CHAPTER III

SYSTEMATIC PALEONTOLOGY

3.1 Introduction to fusulinoidea

Fusulinoideas are the single-cell invertebrate fossil. They belong to Phylum Protozoa, Class Sarcodina, Order Foraminifera, and Superfamily Fusulinoidea. Fusulinoidea had their beginning in lastest Mississippian time, but the last members seemingly did not survive to the end of Permian time. During this relatively short time interval, they developed into many biologic brances, rapid evolution and widely spread in many parts of paleo-marine of the world. They are the excellent index fossil during Upper Paleozoic. They are larger foraminifers which characterized by distinctive complex internal structure of their spindle-shaped, spheroidal or discoid calcareous test (Figure 3.1). The fusulinoideas were sensitive to their physical environment and mostly are closely restricted to certain lithology units such as generally found in limestone, but absent or very rare in dark colored shale and very coarse-grained or finely laminated sandstone.

Ecology

Although the knowledge of paleoecology of fusulinoidea is still incomplete, but many researchers agree that this larger foraminifera were probably benthic, except their juvenile stage, which presumably had an epiplanktonic or planktonic mode of life as in many recent benthic foraminifers. They were 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).

Morphology of fusulinoideas

General description of shell

The individual shells of fusulinoideas are remarkably similar in almost all respects. Externally, the shells of many species closely resemble each other. Internally,

structures may be markedly different in different forms. The shells of primitive species are relative simple, but those of some more advances forms are among the most complex of all foraminifers. Some of the structure features of fusulinoidean shells can be interpreted from external observations, but many are completely internal. The classification of fusulinoideas is based largely on internal shell structure that generally can be determined only from thin or polish sections. Two sections cut through the beginning chamber reveal most internal stucture of the shell. One of these is cut along the axis of coiling and is called an **axial section**. The other cut at right angles to the axis of coiling is called a **sagittal section**. The terminology applied to sections cut through area other than these two depends on directions of their orientation and position. A section cut normal to the axis of coiling but not through the beginning chamber is termed as **tangential section**. Sections cut in directions not parallel to the axis of coiling or normal to it are referred to as **oblique section** (Figure 3.2).

An external view of the fusulinoidean shells shows a relatively smooth surface broken by shallow , closely space called an **external furrow** was left on the outside leaving a trace of the previous antetheca. Along the side of the specimens may be seen a prominent line called an **antetheca** (Figure 3.3). This was the growing surface, and as the animal grew, adding **chambers** along the long axis, the antetheca extended forward. Starting as a small spherical shell, the animal added material, elongating the shell, and developing longer and longer chambers, one at a time (Figure 3.4) (Thompson, 1964).

Proloculus

All the fusulinoideas are multi-chambered, and the chambers can be divided into the first chambers, the proloculus, and the chambers of the coiled part of the shell (Figure 3.4). In most fusulinoideas the proloculus is spherical to subspherical in shape and the prolocuti of conspecific specimens generally are closely similar in size. Although the proloculus of most forms is spherical, or nearly so, in some it is irregularly subspherical or even irregularly rectangular in shape. Almost all forms possessing irregular prolocuti are large, are highly developed biologically within their respective subfamilies, and have large prolocuti.

Chamber

The proloculus aperture opens into the first chamber of the coils part of the shell. The first coiled chamber is smaller in cross section than the proloculus (Figure 3.5), but in most samples it is distinctly elongate in the direction of the axis of coiling of the outer volutions. The chambers are widest in the center of the shell and are reduced to near-zero width at the poles. Starting with the first few chambers of the first volution, the chambers gradually increase in height. This increase is almost uniform throughout most of the shell in many fusulinoideas, but chambers of the last one or two volutions of geronic individuals in many forms are lower than those of the immediately preceding volutions.

Antetheca and septa

The septa, plural, are partitions between chambers of fusulinoideas. The anterior wall of the last chamber, the **antetheca**, become the **septum** between the last two chambers when as additional chamber is developed. The antetheca of the shell contains numerous small opening called **septa pores**. The septa of members of subfamily Fusulininae are corrugated or fluted to some extent. The fluting in primitive forms is confined to broad undulations in the extreme polar region and to the basal part of the septa. In more highly developed forms, the plication of septal wall progressively moves from the poles toward the center of the shell and progressive moves up toward the tops of the septa. The salient of the fold in the antetheca corresponds in position to the re-entrant in the fold of the preceding septum. Chamberlets develop with closely spaced septa or sufficiently strong **septal fluting**, adjacent septa are brought into contact at base of the chambers that open upward (Figure 3.6). Resorption of the septa where opposing folds touch and form passageways between chambers are called **cuniculi** (Figures 3.7 and 3.8).

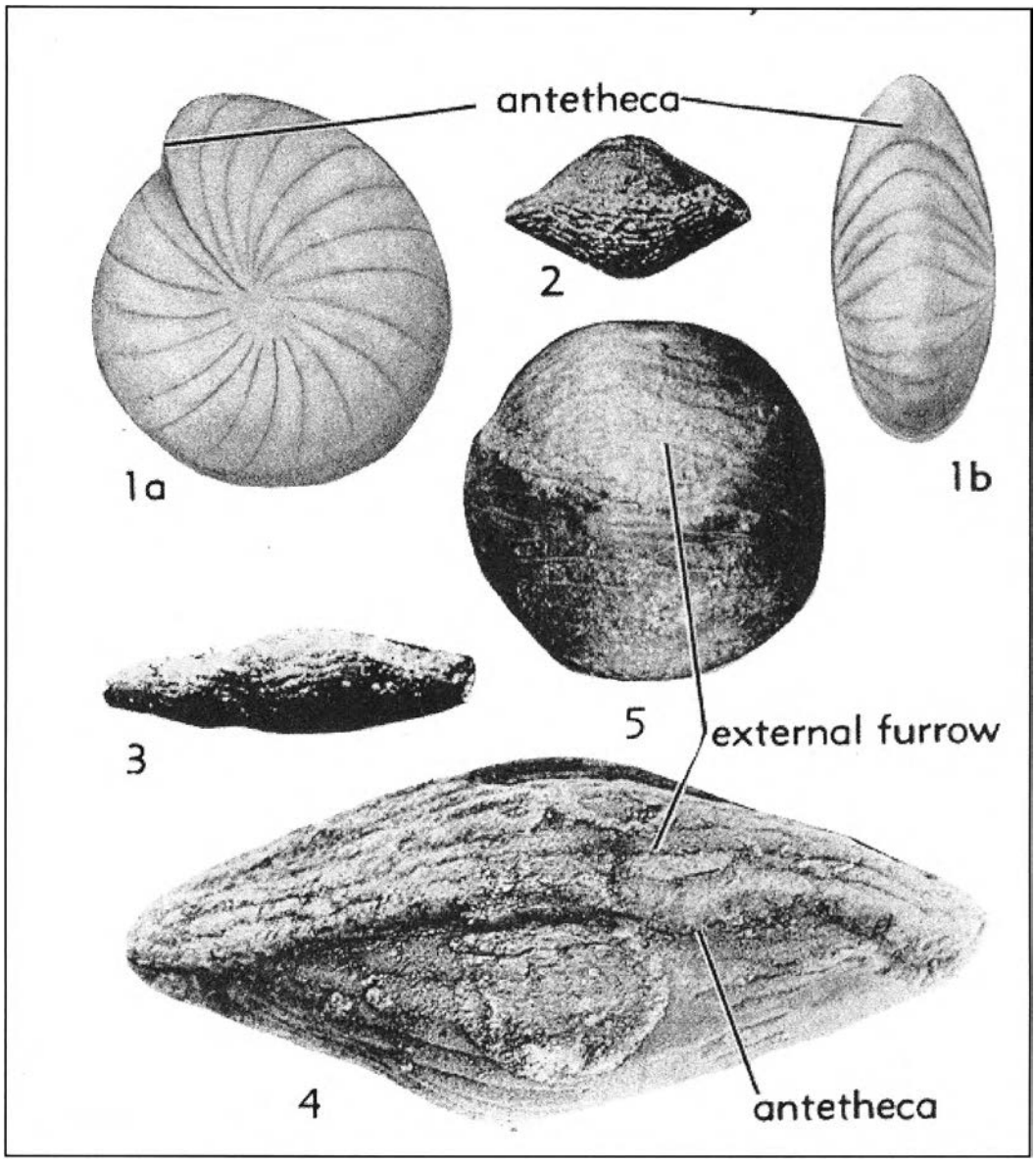

Figure 3.1 External structure of fusulinoidea showing typical shapes of shells:

1. Discoid 2-4. Fusiform 5. Spheroidal.

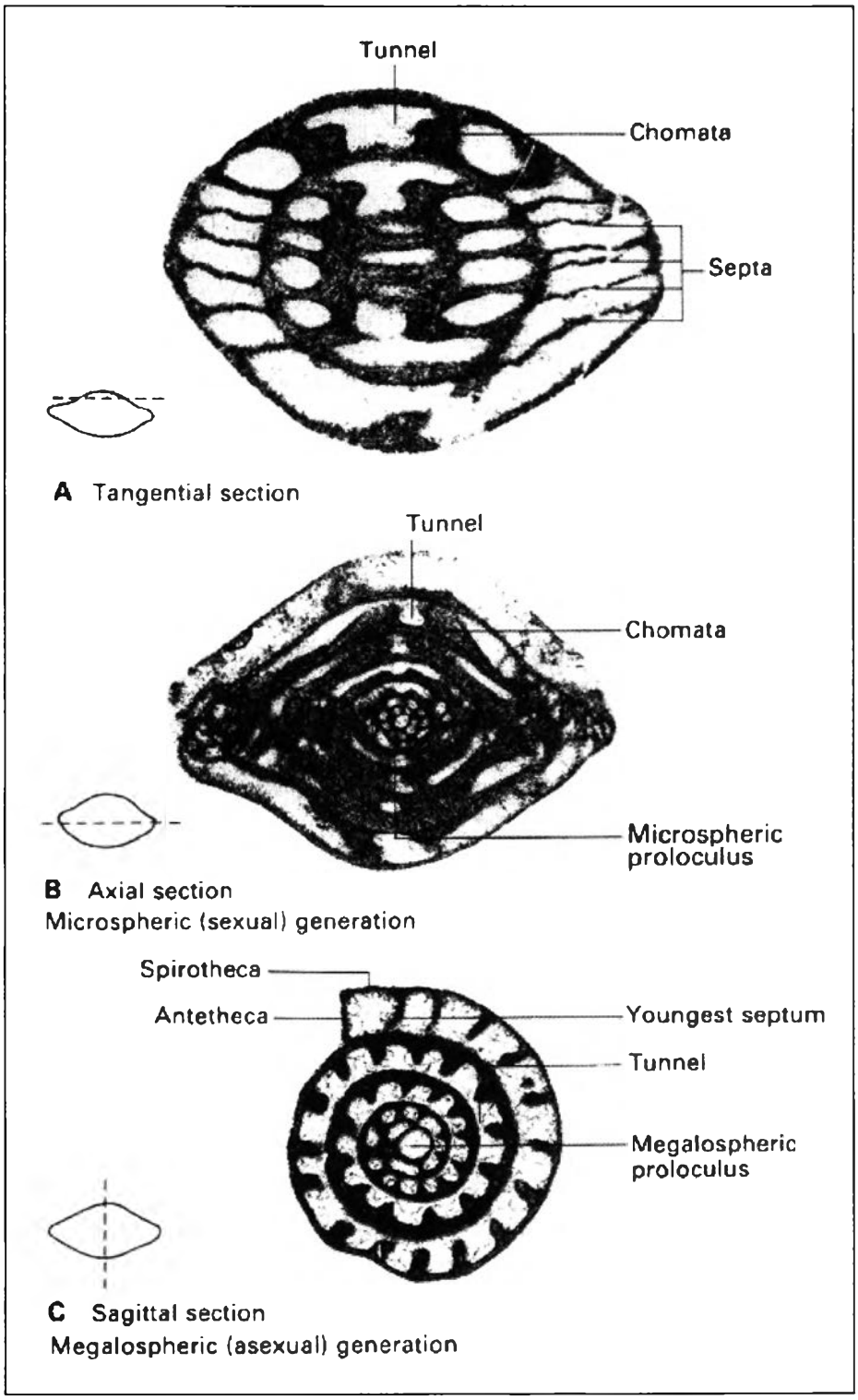

Figure 3.2 Type of fusulinoidea sections: Microspheric and megalospheric generations of *Fusulinella* sp. (Boardman and others, 1987).

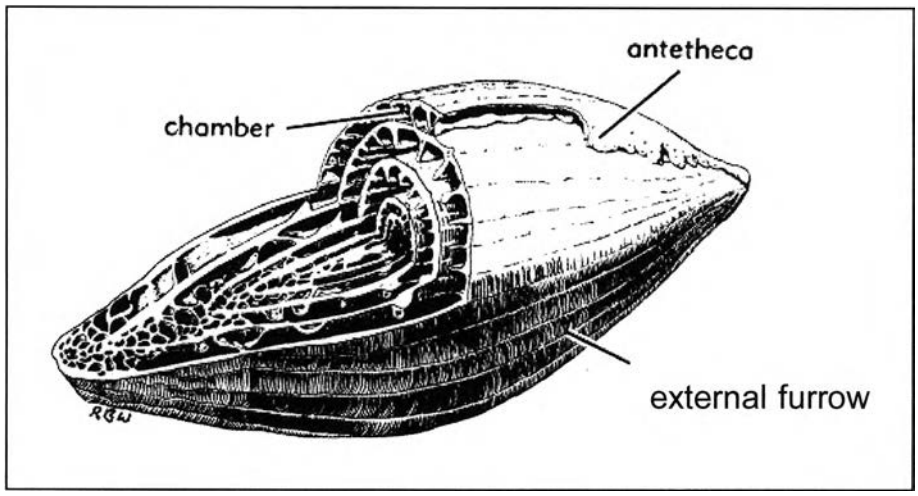

Figure 3.3 Drawing of fusulinoidea showing antetheca, external furrow and chamber.

(Available from: http://www.kgs.ku.edu/Publications/ancient/f06_fusulin.html)

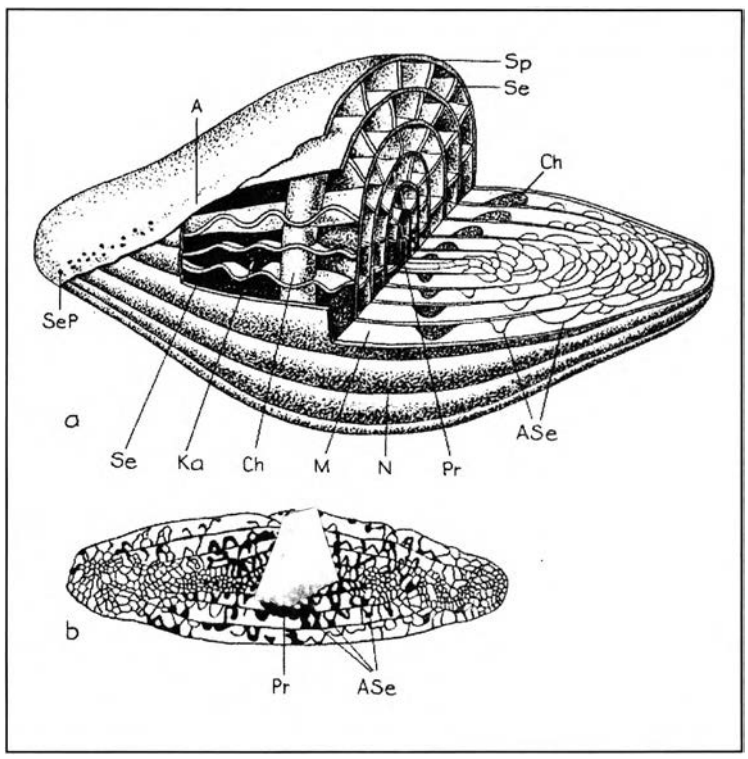

Figure 3.4 Diagram of fusulinoidea test showing structure features: A - antheteca, Ch – chomata, M - tunnel, N - external furrow, Pr - proloculus, Se - septa, SeP- septa pore.

(Available from: http://mac01.eps.pitt.edu/geoweb/courses/GEO1200/lab2/fusulinid.htm)

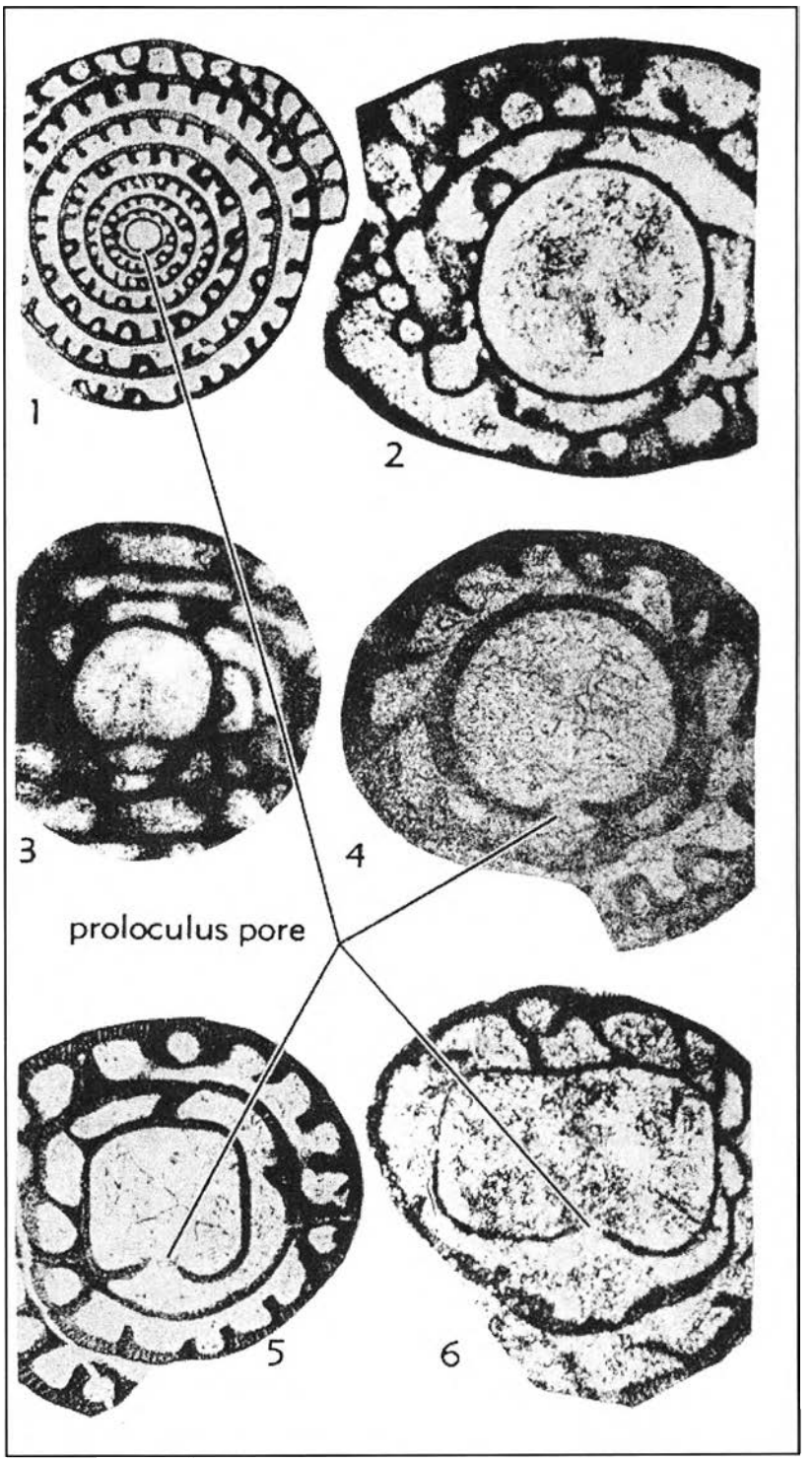

Figure 3.5 Initial chamber (proloculi) of fusulinoidean shells illustrated by species of *Parafusulina*, Permian (Thompson, 1964).

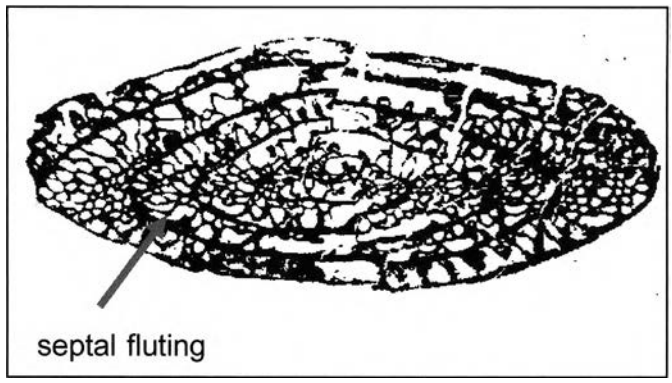

Figure 3.6 Septal fluting of fusulinoideas.

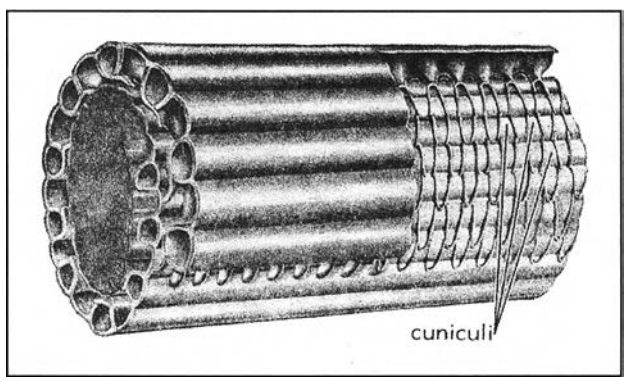

Figure 3.7 Diagram illustrating inferred development of cuniculi in *Parafusulina* and *Polydiexodina* (Thompson, 1964).

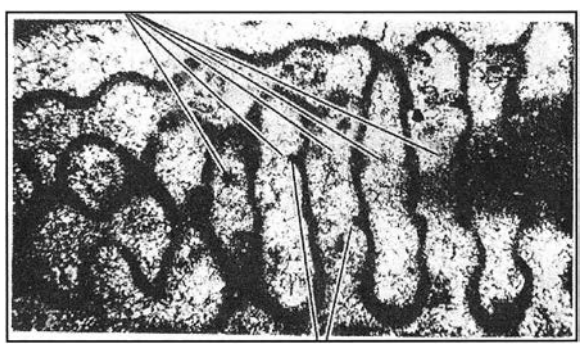

Figure 3.8 Rudiments of salient of septa left after excavation of cuniculi in the test of *Parafusulina nosonensis* **Thompson & Wheeler**, Lower Permian, shown in part of tangential section of paratype, X30 (Thompson, 1964).

Spirotheca

The wall of the chamber is referred to **spirotheca**. It is composed of microgranular calcium carbonate, some with two or more wall layers. The structure of the spirotheca, which furnishes one of the most reliable criteria for differentiation and classification of many fusulinoideas, is highly complicated, and its evolution has been determined within many branches of the group (Figure 3.9 and 3.10). The spirotheca of most primitive form is composed of a central thin dense layer, the **tectum**, and adjoining less dense but thicker structureless layers, the **upper tectorium** above and the **lower tectorium** below resulting in three-layered spirotheca. In most advanced forms, the tectum is supplemented by various other layers. **Diaphanotheca**, a transparent layer, is developed below the tectum resulting in four-layered spirotheca. The thick layer of honeycomb-like structure or **keriotheca** is supplemented below tectum. Thin sections of the spirotheca show numerous dark lines normal to its surfaces, and these are separated by larger transparent areas, **alveoli**, are columnar in cross section and are surrounded by the darker thin areas. Thin, dense, diaphragm-like partitions that extend across the chambers at various angles and in various parts of the chambers are termed **phrenothecae** (Figure 3.11) (Moore, 1964).

Septula

The lower surface of the spirotheca of member of the Subfamily Neoschwagerininae contains ridges called **septula** that hang down into the chambers. In primitive members, the septula are transverse to the axis of coiling called **transverse septula**. Highly developed members have two sets of septula, one of which is transverse septula and the other parallel to the axis of coiling are termed **axial septula**. The structure of septula are represented by broad, short, narrow, uniform in lenge and in some genus septula are in contact with the parachomata immediately adjacent to the septa, where the parachomata are highest and septula are longest. Short transverse septula, termed **secondary transverse septula**, occur above the foramina in the outer volutions and throughout the shell of higher forms. The secondary transverse septula

resemble the primary transverse septula in all respects except that they are shorter and narrower (Figure 3.12).

Tunnel and foramina

So far as has been demonstrated, the only communication between the inside of the fusulinoidean shell and the exterior is by means of the numerous septal pores in the antetheca. After the shell developed a few chambers beyond the antetheca of a given chamber, communication with earlier parts of the shell was facilitated by resorption of the lower surface of septum so as to form a single opening, the **tunnel** (Figure 3.13), several widely spaced openings, multiple tunnels, or a series of small, closely spaced elliptical opening, **foramina**. About the same time as the development of these openings, the fusulinoidean laid down dense deposits of calcite in several parts of the shell. Ridges of dense calcite, the **chomata**, were deposited at the sides of the tunnel and **parachomata** developed to some extent between adjacent foramina. Dense deposits or **axial filling** completely fill the chambers in the polar regions (Figure 3.14).

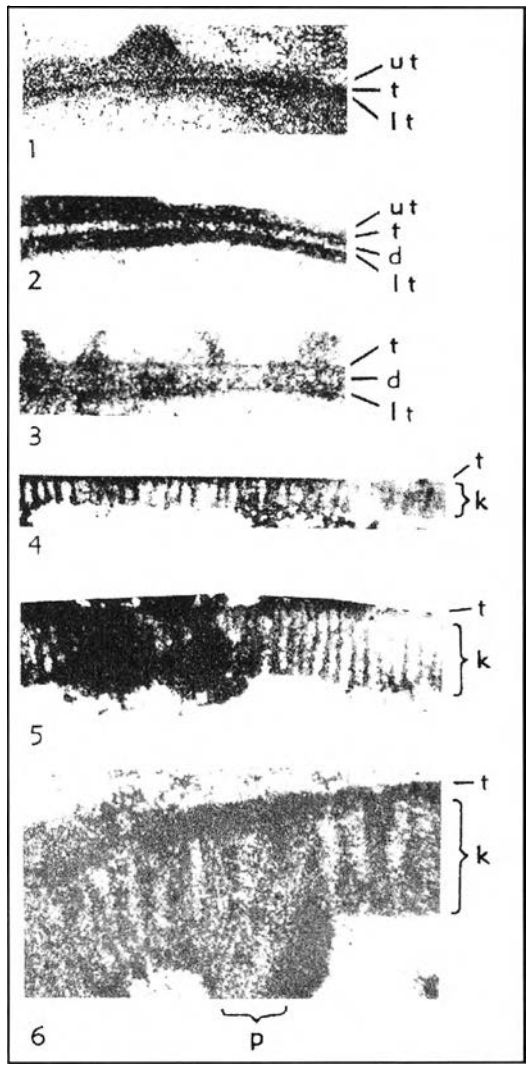

Figure 3.9 Spirotheca structure of fusulinoideas, all x100 (1922).-1.*Profusulinella regia* **Thompson**, M.Penn., USA (Tex.); three-layered spirotheca. 2. *Fusulina* sp., M.Penn., USA (N.Mex.); four-layered spirotheca. 3. *Fusulina cylindrical* **Fischer De Waldheim**, Low.U.Carb.; spirotheca composed of tectum, diaphanotheca and discontinuous lower tectorium. 4. *Triticites irregularis* **(Staff)**, U.Penn., USA (Iowa); spirotheca composed of tectum and alveolar keriotheca. 5. *T. moorei* **Dunbar & Condra**, U.Penn., USA (Tex.); like fig.4. 6. *Schwagerina furoni* **Thompson**, U.Perm., Afghan; thick spirotheca composed of tectum and keriotheca, with inserted pycnotheca continuous above septa. *[Explanation: d, diaphanotheca; k, keriotheca; lt, lower tectorium; t, tectum; ut upper tectorium and p, pycnotheca.]*.

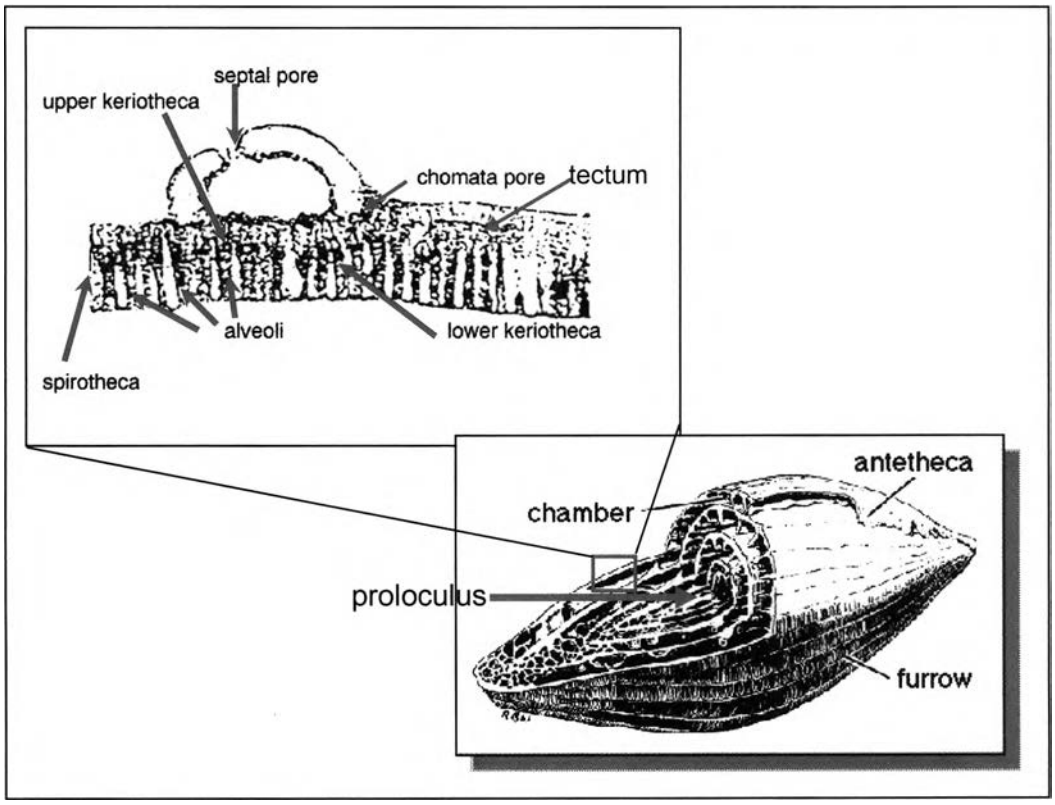

Figure 3.10 Part of sagittal section of spirotheca of *Schwagerina campensis* showing septal and chomata pores, alveoli, lower and upper keriothecae and tectum.

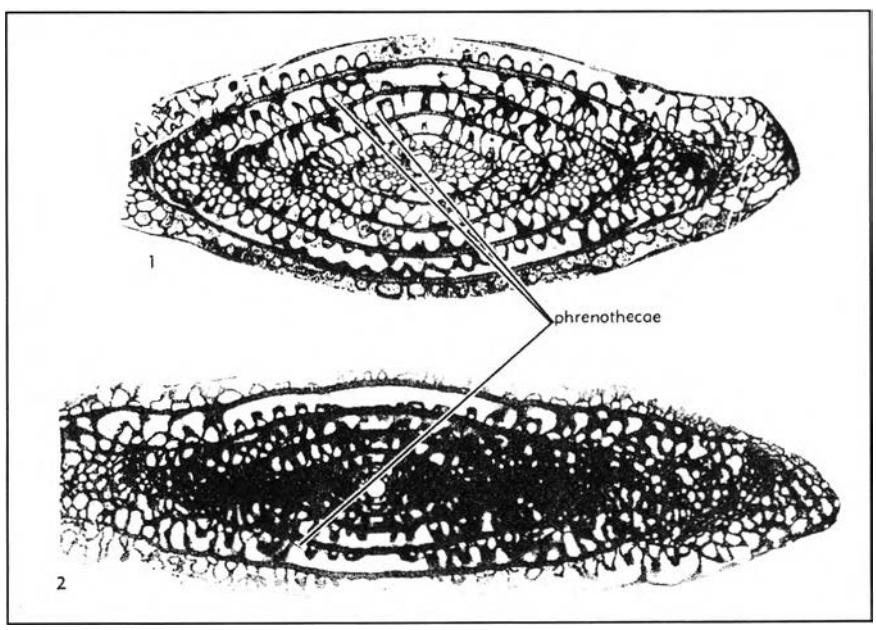

Figure 3.11 Phrenothecae of fusulinoideas illustrated by *Pseudofusulina* Dunbar & Skinner, L. Perm.

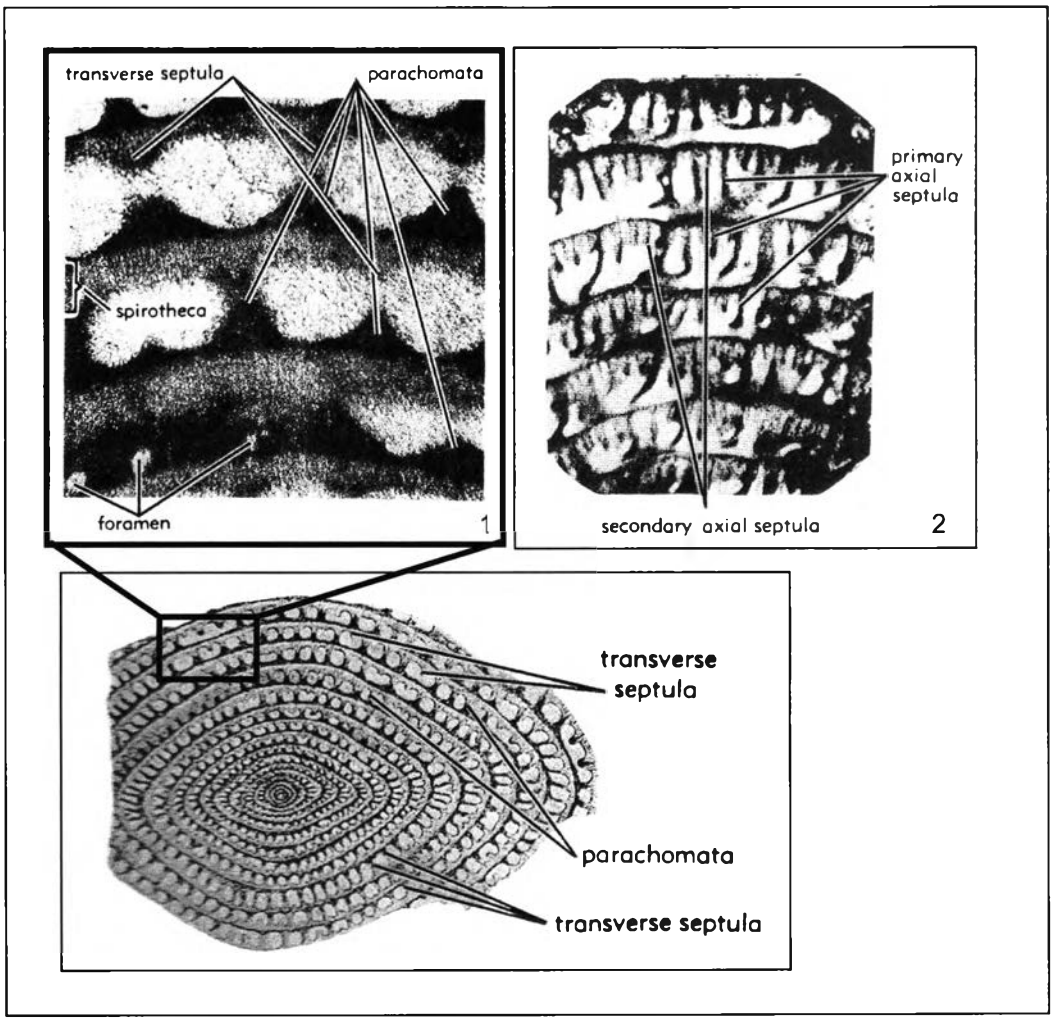

Figure 3.12 Spirotheca, rudimentary transverse and axial septula and parachomata shown in 1. Axial section of *Cancellina primigena* Heyden, X100. 2. Part of sagittal section of *Lepidolina multiseptata* (Deprat), X45.

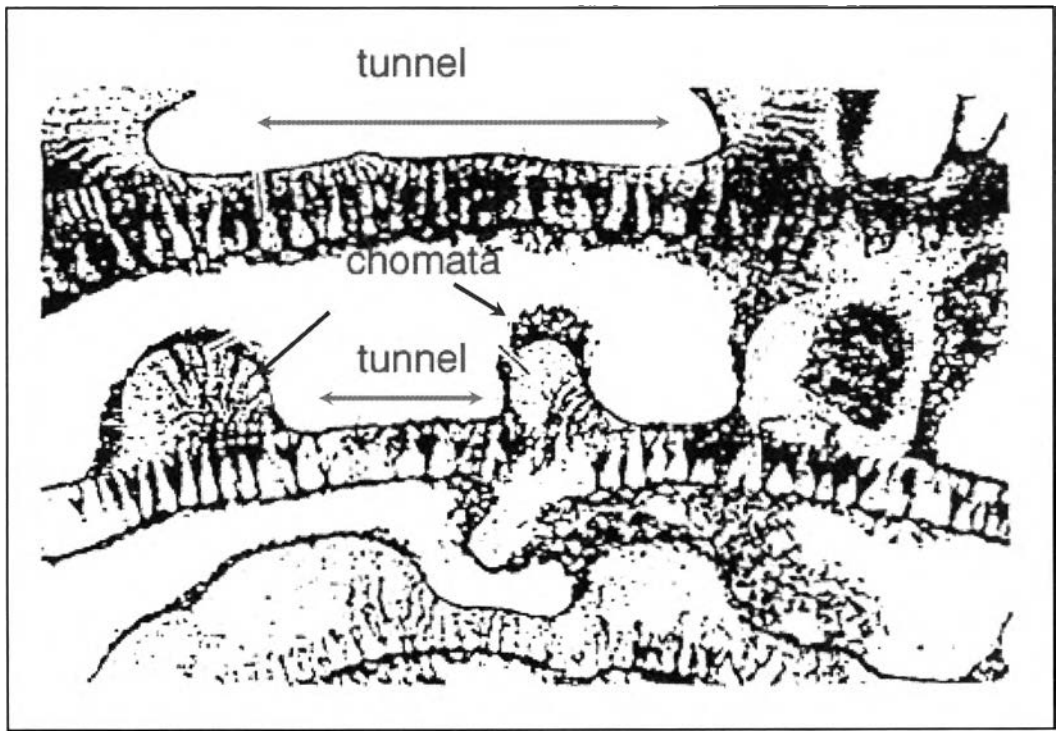

Figure 3.13 Part of axial section of *Schwagerina campensis* showing tunnel, chomata and chomata pores, x200 (Moore, 1964).

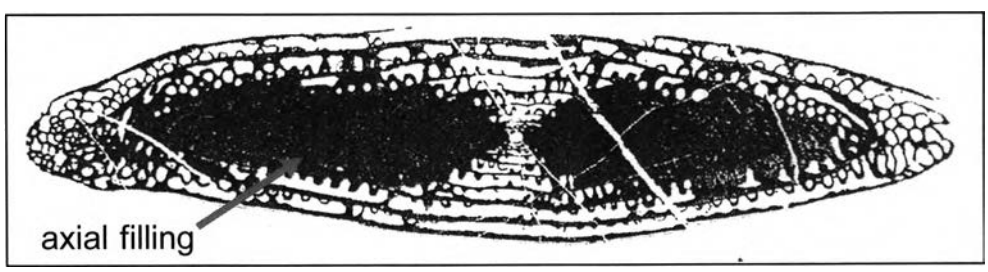

Figure 3.14 Axial filling in fusulinacean shells of *Parafusulina kaerimizensis* (Ozawa), x 8.5.

3.2 Systematic Description of Fusulinoideas

Fusulinoideas discovered in the study area in Amphoe Ta Khli, Amphoe Tak fa and Amphoe Phrayuha Khiri, Changwat Nakhon Sawan belong to 6 families, 10 subfamilies and 25 genera 37 species. Most of fusulinoideas in study areas were not well preserved. Though, internal structure and wall of some specimens were destroyed, the trace of wall structure and internal structure still exist and they are useful information for fusulinoidean paleontological study in these areas. Identification of fusulinoidea in study area is described as follows:

Order Foraminiferida **Eichwald**, 1830

Suborder Fusulinina **von MÖLLER**, 1878

Superfamily Fusulinoidea **von MÖLLER**, 1878

3.2.1 Family Ozawainellidae Thompson & Foster, 1937

Genus *Ozawainella* **Thompson**, 1935

Ozawainella sp. (Pl. 11, Figs. 12-16)

Materials – Axial sections from KLK 3-2.6, KLK18-6.2, KN 0-6.2, 0-6.4 and Oblique section from KN 6-12.1.

Description – Shell is relatively large for the genus. It assumes a thick lenticular form with nearly straight to slightly convex lateral slopes, angular peripheries and obtuse poles. Only available axial section is 0.84 mm in length and 1.84 mm in width. Proloculus seems to be spherical. Shell expands nearly uniformly. Spirotheca structure is not known exactly due to unfavourable state of preservation. Spirotheca is thin.

Comparison – The present species is most closely allied to *Ozawainella* sp. B. described by Pitakpaivan (1965) from the Chondhurian, near Takhli, Central Thailand. Only difference is in smaller apical angle in the present specimen, and both are assumed to be conspecific with each other.

Straigraphical distribution – Rare in the lower to middle part of Khao Look Klone and very rare at lower part of Khao Noi.

Geological range – Sakmarian to Murgabian (Wordian)

Associated fusulinoideas – *Staffella* sp., *Pseudostaffella* sp., *Nankinella* sp., *Schubertella* sp. and *Pseudofusulina* sp.

3.2.2 Family Staffellidae Miklukho-Maklay, 1949

Genus *Staffela* **Ozawa**, 1925

Staffella sp. (Pl. 11, Fig. 4)

Material – Axial section from KLK 16-1.1.

Description – Test subspherical at maturity, discoidal in early volutions; Spirotheca structure is not known exactly due to unfavourable state of preservation. Spirotheca is thin. Septa plane.

Comparison – Specific comparison of the present form to other known species is very difficult due to extreme insufficiency of material. As the genus, *Staffella*, the present form is largely replaced by secondary mineralization in characters observed in the only available axial specimen.

Straigraphical distribution – Rare in the middle part of Khao Look Klone.

Geological range – Yakhtashian (Artinskian) to Midian (Capitanian)

Associated fusulinoideas – *Ozawainella* sp., *Pseudostaffella* sp., *Nankinella* sp., *Schubertella* sp. and *Pseudofusulina* sp.

3.2.3 Family Nankinellidae Miklukho-Maclay, 1963

Genus *Nankinella* **Lee**, 1933

Nankinella sp. (Pl. 12, Figs. 1-26)

Materials – Axial sections from KP 3.3, 13.1, 14.4, KKJ 1-4.3, KLK 2.1-1.2, 2.2-4.1, 2.2-4.2, 2.2-5.1, 3-1.1, 3-2.2, 3-2.5, 17.2, 18-1.1, 18-2.1, 18-6.3, 22.1-1.1, KN 7, 23-7.9, Oblique sections from KN 6-3.2, 6-3.1, 6-2.2, 7-1.1, 7-1.2, 7.1-5.3, 7.3-15.1 and Sagittal section from KN 0-5.2.

Description – Shell inflated discoidal and large for the genus, with a short axis of coiling and gently convex lateral slopes. Proloculus spherical and considerably large for the size of shell. Shell expands almost uniformly throughout growth. Spirotheca thin and consist apparently of a tectum and a less dense lower layer, but minute structure of the latter is not recognized. Septa completely plane and numerous in number. Chomata poorly developed, being only low deposits on the upper surface of spirotheca in outer few volutions. Tunnel not well defined.

Comparison – The present species are closely to *Nankinella* sp. by Toriyama (1975) from the Khao Phlong Phrab hill, Changwat Saraburi.

Straigraphical distribution – Commonly along Khao Look Klone and very rare at lower and middle part of Khao Noi.

Geological range – Sakmarian to Murgabian (Wordian)

Associated fusulinoideas – *Ozawainella* sp., *Staffella* sp., *Pseudostaffella* sp., *Schubertella* sp., *Pseudofusulina* sp., *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Neothailandina* sp., *Pravitroschwagerina* sp., *Chusenella* sp., and *Neofusulinella* sp.

Genus *Sphaerulina* **Lee**, 1933

Sphaerulina sp. (Pl. 11, Figs. 8-11)

Materials – Oblique sections from KLK 2.2-3.2, 9-2.1, 23-1.1 and KN 23-7.11.

Description – Shell small and probably subspherical or almost spherical, with about 2.0 mm in length and width. Size and shape of proloculus, and mode of coiling of inner volutions unknown. Due to secondary mineralization, spirotheca structure has been much replaced, but spirotheca seem to be composed of two layers, a thin upper layer and a thicker lower layer. Septa also affected by secondary mineralization. They are plane throughout the growth of shell and rather widely spaced. Character of chomata and tunnel unknown.

Comparison – The present species is closely to *Sphaerulina* sp. B. described by Pitakpaivan (1965) from the Chondhurian, near Takhli, Changwat Nakhon Sawan.

Straigraphical distribution – Rare in the lower to middle part of Khao Look Klone and very rare at KN 23.

Geological range – Murgabian (Wordian) to Midian (Capitanian)

Associated fusulinoideas – *Ozawainella* sp., *Staffella* sp., *Pseudostaffella* sp., *Nankinella* sp., *Schubertella* sp. and *Pseudofusulina* sp.

3.2.4 Family Fusulinidae von MÖLLER, 1878

Subfamily Schubertellinae Skinner, 1931

Genus *Schubertella* Staff & Wedekine, 1910

Schubertella sp. (Pl. 10, Figs. 1-33 and Pl. 11, Figs. 17-22)

Materials – Axial sections from KN 0-4.1, 0-4.3, 0-6.3, 0-8.1, 0-12.1, 3-5.1, 3-8.1, 8-1.2, 22.1-2.1, 23-4.7, 23-7.2, KP 14.2, BHK 2-3.5, Oblique sections from BHK 2-6.3, KN7.1-7.1, 7.1-6.1, 7.3-5.1, 7.3-5.6, 7.3-15.2, 7.3-16.2, 8-8.1, 11-8.1, 21-3.3, 22-2.2, 24-1.5, 24-3.1, KLK 4.1-1.2, 4.1-1.3, 4.1-4.3, Sagittal sections from KN0-7.2, 0-7.4, 0-11.3, 3-5.5, 23-4.8. 23-4.15, KLK 8-2.1, BHK 2-6.2, Tangential section from KN 24-7.6, 24-8.3.

Description – Shell fusiform, first 1 to 3 volitions discoidal, coiled at large angle to outer volutions; spirotheca of tectum with lower layer or of single thin layer only; septa unfluted; chomata large, highly asymmetrical.

Geological range – Yakhtashian (Artinskian) to Murgabian (Wordian)

Associated fusulinoideas – *Ozawainella* sp., *Staffella* sp., *Pseudostaffella* sp., *Nankinella* sp., *Pseudofusulina* sp., *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Chusenella* sp., and *Neofusulinella* sp.

Genus *Eoschubertella* **Thompson**, 1937

Eoschubertella sp. (Pl. 11, Figs. 1-3)

Materials – Axial sections from KN 11-9.2, 23-4.12 and 24-3.5.

Description – Shell small, inflated-ellipsoidal to fusiform. First one or two volutions coiled at large angle to outer ones. Spirotheca composed of tectum with upper and lower tectoria. Septa plane and tunnel broad for shell size, bordered by low chomata.

Straigraphical distribution – Rare in the middle to upper part of Khao Noi.

Geological range – Yakhtashian (Artinskian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Subfamily Fusulininae **von MÖLLER**, 1878

Genus *Neofusulinella* **Deprat**, 1912

Neofusulinella sp. (Pl. 11, Figs. 5-7)

Materials – Oblique sections from KN 12.1-1.1, 12.1-7.1, 22.1-8.1.

Description – Shell small, planispiral throughout, inflated-fusiform, early volutions discoidal, spirotheca composed of tectum, and lower transparent layer without obvious alveoli; septa fluted in end zones; chomata narrow to massive.

Comparison – The present species is resembles *Neofusulinella saraburiensis* described by Toriyama, Kanmera and Ingavat (1969) from Khao Phlong Phrab, Changwat Saraburi.

Straigraphical distribution – Rare in the middle to upper part of Khao Noi.

Geological range – Kubergandian (Roadian) to Murgabian (Wordian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Schubertella* sp. and *Nankinellla* sp.

Genus *Yangcheinia* **Lee**, 1933

Yangcheinia sp. (Pl. 5, Figs. 13-16)

Materials – Axial sections from KNV 1-3.1, 1-5.5, 1-9.2 and Sagittal section from BHK 1-1.3.

Description – Shell small, inflated-fusiform, inner 3 or 4 volutions discoidal, with asymmetrical to fusiform outer volutions; spirotheca consisting of tectum and diaphanotheca with thick lower and upper tectoria; septa unfluted; chomata massive, extending almost to polar ends.

Geological range – Murgabian (Wordian) to Midian (Capitanian)

Associated fusulinoideas – *Pseudofusulina* sp., *Parafusulina* sp., *Pseudodoliolina* sp., *Neothailandina* sp., *Afghanella* sp., *Neoschwagerina* sp. and *Verbeekina* sp.

Subfamily Schwagerina **Dunbar & Henbest**, 1930

Genus *Parafusulina* **Dunbar & Skinner**, 1931

Parafusulina sp.

(Pl. 1, Figs. 14, Pl. 2, Figs, 1-8, Pl. 3, Figs. 4-6 and Pl. 4, Figs. 1-3)

Materials - Oblique sections from KN 22.1-2.5, BHK 1-1.1, 2-3.1, KMN 1-4, 1-12, KLK 24-1.1, Axial sections from KNV 1-10, 1-14, BHK 1-15, 2-2, KMN 1-1.1, Sagittal sections from BHK 1-4.1, 1-9 and 1-15 and Tangential section from BHK 1-10.1.

Description – Shell elongate, cylindrical to irregular in shape; spirotheca composed of tectum and alveola keriotheca, abnormally thin for size of shell, septa intensely fluted, forming cuniculi, axial fillings heavy.

Geological range – Sakmarian to Midian (Capitanian)

Associated fusulinoideas – *Pseudofusulina* sp., *Yangcheinia* sp., *Pseudodoliolina* sp., *Neothailandina* sp., *Afghanella* sp., *Neoschwagerina* sp., *Verbeekina verbeeki*

Genus *Pseudofusulina* **Dunbar & Skinner**, 1931

Pseudofusulina sp.

(Pl. 1, Figs. 1-13, Pl. 2, Fig. 9 Pl. 3, Figs.1-3, 7-9 and Pl. 4, Figs. 4-7)

Materials – Axial sections from BHK 2-1, 2-4.2, 2-14.1, KNV 1-10.2, KLK 1-1.1, 2.2-3.1, 39-1.1, KN 0-7.1, 0-14.3, 6.1-3.1, 7.3-9.2, 7.3-13.1, KS 11.1, Oblique sections from KLK 39-3.1, 40-4.1, KMN 1-9, 2-4, 2-14, BHK 2-2.9, KN 7.2-6.5, 7.3-12.1, 8.1-3.4, 8.1-3.5, 23-6.1, Sagittal sections from KMN 2-9.1, KS 11.3.

Description – Shell fusiform, large, loosely coiled throughout; spirotheca thick, composed of tectum and alveola keriotheca, septa broadly but higher fluted, axial fillings light in some, absent in most, phrenothecae abundant.

Geological range - Sakmarian to Midian (Capitanian) (**Leven**, 1997)

Associated fusulinoideas – *Parafusulina* sp., *Yangcheinia* sp., *Pseudodoliolina* sp., *Neothailandina* sp., *Thailandina* sp., *Afghanella* sp., *Neoschwagerina* sp., *Verbeekina verbeeki* **Geinitz**, *Ozawainella* sp., *Staffella* sp., *Pseudostaffella* sp., *Nankinella* sp., *Schubertella* sp. *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Pravitroschwagerina* sp., *Chusenella* sp. and *Neofusulinella* sp.

Genus *Skinnerella* **Coogan**, 1960

Skinnerella sp. (Pl. 5, Figs. 1-6)

Materials – Axial sections from KS 1, 4.3, 5, 9, Oblique sections from KS 2.1, 17.2.

Description – Shell inflated fusiform, first two or three volutions tightly coiled and elongate fusiform. Proloculus large and spherical. Spirotheca thick composed of tectum and alveolar keriotheca. Septal highly fluted throughout shell. Axial filling occur in polar areas of inner two to five volutions.

Comparison – Specific comparison of the present form to other known species is very difficult due to extreme insufficiency of material.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Pseudofusulina* sp.

Genus *Pravitroschwagerina* **Toriyama**, 1982

Pravitroschwagerina sp. (Pl. 4, Figs. 12-13)

Materials – Axial section from KN 9-1.1, Oblique section from KN 8.1-8.5.

Description – Shell moderate, fusiform to very elongated cylindrical form, with a straight to slightly arching axis of coiling, convex but somewhat irregular lateral slopes, and rounded poles. Shell expands rather rapidly. Spiratheca consists of a thin dense tectum and very thick keriotheca. Keriotheca is very coarse in alveolar structure. The most characteristic feature of this species is the twisting or shifting of spirotheca in the outer volutions, from which the generic name was derived. In the outer two or three volutions of many, if not all, of the specimens the spirotheca is formed immediately above the tectum of the preceding volution, leaving a very small or no open chamber space in between. Septa are thick and fold strongly and irregularly.

Comparison – The present species is most closely to *Pravitroschwagerina* sp. described by Pitakpaivan (1982) from Wang Saphung, Changwat Loei which closely allied to the Subfamily Schwagerininae.

Straigraphical distribution – Rare in middle part of Khao Look Klone.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp.*and Nankinellla* sp.

3.2.5 Family Chusenellidae Kahler and Kahler, 1966

Subfamily Chusenellinae **Kahler and Kahler**, 1966

Genus *Chusenella* **Hsü**, 1942

Chusenella sp. (Pl. 5, Figs. 7-12)

Materials - Axial sections from KNN 10.2, KP 4.1, Oblique sections from KLK 5-5.1, 13.1-2.3, Sagittal section from KLK 5.1-3.1 and Tangential section from KLK 5-1.1.

Description – Shell moderate in size, and less elongate fusiform. Shell of 7 volutions attains a length of 4.3 mm and a width of 3 mm. Axis extends rapidly from the first volition to maturity. Proloculus small and spherical. Shell coils somewhat tightly in two to three volutions and expand considerably rapidly in the succeeding volutions. Chamber almost the same in height from pole to pole. Spirotheca composed of tectum and alveola keriotheca, moderate in thickness. Septa folded throughout shell. Chomata very weakly developed from the second or third volution, being low and not massive. Tunnel low and wide. Heavy axial filling occur in polar areas of inner four to five volutions

Geological range – Kubergandian (Roadian) to Midian (Capitanian)

Associated fusulinoideas – *Lepidolina* sp., *Verbeekina verbeeki* **Geinitz**, *Colania* sp. and *Sumatrina* sp.

Superfamily Verbeekinoidea **Staff and Wedekine**, 1910

3.2.6 Family Verbeekinoidea Staff and Wedekine, 1910

Subfamily Verbeekinoidea **Staff and Wedekine**, 1910

Genus *Verbeekina* **Staff**, 1909

Verbeekina verbeeki **Geinitz** (Pl. 4, Figs. 8-11)

1876. *Fusulina verbeeki* **Geinitz**. Palaeontolographica, XXII, 399-400.

1925. *Verbeekina verbeeki* **Ozawa**. Jour. Coll. Sci. Imp. Univ. Tokyo, XLV, (6), 48-51, Pl. X, Figs. 6-7.

1936. *Verbeekina verbeeki* **Thompson**. Jour. Paleont., 10, (3), 197-200, Pl.24, Figs. 1-8.

1956. *Verbeekina verbeeki* **Chen**. Palaeontologia Sinica, N.S., B, 6, 47-48, Pl. IX, Figs. 5-6; Pl. XIII, Figs. 1-2.

1958. *Verbeekina verbeeki* **Chen**. Mem. Fac. Sci. Kyushu Univ., (D), 7, 205-208, Pls. 37-38.

Materials – Axial sections from KKJ 1-4.1, KNV 1-16, KMN 1-14 and Sagittal section from KNV1-4.1.

Description - Shell large and spherical, with straight axis of coiling. Shell expands rapidly and almost uniformly from the second or third voluion outwards. Spirotheca consists essentially of tectum and a keriotheca . Septa thin and essentially the same in structure as spirotheca, but downward extension of keriotheca very short. Septa unfluted throughout length of shell. Parachomata do not occur in inner seven to eight volutions. They begin to appear in the eighth or ninth volution, where they are very rare and very low narrow ridges, extending less than one-fourth the distance across the chambers.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 4 Fig.
KKJ 1-4.1	5.0	3.8	11	0.6	10	8
KNV 1-16	2.9	2.8	8	-	-	9
KMN 1-14	5.1	4.3	10	0.6	-	10
KNV 1-4.1	3.9	3.2	8	-	-	11

Specimen No.	Thickness of spirotheca (micron)										
	1	2	3	4	5	6	7	8	9	10	11
KKJ 1-4.1	30	25	20	10	20	20	30	30	50	50	50
KNV 1-16	35	30	30	20	25	20	30	50	-	-	-
KMN 1-14	15	10	10	10	15	20	20	20	20	25	-
KNV 1-4.1	30	40	30	40	50	50	60	40	-	-	-

Comparison – The present species is most closely to *Verbeekina verbeeki* from the Maoteetang hill, near Khao Plong Phrab (Pitakpavan, 1965).

Geological range – Kubergandian (Roadian) to Midian (Capitanian)

Associated fusulinoideas – *Parafusulina* sp., *Pseudofusulina* sp., *Afghanella* sp. *Chusenella* sp., *Lepidolina* sp., *Colania* sp. and *Sumatrina* sp.

Armenia sp. **Miklukho-Maklay**, 1955 emend. **Sheng** 1963 (Pl. 14, Figs. 1-5)

Materials – Axial section from KN 7.3-11.1, Oblique sections from KN 3-4.3, 3-2.1, 11-9.1, 23-3.4.

Description – Shell small to moderate and subspherical to spherical, having slightly umbilicated to rounded poles. Inner few volutions short axis of coiling to subspherical one in outer volutions. Shell tightly coiled in inner volutions and gradually increase in height in outer volutions. Proloculus minute. Spirotheca thick composed of a tectum and a finely alveolar keriotheca. Parachomata well developed throughout length of shell, but discontinuous and uneven in height.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Verbeekina (Armenia) saraburiensis **Toriyama and Kanmera** (Pl. 14, Figs. 6)

Meterial – Oblique section from KN 0-1.1.

Description – Shell subspherical and small for the genus, with straight axis of coiling and broadly round poles. Shell exclusive planispiral. The first volution spherical to subspherical, and from the second volution to maturity axial profile is nearly the same. Proloculus large for the size of shell, and spherical to subspherical. Shell expands relatively slowly in inner two to three volution and considerably rapidly in outer volutions. Chamber is essentially the same in height from pole to pole. Spirotheca thin and consists of a dense tectum and a keriotheca, in the latter of which very fine alveoli are observable throughout the growth of shell. Parachomata well developed throughout the growth. In inner volutions they are widely spaced being low and wide with about a half

as high as chamber. In outer volutions they are semicircular or triangular in cross section, but even in high, having one0 fourth to more than a half as high as chamber.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 14 Fig.
KN 0-1.1	2.0	1.7	7	1.5	10	6

Specimen No.	Thickness of spirotheca (micron)						
	1	2	3	4	5	6	7
KN 0-1.1	10	10	10	10	20	20	20

Comparison – *Verbeekina (Armenia) saraburiensis* is one of the most primitive representatives of the genus. It is earlier stage of a phylogenetic lineage of *Misellina-Verbeekina* (*Armenia*)-*Verbeekina* (*Verbeekina*). The present species is not comparable with any species.

Straigraphical distribution – Only in KN 0.

Geological range – Murgabian (Wordian) to Midian (Capitanian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Subfamily Misellininae **Miklukho-Maklay**, 1958

Genus *Misellina* **Schenck and Thompson**, 1940

Misellina sp. (Pl. 13, Figs. 16-17)

Materials – Oblique sections from KN12-7.2 and 12.1-5.1.

Description - Shell small to moderate, subspherical to oval, planispiral except for juvenile volutions of microspheric specimens. Spirotheca of two layers, a tectum and an alveolar

keriotheca. Parachomata massive and well developed throughout length of shell. Circular to semicircular foramina occur at best of septa. No septula exist.

Comparison – The present species is resembles *Misellina* sp. described by Toriyama, Kanmera and Ingavat (1969) from Khao Phlong Phrab, Changwat Saraburi.

Straigraphical distribution – Rare in the middle to upper part of Khao Noi.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Misellina cf. *termieri* **Deprat** (Pl. 13, Figs. 7-15)

1915. *Doliolina termieri* **Deprat**. Mem.Serv.Geol. I' Indochina, tome4, fasc.1 p.17-18, pl.3, figs15-20.

1962. *Misellina* cf. *termieri* **Suyari**. Jour. Gakugei, Tokushima univ., Nat. Sci., vol.12, p.33, pl.10, fig. 6-8.

1964. *Misellina termieri* **Leven**. Paleont. Jour. Acad. Sci. USSR, 1964, 4, pl.1, figs. 7-9.

1967. *Misellina termieri* **Leven**. Geol. Inst. Acad. Sci. USSR, Transact.167, p.183, pl.29, figs. 10-11.

Materials - Axial sections from KN 7.1-3.1, KN 3-1.1, 3-10.1, KN 8-1.1, 12.1-4.1, KN 22-3.1, 22-3.2, 22.1-6.1, Tangential section from KN 12-4.1.

Description – Shell small and elliptical in axial profile, with straight axis of coiling, exclusively convex lateral slopes and broadly rounded poles. Mature shell of 6 to 8 volutions 1.6 to 2.1 mm in length and 1.5 to 1.8 mm in width. The first two volutions nearly spherical to subspherical. Axis extends slowly during growth. Proloculus small and spherical to subspherical. Shell expands very slowly in the first volution, and from the second volution expansion becomes gradual and slightly rapid. Spirotheca rather thick for size of shell, consisting a tectum and a lower thick layer. Faint alveolar structure

observed in the lower layer of outer three to four volutions. Septal essentially the same in structure as spirotheca, being composed of downward extension of tectum coated by lower layer on both sides. Parachomata present in all but the first volution. In the second and third volutions, however, they are still incipient in development. In outer volutions they are high and narrow and a half to two-thirds as high as chambers.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 13 Fig.
KN 7.1-3.1	2.0	1.5	7	0.5	5	7
KN 3-10.1	1.6	1.5	6	-	-	9
KN 8-4.1	1.6	1.6	6	-	-	10
KN 12.1-4.1	2.1	1.8	8	0.5	-	12
KN 22-3.1	2.0	1.5	7	-	-	13

Specimen No.	Thickness of spirotheca (micron)							
	1	2	3	4	5	6	7	8
KN 7.1-3.1	10	10	10	10	10	10	10	-
KN 3-10.1	20	30	30	50	50	50	-	-
KN 8-4.1	10	10	20	20	20	20	-	-
KN 12.1-4.1	10	10	10	20	25	15	40	30
KN 22-3.1	10	10	20	20	20	20	15	-

Comparison – Although this specimens are not sufficient in number, they are considerably well agreeable with *Misellina termieri* **Deprat** in many shell characteristics, except that this specimens have a small proloculus than Deprat's type.

Straigraphical distribution – Commonly in Khao Noi section.

Geological range – Bolorian (Kungurian) to Kubergandian (Roadian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Misellina confragaspira **Leven** (Pl. 13, Figs. 18-26)

1967. *Misellina confragaspira* **Leven**. Acad. Sci. USSR, Geol. Inst. Transact. Vol.167, p.184-185, pl.31, figs.2-4.

Materials - Axial sections of KN 0-15.1, 14-1.1, 15-2.1, 21-8.1, 23-3.4, 23-4.1, 23-4.11, Sagittal section from KN 7.3-15.4 and Oblique section from KN 22.1-5.1.

Description – Shell small and typical fusiform with straight axis of coiling gently convex lateral slopes, and rounded poles. Mature shell 5 to 8 volutions attain a length of 1.7 to 2.4 mm and a width of 1.1 to 2.2 mm. The first one to two volutions spherical to subspherical, the succeeding two volutions short fusiform, and outer three to four volutions take typical fusiform. Proloculus spherical to subspherical with structureless thin wall of about 12 microns. Shell expands slowly in inner three volutions, and less slowly and uniformly in outer volutions. Chamber nearly the same in height in central half of shell, and becomes gradually high towards poles. Spirotheca thin and consists of tectum and a keriotheca. Fine alveolar structure of keriotheca is not observable in inner few volutions. Rugosity of spirotheca is hardly observed. Septa essentially the same in structure as spirotheca. Although neither axial nor transverse septula present, it is noted that the lower surface of spirotheca in outer volutions partly show slight downward swelling just above parachomata, which suggests very incipient stage in forming primary transverse septula. Parachomata well developed throughout growth, being high and narrow. They are usually about a half to two-thirds as high as chambers, but in some specimens they are almost the same in height as chamber and their tips almost reach lower surface of spirotheca in outer volutions.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 13 Fig.
KN 15-2.1	2.3	1.5	7	1.0	-	18
KN 0-15.1	2.4	1.8	7	1.0	-	19
KN 7.3-15.4	2.3	2.2	8	1.0	5	20
KN 22.1-5.1	2.1	1.8	6	2.0	10	21
KN 23-4.1	2.4	1.6	8	2.0	5	22
KN 24-3.4	1.8	1.1	6	1.5	10	23
KN 14-1.1	1.7	1.3	5	2.1	10	25
KN 21-8.1	2.0	1.5	6	2.3	5	26

Specimen No.	Thickness of spirotheca (micron)							
	1	2	3	4	5	6	7	8
KN 15-2.1	10	10	10	20	10	10	20	-
KN 0-15.1	20	20	20	20	20	20	10	-
KN 7.3-15.4	10	10	10	10	10	10	10	10
KN 22.1-5.1	10	10	10	10	10	10	-	-
KN 23-4.1	10	10	10	10	10	10	20	15
KN 24-3.4	10	10	10	10	15	10	-	-
KN 14-1.1	10	10	10	10	10	-	-	-
KN 21-8.1	10	10	10	10	10	10	-	-

Comparison – The present species is resembles *Misellina confragaspira* **Leven** described by Toriyama (1975) from Khao Phlong Phrab, Changwat Saraburi.

Straigraphical distribution – Commonly in the Khao Noi section.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Misellina ovalis **Deprat** (Pl. 13, Figs. 1-3)

1915. *Doliolina ovalis* **Deprat.** Mem. Serv. Geol. I' Indochina, tome4, fasc.1 p.15-16, pl.3, figs.1-4.

1962. *Misellina ovalis* **Sheng.** Acta. Palaeont. Sinica, vol.10, no.4, p.428-429, pl.1, figs.10-14.

1963. *Misellina ovalis* **Sheng**. Palaeont. Sinica, N.S., B., no.10, p.221-222, pl.34, figs.16-21.

1967. *Misellina ovalis* **Leven**. Academy of Science of USSR, Geol. Inst., Transact. vol.167, p.181, pl.26, fig.2, 3, 6; pl.33, fig.2.

Materials - Axial sections from KN 0-5.3, 0-13.2 and 3-8.3.

Description – Shell small and oval in axial profile, with gently convex lateral slopes and rounded poles. Mature shell 4 to 5 volutions 1.5 to 2.1 mm in length and 0.9 to 1.3 mm in width. The first volutions subspherical, the second volutions ellipsoidal, and thereafter shell assumes oval in axial profile. Proloculus small and spherical. First one or two volutions coils somewhat tightly, and succeeding volutions expands more or less rapidly but almost uniformly. Spirotheca relatively thin, consisting of a tectum and a fine alveolar keriotheca. Alveolar structure is not clear in inner volutions. Parachomata considerably well developed in all but the first two volutions where they are not present or very rudimentary if present. In outer volutionsparachomata low and broad, being one-third to a half as high as chambers. Septa thin and relatively tightly spaced.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 13 Fig.
KN 0-5.3	2.1	1.3	5	2.5	10	1
KN 0-13.2	1.7	0.9	4	3	-	2
KN 3-8.3	1.5	0.9	4	3.0	10	3

Specimen No.	Thickness of spirotheca (micron)				
	1	2	3	4	5
KN 0-5.3	15	20	30	30	30
KN 0-13.2	10	20	20	20	-
KN 3-8.3	10	10	10	20	-

Comparison – These specimens, though not sufficient in number, are resemble *Misellina ovalis* **Deprat** from Khao Phlong Phrab, Changwat Saraburi.

Straigraphical distribution – Rare in the lower part of Khao Noi.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Misellina otai **Sakaguchi and Sugano** (Pl. 13, Fig. 5-6)

1967. *Misellina otai* **Sakaguchi and Sugano**. Jour. Osaka Gakugei Univ., B, no. 15, p.145-147, p.11, figs. 1-12.

Materials - Axial section from KN 22-2.1 and 23-7.13.

Description - Shell small and nearly spherical, with straight axis of coiling, exclusively convex lateral slopes, and broadly rounded but slightly umbilicated polar regions.

Proloculus seems to be almost spherical, shell coils tightly in inner three volutions. Chamber is the same in height throughout volution. Spirotheca rather thick for the size of shell, consisting of a tectum and a lower keriotheca. Parachomata not present in the first volution. In outer volution broad and low parachomata well developed, being one-third to a half as high as chamber.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 13 Fig.
KN 22-2.1	1.2	1.1	4	-	-	5
KN 23-7.13	1.3	1.1	6	0.5	5	6

Specimen No.	Thickness of spirotheca (micron)					
	1	2	3	4	5	6
KN 22-2.1	10	20	20	20	-	-
KN 23-7.13	10	10	10	20	20	20

Comparison – The present specimen well agree with the Khao Phlong Phrab specimen.

Straigraphical distribution – Rare in the middle to upper part of Khao Noi.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Misellina claudiae **Deprat** (Pl. 13, Fig. 27-35)

1912. *Doliolina claudiae* **Deprat**. Mem. Serv. Geol. l'Indochine, tome1, fasc.3, p.44-45, pl.4, figs.5-9.

1913. *Doliolina claudiae* **Deprat**. Ibid. tome2, fasc.1, p.50.

1925. *Doliolina claudiae* **Ozawa**. Jour. Coll. Sci. Imp. Univ. Tokyo, vol.45, no.4, p.18, pl.2, figs.1,2.

1934. *Doliolina claudiae* Chen. Palaeontologia Sinica, Ser.B, vol.4, no.2, p.99-100, pl.16, figs. 13-20.

1936. *Doliolina claudiae* **Huzimoto**. Sci. Rep. Tokyo Bunrika Daigaku, Sec. C, vol.1, no.2, p.104-105, pl.21, figs.4-9.

1957. *Misellina* cf. *claudiae* **Kobayashi**. Sci. Rep. Tokyo Bunrika Daigaku, Sec. C, vol.5, no.48, p.296-297, pl.1, fig.19.

1958. *Misellina claudiae* **Sakagami**. Jour. Hokkaido Gakugei Univ., vol.9, no.2, p.89-90, pl.4, figs. 1,2.

1958. *Misellina claudiae* **Toriyama**. Mem. Fac. Sci. Kyushu Univ., Ser.D, Geol., vol.7, p.208-211, pl.38, figs. 1-17.

1960. *Misellina claudiae* **Kanuma**. Bull. Tokyo Gakugei Univ., no.11, p.64-65, pl.11, figs. 2-9.

1961. *Misellina* aff. *Claudiae* **Nogami**. Mem. Coll. Sci. Univ. Kyoto, Ser.B, vol.28, no.2, p. 169-171, pl.7, figs. 7-9.

1963. *Misellina claudiae* **Kanmera**. Mem. Fac. Sci. Kyushu Univ., Ser.D, Geol., vol.14, no.2, p.110-112, pl.14, figs. 7-14.

1963. *Misellina claudiae* **Sheng**. Palaeont. Sinica, N.S., B., no.10, p.222-223, pl.28, fig. 15; pl.30, figs. 12-19.

1967. *Misellina claudiae* **Leven**. Acad. Sci. USSR, Geol. Inst. Transact.l.167, p.181-182, pl.30, figs.12-19.

Materials - Oblique sections from KN 3-11.1, 3-13.1, 3-9.2, KN 7.3-1.1, Axial section from KN 5-4.1, 5-12.1, 5-3.2 and Sagittal section from KN 7.1-8.1, 7.1-9.3.

Description - Shell large and nearly spherical, with straight axis of coiling. Mature shell 10 to 11 volutions 2.3 in length and 2.2 mm in width. Proloculus seems to be almost spherical, shell coils tightly in inner five volutions. Chamber is the same in height throughout volution. Spirotheca rather thick for the size of shell, consisting of a tectum

and a lower keriotheca. Parachomata not present in the first volution. In outer volution broad and low parachomata well developed, being one-third to a half as high as chamber.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 13 Fig.
KN 5-4.1	2.4	2.3	9	-	-	30
KN 5-12.1	2.7	2.5	10	-	-	31
KN 5-3.2	2.2	2.6	11	-	-	35

Specimen No.	Thickness of spirotheca (micron)										
	1	2	3	4	5	6	7	8	9	10	11
KN 5-4.1	10	10	10	20	20	20	30	30	20	-	-
KN 5-12.1	10	10	15	15	20	20	20	20	20	20	-
KN 5-3.2	20	20	20	30	30	30	30	30	30	30	10

Comparison – The Khao Noi specimen well agree with the Deprat's type in essential diagnostic characteristics. This specimens have, however, more numerous number of volution and small proloculus.

Straigraphical distribution – Rare in the lower part of Khao Noi.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Subgenus *Brevaxina* **Schenck and Thompson**, 1940

Misellina (Brevaxina) sp. (Pl.13, Fig. 4)

Material - Sagittal section from KN 8-14.2.

Description - Shell small, nautiloid to staffeloid having umbilicated poles and a short axis of coiling. Except for inner volutions which are evolute, shell involute. Height of volution rather rapidly increases. Parachomata small and widely spaces. Spirotheca and septa thin.

Comparison – Specific comparison of the present form to other known species is very difficult due to extreme insufficiency of material, observed in the only available sagittal specimen.

Straigraphical distribution – Only in KN 7.

Geological range – Bolorian (Kungurian)

Associated fusulinoideas – *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

3.2.7 Family Pseudodoliolinidae Leven, 1963

Genus *Pseudodoliolina* **Yabe and Hanzawa**, 1932

Pseudodoliolina sp. (Pl. 6, Fig. 11-14)

Materials - Oblique sections from BHK 2-3.2, 2-4.3, Tangential section from BHK 2-6.1, Axial section from BHK 2-18.2.

Description – Shell small and elongate cylindrical, with almost straight axis of coiling, almost flat to gently convex lateral slopes, and broadly round poles. Only available axial section of eight volutions is 4.5 mm in length and 2.0 mm in width, Proloculus subspherical and large for size of shell. Shell expands gradually and nearly uniform throughout growth, although slightly rapidly in outer volutions. Spirotheca very thin, consists of a inner dense layer in inner five volutions. In some, especially, central part of

outer volutions, spirotheca is composed of a tectum and a less dense lower layer, in the latter of which, however, no minute structure is observable. Parachomata do not occur in inner two volutions, but well developed from the third to last volutions, with semicircular shape in axial profile. They are rather widely space, and about a half to two-thirds as high as chambers

Comparison – This specimen well agree with the *Pseudodoliolina saraburiensis* **Toriyama and Kanmera** (1975) in essential diagnostic characteristics. These specimens have small and short cylindrical form of shell suggest that the present species is an ancestral form of Metadoliolina pinguis.

Geological range – Kubergandian (Roadian) to Midian (Capitanian)

Associated fusulinoideas– *Pseudofusulina* sp., *Parafusulina* sp., *Yangcheinia* sp., *Neothailandina* sp., *Afghanella* sp., *Neoschwagerina* sp.

3.2.8 Family Neoschwagerinidae Dunbar and Condra, 1928

Subfamily Thailandininae **Toriyama and Kanmera**

Genus *Neothailandina* **Toriyama and Kanmera**

Neothailandina sp. (Pl. 6, Figs. 2-4)

Materials - Axial section from BHK 1-14.1, 2-14.2 and 2-17.

Description – Shell moderately large, thick fusiform to large subcylindrical, with a straight to slightly curving axis of coiling, usually slightly concave lateral slopes and bluntly pointed to rounded poles. Mature megalospheric individuals possessing six to nine volutions attain a length of 4.5 to 10.5 mm. and a width of 2.7 to 4.3 mm. and give form ratios ranging from 1.6 to 3.0. Proloculus very large, but microspheric form commonly present. Spirotheca almost entirely destroyed by secondary replacement, but appears to be composed of a tectum and a lower thicker, less dense layer. Transverse septula, which have also been completely replaced, occur at least in outer volutions or throughout shell, and reach the tops of parachomata almost across the chamber, leaving a lateral opening at the top of parachomata in the center of the chamber. Axial

septula apparently not present. Parachomata occur throughout growth of shell, more than half to two-thirds as high as the chambers. Small circular foramina occur between parachomata at the base of septa.

Comparison – The present species is similar to some species of *Cancellina* and *Neoschwagerina* in the general shell structure, size and shape, but shells of species of the present genus are largely or almost completely replaces by secondary mineralization.

Geological range – Kubergandian (Roadian) to Murgabian (Wordian)

Associated fusulinoideas – *Pseudofusulina* sp., *Parafusulina* sp., *Yangcheinia* sp., *Pseudodoliolina* sp., *Afghanella* sp., and *Neoschwagerina* sp.

Neothailandina pitakpaivani **Toriyama and Kanmera** (Pl. 6, Figs. 1, 7)

Materials - Axial sections from BHK 1-6 and 2-5.

Description – Shell highly inflated fusiform with bluntly pointed to rounded poles. Lateral slopes slightly concave or convex. In megalospheric from mature shell consists of 4½ to 6½ volutions and attains a length of 2.3 to 5.6 mm and a width of 2.1 to 2.9 mm. In microspheric form shell large, reaching a length of 6.5 mm and a width of about 3.7 mm. In megalospheric form proloculus very large. Inner volutions subspherical. Because of secondary replacement the spirothecal structure is obscure, but the spirotheca seems to be composed of a tectum and a lower, less dense, thicker layer. Thickness of spirotheca is not measured exactly, especially in the inner volutions, but it ranges from 40 – 50 microns in the inner volutions and 50 – 65 microns in the outer ones. Septa has also been completely replaced, and therefore details of their structure cannot be determined. They seem to be rather thick and are unfluted throughout the shell. Transverse septula well developed almost throughout the shell and reach tops of parachomata almost across the chamber, leaving a lateral opening at the top of parachomata at the center of the chambers. Axial septula appear not to be present.

Parachomata occur throughout growth of shell. Small circular foramina occur between parachomata at the base of septa.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 6 Fig.
BHK 1-6	5.6	2.9	6½	0.9	30	1
BHK 2-5	2.3	2.1	4½	-	-	7

Specimen No.	Thickness of spirotheca (micron)						
	1	2	3	4	5	6	7
BHK 1-6	10	10	10	15	30	40	-
BHK 2-5	20	20	30	20	-	-	-

Comparison – The present species resembles *Thailandina hongnusonthiae* **Toriyama and Kanmera**, from which it differs in its well developed transverse septula.

Straigraphical distribution – Commonly in Khao Noi section.

Geological range – Kubergandian (Roadian) to Murgabian (Wordian)

Associated fusulinoideas – *Pseudofusulina* sp., *Parafusulina* sp., *Yangcheinia* sp., *Pseudodoliolina* sp., *Afghanella* sp., and *Neoschwagerina* sp.

Genus *Thailandina* **Toriyama and Kanmera**

Thailandina buravasi **Toriyama and Kanmera** (Pl. 6, Fig. 5)

Material - Axial section from KN 23-7.8.

Description – Shell small and, thickly fusiform to ellipsoidal, with slightly convex lateral slopes and bluntly pointed poles. Proloculus large. Shell expands uniformly. Chamber of nearly the same height throughout length of shell. Spirotheca has been almost entirely replace by secondary mineralization, but it exhibits two layers, i.e. an extremely thin dark

upper layer- probably the tectum and a less dense, seeming structureless lower layer. The lower layer may originally have been very finely alveola. Spirotheca rather thin. Septa thick, unfluted throughout growth of shell. Neither axial nor transverse septula present. The lower surface of the spirotheca os always smooth and never undulatory or expanding fan-shaped. Parachomata occur almost throughout growth of shell, but it is not certain whether they are developed in the first volution. They are less than half as high as the chambers, but as they approach the septa, they become higher so as to attain two-third the height of the chamber. Small foramina are recognized between parachomata at the basal part of septa.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 6 Fig.
KN 23-7.8	1.9	1.5	5	-	-	5

Specimen No.	Thickness of spirotheca (micron)				
	1	2	3	4	5
KN 23-7.8	-	20	20	30	20

Comparison – Shell of the present species are so highly replaced by secondary mineralization that the detailed structure of the spirotheca and septa cannot be determined. In general, shell structure of the present species is somewhat similar to *Misellina claudiae* **Deprat**. These species has a large shell, a much larger proloculus, smaller parachomata in proportion to the shell size and M. claudiae have never been replaced secondarily.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Thailandina sp. (Pl. 6, Fig. 6, 8)

Materials - Oblique section KN 22.1-1.1 and Sagittal section from KN 22-2.5.

Description – Shell small, inflated fusiform with convex lateral slopes and bluntly pointed poles. Mature shell consists of seven to eight volutions. Spirotheca thin and appear to be composed of a tectum and a lower, less dense layer. Septa completely replace, therefore the structure and a number of septa are difficult to determine. Transverse septula no developed. Parachomata occur throughout growth of shell, being about half as high as the chamber. Small foramina occur between parachomata at the base of septa.

Comparison – The present species is closely similar to *Thailandina buravasi* **Toriyama and Kanmera** but it is distinguishable in its more tightly coild shell and its much thinner spirotheca for the corresponding volutions.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Maklaya* sp., *Armenia* sp., *Verbeekina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Subfamily Neoschwagerinidae **Dunbar and Condra**, 1928

Genus *Maklaya* **Kanmera and Toriyama**

Maklaya sp. (Pl. 14, Figs. 7-12)

Materials - Oblique sections KN 23-7.12, 23-4.3 ,24-8.6, 24-4.2, 24-4.6 and 24-2.3.

Description – Shell small, subspherical to ellipsoidal, with bluntly pointed to rounded poles and convex lateral slopes. Mature individuals usually possess 7 to 12 volutions and attain a length of 2.1 to 3.5 mm and a width of 1.5 to 3.1 mm. Proloculus minute to small. Inner one to two volutions discoidal and coiled somewhat askew to later volutions. Coiling tight and uniform throughout growth of shell. Spirotheca thin in inner volutions, but thick in middle to outer ones, and composed of a tectum and a very finely alveolar

keriotheca. Short but broad fan-shaped incipient transverse septula occur facing each of the parachomata. They consist of downward prolongations or expansions of keriotheca elements. Seta composed of a tectum and anterior and posterior downward extensions of keriotheca. No axial septula present. Parachomata developed almost throughout growth of shell except in the first volution, low in the central part of chambers, but becoming higher adjacent to septa where they commonly reach the lower ends of rudimentary transverse septula. Foramina occur between parachomata at the base of septa.

Comparison – The present genus is superficially close to *Cancellina* in the general shell structure but the principal difference lies in the thickness of spirotheca and septa for size of the shell.

Straigraphical distribution – Commonly in the upper part of Khao Noi section.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Maklaya pamirica **Leven** (Pl. 14, Figs. 17-19)

1967 *Cancellina pamirica* **Leven**. Academy of Science of USSR, Geol. Inst., Transact. vol.167, p.186-187, pl.32, fig.1, 3.

Materials - Oblique sections from KN 5-11.2, 5-11.1 and 5-10.1.

Description – Shell small, subspherical with uniformly convex lateral slopes and broadly rounded poles. Mature specimens consist of 7 volutions and attain a length of 2.0 mm and a width of 1.8 to 2.0 mm. Proloculus minute. Inner 1 or 2 volutions staffelloid with a short axis of coiling; beyond the second volution the shell increase more in length than height , but mature shells tend to become spherical again, Chamber almost the same in height throughout length of shell. Spirotheca thick, consisting of a thin tectum and a

thick keriotheca with very fine alveoli. Lower surfaces of keriotheca highly undulatory with broad but slight downward prologations of keriothecal elements which face parachomata. Keriotheca thickest in central part of shell, gradually decreasing in thickness polewards. Septa thick and unfluted throughout growth of shell, composed of a downward deflection of the tectum and anterior and posterioe extensions of the keriotheca. Parachomata appear in the second volution. They are rudimentary in the central part of the chambers but high and broad adjacent to the septa, where they reach the lower ends of downward prolongation of keriotheca, forming seemingly transverse septula. Minute foramina occur between septa at the base of septa.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 14 Fig.
KN 5-11.2	2.0	2.0	7	-	-	17
KN 5-11.1	2.0	1.8	7	-	-	18

Specimen	Thickness of spirotheca (micron)						
No.	1	2	3	4	5	6	7
KN 5-11.2	10	10	10	15	10	15	15
KN 5-11.1	10	10	15	15	15	15	15

Comparison – The present genus is superficially closet to *Maklaya pamirica* **Toriyama and Kanmera**.

Straigraphical distribution – Very rare in the upper part of Khao Noi section.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Thailandina* sp., *Armenia* sp., *Verbeekina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Maklaya sethaputi **Kanmera and Toriyama** (Pl. 14, Figs. 13-16)

Materials - Oblique sections from KN 9-4.1, 9-7.1 and Axial sections from KN 24-4.3, 24-1.1.

Description – Shell small, subspherical to ellipsoidal with a slightly curving axis of coiling, convex lateral slopes and bluntly pointed poles. Mature specimens have 4 to 8 volutions and measure 1.1 to 2.6 mm in length and 1.0 to 1.6 mm in width. Proloculus minute to small. Inner 2 to 2 ½ volutions tightly coiled, followed by somewhat rapidly expanding shell until the sixth volution. In the mature stage of growth expansion of shell almost uniform. Spirotheca consists of a tectum and a thick, very finely alveolar keriothica. Lower surface of spirotheca undulatory with short but broad downward prolongations of keriotheca facing parachomata. Lower ends of these fan-shaped rudimentary transverse septula join with the tops of parachomata adjacent to septa. Septa thick and composed of downward deflection of a tectum and anterior and posterior extensions of keriotheca. Parachomata first appear in the second volution, being triangular in cross section, low in the central part of the chambers, but becoming more than half as high as the chambers adjacent to septa. Small foramina occur between parachomata at the base of septa.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 14 Fig.
KN 9-4.1	2.1	1.4	7	-	-	13
KN 9-7.1	1.1	1.0	4	-	-	14
KN 24-4.3	2.6	1.5	7	-	-	15
KN 24-1.1	2.6	1.6	8	2	5	16

Specimen No.	Thickness of spirotheca (micron)							
	1	2	3	4	5	6	7	8
KN 9-4.1	-	10	20	20	40	20	20	-
KN 9-7.1	10	15	15	15	-	-	-	-
KN 24-4.3	-	-	10	15	20	20	20	-
KN 24-1.1	10	10	15	10	20	20	20	10

Comparison – *Maklaya sethaputi* is also closely allied to *Neoschagerina simplex* Ozawa but is distinguishable by its smaller shell, less developd transverse septula and relatively thicker spirotheca for the size of shell. *M. sethaputi* is probably ancestral to *N. simplex*

Straigraphical distribution – Very rare in the upper part of Khao Noi section.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Maklaya saraburiensis Kanmera and Toriyama (Pl. 14, Figs. 20-24)

Materials - Oblique sections from KN 5-11.3, 10-1.1, 23-9.1, 23-7.1 and 23-8.2.

Description – Shell small, subspherical with bluntly pointed poles and convex lateral slopes. Mature specimens possess 8 to 10 volutions and measure 2.0 to 2.2 mm in length and 1.6 to 1.8 mm in width. Proloculus minute. Shell expands uniformly. Inner 2 to 2 ½ volutions have a short axis of coiling. Height of the chambers almost the same throughout length of shell in the outer volutions, but becoming higher poleward in the inner ones. Spirotheca consists of tectum and a faintly alveolar keriotheca. Lower surface of spirotheca undulatory with very short but broad downward prolongations of keriotheca elements. Each of these fan-shaped prolongations occurs immediately above each parachomata and joins with the top of the latter adjacent to septa. Septa composed of downward deflection of a tectum and anterior and posterior extensions of

keriotheca. Parachomata appear in the second volution, being triangular in cross-section, low in central part of the chambers but becoming more than two-thirds as high as the chambers adjacent to septa. Small foramina occur between parachomata at the base of septa.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 14 Fig.
KN 10-1.1	2.5	2.1	8	-	-	21
KN 23-9.1	2.4	2.1	8	1.3	5	22
KN 23-7.1	2.3	1.8	8	-	-	23
KN 23-8.2	1.1	1.5	6	-	-	24

Specimen No.	Thickness of spirotheca (micron)							
	1	2	3	4	5	6	7	8
KN 10-1.1	10	10	10	20	20	20	20	20
KN 23-9.1	10	10	10	10	15	15	15	15
KN 23-7.1	10	10	10	10	10	10	10	15
KN 23-8.2	10	10	10	15	15	15	-	-

Comparison – The present genus resembles species of *Misellina* but its distinguished from the previously known species of the genus in having fan-shaped rudimentary transverse septula.

Straigraphical distribution – Commonly in the upper part of Khao Noi section.

Geological range – Kubergandian (Roadian)

Associated fusulinoideas – *Misellina* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Genus *Neoschwagerina* **Yabe**, 1903

Neoschwagerina sp. (Pl. 6, Figs. 9-10)

Materials - Axial sections KKJ 1-9.1 and 1-10.

Description - Shell moderate, subspherical to fusiform, having bluntly pointed to rounded poles, a straight to slightly shifting axis of coiling and numerous volutions. Proloculus of megalospheric specimens moderate in size. Microspheric generation is distinguishable from megalospheric one by the different mode of coiling of juvenile volutions and the slight difference of proloculus-size. Spirotheca thick composed of a tectum and a fine alveolar keriotheca. Primary transverse septula broad and triangular or fan-shapes in cross section. Axial septula thick and short. Secondary transverse septula appear in outer volutions of evolved species including the type-species. Parachomata massive and low, usually connected with lower end of primary transverse septula.

Comparison – *Neoschwagerina* sp. somewhat resembles *N. creticulifera* in many respects but its distinguished by having a large proloculus and a slightly primitive development of axial and secondary transverse septula.

Geological range – Murgabian (Wordian) to Midian (Capitanian)

Associate fusulinoideas – *Misellina* sp., *Armenia* sp., *Verbeekina* sp., *Thailandina* sp., *Pravitroschwagerina* sp., *Pseudofusulina* sp., *Chusenella* sp., *Neofusulinella* sp., *Schubertella* sp. and *Nankinellla* sp.

Neoschwagerina simplex **Ozawa** (Pl. 7, Figs. 1-5)

1927. *Neoschwagerina simplex* **Ozawa**. Jour. Fac. Sci. Imp. Univ. Tokyo, Sect. II, vol.2, no.3, p.153-154, pl.34, figs.7-11, 22, 23; pl.37, figs.3a, 6a.

1934. *Neoschwagerina* cf. *simplex* **Dutkevitch** and **Khabakov**. Acad. Sci., USSR, vol.7, pl.2, figs.4,5.

1956. *Neoschwagerina simplex* **Chen**. Palaeontologia Sinica, N.S., vol.6, no.2, p.55-56, pl.12, figs.13, ?14, 16 (non fig.15).

1957. *Cancellina sphaerica* **Miklukho-Maklay**. Uchenye Zapiski Lgu, no.225, p.122-123, pl.5, fig.1.

1957. *Neoschwagerina* cf. *simplex* **Kanmera**. Mem. Fac. Sci., Kyushu Univ., Ser.D, vol.6, no.1, pl.20, fig.1.

1959. *Neoschwagerina simplex* **Honjo**. Jour. Fac. Sci., Hokkaido Univ., Ser.4, vol.10, no.1, p.139-142, pl.3, figs. 1, 4, 5; pl.4.

1959. *Neoschwagerina sphaerica* **Honjo**. Jour. Fac. Sci., Hokkaido Univ., Ser.4, vol.10, no.1, p.159, pl.3, fig. 3.

1960. *Neoschwagerina* cf. *simplex* **Kanuma**. Bull. Tokyo Gakugei Univ., vol.11, p.67-68, pl.11, figs. 1, 10, 11.

1962 *Neoschwagerina simplex* **Suyari**. Jour. Gakugei, Tokushima Univ., Nat. Sci., vol.12, p.36. pl.11, fig.1.

1963. *Neoschwagerina simplex* **Kanmera**. Mem. Fac. Sci., Kyushu Univ., Ser.D, Geol., vol.14, no.2, p.112-113, pl.13, figs.1-6; pl.14, fig.1-6, pl.19, fig.15.

1967. *Neoschwagerina simplex* **Leven**. Acad. Sci. USSR, Geol. Inst. Transect., vol.67, p.189-190, pl.32, figs.8-10.

1970. *Neoschwagerina simplex* **Ozawa**. Mem. Fac. Sci., Kyushu Univ., Ser.D, Geol., vol.20, no.1, pl.4, figs.9-11.

Materials - Axial sections from KNV 1-3.2, BHK 2-11, Sagittal section from KNV 1-3.3, Tangential sections from KNV 1-5.3 and 1-9.3.

Description – Shell is moderate in size for the genus *Neoschwagerina*, and is subspherical to thick fusiform with the straight to slightly shifting axis of coiling, convex lateral slopes and broadly rounded poles. Inner three to four volutions assume spherical to subspherical form, and from the fourth or fifth volution shell takes thick fusiform. Proloculus small and spherical in most of specimens, but in some it takes ellipsoidal shape. Expansion of shell is very slow in the first one to two volutions and becomes less slow and uniform in the succeeding volutions. Chamber is nearly the same in height throughout the length of shell. Spirotheca is thin in inner few volutions but become

thicker in out volutions where alveolar structure is shown very clearly. Septa thick and the same in structure as spirotheca. Axial septula may occur in inner three to five volutions, and one axial septulum appears between two adjacent septa in outer volutions, through very primitive in development, being only low swelling of the lower surface of keriotheca. The primitive transverse septula well developed throughout the length of shell. The secondary transverse septula not develop in most part of shell.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 7 Fig.
KNV 1-3.2	0.5	0.5	6	0.3	10	1
KNV 1-3.3	1.3	1.2	5	2.0	10	2
BHK 2-11	1.9	1.7	7	0.7	10	3
KNV 1-5.3	0.6	0.5	6	-	-	4
KNV 1-9.3	1.8	1.3	7	-	-	5

Specimen No.	Thickness of spirotheca (micron)						
	1	2	3	4	5	6	7
KNV 1-3.2	10	10	10	10	20	20	-
KNV 1-3.3	10	10	20	20	20	-	-
BHK 2-11	10	10	10	20	20	20	15
KNV 1-5.3	10	10	30	20	30	20	-
KNV 1-9.3	20	20	30	40	30	30	-

Comparison – *Neoschwagerina simplex* is a good guide species for the lower part of *Neoschwagerina* zone (Toriyama, 1975). Its primitive for the genus *Neoschwaerina*.

Geological range – Murgabian (Wordian)

Associated fusulinoideas – *Pseudofusulina* sp., *Parafusulina* sp., *Yangcheinia* sp., *Pseudodoliolina* sp., *Neothailandina* sp., *Afghanella* sp., *Colania* sp., *Sumatrina* sp., *Pseudofusulina* sp., *Verbeekina* sp. and *Yangcheinia* sp.

Subfamily Lepidolininae **Miklukho-Maklay**, 1958

Genus *Lepidolina* **Lee**, 1933 emend.

Lepidolina lepida (Pl. 8, Figs. 1-12 and Pl. 9, Figs. 1-2)

Materials - Axial sections from KK 11, KCL 2.1, Oblique sections from KK 7.1, 7.2, KT 5.1, 15.1, 17, 18.2, Sagittal sections from KK 8.1, 14.3, KCL 1.1, KP 6.1.

Description – Shell small and elongate cylindrical, with almost straight axis of coiling, almost flat to gently convex lateral slopes, and broadly round poles. Mature shell have 9 to 13 volutions is 4.1 to 10.2 mm in length and 3.3 to 4.0 mm in width, Proloculus subspherical and large for size of shell. Shell expands gradually and nearly uniform throughout growth, although slightly rapidly in outer volutions. Spirotheca very thin, consists of an inner dense layer in inner five volutions. In some, especially, central part of outer volutions, spirotheca is composed of a tectum and a less dense lower layer, in the latter of which, however, no minute structure is observable. Parachomata do not occur in inner two volutions, but well developed from the third to last volutions, with semicircular shape in axial profile. They are rather widely space, and about a half to two-thirds as high as chambers.

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 8 Fig.
KK 11	10.2	3.4	13	4.0	10	1
KCL 2.1	7.1	3.7	13	5.5	10	2
KK 7.1	6.1	3.5	10	4.0	10	3
KK 7.2	3.4	3.4	11	4.0	10	4

Specimen No.	L (mm)	W (mm)	No. vol.	Diameter of Proloculus (mm)	Thickness of Proloculus wall (microns)	Pl. 8 Fig.
KK 8.1	6.3	4.0	13	5.0	20	5
KK 5.1	4.7	3.3	9	5.0	10	6
KT 17	4.1	3.9	12	3.5	-	7
KCL 1.1	5.1	3.7	11	5.0	10	8
KP 6.1	3.0	2.6	9	2.5	-	9
KT 15.1	3.0	2.8	9	2.5	-	10
KT 18.2	5.1	3.8	13	2.5	-	11

Specimen No.	Thickness of spirotheca (micron)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
KK 11	10	30	20	20	20	30	30	20	30	30	30	20	10
KCL 2.1	10	10	10	10	20	20	20	30	20	20	20	20	20
KK 7.1	10	10	10	10	20	20	30	20	20	20	-	-	-
KK 7.2	20	20	20	20	10	10	10	10	10	30	10	-	-
KK 8.1	10	10	10	20	20	20	20	20	20	20	20	10	30
KK 5.1	10	20	30	30	30	30	20	20	30	-	-	-	-
KT 17	10	10	10	10	20	20	20	10	20	20	10	20	-
KCL 1.1	10	10	20	20	20	30	40	30	30	30	20	-	-
KP 6.1	10	10	10	10	10	10	10	10	10	-	-	-	-
KT 15.1	10	10	10	10	20	20	30	30	20	-	-	-	-
KT 18.2	10	10	10	10	10	10	10	10	10	10	20	20	20

Comparison – The present genus is superficially closely to *Lepidolina* from Changwat Sra Kaeow in the general shell structure but the principal difference lies in the number of volutions.

Geological range – Midian (Capitanian)

Associated fusulinoideas – *Verbeekina verbeeki* **Geinitz**, *Chusenella* sp. and *Pseudofusulina* sp.

Genus *Colania* **Lee**, 1933, emends. **Ozawa**, 1970

Colania sp. (Pl. 7, Fig. 7-19)

Materials - Sagittal sections from KP 3.2, 4.2, 5.2, KK 18.1, Oblique sections KP 11.1, KT 9.2, KK 12.2, KP 8.1, KNN 11.1, KNN 13.2, 17.1, Axial sections from KT 22 and KP 2.1

Description – Shell moderate to large for the genus, and it's inflated fusiform with straight axis of coiling, nearly straight to gently convex lateral slopes, and bluntly rounded poles. Mature shell of 10 to 13 volutions attain a length of 4.00 to 6.62 mm and a width of 2.20 to 3.77 mm. Shell exclusively planispiral throughout growth. The first one or two volutions subspherical, and in the succeeding five to six volutions axis extends gradually and slightly rapidly. In outer volutions axial extension is almost uniform. Proloculus small to moderate for the size of shell, with almost spherical to subspherical form. Spirotheca consists of a dense thin layer of tectum and a lower layer of keriotheca. Alveolar structure of keriotheca is clear and very fine. Septa essentially the same in structure as spirotheca, consisting of downward deflection of tectum and downward extension of keriotheca on both sides of tectum. Axial septula not present in inner few volutions. They first appear in the third to fifth volution, but very rare in occurrence and very primitive in development, only primitive salience of the lower surface of keriotheca. In outer volutions one to three, rarely four, axial septula occurs between two adjacent septa. Primary transverse septula, are slender and both sides of each septulum nearly parallel, occur throughout the shell, with lower surface in contact with tops of parachomata. Secondary transverse septula not present in most, if not all, parts of shell.

Geological range – Midian (Capitanian)

Associated fusulinoideas – *Neoschwagerina* sp., *Sumatrina* sp., *Chusenella* sp., and *Verbeekina verbeeki* **Geinitz**.

Subfamily Sumatrimninae **Kahler and Kahler**, 1946

Genus *Sumatrina* **Volz**, 1904

Sumatrina sp. (Pl. 9, Figs. 1-16)

Materials - Axial section from KKJ 1-2.1, Oblique sections KKJ 1-5.4, 1-9.2, KNN 5.3, 10.4, 23.1.

Description –Shell medium and elongate fusiform to cylindrical, having a straight to slightly shifting axis of coiling, a small number of volutions, and a relatively large proloculus. Spirotheca extremely thin, composed of a tectum and an extremely thin keriotheca. Septa long and thin, and widely spaced. Primary transverse septula thin and short. Secondary transverse septula also thin and uniform in size and shape, their lower part thickened, and club-shaped in cross-section. Two to four secondary transverse septula exist between primart transverse septula. Parachomata massive and high, connecting with lower end of primart transverse septula. Foramina numerous, occurring throughout the length of shell.

Geological range – Midian (Capitanian)

Associated fusulinoideas – *Neoschwagerina* sp., *Colania* sp., *Chusenella* sp. and *Verbeekina verbeeki* **Geinitz**.

Genus *Afghanella* **Thompson**, 1946 (Pl. 7, Fig. 6 and Pl. 9, Figs. 3-10)

Materials - Oblique sections from KMN 1-3.2, KNV 1-5.1, 1-5.4, 1-6.2, 1-11.3, Axial sections from KNV 1-1.1, 1-2.1, 2-5.

Description - Shell inflates fusiform to typical fusiform, having a straight axis of coiling and a moderate to large proloculus. Spirotheca thin composed of a tectum and a keriotheca. Septa thin and long and widely spaced primary transverse septula short and thin, and uniform in size and shape. Secondary transverse septula thin and short. Lower part of septula thickened by secondary deposits related to parachomata. Parachomata well developed, narrow, and high. Foramina semicircular.

Geological range – Murgabian (Wordian) to Midian (Capitanian)

Associated fusulinoideas – *Parafusulina* sp., *Pseudofusulina* sp., *Verbeekina* sp., *Yangcheinia* sp., *Neoschwagerina* sp., *Pseudodoliolina* sp., *Neothailandina* sp.