzag carbon nano tubes and chiral carbon nano tubes. These three nomenclatures have been developed based on how the graphite is rolled up during its production. The chiral vector is represented by two indices n and m corresponding to the number of unit vectors along the two

directions in the honeycomb crystal lattice of graphene. If n = m, we term the carbon nano tubes as arm chair. If m = 0, the carbon nano tubes are called as zigzag (Prasher RS *et. al*., 2009). The remaining carbon nano tubes are called as chiral.

Thus, the two integers (n and m) locate the hexagon of the network that match after the nano tube rolls with the hexagon. The chiral vector (**C_h**), diameter and chiral angle are described by the equations (Irina *et. al*., 2016),

$$\mathbf{C_h} = n\mathbf{a_1} + m\mathbf{a_2} \quad \ldots.(1)$$

Where $\mathbf{a_1}$ and $\mathbf{a_2}$ are the respective unit vectors of the hexagonal lattice

The diameter of a tubulene is expressed as

$$d_t = \frac{\sqrt{3}a_{c-c}(m^2 + mn + n^2)^{1/2}}{\pi} \quad \ldots (2)$$

such that $a_{c\text{-}c}$ is the difference between the nearest carbon atoms.

The chiral angle is given by

$$\Theta = \tan^{-1}\left(\frac{\sqrt{3m}}{m+2n}\right) \quad \ldots. (3)$$

A lattice vector (**T)** is also introduced to study the properties of the carbon nanotubes as one –dimensional set up which is oriented along the tubulene axis orthogonally to the chiral vector and represented as (Irina *et. al*., 2016).

$$\mathbf{T} = \frac{(2m+n)a_1 - (2n+m)a_2}{d_k} \quad \ldots.(4)$$

Where d_k is defined by

$$d_k = \begin{cases} \text{d if n-m is not a multiple of 3d} \\ \text{3d if n = m is a multiple of 3d} \end{cases}$$

such that d is the greatest common divisor of (n,m).

Synthesis techniques

Different techniques have been developed by various scientists for the production of carbon nano tubes with different structure and morphology. The single walled carbon nano tubes are single layer of graphene and require a catalyst for synthesis while the multi walled carbon nano tubes are multi layer of graphene and can be produced without a catalyst. The process of bulk synthesis is tedious in production of SWCNTs due to its high sensitivity on atmospheric condition and other conditions while these problems are rarely encountered in the production of MWCNT. The level of purity is very less in SWCNT compared to that of MWCNT. The characterization process in SWCNT is easier compared to that of MWCNT. In most of the method, the catalyst influences the quality, structure and yield of the carbon nano tubes. The catalyst used is normally the transition metal nano particles (Thess *et. al*., 1996). Some important methods are discussed briefly:

ARC discharge method

Carbon nano tubes in this method are produced through arc evaporation of two carbon tubes placed apart by some few millimeters enclosed by an inert gas like helium at low pressure. A high temperature is developed at around 100 amps between the two electrodes to evaporate the anode which in turn forms hot plasma and produce rod shaped tubes on the cathode (Yamaguchi *et. al*., 2004, Ebbesen *et. al.,* 1992).This method is good for bulk production of CNTs. The single walled carbon nano tubes produced by this method have a diameter of around 0.6nm – 1.4 nm and have only some structural defect. However, the multi walled carbon tubes produced in this method have an inner diameter of around 1nm - 3 nm and outer diameter of approximately 10 nm and can be synthesized without a catalyst but the manipulation for the chirality of the

carbon nano tubes is very less. The cost factor involved in this method is very high and the carbon nano tubes produced are normally short with no uniformity in size. However, the rare occurrence of structural defects makes this method relevant for researchers (Journet, 1997).

Laser ablation

The Laser ablation method involves the process of blasting graphite with intense laser pulses. A pulsed laser vaporizes a graphite target in a tube furnace kept at very high temperature. The grown nano tubes are collected in the copper collector when inert gases like argon or nitrogen are pumped into the chamber at around 500 torr (Shifrina, 2011).This method require high values of power and temperature with ideal vacuum conditions and continuous graphite target replacement to induce reorganization of carbon atoms into carbon nano tubes (Thess *et. al.,* 1996). This method is not cost effective and produces only powered samples with carbon nano tubes of around 5 -20 microns tangled into bundles with a yield of around 70 percent

Chemical vapor deposition

The problems related with industrial production and ordered synthesis were improved by the chemical vapor deposition method (Mamalis *et. al.,* 2004).The chemical vapor deposition involves the chemical breakdown of a hydrocarbon on substrate (H. Dai, 2002).The substrate is placed in the oven and heated to high temperature of around 700º C to 900 º C at atmospheric pressure (Xie *et. al.,* 2000) and a carbon bearing gas is added gradually. The metallic particles are implanted in properly aligned holes in the substrate. Then, acetylene at a relatively high temperature is decomposed into the substrate which in turn grows nano tubes. The growth direction on the substrate can be controlled in this method (Li *et. al.,* 1996) The yield of long single walled carbon nano tubes with a diameter of around 0.6nm to 4nm and multi walled carbon nano tubes of 10nm – 240 nm in this method is quite appreciable with comparatively less temperature but the growth area normally crack and shrink.

Applications

The unique characteristics of carbon nano tubes allow it to be used for various practical applications in this era of nanotechnology. CNTs have wide applications in diverse fields like electronics, energy storage and management, material science, medical and allied science, bio medical applications, sensors, fillers, ceramics, reinforced plastics, fibers, fabrics etc. CNTs can be used in nano-electronics due to the high conductivity (Baughman *et. al*., 2002) of single walled carbon nano tubes. It can also be used as interconnect option to copper on an integrated circuit due to its low resistivity and small dimension.

Researchers have demonstrated a very effective transistor such that a molecule can be positioned inside a carbon nano tube to effect the electronic current flowing across it. Carbon nano tubes are also used in electrochemical devices due to its high electrical conductivity and large surface area (Rotman, 2002).It is known from various research findings that the storage capacity of batteries can be increased effectively by using carbon nano tubes(Cao *et. al.,*2001). The solar cells designed with the use of carbon nano tubes enhances the efficiency of the solar cells and can be used in an area where the cell may not necessarily face the sun.

High specific capacitance that requires high power and storage capabilities can be designed by using carbon nano tubes (Frackowiak *et. al.,* 2002). Researchers have used CNTs to construct an actuator that can

work with relatively low voltage and high temperature (Jurewicz *et. al*., 2001). Carbon nano tubes can also be utilized as fillers (Bhattacharyya *et. al.,* 2004) for various polymeric materials that can alter the properties of the materials according to the needs. The tensile modulus and the yield strength can be enhanced with proper fillings (Helland *et. al.,* 2007). The carbon nano tubes can be utilized to construct different sophisticated sensors and can also be used to monitor leaks in chemical plants (Wong, 1998). It can also be used to detect a specific chemical or biological element (Park *et. al*., 2009).

The carbon nano tubes have the property of entering various parts of human organs which makes the study very interesting in health care. Drug delivery system in living being by using CNTs are found to be more effective, safer, less toxic and can even pass through membranes carrying the therapeutic drugs, vaccine and nucleic acid into the cells (Akiladevi, 2010).The anticancer drug polyphosphazene platinum administered with the help of carbon nanotubes increases the permeability, distribution and retention in the brain due to controlled lipophilicity of carbon nano tubes (Pai *et. al.,* 2006).Genes and atoms can be manipulated to develop bioimaging genomes, proteomics and tissue engineering (Pai *et. al*., 2006). The method of killing selectively the cancer cell is found to be more effective with the use of carbon nano tubes (Kam *et. al*., 2005).

Conclusion

Carbon nano tubes have unique mechanical, electrical, physical, structural and chemical properties. It will play a major role in many emerging fields of medicine, engineering, electronic and material science. However, there are certain drawbacks associated with the use of carbon nanotubes in many emerging fields. We need to search for new methods to overcome the deficiency of solubility in many solvents compatible with the biological milieu (Lacerda, 2006). The toxicity of carbon nano tubes is confirmed (Simeonova, 2009) and therefore further researches are required to tackle the ill effects of carbon nano tubes.

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RÜSIE

Translation: 'A movement for a cause' is the literal translation of the Tenyidie word **'Rüsie'**. It is a movement of united action and efforts by a group or a community for a specific purpose.

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