

Paleontological Study of Fusulinoidean Fossils from the Terbat Formation, Sarawak, East Malaysia

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Paleontological Study of Fusulinoidean Fossils from the Terbat Formation, Sarawak, East Malaysia

Takuya SAKAMOTO* and Takeshi ISHIBASHI

Abstract

Carboniferous-Permian rocks belonging to the Terbat Formation are restrictively distributed at the southern area of Kuchin of west Sarawak, East Malaysia, Borneo. The formation is composed of limestone, chert, and shale. The present paper deals with the smaller foraminifers and fusulinoidean fossils of which are given paleontological descriptions. Twenty-nine species including 9 unidentified species of 18 genera of fusulinoidean fossils are described. They comprise such genera as *Millerella*, *Ozawainella*, *Pseudostaffella*, *Fusiella*, *Schubertella*, *Boultonia*, *Profusulinella*, *Fusulinella*, *Beedeina*, *Fusulina*, *Quasifusulina*, *Darvasites*, *Chusenella*, *Rugosofusulina*, *Paraschwagerina*, *Triticites*, and *Sphaeroschwagerina*. The micropaleontological reports on foraminifers including fusulinoidean fossils (VACHARD, 1990) and conodont (METCALFE, 1985) of the Terbat Formation have been published. This is the report describing the fusulinoidean fossils on the basis of many samples around Terbat area. Other associated smaller foraminifers, bryozoans, ostracods, algae, corals, and crinoids are also illustrated.

The fusulinoidean fauna is ranging from the Middle Moscovian of lower Upper Carboniferous up to Upper Asselian of the lower Lower Permian, and correlated with the previously known fusulinoidean zones and fauna of the Eastern Tethys region including Thailand, South China, and Japan.

Keywords: Fusulinoidean, Carboniferous-Permian, Borneo, East Malaysia

1. Introduction

The State of Sarawak, most of which is covered with jungle, is located in Northwest Borneo, East Malaysia, as shown in Fig. 1. The village of Terbat is situated approximately 70 km to the south-southeast of Kuching, the capital of Sarawak State (Fig. 2). The distribution of the Terbat Formation shows a belt, centering Terbat, about 3 km wide, extending about 13 km in a northwest-southeast direction. The central part of the Terbat Formation belt is crossed by the Sungai (=river) Kedup from west to east-winding intensely with some tributaries. Its drainage area is the very low-lying country and called Kedup Valley. The formation also crops out at Gunong (=mountain) Selabor, about 5 km northwest of Terbat (northwest end of the belt) and forms a steep limestone hill 400 m high which contrasts with the area of low relief in the Kedup Valley (Fig. 3). An extensive cave system penetrates the complete length of the hill. The Terbat Formation comprises

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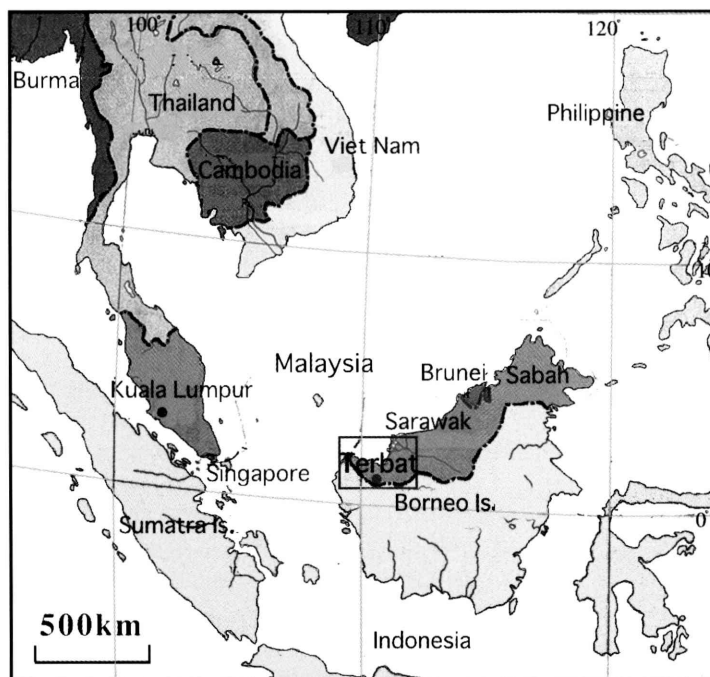


Fig. 1. Index map of study area of Borneo, East Malaysia.

limestone, chert, and shale. Limestone is the most common rock type of formation and frequently contains abundant foraminifers of Carboniferous-Permian.

Paleozoic rocks in the Kedup Valley were first proved by KREKELER (1932, 1933) and reported the occurrence of fossiliferous Paleozoic rocks by KREKELER (1955). The Terbat Formation was named and described by HAILE (1954) who accorded it a Carboniferous-Permian age based on identification of foraminifers by the late A. G. DAVIS. The Gunong Selabor area was briefly mapped by WILFORD (1955) and his list of fossils from the formation contains the following fusulinoideans: *Parafusulina* cf. *granum avenae* (ROEMER), *P.* sp., ?*P.* sp. and ?*Staffella* sp., in association with other foraminifers, algae, radiolaria and coelentelata.

CUMMINGS (1955, 1962) recognized 23 species of foraminifers from this formation with illustrations of specimens in a few plates, describing the concise characters of some ones, and included fusulinoideans of the following species: *Schwagerina* spp., *Pseudoschwagerina* (*Zellia*) *heritschi heritschi* KÄHLER and KÄHLER, *P.* cf. *uber* THOMPSON and HAZZARD, *P.* spp., *Paraschwagerina* cf. *gigantea* (WHITE), *P.* spp. and *Staffella*? spp. The age of the fauna was determined as Lower Permian. Nearly the same species reported by CUMMINGS (1962) were listed by WILFORD and KHO (1965), and they newly identified *Triticites* sp., *Quasifusulina* sp., ?*Pseudofusulina* sp. and *Schubertella* sp. with no paleontological description.

SANDERSON (1966) reported only the names of the fusulinoideans contained in the limestone collections from both Gunong Selabor and Kedup Valley as follows : *Taitzeoella librovitchi* (DUTKEVICH), *Profusulinella* cf. *priscoidea* RAUSER-CHERNOUSSOVA, *P.* cf. *regia* THOMPSON, *Pseudostaffella sphaeroidea* (MÖLLER), *P.* *greenlandica* ROSS and DUNBAR, *Fusulinella* sp., *F.* cf. *eopulchra* RAUSER-CHERNOUSSOVA, ?*Paraefusulina* sp., *Ozawainella* cf. *mosquensis* RAUSER-CHERNOUSSOVA, *Fusiella* sp., *Fusulina* sp., and *Millerella* sp. He concluded the formation to extend down into the lower Upper Carboniferous (Moscovian and Upper Bashkirian).

Based on these facts, the present paper deals with the systematic paleontology of the fusulinoidean fossils collected from the Terbat Formation. Additionally, the correlation with other fusulinoidean fauna of Eastern Tethys Realm is discussed in this paper. In order to enter into particulars of fusulinoidean assemblages, a detailed field survey was carried out in Gunong Selabor and Kedup Valley along Sungai Kedup and its tributaries (Fig. 3 and Fig. 4). As shown in these figures, limestone specimens were collected



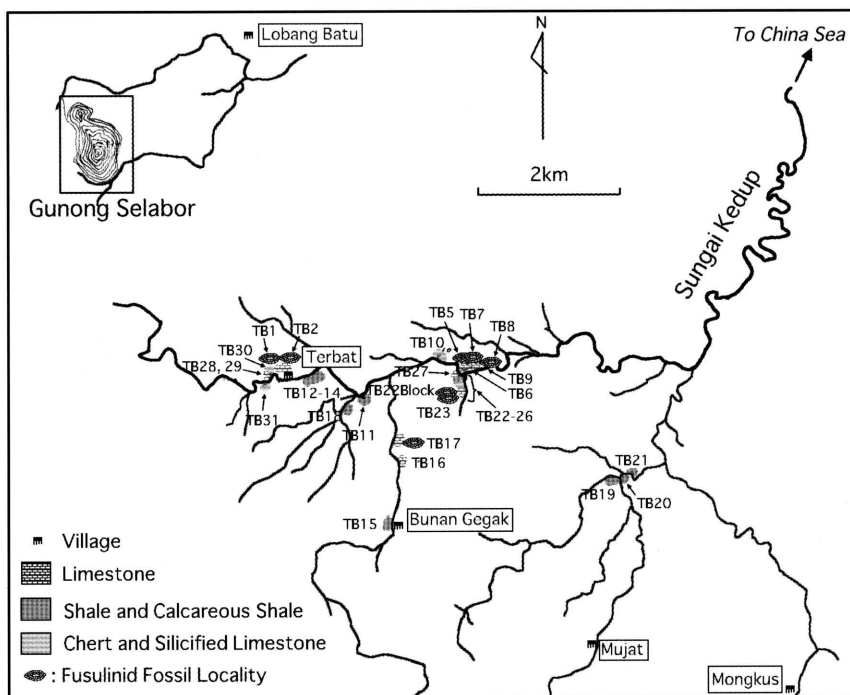


Fig. 3. The map showing the localities of sampling point at Kedup Valley, Sarawak.

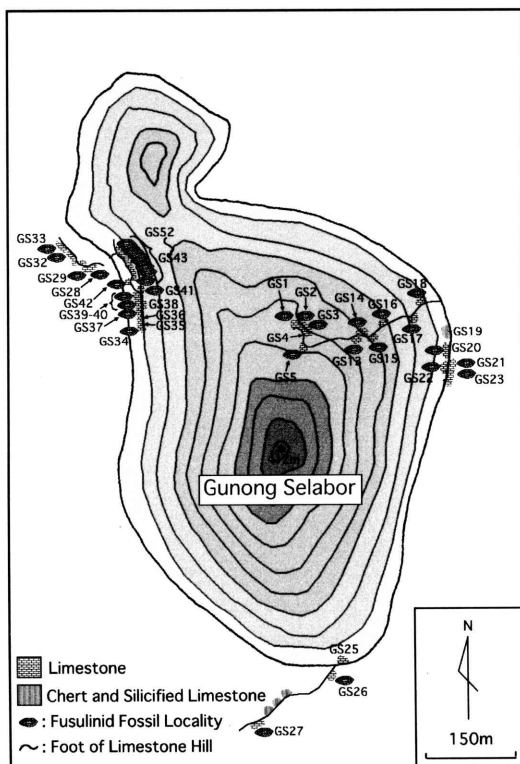


Fig. 4. Location map of samples at the Gunong Selabor, Sarawak.

from over 70 localities in the field. The fusulinoideans and other organisms were classified and identified by means of the observations of about 600 thin sections from the collected limestones. The distribution of fusulinoidean species in the collections from Kedup Valley is shown in Table 1, that from Gunong Selabor in Table 2, and other organisms in Table 3, respectively. The result of this study has an important significance in the consideration of faunal assemblages of Carboniferous-Permian not only in Malaysia, but also in the world.

The thin sections with a prefix GK-D are deposited at the Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University.

II. Acknowledgements

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III. Geology of the Terbat Formation

The Terbat Formation occurs in the Upper Kedup Valley at Terbat Village, the type area, and in much of the very low-lying country to the south of the Sungai Kedup which is drained by the several tributaries. The formation also crops out at Gunong Selabor, an isolated precipitous limestone hill rising to 412 m at sea level and situated about 5 km northwest of Terbat.

According to PIMM (1965), and WILFORD and KHO (1965), the Terbat Formation is surrounded by sediments of the Sadong Formation referred to Triassic. ISHIBASHI (1975) described the Middle Triassic ammonoid, *Sturia* aff. *sanzovinii* (MOJSISOVICS) from it. The Sadong Formation rests with angular unconformity on the Terbat Formation, in the Kedup Valley and is in fault contact with the formation at Gunong Selabor.

According to WILFORD and KHO (1965), the Terbat Formation, folded strongly, is steeply dipping and most dips are between 70° and 90°. The strike of the large outcrop referred to the Terbat Formation in Kedup Valley which has a northwesterly strike parallel to that of the adjacent, and overlying Sadong Formation. On the other hand, at Gunong Selabor the strike is more variable though north to north-northeast trends are common. The Terbat formation is at least 900 m thick but the total thickness cannot be ascertained as neither the base nor the top of the formation is exposed.

The formation is composed of massive limestone, chert and shale. The limestone contains foraminifers of lower Upper Carboniferous (Upper Bashkirian) to Lower Permian (Sakmarian) (YIN, 1991). Recrystallization in the limestone is common and in places is associated with dolomitisation and silicification. The Terbat Formation limestone from Kedup Valley is gray to dark-gray in color, massive, sparsely fossiliferous rock, and originally had a microcrystalline calcite (micrite) matrix. The original textures and fauna of the limestone are partly obliterated by varying degrees of recrystallization producing coarse-grained clear calcite mosaic. Foraminifers and bryozoan debris are the most common fossils contained in the limestone. The limestone at Gunong Selabor is mostly massive and pale-gray in color. The faunal content of the limestone varies from sparse to abundant. The most widespread fossils are foraminifers and fragments of crinoids, but algae and bryozoans make up a considerable proportion of some rocks.

Chert is interbedded with the limestone or occurs as rows of nodules parallel to the bedding planes. Large chert boulders occur throughout the outcrops. The pale colored chert tends to replace the limestone matrix, and the dark colored chert does the fossil-rich beds. Some microsections show relict fossil, entirely replaced by silica. The shale forms a distinct belt within the limestone in the Kedup Valley but at Gunong Selabor it is rare. It is gray to dark-gray color and some of it is quite calcareous.

IV. Discussion of fusulinoidean Fauna

The distribution of the total fusulinoidean assemblages collected from the Terbat Formation, including generic determinations, (several specimens are of family or subfamily rank), is summarized in Tables 1 and 2. Of which 29 species including 9 unidentified species of 18 genera are described in this work as follows;

Millerella? sp., *Ozawainella* spp., *Ozawainella* ex gr. *digitalis* MANUKALOVA, *Ozawainella* cf. *mosquensis* RAUSER-CHERNOUSSOVA, *Ozawainella* *angulata* (COLANI), *Ozawainella* cf. *pseudotingi* DUTKEVICH, *Pseudostaffella sphaeroidea* (MÖLLER), *Fusiella* sp., *Schubertella* spp., *Schubertella* sp. A, *Schubertella* cf. *simplex* LANGE, *Boultonia* sp., *Profusulinella* cf. *ovata* RAUSER-CHERNOUSSOVA, *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA, *Beedeina lanceolata* (LEE and CHEN), *Fusulina pulchella* GRYZLOVA, *Fusulina* spp., *Quasifusulina* cf. *tenuissima* (SCHELLWIEN), *Darvasites pseudosimplex* (CHEN), *Darvasites?* sp., *Paraschwagerina* cf. *yanagidai* IGO, *Pseudofusulina* cf. *tschernyschewi* (SCHELLWIEN), *Rugosofusulina* cf. *extensa* (SKINNER and WILDE), *Triticites* cf. *suzukii* (OZAWA), *Triticites* cf. *haydeni* (OZAWA), *Triticites?* spp., *Chusenella* cf. *shengi* TORIYAMA and KANMERA, *Chusenella* cf. *schwagerinaeformis* SHENG, and *Sphaeroschwagerina* aff. *sphaerica* (SCHERBOVICH).

The followings are discussion of the fauna of each locality where relatively determinable fusulinoidean fossils were found.

1. TB1, TB2: Neighborhood of Terbat. These massive, dark-gray limestones are composed of bioclasts (chiefly fusulinoideans, smaller foraminifers and crinoid stems) sparsely distributed in microcrystalline calcite matrices. Based on DUNHAM (1962) and EMBRY and KLOVAN (1972), they are assignable to bioclastic wackestones.

The following fusulinoideans have been identified: *Sphaeroschwagerina* aff. *sphaerica* (SCHERBOVICH), *Rugosofusulina* cf. *extensa* (SKINNER and WILDE), *Pseudofusulina* cf. *tschernyschewi* (SCHELLWIEN), *Darvasites pseudosimplex* (CHEN), *Chusenella* cf. *shengi*, *Quasifusulina* cf. *tenuissima* (SCHELLWIEN), *Parafusulina* sp., *Triticites?* spp., *Boultonia* sp., *Fusiella* sp., *Schubertella* sp., and *Millerella?* sp.

Sphaeroschwagerina sphaerica (SCHERBOVICH) was originally described from the European part of Russia. Subsequently, this species has been described from many localities in the Asian countries (e.g., PITAKPAIVAN, 1966; CHEN and WANG, 1983), and it is a zonal index species of the upper part of the Asselian Stage in the type section (WATANABE, 1991). It is associated with *Pseudofusulina tschernyschewi* (SCHELLWIEN) in the Central Timan region (WATANABE, 1991). The latter ranges up to the Lower Sakmarian Stage. *Sphaeroschwagerina sphaerica* was also reported from the limestone of Noankowtok, Central Thailand by PITAKPAIVAN (1966). According to LIN *et al.* (1979), *Rugosofusulina* cf. *extensa* (SKINNER and WILDE) was found from the *Pseudoschwagerina* zone in the Chuanshan Formation of Hunan, South China associated with *Sphaeroschwagerina sphaerica* (SCHERBOVICH). *Quasifusulina tenuissima* (SCHELLWIEN) is a common species in the Ural and Tethyan Lower Permian (IGO, 1972). *Chusenella* cf. *shengi* TORIYAMA and KANMERA, and *Chusenella* cf. *schwagerinaeformis* SHENG have been also reported from the Lower Permian of Thailand together with *Rugosofusulina* and *Sphaeroschwagerina*.

All the records cited above indicate that the fusulinoidean fauna of TB1 and TB2 is undoubtedly referred to the Upper Asselian Stage of Lower Permian and can be correlated to the *Sphaeroschwagerina sphaerica*-*Pseudofusulina firma* Zone of Russia, *Sphaeroschwagerina glomerata* Zone of South China, the limestone of Noankowtok, Central Thailand.

2. TB5: 2 km down the Sungai Kedup from Terbat. This limestone is dark-gray and sparsely fossiliferous, chiefly containing fusulinoidean fossils which have suffered recrystallization in several phases. It has almost the same original lithology and diagenetic history as TB1 and TB2. The following fusulinoidean species are contained: *Darvasites pseudosimplex* (CHEN), *Darvasites?* sp., and *Sphaeroschwagerina?* sp.

The specimens of *Darvasites* contained in the limestone of TB5 do not contribute much to the age determination because they are too poor to make a comparison with any known species of the genus. *Darvasites pseudosimplex* (CHEN) was first described from the *Darvasites* subzone in southeast Hunan, South China accompanied with some species of the index genus. This subzone is correlated to the middle part of the Sakamotozawan Stage in Japan. However, it is extremely doubtful whether the limestone of TB5 can be correlated with Middle Sakamotozawan because of the poverty of the information in fauna.

3. TB7: Nearly the same location of TB5. The dark-gray packstone contains fusulinoidean debris with recrystallized micritic matrix.

The following species have been identified: *Sphaeroschwagerina?* sp., *Quasifusulina* sp., *Triticites?* spp., *Boultonia* sp., and *Schubertella* sp. Most of these genera are known to occur in rocks of Upper Carboniferous to Lower Permian in age, especially *Sphaeroschwagerina* occurs in the Asselian rocks restrictively. Based on the occurrence of *Sphaeroschwagerina*, this limestone is probably correlated to the Asselian Stage.

4. GS1: North side of Gunong Selabor peak. This pale-gray limestone contains quite abundant foraminifers, and rare algae. This limestone would be originally referred to foraminiferal packstone, but has undergone recrystallization of the micritic matrix, with the production of a coarse-grained mosaic of secondary calcite.

Table 1. Distribution of fusulinoidean species of the Terbat Formation at Kedup Valley.

species \ Loc. No.	TB 1	TB 2	TB 5	TB 7	TB 8	TB 17	TB 22T	TB 23
<i>Rugosofusulina</i> cf. <i>extensa</i>	●	●						
<i>Darvasites pseudosimplex</i>	▲		●					
<i>Darvasites?</i> sp.			▲		▲			
<i>Chusenella</i> cf. <i>shengi</i>	▲					×		
<i>Sphaeroschwagerina</i> aff. <i>sphaerica</i>	▲	▲						
<i>S.?</i> sp.			▲	▲				
Pseudoschwagerinidae gen.et sp. indet.				×				
<i>Quasifusulina</i> cf. <i>tenuissima</i>	●	●		▲				
<i>Paraschwagerina</i> cf. <i>yanagidai</i>	×							
Schwagerinidae gen. et sp. indet.							▲	
<i>Triticites?</i> sp.		×		×				
<i>Pseudofusulina</i> cf. <i>tschernyschewi</i>		▲						
<i>Boultonia</i> sp.	×	▲		×				
<i>Schubertella</i> sp. A	▲	▲		×	×			
<i>Millerella?</i> sp.	▲	▲						
Ozawainellidae gen.et sp. indet.								×

● : Abundant ▲ : Common × : Rare

Table 2. Distribution of fusulinoidean species of the Terbat Formation at Gunong Selabor.

species	Loc. No.	GS 1	GS 2	GS 3	GS 5	GS 13	GS 14	GS 15	GS 16	GS 17	GS 18	GS 20	GS 21	GS 22	GS 23	GS 26	GS 27	GS 28	GS 29	GS 32	GS 33	GS 34	GS 37	GS 39	GS 40	GS 41	GS 42	GS 43	GS 44	GS 45	GS 47	GS 48	GS 49	GS 50	GS 51	GS 52		
Schwagerinidae gen. et sp. indet.		×		×	×					×					×	×																						
<i>Triticites</i> cf. <i>haydeni</i>				▲																																		
<i>T.</i> cf. <i>suzukii</i>							▲				●																											
<i>T.</i> ? spp.				▲																																		
<i>Fusiella</i> sp. A		▲																																				
<i>Schubertella</i> cf. <i>simplex</i>		●					×	×													●						×											
<i>S.</i> spp.		▲																																				
Schubertellidae gen. et sp. indet.																								×								×						
<i>Ozawainella</i> ex gr. <i>digitalis</i>		▲																																				
<i>O.</i> <i>angulata</i>																						×	×														×	
<i>O.</i> <i>mosquensis</i>																																			×	×		
<i>O.</i> cf. <i>pseudotingi</i>																																					×	
<i>O.</i> spp.		●																								×		×		×		×	▲		×		▲	
Ozawainellidae gen. et sp. indet.									×			×																								×		
<i>Beedeina lanceolata</i>		●																																				
<i>B.</i> sp.		×																																				
<i>Fusulina pulchella</i>													▲									×							×	×	▲			●		▲		
<i>F.</i> sp.										×		▲																▲?				×	×		×	●		
Fusulinidae gen. et sp. indet.														▲																								
<i>Fusulinella eopulchra</i>		▲																																				×
<i>Profusulinella</i> cf. <i>ovata</i>		●																				▲																
<i>Pseudostaffella sphaeroidea</i>		×																				▲							▲				▲				▲	
<i>P.</i> sp.																																				▲		
Pseudostaffellidae gen. et sp. indet.																	×																					
<i>Profusulinella</i> sp.																			▲			▲													×			
<i>Eoschubertella</i> sp.																			▲?		▲	▲?				×												
<i>Nankinella</i> sp.																						▲																

● : Abundant ▲ : Common × : Rare

The following fusulinoideans have been identified: *Beedeina lanceolata* (LEE and CHEN), *Beedeina* sp., *Profusulinella* cf. *ovata* RAUSER-CHERNOSSOVA, *Schubertella* cf. *simplex* LANGE, *Schubertella* spp., *Fusiella* sp., *Ozawainella* ex gr. *digitalis* MANUKALOVA, *Ozawainella* spp., *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA, and *Pseudostaffella sphaeroidea* (MÖLLER).

Beedeina lanceolata (LEE and CHEN) and *Pseudostaffella sphaeroidea* (MÖLLER) are well known species of the Huanglung Limestone, Penchi Series of South and North China (LEE *et al.* 1930; LIN *et al.*, 1991), and the Ichinotani Formation of Central Japan (IGO, 1972), respectively. They are corresponding with the upper part of the Moscovian Stage in the standard Carboniferous subdivision or with the Kurikian Stage in Japan. *Schubertella* cf. *simplex* Lange occurs in the *Beedeina konnoi* subzone of the Tangshan Formation, Hebei, North China accompanied with many species of *Beedeina*. *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA is obtained from the zone of the same name, established by KAWANO (1961), in Handa Plateau of the Western Chugoku Massif, Southwest Japan. This zone can be correlated to the *Fusulinella biconica* Zone of the Akiyoshi Limestone Group. Based on the facts mentioned above, the limestone collected at GS1 is probably referred to Upper Moscovian in age.

5. GS3: North side of Gunong Selabor peak. This pale-gray bioclastic wackestone contains only one fusulinoidean genus and few smaller foraminifers. The following fusulinoideans are included: *Triticites* cf. *haydeni* (OZAWA) and *Triticites*? spp.

Triticites haydeni (OZAWA) was originally described by OZAWA (1925) and also described by TORIYAMA (1958) from the Akiyoshi Limestone Group, Southwest Japan associated with other species of *Triticites*. *Triticites* aff. *haydeni* was reported by IGO (1972) from the *Triticites ozawai-Paraschwagerina yanagidai* Zone of North Thailand. This zone referred to the Lowest Permian was established by him in the Ban Num Lum and Tham Nam Maholan sections. Recently, WATANABE (1991) made a detailed study on the fusulinoidean biostratigraphy based on inflated schwagerinids of the Upper Carboniferous and Lower Permian, and concluded that the *Triticites ozawai-Paraschwagerina yanagidai* Zone can be correlated to the upper part of the Gzhelian Stage. Accepting his view, the limestone of GS3 is referable to Upper Gzhelian.

6. GS14: Northeast side of Gunong Selabor peak. This limestone, which is pale-gray in color and originally referred to bioclastic grainstone, contains fusulinoideans and bryozoan debris. The following fusulinoideans have been identified: *Triticites* cf. *suzukii* (OZAWA) and *Schubertella* cf. *simplex* Lange.

Triticites suzukii (OZAWA) has been previously known to occur in Japan and Thailand, however, the views of its stratigraphic position have been different by the students. Consequently, the geological age of this limestone is here considered as the Gzhelian of Upper Carboniferous.

7. GS21: East foot of Gunong Selabor. This gray limestone assignable to bioclast wackestone has suffered partial dolomitization. It contains following fusulinoidean fossils: *Fusulina pulchella* Gryzlova, and *Fusulina* sp.

Fusulina pulchella GRYZLOVA, was described from the Mjachkovo horizon in Russia (GRYZLOVA, 1951). The same species was described by IGO (1972) from the *Fusulina pulchella* Zone of Upper Moscovian in North Thailand. According to these evidence, the limestone of GS21 is evidently correlated to the Mjachkovo (upper part of Moscovian) in the Russian Platform, and to the *Fusulina pulchella* zone in Thailand.

8. GS32, GS33, GS43, GS47, GS49, GS50, GS52: Northwest foot of Gunong Selabor. These pale-gray limestones are moderately fossiliferous and referable to wackestone or packstone. They have

partially undergone recrystallization of the micritic matrices.

The identified fusulinoidean species are following: *Pseudostaffella sphaeroidea* (MÖLLER), *Pseudostaffella* sp., *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA, *Fusulinella* sp., *Ozawainella angulata* (COLANI), *Ozawainella* cf. *mosquensis* RAUSER-CHERNOUSSOVA, *Ozawainella* cf. *pseudotingi* DUTKEVICH, *Ozawainella* spp., *Fusulina* spp., and *Nankinella* sp., associated with *Profusulinella* sp., and *Eoschubertella* sp. doubtfully.

Pseudostaffella sphaeroidea (MÖLLER), abundant in these limestones, occurred from the Podol to Mjachkovo in Russia (IGO, 1972). *Ozawainella angulata* (COLANI), long-ranging species, has been found from the Kashira to Mjadjkovo in the type section (IGO, 1972). These two species are found from the *Fusulina pulchella* zone of North Thailand by IGO (1972). These two well-known species are also described from the *Fusulina* Zone in China, Japan, and other Tethys regions (LIN *et al.*, 1991; IGO, 1957, 1972 *etc.*). *Ozawainella mosquensis* RAUSER-CHERNOUSSOVA was described from the Kashira to Podol horizons on the Russian Platform (RAUSER-CHERNOUSSOVA, 1951). *Ozawainella pseudotingi* DUTKEVICH was reported by LIN *et al.* (1991) from the rocks of lower Lower Carboniferous to Lower Permian. Based on these faunal evidence, the present fauna corresponds to that of GS21 and can be correlated to the upper part of Moscovian in the Russian Platform, the *Fusulina pulchella* Zone in Thailand and the Zone of *Fusulina* or the Kurikian in Japan.

The correlation of the Terbat Formation with other Tethys regions are summarized in Fig. 5.

Table 3. Distribution of micro organisms except for fusulinoideans from the Terbat Formation.

species	Loc. No.	Kedup Valley							Gunong Selabor																		
		TB 1	TB 2	TB 13-1	TB 13-2	TB 24	TB 26	TB 29	GS 1	GS 3	GS 4	GS 5	GS 13	GS 14	GS 15	GS 18	GS 23	GS 26	GS 27	GS 33	GS 42	GS 43	GS 47	GS 49			
Foraminiferids					●																						
Nodosaria sp.									●											●							
Geinitzina sp.									●																		
Palaeotextularia sp.			●						●												●	●		●			
Endothyra sp.			●										●							●				●			
Planoendothyra sp.										●																	
Tetrataxis sp.		●							●				●	●					●				●				
Tuberitina sp.		●	●						●																		
Calcisphaera sp.		●																									
Climacammina sp.									●					●													
Bradyina sp.														●													
Globivalvulina sp.														●													
Nodosinella sp.		●	●																								
Algae																											
Vermiporella sp.					●																						
Pseudovermiporella sp.														●													
Solenopora sp.																●			●								
Epimastopora sp.																		●									
Parachaetetes sp.									●																		
Bryozoans																											
Streblascopora sp.														●													
Penniretepora sp.														●	●												
Sulcoretepora? sp.														●													
Bryozoan debris				●	●	●	●	●				●	●			●	●	●									
Other Organisms																											
Ostracods														●													
Crinoid stems						●		●			●						●	●			●				●		

● : Abundant ▲ : Common × : Rare

● : Abundant ▲ : Common × : Rare

V. Concluding Remarks

Twenty-nine species and subspecies of fusulinoideans, including 9 unidentified species, of 19 genera are described from the Terbat Formation. All of them are previously established species. The same unidentified species of fusulinoideans and smaller foraminifers were obtained. The latter is illustrated in the plates in this paper. They almost belong to the types of fusulinoideans which are widely distributed geographically in the Late Paleozoic of East Asia. Among the 17 identified species, 9 species are known to occur in Thailand, 8 in South China, Russia, and Japan, and seven in North China. This indicates that the fusulinoideans of the Terbat Formation have much affinity to those of their regions. The following faunas are recognized from the present formation in descending order:

Lower Permian

Sphaeroschwagerina aff. *sphaerica* - *Rugosofusulina* cf. *extensa* fauna

Upper Carboniferous

Triticites fauna

Fusulina pulchella - *Pseudostaffella sphaeroidea* fauna

Profusulinella cf. *ovata* - *Beedeina lanceolata* fauna

These four fusulinoidean faunas are ranging from the middle part of Moscovian to the upper part of Asselian, and correlated to previously known fusulinoidean zones of the Tethyan region including Thailand, South China, and Japan (Fig. 5). This result obtained in the present study will be available for the future studies on the faunal assemblage of Carboniferous to Permian in the Tethys Region. The distribution of the sampling points in Gunong Selabor is restricted within the narrow

Geologic Age		This Study	Thailand (INGAVAT <i>et al.</i> ; 1965, WATANABE ; 1991)	South China (XIANG <i>et al.</i> ; 1980, etc...)	Akiyoshi (OTA ; 1977, WATANABE ; 1991)
Lower Permian	Sakmarian		<i>Robustoschw. schellwieni</i> f.	<i>Robustoschw. schellwieni</i> z.	<i>Pseudofusus. vulgaris</i> z.
	Asselian	<i>Sphaeroschw. aff. sphaerica</i> - <i>Rugosofusulina</i> cf. <i>extensa</i> f.	<i>Sphaeroschwagerina sphaerica</i> f.	<i>Sphaeroschwagerina golmerosa</i> z.	<i>Pseudoschwagerina muongthensis</i> z.
		?		<i>Sphaeroschwagerina constans</i> z.	
			<i>Paraschw. indigesta</i> f.		
Upper Carboniferous	Gzhelian	<i>Triticites</i> fauna	<i>Pseudoschw. yanagidai</i> - <i>Triticites ozawai</i> z.	<i>Triticites simplex</i> z.	<i>Triticites simplex</i> z.
	Kasimovian	?		<i>Tri. pseudomontiparus mesopachus</i> z.	<i>Triticites matsumotoi</i> z.
			<i>Protriticites tethydis</i> z.		
	Moscovian	<i>Fusulina pulchella</i> - <i>Pseudostaffella sphaeroidea</i> fauna	<i>Fusulina pulchella</i> z.	<i>Fusulina-Fusulinella</i> z.	<i>Beedeina akiyoshiensis</i> z.
		<i>Beedeina lanceolata</i> fauna	<i>Hemifusulina</i> (?) <i>thaiensis</i> z.		<i>Fusulinella biconica</i> z.
		?	<i>Beedeina paradistenta</i> z.		
			<i>Profusulinella prisca timanica</i> z.		
	Bashkirian		<i>Profusulinella parva</i> z.		
				<i>Pseudostaff. antiqua</i> z.	<i>Pseudostaff. antiqua</i> z.

Fig. 5. Correlation chart of fusulinoidean zones of Upper Carboniferous - Lower Permian with other major areas of Tethys.

limits in the present investigation. Consequently, more comprehensive survey is necessary for the clarification of the systematic stratigraphy in the future.

The smaller foraminifers and other organisms associated with fusulinoideans are only illustrated this time, but they are useful for correlation to fossil assemblages of limestones of other Tethys regions such as South China and Southeast Asia (*i.e.*, ISHIBASHI *et al.*, 1998).

VI. Description of Species

Superfamily **Fusulinoidea** VON MÖLLER, 1878

Family **Ozawainellidae** THOMPSON and FOSTER, 1937

Subfamily **Ozawainellinae** THOMPSON and FOSTER, 1937

Genus ***Millerella*** THOMPSON, 1942

***Millerella?* sp.**

[Pl. 3, Figs. 23–25]

Descriptive Remarks.— Only one axial and two sagittal specimens having very small, lenticular shells were obtained. Their shells are composed of 3 volutions. In well-oriented specimen (Pl. 3, Fig. 23), axial length 0.13 mm, median width 0.39 mm and form ratio 0.33. Median width of first to third volutions 0.13, 0.22, and 0.39 mm, respectively. Proloculus minute, its outside diameter 40 μ m. Spirotheca thin; thickness of outermost volution 15 μ m. Wall structure obscure owing to recrystallization.

They may belong to the genus *Millerella*, but they are too poor to make detailed comparison and specific identification.

Occurrence.— TB1, TB2.

Genus ***Ozawainella*** THOMPSON, 1935

Ozawainella ex gr. digitalis MANUKALOVA, 1951

[Pl. 1, Fig. 2 and 3; Table 4]

Ozawainella ex gr. digitalis: MANUKALOVA, in RAUSER-CHERNOUSOVA *et al.*, 1951, p. 132, pl. 10, fig. 3.

Table 4. Measurements of *Ozawainella ex gr. digitalis* Manukalova in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions			
					1	2	3	4
Pl. 1 Fig. 2	0.20	1.05	0.19	0.020	0.16	0.30	0.61	1.05
Pl. 1 Fig. 3	0.23	0.90	0.26	-	0.14	0.29	0.46	0.90

Description.— Test small, discoidal, coiling axis short. Inner 2 volutions round, but outer volutions subangular to narrowly rounded. Coiling is almost planispiral, involute but partially evolute in the last volution. Polar regions of outer ones umbilicated. Number of volution 4–5 in mature specimens. Width 0.90 to 1.05 mm, length 0.20 to 0.23 mm, and ratio width to length 0.22. Proloculus small with diameter of 20 μ m. Wall thin, about 20 μ m of last volution, and dark, but wall structure obscure owing to recrystallization. Septa completely unfluted throughout. Chomata not clear and tunnel narrow. The measurements of this species given in Table 4.

Remarks.— This species was described in Russia by some authors (*e.g.*, PUTRJA, 1956). In the taxonomic characters the present form agrees well with their types. The present specimens resemble *Ozawainella stellae* MANUKALOVA, but differs in its smaller shell.

Occurrence.— GS1.

***Ozawainella cf. mosquensis* RAUSER-CHERNOUSOVA, 1951**

[Pl. 1, Figs. 7 and 8]

Compare.—*Ozawainella mosquensis*:— RAUSER-CHERNOUSOVA, in RAUSER-CHERNOUSOVA *et al.*, 1951, p. 136, 137, pl. 10, figs. 14–16.

Description.— Test small, discoidal in shape, involuted with acutely pointed periphery and depressed umbilical region. Coiling axis straight. Mature shell probably consists of 4 to 5 volutions. In the tangential section of the specimen (Pl. 1, Fig. 7), axial length 0.53 mm, radius vector of the last volution 0.55 mm, and form ratio 0.48.

Width probably third to fifth volutions of this specimen (the first and second volutions can not be observed).— 0.41, 0.80, and 1.10 mm, respectively. Shape of each volution essentially the same throughout growth. Proloculus unknown. Thickness of spirotheca 20 to 28 μm . Septa unfluted throughout. Chomata well-developed, symmetrical and massive. Tunnel path regular, narrow, and low.

Remarks.— The present specimens resembles *Ozawainella mosquensis* RAUSER-CHERNOUSOVA described from Russia, in several respects. However, definite specific determination has been reserved until more materials can be accumulated.

Occurrence.— GS49, GS50.

***Ozawainella angulata* (COLANI, 1924)**

[Pl. 1, Figs. 9 and 10; Table 5]

Fusulinella angulata: COLANI, 1924, p. 74, 75, 112, 133, pl. 2, figs. 4, 7–14, 16–18, 20, 21, 26, 34, 35, 41.

Staffella angulata: LEE, CHEN and CHU, 1930, p. 117, 118, pl. 7, figs. 12–21.

Ozawainella angulata: TORIYAMA, 1944, p. 69, 70, pl. 6, figs. 1, 2.

Ozawainella angulata: RAUSER-CHERNOUSOVA *et al.*, 1951, p. 140, pl. 11, figs. 6, 7.

Ozawainella angulata: IGO, 1957, p. 181, 182, pl. 3, figs. 1–3.

Ozawainella angulata: IGO, 1972, p. 77, pl. 9, figs. 12–14, 20, 21.

Ozawainella angulata: LEVEN, 1978, p. 85, pl. 1, fig. 9.

Ozawainella angulata: LEVEN, 1978, p. 86, pl. 1, fig. 10.

Ozawainella angulata: CHEN and WANG, 1983, p. 31, pl. 1, figs. 20–26.

Ozawainella angulata: LIN, MENG and WU, 1991, p. 78, pl. 13, figs. 1–4.

Table 5. Measurements of *Ozawainella angulata* (COLANI) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 1 Fig. 9	0.36	1.23	0.29	0.020		0.22	0.39	0.58	0.86	1.23
Pl. 1 Fig. 10	0.49	0.55 (half)	0.45	0.030	0.16	0.28	0.34	0.80	1.10	

Description.— Shell small, discoidal in shape with acutely pointed periphery and slightly convex or depressed poles. Mature shells with 5 to 6 volutions. Axial length 0.36 to 0.49 mm, median width 1.10 to 1.23 mm, and form ratio 0.29 to 0.45.

Heights of volutions regularly increasing in inner, but rather rapidly in outer ones. Proloculus minute, spherical and outer diameter 20 to 30 μm . Spirotheca thin, about 30 μm in outer volution, but wall structure obscure owing to recrystallization. Septa numerous, unfluted throughout. Chomata massive, extending to poles, and symmetrical. Tunnel low, path regular.

Remarks.— This specimens are very similar to many previously known specimens, especially in the shape and size of the shell, and other features.

Occurrence.— GS33, GS52.

***Ozawainella cf. pseudotingi* PUTRJA, 1956**

[Pl. 1, Fig. 12]

Compare.—*Ozawainella pseudotingi*: PUTRJA, 1956, p. 385, pl.3, figs. 13-15.*Ozawainella pseudotingi*: LIN, MENG and WU, 1991, p. 79, 80, pl. 13, figs. 14-18.

Description.— Test very small, compressed lenticular in form with acutely pointed periphery. Coiling is almost planispiral, involute. Number of volutions is 4 in mature specimens. Axial length 0.20 mm, median width 0.52 mm, and form ratio 0.38.

Median width of the first to forth volutions: 0.11, 0.21, 0.34, and 0.52 mm, respectively. Heights of volutions regularly increasing. Proloculus small and spherical with diameter of 40 μm . Spirotheca thin, about 20 μm in outer volution. Wall structure undifferentiated owing to recrystallization. Septa unfluted throughout. Chomata less clear.

Remarks.— The present specimen resembles *Ozawainella pseudotingi* DUTKEVICH described from Hebei, North China by LIN *et al.* (1991), but the latter has a slightly larger shell. More numerous specimens are necessary for definite specific determination.

Occurrence.— GS52.

***Ozawainella* spp.**

[Pl. 1, Figs. 1, 4-6, 11, 13 and 14]

Remarks.— Many specimens with small lenticular shells and acutely pointed periphery were obtained. They are 0.8 to 1.2 mm in median width and 0.2 to 0.4 mm in axial length. Their wall structures are obliterated by recrystallization. Some of these specimens are similar to *Ozawainella angulata* (COLANI) and *O. praestellae* RAUSER-CHERNOUSSOVA. More numerous well-oriented and complete specimens are necessary for specific identification.

Occurrence.— GS1, GS42, GS50, GS52.

Subfamily *Pseudostaffellinae* PUTRYA, 1956**Genus *Pseudostaffella* THOMPSON, 1942*****Pseudostaffella sphaeroidea* (MÖLLER, 1878)**

[Pl. 1, Figs. 15-24:Table 6]

Boretis spaaeroidea?: EHRENBURG, 1854, pl. 37, figs. 11-13.*Fusulinella sphaeroidea*: MÖLLER, 1878, p. 107-111, pl. 5, figs. 4a-e, pl. 15, figs. 1a, b.*Fusulinella (Staffella) sphaeroidea*: LEE, 1927, p. 13-16, pl. 2, figs. 8, 10-11.*Staffella sphaeroidea*: LEE, CHEN and CHU, 1930, p. 114, 115, pl. 6, fig. 26.*Pseudostaffella sphaeroidea*: RAUSER-CHERNOUSSOVA *et al.*, 1951, p. 128, pl. 9, figs. 3-5.*Pseudostaffella sphaeroidea*: IGO, 1957, p. 197-199, pl. 5, figs. 9-18.*Pseudostaffella sphaeroidea*: IGO, 1972, p. 80, 81, pl. 9, figs. 38, 39.*Pseudostaffella sphaeroidea*: ZHANG, 1982, p. 136, 137, pl. 1, figs. 23-24, 27.*Neostaffella sphaeroidea*: CHEW, 1987, p. 254, pl. 2, figs. 1-3, 5-7, 10, 12.*Pseudostaffella sphaeroidea*: LIN, MENG and WU, 1991, p. 85, pl. 14, figs. 3, 4.Table 6. Measurements of *Pseudostaffella sphaeroidea* (MÖLLER) in mm.

No. of sp.	Length	Width	Form Ratio	Prof. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 1 Fig. 15	1.06	0.88	1.20	-	0.11	0.22	0.34	0.52	0.70	0.88
Pl. 1 Fig. 17	0.99	0.87	1.14	0.060	0.13	0.23	0.38	0.60	0.87	
Pl. 1 Fig. 21	0.85	0.76	1.12	0.050	0.12	0.19	0.33	0.57	0.76	

Description.— Shell small, subspherical to subquadrangular with broadly rounded periphery and somewhat umbilicated poles. Mature shells with 5 to 6 volutions. Axial length 0.85 to 1.06 mm, median width 0.76 to 0.88 mm, and form ratio 1.12 to 1.20.

Proloculus minute, spherical, and average diameter of 55 μm . Inner first and second volutions closely coiled and height of volutions low. Outer ones gradually increasing their height. Spirotheca thin, about 20 μm in outer volution. Wall structure obscure owing to recrystallization. Septa numerous, and almost unfluted throughout.

Chomata massive, well developed, asymmetrical, tunnel side slope about vertical, and polewards slope extended to poles. Tunnel high and narrow, almost path regular.

Remarks.— The specimens collected from the Terbat Formation are very similar to many previously known specimens, but they have slightly smaller numbers of volutions.

Occurrence.— GS1, GS43, GS47, GS49.

Family **Schubertellidae** SKINNER, 1931

Subfamily **Schubertellinae** SKINNER, 1931

Genus **Fusiella** LEE and CHEN, in LEE *et al.*, 1930

Fusiella sp.

[Pl. 1, Figs. 26–28 and 29]

Descriptive Remarks.— Only three specimens having elongated fusiform shells with slightly inflated median part and rounded poles were obtained from the Terbat Formation. The specimen of axial section (Pl. 1, Fig. 27) have 5 volutions, 1.75 mm in axial length, 0.68 mm in median width and form ratio 2.57. Median width of the first to fifth volutions: 0.11, 0.18, 0.29, 0.46 and 0.68 mm, respectively. Proloculus minute and spherical with diameter of 45 μm . Their internal characters are obliterated by recrystallization. One oblique-centered specimen (pl.1, Fig. 28) having a larger shell for this genus was obtained. It is 2.68 mm in axial length, 1.01 mm in median width and form ratio 2.65. Shell composed of 6 volutions. Spirotheca thin, about 28 μm in outer volution.

Occurrence.— GS1.

Genus **Schubertella** STAFF and WEDEKIND, 1910

Schubertella cf. simplex LANGE, 1925

[Pl. 1, Figs. 30–40:Table 7]

Compare.—

Schubertella simplex: LANGE, 1925, p. 254, pl. 3, figs. 60a–d.

Schubertella simplex: SHENG, 1956, p. 184, 206, pl. 5, figs. 9–14.

Schubertella cf. simplex: SHENG, 1963, p. 36, 160, 161, pl. 4, fig. 13.

Schubertella cf. simplex: SAKAGAMI and IWAI, 1974, p. 55–58, pl. 4, figs. 22–26.

Schubertella simplex: ZHANG, 1982, p. 144, pl. 2, figs. 5, 6, 13–17.

Schubertella cf. simplex: LIN, MENG and WU, 1991, p. 87, 88, pl. 14, fig. 23.

Table 7. Measurements of *Schubertella cf. simplex* LANGE in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions			
					1	2	3	4
Pl. 1 Fig. 35	0.72	0.47	1.53	0.040	0.12	0.21	0.31	0.47
Pl. 1 Fig. 30	0.78	0.36	2.17	0.040	0.09	0.16	0.26	0.36
Pl. 1 Fig. 37	0.69	0.46	1.50	0.050	0.09	0.18	0.28	0.46
Pl. 1 Fig. 36	0.43	0.31	1.39	0.050	0.13	0.20	0.31	

Description.— Shell very small, globular fusiform, attains usually 4 volutions. The first volution is coiled at a large angle to the axis of the outer ones. Average length of shell 0.66 mm, width 0.40 mm and form ratio 1.65 for 4 specimens. Proloculus spherical and large for size of shell with average diameter of 45 μm . Spirotheca very thin, average thickness of outer volutions 18 μm . Wall structure obscure owing to recrystallization. Septa nearly straight in median portion but become slightly fluted in axial regions. Chomata moderately developed and tunnel narrow.

Remarks.— The present form has the most strong resemblance in shell size and other essential characters to *Schubertella* cf. *simplex* LANGE which was reported from the Pha Duk Chik Limestone of North Thailand.

Occurrence.— GS1, GS14, GS15, GS33, GS41.

***Schubertella* sp. A**

[Pl. 3, Figs. 26–28]

Descriptive Remarks.— Only three, small and elongate ovate specimens were obtained. Mature specimen (Pl. 5, Fig. 6) consists of 3 volutions. It has an axial length 0.60 mm, median width of 0.36 mm and form ratio of 1.67. Median width of first to third volutions 0.14, 0.23, and 0.36 mm respectively. Proloculus is rather large in size of shell, about 40 μm . Early whorls are close coiled, later with coiling axis at a sharp angle to that of early stage. Thickness of outermost spirotheca is 15 μm . Septa plane throughout.

More numerous specimens are necessary for specific identification.

Occurrence.— TB1, TB2.

***Schubertella* spp.**

[Pl. 1, Figs. 25, 41 and 42]

Remarks.— Several specimens with elongated fusiform shells were obtained. They are about 0.8 to 1.1 mm in axial length, 0.4 mm in median width, and form ratio 2.1 to 2.5. The internal characters are obliterated by recrystallization. More numerous well-preserved and well-oriented specimens are necessary for specific identification.

Occurrence.— GS1.

Subfamily **Boultoniinae** SKINNER and WILDE, 1954

Genus ***Boultonia*** LEE, 1927

***Boultonia* sp.**

[Pl. 3, Figs. 29–33]

Descriptive Remarks.— Test small, elongated fusiform to triangular. First and second volutions discoidal, later volutions with abruptly changed axis of coiling and rapidly becoming elongate. Mature specimen consists of 3 to 4 volutions. In complete specimen (Pl. 3, Fig. 29), axial length 0.97 mm, median width 0.28 mm and form ratio 3.46. Median width of first to third volutions 0.13, 0.19 and 0.28 mm respectively. Spirotheca thin, 13 μm in outer volution, and its structure obscure owing to recrystallization. Septa strongly fluted throughout. Chomata developed.

The present specimens resemble *Boultonia simplicata* SHENG and WANG from North China, however the latter have smaller shell than the former. These specimens also resemble *B. subteretalis* RUI and HOU from North China in size and shape of shell. However, more numerous well-oriented and complete specimens are necessary for specific identification.

Occurrence.— TB1, TB2, TB7.

Family **Fusulinidae** VON MÖLLER, 1878
 Subfamily **Fusulinellinae** STAFF and WEDEKIND, 1910
 Genus **Profusulinella** RAUSER-CHERNOSSOVA and BELYAEV, 1936
Profusulinella cf. ovata RAUSER-CHERNOSSOVA, 1938
 [Pl. 2, Figs. 2-9, 12-14 and 18:Table 8]

Compare.-

Profusulinella ovata: RAUSER-CHERNOSSOVA, 1938, p.101, pl. 1, figs. 14-16.

Profusulinella ovata: PUTRJA and LEONTOVICH, 1948, p. 20-21, pl. 1, figs. 5-6.

Profusulinella ovata: RAUSER-CHERNOSSOVA, 1951, p. 162-163, pl. 14, figs. 2,3.

Profusulinella ovata: ROSS and MONGER, 1978, p. 48-50, pl. 8, figs. 26,31-34, 36, 37, 39, 40; pl. 10, figs. 1-3, 5, 6, 8-11.

Profusulinella ovata: ZHANG, L. and RUI, L. 1979, p.4, pl. 1, fig. 26.

Table 8. Measurements of *Profusulinella cf. ovata* RAUSER-CHERNOSSOVA in mm.

No. of sp.	Length	Width	Form Ratio	ProL. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 2 Fig. 5	1.63	0.78	2.09	0.05	0.16	0.27	0.39	0.56	0.78	
Pl. 2 Fig. 3	1.56	0.66	2.36	0.03	0.16	0.25	0.36	0.56		
Pl. 2 Fig. 9	2.01	1.11	1.81	-	0.09	0.20	0.30	0.47	0.72	1.11
Pl. 2 Fig. 2	1.70	0.65	2.62	0.04	0.13	0.22	0.35	0.52	0.65	

Description.— Shell fusiform, narrowly rounded poles, convex lateral slopes. Mature Specimens of 5 to 6 volutions 1.56 to 2.01 mm long, 0.65 to 1.11 mm wide, form form ratio of 1.81 to 2.62. First volution coiled nearly at right angles to outer volutions. First volution subspherical, second inflated-fusiform, from Third outwards fusiform.

Proloculus spherical small, its outside diameter 30 to 50 μ m. Shell expands rather slowly uniformly. Spirotheca thin, average thickness of outer volutions 30 μ m. Wall structure obscure owing to recrystallization, but it seems to be composed of three layers, namely upper tectorium, tectum, and lower tectorium.. Septa completely unfluted throughout their length, rather widely spaced. Tunnel low and wide, chomata distinct in outer volutions, not visible in first two volutions.

Remarks.— The present species described by RAUSER-CHERNOUSSOVA from the Russian platform. The present specimens are almost allied to the holotype of Russia, but have more larger than that of the latter in shell size. The present specimens closely resemble to smaller specimens of *Brisich Columbia* described by ROSS and MONGER (1978) but little differ from the former in having more large form ration than the latter.

Occurrence.— GS1, GS33 and GS43

Genus **Fusulinella** VON MÖLLER, 1877
Fusulinella eopulchra RAUSER-CHERNOUSSOVA, 1951
 [Pl. 2, Figs. 9-11, and 15-17]

Fusulinella eopulchra: RAUSER-CHERNOUSSOVA, in RAUSER-CHERNOUSSOVA *et al.*, 1951, p. 235, pl. 35, figs. 5-8.

Fusulinella eopulchra: KAWANO, 1961, p. 62-64, pl. 1, figs. 17-24, pl. 2, figs. 1-3.

Fusulinella eopulchra: ROSS and DUNBAR, 1962, p. 26-28, pl. 4, figs. 1-5.

Description.— Shell small, rhomboidal, having a straight to slightly curved axis of coiling. Lateral slopes straight to concave, but convex in inner volution. Mature specimens having 5

volution, 2.00 to 2.51 mm in length and 1.14 to 1.24 mm in width. Form ratio 1.61 to 2.20. Nearly axial sectioned specimen (pl. 2, Fig. 15), width of first to fifth volutions are 0.24, 0.39, 0.59, 0.95, and 1.24 mm, respectively.

Proloculus spherical, its outside diameter of 100 μ m. First one to two volutions somewhat tightly coiled, becoming gradually loose. Spirotheca rather thick of about 35 μ m in outside volutions. Wall structure not clear owing to recrystallization. Septa relatively thick, not fluting, except extreme polar regions. Chomata developed throughout. Heights of them more than one-half of heights of chambers. Tunnel narrow throughout.

Remarks.— The present specimens closely resemble *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA from the Moscow Basin in Russia. However, the test is slightly smaller than that of the type specimen. This species also resembles *Fusulinella itoi* OZAWA from the Akiyoshi Limestone Group, but the latter differs from the former by having a longer shell.

Occurrence.— GS1, GS33, GS43 and GS52,

Subfamily **Fusulininae** VON MÖLLER, 1878

Genus **Beedeina** GALLOWAY, 1933

Beedeina lanceolata (LEE and CHEN, 1930)

[Pl. 2, Figs. 19-26, Pl. 3, Figs. 1-3; Table 9]

Girtyina lanceolata: LEE and CHEN, in Lee et al., 1930, p. 134, 135, pl. 13, figs. 5, 6.

Fusulina lanceolata: TORIYAMA, 1944, p. 75, 76, pl. 6, figs. 14, 15.

Fusulina lanceolata: IGO, 1957, p. 214, 215, pl. 10, figs. 1-10.

Fusulina lanceolata: ZHANG and RUI, 1980, pl. 1, figs. 29, 31.

Table 9. Measurements of *Beedeina lanceolata* (LEE and CHEN) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 3 Fig. 1	1.73 (half)	1.51	2.29	0.08	0.23	0.42	0.64	0.92	1.26	-
Pl. 3 Fig. 2	3.02	1.53	1.97	0.10	0.24	0.36	0.57	0.87	1.05	-
Pl. 2 Fig. 20	1.39 (half)	1.37	2.03	0.10	0.31	0.47	0.73	1.00	1.37	-

Description.— Shell of moderate size, rhombic to inflated fusiform in outline, with inflated median part and sharply pointed poles. Lateral slopes almost smooth, but in some specimens slightly concave and convex. Mature shells with 5 to 5.5 volutions. Axial length 2.78 to 3.46 mm, median width 1.37 to 1.55 mm, and form ratio 1.97 to 2.29.

Shell expands somewhat uniformly. Inner first and second volutions closely coiled and ellipsoidal in shape. Proloculus relatively large, spherical in shape, and average external diameter in 4 specimens 0.10 mm. Spirotheca composed of four layers, thin tectum, rather thick diaphanotheca, and upper and lower tectoria. Average thickness of outer spirotheca 35 μ m. Septa numerous, rather irregularly fluted throughout.

Chomata well developed, high, finger shape, and asymmetrical. Tunnel essentially with regular path, and low.

Remarks.— The present species was described originally from the Huanglung limestone of South China (LEE et al., 1930). The materials obtained from the Terbat Formation closely related to the original specimens, in shape of shell, septal fluting and other characters, however, the former having rather smaller shell and slightly thicker spirotheca than the latter.

Occurrence.— GS1.

Genus *Fusulina* FISCHER DE WALDHEIM, 1829*Fusulina pulchella* GRYZLOVA

[Pl. 3, Figs. 5, 6, 10 and 12; Table 10]

Fusulina pulchella: GRYZLOVA, in RAUSER-CHERNOUSOVA *et al.*, 1951, p. 311, pl. 54, fig. 5.*Fusulina pulchella*: IGO, 1972, p. 91, 92, Pl. 13, figs. 7, 8.Table 10. Measurements of *Fusulina pulchella* GRYZLOVA in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 3 Fig. 5	5.60	1.61	3.48	-	0.17	0.29	0.44	0.66	0.97	1.61
Pl. 3 Fig. 6	6.36	1.67	3.81	0.09	0.22	0.35	0.49	0.79	1.22	1.67

Description.— Shell medium to large, subcylindrical to elongated fusiform in shape with bluntly rounded poles. Mature shell consists of 6 volutions. Axial length 5.60 to 6.36 mm, median width 1.61 to 1.67 mm, and form ratio 3.48 to 3.81. Heights of volutions increase gradually. Proloculus small, spherical and 90 μ m in diameter. Spirotheca thin; their average thickness of them in outer volutions 68 μ m. Wall structure obscured by recrystallization, but in outer volutions, it seems to consist of alveolar keriotheca. Septa rather strongly and more or less regularly fluted and complicated in polar regions. Chomata rather poorly developed. Tunnel low, path almost regular.

Remarks.— This specimens closely resemble *Fusulina pulchella* previously described in many characters. However the former have slightly slenderer shells and smaller proloculus than the latter.

Occurrence.— GS21.

Fusulina spp.

[Pl. 3, Figs. 4, 7-9, 11 and 13]

Descriptive Remarks.— Many ill-oriented specimens with large, subcylindrical to elongated fusiform in shape and with bluntly rounded or rarely acutely pointed poles come to hand. The thin sectioned specimens about 0.8 to 1.0 mm in median width and 3.3 to 4.7 mm in axial length. Septa numerous, rather strongly and regularly fluted and complicated in polar regions.

Occurrence.— GS18, GS21, GS50.

Genus *Quasifusulina* CHEN, 1934*Quasifusulina cf. tenuissima* (SCHELLWIEN, 1898)

[Pl. 5, Figs. 8, 10-15 and 17; Table 11]

*Compare.**Fusulina tenuissima*: SCHELLWIEN, 1898, p. 255-257, pl. 19, figs. 7a, b, 8, 9.*Quasifusulina longissima*: SUYARI, 1962, p. 10, pl. 4, figs. 12, 13.*Quasifusulina tenuissima*: IGO, 1972, p. 93-95, pl. 14, figs. 15-23.*Quasifusulina tenuissima*: CHEN and WANG, 1983, p. 46, 47, pl. 4, figs. 7, 9.Table 11. Measurements of *Quasifusulina cf. tenuissima* (SCHELLWIEN) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 5 Fig. 8	5.42	2.06	2.63	0.42, 0.62	0.53	0.74	0.98	1.31	1.67	2.06
Pl. 5 Fig. 13	4.90	2.08	2.34	0.53	0.68	0.93	1.33	1.80	-	

Description.— Shell subcylindrical with rounded poles and slightly arcuate axis of coiling. Mature shell consists of 5 to 6 volutions. Axial length 4.62 to 10.84 mm, median width 2.06 to 2.83 mm, and form ratio 2.34 to 3.83. Proloculus large, spherical or subspherical, with outside diameter of 42 to 53 μm . Heights of volutions increase gradually, lowest at median part. Spirotheca thin, composed of two or three layers. Tectum extremely thin. Underlying, less dense thick layer diaphanotheca-like and has fine alveoli-like structure. Thicknesses of spirotheca essentially equal throughout, about 40 μm in outer volutions.

Septa thin, numerous, rather regularly fluted in median part but strongly complicated in polar region. Septal folds with obtuse crest rather high, attaining more than half of the chamber height. Dense axial filling developed. No chomata developed.

Remarks.— The present specimens closely resemble *Quasifusulina tenuissima* described by IGO (1972) from North Thailand. However, as there is only ill-oriented or broken specimens at hand, it is referred *Q. tenuissima* with doubt, until more specimens are obtained.

Occurrence.— TB1, TB2, TB7.

Family **Schwagerinidae** DUNBAR and HENBEST, 1930
Subfamily **Schwagerininae** DUNBAR and HENBEST, 1930
Genus **Darvasites** MIKLUCHO-MACLAY, 1959
Darvasites pseudosimplex (CHEN, 1934)
[Pl. 4, Figs. 1-5; Table 14]

Tritisites pseudosimplex: CHEN, 1934, p. 25, pl. 1, figs. 19-20.

Darvasites pseudosimplex: LEVEN, 1997, p. 66, pl. 9, Fig. 11.

Table 14. Measurements of *Darvasites pseudosimplex* (CHEN) in mm.

No. of sp.	Length	Width	Form Ratio	Proloc. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 4 Fig. 1	5.24	2.04	2.57	-	0.33	0.59	0.91	1.28	1.66	2.04
Pl. 4 Fig. 2	5.11	1.95	2.62	0.09	0.21	0.38	0.71	1.21	1.95	

Description.— Shell inflated fusiform, with almost straight coiling axis, convex lateral slopes, and bluntly pointed poles. It consists of 5 to 6.5 volutions. Axial length 5.11 to 5.24 mm, median width 1.95 to 2.04 mm, and form ratio 2.57 to 2.62 in mature complete specimens. The polar ends of the succeeding one to two volutions sharply pointed.

Proloculus minute and spherical, having an outside diameter of 90 μm . The shell coils relatively slowly in the first two volutions but expands rapidly and uniformly in the succeeding outer volutions, and have cuniculi. Spirotheca moderately thick for the size of the shell and distinctly alveolar. Average thickness of the spirotheca of outermost volutions 64 μm . Lower margins of septa fluted throughout the length of shell, but the upper margins plane except in the polar regions. Chomata only developed in inner one or two volutions.

Remarks.— The present specimens are similar to the specimens of the Swine Limestone, Kuanshan, Lungtan, Kiangsu of South China originally described by CHEN (1934). This species was also described by LEVEN (1997) from the central Afghanistan. The Borneo specimens have the same characteristics with the Afghanistan specimen and are clearly identical to *Darvasites pseudosimplex* (CHEN).

Occurrence.— TB1, TB5.

***Darvasites?* sp.**

[Pl. 5, Figs. 4 and 5]

Descriptive remarks.— Shell has ovoid and medium size. Half length is 1.76 mm, median width 2.33 mm with form ratio 2.33. Septa are moderately folded near the base, more prominent toward the poles.

The present specimens probably belong to the genus *Darvasites* by its characteristics of shell form and inner structures, and are similar to *Darvasites* cf. *pseudosimplex* collected from the Loc. TB1 and TB 5 of the same localities, but are having smaller form ratio than that of the latter. The present materials are too insufficient to make a detailed specific comparison.

Occurrence.— TB5, TB8.

Genus *Paraschwagerina* DUNBAR and SKINNER, 1936

Paraschwagerina* cf. *yanagidai IGO, 1972

[Pl. 4, Fig. 6]

Compare.—

Paraschwagerina yanagidai: IGO, 1972, p. 111, pls. 19, figs. 1-5.

Description.— Shell moderate in size, and fusiform with straight axis of coiling, sharply pointed poles. Shell 7.6 mm in length, and 3.5 mm in width, with form ratio of 2.2. Axis extends rapidly from the first volution to maturity with width of 6 volutions 0.16, 0.28, 0.47, 0.79, 1.15, and 1.73 in mm, respectively. Septa fluted throughout, most strongly toward the poles. Wall consists of tectum and coarsely alveolar keriotheca. Axial fillings develop in polar regions.

Proloculus small; spirotheca of schwagerinid type in structure; Septa folded throughout shell and their folds high, reaching to about two-third of chambers. Their height nearly equal to width.

Remarks.— *Paraschwagerina yanagidai* described by IGO (1972) from Wang Saphung, Loei area of north Thailand. The present material consists of only one nearly axial section, and is poor preserved. The present specimen resembles the Thailand specimens in having the similar loose coiled inner juvenarium, but differs at the shell-size having smaller proloculus

Genus *Pseudofusulina* DUNBAR and SKINNER, 1931

Pseudofusulina* cf. *tschernyschewi (SCHELLWIEN, 1908)

[Pl. 5, Figs. 6 and 7; Table 13]

Compare.—

Fusulina tschernyschewi: SCHELLWIEN, 1908, p. 168-170, pl. 14, figs. 1-12.

Schwagerina tschernyschewi: TORIYAMA, 1958, p. 138-140, pl. 16, fig. 7.

Schwagerina tschernyschewi: KAWANO, 1961, p. 85, 86, pl. 5, figs. 6-8.

Pseudofusulina cf. *tschernyschewi*: SAKAGAMI and IWAI, 1974, p. 66-68, pl. 5, figs. 17-24.

Table 13. Measurements of *Pseudofusulina* cf. *tschernyschewi* (SCHELLWIEN) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions					
					1	2	3	4	5	6
Pl. 5 Fig. 7	2.11 (half)	1.82	2.32	0.038	0.18	0.32	0.52	0.80	1.25	1.82
Pl. 5 Fig. 6	1.63 (half)	1.84	1.77	-	0.16	0.32	0.53	0.80	1.32	1.84

Description.— Shell medium in size, cylindrical fusiform with straight axis of coiling. Mature shell attains 6 volutions, half length 1.63 to 2.11 mm, width 1.82 to 1.84 mm, and form ratio 1.77 to 2.32.

Proloculus spherical and small, 38 μ m in diameter. Shell expands uniformly throughout the shell growth. Spirotheca composed of tectum and rather coarsely alveolar keriotheca, gradually thickened from inner to outer volutions. Average thickness of spirotheca of the outermost volution 81 μ m. Septa weakly fluted in the central portion of the shell, but in the lateral and polar regions the flutings become stronger.

Remarks.— The present form is the closest in many essential characters to *Pseudofusulina* cf. *tschernyschewi* which SAKAGAMI and IWAI (1974) described from North Thailand. However the size of the former test is slightly smaller, and the thickness of the spirotheca is thinner than those of the latter.

Occurrence.— TB2.

Genus *Rugosofusulina* RAUSER-CHERNOUSOVA, 1937

Rugosofusulina cf. *extensa* (SKINNER and WILDE, 1965)

[Pl. 5, Figs. 18-20, Pl. 6, Figs. 1-5; Table 12]

Compare.—

Pseudofusulina *extensa*: SKINNER and WILDE, 1965, p. 63, pl. 24, figs. 14-20

Rugosofusulina cf. *extensa*: LIN, PAN and MENG, 1979, pl. 3, fig. 13.

Rugosofusulina *extensa*: LIN, MENG and WU, 1991, p. 118, pl. 22, fig. 5.

Table 12. Measurements of *Rugosofusulina* cf. *extensa* (SKINNER and WILDE) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions			
					1	2	3	3.5
Pl. 5 Fig. 18	10.31	2.41	4.28	0.28	0.52	1.03	1.95	2.41
Pl. 5 Fig. 20	9.31	3.02	3.08	0.61	0.83	1.42	2.57	3.02
Pl. 6 Fig. 2	9.19	2.98	3.08	0.30	0.57	1.06	1.98	2.98
Pl. 6 Fig. 4	9.56	2.50	3.82	0.31, 0.42	0.48	0.76	1.51	2.50

Description.— Shell subcylindrical to elongated fusiform with substraight to slightly inflated median part and broadly rounded poles. Mature shell consists of 3.5 to 4 volutions. Axial length 9.19 to 10.31 mm, median width 2.41 to 3.02 mm, and form ratio 3.08 to 4.28. Inner first volution tightly coiled and short fusiform in shape. Outer volutions rapidly increase in their length.

Proloculus rather large, spherical to subspherical, and its outside diameter 28 to 61 μ m. Spirotheca composed of tectum and coarse alveolar keriotheca. Thickness of spirotheca moderate; 10 to 13 μ m in outermost volutions. Spirotheca slightly undulating. Rugosity has minute amplitude on upper surface of spirotheca. Septa numerous, thin, irregularly fluted along axis of coiling, but rather regularly fluted in median part of outer volutions.

Tunnel path almost straight, high, and rather wide. Chomata well-developed in inner volutions, but almost lacking in outer one or two volutions.

Remarks.— The present specimens closely resemble the specimen reported by LIN *et al.* (1979) from Hunan, China. The Hunan specimen has taxonomic characteristics as size and shape of shell, mode of septal fluting and others agree with the specimens from the Terbat Formation. The Terbat specimens are also related to *Pseudofusulina* (*Daixina*) *lalaotuensis* (SHENG) described by IGO (1972) from North Thailand, in shell size and shape, and other several respects. However, the latter have smooth surface of spirotheca and a smaller proloculus.

Occurrence.— TB1, TB2.

Genus *Triticites* Girty, 1904
Triticites cf. suzukii (OZAWA, 1925)
 [Pl. 2, Fig. 1; Pl. 3, Figs. 14-19]

Compare.—

Schellwienia suzukii: OZAWA, 1925, p. 43, 44, pl. 4, fig. 2.

Triticites suzukii: TORIYAMA, 1958, p. 78-81, pl. 7, figs. 12-23.

Triticites suzukii: KAWANO, 1961, p. 67, 68, pl. 2, figs. 13-22.

Triticites suzukii: SUGIYAMA and TORIYAMA 1981, p. 11, 12, pl. 3, figs. 3-7.

Description.— Shell small, fusiform, with nearly straight axis of coiling, gently convex lateral slopes, and bluntly rounded polar ends. Well-oriented specimen (Pl. 3, Fig. 14) composed of 5 volutions, 1.81 mm long and 1.12 mm wide, form ratio 1.62. Median width of first to fifth volutions for the same specimen 0.20, 0.31, 0.50, 0.80, and 1.12 mm, respectively.

Proloculus relatively large, spherical in shape, its outside diameter 12 to 19 μm . Shell coils tightly, but expands in last one or one and a half volutions exceeds inner volutions. Spirotheca consists of a tectum and a coarse keriotheca. Thickness of spirotheca of fourth volution 80 μm . Septa rather thick, fluted weakly in axial regions. Tunnel low, and chomata distinct almost throughout shell.

Remarks.— The present specimens closely resemble *Triticites suzukii* from the Akiyoshi Limestone Group, except for having smaller form ratio and coarser keriotheca. However, as there are only ill-oriented and/or broken specimens at hand and its detailed characters are not known, it is referred *T. suzukii* with doubt, until more complete and well-oriented specimens are obtained.

Occurrence.— GS14, GS18.

Triticites cf. haydeni (OZAWA, 1925)
 [Pl. 3, Fig. 22]

Compare.—

Schellwienia haydeni: OZAWA, 1925, p. 39, 40, pl. 9, figs. 8, 9.

Triticites haydeni: KANMERA, 1958, p. 167, 168, pl. 26, figs. 14-19.

Triticites haydeni: TORIYAMA, 1958, p. 99-102, pl. 10, figs. 1-9.

Triticites aff. haydeni: IGO, 1972, p. 100, 101, pl. 15, figs. 15-25.

Description.— Shell medium, elongated fusiform with slightly inflated median part and bluntly rounded poles. This specimen consists of 5 volutions. Axial length 5.38 mm, median width 1.39 mm, and form ratio 3.87. Median width of first to fifth volutions 0.20, 0.32, 0.52, 0.85 and 1.39 mm respectively.

Heights of volutions increase rather regularly. Proloculus spherical, its outside diameter 90 μm . Spirotheca composed of tectum and keriotheca. Thickness of spirotheca of outermost volution 55 μm . Septa less convoluted in polar region, slightly and rather irregularly fluted in other parts of the shell. Chomata developed and asymmetrical. Tunnel almost straight path, low and somewhat wide.

Remarks.— In comparison with the Akiyoshi specimens originally described by OZAWA (1925) and TORIYAMA (1958), the present ones have slenderer shells. They also resemble Igo's Thailand specimens in many respects. However, definite specific identification has been reserved until more materials can be accumulated.

Occurrence.— GS3.

***Triticites?* spp.**

[Pl. 3, Figs. 20 and 21, Pl. 5, Figs. 1-3 and 9]

Remarks.— Several ill-oriented and broken specimens with cylindrical, fusiform and inflated fusiform shells were obtained. They may belong to *Triticites*, however, it is impossible to make detailed comparison and specific identification. Only photographic illustrations are shown.

Occurrence.— TB2, TB7, GS3.

Subfamily **Chusenellinae** KHAHLER and KHAHLER, 1966

Genus **Chusenella** HSU, 1942 emend. CHEN, 1956

Chusenella cf. schwagerinaeformis SHENG, 1963

[Pl. 4, Figs. 10 and 12]

Compare.

Dunbarinella sp. A: TORIYAMA, 1958, p. 125-126, pl. 13, figs. 21-22.

Chusenella schwagerinaeformis: SHENG, 1963, p. 221, pl. 23, figs. 1-6.

Chusenella aff. *schwagerinaeformis*: SADA, 1964, p. 253-254, pl. 27, figs. 11-13 [non pl. 24, figs. 18-19]

Chusenella schwagerinaeformis: LEVEN, 1967, p. 156, pl. 14, figs. 2, 3.

Chusenella schwagerinaeformis: WANG, SHENG and ZHANG, 1981, p. 50-51, pl. 12, figs. 6, 7, 12.

Chusenella schwagerinaeformis: LEVEN, 1997, p. 73, pl. 18, figs. 9, 10.

Description.— Only one elongated fusiform specimens with slightly acuminate poles were obtained. Axial length 4.2 mm, median width 2.3 mm, and form ratio 1.9. In the nearly well-oriented specimen (Pl. 6, Fig. 10), median width of first to sixth volutions 0.16, 0.28, 0.47, 0.79, 1.15 and 1.73 mm, respectively. Septa numerous, intensely and regularly fluted. Spirotheca consists of a tectum and alveolar keriotheca.

Remarks.— The present specimens have similar characteristics to those of *Chusenella schwagerinaeformis* described by SHENG (1963) from the Maokou Limestone of Yishan of Kwangsi, South China. Also the Sarawak specimens are very similar to the Thai specimens of *Chusenella schwagerinaeformis* in size and characteristics of spirotheca, wall, axial fillings, and shell form described by TORIYAMA (1975).

The present specimens are closely similar to the specimen of *C. schwagerinaeformis* illustrated by LEVEN (1997, pl. 18, fig. 10) in having the similar feature of shell, form ratio, septal flutings, and axial fillings.

They may probably be conspecific with each other, although the materials are only two sections.

Occurrence.— TB1, TB2.

Chusenella cf. shengi TORIYAMA and KANMERA, 1979

[Pl. 4, Figs. 7-9 and 14]

Compare.

Fusulina aff. *douvillei*: COLANI, 1924, pl. 13, Fig. 1, [non pl. 10, figs. 5, 25; pl. 13, figs. 2-26]

Schwagerina douvillei: SHENG, 1956, p. 187-188, 211, pl. 7, figs. 1-6.

Chusenella (Chusenella) shengi: TORIYAMA and KANMERA, 1979, p. 49-50, pl. 7, figs. 8-11.

Description.— The incomplete specimens having large fusiform shells with acutely pointed poles. Axial shell having 6.0 to 7.6 mm in length, median width of 2.0 to 3.5 mm, and form ratio of 2.2 to 3.0 mm in mature and nearly well-oriented specimens. Septa fluted throughout, most strongly toward the poles. Wall consists of tectum and coarsely alveolar keriotheca. Axial fillings

develop in polar regions.

Remarks.— The material is only one axial thin-section. The specimen is very similar to the holotype designated by TORIYAMA and KANMERA (1979) descriptive by SHENG (1956) from the Maokau Limestone of southern Shensi of China. The detailed remarks were explained by TORIYAMA and KANMERA (1979) on the confusion of specific assignment for many workers.

The present specimen also resembles the specimen of Thailand described by TORIYAMA and KANMERA (1979) in having shell of fusiform, similar form ratio, axial fillings, and small proloculus, but the latter differs in having regular septal foldings, and heavy axial fillings.

Occurrence.— TB1, TB2, TB17.

Subfamily **Biwaellinae** DAVYDOV, 1984

Genus **Sphaeroschwagerina** MIKLUCHO-MACLAY, 1959

Sphaeroschwagerina aff. sphaerica (SCHERBOVICH, 1949)

[Pl. 4, Figs. 11, 13 and 15: Table 15]

Compare.—

Schwagerina sphaerica: SCHERBOVICH, in RAUSER-CHERNOUSOVA *et al.*, 1949, p. 37, 38, pl. 9, figs. 7–8, pl. 10, fig. 1.

Pseudoschwagerina sphaerica: PITAKPAIVAN, 1966, p. 93–96, pl. 2, figs. 11–13.

Pseudoschwagerina sphaerica: LIN, PAN and MENG, 1979, pl. 4, figs. 15–17.

Sphaeroschwagerina sphaerica: ZHANG and RUI, 1980, pl. 2, fig. 4.

Sphaeroschwagerina sphaerica: CHEN and WANG, 1983, p. 112, 113, pl. 24, figs. 1, 2.

Table 15. Measurements of *Sphaeroschwagerina* aff. *sphaerica* (SCHERBOVICH) in mm.

No. of sp.	Length	Width	Form Ratio	Prol. Diam.	Width of volutions						
					1	2	3	4	5	6	7
Pl. 4 Fig. 11	6.17	5.22	1.18	0.03	0.13	0.20	0.35	1.13	2.13	4.07	5.22
Pl. 4 Fig. 15	5.7?	2.63 (half)	1.08	-	0.12	0.20	0.35	1.08	1.21 (half)	2.06 (half)	2.63 (half)

Description.— Shell large, almost spherical, poles slightly pointed. Mature specimen of 6.5 to 7 volutions about 6.0 mm in axial length, 5.2 mm in median width, and form ratio 1.1 to 1.2. Early volutions closely coiled, forming a compact and rather slender fusiform juvenarium of 3 volutions, which is followed by a rapid change to the high, inflated volutions of the adult shell. The last volution less inflated than the penultimate.

Proloculus spherical, 30 μ m in diameter. Spirotheca very thin in the inner three volutions and remarkably thick in the last two volutions. Its thickness of the outermost volution 105 to 115 μ m. Wall structure not clear in inner volutions, but in outer volutions it consists of tectum and thick keriotheca. Septa almost plane or feebly and irregularly folded in the polar regions. In a sagittal section the septa are very thin.

Chomata inconspicuous in the juvenarium, low and rather wide, may be rudimentarily present in the outer volutions. The measurements of the present specimens are given in Table 15.

Remarks.— The present specimens closely resemble *Sphaeroschwagerina sphaerica* described by PITAKPAIVAN (1966) from Noankowtok, Central Thailand, in shape of shell, form of volutions and other characters, except for smaller number of volutions. However, as there is no complete and well-oriented specimen at hand, they are referred *S. sphaerica* with doubt, until more specimens are obtained.

Occurrence.— TB1, TB2.

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Plate 1

Explanation of Plate 1

(All figures are in x40 unless indicated otherwise)

Figs. 1, 4-6, 11, 13 and 14. *Ozawainella* spp.

1, 11, 13, 14. Tangential sections, Nos. Loc. GS1-526, GS50-400, GS52-299 and GS52-521. (GK-D 33001, 33005-33007)

4. Axial section, No. Loc. GS1-527. (GK-D 33002)

5, 6. Sagittal sections, Nos. Loc. GS1-527, GS42-371. (GK-D 33003 - 33004)

Figs. 2 and 3. *Ozawainella* ex gr. *digitalis* MANUKALOVA

2. Oblique tangential section, No. Loc. GS1-527. (GK-D 33008)

3. Axial section, No. Loc. GS1-525. (GK-D 33009)

Figs. 7 and 8. *Ozawainella* cf. *mosquensis* RAUSER-CHERNOUSOVA *et al.*

7, 8. Incomplete tangential sections, Nos. Loc. GS49-512 and GS50-270. (GK-D 33010-330011)

Figs. 9 and 10. *Ozawainella angulata* (COLANI)

9. Near axial section, No. Loc. GS52-277. (GK-D 33012)

10. Oblique centered section, No. Loc. GS33-239. (GK-D 33013)

Fig. 12. *Ozawainella* cf. *pseudotingi* DUTKEVICH

Axial section, No. Loc. GS52-523. (GK-D 33014)

Figs. 15-24. *Pseudostaffella sphaeroidea* (MÖLLER)

15 and 21. Tangential sections, Nos. Loc. GS49-266 and GS49-297, x20. (GK-D 33015, 33021)

16 and 20. Sagittal sections, Nos. Loc. GS43-375 and GS1-524, 20: x20. (GK-D 33016, 33020)

17 and 19. Axial sections, Nos. Loc. GS49-507 and GS49-506, x20. (GK-D 33017, 33019)

18. Slightly oblique near axial section, No. Loc. GS49-508, x20. (GK-D 33018)

22 and 23. Oblique centered sections, Nos. Loc. GS47-295 and GS49-298, x20. (GK-D 33022-33023)

24. Slightly oblique tangential section, No. Loc. GS43-375, x20. (GK-D 33024)

Figs. 25, 41 and 42. *Schubertella* spp.

25 and 41. Near axial sections, Nos. Loc. GS1-421 and GS1-533, 25: x20. (GK-D 33025, 33026)

42. Axial section, No. Loc. GS1-531. (GK-D 33027)

Figs. 26-28 and 29. *Fusiella* sp.

26. Tangential section, No. Loc. GS1-419, x20. (GK-D 33028)

27. Axial section, No. Loc. GS1-421, x20. (GK-D 33029)

28. Oblique centered section, No. Loc. GS1-416, x20. (GK-D 33031)

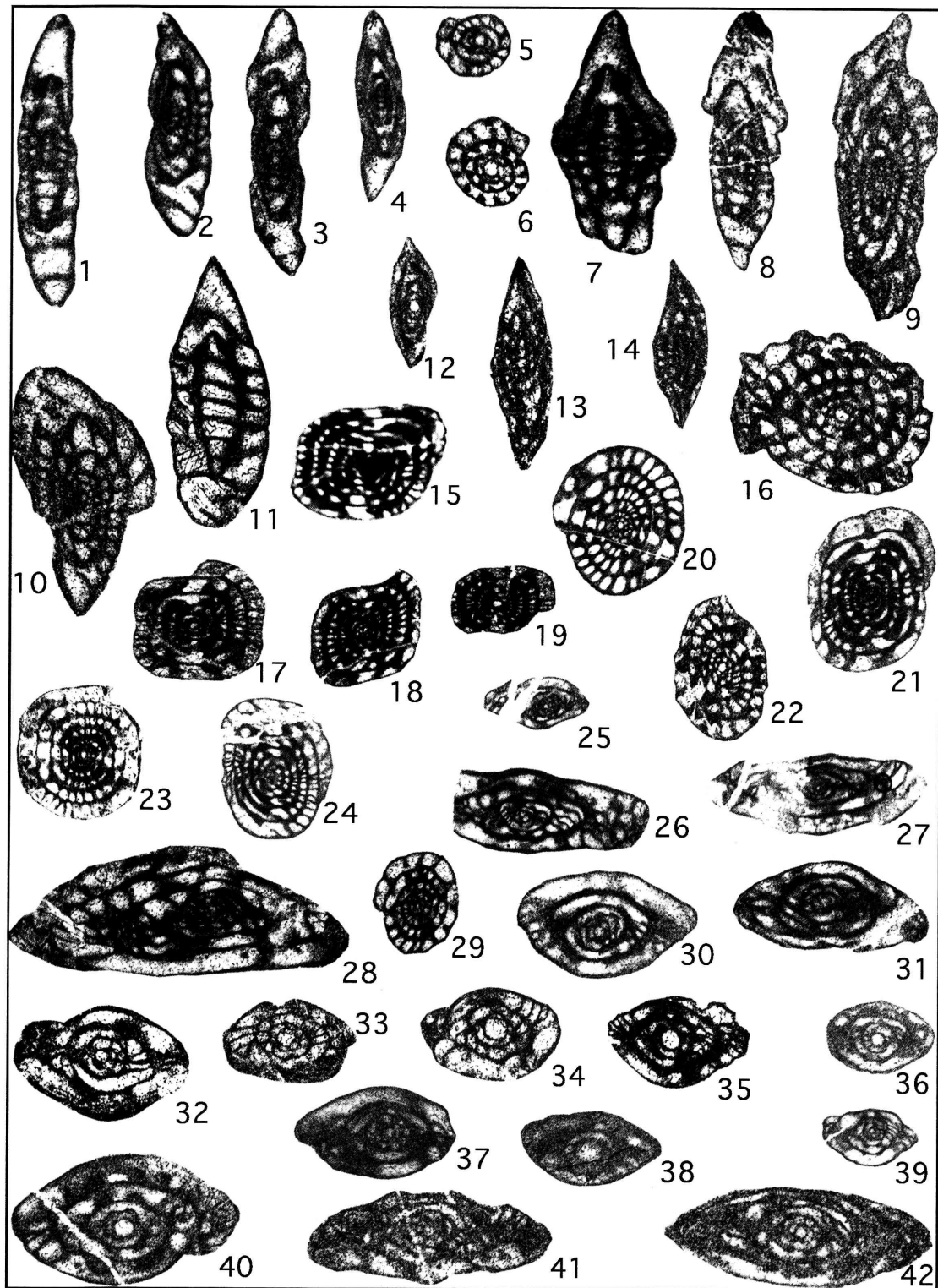
29. Sagittal section, No. Loc. GS1-416, x20. (GK-D 33030)

Figs. 30-40. *Schubertella* cf. *simplex* LANGE

30 and 35-37. Axial sections, Nos. Loc. GS1-526, GS1-529, GS15-202 and GS1-530. (GK-D 33032-33035)

31, 33, 38 and 39. Slightly tangential, near axial sections, Nos. Loc. GS1-526, GS33-239, GS14-100 and GS33-486, 39: x20. (GK-D 33036-33039)

32, 34 and 40. Oblique centered sections, Nos. Loc. GS33-294, GS33-293 and GS41-366. (GK-D 33040-330442)



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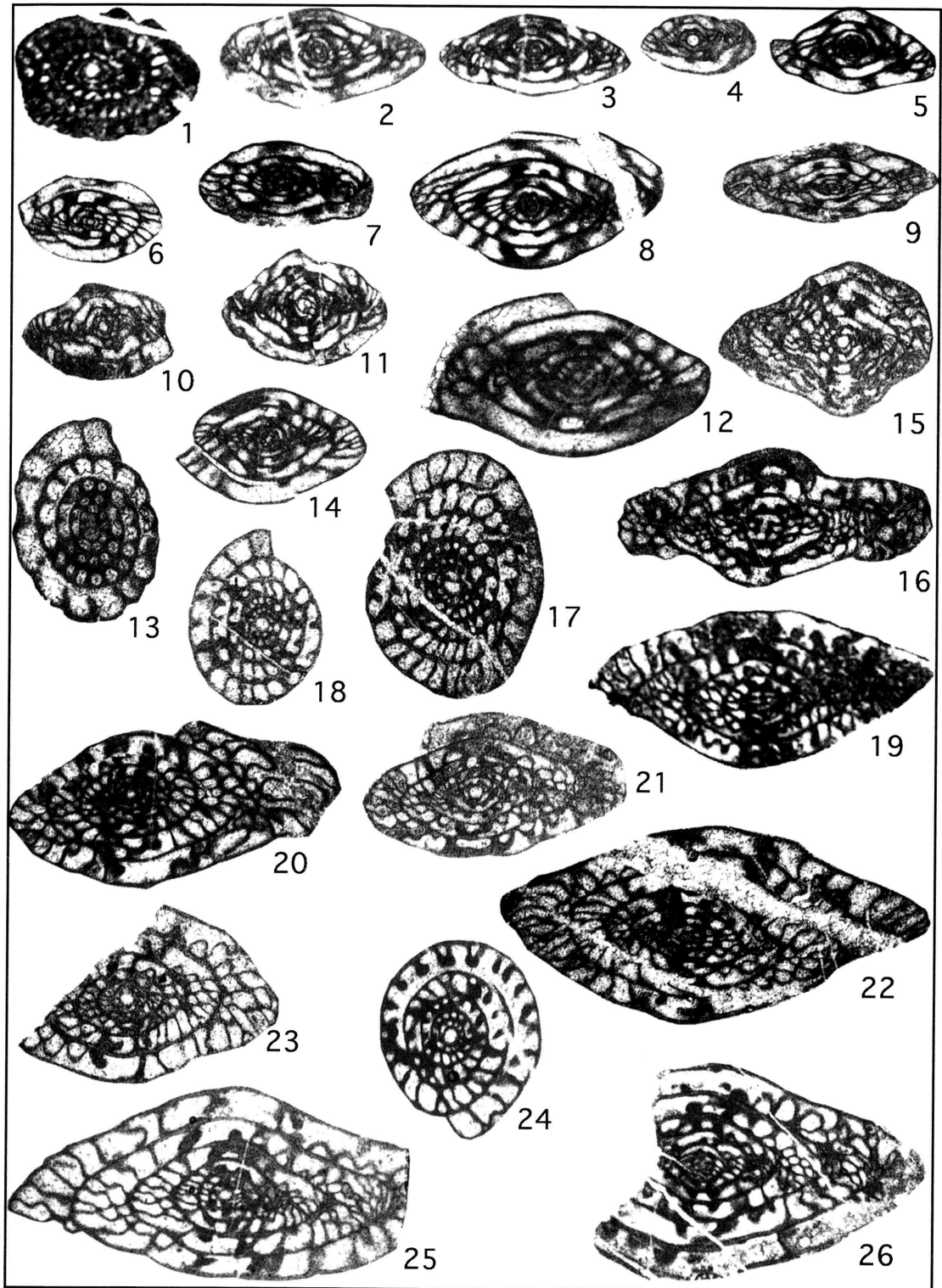
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Plate 2

Explanation of Plate 2

(All figures are in x20 unless indicated otherwise)

- Fig. 1. *Triticites* cf. *suzukii* (OZAWA) (See also Pl. 3, Figs. 14-19)
Oblique centered section, No. Loc. GS14-199. (GK-D 33043)
- Figs. 2-9, 12-14 and 18. *Profusulinella* cf. *ovata* RAUSER-CHERNOUSSOVA
2, 3 and 9. Axial sections, Nos. Loc. GS1-527, GS1-527 and GS33-489. (GK-D 33044, 33045 and 33051)
4. Axial section of immature specimen, No. Loc. GS33-493. (GK-D 33046)
5, 12 and 14. Oblique near centered sections, Nos. Loc. GS1-526, GS1-182 and GS1-417, 12: x40. (GK-D 33047, 33052 and 33054)
6 and 7. Oblique centered section, Nos. Loc. GS33-486 and GS1-532. (GK-D 33048-33049)
8. Tangential section, No. Loc. GS1-526. (GK-D 33050)
13. Transverse section, No. Loc. GS1-182, x40. (GK-D 33053)
18. Sagittal section, No. Loc. GS1-417. (GK-D 33055)
- Figs. 10-11 and 15-17. *Fusulinella eopulchra* RAUSER-CHERNOUSSOVA
10. Axial sections, Nos. Loc. GS33-491 (GK-D 33056)
11. Axial sections, Nos. Loc. GS43-375 (GK-D 33057)
15. Incomplete axial section, No. Loc. GS52-517. (GK-D 33058)
16. Tangential section, No. Loc. GS1-416. (GK-D 33059)
17. Sagittal section, No. Loc. GS1-416. (GK-D 33060)
- Figs. 19-26. *Beedeina lanceolata* (LEE and CHEN) (See also Plate 3, Figs. 1-3)
19. Tangential section, No. Loc. GS1-182. (GK-D 33061)
20, 21 and 23. Oblique centered sections, Nos. Loc. GS1-526, GS1-524 and GS1-524. (GK-D 33062, 33063, 33065)
22 and 26. Tangential sections, Nos. Loc. GS1-417 and GS1-524.
24. Sagittal section, No. Loc. GS1-528. (GK-D 33066)
25. Slightly oblique, axial section, No. Loc. GS1-419. (GK-D 33067)

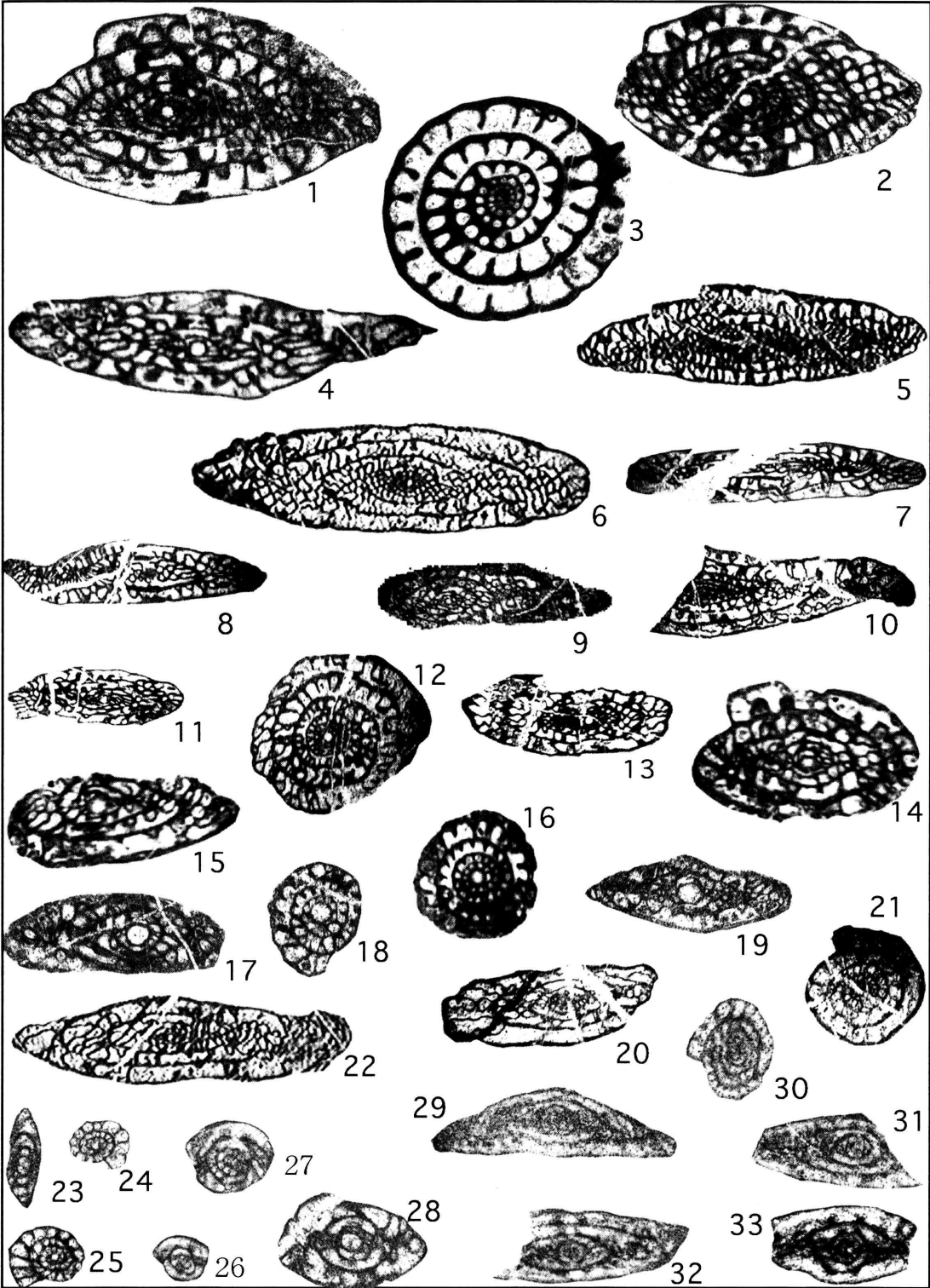


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Plate 3

Explanation of Plate 3

- Figs. 1-3. *Beedeina lanceolata* (LEE and CHEN) (See also Plate 2, Figs. 19-26)
1 and 2. Axial sections, Nos. Loc. GS1-530 and GS1-528, x20. (GK-D 33069-33070)
3. Transverse section, No. Loc. GS1-419, x20. (GK-D 33071)
- Figs. 4, 7-9, 11 and 13. *Fusulina* spp.
4, 9, 11 and 13. Oblique centered sections, Nos. Loc. GS50-502, GS18-469, GS50-271 and GS21-476, 4: x20, 9, 11, 13: x10, (GK-D 33072, 33075, 33076a, 33076b).
7 and 8. Tangential sections, Nos. Loc. GS50-499 and GS50-269, x10. (GK-D 33073-33074)
- Figs. 5, 6, 10 and 12. *Fusulina pulchella* GRYZLOVA
5. Near centered axial section, No. Loc. GS21-482, x10. (GK-D 33077)
6. Oblique centered section, No. Loc. GS21-483, x10. (GK-D 33078)
10. Incomplete, near centered axial section, No. Loc. GS21-479, x10. (GK-D 33080)
12. Sagittal section, No. Loc. GS21-477, x10. (GK-D 33079)
- Figs. 14-19. *Triticites* cf. *suzukii* (OZAWA) (See also Pl. 2, Fig. 1)
14. Axial section, No. Loc. GS18-215, x20. (GK-D 33081)
15, 17 and 19. Oblique centered sections, Nos. Loc. GS18-214, GS18-290 and GS18-467, x20. (GK-D 33082, 33084a and 33084b)
16 and 18. Sagittal sections, Nos. Loc. GS18-214, GS18-290, x20. (GK-D 33083, 33085)
- Figs. 20 and 21. *Triticites*? spp.
20. Oblique tangential section, No. Loc. GS3-333, x10. (GK-D 33086)
21. Transverse section, No. Loc. GS3-333, x10. (GK-D 33087)
- Fig. 22. *Triticites* cf. *haydeni* (OZAWA)
Axial section, No. Loc. GS3-427, x10. (GK-D 33088)
- Figs. 23-25. *Millerella*? sp.
23. Axial section, No. Loc. TB1-033, x40. (GK-D 33089)
24 and 25. Sagittal sections, Nos. Loc. TB2-074 and TB2-095, x40. (GK-D 33090, 33091)
- Figs. 26-28. *Schubertella* sp. A
26 and 27. Tangential sections, Nos. Loc. TB1-015 and TB2-092, x40. (GK-D 33092, 33093)
28. Axial section, No. Loc. TB2-099, x40. (GK-D 33094)
- Figs. 29-32. *Boultonia* sp.
29. Near centered axial section, No. Loc. TB2-096, x40. (GK-D 33095)
30. Transverse section, No. Loc. TB2-098, x40. (GK-D 33096)
31 and 32. Tangential sections, Nos. Loc. TB2-093 and TB1-539, x40. (GK-D 33097, 33098)
33. Incomplete axial section, No. Loc. TB1-536, x40. (GK-D 33099)



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Plate 4

Explanation of Plate 4

(All figures are in x10)

Figs. 1-5. *Darvasites pseudosimplex* (CHEN)

1 and 4. Tangential sections, Nos. Loc. TB5-399 and TB1-538. (GK-D 33100, 33103)

2. Axial section, No. Loc. TB1-543. (GK-D 33101)

3 and 5. Transverse sections, Nos. Loc. TB1-013 and TB1-033. (GK-D 33102, 33104)

Fig. 6. *Paraschwagerina* cf. *yanagidai* IGO

Slightly oblique axial section, No. Loc. TB1-004. (GK-D 33105)

Figs. 7-9 and 14. *Chusenella* cf. *shengi* TORIYAMA and KANMERA

7. Oblique centered section, No. Loc. TB1-014. (GK-D 33106)

8. Silicified axial section, No. Loc. TB17-129. (GK-D 33107)

9. Tangential section, No. Loc. TB1-011. (GK-D 33109)

14. Transverse section, No. Loc. TB1-007. (GK-D 33108)

Figs. 10 and 12. *Chusenella* cf. *schwagerinaeformis* SHENG

10. Near axial section, No. Loc. TB2-059. (GK-D 33110)

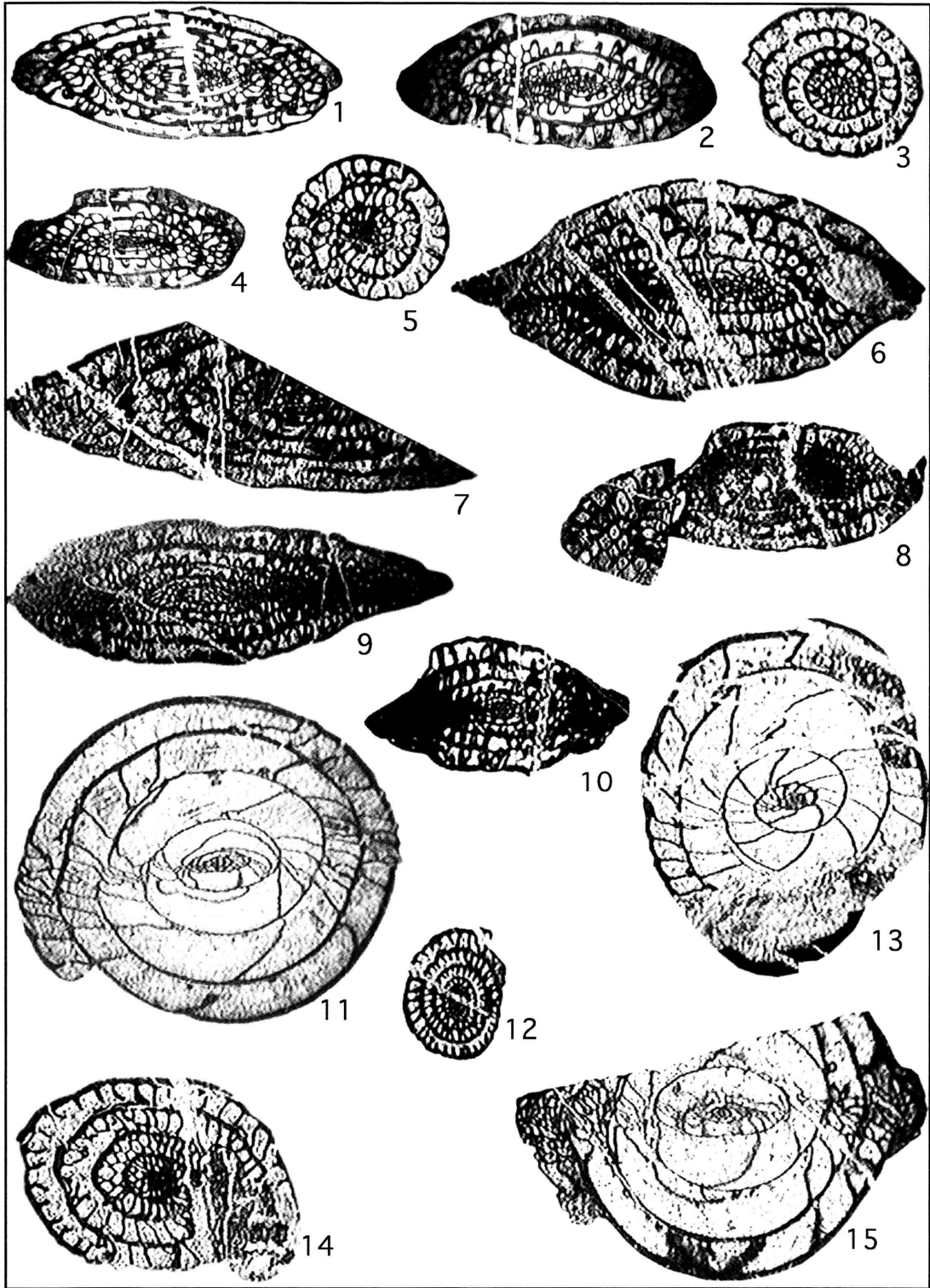
12. Transverse section, No. Loc. TB2-060. (GK-D 33111)

Figs. 11, 13 and 15. *Sphaeroschwagerina* aff. *sphaerica* (SCHERBOVICH)

11. Near centered oblique section, No. Loc. TB1-001. (GK-D 33112)

13. Oblique section, No. Loc. TB2-053. (GK-D 33113)

15. Axial section, No. Loc. TB2-062. (GK-D 33114)



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Plate 5

Explanation of Plate 5

Figs. 1-3 and 9. *Triticites?* spp.

1. Axial section of immature specimen, No. Loc. GS3-426, x20. (GK-D 33115)
- 2 and 3. Axial sections, Nos. Loc. TB7-385 and TB2-086, 13: x20, 14: x40. (GK-D 33116, 33017)
9. Near centered tangential section, No. Loc. TB7-305, x10. (GK-D 33118)

Figs. 4 and 5. *Darvasites?* sp.

4. Axial section, No. Loc. TB8-284, x10. (GK-D 33119)
5. Transverse section, No. Loc. TB5-403, x10. (GK-D 33120)

Figs. 6 and 7. *Pseudofusulina* cf. *tschernyschewi* (SCHELLWIEN)

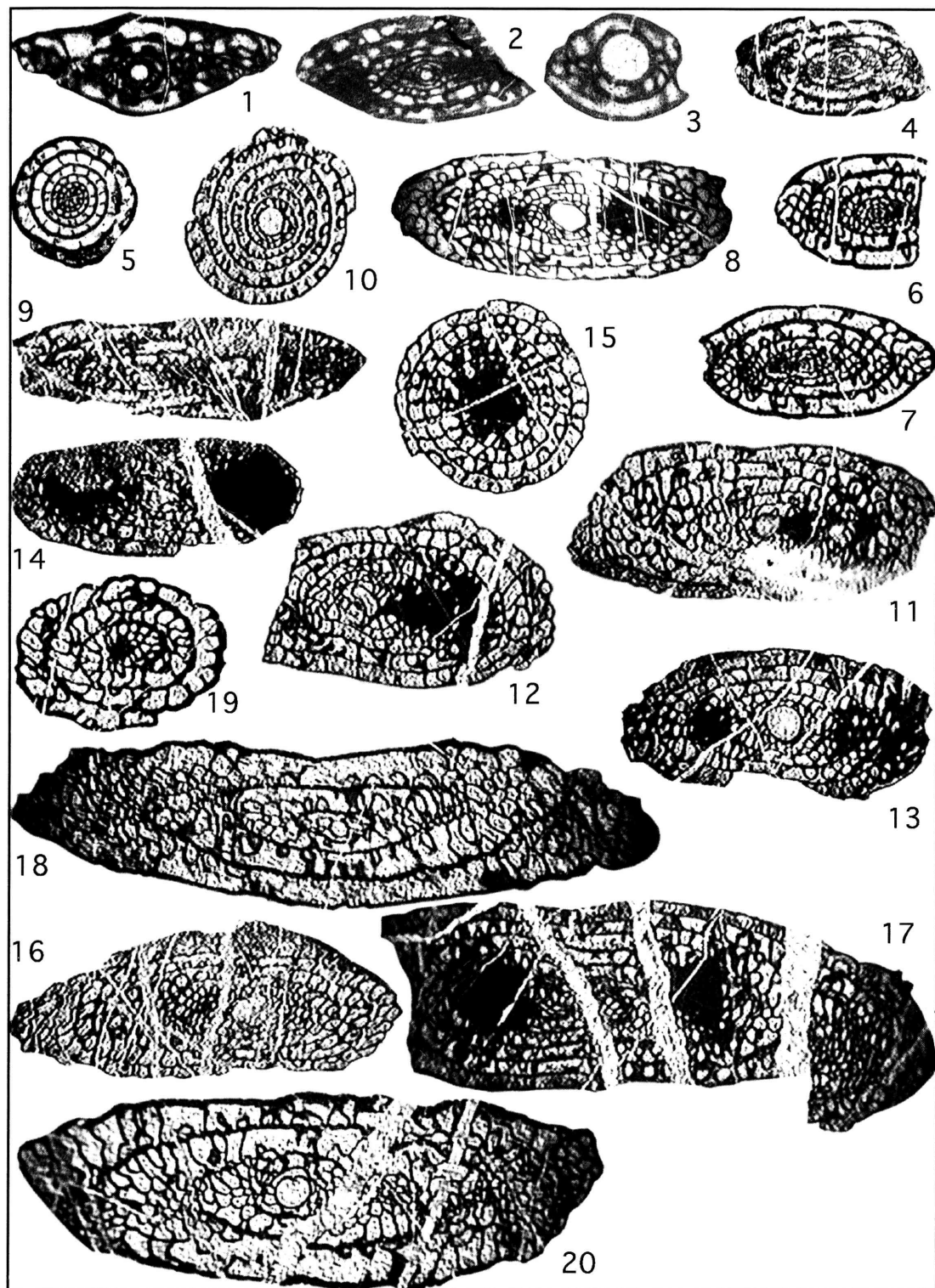
6. Slightly oblique section, No. Loc. TB2-056, x10. (GK-D 33121)
7. Tangential section, No. Loc. TB2-052, x10. (GK-D 33122)

Figs. 8 and 10-17. *Quasifusulina* cf. *tenuissima* (SCHELLWIEN)

- 8, 11 and 13. Axial sections, Nos. Loc. TB1-542, TB1-008 and TB2-051, x10. (GK-D 33123-33125)
10. Sagittal section, No. Loc. TB1-003, x10. (GK-D 33126)
- 12 and 14. Near centered tangential sections, Nos. Loc. TB1-009, TB2-074, x10. (GK-D 33127, 33128)
15. Transverse section, No. Loc. TB2-065, x10. (GK-D 33129)
16. Oblique near centered section, No. Loc. TB7-304, x10. (GK-D 33131)
17. Tangential section, No. Loc. TB2-054, x10. (GK-D 33130)

Figs. 18-20. *Rugosofusulina* cf. *extensa* (SKINNER and WILDE) (See also Plate 6, Figs 1-5)

- 18 and 20. Axial sections, Nos. Loc. TB1-005, TB1-540, TB1-539 and TB1-534, x10. (GK-D 33132a, 33132b)
19. Transverse section, No. Loc. TB2-067, x10. (GK-D 33133)

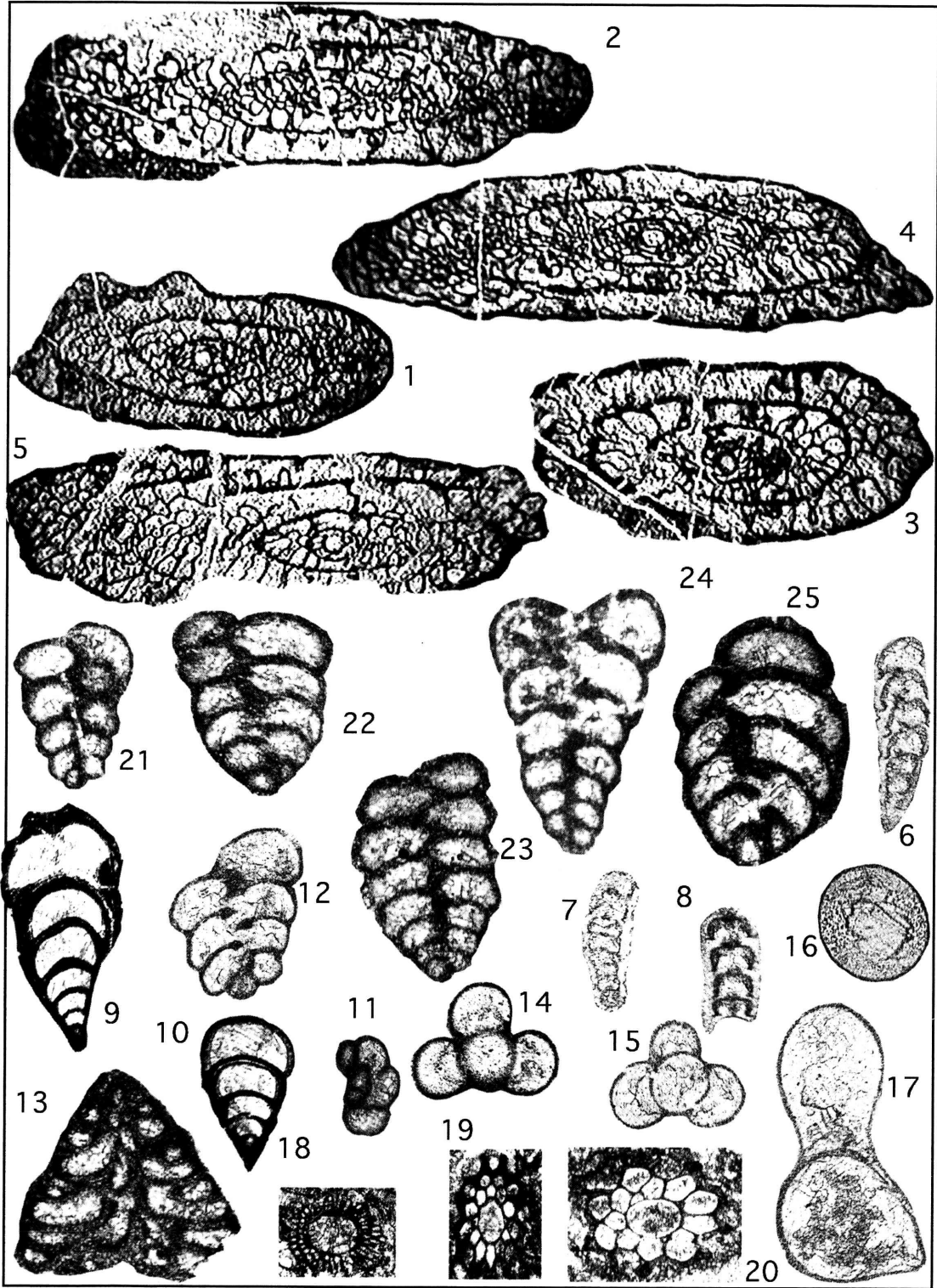


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Plate 6

Explanation of Plate 6

- Figs. 1-5. *Rugosofusulina* cf. *extensa* (SKINNER and WILDE) (See also Plate 5, Figs. 15-20)
2 and 4. Axial sections, Nos. Loc. TB1-005, TB1-540, TB1-539 and TB1-534, x10. (GK-D 33135, 33137)
1, 3 and 5. Oblique centered sections, Nos. Loc. TB1-536, TB1-540 and TB2-057, x10. (GK-D 33134, 33136, 330138)
- Figs. 6-8. *Nodosinella* sp.
Nos. Loc. TB1-542, TB1-008 and TB2-059, Figs. 6, 7: x80, Fig. 8: x40. (GK-D 33139, 33140, 33141)
- Figs. 9 and 10. *Nodosaria* sp. B
Nos. Loc. TB13-2-111 and TB13-2-113, x40. (GK-D 33142, 33143)
- Fig. 11. *Endothyra* sp. B
No. Loc. TB2-064, x40. (GK-D 33144)
- Fig. 12. *Palaeotextularia* sp.
No. Loc. TB2-084, x40. (GK-D 33145)
- Fig. 13. *Tetrataxis* sp.
No. Loc. TB1-539, x40. (GK-D 33146)
- Figs. 14, 15 and 17. *Tuberitina* sp.
Nos. Loc. TB2-056, TB2-093 and TB1-012, x80. (GK-D 33147-33149)
- Fig. 16. *Calcisphaera*
No. Loc. TB1-022, x80. (GK-D 33150)
- Fig. 18. *Vermiporella* sp.
No. Loc. TB13-2-111, x20. (GK-D 33151)
- Figs. 19 and 20. Bryozoan debris
Nos. Loc. TB13-1-199 and TB13-1-109, x20. (GK-D 33152, 33153)
- Figs. 21-25. *Palaeotextularia* sp.
Nos. Loc. GS43-374, GS33-237, GS33-486, GS49-297 and GS1-532, x40. (GK-D 33154-33158)



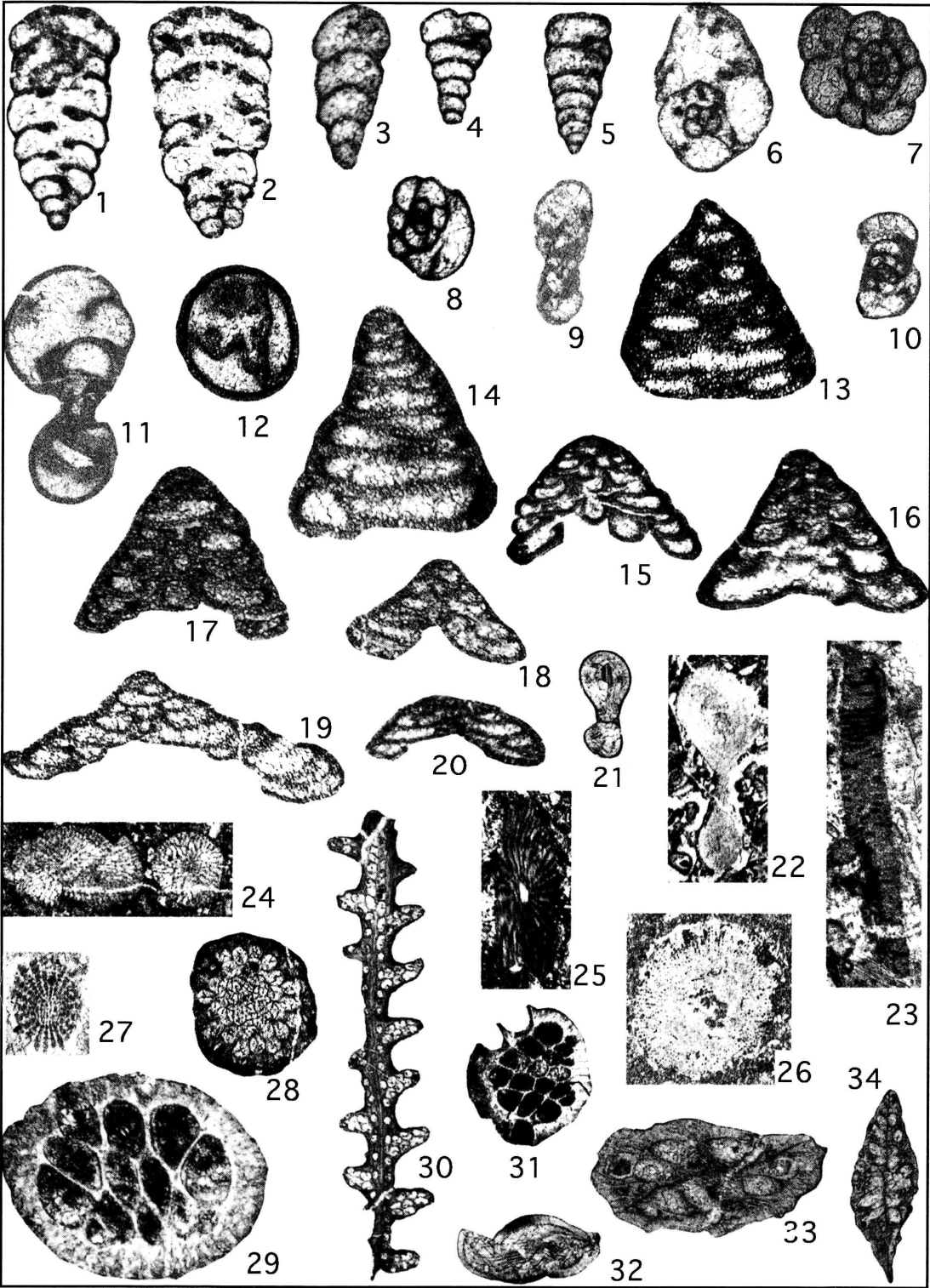
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Plate 7

Explanation of Plate 7

- Figs. 1 and 2. *Climacammina* sp.
Nos. Loc. GS1-526 and GS14-197, x20. (GK-D 33159, 33160)
- Figs. 3 and 5. *Nodosaria* sp. A
Nos. Loc. GS33-488 and GS1-415, 3: x40, 2: x20. (GK-D 33161, 33162)
- Fig. 4. *Geinitzina* sp.
No. Loc. GS1-526, x20. (GK-D 33163)
- Fig. 6. *Bradyina* sp.
No. Loc. GS14-199, x20. (GK-D 33164)
- Figs. 7-10. *Endothyra* spp.
Nos. Loc. GS13-441, GS33-293, GS49-266 and GS49-297, x40. (GK-D 33165-33168)
- Fig. 11. *Planoendothyra* sp.
No. Loc. GS3-434, x40. (GK-D 33169)
- Fig. 12. *Globivalvulina* sp.
No. Loc. GS14-287, x20. (GK-D 33170)
- Figs. 13-21. *Tetrataxis* spp.
Nos. Loc. GS14-199, GS1-526, GS1-528, GS1-527, GS14-287, GS1-528, GS47-258, GS13-195 and GS27-224, 13, 14, 16-21: x40, 15: x20. (GK-D 33171-33179)
- Fig. 22. *Tuberitina* sp. A
No. Loc. GS1-424, x20. (GK-D 33180)
- Fig. 23. *Solenopora* sp.
Nos. Loc. GS27-221, x10. (GK-D 33181)
- Fig. 24. *Epimastopora* sp.
No. Loc. GS26-355, x20. (GK-D 33183)
- Fig. 25. *Parachaetetes* sp.
No. Loc. GS1-532, x20. (GK-D 33184)
- Fig. 26. *Pseudovermiporella* sp.
No. Loc. GS14-199, x10. (GK-D 33185)
- Fig. 27. Echinoderm fragment
No. Loc. GS18-472, x20. (GK-D 33182)
- Fig. 28. Alga?
No. Loc. GS27-221, x40. (GK-D 33186)
- Fig. 29. *Streblascopora* sp.
No. Loc. GS14-200, x20. (GK-D 33187)
- Figs. 30-32. *Penniretepora* sp.
Nos. Loc. GS14-445, GS15-464 and GS14-199, 30: x40, 31: x10, 32: x20. (GK-D 33188-33190)
- Fig. 33. *Streblascopora*? sp
No. Loc. GS14-451, x20. (GK-D 33191)
- Fig. 34. and 35. *Sulcoretepora*? sp.
No. Loc. GS14-446, x10., No. Loc. GS14-446, x20. (GK-D 33192, 33193)



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