

## NEOGENE PALAEOLOGY OF THE SURMA GROUP, MIZORAM, INDIA. 2 - THE TELLINOIDEA (MOLLUSCA : BIVALVIA)

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### ABSTRACT

The Bhuban Formation, Surma Group (lower to middle Miocene) of Mizoram is rich in mega-invertebrate palaeobiota dominated by bivalves. Superfamily Tellinoidea of the Class Bivalvia is represented in these sediments by four genera viz., *Tellina*, *Apolymetis*, *Gari* and *Solecortus*. The author has described two species of the genus *Apolymetis* previously. Twelve species of the genera *Tellina*, *Gari* and *Solecortus* are described here for the first time, of which four are designated as new. The fossil assemblage seems to be allochthonous.

The fossil assemblage indicates an overall age of Aquitanian–Helvetian for the Bhuban Formation. It also points to a sandy substrate with depth ranging from inter-tidal to 75 fathoms (135 m), and normal salinity of seawater.

**Key words:** Neogene (lower to middle Miocene), Tellinoidea, Surma Group (Bhuban Formation), Mizoram

### INTRODUCTION

The Miocene sediments of northeastern region including the Andaman Nicobar Islands and adjoining Myanmar have yielded a large number of bivalve taxa (Cotter, 1923; Eames, 1950; Kanjilal and Srinivasan, 2002; La Touche, 1891; Lyngdoh, Tiwari and Kachhara, 1999; Mishra *et al.*, 1996; Mukerjee, 1928, 1929 and 1939; Noetling 1895 and 1901; Pascoe, 1962 and 1973; Pinfold, 1919; Sale, 1932; Sale and Evans, 1940; Tiwari, 1992 and 2001; Tiwari and Kachhara, 2000 and 2003 and Vredenburg, 1921). Though the majority of the bivalve taxa hitherto known from these areas are long ranging, a few of them have restricted ranges suitable enough for dating the fossiliferous horizons. Besides, they provide valuable information regarding depositional environment and bathymetry.

The family Tellinidae of Superfamily Tellinoidea comprises a very interesting group of Molluscs in the Class Bivalvia. While preserving their distinct familial characters, they live in every latitude from polar to equatorial waters and have a worldwide distribution. During the geological past, the members of

this Superfamily have had a similarly wide distribution, and many fossil species are reported from the Lower Cretaceous through Pleistocene formations in all parts of the world (Afsher, 1969).

This paper describes marine fossils belonging to Superfamily Tellinoidea collected from the Bhuban Formation, Surma Group (lower to middle Miocene) of Mizoram. Most of the fauna described here come from the upper part of the Upper Bhuban unit. Fossil localities are sporadic and yield a small number of species. The preservation of fossils is not good and they are usually in the form of external casts, and mostly are single valves. Though none of the specimens retain their shell covering, the details of external sculpture, and shape and size of the original bivalves are well preserved to warrant specific identification.

Published literature on the Tellinoidea from the Bhuban Formation, Surma Group of Mizoram is poor. Das Gupta (1982), Sinha, Chatterjee and Satsangi (1982) and Patil (1990 and 1991) have referred to the occurrence of a few genera of Tellinoidea from the Bhuban sediments of the state. Tiwari and Kachhara (2000), for the first time, described two new species of *Apolymetis* from these sediments of the study area. The specimens described here have been collected from eight fossiliferous localities, four each around Aizawl and Lunglei towns of Mizoram (Figs. 1 and 2). The stratigraphic and temporal distribution of fossil localities is shown in Fig. 3.

The general geology of Mizoram has been described by various workers viz., Ganguly (1975 and 1983), Ganju (1975), Nandy *et al.*, (1983), Nandy (2001), Karunakaran (1972) and Shrivastava *et al.*, (1979).

The classification suggested by Newell (in Moore *et al.*, 1969 and Davies, 1975) has been followed in the present work. The identification of genera and species is mainly based on the external features. The specimens described here are housed in the Palaeontology Museum, Department of Geology, Mizoram University, Aizawl-796 009, Mizoram. The following abbreviations are used in the present paper: OD= original designation, SD= subsequent designation, Sp. No.= specimen number, n. sp.= new species, cf.= comparable to, s. str.= sensu stricto, RV = right valve, LV = left valve, BV = both valve, SV = single valve, c = computed, GSI = Geological Survey of India, MZU= Mizoram University and I = invertebrates. Figures in

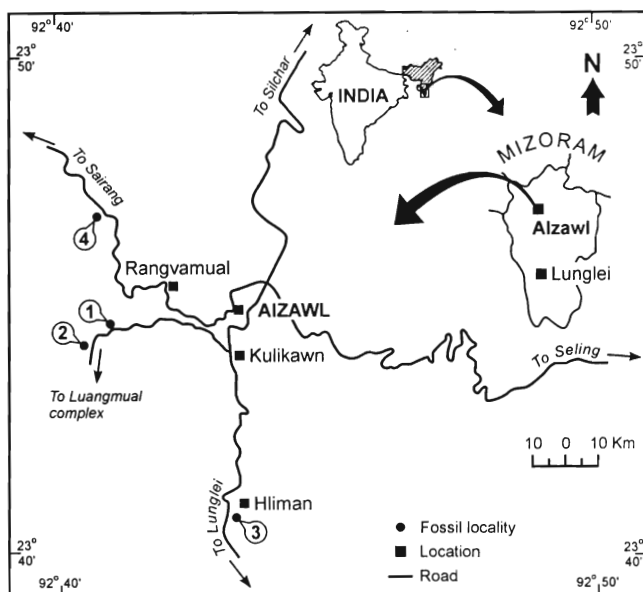


Fig. 1. Fossil localities around Aizawl, Mizoram.

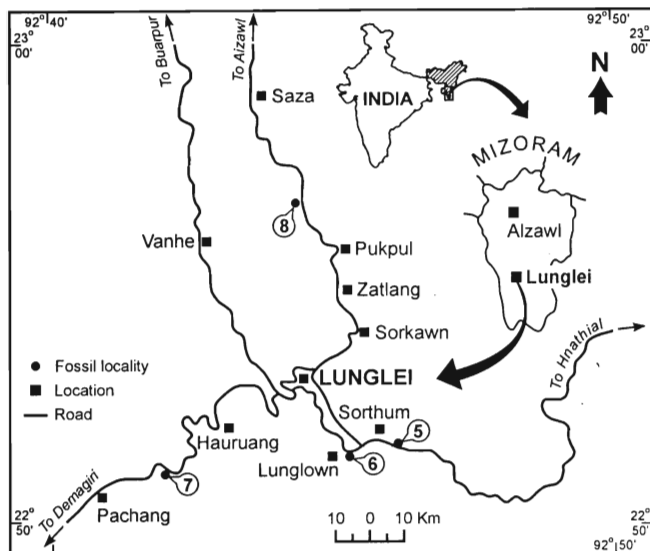


Fig. 2. Fossil localities around Lunglei, Mizoram.

the parentheses indicate percent values of the concerned parameters with respect to shell length.

### SYSTEMATIC PALAEOZONTOLOGY

Phylum **Mollusca** Linne', 1758

Class **Bivalvia** Linne', 1758

Subclass **Heterodonta** Neumayr, 1884

Order **Veneroida** Adams and Adams, 1856

Superfamily **Tellinoidea** de Blainville, 1814

Family **Tellinidae** de Blainville, 1814

Subfamily **Tellininae** de Blainville, 1814

Genus **Tellina** Linne', 1758

*Type species: Tellina radiata* Linne', 1758; SD Children, 1823. Recent; West Indies.

*Tellina pilgrimi* Cox

(Pl. I, figs. 1-3)

*Tellina pilgrimi* Cox, 1936, p. 37, Pl. IV, figs. 11, 12- a-b.

*Material:* One bivalved specimen and seven left valves.

*Horizons and Locality:* Upper unit of Bhuban Formation; Luangmual, Hlimen quarry, Theiriat and Pachang (Locality No. 1, 2, 3, 5 and 7).

*Measurements in mm:*

Specimen No.	Length	Height	Inflation
MZU /1/74	27.00	20.20 (74.80)	2.40(8.88) LV
MZU /1/75	40.50	27.00 (66.66)	3.30 (8.14) LV

MZU /1/76	27.00	19.00 (77.27)	2.30 (8.51) LV
MZU /1/77	25.00	17.50 (70.37)	2.20 (8.80) LV
MZU /1/78	18.00	12.00 (66.66)	2.00 (11.11) LV
MZU /1/79	27.40	17.00 (65.69)	2.35 (8.57) LV
MZU /1/80	29.40	21.70 (73.80)	5.20 (17.68) BV
MZU /1/81	28.00	20.60 (73.57)	2.30 (8.21) LV

*Remarks:* The present species originally described and figured by Cox (1936, p. 37, Pl. IV, figs. 11, 12 a-b) from Kuh-I-Namak under the new name *Tellina pilgrimi* is variable in form. The holotype of this species (G.S.I. No. 17375, figs. 12 a-b) is more elongate (H/L=69.00%) and the umbones are little posterior to median whereas the paratypes have almost median umbo and greater height to length ratio (75.00%). In the present collection, a specimen (MZU/1/75) shows close similarity with the holotype (G.S.I. No. 17375) and the rest with the paratypes. Hence, these are referred to *Tellina pilgrimi* Cox without reservation. This species may belong to the subgenus *Eurytellina* Fischer in view of its compressed and elongate outline, unrostrate posterior and peculiar concentric sculpture. However, the subgeneric assignment is deferred for the want of internal characters.

Two left valves in the present collection (MZU /1/78 and MZU /1/79) are of rather short stature and have umbo at about posterior-third. These might prove to be a different form on the availability of more and better-preserved material.

This is the first record of this form from the Miocene beds of India.

*Tellina maubawka* n. sp.

(Pl. II, fig. 5)

*Etymology:* The trivial name is derived after the type locality, i. e. Maubawk, Aizawl.

*Material:* One left valve.

*Type Horizon and Locality:* Upper unit of Bhuban Formation; Maubawk, (Locality No. 4).

*Measurements in mm:* Holotype (MZU /1/82) measures as: Length-29.00; Height-19.50 (67.24%); and Inflation-3.40 (11.72%, SV).

*Diagnosis:* Ovate-truncate outline, height about two-thirds of the length, obliquely rounded anterior margin, sinuous ventral margin, a prominent furrow from umbo towards postero-ventral corner accompanied by a very narrow depression posterior to it and a shallow and broad depression anterior to it, and fine but sharp concentric growth lines.

*Description:* Shell medium sized, ovate-truncated, height about two-thirds of length and moderately inflated, more so towards the posterior. The umbo is situated at about posterior-

### EXPLANATION OF PLATE I

- Tellina pilgrimi* Cox, Theiriat (Upper unit of Bhuban Formation); exterior of left valve (MZU /1/80) X 1.4.
- Tellina pilgrimi* Cox, Theiriat (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/80) X 1.4.
- Tellina pilgrimi* Cox, Haurang (Upper unit of Bhuban Formation); exterior of left valve (MZU /1/81) X 1.5.
- Gari (Gari) natensis* Noctling; Luangmual (Upper unit of Bhuban Formation); exterior of right valves (MZU /1/99) X 2.0.
- Tellina indifferens* Noctling; Luangmual (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/83) X 1.4.
- Tellina indifferens* Noctling; Luangmual (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/84) X 1.3.
- Tellina ovata* n. sp. Pukpui (Upper unit of Bhuban Formation); exterior of left valve; Holotype (MZU /1/87) X 1.3
- Tellina ovata* n. sp. Haurang (Upper unit of Bhuban Formation); exterior of left valve; Paratype (MZU /1/88) X 1.6.
- Tellina ovata* n. sp. Haurang (Upper unit of Bhuban Formation); exterior of right valve; Paratype (MZU /1/88) X 1.6.
- Tellina ovata* n. sp.; South Hlimen (Upper unit of Bhuban Formation); exterior of right valve; Paratype (MZU /1/89) X 1.5.
- Tellina hilli* Noctling; Luangmual (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/91) X 1.5.
- Tellina hilli* Noctling; Haurang (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/92) X 2.0.



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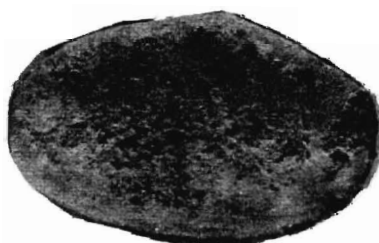
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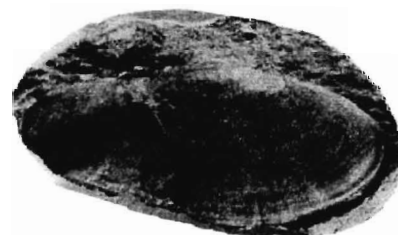
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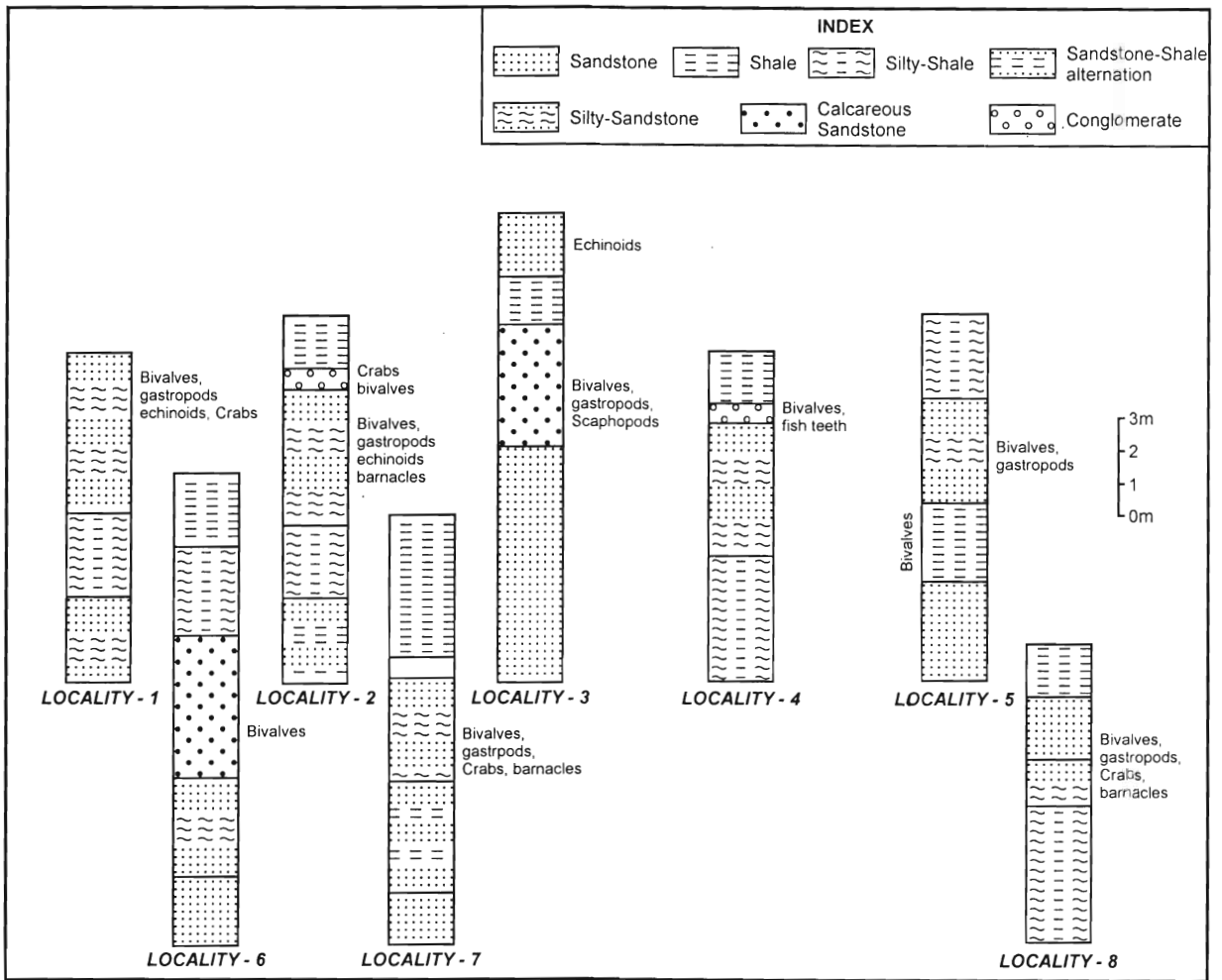


Fig. 3. Measured litho-columns in the Middle (6) and Upper Bhuban Formation (1, 2, 3, 4, 5, 7 and 8) at the fossil localities.

third of shell length. Antero-dorsal margin long and meeting obliquely rounded anterior one in an acute angle of  $60^\circ$ . Ventral margin feebly arched. Posterior margin oblique but truncated and meeting very short postero-dorsal one obliquely. A prominent furrow runs from umbo towards postero-ventral corner. A very narrow depression occurs posterior to it and a shallow and broad depression anterior to it. These produce an obscure sinuosity in the ventral margin.

The external surface is covered with fine but sharp concentric growth lines which are sinuous in a broad and shallow depression and then rise obliquely to continue up to the posterior extremity. However, these are feebly convex in the main furrow.

Internal characters are not discernible.

*Remarks:* In view of a prominent furrow in the posterior region that is accompanied by a depression on both side, and peculiar ornamentation, the christened species is different from all other hitherto known forms of *Tellina*. On account of these characters, it is similar to the subgenus *Hemimetis* Thiele that is a Recent subgenus known to occur in the Indo-Pacific region. However, its subgeneric status cannot be ascertained in the absence of internal characters.

*Tellina indifferens* Noetling  
(Pl. I, figs. 5-6)

*Tellina indifferens* Noetling, 1901, p. 221, Pl. XV, figs. 3, a-b.

*Tellina indifferens* Noetling: Mukerjee, 1939, p. 10

*Material:* One left and three right valves.

*Horizon and Locality:* Upper unit of Bhuban Formation; Luangmual (Locality No. 1).

*Measurements in mm:*

Specimen No.	Length	Height	Inflation
MZU 11/83	28.00	20.50 (73.21)	2.00 (7.14) RV
MZU 11/84	36.00	25.00 (69.44)	2.20 (6.11) RV
MZU 11/85	27.00	20.50 (75.31)	2.10 (7.77) LV
MZU 11/86	20.50	13.00 (63.41)	1.80 (8.78) RV

*Remarks:* Characters such as its smooth and rather flat surface, elongate-triangular outline, sub-terminal umbo, narrow and elongated anterior, short and rounded posterior leave no doubt about the specific identity of the collected specimens as *Tellina indifferens* Noetling (1901, *loc. cit.*). Further, on direct comparison, these are found to match well with the type example (No. 7629 of G.S.I. collection).

Noetling (1901, *loc. cit.*) has broadly assigned this form to the genus *Tellina* Linne'. However, the author is of the view that it may be transferred to subgenus *Moerella* Fischer, in view of distinctly in-equilateral condition, obscurely rostrate posterior and small size.

The species is so far hitherto unknown from the area under study.

*Tellina ovata* n. sp.

(Pl. I, figs. 7-10)

*Etymology:* The trivial name is derived from its ovate outline.

*Material:* One complete shell and two left valves.

*Type Horizons and Locality:* Upper unit of Bhuban Formation; South Hlimen, Haurang and Pukpui (Locality Nos. 4, 7 and 8).

*Measurements in mm:*

	Specimens No.	Length	Height	Inflation
Holotype	MZU //87	31.00	18.00 (58.06)	3.12 (10.00) LV
Paratypes	MZU //88	31.20	19.20 (61.53)	7.50 (24.40) BV
	MZU //89	34.00	20.00 (58.82)	3.75 (11.02) RV

*Diagnosis:* Transversely ovate outline with truncated posterior, height about three-fifth of the length, equally sloping antero- and postero-dorsal margins, equally tall anterior and posterior margins, surface with regularly spaced concentric grooves and flank with fine, closely spaced oblique lines.

*Description:* Shell comparatively small, transversely ovate with truncated posterior, height about three-fifths of the length and feebly inflated (inflation about one-quarter to one-fifths of shell length). Anterior and posterior margins are of equal height, the former being arcuate and latter truncated. These in turn meet the feebly arched ventral margin uninterruptedly. Dorsal margin on either side of umbo is more or less equally sloping and its postero-dorsal is shorter than the antero-dorsal. A faint carina runs from the umbo towards the postero-ventral corner. Posterior to it, the shell surface is slenderly concave and produces a feeble flexure.

The shell surface bears few regularly spaced concentric grooves, which are almost parallel to the margins saving dorsal one, to which these meet at right angle. In addition to the above, flank is also ornamented with fine, closely spaced oblique lines.

Interior not exposed.

*Remarks:* In the present material, the paratype (No. MZU //87), is found to be identical in shape to the specimen no. USNM-216044 belonging to *Tellina emacerata* Conrad from the Clallam Formation of U.S.A. (Addicott, 1976, p. 31, Pl. VIII, figs. 5, 7 and 10) but the latter does not possess fine oblique lines, and differs from the present one. Likewise, it approaches *Tellina (Moerella)?* sp. recorded by Dey (1962, p. 27, Pl. III, fig. 13) which can be differentiated in the same manner.

Comparatively small size and elongate-ovate outline of the present specimens suggest their affinity with the subgenus *Moerella* Fischer, but the presence of oblique ornamentation besides regularly spaced concentric one and lesser degree of inequilateralism strongly favour their reference to the subgenus *Oudardia* Monterosato. However, exact subgeneric assignment is possible only when better preserved specimens with internal characters are available to the author.

*Tellina* cf. *foliacea* Reeve  
(Pl. II, fig. 6)

The synonymy of typical form is as follows:

*Tellina (Phylloda) foliacea* Reeve, 1864, Pl. III, fig. II.

*Tellina (Phylloda) foliacea* Reeve: Noetling, 1901, p. 222, Pl. XIV, figs. 3, 3a.

*Material:* A left valve with eroded exterior.

*Horizon and Locality:* Upper unit of the Bhuban Formation; Haurang (Locality no. 7).

*Measurements in mm:* The single specimen (MZU // 90) measures as: Length-46.50; Height-20.00 (40.03).

*Remarks:* The Mizoram specimen agrees well with the Myanmar example described and figured by Noetling (1901, loc. cit.; GSI No. 7617), under the name *Tellina (Phylloda) foliacea* Reeve from the Miocene rocks. It exhibits all the essential characters such as ovate triangular outline, nearly equilateral condition and almost flat surface but striations are not discernible because of the eroded exterior. Besides, internal characters are not accessible to ascertain the subgeneric status of the specimen. It is, therefore, referred to as *Tellina* cf. *foliacea* Reeve.

The form is reported for the first time from the study area.

*Tellina hilli* Noetling  
(Pl. I, figs. 11-12)

*Tellina (Tellinella) hilli* Noetling, 1895, p. 13, Pl. III, figs. 5-6a.

*Tellina (Tellinella) hilli* Noetling, 1901, p. 223, Pl. XIV, figs. 7 a-d.

*Material:* Two right valves

*Horizons and Locality:* Upper unit of Bhuban Formation; Luangmual and Haurang (Locality 2 and 7).

*Measurements in mm:*

Specimen No.	Length	Height	Inflation
MZU //91	30.00	15.00 (50.00)	3.00 (10.00) RV
MZU //92	35.00	16.00 (45.71)	3.50(10.00) RV

*Remarks:* Both the examples at hand are of right valves with slightly eroded exterior. These exhibit elongate-triangular outline, slightly twisted posterior extremity, median umbones, acuminate anterior margin and three keels in the posterior region, thus they belong to *Tellina (Tellinella) hilli* Noetling (1901, loc. cit., G. S. I. No. 7621). However the anterior keels and ornamentation are not so well defined in the present specimens and internal characters could not be studied. Hence, these are referred to as *Tellina hilli* Noetling

The species is so far hitherto unknown from the area under investigation.

*Tellina pseudohilli* Noetling  
(Pl. II, fig. 1)

*Tellina (Tellinella) pseudohilli* Noetling, 1901, p. 226, Pl. XIV, figs 9 a-c.

*Material:* A right valve, slightly broken.

*Horizon and Locality:* Upper unit of Bhuban Formation; Luangmual (Locality no. 1).

*Measurements in mm:* Solitary example (MZU //93) measures as: Length-45.00 (c), Height-26.00 © (57.57).

*Remarks:* At first, this specimen could not be identified because of slightly broken valve. However, on direct comparison it was found to tally well in all essential characters with the type material of *Tellina (Tellinella) pseudohilli* Noetling (1901, G.S.I. no. 7623). Thus, it may be assigned to *Tellina (Tellinella) pseudohilli* Noetling (1901). However, poor preservation of the specimen does not warrant its assignment to the subgenus *Tellinella*.

The species in question is recorded for the first time from the area under study.

*Tellina compressa* n. sp.  
(Pl. II, figs. 2-3)

*Etymology:* The trivial name is derived from the excessively compressed nature of the shell.

*Material:* One complete specimen with opened valves and a left valve.

*Type Horizons and Locality:* Middle and Upper units of Bhuban Formation; Luangmual and Haurang (Locality no. 1 and 6).

*Measurements in mm:*

	Specimen No.	Length	Height	Inflation
Holotype	MZU/1/94	39.00	21.00	2.00 (5.15)
			(55.12)	LV
		38.00	22.00	2.00 (5.26)
			(57.89)	RV
Paratype	MZU/1/95	27.00	14.00	1.90 (7.37)
			(51.85)	LV

*Diagnosis:* Ovate-trigonal outline, height slightly in excess of half of the length, laterally compressed, equal antero- and postero-dorsal margins, a deep groove near the posterior extremity from umbo to ventral in left valve and a faint ridge in right valve, a shallow and broad depression on either side of groove; surface ornamented with fine concentric lines.

*Description:* Shell medium sized, slightly in-equivalved, left valve little larger than the right one, ovate-trigonal, height in excess of half of the length and laterally compressed. Umbones low and median. Antero-dorsal and postero-dorsal margins are almost of equal length, straight and subtend an angle of 140° at umbo in right valve and 125° in the left valve. Anterior margin short and rounded, whereas posterior one arcuate and becomes sinuous at postero-ventral corner in right valve. Ventral margin long and feebly arched. There is a deep groove near the posterior extremity from umbo to ventral in left valve and corresponding to it a faint ridge in right valve. On either side of it, a shallow and broad depression exists. Another groove runs along the postero-ventral margin separated by a faint carina from the preceding structure.

Shell surface ornamented with fine concentric lines which have a tendency to become coarse towards ventral. In right valve, concentric lines become undulose while crossing over the posterior depression.

Internal characters not discernible.

*Remarks:* The most closely allied species to the present one is *Tellina (Tellinella) pseudohilli* Noetling (1901, p. 223, Pl. XIV, figs. 7a-d, 8 a-b) that has similar outline and umbonal position, but can be differentiated at once by its nonsinuate and rostrate posterior.

The Lower Oligocene species *Tellina tricarinata* Nagao (in Oyama *et al.*, 1960, p. 201, Pl. LXI, figs. 7 a-b) from the Kayuragi Formation of Japan is also a comparable form in outline and median umbo but its tricarinate posterior isolates it from the species described here.

The present species agrees well with *Tellina natoensis* Masuda (in Nakagawa, 1998, p. 133. Pl. 25, figs 1 a-c) in overall configuration and in the nature of the margins. However the latter can be distinguished from the former ones in the nature of posterior flexure.

*Tellina salinensis* Cotter

(Pl. II; fig. 4)

*Tellina salinensis* Cotter, 1923, p. 13, Pl. III, figs. 7, a-c

*Material:* Three specimens

*Horizon and Locality:* Upper unit of Bhuban Formation; Luangmual (Locality no. 1)

*Measurements in mm:*

Specimen No.	Length	Height	Inflation
MZU /1/96	43.00	33.00 (76.74)	5.00 (11.52) LV
MZU /1/97	32.00	26.00 (81.25)	4.00 (12.50) LV
MZU /1/98	32.50	24.00 (73.84)	3.20 (9.84) RV

*Remarks:* The material at hand is slightly ill-preserved and includes two left and one right valves. After direct comparison with GSI type specimen no. 12367, these are assigned to the species *Tellina salinensis* Cotter (1923, *loc. cit.*) because of their overall resemblance and possession of such features as subtrigonal outline, twisted posterior end, distinct posterior flexure in right valve and rather obscured one in left valve, concave postero-dorsal margin and broadly arched anterior one. However, the type specimens are of greater dimension and come from considerably older horizon, i.e. Yaw stage (Eocene) of Myanmar.

In the light of the present finding, the range of *Tellina salinensis* Cotter is to be extended upward from Eocene to Lower Miocene.

Family **Psammobiidae** Fleming, 1828

Subfamily **Psammobiinae** Fleming, 1828

Genus **Gari** Schumacher, 1817

*Type species:* *Gari vulgaris* (= *Solen amethystus* Wood, 1815); SD Children, 1823. Recent; East Indies.

*Gari (Gari) natensis* Noetling

(Pl. I, fig. 4)

*Gari natensis* Noetling, 1901, p. 228, Pl. XV, figs. 6, a-e.

*Material:* One right valve

*Horizon and Locality:* Upper unit of Bhuban Formation; Luangmual (Locality no. 2)

*Measurements in mm:* Single specimen (no. MZU /1/99) measures as: Length-13.70, Height -8.80 (64.23) and Inflation-1.10 (8.02, SV).

*Remarks:* The available example is small but better preserved than the type specimen (no. 7629 of GSI collection) of *Gari natensis* Noetling (1901, *loc. cit.*). It exhibits similar type of outline, posterior region and ornamentation. Hence, its assignment is justifiable. However, the character *i.e.* the concentric lines while crossing over the carina produce nodes, is more clearly marked in the Mizoram example than on the type one.

Subgenus **Psammobia** Lamarck, 1818

*Type species:* *Tellina fervensis* Gmelin 1791; SD Children, 1822. Recent; England.

## EXPLANATION OF PLATE II

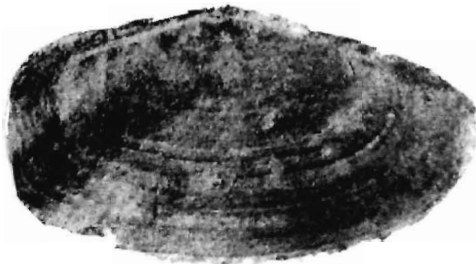
- Tellina pseudohilli* Noetling; Luangmual (Upper unit of Bhuban Formation); exterior of right valve (MZU /1/93) X 1.3.
- Tellina compressa* n. sp.; Lunglawn (Middle unit Bhuban Formation); exterior of left valve; Holotype (MZU /1/94) X 1.6.
- Tellina compressa* n. sp.; Lunglawn (Middle and upper units of Bhuban Formation); exterior of right valve; Holotype (MZU /1/94) X 1.6.
- Tellina salinensis* Cotter; Luangmual (Upper unit of Bhuban Formation); exterior of left valve (MZU /1/96) X 1.0.
- Tellina maubawka* n. sp.; Maubawk (Upper unit of Bhuban Formation); exterior of left valve; Holotype (MZU /1/82); X 2.0
- Tellina* cf. *foliacea* Reeve; Hauruang (Upper unit of Bhuban Formation); exterior of left valve; (MZU /1/90) X 1.6.
- Gari* aff. *kingi* (Noetling); South Hlimen (Upper unit of Bhuban Formation); exterior of left valve; (MZU /1/100) X 1.8.
- Solecurtus rectangulus* n. sp.; Hauruang (Upper unit of Bhuban Formation); exterior of left valve; Holotype (MZU/1/ 101) X 1.8.



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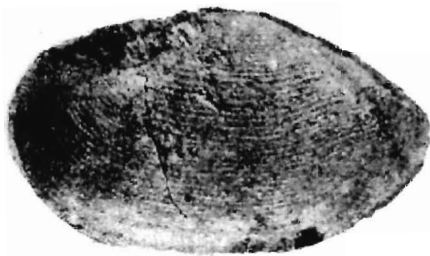
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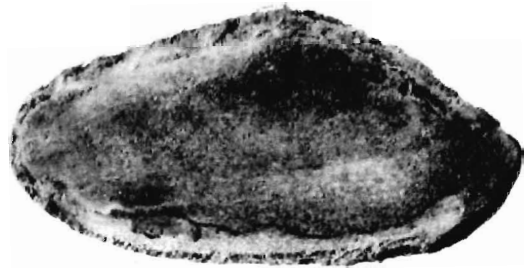
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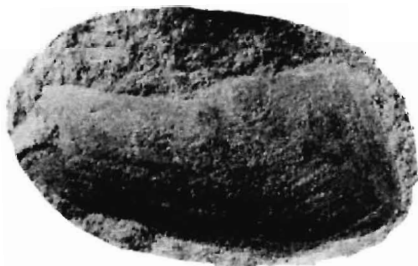
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*Gari* (*Psammobia*) aff. *kingi* (Noetling)  
(Pl. II, fig. 7)

The synonymy for typical *Gari* (*Psammobia*) *kingi* Noetling is as follows:

*Gari kingi* Noetling, 1901, p. 232, Pl. XV, figs 11, 11a, 12, 12a, 13 and 13a.

*Psammobia kingi* (Noetling): Mukerjee, 1939, p. 12.

*Material*: One left valve

*Horizon and Locality*: Upper unit of the Bhuban Formation; South Hlimen (Locality no. 4)

*Measurements in mm*: Measurements could not be taken due to fragmentary nature of the specimen (no. MZU //100).

*Remarks*: The lone available example is fragmentary and its dorsal and anterior margins are hidden under the hard matrix. It has close affinity with the type specimen (no. 7634 of GSI collection) of *Gari kingi* Noetling (1901, *loc. cit.*) from the Miocene beds of Myanmar in respect of posterior region and oblique ornamentation. Since no further comparison is possible, it is referred to as *Gari* (*Psammobia*) aff. *kingi* Noetling.

*Family* Solecurtidae d'Orbigny, 1846

*Subfamily* Solecurtinae d'Orbigny, 1846

*Genus* *Solecurtus* de Blainville, 1824

*Type specimen*: *Solen strigilatus* Linne', 1758; SD Deshayes, 1829. Recent; Mediterranean.

*Solecurtus rectangulus* n. sp.  
(Pl. II, fig. 8)

*Etymology*: The trivial name is derived from the rectangular outline of the valve.

*Material*: One left valve

*Type Horizon and Locality*: Upper unit of Bhuban Formation; Haurang (Locality no 7)

*Measurements in mm*: Holotype (MZU //101 measures as: Length-36.50; Height-19.30 (50.13); and Inflation-4.20 (11.50, SV).

*Diagnosis*: Transversely rectangular outline, slightly inequilateral nature, length approximately twice the height, umbo obtuse and little anterior to mid-line, flat and parallel dorsal and ventral margins, ventral quarter of the valve ornamented with comarginal growth lines whereas remaining part with fine and equally spaced radial ribs.

*Description*: Shell medium sized, transversely rectangular, slightly inequilateral, length approximately twice the height and feebly inflated. Umbo obtuse, little anterior to mid-line and salient by 2.50mm. Dorsal and ventral margins are almost flat and parallel. Posterior margin slenderly arched and vertical. Anterior margin equally higher and broadly rounded.

Surface anterior to a line joining umbo and antero-ventral corner is nearly smooth. However, ventral quarter of the valve is ornamented with comarginal growth lines. Remaining part is sculptured with fine and equally spaced radial ribs which are parallel to the posterior margin in posterior-third and become oblique towards anterior. The obliquity and spacing of ribs increases forwardly.

Interior not exposed

*Remarks*: The other species of the genus *Solecurtus* available to the author differ from the present one in following manner:

*Solecurtus sindiensis* (Vredenburg) (1928, p. 458, Pl. XXXI, fig. 6, G.S.I. type no. 13432) from the Gaj beds of Kachchh has oblique ribs that are much finer and crowded. *Solecurtus antiquates* (Pulteney) Antunnes *et al.* (1972), Pl. 481, Pl. III, fig. 21) from the Miocene of Lisbon, has prominent commarginal

growth lines leaving aside dorsal-third and less inconspicuous oblique ribs. The Miocene species from Myanmar, namely, *Solecurtus exsulcatus* Noetling (1901, p. 235, Pl. XV, fig. 15) bears more densely and less widely spaced oblique ribs and non-salient umbo. *Solecurtus luzonensis* Kanno *et al.*, (1982, p. 77, Pl. XVI, figs. 9-a-b) from the Upper Miocene of Philippines is of elliptical outline and has a non-salient umbo. *Solecurtus divaricatus* Lischke (Noda *et al.*, 1994) from the Kume Formation (Pliocene) of Japan is also a different species on account of its sub-quadrate outline and sculpture of fine concentric growth line crossed over by longitudinal striations.

## DISCUSSION

Tiwari and Kachhara (2003) proposed five molluscan biozones in the Tertiary sediments of Mizoram. These, in the ascending order, are *Meretrix agrestis* Zone (1) of late Eocene to Oligocene age, *Glycymeris sindiensis* – *Nuculana virgo* Zone (2) of Aquitanian age, *Ostrea latimarginata* – *Natica pellis tigrina* Zone (3) of Aquitanian-Burdigalian age, *Pecten* (*Oopecten*) *gigas* Zone (4) of Burdigalian age and *Pecten* sp. Zone (5) of Helvetian age. Zone 1 lies in the Barail Group, Zone 2 in lower and middle units of the Bhuban Formation and Zone 3, 4 and 5 in the upper unit of the Bhuban Formation respectively. The distribution of above-described fossils assemblage is as under:

*Tellina saliensis* Cotter is confined to Zone 2, *Tellina maubawka* n. sp. and *Gari* (*Psammobia*) aff. *kingi* (Noetling) to Zone 3, *Tellina* cf. *foliacea* Reeve and *Solecurtus rectangulus* n. sp. to Zone 5. *Tellina pilgrimi* Cox ranges from Zone 2 to Zone 5, *Tellina indifferens* Noetling and *Gari* (*Gari*) *natensis* Noetling from Zone 3 to Zone 4, *Tellina ovata* n. sp. from Zone 3 to Zone 5, *Tellina hilli* Noetling from Zone 2 to Zone 5, *Tellina pseodohilli* Noetling from Zone 4 to Zone 5 and *Tellina compressa* n. sp. from Zone 2 to Zone 4. As such, this faunal assemblage is indicative of Aquitanian to Helvetian age.

*Tellina* s. str., *Gari*, and *Solecurtus* all are infaunal siphonate, actively mobile including active crawlers and burrowers, unattached and surface deposit feeders (Todd, 2002). *Tellina* inhabits intertidal to 75 fathoms (135 m) depth and is rather common on beaches. It is also frequently found buried shallowly in muddy to sandy bottoms of lower to subtidal zone (Hatai *et al.*, 1970). Noda *et al.*, (1994) pointed out that occurrence of *Apolymetis* in the Miocene marine fauna is an index species for the tropical environment and geological age. The genus *Gari* is restricted to subtropical to tropical seas. The species of *Gari* is not so well known among the Indian fossil faunas. Species of *Apolymetis* and *Gari* may indicate that the present molluscan fauna is influenced by tropical or at least subtropical sea conditions. According to the detailed examinations of Indo-Pacific Recent species of the genus *Gari* by Willan, 1992 (in Noda *et al.*, 1994), it generally inhabits sandy bottoms from the inter-tidal zone to 10 m in depth.

Shells do not show abnormal growth such as a dwarfed nature or unusual thickening, indicating that the assemblage lived in seawater of normal salinity. Most of the bivalves are separate valves suggesting that the assemblage is allochthonous.

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