

CHAPTER III

SYSTEMATIC PALEONTOLOGY

Fusulinids are excellent index fossils of the late Paleozoic eon. Their complicated internal structures lead them to be classified into many species and are described in this chapter.

3.1 Introduction to fusulinids

Fusulinids are the single-cell invertebrate fossils. Their tests or shells are commonly fusiform or subcylindrical in shapes and coiled around an axis called axis of coiling and are range from 1 mm. to 100 mm in length. They belong to Phylum Protozoa, Class Sarcodina, Order Foraminiferida. The fusulinaceans are ranked as a Superfamily of Suborder Fusulinina, in species level they are identified into many hundreds of species. Many researchers indicated that they are an exclusively late Paleozoic group of fossils and had their beginning in late Mississippian time and absent at the close of Permian Period (Thompson, 1964), but, Loeblich and Tappan (1988) have proposed a new age interval of Superfamily Fusulinacea to be Middle Devonian-Upper Permian with the evidences of many new genera. Many genera of fusulinids are excellent index fossils because of their short ranges, rapid evolution and widely spread in many parts of paleo-marine of the world.

Fusulinids are generally found in limestones, but absent or very rare in dark-colored shale and very coarse-grained or finely laminated sandstone. Ross (1979) explained about three major types of the depositional environments which fusulinids are common. The first type is thin, algal-rich limestone on the cratonic shelves of the major Northern Hemisphere continents. The second type is the shelf edges include reefs and lagoons as well as some deeper water carbonate environments between the reefs. The third depositional setting is less thoroughly understood but includes thick carbonate deposit that may have abrupt lateral changes in facies into dark shales, greywackes, and ribbon chert. These depositional facies are associated with basaltic non-cratonic

igneous rocks and are probably closely related to former island arc and reef environments.

Although the knowledge of the paleoecology of fusulinids is still incomplete, but many authors agree that fusulinids were probably benthic, except for their juvenile stage, which presumably had an epiplanktonic or planktonic mode of life as in many Recent benthic foraminifers. They were probably able to slowly crawl with pseudopodia on the surface of substrates and to climb on sessile plants and animals in a shallow, warm, open water environment (Kanmera et al., 1976).

3.1.1 Morphology of fusulinids

Though fusulinids are various in form and size, but they have the same important features (Figure 3.1). The study of fusulinids usually consider on their significance morphologies as follows:

- Proloculus
- Septa and Antetheca
- Spirotheca
- Septula
- Tunnel, Foramina, Chomata, Parachomata and Axial fillings

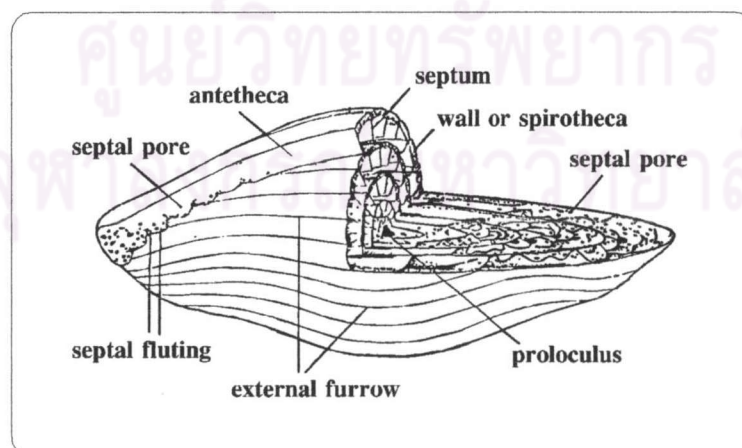


Figure 3.1 Diagram showing the structure of a fusulinid test; *Triticites* sp. (modified from Cushman, 1950 and Moore et al., 1952).

Proloculus

All fusulinids are multi-chambered. Growth starts with an initial chamber called **proloculus**. In most fusulinids the proloculus is spherical to subspherical in shape. Moreover, the features of the wall of the proloculus also are recognized. The proloculus wall in most fusulinids is thicker than that of the first volutions of the shell. Various shapes of proloculus are shown in Figure 3.2.

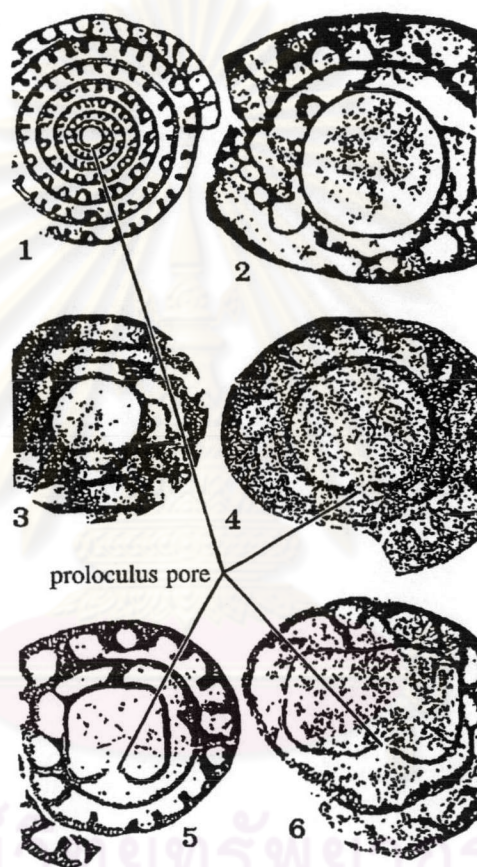


Figure 3.2 Initial chambers (proloculi) of some fusulinids (Thompson, 1964).

1. *Parafusulina padangensis* (Lange); almost spherical proloculus with slightly thickened wall near pore, x10.
2. *Parafusulina gigantea* (Deprat); spherical proloculus but no intersecting pore, X20.
3. *Parafusulina parumvoluta* (Deprat); pore at base of depressed funnel, X23.5.
4. *Parafusulina dongvanensis* (Colani); subspherical proloculus with depressed area around pore, X27.
5. *Parafusulina japonica* (Gumbel); subquadrate proloculus with depressed area around pore, X30.
6. *Parafusulina gigantea* (Deprat); rectangular proloculus with cone around pore, X20.

Septum and Antetheca

The **septa**, plural, are partitions between chambers of fusulinids. Anteriorly, wall of last chamber, septum becomes **antetheca**. Antetheca is punctured by numerous small openings called **septal pores**. For the primitive genera they usually have planes surface or straight septa, but for the advanced genera, the septa become wavy or flute along the lower margin. The **chamberlets** develop where opposing folds touch and partly divide the chambers. Resorption of the septa where opposing folds touch and form passageways between chambers are called **cuniculi**. The fluted septum of some Schwagerininae and Fusulininae are shown in Figure 3.3.

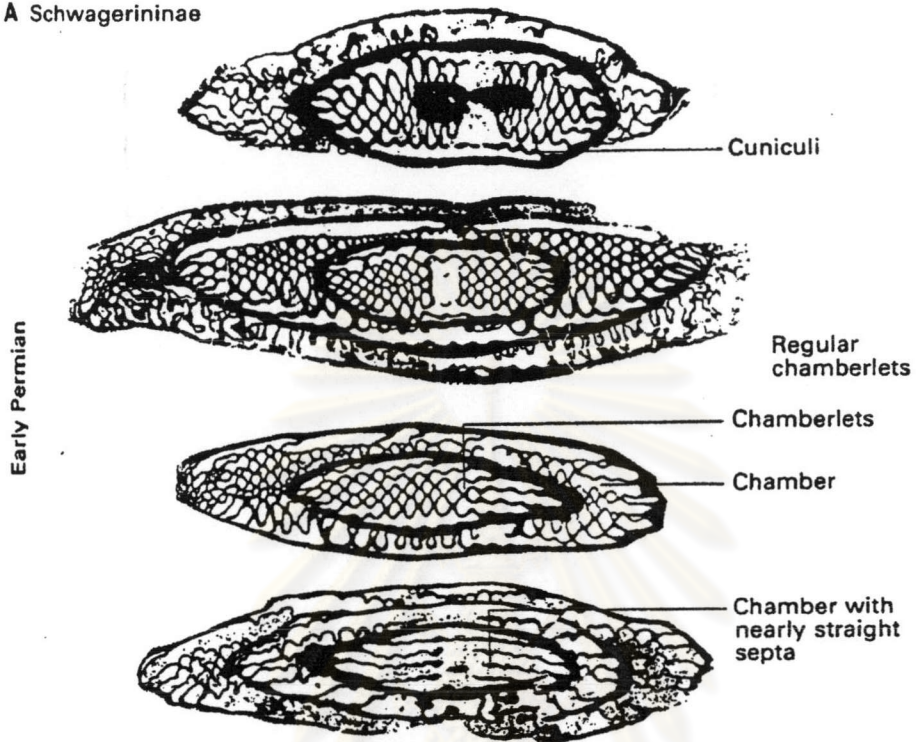
Spirotheca

The wall of the chamber is referred to **spirotheca**. It composed of microgranular calcium carbonate, some with two or more wall layers. The structure of the spirotheca, (Figure 3.4) which is one of the most reliable criteria for differentiation and classification of many fusulinaceans, is highly complicated. In primitive forms it consists of a thin, dense, primary layer or **tectum** that is later covered above and below by layers of tectoria. In most advanced forms, the tectum is supplemented by various other layers, including transparent layer or **diaphanotheca**, or supplemented by a thick layer of honeycomb-like structure or **keriotheca**. The deep prismatic or cylindrical cavity in keriotheca called **alveolus** (plu., alveoli).

Septula

The lower surface of the spirotheca of member of the Subfamily Neoschwagerininae contains ridges that hang down into the chambers are named **septula**. Septula that transverse to the axis of coiling are termed **transverse septula**, and those parallels to the axis are termed **axial septula**. (Figure 3.5) The shape of septula must be recognized ; broad , short, narrow, uniform in length or irregular etc.

A Schwagerininae



B Fusulininae

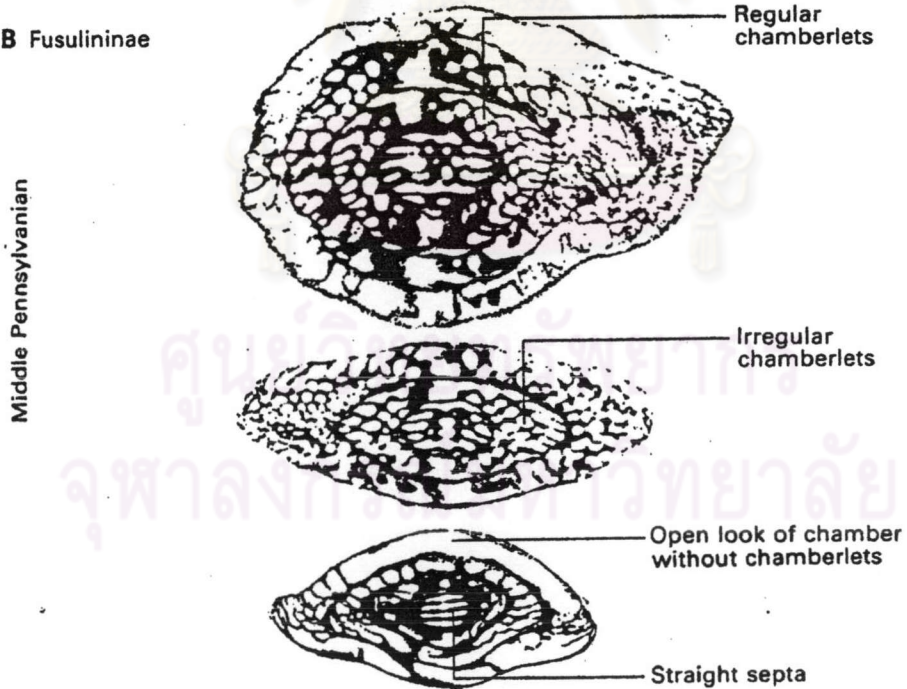


Figure 3.3 Septal fluting of some Schwagerininae and Fusulininae

(Boardman et al., 1987).

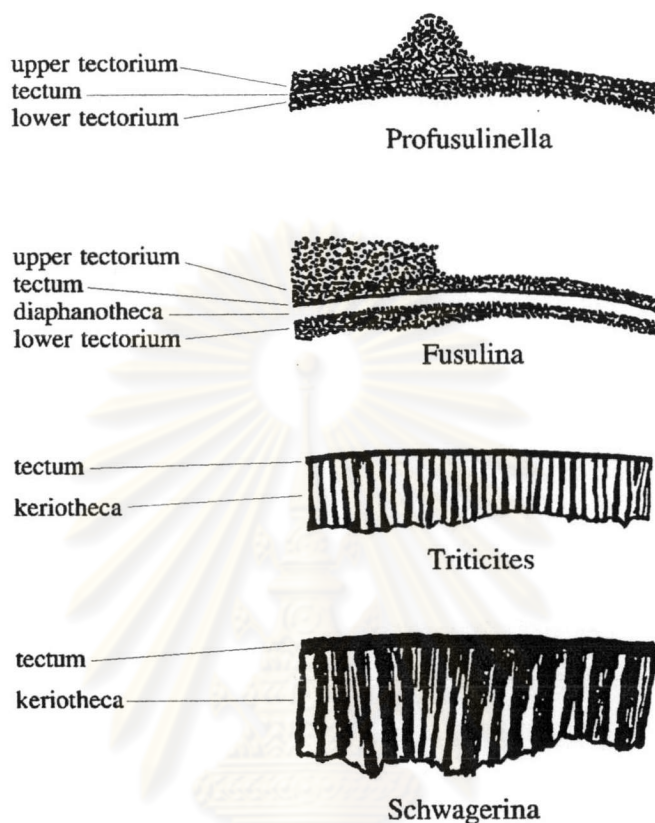


Figure 3.4 Spirothecal structure of some fusulinids (Moore et al., 1952).

Tunnel, Foramina, Chomata, Parachomata and Axial fillings

A centrally located low basal slit-like opening is called **tunnel**, penetrates all septa except those of the last volution. A series of small, closely spaced elliptical openings is called **foramina**. The tunnel is bordered on each side by secondary ridges of calcite, the **chomata**. Another cumulative calcium carbonate like chomata developed throughout the shell are termed **parachomata**. Axial fillings are dense deposit of calcium carbonate accumulates in the axial region. Some fusulinids may have heavy axial fillings but some are very rare in axial fillings. Tunnel, chomata, axial fillings, foramina, and parachomata of some fusulinids are shown in Figure 3.6.

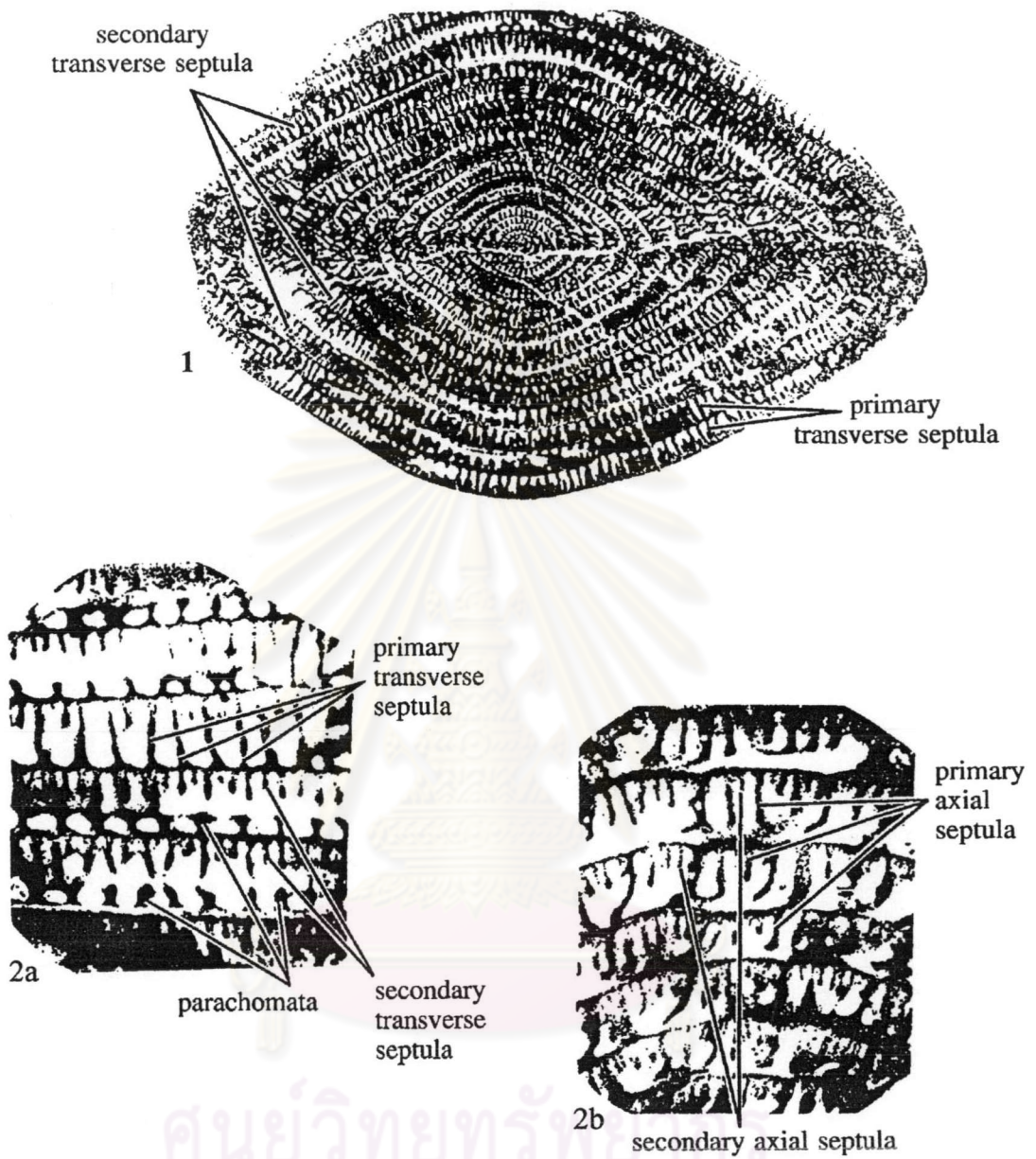


Figure 3.5 Septula of some fusulinids (Thompson, 1964).

1. *Yabeina inouyei* (Deprat), axial section, X10. 2a. *Lepidolina multiseptata* (Deprat), axial section, X45. 2b. *Lepidolina multiseptata* (Deprat), sagittal section, X45.

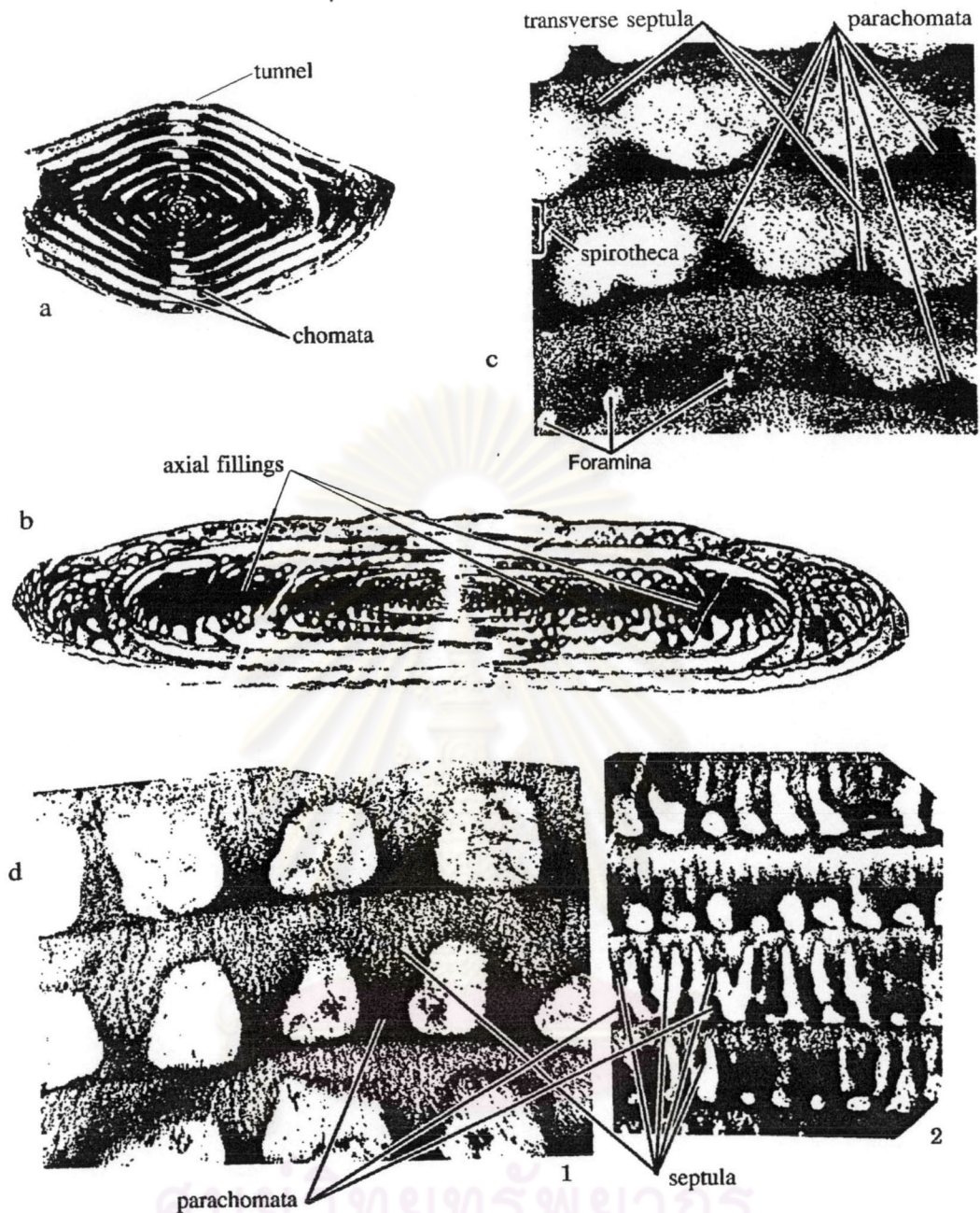


Figure 3.6 Tunnel, chomata, axial fillings, foramina, spirotheca, parachomata and septula of some fusulinids (Thompson, 1964).

- a. Tunnel and chomata of *Yanchienia tobleri* Thompson, axial section, X 16.3. b. Axial filling of *Parafusulina wanneri* (Schubert) axial section, X 8. c. Spirotheca, transverse septula and parachomata of *Cancellina primigena* (Hayden), axial section, X 100. d. 1, Alveolar structure of spirotheca, parachomata, and septula in *Neoschwagerina haydeni* Dutkevich and Khabakov, axial section, X 100. 2, Septula and parachomata of *Yabeina inouyei* (Deprat), axial section, enlarged.

3.1.2 Sections for microscopic study

Some of the structural features of fusulinid shells can be examined from external morphology, but many characteristics completely internal. There are several types of fusulinids section for microscopic study as shown in Figure 3.7. Two sections cut through the beginning chamber reveal most internal features of the shell. One is cut along the axis of coiling through the center of proloculus and is called as **axial section**. The other, cut at right angles to the axis of coiling through the center of proloculus, is called a **sagittal section**. The terminology applied to a section cut normal to the axis of coiling but not through the beginning chamber is a **parallel section**. One cut parallel to the axis of coiling but not through the beginning chamber is termed **tangential section**. Sections cut in directions not parallel to the axis of coiling or normal to it are referred to as **oblique sections**.

3.1.3 Measurement

To identify the fusulinids in this study, the following characters are measured.

- **Proloculus size** : The outside diameter of the longer axis is taken as the measure of the proloculus size.
- **Radius vector or half diameter (R.V.)** : The radius vector is measured perpendicularly to the axis of coiling from the center of the proloculus to the outer surface of tectum of each consecutive volution.
- **Half length (H.L.)** : Half length is measured from the center of the proloculus to the outer surface of the tectum at the polar end in the respective volution.
- **Form ratio** : The form ratio is determined as the proportion of the half length (H.L) and the radius vector (R.V) .
- **Thickness of spirotheca and proloculus wall** : The sum of all layers for each consecutive volution and proloculus wall.
- **Number of volution** : The number of whorls that coil around axis of coiling.

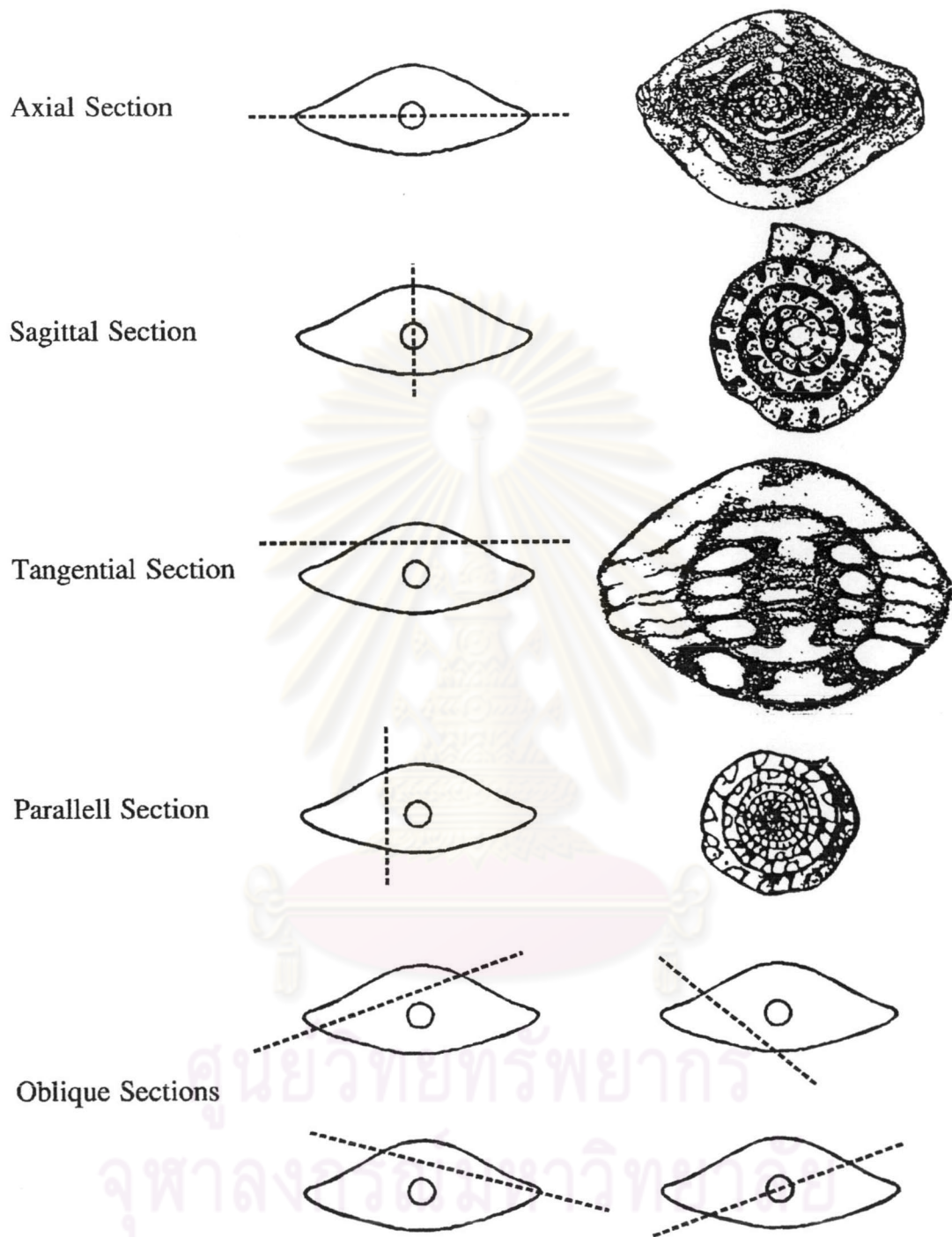


Figure 3.7 Types of fusulinid sections (modified from Boardman et al., 1987).

- **Number of septula** : The septula of the family Neoschawagerinidae must be counted include :-
 - The number of axial septula between adjacent septa is counted for each consecutive volution.
 - The transverse septula is the first appearance and the number of secondary transverse septula in the course of shell growth were examined.

The diagrammatic representation of basic morphology and measurement of fusulinids is illustrated in Figure 3.8.

Besides measurement, the spirothecal structure, fluting of septa, chomata, tunnel, parachomata, axial fillings and some specific morphology also be observed through microscope.

3.1.4 Classification

Many authors established classification of fusulinids such as Thompson (1964), Rozovskaya (1975), and the last one Loeblich and Tappan (1988), the comparison of classifications is as shown in Table 3.1. This study respects Loeblich and Tappan's classification (1988) because of an up-to-date compilation from many references, ultrastructure studies of wall and detailed morphologic revision made with aid of modern technology : transmission microscopy of carbon replicas and scanning electron microscope. Furthermore, information as to geologic range is given in greater detail than previous publication and some is indicated to the level of geologic stage.

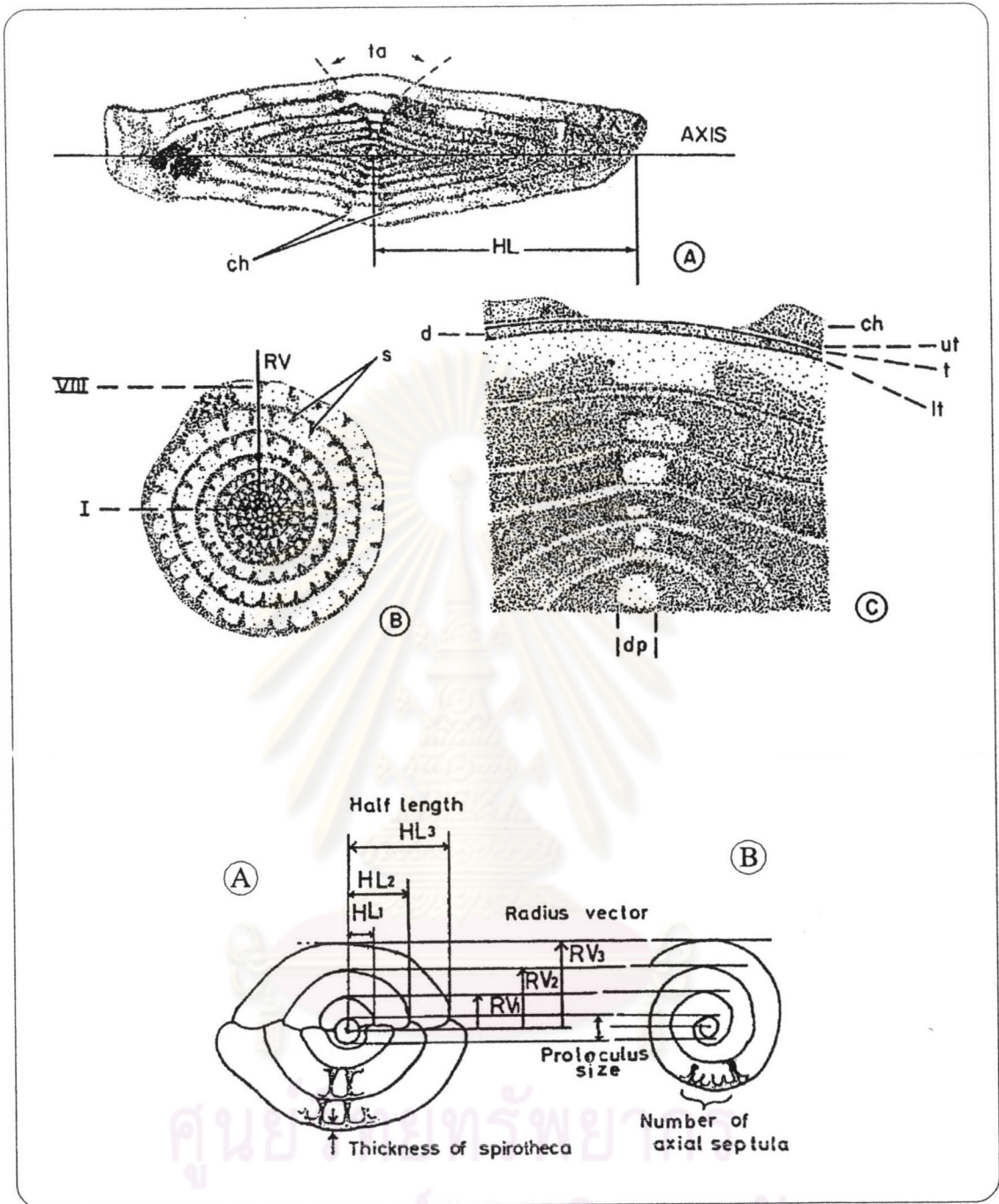


Figure 3.8 Diagrammatic representation of basic morphology and measurements of fusulinids (modified from Ozawa, 1970b and Tasch, 1973).

fusulinids (modified from Ozawa, 1970b and Tasch, 1973).

A) Axial sections. (B) Sagittal sections. (C) detailed wall structure.

ta = tunnel angle; ch = chomata; HL = half length; RV = radius vector; s = septa;

d = diaphanotheca; ut = upper tectorium; lt = lower tectorium; t = tectum;

dp = outer diameter of proloculus.

| THOMPSON, 1964 | ROZOVSKAYA, 1975 | LOEBLICH AND TAPPAN, 1988 |
|--------------------------|------------------------------|------------------------------|
| Superfamily FUSULINACEA | Order FUSULINIDA | Superfamily FUSULINACEA |
| 1. Family OZAWAINELLIDAE | 1. Superfamily FUSULINACEA | 1. Family LOEBLICHIIDAE |
| 2. Family STAFFELLIDAE | 1.1 Family LOEBLICHIIDAE | 2. Family OZAWAINELLIDAE |
| 3. Family FUSULINIDAE | 1.2 Family OZAWAINELLIDAE | 3. Family SCHUBERTELLIDAE |
| 4. Family VERBEEKINIDAE | 1.3 Family SCHUBERTELLIDAE | 4. Family FUSULINIDAE |
| | 1.4 Family FUSULINIDAE | 5. Family SCHWAGERINIDAE |
| | 1.5 Family SCHWAGERINIDAE | 6. Family STAFFELLIDAE |
| | 2. Superfamily VERBEEKINACEA | 7. Family VERBEEKINIDAE |
| | 2.1 Family STAFFELLIDAE | 8. Family NEOSCHWAGERINIDAE |
| | 2.2. Family VERBEEKINIDAE | |
| | 2.3 Family NEOSCHWAGERINIDAE | |
| | 106 genus | 167 genus |
| 83 genus | | |

Table 3.1 Comparison of fusulinids classifications (Thompson, 1964; Rozovskaya, 1975; Loeblich and Tappan, 1988).

3.2 Systematic descriptions

The thirteen species of the fusulinids of nine genera in four families are studied and described in this work. The followings are identified species:

Order FORAMINIFERIDA Eichwald, 1830

Suborder FUSULININA Wedekind, 1937

Superfamily FUSULINACEA von Moller, 1878

Family Schubertellidae Skinner, 1931.

Subfamily Scubertellinae Skinner, 1931.

Genus *Neofusulinella* Deprat, 1912.

- *Neofusulinella lantenoisi* Deprat, 1913.....Pl.1, figs.4-8.
- *Neofusulinella cf. saraburiensis* Toriyama, Kanmera, and Ingavat, 1969.....Pl.1, figs.1-3.

Family Schwagerinidae Dunbar and Henbest, 1930.

Subfamily Chusenellinae F.Kahler and G. Kahler, 1966.

Genus *Chusenella* Hsu, 1942.

- *Chusenella cf. schwagerinaeformis* Sheng, 1963.....l.2, figs.1-3.

Subfamily Schwagerininae Dunbar and Henbest, 1930.

Genus *Parafusulina* Dunbar and Skinner, 1931.

- *Parafusulina gigantea* (Deprat), 1913.....Pl.4, figs.1-6.
- *Parafusulina loeyensis* Pitakpaivan, 1966.....Pl.5, figs.1-5.
- *Parafusulina sp.A.* Dunbar and Skinner, 1931.....Pl.3, figs.1-3.

Genus *Pseudofusulina* Dunbar and Skinner, 1931.

- *Pseudofusulina sp.* Dunbar and Skinner, 1931.....Pl.3, figs.4-7.

Family Verbeekinae Staff and Wedekind, 1910.

Subfamily Verbeekinae Staff and Wedekind, 1910.

Genus *Verbeekinae* Staff, 1909.

- *Verbeekina verbeeki* (Geinitz), 1876.....Pl.6, figs.1-5.

Subfamily Misellinae A.D.Miklulho – Maklay, 1958.

Genus *Metadoliolina* Ishii and Nogami, 1961.

- *Metadoliolina nongmuangensis* sp. nov.....Pl.7, figs.1-3.

Subfamily Pseudodoliolinae Leven, 1963.

Genus *Pseudodoliolina* Yabe and Hanzawa, 1932.

- *Pseudodoliolina pseudolepida* (Deprat), 1912.....Pl.7, figs.4-5.

Family Neoschwagerinidae Dunbar and Condra, 1927.

Subfamily Neoschwagerininae Dunbar and Condra, 1927.

Genus *Colania* Lee, 1934.

- *Colania douvillei* (Ozawa), 1922.....Pl.8, figs.1-4.

Subfamily Sumatrinae Silvestri, 1933.

Genus *Sumatrina* Volz, 1904.

- *Sumatrina annae* (Volz), 1904.....Pl.9, figs.1-3.
- *Sumatrina* cf. *longissima* Deprat, 1914.....Pl.9, figs.4-8.

The detailed descriptions of the thirteen species in the area of Khao Wong and Khao Chakkachan, Amphoe Nong Muang, Changwat Lop Buri, are as follows :

Family Schubertellidae Skinner, 1931

Subfamily Schubertellinae Skinner, 1931

Genus *Neofusulinella* Deprat, 1912

Type species : *Neofusulinella praecursor* Deprat, 1913

Diagnosis :- Test small and ovoid in the early stage, later fusiform, up to 3 mm in length, planispirally coiled throughout, about six or seven whorls, septa flat, slightly curved forward, plane or only slightly fluted; chomata large and asymmetrical.

Neofusulinella lantenoisi Deprat, 1913

Plate 1, figs.4-8

- 1913 *Neofusulinella lantenoisi* Deprat, pp.41-42, pl.7, figs.23-25.
 1966 *Neofusulinella lantenoisi* Pitakpaivan, pp.24-26, pl.1, fig.16.
 1969 *Neofusulinella lantenoisi* Toriyama, Kanmera, and Ingavat, pp.28-31,
 pl.4, figs.1-14.
 1973 *Neofusulinella lantenoisi* Toriyama and Pitakpaivan, pp.47-48, pl.5,
 figs.8-12.

Description :- Shell small and typical fusiform, with a straight axis of coiling and bluntly pointed poles. Lateral slope slightly convex to almost straight, slightly concave in outer volutions of some specimens, probably due to secondary deformation. Mature specimens of 6 to 9 volutions attain 1.8 - 2.6 mm in length and 1.1 - 1.7 mm in width. Form ratio ranges from 1.40-1.53. Proloculus small and spherical with an average outside diameter is 0.05 mm in two specimens. One or two inner volutions are subspherical to thickly fusiform. From the fourth volution the shell assumes nearly the same shape as mature shell. Expansions of shell are slow in inner three to four volutions, becoming rapid and almost constant in outer volutions. Average heights of the first to seven volutions in three specimens are 0.06, 0.11, 0.17, 0.22, 0.33, 0.46, and 0.55 mm, respectively. Chambers are nearly the same in height throughout length of shell. Spirotheca thin, consisting of a thin dark layer of tectum and a thicker inner layer.

Thickness of spirotheca in the first to seventh volutions of three specimens average 7, 7, 7, 10, 10, 10, and 10 microns, respectively. Septa thin and numerous, consisting of downward deflection of spirotheca. Septa plane in central portion of shell, but making characteristic fine complicated fluting in the axial regions of outer volutions. Septal perforations distinct in most volutions except inner two volutions. Tunnels are narrow in inner volutions but widening outwards. Tunnel angles of the third to eighth volutions average 29, 23, 36, 24, 18, and 35 degrees, respectively in two specimens. Chomata not present in the first two volutions, but prominent in outer volutions. They are massive and asymmetrical, being nearly half as high as the chambers. Tunnel side of chomata very steep or almost vertical but pole-ward slopes downward rapidly to gently toward poles.

Remarks :-The specimens described and illustrated as *Neofusulinella lantenoisi* are identical with Deprat's originally illustrate types in almost every important characteristics ; size and shape of shell, number of volutions, rate of expansions, structure and thickness of spirotheca, characteristic septal fluting in the axial portion, and massive chomata. In Thailand, Pitakpaivan (1966) reported *Neofusulinella lantenoisi* from the Chondhurian limestone of Changwat Nakorn Sawan, along with three species of *Ozawainella* and *Sphaerulina crassispira japonica* Kanmera. However, the Chondhurian specimens are not sufficiently preserved for a detailed comparison. After that, Toriyama, et al.(1969) described several species of *Neofusulinella* from Thailand, especially from Khao Phlong Prab section in Changwat Saraburi, and provided new information for a better understanding of this genus. In comparison with specimens from Khao Phlong Prab described by Toriyama et al.(1969), the latter has rather wider shape and relatively thinner spirotheca than the former.

Material :- Khao Chakkachan : TT0071 in lower part of unit C₂ ; TT0078, TT0215, TT0216, TT0217, TT0218, TT0219, TT0220 and TT0221 in unit C₁. Khao Wat Kirinakratanaram : TT0079, TT0082, TT0091, TT0092, TT0098, and TT0101 throughout unit C₁.

Age :- Lower Radian to Upper Wordian (Toriyama et al., 1974).

Measurement of *Neofusulinella lantenoisi* Deprat, 1912.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0071 | 2.6 | 1.7 | 1.53 | ? | ? |
| TT0078 | 2.1 | 1.5 | 1.40 | 0.03 | ? |
| TT0098 | 1.8 | 1.1 | 1.64 | 0.07 | 5 |

| Spec. No. | H.L. (mm) | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0071 | 0.21 | 0.35 | 0.52 | ? | 0.57 | 0.73 | 0.92 | 1.09 | ? |
| TT0078 | 0.05 | 0.11 | 0.31 | 0.52 | 0.66 | 0.89 | 1.04 | ? | - |
| TT0098 | 0.07 | 0.11 | 0.19 | 0.30 | 0.44 | 0.64 | 0.90 | ? | - |

| Spec. No. | R.V. (mm) | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0071 | 0.09 | 0.14 | 0.19 | ? | 0.33 | 0.47 | 0.54 | 0.71 | 0.86 |
| TT0078 | 0.05 | 0.08 | 0.12 | 0.18 | 0.31 | 0.42 | 0.56 | 0.74 | - |
| TT0098 | 0.05 | 0.10 | 0.20 | 0.27 | 0.36 | 0.50 | ? | ? | - |

| Spec. No. | H.L./R.V. | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0071 | 2.33 | 2.50 | 2.74 | ? | 1.73 | 1.55 | 1.70 | 1.54 | ? |
| TT0078 | 1.00 | 1.38 | 2.58 | 2.89 | 2.13 | 2.12 | 1.86 | ? | - |
| TT0098 | 1.40 | 1.10 | 0.95 | 1.11 | 1.22 | 1.28 | ? | ? | - |

| Spec. No. | Thickness of Spirotheca (microns) | | | | | | | | |
|-----------|-----------------------------------|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0071 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| TT0078 | 5 | 5 | 5 | ? | ? | 10 | 10 | 10 | - |
| TT0098 | 5 | 5 | 5 | 10 | 10 | 10 | 10 | - | - |
| TT0098 | ? | 5? | 10 | 14 | 19 | 29 | ? | ? | - |

| Spec. No. | Septal Count | | | | | | | | |
|-----------|--------------|----|----|----|----|----|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0098 | ? | 5? | 10 | 14 | 19 | 29 | ? | ? | - |

| Spec. No. | Tunnel angle (degrees) | | | | | | | | |
|-----------|------------------------|----|----|----|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0071 | ? | 18 | 32 | 26 | 30 | 21 | 16 | ? | |
| TT0098 | - | - | 26 | 20 | 42 | 27 | 21 | 35 | |

Neofusulinella cf. saraburiensis Toriyama, Kanmera, and Ingavat, 1969

Plate 1, figs. 1-3

1969 *Neofusulinella saraburiensis* Toriyama, Kanmera, and Ingavat, pp.22-23, pl.3, figs.1-11.

1973 *Neofusulinella saraburiensis* Toriyama and Pitakpaivan, pp.46-47, pl.5, figs.2-7.

Description :- Shell minute, moderate fusiform, with a straight axis of coiling, nearly straight convex lateral slopes, and bluntly pointed poles. Mature specimens of 6 volutions attain 0.8 to 1.3 mm in length and 0.5 to 0.7 mm in width. Form ratio ranges from 1.60 to 1.86. Proloculus is minute and spherical, outside diameter ranging from 0.04 to 0.05 mm in two specimens. Spirotheca thin, consisting of a very thin dark layer of tectum and a thicker inner layer. Thickness of spirotheca in the first to fourth volutions of two specimens average 5, 8, 10, and 10 microns, respectively. Tunnel low and narrow in the inner volutions but widening outwards. Tunnel angles of the third to fifth volutions are 36, 40, and 38 degrees, respectively in one specimen. Chomata massive and asymmetrical, one-third to one-half as high as the chambers. Tunnel side of chomata steep to vertical but pole-ward slope gentle.

Remarks :- The specimens of the study area, though not enough in number and poor state of preservation, are similar to *Neofusulinella saraburiensis* (Toriyama et al., 1969),

the most primitive species among the three species (*N. praecursor*, *N. lantenoisi*, and *N. saraburiensis*), in many diagnosis characteristics, especially in minute size of shell, form ratio, few whorls, outside diameter of proloculus, and tunnel angle, massive and asymmetrical of chomata. They tentatively assigned to *Neofusulinella* cf. *saraburiensis* until the final decision can be made on more sufficient material.

Material :- Khao Chakkachan : TT0071 in lower part of unit C₂ ; TT0078, TT0215, TT0216, TT0217, TT0218, TT0219, TT0220 and TT0221 in unit C₁. Khao Wat Kirinakratanaram : TT0079, TT0091, TT0092, and TT0098 in unit C₁.

Age :- Kungurian to Upper Roadian (Toriyama et al., 1974).

Measurement of *Neofusulinella* cf. *saraburiensis* Toriyama, Kanmera, and Ingavat, 1969.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0091 | 1.3 | 0.7 | 1.86 | 0.04 | 5 |
| TT0098 | 0.8 | 0.5 | 1.60 | 0.05 | 10 |

| Spec. No. | H.L. (mm) | | | | | |
|-----------|-----------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0091 | 0.15 | 0.24 | 0.36 | 0.47 | 0.62 | 0.78 |
| TT0098 | 0.17 | 0.24 | 0.35 | 0.50 | ? | - |

| Spec. No. | R.V. (mm) | | | | | |
|-----------|-----------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0091 | 0.06 | 0.12 | 0.18 | 0.24 | 0.33 | 0.44 |
| TT0098 | 0.08 | 0.11 | 0.18 | 0.26 | ? | - |

| Spec. No. | H.L./R.V. | | | | | |
|--------------|-----------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0091 | 2.50 | 2.00 | 2.00 | 1.96 | 1.88 | 1.77 |
| TT0098 | 2.12 | 2.18 | 1.94 | 1.92 | ? | - |

| Spec. No. | Thickness of Spirotheca (microns) | | | | | |
|--------------|--------------------------------------|---|----|----|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0091 | 5 | 8 | 10 | 10 | ? | - |
| TT0098 | 5 | 8 | 10 | 10 | ? | - |

| Spec. No. | Septal count (microns) | | | | | |
|--------------|---------------------------|---|-----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0098 | ? | ? | 14? | 22 | 26 | 27 |

| Spec. No. | Tunnel angle (degrees) | | | | | |
|--------------|------------------------|---|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| TT0091 | - | - | 36 | 40 | 38 | ? |

Family Schwagerinidae Dunbar and Henbest, 1930

Subfamily *Chusenellinae* F.Kahler & G. Kahler, 1966

Genus *Chusenella* Hsu, 1942

Type species : *Chusenella ishanensis* Hsu, 1942

Diagnosis :- Test ovate, robust fusiform to elongate fusiform with sharp apices, up to 13.5 mm in length, small to medium-sized proloculus, early whorls tightly coiled, up to eight or nine volutions in the adult, later ones more loosely expanded, early septa without fluting, later septa highly and tightly fluted throughout length; wall thin, with tectum and weakly fibrous keriotheca increasing slowly in thickness, rudimentary chomata in the juvenile stage of some species, or chomata may be completely lacking throughout, axial filling prominent, but tunnel present in the equatorial region.

Chusenella cf. *schwagerinaeformis* Sheng, 1963

Plate 2, figs. 1-3

1963 *Chusenella schwagerinaeformis* Sheng, p.211, pl.23, figs.1-6.

1976 *Chusenella schwagerinaeformis* Toriyama, pp.37-39, pl.10, figs. 8-12.

Description : -Shell moderate in size, short fusiform with slightly curving axis of coiling. Lateral slopes gently convex in inner volutions, they change to more or less concave near pole in outer volutions, forming a little inflated polar areas. Dimension of shell 7.0 to 8.2 mm long and 3.0 to 3.5 mm wide, with form ratios of 2.33 and 2.34, respectively. Ratios of half length to radius vector of the first to seventh volutions in two specimens average 4.82, 3.04, 3.08, 2.76, 1.93, 2.06, and 2.40, respectively. Proloculus is small and spherical or subspherical, with outside diameter of 0.18 to 0.22 mm in three specimens. Shell tightly coils in inner two to three volutions, but expands rapidly and almost uniformly in succeeding volutions. Radius vectors of the first to seventh volutions in three specimens average 0.17, 0.31, 0.49, 0.69, 1.04, 1.39, and 1.49 mm, respectively. Chamber about the same in height from pole to pole. Spirotheca consists of tectum and finely alveolar keriotheca. Thickness of spirotheca of the first to seventh volutions in three specimens average 31, 31, 52, 76, 94, 83, and 73 microns, respectively. Septa highly and regularly fluted throughout growth except in the first one or two volutions where they are weakly fluted or nearly plane. Chamberlets formed by strong flutings reach tops of chamber except in equatorial portion. Chomata developed in all, except in the last volution. Tunnel low and narrow, with more or less irregular path. Tunnel angles of the first to sixth volutions are 20, 20, 30, 37, 38, and 40 degrees, respectively. Axial fillings moderately defined.

Remarks :- Although the study area specimens are insufficient in number, their important characteristics are almost the same to those of *Chusenella schwagerinaeformis* Sheng from Khao Phlong Prab, Changwat Saraburi, described by Toriyama (1976), and Sheng (1963)'s originally type from the Maokou Limestone near Pingding, Yishan of Kwangsi, except that the former have thicker axial fillings. Thus, the present specimens are

identified as *Chusenella* cf. *schwagerinaeformis* Sheng until the author can reach enough specimens for comparison in the future.

Material :- Khao Wong :TT0186, TT0187, TT0188, and TT0190.

Age :- Wordian (Sheng, 1963).

Measurement of *Chusenella* cf. *schwagerinaeformis* Sheng, 1963.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0188 | ? | 3.5 | ? | 0.21 | 31 |
| TT0187 | 8.2 | 3.5 | 2.34 | 0.18 | 26 |
| TT0186 | 7.0 | 3.0 | 2.33 | 0.22 | 31 |

| Spec. No. | H.L. (mm) | | | | | | |
|-----------|-----------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TT0188 | ? | ? | ? | ? | ? | ? | ? |
| TT0187 | 1.56 | 2.17 | 2.62 | 3.14 | ? | ? | - |
| TT0186 | 0.31 | 0.40 | 0.96 | 1.36 | 1.64 | 2.41 | 3.55 |

| Spec. No. | R.V. (mm) | | | | | | |
|-----------|-----------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TT0188 | 0.16 | 0.22 | 0.31 | 0.49 | 0.74 | 1.07 | 1.50 |
| TT0187 | 0.21 | 0.52 | 0.83 | 1.05 | 1.54 | 1.93 | - |
| TT0186 | 0.14 | 0.21 | 0.32 | 0.54 | 0.85 | 1.17 | 1.48 |

| Spec. No. | H.L./R.V. | | | | | | |
|-----------|-----------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TT0188 | ? | ? | ? | ? | ? | ? | ? |
| TT0187 | 7.43 | 4.17 | 3.16 | 2.99 | ? | ? | |
| TT0186 | 2.21 | 1.90 | 3.00 | 2.52 | 1.93 | 2.06 | 2.40 |

| Spec. No. | Thickness of Spirotheca (microns) | | | | | | |
|--------------|--------------------------------------|----|----|-----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TT0188 | 21 | 31 | 31 | 52 | 94 | 83 | 73 |
| TT0187 | 52 | 42 | 63 | 104 | 94 | 94 | |
| TT0186 | 21 | 21 | 62 | 73 | 94 | 73 | 73 |

| Spec. No. | Tunnel angle (degrees) | | | | | | |
|--------------|---------------------------|----|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TT0186 | 20 | 20 | 30 | 37 | 38 | 41 | - |

Subfamily Schwagerininae Dunbar & Henbest, 1930

Genus *Parafusulina* Dunbar and Skinner, 1931

Type species : *Parafusulina wordensis* Dunbar and Skinner, 1931

Diagnosis :- Test elongate, up to 65 mm in length, fusiform to subcylindrical, tapering slightly to the bluntly rounded poles, proloculus large, followed by seven to nine gradually enlarging volutions, coiling axis straight to irregular, septa numerous, intensely and regularly fluted, folds of adjacent septa touching and forming numerous chamberlets above the floor of the chamber, and producing cuniculi against the floor; wall thin relation to the size of the test, of tectum and alveolar keriotheca, tunnel low and well defined, no chomata, but with heavy axial fillings.

Parafusulina gigantea (Deprat) Toriyama, 1958

Plate 4, figs.1-6

- 1913 *Fusulina gigantea* Deprat, pp.29-30, pl.1, figs.1-6.
- 1958 *Parafusulina gigantea* Toriyama, pp.200-203, pl.36, figs.2-11.
- 1963 *Parafusulina gigantea* Sheng, p.201, pl.20, figs.1-5, 9, 11; pl.2, figs.3-5.
- 1973 *Parafusulina gigantea* Toriyama and Pitakpaivan, pp.48-50, pl.5, figs. 13-20.
- 1976 *Parafusulina gigantea* Tittirananda, pp.108-109, pl.42, figs.5-9; pl.47,

fig.7; pl.49, figs.1, 3, 4; pl.50, figs.8, 1.

1979 *Parafusulina gigantea* Toriyama and Kanmera, pp.44-46, pl.5, figs.10-13.

Description:- Shell is very large elongate fusiform, bluntly pointed poles. The shell mostly comprises 6 volutions, rarely 7 or 8 volutions. The largest shell at our disposal has 6 volutions, with 19.0 mm length and 4.5 mm width. The shell is nearly spherical only in the first volution, and due to rather rapid expansion the shell assumes a thick fusiform in the second to third volutions, and elongate fusiform in later ones. The average ratio of half-length to radius vector of the first to sixth volutions in 8 specimens are 1.30, 2.00, 2.15, 2.93, 2.60, and 2.81, respectively. Proloculus is very large, spherical, ellipsoidal, elongate quadrangle, or considerably irregular in shape. Outside diameter of proloculus varies from 0.38 to 1.22 mm. Proloculus wall is apparently structureless and very thin for the size of the proloculus. The shell expands rapidly and almost uniformly throughout all. Average radius vectors of the first to sixth volution of 8 specimens are 0.44, 0.65, 0.96, 1.32, 1.74 and 2.22 mm, respectively. The chambers are lowest in the equatorial portion, increasing in height pole-wards. Spirotheca consists of thin tectum and coarsely alveolar keriotheca. It increases in thickness very rapidly as the shell grows except in the last one or two volutions where it becomes thinner than the preceding volution. Average thickness of the spirotheca in the first to sixth volutions of eight specimens is 39, 63, 98, 117, 137 and 114, respectively. Septa are numerous except for the first volution, septal count of the first to sixth volutions in three specimens average 16, 21, 28, 36, 36, and 41, respectively. They are so highly and narrowly fluted throughout the shell that cuniculi are well developed. Tunnel is low and wide, with somewhat irregular path. Approximate tunnel angles in the two to fifth volutions in three specimens are 46, 37, 32, and 32 degrees, respectively. No axial fillings are present.

Remarks :- This species is easily distinguished from the known species of the genus by its large and fusiform shell, exceeding large proloculus and very thick spirotheca. These specimens agree with *Fusulina gigantea* Deprat (1913) from Indochina in number of volutions, absolute size, ratio of half-length to radius vector, proloculus size, and thickness of spirotheca. They also agree with the specimens from Khao Khao,

Changwat Saraburi, described by Toriyama and Kanmera (1979), in all characteristics. The specimens from unit II, III, VI, and VII of the sections along Highway 21, studied by Tittirananda (1976), agree with the present specimens in general characteristics, but their measurements had not any records for comparison. In comparison with Sheng's specimens (1963) from the lower part of the Maokou limestone, Kwangsi, China, our *Parafusulina gigantea* is rather bigger than those from China.

Material :- Khao Chakkachan : unit C₂ abundant in TT0008, TT0009, TT0010, TT0012, TT0013, TT0014, TT0017, TT0018, TT0019, TT0020, TT0021, TT0022, TT0023, TT0025, TT0028, TT0031, TT0040, TT0041, TT0042, TT0044, TT0045, TT0046, TT0053, TT0056, TT0058, TT0061, TT0071, TT0072, TT0073, and TT0214; unit C₁ in TT0074, TT0075, TT0076, TT0078, TT0215, TT0216, TT0217, TT0218, TT0219, TT0220, and TT02221. Khao Wat Kirinakratanaram : unit C₁ common to rare in TT0079, TT0082, TT0083, TT0085, TT0086, TT0090, TT0091, TT0092, TT0094, TT0098, TT0101, TT0104, TT0105, and TT0114.

Age :- middle of Middle Permian or Wordian (Toriyama and Kanmera , 1979).

Measurement of *Parafusulina gigantea* (Deprat) Toriyama, 1958.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|-----------|-----------|------------|-----------------------------------|---|
| TT0010 | 10.0 | 4.2 | 2.38 | 0.75 | 21 |
| TT0013 | 19.0 | 4.5 | 4.22 | 1.22 | 21 |
| TT0022 | 11.5 | 3.8 | 3.02 | 0.69 | 21 |
| TT0042 | 10.0 | 3.6 | 2.78 | 0.69 | 36 |
| TT0053 | 12.8 | 4.0 | 3.20 | 0.38 | 31 |
| TT0058 | 14.0 | 4.0 | 3.50 | 0.55 | 31 |
| TT0071 | 13.5 | 3.5 | 3.86 | 0.76 | 21 |
| TT0082 | 9.5 | 3.8 | 2.50 | 0.64 | 42 |

| Spec. No. | H.L. (mm) | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0010 | 0.53 | 1.39 | 2.08 | 2.81 | 3.65 | 5.59 | - | - |
| TT0013 | 0.80 | 1.80 | 3.00 | 4.25 | 6.90 | 8.90 | - | - |
| TT0022 | 0.38 | 0.83 | 1.44 | 2.77 | 4.28 | 5.86 | - | - |
| TT0042 | 0.49 | 1.22 | 1.94 | 2.22 | 3.26 | 4.48 | 5.77 | - |
| TT0053 | 0.42 | 0.91 | 1.78 | 2.72 | 5.01 | 5.49 | 7.58 | ? |
| TT0058 | 0.79 | 1.44 | 2.27 | 3.84 | 6.01 | 6.99 | - | - |
| TT0071 | 0.40 | 1.49 | 2.19 | 2.91 | 4.70 | 6.71 | - | - |
| TT0082 | 0.58 | 1.25 | 1.87 | 2.90 | 4.15 | 4.77 | - | - |

| Spec. No. | R.V. (mm) | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0010 | 0.48 | 0.68 | 1.04 | 1.42 | 1.80 | 2.15 | - | - |
| TT0013 | 0.48 | 0.72 | 1.07 | 1.44 | 1.82 | 2.26 | - | - |
| TT0022 | 0.46 | 0.65 | 0.93 | 1.29 | 2.02 | 2.36 | - | - |
| TT0042 | 0.44 | 0.60 | 0.93 | 1.29 | 1.72 | 2.15 | ? | - |
| TT0053 | 0.33 | 0.53 | 0.80 | 1.11 | 1.43 | 1.81 | 2.18 | 2.38 |
| TT0058 | 0.33 | 0.56 | 0.86 | 1.24 | 1.57 | 1.92 | - | - |
| TT0071 | 0.56 | 0.73 | 1.10 | 1.43 | 1.83 | 2.20 | - | - |
| TT0082 | 0.45 | 0.70 | 0.98 | 1.38 | 1.77 | 2.92 | - | - |

| Spec. No. | H.L./R.V. | | | | | | | |
|--------------|-----------|------|------|------|------|------|------|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0010 | 1.10 | 2.04 | 2.00 | 1.98 | 2.03 | 2.6 | - | - |
| TT0013 | 1.67 | 2.5 | 2.8 | 2.95 | 3.79 | 3.94 | - | - |
| TT0022 | 0.83 | 1.28 | 1.55 | 2.15 | 2.12 | 2.48 | - | - |
| TT0042 | 1.11 | 2.03 | 2.09 | 1.72 | 1.90 | 2.08 | ? | - |
| TT0053 | 1.27 | 1.72 | 2.22 | 2.45 | 2.80 | 3.03 | 3.48 | ? |
| TT0058 | 2.39 | 2.57 | 2.64 | 3.10 | 3.19 | 3.64 | - | - |
| TT0071 | 0.71 | 2.04 | 1.99 | 2.03 | 2.57 | 3.05 | - | - |
| TT0082 | 1.29 | 1.79 | 1.91 | 2.10 | 2.34 | 1.63 | - | - |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | |
|--------------|--------------------------------------|----|-----|-----|-----|-----|-----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0010 | 36 | 47 | 104 | 125 | 146 | 115 | - | - |
| TT0013 | 42 | 89 | 115 | 136 | 109 | 115 | - | - |
| TT0022 | 26 | 52 | 115 | 94 | 177 | 115 | - | - |
| TT0042 | 31 | 68 | 74 | 115 | 141 | 115 | 115 | - |
| TT0053 | 42 | 52 | 104 | 146 | 135 | 125 | 250 | 73 |
| TT0058 | 42 | 62 | 94 | 135 | 130 | 125 | - | - |
| TT0071 | 52 | 73 | 94 | 83 | 115 | 94 | - | - |
| TT0082 | 42 | 63 | 83 | 104 | 146 | 104 | - | - |

| Spec. No. | Septal Count | | | | | | | |
|--------------|--------------|----|----|----|----|-----|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0022 | ? | 15 | 21 | 29 | 36 | 37 | - | - |
| TT0042 | 17 | 26 | 33 | 42 | 35 | 45 | - | - |
| TT0082 | 15 | 23 | 29 | 36 | 38 | 38? | - | - |

| Spec. No. | Tunnel angle (degrees) | | | | | | | |
|--------------|---------------------------|----|----|----|----|----|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0013 | - | 50 | 45 | 35 | ? | ? | - | - |
| TT0022 | - | - | 40 | 30 | 40 | 50 | - | - |
| TT0053 | - | 42 | 26 | 30 | 28 | 41 | - | - |

Parafusulina loeyensis Pitakpaivan, 1966

Plate 5, figs. 1-5

1966 *Parafusulina loeyensis* Pitakpaivan, pp.50-53, pl.6, figs.1-4.

1976 *Parafusulina* cf. *loeyensis* Tittiranandā, p.109, pl.42, figs.1-4; pl.43, fig.7; pl.45, figs. 1-4, 6; pl.49, fig.2.

Description :- Shell is thickly elongate fusiform with gentle to strong concavity or constriction around the equatorial region, and lateral slopes converging to sub-obtuse rounded poles, comprises 7 to 9 volutions, mostly 7 volutions and is of very variable

size, maximum 16.80 mm in length and 5.0 mm in diameter. Average size of 10 specimens is 10.3 mm in length, 3.8 mm in diameter. Shell in somewhat closely coiled at first, later having a greater height of volutions. Axis is straight. Height of the volution increases but a little towards the poles as the shell elongates. Form ratio normally about 2 in the first volution, increasing nearly 3 in outer volutions. Proloculus large, spherical or slightly ovate, ranging in size from 0.36 to 0.64 mm. Proloculus wall rather thick, average 43 microns. Spirotheca moderately thick, consisting of tectum and coarsely alveolar keriotheca thickest at the equator. Spirotheca of the first volution is thinner than the proloculus wall, thickness increases from 21-52 microns in first volution to 52-63 microns in last volution. Septa regularly and strongly fluted, septal loop high in the axial section and widely spaced. In tangential section or weathered shell, the cuniculi are well shown. Chomata presents on the proloculus wall only, but not clearly appearance. Tunnel high and wide but not well seen, generally almost straight but rarely very irregular. Secondary deposit varying much both in intensity and distribution, some deposit in form of dense massive material entirely and heavily filling the chambers. Some deposit in form of dense material coating on the chamber wall.

Remarks :- The specimens described and illustrated as *Parafusulina loeyensis* which were originally identified by Pitakpaivan (1966) in constriction around the equatorial region, thickness of the first volution spirotheca that thinner than the proloculus wall, average size, form ratio, number of volutions, and proloculus. *Parafusulina cf. loeyensis* were also discovered by Tittirananda (1976) at unit II, V and VI of Khao Khad, Saraburi-Lom Sak Highway or Highway 21, but the descriptions of those specimens had not any measurements report.

Material :- Khao Chakkachan : abundant in TT0008, TT0009, TT0010, TT0012, TT0013, TT0014, TT0019, TT0020, TT0021, TT0022, TT0023, TT0025, TT0028, TT0031, TT0035, TT0038, TT0040, TT0041, TT0042, TT0045, TT0046, TT0047, TT0049, TT0050, TT0052, TT0053, TT0056, TT0058, TT0059, TT0064, TT0067, TT0070, TT0071, TT0072, TT0073, TT0074, TT0076, TT0078, and TT0083. Khao Wat Kirinakratanaram : very rare in TT0083.

Age :-Kungurian to Wordian (Pitakpaivan, 1966) and Artinskian to Wordian (Tittiranada, 1976).

Measurement of *Parafusulina loeyensis* Pitakpaivan, 1966.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0009 | 10.5 | 4.0 | 2.63 | 0.49 | 31 |
| TT0013 | 16.8 | 4.0 | 4.20 | 0.36 | 21 |
| TT0023 | 10.0 | 3.5 | 2.86 | ? | ? |
| TT0028 | 12.0 | 5.0 | 2.40 | 0.61 | 37 |
| TT0040 | 8.6 | 3.3 | 2.61 | 0.52 | 63 |
| TT0042 | 9.0 | 3.2 | 2.81 | 0.64 | 52 |
| TT0053 | 10.0 | 4.3 | 2.32 | 0.48 | 52 |
| TT0067 | 8.5 | 3.8 | 2.24 | 0.62 | 47 |
| TT0072 | 9.0 | 3.0 | 3.00 | 0.52 | 42 |
| TT0074 | 8.5 | 3.8 | 2.24 | 0.46 | 42 |

| Spec. No. | H.L. (mm) | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0009 | 0.41 | 0.85 | 1.57 | 2.03 | 2.70 | 3.63 | 4.69 | 5.42 | - |
| TT0013 | 0.92 | 2.04 | 3.40 | 4.67 | 6.56 | 7.42 | 8.54 | - | - |
| TT0023 | 0.50 | 0.93 | 1.49 | 2.24 | 3.00 | 4.20 | 5.16 | - | - |
| TT0028 | 0.68 | 1.30 | 2.29 | 2.86 | 3.71 | 4.49 | 5.31 | 5.95 | 6.37 |
| TT0040 | 0.62 | ? | 1.85 | 2.64 | 3.40 | 4.38 | - | - | - |
| TT0042 | 0.65 | 0.96 | 1.43 | 2.08 | 3.02 | 3.86 | 4.60 | - | - |
| TT0053 | 0.36 | 0.64 | 1.06 | 1.51 | 2.15 | 2.82 | 3.27 | 4.02 | 4.54 |
| TT0067 | 0.90 | 1.42 | 1.72 | 2.34 | 2.99 | 4.07 | 4.68 | - | - |
| TT0072 | 0.68 | 1.25 | 1.82 | 2.77 | 3.77 | 4.97 | - | - | - |
| TT0074 | 0.83 | 1.15 | 1.43 | 1.97 | 2.57 | 3.15 | 3.90 | 4.68 | |

| Spec. No. | R.V. (mm) | | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0009 | 0.36 | 0.48 | 0.65 | 0.89 | 1.16 | 1.45 | 1.83 | 2.36 | - |
| TT0013 | 0.32 | 0.51 | 0.73 | 1.04 | 1.36 | 1.76 | 2.08 | - | - |
| TT0023 | 0.24 | 0.43 | 0.63 | 0.85 | 1.09 | 1.39 | 1.69 | - | - |
| TT0028 | 0.32 | 0.45 | 0.62 | 0.85 | 1.16 | 1.51 | 1.86 | 2.22 | 2.54 |
| TT0040 | 0.35 | 0.49 | 0.67 | 0.92 | 1.26 | 1.55 | - | - | - |
| TT0042 | 0.33 | 0.44 | 0.59 | 0.84 | 1.10 | 1.41 | 1.74 | | |
| TT0053 | 0.33 | 0.46 | 0.62 | 0.83 | 1.05 | 1.39 | 1.75 | 2.08 | 2.43 |
| TT0067 | 0.44 | 0.60 | 0.82 | 1.10 | 1.39 | 1.68 | 2.02 | - | - |
| TT0072 | 0.27 | 0.41 | 0.59 | 0.78 | 1.06 | 1.36 | - | - | - |
| TT0074 | 0.31 | 0.42 | 0.60 | 0.82 | 1.07 | 1.35 | 1.70 | 1.99 | - |

| Spec. No. | H.L./R.V. | | | | | | | | |
|--------------|-----------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0009 | 1.14 | 1.77 | 2.42 | 2.28 | 2.33 | 2.50 | 2.56 | 2.30 | - |
| TT0013 | 2.88 | 4.0 | 4.66 | 4.49 | 4.82 | 4.22 | 4.11 | - | - |
| TT0023 | 2.08 | 2.16 | 2.36 | 2.64 | 2.75 | 3.02 | 3.05 | - | - |
| TT0028 | 2.12 | 2.89 | 3.69 | 3.36 | 3.20 | 2.97 | 2.85 | 2.68 | 2.51 |
| TT0040 | 1.77 | ? | 2.76 | 2.87 | 2.70 | 2.83 | - | - | - |
| TT0042 | 1.97 | 2.18 | 2.42 | 2.48 | 2.74 | 2.74 | 2.64 | - | - |
| TT0053 | 1.09 | 1.39 | 1.71 | 1.82 | 2.05 | 2.03 | 1.87 | 1.93 | 1.87 |
| TT0067 | 2.04 | 2.37 | 2.10 | 2.13 | 2.15 | 2.42 | 2.32 | - | - |
| TT0072 | 2.52 | 3.05 | 3.08 | 3.55 | 3.56 | 3.65 | - | - | - |
| TT0074 | 2.68 | 2.74 | 2.43 | 2.40 | 2.40 | 2.33 | 2.29 | 2.35 | - |

| Spec. No. | Septal Count | | | | | | | | |
|--------------|--------------|---|---|----|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0013 | ? | ? | ? | 26 | 23 | 32 | 32 | 21 | - |

| Spec. No. | Tunnel angle (degrees) | | | | | | | | |
|--------------|---------------------------|---|---|---|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0053 | - | - | - | - | 37 | 32 | 29 | 26 | ? |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | |
|--------------|--------------------------------------|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0009 | 21 | 31 | 42 | 47 | 73 | 63 | 73 | 73 | - |
| TT0013 | 52 | 52 | 63 | 73 | 83 | 78 | 83 | - | - |
| TT0023 | 52 | 31 | 47 | 57 | 57 | 73 | 52 | - | - |
| TT0026 | 21 | 31 | 31 | 47 | 73 | 63 | 63 | 83 | 52 |
| TT0040 | 42 | 36 | 52 | 52 | 47 | - | - | - | - |
| TT0042 | 36 | 31 | 42 | 52 | 57 | 78 | 63 | - | - |
| TT0053 | 21 | 21 | 42 | 52 | 52 | 63 | 63 | 73 | 63 |
| TT0067 | 31 | 31 | 42 | 52 | 63 | 63 | 83 | - | - |
| TT0072 | 31 | 31 | 52 | 52 | 73 | 73 | - | - | - |
| TT0074 | 36 | 42 | 36 | 52 | 52 | 63 | 52 | 68 | - |

Parafusulina sp. A Dunbar and Skinner, 1931

Plate 3, figs.1-3

1931 *Parafusulina* Dunbar and Skinner, p.258.

1988 *Parafusulina* Loeblich and Tappan, p.278, pl.283, figs.7-10.

Description :- Shell medium, short ellipsoidal and slightly rounded central part with acuminate poles, 2.8 to 4.7 mm long and 1.4 to 2.3 mm wide give the form ratio 2.00 to 2.04. Proloculus very large, spherical. Outside diameters of three specimens average 61 mm. Thickness of proloculus walls are 40 to 50 microns. Proloculus wall is thicker than the first volution spirotheca. Spirotheca are thick, composed of tectum and finely alveolar keriotheca. Thickness of spirotheca in the first to fourth volutions of three specimens average 37, 48, 50, and 58 microns, respectively. Septa are thick, closely spaced with high and narrowly fluting throughout the length of shell. The fluting extend from two-third to three- fourth as high as the chambers. Septal counted in first to third volutions of one specimen are 14, 24, and 26, respectively. Axial fillings very heavy in the polar regions.

Remarks :- The present specimens agree with the genus *Parafusulina* in several characteristics. Insufficiency of material for comparison and lack of references in this time, thus, the present specimens is assigned only as *Parafusulina* sp.A.

Material :- Khao Chakkachan : very rare in TT0021.

Age :- The range of the genus *Parafusulina* is Permian (Loeblich and Tappan, 1988), but in study area it occur together with *Parafusulina gigantea* and *Parafusulina loeyensis*, thus the present specimen may be Wordian in age.

Measurement of *Parafusulina* sp. A Dunbar and Skinner, 1931.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0021/5 | - | 1.5 | - | 0.60 | 50 |
| TT0021/18 | 4.7 | 2.3 | 2.04 | 0.69 | 50 |
| TT0021/20 | 2.8 | 1.4 | 2.0 | 0.55 | 40 |

| Spec. No. | H.L. (mm) | | | |
|-----------|-----------|------|------|------|
| | 1 | 2 | 3 | 4 |
| TT0021/5 | - | - | - | - |
| TT0021/18 | 0.73 | 1.30 | 1.70 | 2.38 |
| TT0021/20 | 0.52 | 0.75 | 1.05 | 1.40 |

| Spec. No. | R.V. (mm) | | | |
|-----------|-----------|------|------|------|
| | 1 | 2 | 3 | 4 |
| TT0021/5 | 0.50 | 0.70 | 1.00 | - |
| TT0021/18 | 0.48 | 0.66 | 0.90 | 1.14 |
| TT0021/20 | 0.35 | 0.45 | 0.60 | 0.70 |

| Spec. No. | H.L./R.V. | | | |
|--------------|-----------|------|------|------|
| | 1 | 2 | 3 | 4 |
| TT0021/5 | - | - | - | - |
| TT0021/18 | 1.52 | 1.97 | 1.89 | 2.09 |
| TT0021/20 | 1.49 | 1.67 | 1.75 | 2.00 |

| Spec. No. | Thickness of spirotheca (microns) | | | |
|--------------|--------------------------------------|----|----|----|
| | 1 | 2 | 3 | 4 |
| TT0021/5 | 40 | 40 | 50 | - |
| TT0021/18 | 45 | 70 | 55 | 75 |
| TT0021/20 | 25 | 35 | 45 | 40 |

| Spec. No. | Septal Count | | | |
|--------------|--------------|----|----|---|
| | 1 | 2 | 3 | 4 |
| TT0021/5 | 14 | 24 | 26 | ? |

Genus *Pseudofusulina* Dunbar and Skinner, 1931

Type species : *Pseudofusulina huecoensis* Dunbar and Skinner, 1931

Diagnosis :- Test large, up to 15 mm in length, elongate fusiform, with acuminate poles, axis of coiling straight, large proloculus followed by about eight loosely coiled whorls, septa fluted throughout, most strongly at the base of the septa and toward the poles and may be sufficiently strongly folded to produce closed chamberlets, thin dense partitions or phrenothecae may across the chambers between folds of the septa; wall thick, of tectum and coarsely alveolar keriotheca, axial fillings may be thin and confined to the poles, or even absent in some species, chomata distinct in early taxa, but less prominent in later ones, tunnel straight.

Pseudofusulina sp. Dunbar and Skinner, 1931

Plate 3, figs.4-7

1931 *Pseudofusulina* Dunbar and Skinner, p.252

1988 *Pseudofusulina* Loeblich and Tappan, pp.278-279, pl.281, figs.1,2;
pl.282, figs.1-7; pl.283, figs.1-6.

Description :- Test large, elongate cylindrical with broad rounded poles, 6.5 mm long and 1.6 mm wide. Form ratio 4.06. Proloculus small, subspherical, outside diameter is 0.10 mm. The proloculus wall is 10 microns - thick. Spirotheca are thick, of tectum and coarsely alveolar keriotheca. Thickness of spirotheca in the first to fifth volutions are 10, 10, 21, 31, and 31 microns, respectively. Septa fluted throughout the length of shell, many irregular forms, mostly low u-shape forms. Axial fillings thin, present at the top of fluted septa.

Remarks :- This specimen agree with the genus *Pseudofusulina* in many characteristics such as thick spirotheca composed of tectum and coarsely alveolar keriotheca, form of septa fluting and loosely coiled whorls. Extreme insufficiency of good-oriented material for comparison and lack of references in this time, thus, the present specimen is assigned only as *Pseudofusulina* sp.

Material :-Khao Wong : rare in TT0182 and TT0186.

Age :- The range of the genus is Asselian to Kungurian (Loeblich and Tappan, 1988) , but in the thesis area it exists among the Wordian fusulinids.

Measurement of *Pseudofusulina* sp. Dunbar and Skinner, 1931.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0186 | 6.5 | 1.6 | 4.06 | 0.10 | 10 |

| Spec. No. | H.L. (mm) | | | | |
|-----------|-----------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| TT0186 | 0.13 | 0.22 | 0.52 | 1.04 | 1.27 |

| Spec. No. | R.V. (mm) | | | | |
|-----------|-----------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| TT0186 | 0.08 | 0.10 | 0.18 | 0.27 | 0.32 |

| Spec. No. | H.L./R.V. | | | | |
|-----------|-----------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| TT0186 | 1.62 | 2.20 | 2.89 | 3.85 | 3.97 |

| Spec. No. | Thickness of Spirotheca (microns) | | | | |
|-----------|-----------------------------------|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 |
| TT0186 | 10 | 10 | 21 | 31 | 31 |

Family Verbeekinidae Staff and Wedekind, 1910

Subfamily Verbeekininae Staff and Wedekind, 1910

Genus *Verbeekina* Staff, 1909

Type species : *Fusulina verbeeki* Geinitz, in Geinitz and von der Marck, 1876

Diagnosis :- Test subspherical, up to about 14 mm in length, tiny proloculus followed by irregularly coiled or endothyroid juvenarium, succeeding whorl of sharply increased diameter, then with up to twenty slowly enlarging planispiral whorl, septa formed by downward deflection of the tectum and keriotheca, angled forward, unfluted; wall of tectum and thin, extremely fine alveolar keriotheca, inner and outer surfaces of the wall and both sides of the septa may be coated with dense calcite resembling parachomata in structure, and the more extensive coatings at the poles may nearly fill the chambers, parachomata absent or rudimentary in early whorls but well developed between the foramina of the outer whorls, project forward from the septa, and may join those of the succeeding chamber and form nearly continuous ridges for a short distance, no tunnel, numerous elliptical basal foramina, as many as a hundred in later whorls.

Verbeekina verbeeki (Geinitz) Ozawa, 1925

Plate 6, figs.1-5

- 1876 *Fusulina verbeeki* Geinitz, pp.399-400.
 1925 *Verbeekina verbeeki* Ozawa, pp.48-51, pl.10, figs.6-7.
 1934 *Verbeekina verbeek* Chen, pp.101-102, pl.16, fig.1.
 1963 *Verbeekina verbeeki* Sheng, pp.215-216, pl.26, figs.1-5.
 1973 *Verbeekina verbeeki* Toriyama and Pitakpaivan, pp.50-53, pl.6, figs.1-5.

Description :- Shell is subspherical. A mature specimen of 13 volutions is 7.6 mm in diameter. The immature specimens have 7 volutions. Form ratios of two specimens average 0.81, 0.86, 1.08, 1.43, 1.08, 1.02, 0.98, 1.00, 0.99, 0.99, 1.04, and 1.05 respectively in the first to twelfth volutions. Proloculus is very minute and spherical, and its outside diameter is probably 0.08 mm in one specimen. The juvenarium consisting of one volution coils tightly. Expansion of the shell is rather slow in the succeeding two or three volutions, but becomes rapid and uniform in outer volutions. The average radius vectors of the first to thirteenth volutions in three specimens are 0.15, 0.27, 0.51, 0.85, 1.25, 1.65, 2.10, 2.49, 2.82, 3.05, 3.25, 3.40, and 3.65 mm, respectively. Spirotheca is relatively thin, consist of a tectum and very finely alveolar keritheca. It increases in

thickness gradually, but slightly decreases in the outer volution of mature specimens. The thickness of the spirotheca of the first to twelfth volutions in three specimens average 14, 21, 22, 31, 31, 38, 58, 41, 42, 31, 21, and 21 microns, respectively. Septa are thin and numerous except for the first volutions. Septal count of the first to twelfth volutions in two specimens average 8, 6, 7, 10, 11, 16, 21, 26, 30, 28, 30, and 30, respectively. Septa are unfluted throughout the length of the shell. Parachomata are not present in inner eight volutions, and they are only rudimental developed in outer volutions. In the outer two or three volutions, parachomata are considerably well developed in narrowly, triangular, discontinuous, about one-fourth to one-third as high as the respective chambers.

Remarks :- Although the exactly oriented sections are not sufficient in number, all the important characteristics observed in the study area materials : size of shell, rate of expansion, thickness of spirotheca, number of septa, and development of parachomata agree with the *Verbeekina verbeeki* from Wat Kirinakratanaram, which were described by Toriyama and Pitakpaivan (1973). Comparing with the specimens from Maoteetang hill (Pitakpaivan, 1966), the former is relatively larger size than the present form. In comparison with specimen from Chekiang, China (Chen, 1934), the present materials are relatively larger than the China specimens. However, other characteristics are hard to compare because of incomplete measurement of those from China. The specimens from Kwangsi, China (Sheng, 1963) is larger size than the present form, while form ratio is conformable. *Verbeekina verbeeki* (Geinitz), 1876 resembles to *Verbeekina minor* Chen, 1934, with earlier whorls tightly coiled in the same manner, but they differ from *V. minor* in having large size, thick spirotheca, and the whorls are more tightly wound than *V. minor*.

Material :- Khao Chakkachan : unit C₁ abundant in TT0074, TT0215, TT0216, TT0218, TT0219, TT0220, TT0221. Khao Wat Kirinakratanaram : unit C₁ abundant in TT0079, TT0086, TT0090, TT0091, TT0092, TT0093, TT0094, TT0095, TT0096, TT0098, TT0101, TT0104, TT0105, and TT0114. Khao Wong : unit W₃ common to rare in TT0174, TT0177, TT0178; unit W₂ common in TT0181, and TT0187.

Age :- Lower Roadian to Upper Capitanian (Ozawa, 1970a).

Measurement of *Verbeekina verbeeki* (Geinitz) Ozawa, 1925.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0090 | 5.5 | 5.3 | 1.04 | ? | ? |
| TT0091 | 2.3 | 1.7 | 1.35 | 0.08 | 5 |
| TT0104 | 5.7 | ? | ? | ? | ? |

| Spec. No. | H.L. (mm) | | | | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| TT0090 | 0.05 | 0.11 | 0.22 | 0.31 | 0.57 | 0.88 | 1.14 | 1.51 | 1.81 | 2.13 | 2.52 | 2.77 |
| TT0091 | 0.09 | 0.20 | 0.41 | 0.53 | 0.92 | 1.08 | ? | - | - | - | - | - |
| TT0104 | - | - | - | - | - | - | - | - | - | - | - | - |

| Spec. No. | R.V. (mm) | | | | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| TT0090 | 0.08 | 0.15 | 0.23 | 0.37 | 0.59 | 0.88 | 1.16 | 1.51 | 1.82 | 2.15 | 2.41 | 2.64 |
| TT0091 | 0.09 | 0.20 | 0.33 | 0.52 | 0.77 | 1.04 | ? | - | - | - | - | - |
| TT0104 | 0.34 | 0.81 | 1.20 | 1.52 | 1.79 | 2.17 | 2.46 | 2.77 | 3.06 | - | - | - |

| Spec. No. | H.L./R.V. | | | | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| TT0090 | 0.62 | 0.73 | 0.96 | 0.84 | 0.97 | 1.00 | 0.98 | 1.00 | 0.99 | 0.99 | 1.04 | 1.05 |
| TT0091 | 1.0 | 1.0 | 1.21 | 1.02 | 1.19 | 1.04 | ? | - | - | - | - | - |
| TT0104 | ? | ? | ? | ? | ? | ? | ? | ? | ? | - | - | - |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | | | | |
|-----------|-----------------------------------|----|----|----|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| TT0090 | 10 | 21 | 13 | 14 | 16 | 21 | 52 | 31 | 42 | 31 | 21 | 21 |
| TT0091 | 10 | 21 | 21 | 36 | 36 | 42 | ? | - | - | - | - | - |
| TT0104 | 21 | 21 | 31 | 42 | 42 | 52 | 63 | 52 | 42 | - | - | - |

Subfamily Misellininae A.D.Miklukho-Maklay, 1958

Genus *Metadoliolina* Ishii and Nogami, 1961

Type species : *Pseudodoliolina pseudolepida* (Deprat) subsp.*gravitesta* Kanmera,
1954.

Diagnosis :- Test large, elongate, up to 10.5 mm in length, ellipsoidal to subcylindrical, slightly inflated in the median plane, poles broadly rounded, small globular proloculus followed by sixteen or more slowly enlarging whorls, septa thin, closely spaced, up to about thirty-three per whorl, flat and unfluted, directed slightly forward at the base; wall of earliest whorls with tectum and less dense lower layer, later whorls with tectum, thick diaphanotheca or keriotheca, and thick inner and outer tectoria, numerous small parachomata about half the chamber height but almost reach the top of the chamber adjacent to the septa; foramina small, circular in early whorls, later elliptical, up to about thirty-four in the later whorls.

Metadoliolina nongmuangensis sp. nov.

Plate 7, figs.1-3

Derivation of specific name :- The specific epithet relates to Amphoe Nong Muang, Changwat Lop Buri, which is situated 1.5 km north of the fusulinids locality.

Holotype :- TT0165, TT0178, TT0181, TT0186, TT0188, TT0201, TT0202 of unit W2 of Khao Wong.

Type locality :- Northwest wing of Khao Wong, Amphoe Nong Muang, Changwat Lop Buri, grid reference 769818.

Diagnosis :- Shell large, and thick melon-shaped, up to 9.0 mm in length, with almost straight axis of coiling, gently convex lateral slopes and broadly rounded poles. Mature shell of eleven to fifteen volutions. First volution subspherical to short ellipsoidal, following one or two volutions short ellipsoidal. Proloculus small and subspherical. Shell

expands slowly in inner two or three volutions. Expansion becomes slightly rapid in the following two to three volutions, almost uniform in outer volutions. Spirotheca thin in inner three to five volutions with tectum and less dense in lower layer, no minute structure observable. Spirotheca thick in outer volutions. Septa numerous, thin, flat and unfluted. Parachomata very few in inner two volutions, well developed in outer volutions. Parachomata several forms : triangle; rod; triangle with rounded pole and high as $\frac{2}{3}$ of chamber height; some reach the tops of the chambers.

Description :- Shell is large, and thick melon-shaped, with almost straight axis of coiling, gently convex lateral slopes and broadly rounded poles. Mature shell of eleven to fifteen volutions is 5.3 to 9.0 mm in length and 1.9 to 4.0 mm in width, having form ratio of 1.94 to 2.89. The first volution is subspherical to short ellipsoidal the following one or two volutions are short ellipsoidal. Ratios of half length to radius vector in the first to fourteenth volutions in 8 specimens average 1.18, 1.50, 1.92, 2.02, 2.23, 2.15, 2.19, 2.14, 2.24, 2.33, 2.32, 2.22, 2.20, and 2.13, respectively. Proloculus is small and subspherical with outside diameter 0.35 mm in the largest and 0.14 mm in the smallest. Shell expands slowly in inner two or three volutions. Expansion becomes slightly rapid in the following two to three volutions, and it is almost uniform in outer volutions. Radius vectors of the first to fourteenth volutions in eight specimens average 0.17, 0.22, 0.27, 0.36, 0.44, 0.58, 0.68, 0.78, 0.89, 1.02, 1.15, 1.32, 1.48, and 1.73 mm, respectively. Spirotheca is thin in inner three to five volutions, consisting of a tectum and less dense lower in which no minute structure is observable. In outer volutions, spirotheca are relatively thick. Thickness of spirotheca for the first to fourteenth volutions in eight specimens average 7, 7, 7, 9, 9, 9, 11, 12, 12, 13, 16, 18, 19, and 23 microns, respectively. Septa numerous, thin, flat and unfluted. Parachomata are very few in inner two volutions. In outer volutions, they are well developed in several forms: triangle; rod; triangle with rounded pole, mostly high as $\frac{2}{3}$ of chamber height; some reaching to the tops of the chambers; about 7 parachomata in one millimeter as counted in the tenth volution. Foramina are circular.

Remarks :- *Metadoliolina nongmuangensis* sp.nov. resembles *Neomisellina lepida* (Schwager) described by Sheng (1963) from Kwangsi, China, in size of shell, diameter of proloculus, form ratio, and characteristic of parachomata, but the present form is distinguished by more volutions, thicker wall, and different spirothecal structure : the spirotheca of *Neomisellina lepida* (Schwager) is composed of a tectum, a keriotheca and a lower dense layer; but in the present form, the spirotheca consisting of only a tectum and less dense layer. Spirotheca structure of the present species is also different from *Pseudodoliolina* with the spirotheca consists of only a single dense layer.

Comparing with *Metadoliolina gravitesta* Kanmera, type species of the genus *Metadoliolina*, the parachomata of thesis materials have average higher height than the former, several in parachomata forms, while *Metadoliolina gravitesta* Kanmera has a short triangular parachomata only.

In comparison with *Metadoliolina dutkevitchi* Sosnina, the former has very larger form ratio and shorter parachomata than the present specimens.

Metadoliolina compacta (Chen) from upper part of the Maokou Limestone, South China (after Sheng, 1963 in Ozawa,1970a), has loose coiled, very low triangular parachomata, thicker spirotheca and less volutions than the thesis materials.

Metadoliolina multivoluta (Sheng) from the Upper Permian Futamatao Formation, Kwanto Mountains, Central Japan reported by Ozawa (1970a), is different from the present materials by its loose coiled, ovate shape, very low triangular parachomata, and very thick spirotheca in outer volution.

In Thailand, *Metadoliolina pinguis* Toriyama and Kanmera was discovered by Toriyama and Kanmera (1976) at Khao Phlong Prab, Changwat Saraburi, shows that it is smaller in size, less whorls, and relatively less form ratio than the materials from the study area. Tittirananda (1976) found *Metadoliolina pinguis* at Khao Khad, Saraburi-Lom Sak Highway; besides *Metadoliolina pinguis*, she also reported *Metadoliolina*

forma. A. from that locality but there are not any records of measurement for comparison, however, she noted that her specimens have the characteristics of *Metadoliolina* cf. *gravitesta* Kanmera.

According to above recorded characteristics, the very numerous *Metadoliolina* from Khao Wong, Amphoe Nong Muang, Changwat Lop Buri is designated to be *Metadoliolina nongmuangensis* sp. nov.

Material :- Very abundant in the middle part to the foot of Khao Wong : TT0152, TT0165, TT0178, TT0179, TT0181, TT0182, TT0183, TT0184, TT0186, TT0187, TT0188, TT0190, TT0201, TT0202 and TT0211.

Age :- The genus *Metadoliolina* is assigned as Middle Wordian to Middle Wuchiapingian in age (Ozawa, 1970a).

Measurement of *Metadoliolina nongmuangensis* sp. nov.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0201 | 9.0 | 4.0 | 2.25 | 0.35 | 5 |
| TT0202 | 8.5 | 3.2 | 2.65 | 0.27 | 5 |
| TT0190 | 7.2 | 3.0 | 2.40 | 0.20 | 5 |
| TT0188 | 5.5 | 2.5 | 2.20 | 0.26 | 5 |
| TT0186 | 5.5 | 1.9 | 2.89 | 0.22 | 8 |
| TT0181 | 6.8 | 3.5 | 1.94 | 0.14 | 8 |
| TT0178 | 5.3 | 2.5 | 2.12 | 0.23 | 8 |
| TT0165 | 7.5 | 3.5 | 2.14 | 0.19 | 5 |

| Spec. No. | H.L. (mm) | | | | | | | | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0202 | 0.41 | ? | ? | ? | 1.04 | 1.36 | 1.72 | ? | ? | 2.63 | 2.89 | 3.15 | 3.52 | 4.10 | ? |
| TT0201 | 0.23 | 0.38 | 0.63 | 0.90 | 1.03 | 1.71 | 2.05 | 2.50 | 2.97 | 3.39 | 3.72 | 4.03 | 4.30 | 4.55 | - |
| TT0190 | 0.19 | 0.31 | 0.50 | 0.65 | 0.74 | 0.93 | 1.21 | 1.48 | 1.67 | 1.89 | 2.24 | 2.46 | 2.69 | 2.98 | 3.20 |
| TT0188 | 0.17 | 0.29 | 0.51 | 0.81 | 1.01 | 1.24 | 1.55 | 1.86 | 2.33 | 2.67 | ? | - | - | - | - |
| TT0186 | 0.17 | 0.29 | 0.47 | 0.58 | 1.04 | ? | ? | ? | ? | 1.67 | 1.94 | 2.25 | 2.51 | - | - |
| TT0181 | 0.12 | 0.27 | 0.42 | 0.54 | 0.65 | 0.94 | 1.17 | 1.43 | 1.70 | 2.05 | 2.29 | 2.57 | 2.79 | 3.10 | 3.37 |
| TT0178 | 0.17 | 0.30 | 0.43 | 0.62 | 0.79 | 0.96 | 1.20 | 1.42 | 1.69 | 1.96 | 2.25 | 2.79 | - | - | - |
| TT0165 | 0.20 | 0.33 | 0.53 | 0.75 | 0.99 | 1.25 | 1.44 | 1.64 | 1.84 | 2.15 | 2.44 | 2.78 | 3.10 | 3.40 | 3.63 |

| Spec. No. | R.V. (mm) | | | | | | | | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0202 | 0.25 | 0.30 | 0.35 | 0.42 | 0.49 | 0.57 | 0.67 | 0.73 | 0.85 | 1.01 | 1.18 | 1.34 | 1.58 | 1.70 | 1.90 |
| TT0201 | 0.20 | 0.26 | 0.32 | 0.41 | 0.51 | 0.60 | 0.73 | 0.84 | 0.96 | 1.14 | 1.27 | 1.44 | 1.58 | 1.74 | - |
| TT0190 | 0.17 | 0.23 | 0.29 | 0.46 | 0.54 | 1.05 | 1.14 | 1.22 | 1.33 | 1.44 | 1.59 | 1.74 | 1.90 | 2.08 | 2.26 |
| TT0188 | 0.17 | 0.21 | 0.25 | 0.31 | 0.36 | 0.45 | 0.53 | 0.66 | 0.76 | 0.86 | 0.98 | - | - | - | - |
| TT0186 | 0.12 | 0.17 | 0.22 | 0.27 | 0.33 | 0.40 | 0.47 | 0.53 | 0.60 | 0.68 | 0.76 | 0.90 | 1.00 | - | - |
| TT0181 | 0.16 | 0.18 | 0.22 | 0.29 | 0.39 | 0.46 | 0.60 | 0.74 | 0.86 | 0.99 | 1.10 | 1.27 | 1.41 | 1.57 | 1.73 |
| TT0178 | 0.16 | 0.21 | 0.27 | 0.34 | 0.42 | 0.53 | 0.65 | 0.79 | 0.94 | 1.06 | 1.23 | ? | - | - | - |
| TT0165 | 0.15 | 0.20 | 0.26 | 0.36 | 0.44 | 0.54 | 0.63 | 0.74 | 0.83 | 0.94 | 1.07 | 1.24 | 1.38 | 1.54 | ? |

| Spec. No. | HL/R.V. | | | | | | | | | | | | | | |
|--------------|---------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0202 | 1.64 | ? | ? | ? | 2.12 | 2.39 | 2.57 | ? | ? | 2.60 | 2.45 | 2.35 | 2.32 | 2.41 | ? |
| TT0201 | 1.15 | 1.46 | 1.97 | 2.20 | 2.51 | 2.85 | 2.81 | 2.98 | 3.09 | 2.97 | 2.93 | 2.80 | 2.72 | 2.61 | - |
| TT0190 | 1.12 | 1.35 | 1.72 | 1.41 | 1.37 | 0.89 | 1.06 | 1.21 | 1.26 | 1.31 | 1.41 | 1.41 | 1.42 | 1.43 | 1.42 |
| TT0188 | 1.00 | 1.38 | 2.04 | 2.61 | 2.81 | 2.76 | 2.82 | 2.71 | 3.07 | 3.10 | ? | - | - | - | - |
| TT0186 | 1.42 | 1.71 | 2.14 | 2.15 | 3.15 | ? | ? | ? | ? | 2.46 | 2.55 | 2.50 | 2.51 | - | - |
| TT0181 | 0.75 | 1.50 | 1.91 | 1.86 | 1.74 | 2.04 | 1.95 | 1.93 | 1.98 | 2.07 | 2.08 | 2.02 | 1.98 | 1.97 | 1.95 |
| TT0178 | 1.06 | 1.43 | 1.59 | 1.82 | 1.88 | 1.81 | 1.85 | 1.80 | 1.80 | 1.85 | 1.83 | ? | - | - | - |
| TT0165 | 1.33 | 1.65 | 2.04 | 2.08 | 2.25 | 2.32 | 2.28 | 2.22 | 2.22 | 2.29 | 2.28 | 2.24 | 2.25 | 2.21 | ? |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | | | | | | | |
|--------------|--------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0202 | 5 | 5 | 5 | 10 | 10 | 10 | 10 | 10 | 13 | 13 | 16 | 19 | 19 | 21 | - |
| TT0201 | 5 | 5 | 5 | 10 | 10 | 10 | 10 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 26 |
| TT0190 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 13 | 13 | 13 | 16 | 19 | 21 | 31 |
| TT0188 | 5 | 5 | 5 | 5 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | - | - | - | - |
| TT0186 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 21 | 21 | - | - |
| TT0181 | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 17 | 17 | 17 | 17 | 21 | 21 |
| TT0178 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | - | - | - |
| TT0165 | 5 | 5 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 8 | 10 | 10 | 10 | 10 | 13 |

| Spec. No. | Septal count | | | | | | | | | | | | | | |
|--------------|--------------|---|---|---|---|---|----|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0181 | ? | ? | ? | ? | ? | ? | 24 | 27 | 13 | 30 | 31 | 42 | 54 | ? | - |

Subfamily Pseudodoliolinae Leven, 1963

Genus *Pseudodoliolina* Yabe and Hanzawa, 1932

Type species : *Pseudodoliolina ozawai* Yabe and Hanzawa, 1932

Diagnosis :-Test of medium size, up to 8 mm in length, elongate ovate, subcylindrical to slightly fusiform, with bluntly to broadly rounded poles, large proloculus followed by up to about twenty planispiral whorls, chambers numerous, septa plane, unfluted, perpendicular to the outer wall; wall thin, undifferentiated in early whorls, later with tectum, light median layer corresponding to the keriotheca and thin inner layer; narrow and high parachomata present throughout growth and may reach the top of the chambers adjacent to the septa, appearing as septula in axial section; numerous foramina developed throughout growth about fifty in outer whorls.

Pseudodoliolina pseudolepida (Deprat) Thompson and Foster, 1937

Plate 7, figs. 4-5

1912 *Doliolina pseudolepida* Deprat, p.46, pl.5, figs.6-9; pl.6, fig.4.

1913 *Doliolina lepida* mut. *pseudolepida* Deprat, p.50.

- 1937 *Pseudodoliolina pseudolepida* Thompson and Foster, pp.141-142, pl.25, figs.2-4.
- 1963 *Pseudodoliolina pseudolepida* Sheng, pp.229-230, pl.29, figs.1-9.
- 1973 *Pseudodoliolina pseudolepida* Toriyama and Pitakpaivan, p.53, pl.6, figs.6-13.
- 1977 *Pseudodoliolina pseudolepida* Toriyama and Kanmera, pp. 12-14, pl.1, figs.13-18; pl.2, figs.1-6.
- 1979 *Pseudodoliolina pseudolepida* Toriyama and Kanmera, pp.54-56, pl.8, figs.7-13.

Description :- Shell is ellipsoidal with broadly rounded poles. A mature specimen of probably 13 volutions is 4.1 mm in length and 1.9 mm width, with a form ratio of 2.16. Proloculus is minute and spherical to subspherical. Outside diameter is 0.10 mm. The inner three to five volutions coil tightly, then the shell expands slowly. The average radius vectors of the first to twelfth volutions in three specimens are 0.06, 0.10, 0.15, 0.21, 0.27, 0.34, 0.43, 0.51, 0.70, 0.80, 0.82, and 0.97, respectively. Spirotheca consists essentially of a very thin, dense tectum. The average thickness of spirotheca of the first to twelfth volutions in three specimens are 7, 7, 8, 8, 12, 8, 8, 9, 10, 10, 10 and 16, respectively. Septa are thin and numerous, having the same structure as that of the spirotheca. Parachomata are well developed throughout the length of shell. They are triangular with rounded at the top, being one-half to two-thirds as high as the chambers; about 6-7 parachomata in one millimeter as counted in the tenth volution.

Remarks :- This species of the genus *Pseudodoliolina* is a common species in the upper middle Permian of Tethys province including Thailand. The present specimens are not enough well-oriented sections to make a good comparison with *Pseudodoliolina pseudolepida* known from other localities. However, only the best specimen from the study area (TT0098) could be compare with the specimens in Limestone Conglomerate C formation of Khao Phlong Phrab, Changwat Saraburi, described by Toriyama and Kanmera (1977), though the present material is smaller than Khao Phlong Phrab specimens but well agree in shape of shell, spirothecal thickness, form ratio, and the

parachomata which resemble to one group with low and triangle with semi-circular in axial profile. In comparison with *Pseudodoliolina pseudolepida* described by Sheng (1963) from Kwangsi, China, the present material has less volutions, and relatively smaller in size than the one from Kwangsi, parachomata is also different in shape and spaced with about 9-10 in one millimeter in most volutions.

Material :- Khao Chakkachan : unit C₂ in TT0073; unit C₁ abundant in TT0216, TT0218, TT0219, TT0220, and TT0221. Khao Wat Kirinakratnaram :unit C₁ abundant in TT0090, TT0091, TT0092, TT0093, TT0096, TT0098, TT0101, TT0104, TT0105, and TT0112.

Age :- Middle Wordian to Middle Capitanian (Ozawa, 1970a)

Measurement of *Pseudodoliolina pseudolepida* (Deprat) Thompson and Foster, 1937.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0091 | 4.1 | 1.8 | 2.27 | 0.08 | 5 |
| TT0098 | 4.1 | 1.9 | 2.16 | 0.10 | 5 |
| TT0104 | 2.3 | 1.5 | 1.53 | ? | ? |

| Spec. No. | H.L. (mm) | | | | | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| TT0091 | 0.16 | 0.22 | 0.31 | 0.41 | 0.52 | 0.60 | 0.71 | 0.94 | 1.20 | 1.36 | 1.69 | 2.03 | - |
| TT0098 | 0.12 | 0.22 | 0.38 | 0.56 | 0.76 | 0.86 | 0.97 | 1.18 | 1.40 | 1.64 | 1.78 | 1.96 | 2.07 |
| TT0104 | ? | 0.24 | 0.33 | 0.44 | 0.53 | 0.65 | 0.85 | 0.95 | 1.14 | ? | - | - | - |

| Spec. No. | R.V. (mm) | | | | | | | | | | | | |
|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| TT0091 | 0.05 | 0.07 | 0.10 | 0.15 | 0.18 | 0.23 | 0.31 | 0.41 | 0.51 | 0.61 | 0.73 | 0.88 | - |
| TT0098 | 0.08 | 0.12 | 0.17 | 0.24 | 0.30 | 0.37 | 0.46 | 0.63 | 0.69 | 0.80 | 0.90 | 1.06 | ? |
| TT0104 | 0.05 | 0.11 | 0.18 | 0.24 | 0.33 | 0.42 | 0.52 | 0.60 | 0.71 | ? | - | - | - |

| Spec. No. | H.L./R.V. | | | | | | | | | | | | |
|--------------|-----------|------|------|------|------|------|------|------|------|------|------|------|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| TT0091 | 3.20 | 3.14 | 3.10 | 2.73 | 2.89 | 2.61 | 2.29 | 2.29 | 2.35 | 2.23 | 2.32 | 2.31 | - |
| TT0098 | 1.50 | 1.83 | 2.24 | 2.33 | 2.53 | 2.32 | 2.11 | 1.87 | 2.03 | 2.05 | 1.98 | 1.85 | ? |
| TT0104 | ? | 2.18 | 1.83 | 1.83 | 1.61 | 1.55 | 1.63 | 1.58 | 1.61 | ? | - | - | - |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | | | | | |
|--------------|--------------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| TT0091 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 21 | |
| TT0098 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 8 | 10 | 10 | 10 | 10 | ? |
| TT0104 | ? | ? | 10 | 10 | 21 | 10 | 10 | 10 | 10 | ? | - | - | - |

| Spec. No. | Septal count | | | | | | | | | | | | |
|--------------|--------------|---|---|---|---|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| TT0098 | ? | ? | ? | ? | ? | 12 | 17 | 17 | 21 | 25 | 31 | ? | - |

Family Neoschwagerinidae Dunbar and Condra, 1927

Subfamily Neoschwagerininae Dunbar and Condra, 1927

Genus *Colania* Lee, 1934

Type species : *Colania kwangsiana* Lee, 1934

Diagnosis :- Test of medium to large size, fusiform, dimorphism distinct, megalospheric test small with large proloculus, microspheric test with tiny proloculus, numerous whorls, and very large test, septa thin and widely spaced, axial septula well developed, thin, short, and of irregular length, slender primary transverse septula connect to the tops of the parachomata, secondary transverse septula rare and only in outer volutions; wall thin, of tectum and keriotheca, parachomata narrow and high; numerous foramina at the base of the septa.

Colania douvillei (Y.Ozawa) T.Ozawa, 1970

Plate 8, figs. 1-4

- 1913 *Neoschwagerina globosa* Deprat [non Yabe, 1906], *ibid.*, p.55.
- 1914 *Neoschwagerina globosa* Deprat [non Yabe, 1906], *ibid.*, pp.29-30.
- 1922 *Neoschwagerina douvillei* Y.Ozawa, pp.368-372, pl.4.
- 1970a *Colania douvillei* T.Ozawa, pp.50-51, pl.7, figs.8-10.
- 1970b *Colania douvillei* T.Ozawa, pp.35-39, pl.3, figs.1-10; pl.4, figs.1-10; pl.5, figs.1-5; pl.6, figs.1-9.
- 1976 *Colania douvillei* Toriyama, pp.103-104, pl.20, figs.22-26.
- 1977 *Colania douvillei* Toriyama and Kanmera, pp.17-24, pl.2, figs.7-17; pl.3, figs.1-16.

Description : Shell is moderate in size, and inflated fusiform in shape. The mature shell has 13 to 15 volutions. The form ratio of 1.38 to 1.83, averaging 1.52 in the thirteenth volution. Proloculus is nearly spherical. The proloculus wall is thin, having a thickness of 5 to 8 microns. The outside diameter of the proloculus varies from 0.17 to 0.20 mm. Shell changes from a subspherical form in inner volutions to an inflated fusiform in outer volutions. The average radius vectors of the first to thirteenth volutions in three specimens are 0.14, 0.21, 0.31, 0.42, 0.53, 0.66, 0.80, 0.95, 1.00, 1.18, 1.40, 1.55, and 1.76 mm, respectively. Spirotheca is thin, composed of a tectum and a keriotheca of fine alveoli. Average thickness of the spirotheca of the first to eight volutions in three specimens are 9, 12, 12, 12, 12, 17, 16, and 21 microns, respectively. Septa are slender and widely spaced. Their lower portion thickened owing to secondary deposit relating to parachomata. Axial septula are not developed in inner volutions. They first appear in the third volution, but very rare, and very primitive in development. In outer volutions one to three, rarely four, axial septula of unequal length occur between to adjacent septa. Primary transverse septula are slender, connect with thin parachomata. Small and short triangular secondary transverse septula occur in the eleventh and more outer volutions.

Remarks :- Ozawa (1970b) studied the materials collected by Toriyama and Kanmera from Khao Imot, near Khao Phong Prab, Changwat Saraburi, very much in detail from biostatistic point of view, and made clear that *Colania douvillei* (Ozawa) is dimorphic, having megalospheric form and microspheric form in the life cycle : megalospheric form shows moderate size, larger proloculus, less volutions(11 or 12, at most 17 volutions), while microspheric form shows very large size, very minute proloculus, and more volutions (20 to 24 volutions). The specimens from Khao Wong, Amphoe Nong Muang, Changwat Lop Buri, well agree to the megalospheric forms from Khao Imot in all important specific features, except its rather smaller in size of proloculus than the former. In comparison with Khao Phlong Prab specimens measured by Toriyama (1976), the present specimens are smaller in size of proloculus than the former too. Comparing with Khao Khao specimens described by Toriyama and Kanmera (1977), the latter are very close similar in several characteristics to the former, except the proloculus diameter is smaller.

Material :- Abundant at the foot of Khao Wong Section G : TT0204, TT0205, TT0207, TT0208, TT0209, and TT0210.

Age :- Lower to Middle Capitanian (Ozawa, 1970a).

Measurement of *Colania douvillei* (Y.Ozawa) T.Ozawa, 1970.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|-----------|-----------|------------|-----------------------------------|---|
| TT0210 | 5.5 | 4.0 | 1.38 | 0.17 | 8 |
| TT0209 | 3.0 | 2.0 | 1.50 | 0.20 | 8 |
| TT0208 | 5.5 | 3.0 | 1.83 | 0.18 | 5 |

| Spec. No. | H.L. (mm) | | | | | | | | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0210 | 0.17 | 0.29 | 0.41 | 0.52 | 0.66 | 0.81 | 1.00 | 1.19 | 1.44 | 1.67 | 1.92 | 2.15 | 2.43 | 2.76 | 2.99 |
| TT0209 | 0.17 | 0.29 | 0.41 | 0.54 | 0.71 | 0.91 | 1.17 | 1.41 | - | - | - | - | - | - | - |
| TT0208 | ? | ? | ? | 0.51 | 0.65 | 0.81 | 1.24 | 1.59 | 1.84 | 2.06 | 2.36 | 2.60 | 2.92 | - | - |

| Spec. No. | R.V. (mm) | | | | | | | | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0210 | 0.12 | 0.19 | 0.26 | 0.36 | 0.46 | 0.59 | 0.72 | 0.86 | 1.03 | 1.19 | 1.41 | 1.56 | 1.81 | 2.01 | 2.19 |
| TT0209 | 0.20 | 0.28 | 0.39 | 0.49 | 0.62 | 0.78 | 0.97 | 1.16 | - | - | - | - | - | - | - |
| TT0208 | 0.09 | 0.17 | 0.28 | 0.40 | 0.51 | 0.62 | 0.71 | 0.82 | 0.97 | 1.17 | 1.40 | 1.55 | 1.72 | - | - |

| Spec. No. | HL/R.V. | | | | | | | | | | | | | | |
|--------------|---------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0210 | 1.42 | 1.53 | 1.58 | 1.44 | 1.43 | 1.37 | 1.39 | 1.38 | 1.40 | 1.40 | 1.36 | 1.38 | 1.34 | 1.37 | 1.36 |
| TT0209 | 0.85 | 1.04 | 1.05 | 1.10 | 1.14 | 1.17 | 1.21 | 1.22 | - | - | - | - | - | - | - |
| TT0208 | ? | ? | ? | 1.28 | 1.27 | 1.31 | 1.75 | 1.94 | 1.90 | 1.76 | 1.69 | 1.68 | 1.70 | - | - |

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | | | | | | | |
|--------------|--------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| TT0210 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 21 | 19 | 31 | 21 | 19 | 21 | 21 | 21 |
| TT0209 | 10 | 16 | 16 | 16 | 19 | 21 | 21 | 21 | - | - | - | - | - | - | - |
| TT0208 | ? | ? | ? | ? | 10 | 19 | 16 | 21 | 31 | 21 | 21 | 26 | 31 | - | - |

Subfamily Sumatrininae Silvestri, 1933

Genus *Sumatrina* Volz, 1904

Type species : *Sumatrina annae* Volz, 1904

Diagnosis:- Test of medium size, elongate fusiform to subcylindrical, large proloculus and few loosely coiled whorls, septa long, thin, and widely spaced, thin and short primary transverse septula, two to four thin secondary transverse septula between adjacent primary transverse septula, their lower part thickened and clavate, may have up to seven axial septula between adjacent septa; wall very thin, of tectum and extremely thin keriotheca, parachomata massive and high, attaching to the lower ends

of the primary transverse septula, axial fillings present in all but part of the last whorl; numerous foramina occur throughout the length of the test.

Sumatrina annae Volz, 1904

Plate 9, figs. 1-3

- 1904 *Sumatrina annae* Volz, pp.98-100, text-figs.27-31.
 1912 *Neoschwagerina (Sumatrina) annae* Deprat, pp.56-57, pl.5, figs.1-3, text-figs.30a-h.
 1963 *Sumatrina annae* Sheng, pp.245-246, pl.36, figs.1-11.
 1973 *Sumatrina annae* Toriyama and Pitakpaivan, pp.57-60, pl.6, figs.14-25.
 1977 *Sumatrina annae* Toriyama and Kanmera, pp.14-17, pl.3, figs.18-28.

Description :- Shell is moderate in size, and inflated fusiform in shape, with an almost straight axis of coiling, gently convex to slightly irregular lateral slopes and bluntly pointed poles, few loosely coiled whorls. The mature shell of seven to nine volutions is 4.2 to 5.5 mm long and 2.0 to 3.2 mm wide, giving a form ratio of 2.10 to 2.75. The first volution is nearly spherical to subspherical shape, and the axis becomes extended rapidly from the second volution. The average ratio of half-length to radius vector of the first to eighth volutions in two specimens are 1.34, 1.67, 1.91, 2.16, 2.24, 2.18, 2.16, and 2.15, respectively. Proloculus is spherical to ellipsoidal and quite large for size of shell. Proloculus wall is thin, having a thickness of 5 to 10 microns. Outside diameter of the proloculus varies from 0.24 to 0.54 mm. The expansion of the shell is slow and uniform in the inner four to five volutions, and become more or less rapid in outer volutions. Average radius vectors of the first to eighth volutions in four specimens are 0.28, 0.35, 0.46, 0.56, 0.69, 0.83, 0.98, and 1.07 mm, respectively. Spirotheca is very thin, consisting of a single dense layer. The average thickness of the spirotheca of the first to eight volutions in four specimens is 7, 7, 8, 9, 9, 10, 10 and 10 microns, respectively. Septa are typically pendant-shaped in sagittal section, and their lower part is mostly solidified and bent anteriorly. Average septal count of fifth to eighth volutions in one specimen are 18, 22, 27, and 37, respectively. Axial septula are well developed

between adjacent septa. They are nearly the same in length, and are pendant-shaped in cross section. Axial septula begin to appear at the end of the first volution or the earlier part of the second volution where they are very rudimentary, being only a swelling of the lower part of spirotheca. Axial septula, 1 or 2, occur in the second and third volution, and 3 to 5 in the fourth volution outward. Primary transverse septula occur throughout the length of shell, the lower edges of which are in contact with the tops of parachomata across the chambers. The secondary transverse septula do not occur in the first volution, and appear in the second volution. From the third to the outermost volution 1 or 2 secondary transverse septula occur between each pair of adjacent primary transverse septula. Parachomata low, irregularly present in each chamber, about 1/3 as high as the chambers. Foramina are circular. No axial fillings are present in most of the specimens.

Remarks :- *Sumatrina annae* Volz is one of the best known species in the Middle Permian of Tethys including Thailand. In comparison with the specimens from Tou-La-Houe', Yun Nan, described by Deprat (1912), the latter has the same manner as the former, except more whorls. The present specimens is very closely similar in many features to the specimens from Kwangsi and Kucichow province, China, described by Sheng (1963), except the latter has larger proloculus. In Thailand, Pitakpaivan (1966) described *Sumatrina annae stricta* (Deprat) from Maoteetang hill, near Phra Phuttabath, Changwat Saraburi, though his specimens are silicified and very badly preserved. Comparing them with the specimens from Limestone Conglomerate formation in Khao Phlong Prab area, Changwat Saraburi, described by Toriyama and Kanmera (1977), the latter has relatively inflated fusiform, less whorls and larger proloculus, these difference are considered to be variations within a species.

Material :- Khao Chakkachan : unit C₁, abundant in TT0074, TT0216, TT0218, TT0219, TT0220, and TT0221. Khao Wat Kirinakratnaram :unit C₁, abundant in TT0091, TT0092, TT0093, TT0096, TT0098, TT0101, TT0104 and TT0105.

Age :- Wordian to Upper Capitanian. (Ozawa, 1970a).

| Spec. No. | Thickness of spirotheca (microns) | | | | | | | | |
|--------------|--------------------------------------|----|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0092 | 5 | 5 | 8 | 10 | 10 | 16 | 10 | 10 | - |
| TT0098 | 5 | 5 | 5 | 5 | 5 | 5 | 10 | 10 | 10 |
| TT0104 | 8 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | - |
| TT0114 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | - | - |

| Spec. No. | Septal Count | | | | | | | | |
|--------------|--------------|---|---|---|----|----|----|----|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| TT0104 | ? | ? | ? | ? | 18 | 22 | 27 | 37 | - |

Sumatrina cf. longissima Deprat, 1914

Plate 9, figs. 4-8

1914 *Sumatrina longissima* Deprat, p.36, pl.5, figs.1-6.

1963 *Sumatrina longissima* Sheng, pp.246-247, pl.36, figs.18-19.

Description :- Shell medium, elongately, cylindrical, median part slightly vaulted, pole bluntly pointed. Mature shell having 7-8 volutions about 2.5 to 6.5 mm long and 0.9 to 1.8 mm wide, with form ratio ranging from 2.67 to 3.61. Average form ratios in the first to seventh volutions in four specimens are 1.41, 1.81, 2.20, 2.39, 2.49, 2.82, and 2.76, respectively. Proloculus spherical to subspherical, outside diameters are about 0.26 to 0.38 mm. Proloculus wall is thin, having thickness of 8 to 10 microns. Spirotheca are thin, composed of a single compact layer, measuring average 8, 8, 8, 9, 9, 10, and 10 microns in the first to seventh volutions in four specimens. Septa are thick and plane. Primary transverse septula pendant-shaped, usually connected with the tops of parachomata. Secondary transverse septula are short, slightly thickened at their lower margins, usually 2 secondary transverse septula intercalated between the adjacent primary transverse septula in the inner volutions, but 2 or 3 occur in the four outer volutions. Axial septula short, slightly thickened at their lower margin, first appear at second or third volution, 3 to 4 axial septula between adjacent septa in outer volutions.

Parachomata low, about 1/3 as high as the respective chambers. Foramina are circular and ellipse.

Remarks :- This form can be distinguished from *Sumatrina annae* Volz by its longer shell, and larger form ratio. It differs from *Sumatrina fusiformis* Sheng in its larger proloculus and no irregular axis of coiling. In comparison with *Sumatrina longissima* Deprat from Kwangsi, China, described by Sheng (1963), besides similarity in several features, the latter is shorter in length than those. Thus, the present materials are assigned as *Sumatrina cf. longissima*.

Material :- Common at foot of Khao Wong Section along with *Colania douvillei* : TT0204, TT0205, TT0207, TT0208, TT0209, and TT0210.

Age :- Capitanian (Ozawa, 1970a).

Measurement of *Sumatrina cf. longissima* Deprat, 1914.

| Spec. No. | L (mm) | W (mm) | Form ratio | Diameter of Proloculus (mm) | Thickness of Proloculus wall (microns) |
|-----------|--------|--------|------------|-----------------------------|--|
| TT0210 | 6.5 | 1.8 | 3.61 | 0.26 | 8 |
| TT0209 | 5.0 | 1.7 | 2.94 | 0.38 | 10 |
| TT0207 | 2.5 | 0.9 | 2.78 | 0.38 | 10 |
| TT0205 | 4.0 | 1.5 | 2.67 | 0.35 | 10 |

| Spec. No. | H.L. (mm) | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0210 | 0.31 | 0.60 | 0.88 | 1.18 | 1.44 | 1.88 | 2.20 | 2.74 |
| TT0209 | ? | ? | ? | 1.67 | 1.93 | 2.24 | 2.50 | |
| TT0207 | 0.35 | 0.52 | 0.74 | 0.89 | 1.22 | | | |
| TT0205 | 0.24 | 0.40 | 0.69 | 0.91 | 1.43 | ? | ? | ? |

| Spec. No. | R.V. (mm) | | | | | | | |
|--------------|--------------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0210 | 0.19 | 0.26 | 0.31 | 0.43 | 0.54 | 0.68 | 0.78 | 0.95 |
| TT0209 | 0.24 | 0.30 | 0.39 | 0.52 | 0.65 | 0.78 | 0.93 | |
| TT0207 | 0.23 | 0.30 | 0.38 | 0.52 | 0.64 | | | |
| TT0205 | 0.21 | 0.29 | 0.38 | 0.48 | 0.59 | 0.75 | 0.90 | |

| Spec. No. | H.L./R.V. | | | | | | | |
|--------------|-----------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0210 | 1.63 | 2.31 | 2.84 | 2.74 | 2.67 | 2.76 | 2.82 | 2.88 |
| TT0209 | ? | ? | ? | 3.21 | 2.97 | 2.87 | 2.69 | |
| TT0207 | 1.52 | 1.73 | 1.95 | 1.71 | 1.91 | | | |
| TT0205 | 1.14 | 1.38 | 1.82 | 1.90 | 2.42 | ? | ? | |

| Spec. No. | Thickness of Spirotheca (microns) | | | | | | | |
|--------------|--------------------------------------|----|----|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0210 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 10 |
| TT0209 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | |
| TT0207 | 10 | 10 | 10 | 10 | 10 | | | |
| TT0205 | 5 | 5 | 5 | 8 | 10 | 10 | 10 | |

| Spec. No. | Septal Count | | | | | | | |
|--------------|--------------|----|----|----|----|----|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| TT0205 | ? | 14 | 16 | 17 | 17 | 27 | ? | ? |



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย