Rivista Italiana di Paleontologia e Stratigrafia	volume 109	no. 2	13 pls.	pp. 307-337	June 2003

PERMIAN FUSULINACEANS OF THE SURMAQ FORMATION IN THE ABADEH REGION, CENTRAL IRAN

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Received January 5, 2002; accepted February 4, 2003

Key words: Permian, fusulinaceans, systematic paleontology, Surmaq Formation, Abadeh region, central Iran

Abstract. Fusulinaceans consisting of 56 species belonging to 30 genera are distinguished from the Surmaq Formation distributed in the Abadeh region, central Iran. Among them, 23 species, including three species newly proposed: *Parafusulina tarazi*, *Skinnerella abadehensis*, and *Sphaerulina iranensis*, are systematically described and discussed. Many microphotographs of fusulinaceans are illustrated so as to understand their wide intraspecific variation and to compare them with other faunas from the Tethyan regions. The Surmaq Formation is biostratigraphically divided into six zones from lower to upper: *Darvasites ordinatus*, *Pseudofusulina quasifusuliniformis*, *Eopolydiexodina persica*, *Afghanella schencki*, *Neoschwagerina occidentalis*, and *Chusenella abichi*. The first zone is probably Yakhtashian, the second is possibly Kubergandian, the third to fifth are Murgabian, and the last is Midian in age, based on the stratigraphic distribution and faunal correlation of neoschwagerinids and schwagerinids in Middle Permian formations of the Tethyan regions. Schwagerinids are dominant in these six zones, whereas almost all neoschwagerinids and verbeekinids are restricted to the fourth and fifth zones. Middle Permian fusulinacean faunas in South West Asian and Mediterranean Sea regions are well represented by those of the Surmaq Formation, and paleobiogeographically assignable to Province A (Western Tethyan Province). Fusulinacean faunas of Province A are largely different from those in Province B (Eastern Tethyan Province) by the very rare occurrence of typical *Colania* and *Lepidolina*, and from Province C (Panthalassan Province) by the presence of *Afghanella* and *Sumatrina*.

Riassunto. Sono studiati i fusulinidi della Formazione Surmaq nella regione di Abadeh, Iran Centrale. Essi ammontano a 56 specie appartenenti a 30 generi. Vengono descritte 23 specie, di cui 3 nuove: *Parafusulina tarazi*, *Skinnerella abadehensis* e *Sphaerulina iranensis*. La fauna viene illustrata abbondantemente per comprendere la sua variabilità intraspecifica e poterla confrontare con altre faune delle regioni tetidiane. La Formazione Surmaq può venir suddivisa in sei biozone, dal basso in alto: *Darvasites ordinatus*, *Pseudofusulina quasifusuliniformis*, *Eopolydiexodina persica*, *Afghanella schencki*, *Neoschwagerina occidentalis* e *Chusenella abichi*. Sulla base della distribuzione e correlazione faunistica dei neoschwagerinidi e schwagerinidi nel Permiano Medio della Tetide, la prima zona è probabilmente di età Yakhtashiana, la seconda è posibilmente Kubergandiana, dalla terza alla quinta sono di età Murgabiana, e l'ultima è di età Midiana. Gli schwagerinidi sono dominanti nelle sei zone, mentre quasi tutti i neoschwagerinidi e verbeekinidi sono limitati alla quarta e quinta zona. Le faune a fusulinidi delle regioni dell'Asia sud-occidentale e del Mediterraneo sono ben rappresentate tra quelle di Surmaq, le quali sono pertanto sono riferibili alla provincia paleobiogeografica A (Provincia della Tetide occidentale). I fusulinidi della Provincia A sono sensibilmente diversi da quelli della Provincia B (Provincia della Tetide orientale) con la presenza molto rara di tipiche *Colania* e *Lepidolina*, e da quelle della Provincia C (Provincia del Panthalassa) di cui sono presenti *Afghanella* e *Sumatrina*.

Introduction

Permian formations in the Abadeh region, central Iran, are well-known for abundant occurrences of Permian fusulinaceans and their conformable relationships with the Triassic formations. They are composed mostly of platform limestone, and divided from lower to upper into the Surmaq, Abadeh, and Hambast Formations. Geologic ages of these three formations are thought to be Yakhtashian to Midian, Midian to Dzhulfian, and Dzhulfian to Dorashamian, respectively. The Surmaq Formation is subdivided further into units 1, 2, and 3, and overlies unconformably the non-marine Carboniferous (Iranian-Japanese Research Group 1981). According to Baghbani (1997), the Surmaq Formation overlies the Vazhnan Formation of Asselian and Sakmarian age.

The Surmaq Formation contains many fusulinaceans including neoschwagerinids, verbeekinids, and schwagerinids useful for biostratigraphic subdivision and paleobiogeographic reconstruction. Fifty six species assignable to 30 genera of fusulinaceans characteristic of the South West

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Asian and Mediterranean Sea regions are distinguished in the Surmaq Formation (Kobayashi & Ishii 2002). Schwagerinids are common throughout the formation, on the other hand, dominant occurrences of neoschwagerinids and verbeekinids are restricted to the middle part of the formation. Fusulinacean faunal composition and species diversity in the Surmaq Formation are dependent largely on limestone lithology. They are important for the tectonic history of the western part of the Cimmerian Continent, and evolution and extinction of fusulinaceans in Permian time (Kobayashi & Ishii 2002).

The main purpose of this paper is to describe fusulinacean faunas of the Yakhtashian to Midian Surmaq Formation. Many microphotographs of fusulinaceans are illustrated here with so as to understand their wide intraspecific variation. Systematically described in this paper are 23 species, including three newly proposed species: *Parafusulina tarazi*, *Skinnerella abadehensis*, and *Sphaerulina iranensis*. Preceding the systematic description, fusulinacean biostratigraphy of the Surmaq Formation and paleobiogeographic implications of the Surmaq faunas are summarized.

All limestone samples used in this paper were collected from the Surmaq Formation at the M-K, L, and N-R sections and Estaki Mine in the Surmaq - Deh Bid area of the Abadeh region (Fig. 1) in 1972 and 1975 by the joint research project organized by Iranian and Japanese geologists and paleontologists including one of us, K. Ishii. Stratigraphy of Permian formations in this region was described in detail by Taraz (1974) and Iranian-Japanese Research Group (1981). Baghbani (1997) reported occurrences of *Misellina* spp., *Maklaya* sp., *Cancellina* spp., *Neoschwagerina simplex*, and *Presumatrina* sp. from the lower part of the Surmaq Formation in the Abadeh region. These fusulinaceans of possibly Bolorian, Kubergandian, and early Murgabian age have not been distinguished in our materials.

All of limestone thin sections are registered and stored in the Hayashibara Museum of Natural History, Okayama, Japan.

Fusulinacean biostratigraphy of the Surmaq Formation

Stratigraphic distribution of fusulinaceans in the Surmaq Formation was examined in three columnar sections, M-K, N-R, and L (Iranian-Japanese Research Group 1981). The close reexamination on the identification and biostratigraphic distribution of fusulinaceans based on the original and newly added materials (Kobayashi & Ishii 2002) shows that the Surmaq Formation is divisible biostratigraphically into six fusulinacean zones from lower to upper: *Darvasites ordinatus* Zone, *Pseudofusulina quasifusuliniformis* Zone, *Eopolydiexodina persica* Zone, *Afghanella schencki* Zone, *Neoschwagerina occidentalis* Zone, and *Chusenella abichi* Zone (Figs. 2, 3).

The alternating beds of thinly and thickly bedded limestone with thin intercalation of chert and shale containing abundant schwagerinids in the Estaki Mine, 8 km northeast of Abadeh (Iranian-Japanese Research Group 1981) are designated as the *Darvasites ordinatus* Zone. Identified species are *Darvasites ordinatus*, *Chalaroschwagerina* cf. *C. mengi*, *Pseudofusulina fusiformis*, *Pamirina leveni*, and others. The zonal index species and other schwagerinids are known from the Yakhtashian to Bolorian in South West Asia (e.g. Leven 1967). Primitive species of *Misellina* showing Bolorian age are not found in our materials from the Surmaq Formation. This zone is thought to be probably Yakhtashian in age based on the occurrence of *Pamirina leveni*. The *Pseudofusulina quasifusuliniformis* Zone, directly overlain by the *Eopolydiexodina persica* Zone, is devoid of any other schwagerinids except for zonal species. *Pseudofusulina quasifusuliniformis* was described from the Kubergandian *Cancellina* Zone of the Southeast Pamir (Leven 1967). Precise correlation and age determination are impossible, because no other reliable index species showing the Kubergandian are found in the formation.

The *Eopolydiexodina persica* Zone represents thinly bedded limestone with abundant *Eopolydiexodina persica*. The biostratigraphic range of this species extends to the lower part of the overlying *Afghanella schencki* Zone in the M-K section. *Eopolydiexodina* is an index genus ranging from the Kubergandian (*Cancellina* Zone) to the middle Murgabian (*Neoschwagerina craticulifera* Zone) according to Leven (1965). In Transcaucasus, the lower part of the Murgabian Gnishik Formation is designated as the *Eopolydiexodina persica* Zone (Kotlyar et al. 1989). Although this zone is probably thought to be early Murgabian, its more detailed correlation and age determination are difficult because of absence of any neoschwagerinids and verbeekinids in this zone.

The base of the *Afghanella schencki* Zone is defined by the first occurrence of *Afghanella schencki* in the M-K section, and its top is at the first occurrence of *Neoschwagerina occidentalis* in the N-R section. Species diversity becomes increasingly high in this zone. Besides *Afghanella schencki*, this zone contains *Afghanella sumatrinaeformis*, *Sumatrina annae*, *Verbeekina heimi*, *Rugososchwagerina xanzensis*, *Skinnerella abadehensis* n. sp., *Parafusulina tarazi* n. sp., and many others. Although *Sumatrina annae* is thought to be zonal species in the lower Midian (Leven 1993), this species ranges from the basal part of the *Neoschwagerina* Zone to the *Lepidolina shiraiwensis* Zone in the eastern Tethyan regions (e.g. Toriyama 1958; Sheng 1963; Toriyama et al. 1975). This zone is thought to be middle to late Murgabian in age based on fusulinacean faunal assemblages in this zone. The top of the *Neoschwagerina occidentalis* Zone, overlying the *Afghanella schencki* Zone, is at the first occurrence of *Chusenella abichi* in the N-R section. The stratigraphic interval, tentatively treated as the *Neoschwagerina*

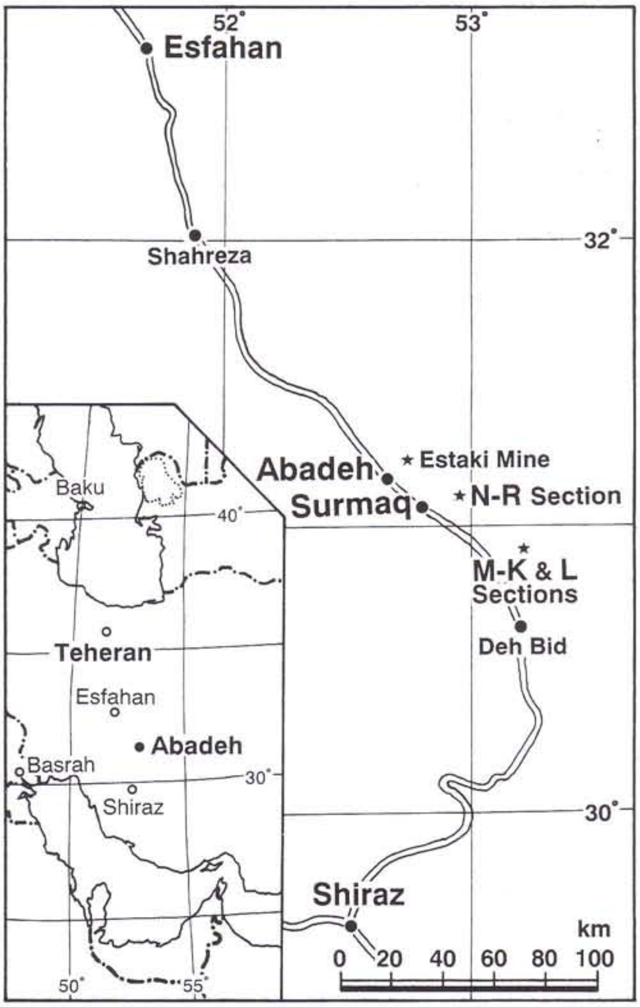


Fig. 1 - Index map showing the localities of the studied sections of the Surmaq Formation in the Abadeh region by the Iranian Japanese Research Group (1981).

haydeni Zone in the M-K section (Fig. 2), is probably correlatable to a part of the *Neoschwagerina occidentalis* Zone in the N-R section (Kobayashi & Ishii 2002). More fusulinacean taxa are distinguished than in the underlying *Afghanella schencki* Zone. *Neoschwagerina occidentalis, N. haydeni, Sumatrina annae*, and others of this zone are well-known and widespread in the South West Asia and Mediterranean Sea regions (e.g., Leven 1967, 1997; Kochansky-Devide & Ramovs 1955). This zone is thought to be late Murgabian age rather than early Midian because of absence of *Yabeina* and *Chusenella abichi* (Kobayashi & Ishii 2002).

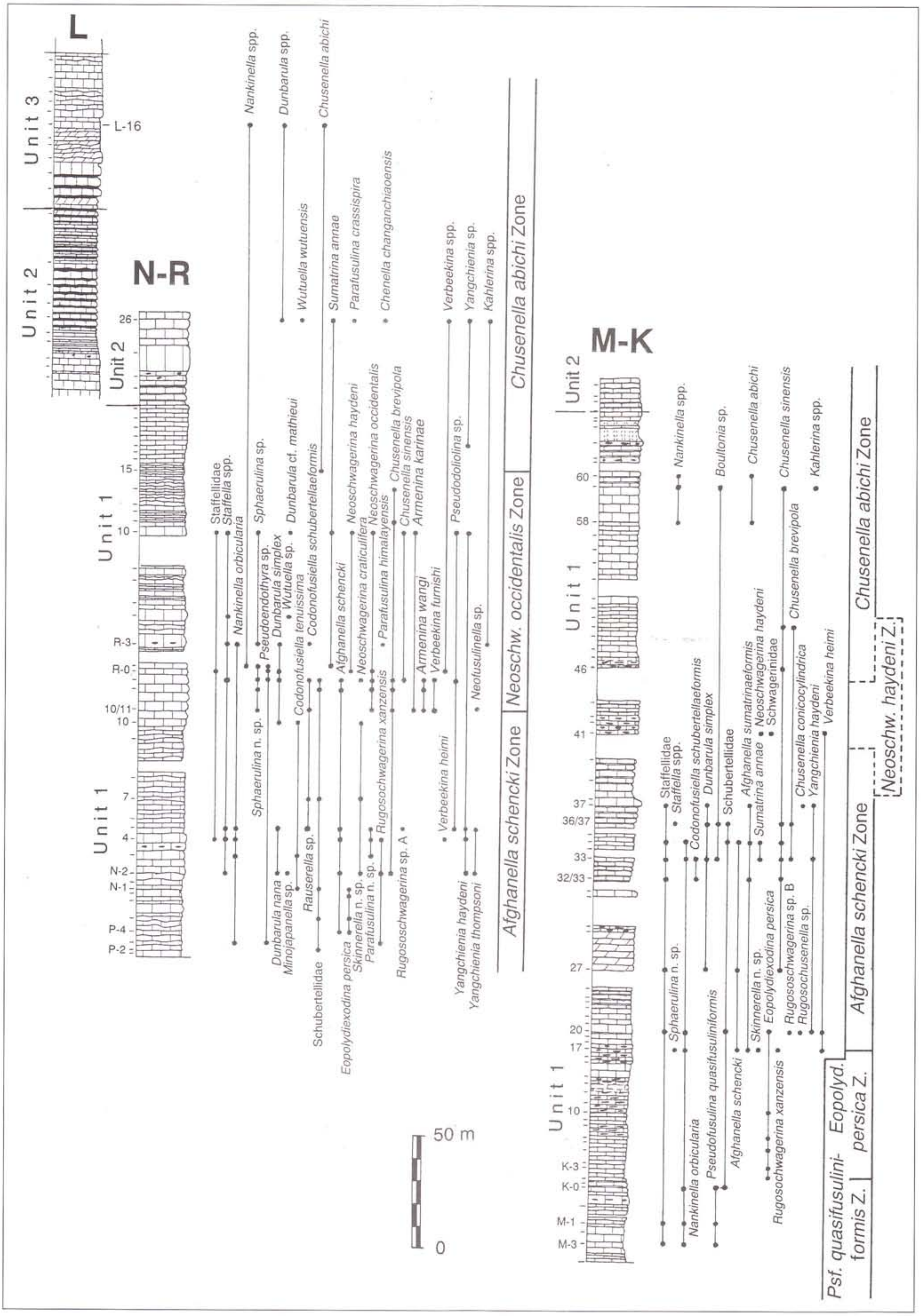
The *Chusenella abichi* Zone corresponds to the uppermost part of unit 1, and units 2 and 3. The base of this zone is defined by the first occurrence of *Chusenella abichi*. *Chusenella abichi, C. sinensis*, and *C. brevipola* are not found from the same collections in association with neoschwagerinids, verbeekinids, and other schwagerinids in this zone. Among neoschwagerinids, *Sumatrina annae* is exclusively found in fusulinacean algal packstone from R-26 of the unit 2. On the other hand, most of limestone of this zone consists of wackestone and lime-mudstone. *Parafusulina crassispira, Wutuella wutuens*, and *Chenella changanchiaoensis* are restricted to this zone, and they are associated with *Sumatrina annae*. *Chusenella abichi* is the index species of Midian of Trancaucasus (Rozovskaya 1965; Kotlyar et al. 1989; Leven 1998). This zone is thought to be Midian in age by the occurrences of these fusulinaceans.

Paleobiogeographic implications of the Surmaq fauna

Faunal analysis of Surmaq fusulinaceans aids in the interpretation of paleogeographic and tectonic evolution of terranes having Gondwana-affinities. Occurrence of *Pamirina* throughout Tethyan regions is thought to have resulted from global Yahtashian to Bolorian transgression. Low species diversity of fusulinaceans in the *Darvasites ordinatus* and *Pseudofusulina quasifusuliniformis* Zones are thought to be referable to the latitudinal control of the Abadeh region in cool to warm temperate zones during late Early to early Middle Permian time (Kobayashi & Ishii 2002). *Eopolydiexodina persica*, abundant in the *Eopolydiexodina persica* Zone, is very common in the Kubergandian and Murgabian of Cimmerian terranes in South West Asia and its surrounding regions (Kobayashi & Ishii 2002). Carbonate deposition was finished by early Midian time in most of these regions.

Although no reliable index taxa showing sure Bolorian to early Murgabian ages are found in our materials, many diverse fusulinaceans, including first appearing neoschwagerinids and verbeekinids, are recognizable in the *Afghanella schencki* Zone. The *Afghanella schencki* fauna is represented by *Afghanella schencki, A. sumatrinaeformis, Sumatrina annae, Verbeekina heimi, Skinnerella abadehensis* n. sp., *Parafusulina tarazi* n. sp., *Rugosochwagerina xanzensis*, and others. Species diversity increases even more in the *Neoschwagerina occidentalis* Zone where three species of *Neoschwagerina*, two species of *Armenina*, and two species of *Verbeekina* first appear. Higher species diversity in the middle to late Murgabian fusulinacean faunas and dominance of verbeekinids and neoschwagerinids, and lithologic characters in the *Afghanella schencki* and *Neoschwagerina occidentalis* Zones suggest the northward movement of western Cimmerian terranes toward the tropical zones (Kobayashi & Ishii 2002).

These Murgabian fusulinacean faunas are closely similar to those of South West Asian and Mediterranean Sea regions. They are somewhat alike to those of the East and South East Asia. Murgabian faunas in the Tethyan regions are quite different from those found in Permian limestone blocks of the Jurassic terranes of Japan and other Circum-Pacific regions where *Afghanella* and *Sumatrina* are completely absent (Kobayashi 1997). Fusulinacean faunal provincialism becomes evident and more easily distinguishable in the these regions toward


L
Unit 3
L-16
Unit 2
N-R
26
Unit 2
15
10
Unit 1
R-3
R-0
10/11
10
7
Unit 1
4
N-2
N-1
P-4
P-2
Nankinella spp.
Dunbarula spp.
Chusenella abichi
Wutuella wutuensis
Sumatrina annae
Parafusulina crassispira
Chenella changanchiaoensis
Verbeekina spp.
Yangchienia sp.
Kahlerina spp.
Staffellidae
Staffella spp.
Nankinella orbicularia
Sphaerulina sp.
Sphaerulina n. sp.
Pseudoendothyra sp.
Dunbarula simplex
Wutuella sp.
Dunbarula cf. mathieui
Codonofusiella tenuissima
Codonofusiella schubertellaeformis
Dunbarula nana
Minojapanella sp.
Rauserella sp.
Schubertellidae
Afghanella schencki
Eopolydiexodina persica
Skinnerella n. sp.
Parafusulina n. sp.
Neoschwagerina haydeni
Neoschwagerina craticulifera
Neoschwagerina occidentalis
Parafusulina himalayensis
Rugososchwagerina xanzensis
Rugososchwagerina sp. A
Chusenella brevipola
Chusenella sinensis
Armenina karinae
Armenina wangi
Verbeekina furnishi
Verbeekina heimi
Pseudodoliolina sp.
Neofusulinella sp.
Yangchienia haydeni
Yangchienia thompsoni
Afghanella schencki Zone
Neoschw. occidentalis Zone
Chusenella abichi Zone
50 m
0
M-K
Unit 2
60
58
Unit 1
46
41
37
36/37
33
32/33
27
20
17
Unit 1
10
K-3
K-0
M-1
M-3
Nankinella spp.
Boultonia sp.
Chusenella abichi
Chusenella sinensis
Kahlerina spp.
Chusenella brevipola
Staffellidae
Staffella spp.
Codonofusiella schubertellaeformis
Dunbarula simplex
Schubertellidae
Afghanella sumatrinaeformis
Sumatrina annae
Neoschwagerina haydeni
Schwagerinidae
Chusenella conicocylindrica
Yangchienia haydeni
Verbeekina heimi
Sphaerulina n. sp.
Nankinella orbicularia
Pseudofusulina quasifusuliniformis
Afghanella schencki
Skinnerella n. sp.
Eopolydiexodina persica
Rugososchwagerina xanzensis
Rugososchwagerina sp. B
Rugosochusenella sp.
Psf. quasifusuliniformis Z.
Eopolyd. persica Z.
Afghanella schencki Zone
Neoschw. haydeni Z.
Chusenella abichi Zone

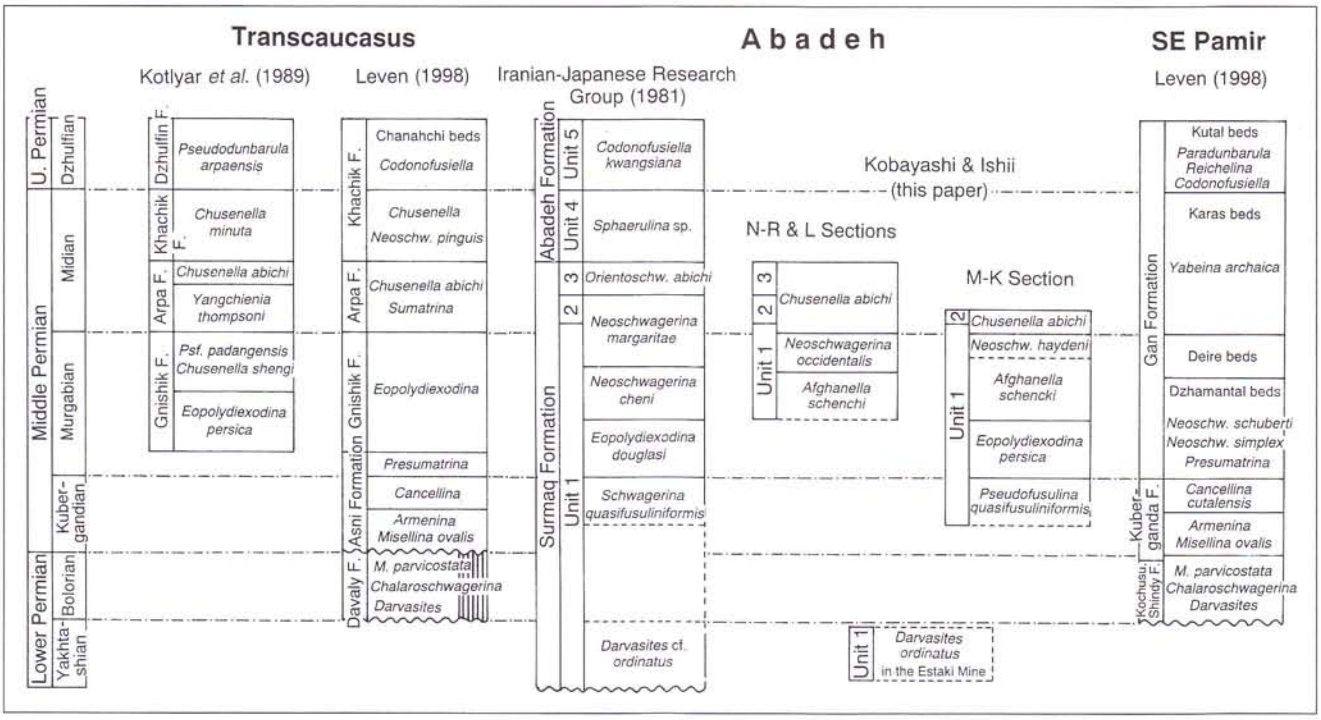


Fig. 3 - Correlation of the Yakhtashian to Dzhulfian in the Transcaucasus, Abadeh region, and Southeast Pamir.

the end of Middle Permian. Phyletic evolution and provincial evolution of neoschwagerinids and verbeekinids are shown clearly by the analysis of the ontogenetic development of test characters and faunal composition in each of these regions.

Fusulinaceans are rare and species diversity becomes poor in the *Chusenella abichi* Zone in the Abadeh region as well as in Transcaucasus. Low species diversity of faunas along with abrupt change of limestone facies in this zone indicate a change of sedimentary environment (Kobayashi & Ishii 2002).

The *Chusenella abichi* fauna in the Abadeh region and Transcaucasus is considered to be contemporaneous with the Midian *Yabeina* fauna. The distribution of the *Yabeina* fauna becomes more restricted than that of pre-Midian faunas in South West Asian and Mediterranean Sea regions, and faunal provincialism had increased more rapidly throughout the Tethyan regions.

Based on time and space distribution, and phyletic evolution of neoschwagerinids and verbeekinids, Middle Permian fusulinacean faunas are largely divisible into Province A (Western Tethyan Province), Province B (Eastern Tethyan Province), Province C (Panthalassan Province) and Province D (Cratonic North American Realm) (Fig. 4), as proposed by Kobayashi (1997). It is concluded that the Middle Permian fusulinacean faunas in the Abadeh region are one of the most representative faunas in the Province A.

Systematic Paleontology

Superfamily Fusulinacea von Moller, 1878

Family Ozawainellidae Thompson and Foster, 1937

Genus *Chenella* A. D. Miklukho-Maklay, 1959

Chenella changanchiaoensis (Sheng & Wang)

Pl. 1, fig. 2-4

1962 *Reichelina ? changanchiaoensis* Sheng & Wang, p. 178, 184, pl. 1, fig. 5-7.

Material. One axial and two tangential sections.

Discussion. Test and height of each volution of the present specimens are smaller than those of the original ones from southern Jiansu, South China by Sheng & Wang (1962). Original ones are associated with *Metadoliolina multivoluta* (Sheng) and others, and the present ones occur with *Sumatrina annae* Volz and others. This species is characteristic in the upper Maokouan of South China and the Midian.

Fig. 2 - Fusulinacean biostratigraphy of the Surmaq Formation in the Abadeh region. The *Darvasites ordinatus* Zone is recognized in the Estaki Mine and not in the other studied sections.

Stratigraphic distribution. Rare in and restricted to R-26 of the unit 2 in the N-R section (*Chusenella abich* Zone).

Genus *Pamirina* Leven, 1970

Type species: *Pamirina darvasica* Leven, 1970, p. 23, 24, pl. 1, fig. 1-12, 23, 24.

1970 *Pamirina* Leven, p. 23 (original designation).
1973 *Chinlingella* Wang & Sun, p. 152, 171, type species: *Chinlingella chinlingensis* Wang & Sun, p. 152, 153, 172, pl. 1, fig. 12, 17 32, pl. 3, fig. 1, 5, 10 (original designation).
1991 *Pamirina (Pamirina)* Ueno, p. 744 (name transferred).
1991 *Pamirina (Levenia)* Ueno, p. 745, 756 (name invalidly proposed); type species: *Pamirina leveni* Kobayashi,1977, p. 11-14, pl. 1, fig. 13-38.
1994 *Pamirina (Levenella)* Ueno, p. 405 (name proposed to replace).

Discussion. *Pamirina* is assignable to the Ozawainellidae and not to the Staffellidae as Loeblich & Tappan (1988) thought on the basis of the spirothecal structure, and is thought to be the ancestor of verbeekinid fusulinaceans (Kobayashi 1977). This genus is an excellent biostratigraphic indicator showing the Yakhtashian. It is impossible to distinguish *Levenella* from *Pamirina* in subgeneric rank by slight differences of spirothecal structure, shape and form ratio of test along with those of volutions, and stratigraphic position, as Ueno (1991) thought.

Pamirina leveni Kobayashi
Pl. 1, fig. 1

1977 *Pamirina leveni* Kobayashi, p. 11-14, pl. 1, fig. 13-38.

Material. One tangential section.

Discussion. A few specimens are recognized in association with *Darvasites ordinatus* and others. The illustrated specimen is possibly identical with *Pamirina leveni* based on its spirothecal structure and mode of coiling.

Stratigraphic distribution. Rare in the basal part of the Surmaq Formation (*Darvasites ordinatus* Zone) at the Estaki Mine.

Family Schubertellidae Skinner, 1931
Subfamily Schubertellinae Skinner, 1931
Genus *Yangchienia* Lee, 1934

Type species: *Yangchienia iniqua* Lee, 1934, p. 14, pl. 1, fig. 1, 1a.

1934 *Yangchienia* Lee, p. 14 (original designation).

Discussion. Some taxonomists assigned *Yangchienia* to the Fusulinidae based mainly on its spirothecal structure with distinct diaphanotheca. Appearances of the early ontogenetic stage of *Yangchienia* are nearly the same as those of *Schubertella*, and different from those of morphologically similar genera such as *Pseudofusulinella* that

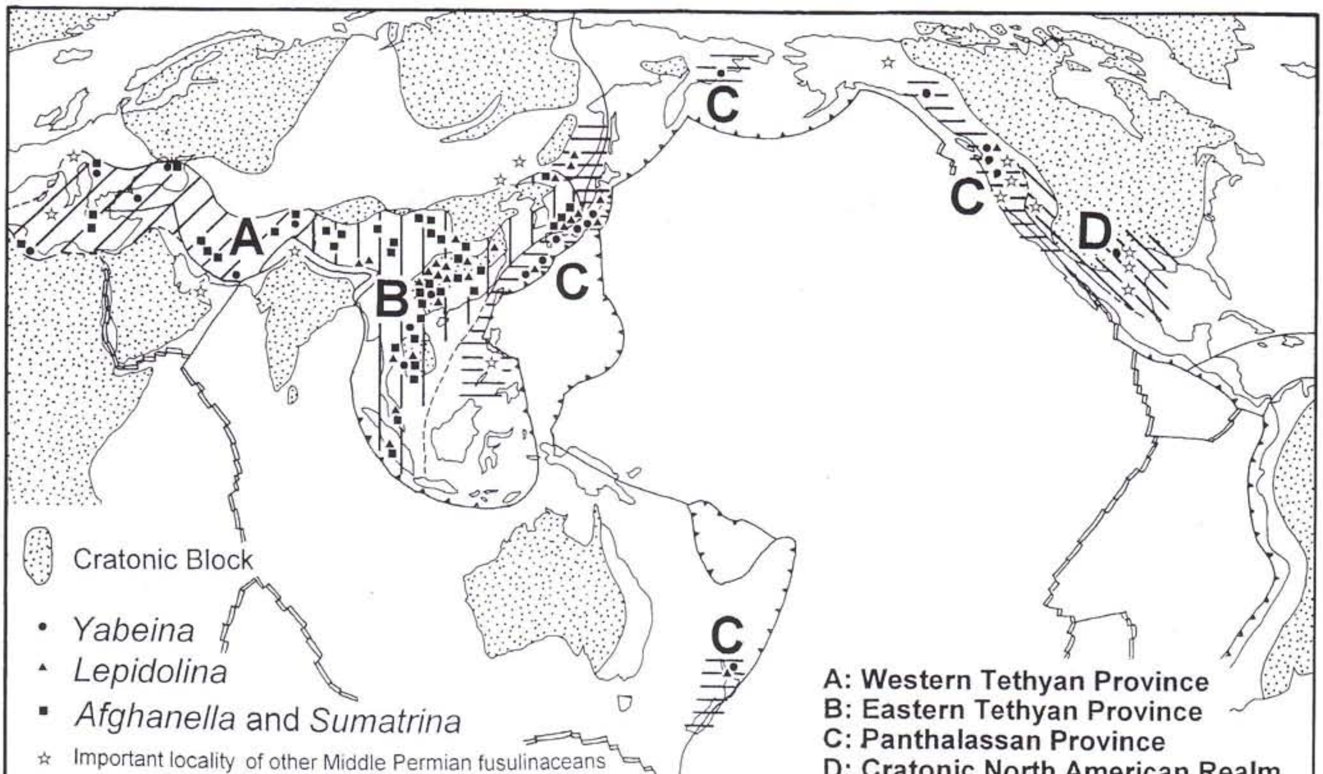


Fig. 4 - Map showing distribution of some neoschwagerinid genera, and middle Permian (Murgabian and Midian) fusulinacean provinces divisible into A, B, C, and D (after Kobayashi 1997).

belongs to the Fusulinidae. As evidenced by the biostratigraphic distribution, no phylogenetic relationships are recognizable between *Yangchienia* and Early Permian genera of Fusulinidae. Accordingly, *Yangchienia* is reasonably assignable to Schubertellinae of Schubertellidae.

Yangchienia haydeni Thompson

Pl. 2, fig. 1-10

1946 *Yangchienia haydeni* Thompson, p. 283, pl. 1, fig. 8-12.

Material. Illustrated four axial, four tangential, one sagittal, and one parallel sections.

Discussion. The type species of *Yangchienia*, *Y. iniqua*, was established on the basis of incomplete material from South China by Lee (1934). Subsequent description of this species from South China by Thompson (1935) was based on specimens without the outermost volutions. Well-developed massive chomata except for *Schubertella*-like inner volutions is characteristic to *Y. iniqua*. The Surmaq specimens are more similar to *Yangchienia haydeni* introduced by Thompson (1946) from the Bamian Limestone rather than *Y. iniqua* in their narrower asymmetrical tunnel and not so massive chomata as those of *Y. iniqua*. *Y. haydeni* closely resembles *Y. thompsoni* proposed by Skinner & Wilde (1966) from Sicily. The former is distinguished from the latter by smaller test, more asymmetrical chomata, and not straight and irregular tunnel.

Stratigraphic distribution. Abundant in R-10 in the N-R section (*Neoschwagerina occidentalis* Zone), common to rare in N-2, N-4, and N-5 in the N-R section (*Afghanella schencki* Zone), and in K-20, K-33, and K-37 in the M-K section (*Afghanella schencki* Zone).

Subfamily Boultoniinae Skinner & Wilde, 1954

Genus *Codonofusiella* Dunbar & Skinner, 1937

Codonofusiella schubertellaeformis (Sheng)

Pl. 1, fig. 34-38

1958 *Dunbarula schubertellaeformis* Sheng, p. 283, pl. 1, fig. 8-12.

Material. Three axial, one tangential, and one oblique sections.

Discussion. The outermost volution in the mature stage is uncoiled in the original Chinese and the present Surmaq specimens. They are assignable to *Codonofusiella* rather than *Dunbarula*. However, their uncoiled volutions are not so clear as in typical forms belonging to *Codonofusiella*, including *C. tenuissima* Sheng from the Surmaq Formation shown in Pl. 1, fig. 39-42 in this paper.

Stratigraphic distribution. Rare in R-3 in the N-R section (*Neoschwagerina occidentalis* Zone), and K-32/33 and K-33 in the M-K section (*Afghanella schencki* Zone).

Genus *Dunbarula* Ciry, 1948

Dunbarula cf. **D. mathieui** Ciry

Pl. 1, fig. 27, 28

Cf. 1948 *Dunbarula mathieui* Ciry, p. 108, pl. 1, fig. 1-13.

Material. One axial and one sagittal sections.

Discussion. The original specimens described by Ciry (1948) and topotype ones by Skinner & Wilde (1967) from Tunisia have larger test, and more strongly fluted and more number of septa than the present Surmaq ones. The original ones are accompanied by evolved forms of *Neoschwagerina* as well as the Surmaq ones. Well-oriented mature specimens are too poorly preserved to understand the morphologic variation of test characters of the present ones. They are comparable to *Dunbarula mathieui* with reservation.

Stratigraphic distribution. Rare in and restricted to R-10 in the N-R section (*Neoschwagerina occidentalis* Zone).

Genus *Wutuella* Sheng, 1963

Wutuella wutuensis (Kuo)

Pl. 1, fig. 12-15

1949 *Gallowaiinella wutuensis* Kuo, p. 233, pl. 1, fig. 1-3.

Material. Two sagittal and two oblique sections.

Discussion. Exact test characters of the present specimens are unknown because of no well-oriented axial sections in the mature stage. However, they are very close to the original ones described from southern Gansu, China by Kuo (1949) in size of test, numerous volutions, septal count, and intensely and regularly fluted septa throughout test.

Stratigraphic distribution. Rare in and restricted to R-26, unit 2 in the N-R section (*Chusenella abich* Zone).

Family Schwagerinidae Dunbar & Henbest, 1930

Subfamily Schwagerininae Dunbar & Henbest, 1930

Genus *Darvasites* A. D. Miklukho-Maklay, 1959

Darvasites ordinatus (Chen)

Pl. 3, fig. 1-4

1934 *Triticites ordinatus* Chen, p. 38, 39, pl. 7, fig. 5-7.

Material. Illustrated two axial, one sagittal, and one tangential sections.

Discussion. The size of the test of the Surmaq specimens is larger than in the original ones from South China by Chen (1934). Among the described specimens, they are the closest to those from the Southeast Pamir by Leven (1967).

Stratigraphic distribution. Common in the basal part of the Surmaq Formation (*Darvasites ordinatus* Zone) at the Estaki Mine.

Genus *Parafusulina* Dunbar & Skinner, 1931

Parafusulina crassispira Leven

Pl. 4, fig. 5-8

1967 *Parafusulina multiseptata crassispira* Leven, p. 172, pl. 18, fig. 3, 5

Material. Illustrated two axial, one sagittal, and one oblique sections.

Discussion. Although fully-grown specimens are few because of abrasion of the outer test, the present specimens are probably identical with the original ones described as a subspecies of *Parafusulina multiseptata* from the Southeast Pamir by Leven (1967).

Stratigraphic distribution. Abundant in and restricted to R-26, Unit 2 in the N-R section (*Chusenella abich* Zone).

Parafusulina tarazi n. sp.

Pl. 4, fig. 9; Pl. 5, fig. 1-6

Origin of the name. After Dr. Hooshang Taraz, former chief geologist of the Geological and Mineral Survey of Iran, successfully conducted the Iranian-Japanese joint research project in the early 1970's.

Type specimens. Holotype HMNS-536 (Pl. 5, fig. 5). Paratypes HMNS-534A (Pl. 4, fig. 9), HMNS-542 (Pl. 5, fig. 1), HMNS-534B (Pl. 5, fig. 2), HMNS-540 (Pl. 5, fig. 3), HMNS-952 (Pl. 5, fig. 4), and HMNS-537 (Pl. 5, fig. 6).

Material. Illustrated six axial, one sagittal sections.

Diagnosis. Medium-sized species of *Parafusulina* with intensely and rather irregularly fluted septa, somewhat thick spirotheca, and absence of axial filling.

Description. Test subcylindrical, with broadly arched to straight periphery, slightly convex lateral slopes and rounded to bluntly pointed poles. Mature test with about seven volutions, more than 10 mm in length, about 4 mm in width, and 2.6 in form ratio. Proloculus large, subspherical or irregular. Its longer diameter ranging from 0.38 to 0.65 mm in the illustrated seven specimens. Half length and height of volution increase slowly, and their measurements depended on orientation of longer diameter of proloculus in thin sections. From the first to seventh volution of the holotype specimen, 0.70, 1.12, 1.81, 2.48, 3.16, 4.36, and 5.27 mm in half length; 0.30, 0.51, 0.82, 1.14, 1.51, 1.84, and 2.11 mm in height of volution; and 2.3, 2.2, 2.2, 2.2, 2.1, 2.4, and 2.5 in form ratio.

Septa intensely and rather irregularly fluted throughout test. Septal count from the first to seventh volution 7, 17, 22, 33, 36 (?), more than 37, and more than 6 in the specimen HMNS-534B shown in Pl. 5, fig. 2. Cunniculi developed in outer volutions, but not so clear as in most species of *Parafusulina*. Tunnel low and its path not straight. Indistinct chomata rudimentarily present only on proloculus. Axial filling absent.

PLATE 1

Fig. 1 - *Pamirina leveni* Kobayashi. Tangential section, HMNS-832, Estaki Mine, x 60.

Fig. 2-4 - *Chenella changanchiaoensis* (Sheng & Wang). 2: axial section, HMNS-669A; 3, 4: tangential sections, 3: HMNS-666B; 4: HMNS-669B, all from R-26, x 40.

Fig. 5, 6 - *Rauserella* sp. 5: oblique section, HMNS-961, N-5, x 50; 6: tangential section, HMNS-984, N-10/11, x 40.

Fig. 7-9 - *Boultonia* sp. Axial sections, 7: HMNS-818A, K-59; 8: HMNS-776, K-36/37; 9: HMNS-766, K-33; all x 40.

Fig. 10 - *Minojapanella* sp. Tangential section, HMNS-523, N-2, x 32.

Fig. 11 - *Wutuella* sp. Oblique section, HMNS-623, R-4, x 20.

Fig. 12-15 - *Wutuella wutuensis* (Kuo). 12, 15: oblique sections; 13, 14: sagittal sections, 12: HMNS-662B; 13: HMNS-672; 14:HMNS-670; 15: HMNS-669C, all from R-26; 12, 15: x 20; 13, 14: x 32.

Fig. 16-26 - *Dunbarula simplex* (Lange). 16-21, 24: axial sections; 22, 23, 25, 26: sagittal sections, 16:HMNS-602; 17: HMNS-608; 18: HMNS-612; 19: HMNS-605; 20: HMNS-624; 21: HMNS-557; 22: HMNS-611; 23: HMNS-594B; 24: HMNS-584B; 25: HMNS-889; 26: HMNS-594C; 16, 17, 19, 22, 23, 26: N-12; 18: R-0; 20: N-10; 21: N-7; 24: N-11; 25: K-37, all x 40.

Fig. 27, 28 - *Dunbarula* cf. *D. mathieui* Ciry. 27: sagittal section, HMNS-628B; 28: axial section, HMNS-630B; both from R-10, 27: x 32; 28: x 30.

Fig. 29-31 - *Dunbarula* spp. Axial sections, 29: HMNS-916; 30: HMNS-928A; 31: HMNS-928B, all from L-16, 29: x 80; 30, 31: x 40.

Fig. 32-33 - *Dunbarula nana* Kochansky-Devide & Ramovs. Axial sections, 32: HMNS-555, N-5; 33: HMNS-530, N-2, both x 40.

Fig. 34-38 - *Codonofusiella schubertellaeformis* (Sheng). 34, 35: axial sections; 36, 38: tangential sections; 37: oblique section, 34: HMNS-620B; 35: HMNS-760A; 36: HMNS-567; 37: HMNS-619; 38: HMNS-760B; 34, 37: R-3; 35, 38: K-33; 36: K-32/33; 34, 37: x 30, others x 40.

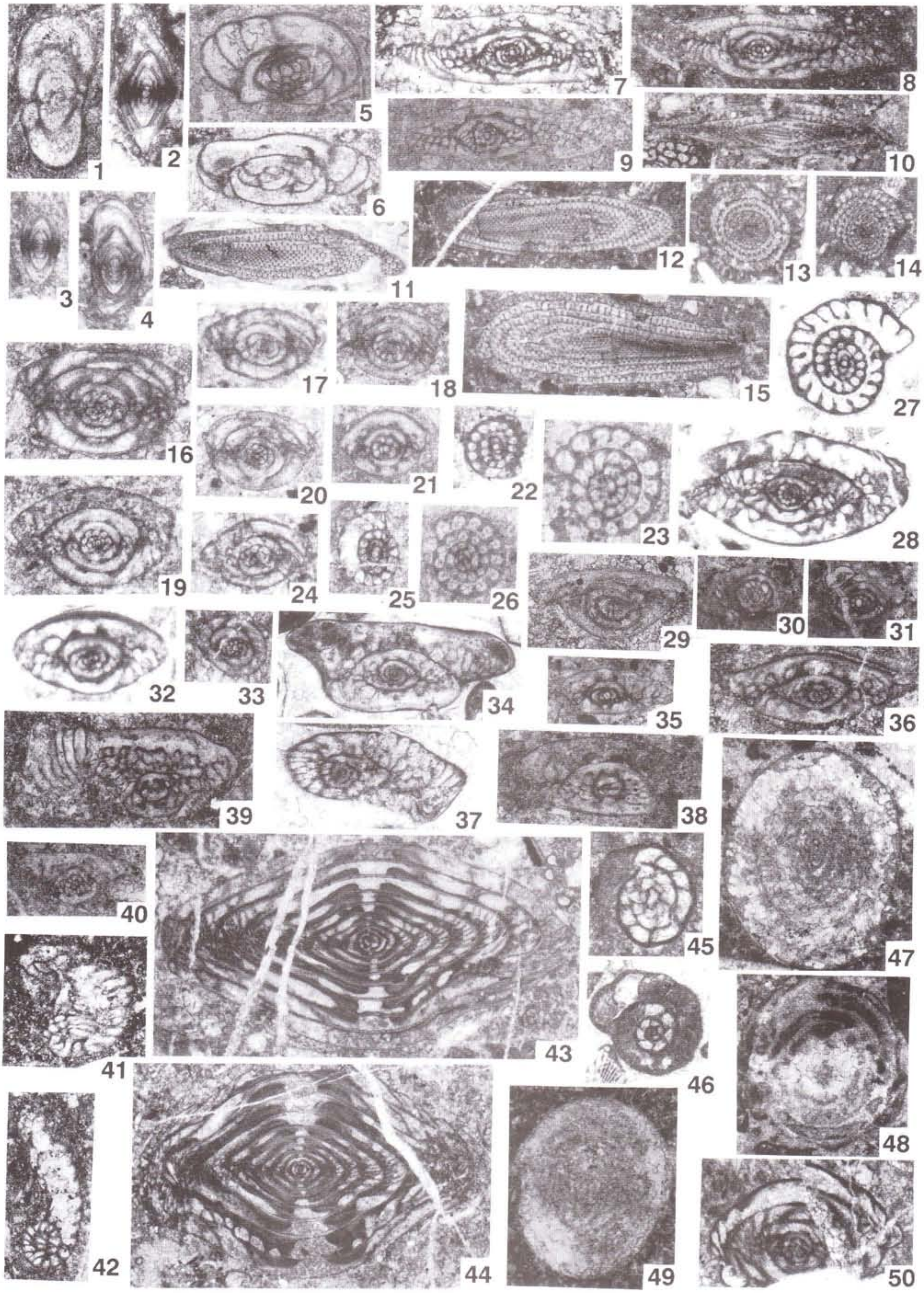
Fig. 39-42 - *Codonofusiella tenuissima* Sheng. 39, 41: tangential sections; 40: axial section; 42: parallel section, 39: HMNS-580B; 40: HMNS-937; 41: HMNS-935A; 42: HMNS-935B, 39: N-10; others from N-1, 39: x 40; others: x 50.

Fig. 43-44 - *Yangchienia thompsoni* Skinner & Wilde. Axial sections, 43: HMNS-958, N-5; 44: HMNS-943, N-2; both x 32.

Fig. 45-46 - *Kahlerina* spp. Parallel sections, 45: HMNS-666D, R-20; 46: HMNS-619, R-3; both x 30.

Fig. 47-49 - *Staffella* spp. Axial sections, 47: HMNS-771, K-36/37; 48: HMNS-967, N-5; 49: HMNS-939, N-2; all x 20.

Fig. 50 - *Neofusulinella* sp. Axial section, HMNS-979B, N-10/11, x 32.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Discussion. This new species closey resembles *Parafusulina multiseptata* (Schellwien) from South China by Chen (1934), and is also similar to the specimens identified with *P. multiseptata* from the Southeast Pamir by Leven (1967). However, the former has a larger test than the latter two, and axial filling is not present in the former. *Parafusulina multiseptata multiseptata* from the upper Kubergandian of central Afghanistan by Lys and Lapparent (1971) also resembles the present new species, but septal fluting is stronger and more irregular in the latter.

Parafusulina tarazi n. sp. is somewhat alike to *Parafusulina himalayensis* Ozawa and Gupta originally described from the Karakorum Range (Gupta & Ozawa, 1985) and from the Surmaq Formation. It is easily distinguished from *P. himayayensis* by smaller proloculus, and much smaller height of volution and half length of the corresponding volution in this new species.

Stratigraphic distribution. Abundant in N-2, N-4, and N-5 in the N-R section (*Afghanella schencki* Zone).

Genus *Pseudofusulina* Dunbar & Skinner, 1931

Pseudofusulina quasifusuliniformis Leven

Pl. 3, fig. 12, 13

1967 *Pseudofusulina quasifusuliniformis* Leven, p. 151, 152, pl. 12, fig. 7-9.

Material. Illustrated two axial sections.

Discussion. Well-developed axial filling, rather thin spirotheca, fluted septa throughout test of the present specimens resemble those of the original ones from the *Cancellina* Zone of the Southeast Pamir by Leven (1967). However, the former has more number of volutions and more tightly coiled inner volutions.

Stratigraphic distribution. Rare to common in M-3, M-1, and K-0 in the M-K section (*Pseudofusulina quasifusuliniformis* Zone).

Genus *Skinnerella* Coogan, 1960

Type species: *Parafusulina schucherti* Dunbar & Skinner, 1937, p. 672-674, pl. 64, fig. 9-12.

1960 *Parafusulina (Skinnerella)* Coogan, p. 262 (original designation).
1971 *Parafusulina (Skinnerella)* Skinner, p. 2, 3 (diagnosis emended).
1997 *Skinnerella* Vachard, in Vachard et al., p. 762, 764 (name transferred).

Discussion. The diagnostic test characters of *Parafusulina (Skinnerella)* were made clearer than those of the original designation by Coogan (1960) through the emendation by Skinner (1971). This genus is distinguished from *Parafusulina* by mode of septal fluting and phrenotheca, and poorly-developed cunniculi. Skinner (1971) doubted the subgeneric-rank distinction between *Parafusulina (Parafusulina)* and *Parafusulina (Skinnerella)* based on apparent morphologic dissimilarities. However, Skinner postponed his conclusion, and followed Coogan's taxonomic treatment. Vachard (Vachard et al., 1997) thought that these two are distinctive in generic rank, and insisted that *Skinnerella* originated in the Texas-Mexico-Guatemala regions in early to middle Leonardian time and then migrated to the Tethyan regions in Kubergandian time.

In Japan, *Skinnerella yabei* (Hanzawa) and its descendant forms range biostratigraphically from the *Misellina claudiae* Zone to at least the *Neoschwagerina craticulifera* Zone (Kobayashi's unpublished data). In the Abadeh region, *Skinnerella abadehensis* n. sp. is associated with *Afghanella schencki*. These Japanese and Iranian examples show the genus *Skinnerella* ranging up into the middle to upper Murgabian in the Tethyan regions.

Skinnerella abadehensis n. sp.

Pl. 6, fig. 1-8; Pl. 7, fig. 1-7

Origin of the name. After geographic name of Abadeh, central Iran.

Type specimens. Holotype HMNS-561 (Pl. 6, fig. 1). Paratypes HMNS-568 (Pl. 6 , fig. 2), HMNS-854 (Pl. 6, fig. 3), HMNS-581A (Pl. 6, fig. 4), HMNS-577B (Pl. 6, fig. 5), HMNS-575 (Pl. 6, fig. 6), HMNS-580A (Pl. 6, fig. 7), HMNS-569 (Pl. 6, fig. 8), HMNS-852 (Pl. 7, fig. 1), HMNS-525 (Pl. 7, fig. 2), HMNS-523 (Pl. 7, fig. 3), HMNS-570A (Pl. 7, fig. 4), HMNS-729 (Pl. 7, fig. 5), HMNS-577A (Pl. 7, fig. 6), and HMNS-570B (Pl. 7, fig. 7).

Material. Illustrated ten axial, three sagittal, and two tangential sections.

PLATE 2

Fig. 1-10 - *Yangchienia haydeni* Thompson. 1-3, 5, 7: axial sections; 4: sagittal section; 6, 9, 10: tangential sections; 8: parallel section, 1: HMNS-630A; 2: HMNS-628E; 3: HMNS-634A; 4: HMNS-631B; 5: HMNS-628D; 6: HMNS-631C; 7: HMNS-627A; 8: HMNS-633; 9: HMNS-634B; 10: HMNS-635B, all from R-10, all x 20.

Fig. 11-19 - *Sphaerulina iranensis* Kobayashi & Ishii n. sp. 11-15, 18: nearly axial sections; 16, 19: tangential sections; 17: sagittal section, 14: holotype; others: paratypes, 11: HMNS-610A; 12: HMNS-617A; 13: HMNS-603; 14: HMNS-593A; 15: HMNS-594A; 16: HMNS-873; 17: HMNS-601B; 18: HMNS-610B; 19: HMNS-601A, 12: R-2, 16: K-17; others from N-12, all x 20.

Fig. 20-26 - *Nankinella orbicularia* Lee. All nearly axial sections, 20: HMNS-710; 21: HMNS-959; 22: HMNS-533; 23: HMNS-752; 24: HMNS-744A; 25: HMNS-741; 26: HMNS-858, 20: M-6; 21:N-5; 22: N-3; 23-25: K-20; 26: K-17; 21, 22: x 20; others x 15.

Fig. 27-30 - *Pseudoendothyra* sp. 27-29: axial sections; 30: tangential sections; 27: HMNS-593B; 28: HMNS-609B; 29: HMNS-609A; 30: HMNS-604, all from N-12, x 20.

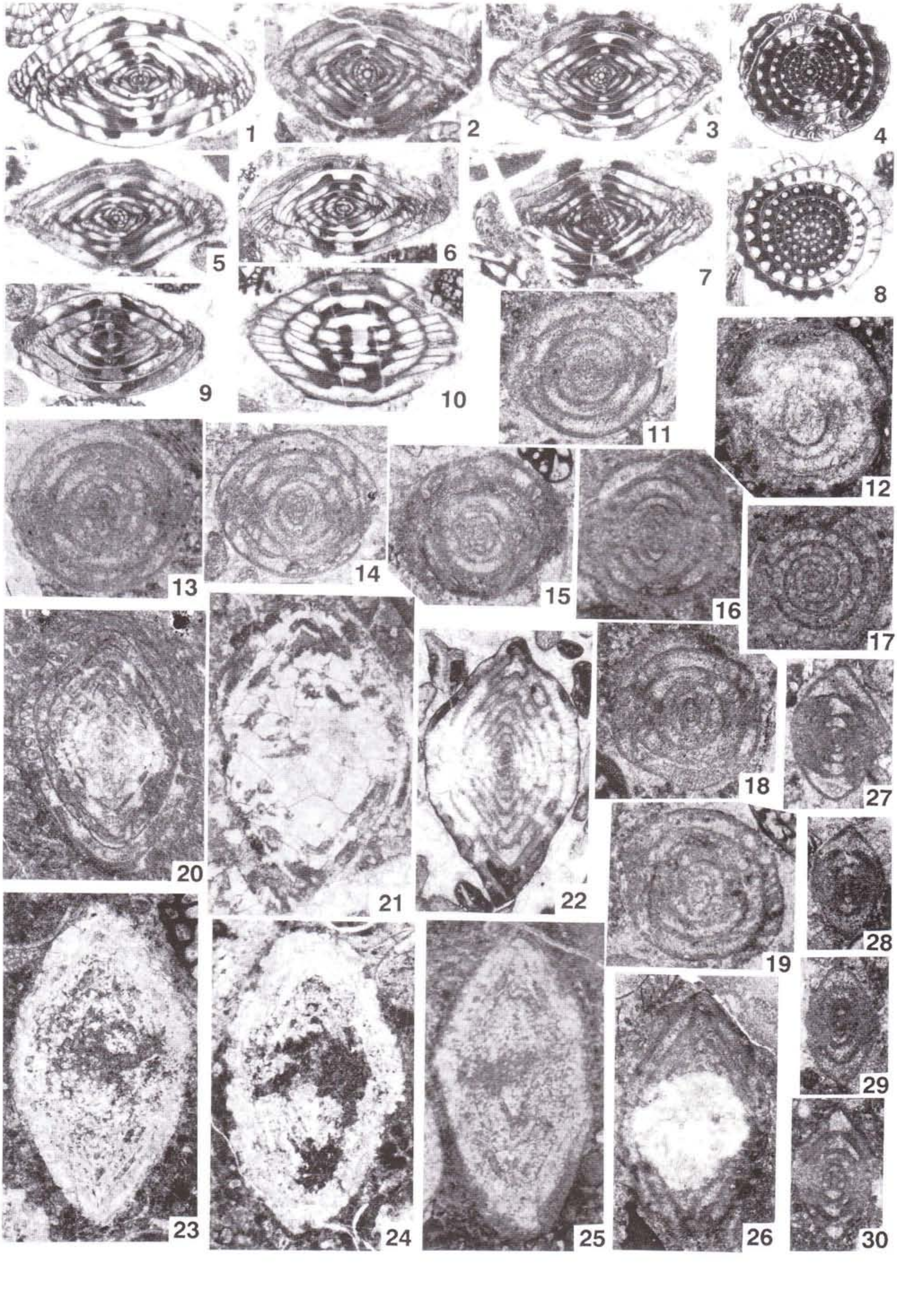
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Table 1 - Measurement of *Parafusulina tarazi* n. sp.

Reg. no. specimen	No. vol.	Length	Width	Form ratio	Longer diam. pro.	Half length							Height of volution							Form ratio of volution							Thickness of spirotheca							Fig. in Pl.
						1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	
HMS-534A	6	?	3,98	?	0,55	1,06	1,54	1,88	2,69	?	?		0,49	0,74	1,12	1,5	1,91	2,19		2,16	2,08	1,68	1,79	?	?		0,03	0,05	0,09	0,1	0,11	0,05		Pl. 4, fig. 9
HMS-542	7,5	11.3?	4.3?	2,6	0,60	0,45	0,96	1,54	2,39	3.45?	4.43?	5.30?	0,41	0,62	0,86	?	?	?	?	1,1	1,55	1,79	?	?	?	?	0,04	0,05	0,06	0,13	0,07	0,05	?	Pl. 5, fig. 1
HMS-534B	6,2	-	3,41	-	0,38	-	-	-	-	-	-		0,39	0,59	0,86	1,18	1,46	1,78		-	-	-	-	-	-		0,03	0,04	0,09	0,07	0,06	0,09		Pl. 5, fig. 2
HMS-540	6,5	9.50?	3.70?	2,6	0,65	0,91	1,4	2,07	3,14	3,9	4,68		0,36	0,64	0,93	1,2	1,49	?		2,53	2,19	2,23	2,62	2,62	?		0,03	0,07	0,07	0,09	0,08	?		Pl. 5, fig. 3
HMS-952	6	7.85?	3.25?	2,4	0,59	0,77	1,28	1,8	2,51	3,19	3.95?		0,36	0,52	0,74	1,09	1,4	1.74?		2,14	2,46	2,43	2,3	2,28	2,3		0,04	0,04	0,06	0,07	0,08	?		Pl. 5, fig. 4
HMS-536	7	10.6?	4,14	2,6	0,42	0,7	1,12	1,81	2,48	3,16	4,36	5,27	0,3	0,51	0,82	1,14	1,51	1,84	2,11	2,33	2,2	2,21	2,18	2,09	2,37	2,5	0,04	0,05	0,1	0,11	0,11	0,06	0,03	Pl. 5, fig. 5
HMS-537	7	?	3.80?	?	0,54	0,68	1,19	1,86	2,65	3,09	4,26	5.32?	0,31	0,46	0,71	0,94	1,26	1,59	?	2,19	2,59	2,62	2,82	2,45	2,68	?	0,03	0,04	0,06	0,06	0,1	0,09	?	Pl. 5, fig. 6

Table 2 - Measurement of *Skinnerella abadehensis* n. sp.

Reg. no. specimen	No. vol.	Length	Width	Form ratio	Longer diam. pro.	Half length							
						1	2	3	4	5	6	7	8
HMS-561	8	10.8?	6.40?	1,7	1,06	0,95	1,47	1,92	2,56	3,31	4,31	5,02	?
HMS-568	8	9,73	5,81	1,7	0,54	0,62	1,12	1,76	1,97	2,85	3,64	4,36	5,25
HMS-854	9	10.5?	6.39?	1,6	0,84	0,65	0,99	1,38	1,79	2.15?	3,17	4,45	5,16
HMS-581A	7	?	?	?	0,74	0,61	1,1	1,53	2,35	3,39	?	?	
HMS-577B	7?	-	?	-	0,96	-	-	-	-	-	-	-	
HMS-575	7,3	-	5,51	-	0,67	-	-	-	-	-	-	-	
HMS-580A	6,5	8.62?	4.98?	1,7	0,61	0,65	1,09	1,72	2,37	3,29	4.35?		
HMS-569	7	8.95?	6.15?	1,5	0,81	0,96	1,29	1,74	2,28	2,81	3,78	4.39?	
HMS-852	5,6	-	4,79	-	0,99	-	-	-	-	-			
HMS-525	7	11	5,61	2,0	0,86	0,74	1,29	1,75	2,51	3,79	4,76	5,71	
HMS-523	7	12.4?	5.25?	2,4	0,97	0,68	1,36	1,96	3,48	4,21	5,16	?	
HMS-570A	8	12.9?	6.98?	1,8	0,88	0,64	1,08	1,53	2,45	3,43	4,68	6,07	?
HMS-729	9	12.5?	6,26	2,0	0,82	0,76	1,16	1,7	2,42	3,28	4,89	5,81	6.65?

Reg. no. specimen	Height of volution								Form ratio of volution							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
HMS-561	0,49	0,75	1,06	1,38	1,84	2,33	2,78	?	1,94	1,96	1,81	1,86	1,8	1,85	1,81	?
HMS-568	0,43	0,66	0,93	1,25	1,66	1,94	2,46	2,9	1,44	1,7	1,89	1,58	1,72	1,88	1,77	1,81
HMS-854	0,36	0,49	0,75	1,09	1,4	2,16	2,65	2,98	1,81	2,02	1,84	1,64	1,5	1,47	1,68	1,73
HMS-581A	0,49	0,69	0,96	1,38	1,84	?	?		1,24	1,59	1,59	1,7	1,84	?	?	
HMS-577B	0,68	0,82	1,21	1,58	2,06	2,44	?		-	-	-	-	-	-	-	
HMS-575	0,56	0,84	1,11	1,53	2,05	2,46	2,88		-	-	-	-	-	-	-	
HMS-580A	0,46	0,72	1,02	1,41	1,85	2.26?			1,41	1,51	1,69	1,68	1,78	1,9		
HMS-569	0,61	0,9	1,21	1,59	2,07	2,46	2.86?		1,57	1,43	1,44	1,43	1,36	1,54	1,5	
HMS-852	0,84	1,15	1,46	1,86	2,41											
HMS-525	0,52	0,91	1,26	1,67	2,1	2,66	2,98		1,42	1,42	1,39	1,5	1,8	1,79	1,92	
HMS-523	0,56	0,78	?	?	?	?	?		1,21	1,74	?	?	?	?	?	
HMS-570A	0,47	0,69	0,96	1,05	1,8	2,19	2,7	?	1,36	1,57	1,59	2,33	1,91	2,14	2,25	?
HMS-729	0,56	0,85	1,16	1,55	1,99	2,47	2,81	3,26	1,36	1,36	1,47	1,56	1,65	1,98	2,07	2

Reg. no. specimen	Thickness of spirotheca								Septal count								Fig. in Pl.
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	
HMS-561	0,02	0,03	0,04	0,06	0,06	0,07	0,06	?	-	-	-	-	-	-	-	-	Pl. 6, fig. 1
HMS-568	0,03	0..03	0,02	0,03	0,03	0,05	0,07	0,04	-	-	-	-	-	-	-	-	Pl. 6, fig. 2
HMS-854	0,02	0,02	0,02	0,03	0,03	0,05	0,05	0,05	-	-	-	-	-	-	-	-	Pl. 6, fig. 3
HMS-581A	0,02	0,02	0,02	0,04	0,04	?	?		-	-	-	-	-	-	-	-	Pl. 6, fig. 4
HMS-577B	0,03	0,03	0,02	0,03	0,05	0,05	?		10?	24	32	36	40	42	45>		Pl. 6, fig. 5
HMS-575	0,03	0,03	0,02	0,03	0,05	0,06	0,07		8	16	30	34	37	39	47	16>	Pl. 6, fig. 6
HMS-580A	0,03	0,03	0,03	0,03	0,05	?			-	-	-	-	-	-	-	-	Pl. 6, fig. 7
HMS-569	0,03	0,03	0,04	0,05	0,06	0,05	?		-	-	-	-	-	-	-	-	Pl. 6, fig. 8
HMS-852	0,03	0,04	0,04	0,05	0,06				7	21	31	36	41?	24>			Pl. 7, fig. 1
HMS-525	0,04	0,03	0,03	0,05	0,04	0,06	0,05		-	-	-	-	-	-	-	-	Pl. 7, fig. 2
HMS-523	0,03	0,05	0,04	0,06	0,06	0,07	?		-	-	-	-	-	-	-	-	Pl. 7, fig. 3
HMS-570A	0,04	0,05	0,04	0,05	0,05	0,07	0,11	?	-	-	-	-	-	-	-	-	Pl. 7, fig. 4
HMS-729	0,03	0,05	0,05	0,06	0,09	0,08	0,06	0,06	-	-	-	-	-	-	-	-	Pl. 7, fig. 5

Diagnosis. Large-sized species of *Skinnerella* having ellipsoidal to inflated fusiform test characteristically showing hexagonal outline in axial sections, very large and irregular-shaped proloculus, intensely and rather irregularly fluted septa sometimes showing mushroom-shaped folded septa (Skinner 1971), and complexly combined adjacent septa even in the median part of test in axial sections.

Description. Test ellipsoidal to inflated fusiform, with straight to broadly arched periphery, convex to straight lateral slopes, and rounded to bluntly pointed poles, commonly showing hexagonal outline in axial sections. Mature test with seven to nine volutions, and mostly more than10 mm in length and more than 6 mm in width giving form ratio from 1.7 to 2.4. Proloculus very large, subspherical, ellipsoidal, or rectangular, and highly variable in its shape, attaining more than 1 mm in its longer diameter. The first volution appears to be an irregularly-shaped chamber comparable to the circum-proloculus chamber in some specimens (ex. Pl. 6, fig. 1, 5, 8; Pl. 7, fig. 1, 4). Shape and size of inner volutions depended largely on orientation of irregularly-shaped proloculus in thin sections. Spirotheca thin in comparison with large test, and composed of tectum and finely alveolar keriotheca.

Septa intensely and rather irregularly fluted throughout test, resulting in the mushroom-shaped folded septa (Skinner, 1971) characteristic in the septal fluting of *Skinnerella*, and complexly combined folds of adjacent septa even in the median part of test (Pl. 6, fig. 3). Septal count 40 or more in outer volutions. Cunniculi very poorly developed in outer volutions, but not found in most specimens. Phrenotheca indistinct. Tunnel low. Chomata present on proloculus and partly in the first volution. Secondary deposits generally well developed in both sides of tunnel regions, and showing X-shaped dis-

PLATE 3

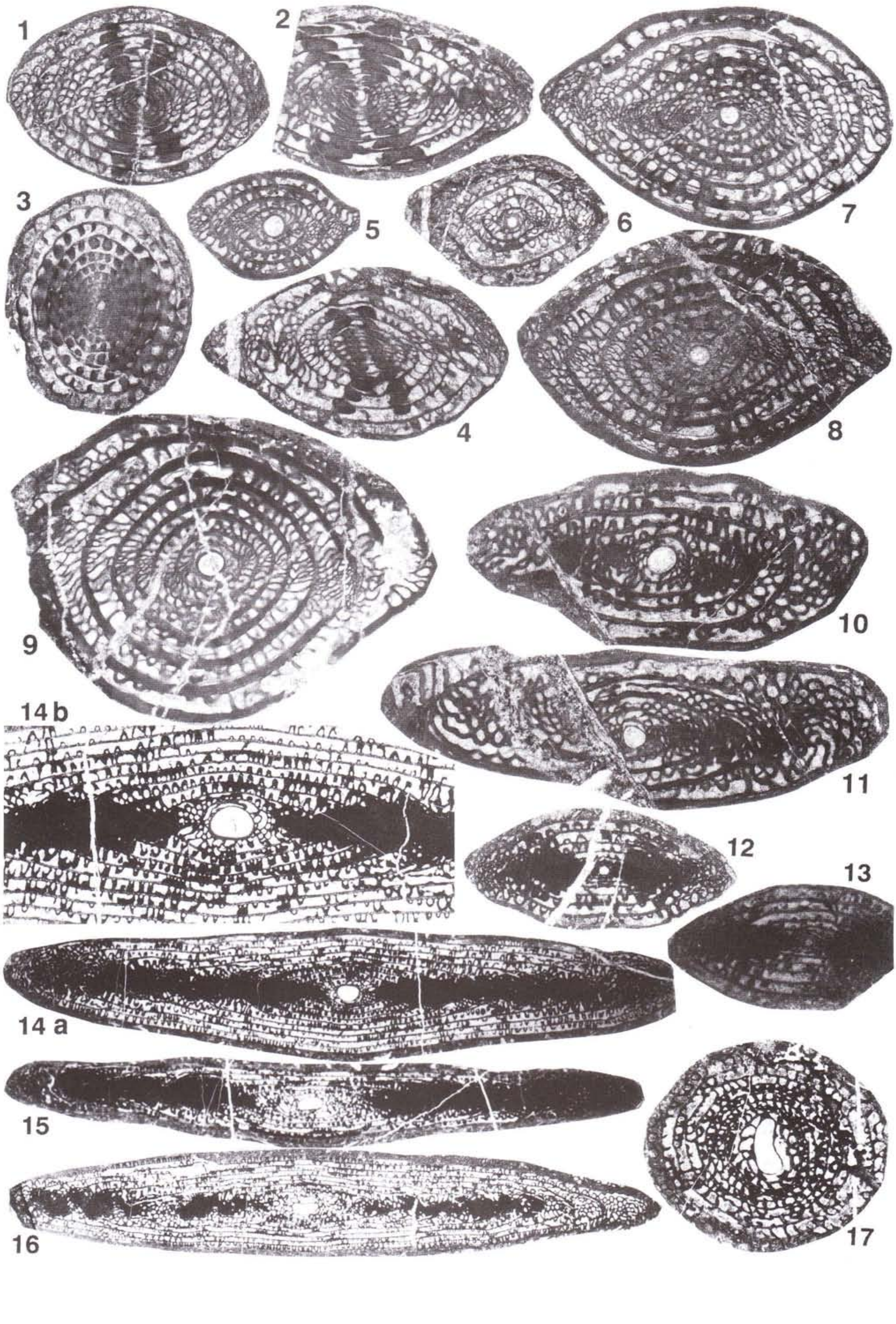
Fig. 1-4 - *Darvasites ordinatus* (Chen). 1: oblique section, HMNS-833; 2: axial section, HMNS-847; 3: sagittal section, HMNS-849; 4: tangential section, HMNS-836, all from Estaki Mine, x 10.

Fig. 5-9 - *Chalaroschwagerina* cf. *C. mengi* (Chen). 5-8: axial sections; 9: oblique section, 5: HMNS-841A; 6: HMNS-839; 7: HMNS-837; 8: HMNS-842; 9: HMNS-834, all from Estaki Mine, x 10.

Fig. 10, 11 - *Pseudofusulina fusiformis* (Schellwien & Dyhrenfurth). Axial sections, 10: HMNS-841B, 11: HMNS-850, both from Estaki Mine, x 10.

Fig. 12, 13 - *Pseudofusulina quasifusuliniformis* Leven. Axial sections, 12: HMNS-716, M-1; 13: HMNS-723, M-3, both x 10.

Fig. 14-17 - *Eopolydiexodina persica* (Kahler). Megalospheric forms, 14-16: axial sections; 17: sagittal section, 14: HMNS-930, N-1; 15: HMNS-930, N-1; 16: HMNS-515, P-9; 17: HMNS-747, K-20; 14a, 15, 16: x 5; 14b, 19: x 10.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tribution as clearly shown in tangential sections (Pl. 7, fig. 6, 7). Those in axis regions referable to axial filling are nearly lacking.

Discussion. *Skinnerella abadehensis* is considered to be one of the most specialized *Skinnerella* from such diagnostic characters as shape of test, very large irregular-shaped proloculus with circum-proloculus chamber, and secondary deposits well developed in both sides of tunnel region. Highly wide variation in many test characters of this new species is represented by the illustrated specimens. These differences are thought to be intraspecific variation. General appearances of the present new species seem to be largely different from those of elongate fusiform to elongate subcylindrical *Skinnerella*. The Surmaq specimens, however, are surely assignable to *Skinnerella* from important and essential characters diagnostic to this genus.

The present new species are most similar to *Parafusulina yabei asiatica* originally described from the Kubergandian of the Southeast Pamir by Leven (1967). However, the former is distinguished from the latter by more irregularly fluted septa and the distribution pattern of secondary deposits. Concerning the development of secondary deposits and septal folding, *Skinnerella abadehensis* is more similar to *Parafusulina (Skinnerella) asiatica* from the Karakorum Range by Gupta and Ozawa (1985). The former is distinct from the latter by its larger test, proloculus, height and width of corresponding volutions, and more strongly fluted septa.

Stratigraphic distribution. Abundant in N-2, N-7, and N-10 in the N-R section (*Afghanella schencki* Zone), and common in K-17 in the M-K section (the base of the *Afghanella schencki* Zone).

Subfamily Chusenellinae Kahler & Kahler, 1966

Genus *Chusenella* Hsu, 1942

Type species: *Chusenella ishanensis* Hsu, 1942, p. 175, text-fig. 1.

1942 *Chusenella* Hsu, p. 175 (original designation).

1955 *Orientoschwagerina* A. D. Miklukho-Maklay, p. 573, 574; type species: *Orientoschwagerina abichi* A. D. Miklukho-Maklay, p. 574, fig. 1a, 1b (original designation).

1966 *Chusenella (Sosioella)* Skinner & Wilde, p. 10; type species: *Chusenella sosioensis* Pasini, 1964, p. 172-178, pl. 10, fig. 1-4; pl. 11, fig. 1-4.

1975 *Chusenella (Chusenella)* Rozovskaya, p. 102, 103 (name transferred).

Discussion. A. D. Miklukho-Maklay (1955) indicated close morphologic similarities of *Orientoschwagerina* from the lower Permian of Transcaucasus to *Paraschwagerina* and *Acervoschwagerina* among known genera. Comparison with the genus *Chusenella*, however, was not done in his description. It is well known that *Orientoschwagerina abichi* is characteristic in the Upper Permian of Transcaucasus since the re-study of topotype materials by Scherbovich (1964). Rozovskaya (1975) thought that *Orientoschwagerina* is a junior synomym of *Chusenella*, and recognized the taxonomic validity of *Chusenella (Chusenella)* and *Chusenella (Sosioella)*. The latter is hardly distinguishable from the former by the difference of mode of septal fluting as Skinner & Wilde (1966) suggested. *Orientoschwagerina* and *Chusenella (Sosioella)* are reasonably considered to be junior synonyms of *Chusenella*.

Chusenella abichi (A. D. Miklukho-Maklay)

Pl. 9, fig. 3-14; Pl. 12, fig. 14, 15

1955 *Orientoschwagerina abichi* A. D. Miklukho-Maklay, p. 574, fig. 1a, 1b.

Material. Illustrated four axial, one sagittal, four tangential, and three parallel sections.

Discussion. The Surmaq specimens are quite identical with the original ones described by A. D. Miklukho-Maklay (1955), and the subsequent ones by Scherbovich (1964) from Transcaucasus. This species is easily distinguishable from other species of *Chusenella* such as *C. brevipola* (Chen), *C. conicocylindrica* Chen, and *C. sinensis* Sheng in the Surmaq and original Chinese specimens by size, shape, and form ratio of test as well as those of each volution. Low specific diversity of the *Chusenella abichi* faunas should be noted along with the association of neither verbeekinids and neoschwagerinids nor other genera of schwagerinids in the Surmaq Formation.

Stratigraphic distribution. Abundant in L-16, unit 3 in the L section, and rare to common in R-15, the upper part of unit 1 in the N-R section, and K-58 and K-

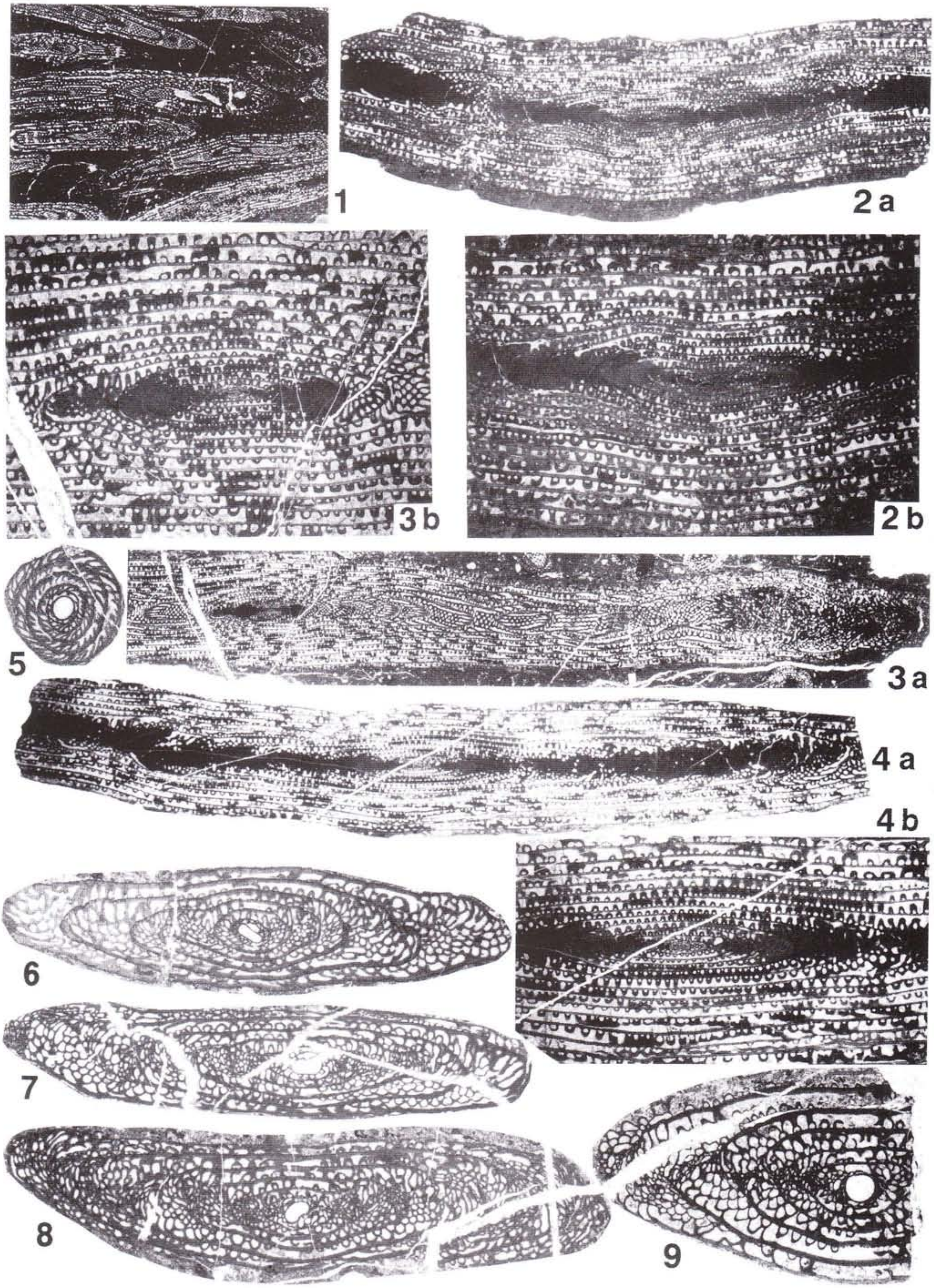
PLATE 4

Fig. 1 - Argillaceous limestone containing abundant specimens of *Eopolydiexodina persica* showing orientation of longer diameter of test parallel to bedding plane, HMNS-513, P-9, x 2.4.

Fig. 2-4 - *Eopolydiexodina persica* (Kahler). Axial sections of microspheric forms, 2: HMNS-522; 3: HMNS-518B (= Pl. 12, fig.16); 4: HMNS-521 (= Pl. 12, fig. 17), all from P-9, 2a, 4a: x 5; 3a: x 3; 2b, 3b, 4b: x 10.

Fig. 5-8 - *Parafusulina crassispira* Leven. 5: sagittal section; 6-8: axial sections, 5: HMNS-668; 6: HMNS-666A; 7: HMNS-662A; 8: HMNS-670, all from R-26, x 10.

Fig. 9 - *Parafusulina tarazi* Kobayashi & Ishii n. sp. Axial section of paratype, HMNS-534A, N-4, x 10.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60, upper part of unit 1 in the M-K section (*Chusenella abichi* Zone).

Subfamily Polydiexodininae A. D. Miklukho-Maklay, 1953

Genus *Eopolydiexodina* Wilde, 1975

Type species: *Polydiexodina afghanensis* Thompson, 1946, p. 150-152, pl. 24, fig. 1-6; pl. 26, fig. 1-7.

1975 *Eopolydiexodina* Wilde, p. 76 (original designation).

Discussion. *Eopolydiexodina* is considered to be a direct descendant of *Skinnerina* from close similarities of intensely and regularly fluted septa in inner volutions of microspheric forms, and obscure, probably lacking, median tunnel except for juvenile volutions of microspheric forms. Dimorphism is very distinct in this genus. *Eopolydiexodina* is not known from anywhere in the Circum-Pacific regions.

It is widely distributed in the Murgabian (middle Guadalupian) of the Cimmerian Terrane of South West Asia and Mediterranean Sea regions assignable paleobiogeographically to Province A (Western Tethyan Province), and also known from coeval formations of Middle, East, and South East Asia belonging to Province B (Eatern Tethyan Province). Although time- and space-distribution of Polydiexodininae is important paleobiogeographically (Kobayashi & Ishii 2002), its evolutional mechanism including its migration path has remained uncertain.

Eopolydiexodina persica (Kahler)

Pl. 3, fig. 14a, 14b, 15, 16, 17; Pl. 4, fig. 1, 2a 2b, 3a, 3b, 4a, 4b; Pl. 12, fig. 16, 17

1933 *Polydiexodina persica* F. Kahler, p. 168, pl. 17, fig. 1, 2a-2c.

Material. More than ten axial and many other sections are examined, among which three axial and one sagittal sections of megalospheric forms, and three axial sections of microspheric forms are illustrated.

Description of megalospheric form. Test very large, elongate cylindrical to subcylindrical, with broadly inflated periphery and broadly rounded poles. Size of test in fully-grown specimens exactly unknown in thin sections due to abrasion of external parts of test and broadly curved axis of coiling. In mature specimens, length more than 28 mm and width more than 5 mm, giving approximate form ratio 4.5 to 6. Number of volutions in fully-mature stage up to 11 or 12.

Proloculus subspherical or irregular, very large, mostly more than 0.7 mm and sometimes over than 1 mm. Heights of volution increase slowly and irregularly. But, they are highly variable in specimens, and depend on shape and orientation of longer diameter of proloculus in thin sections. Height of volution from the first to 10th volution 0.61, 0.79, 0.96, 1.16, 1.35, 1.56, 1.81, 2.10, 2.31, and 2.54 mm in the specimen (HMNS-930) shown in Pl. 3, fig. 14. Half length of their corresponding volution is unknown due to dense axial filling.

Septa intensely and regularly fluted throughout test. Cunniculi well developed throughout. Median tunnel indistinct, and probably lacking. Multiple tunnels accessarily developed in all volutions and even in their polar regions except for inner volutions. Number of tunnels unknown, because they are well recognizable in tangential sections and uncertain in axial sections. More than 20 accessary tunnels countable in outer volutions of mature specimens. Axial filling well developed in most of specimens. Chomata absent.

Description of microspheric form. Test much more larger and more elongate, with more volutions and more irregularly-curved axis of coiling in microspheric forms than in megalospheric. Length possibly more than 80 mm and width more than 7.7 mm, giving form ratio more than 10 in the largest specimen, but unknown exactly. Number of volution more than 20.

Proloculus 24 and 28 (?) microns in the specimen HMNS-521 (Pl. 4, fig. 4a, 4b; Pl. 12, fig. 17) and HMNS-518 (Pl. 4, fig. 3a, 3b; Pl. 12, fig. 16), respectively. Inner three juvenile volutions have chomata and central tunnel, and are coiled askew to the axis of coiling of later volutions.

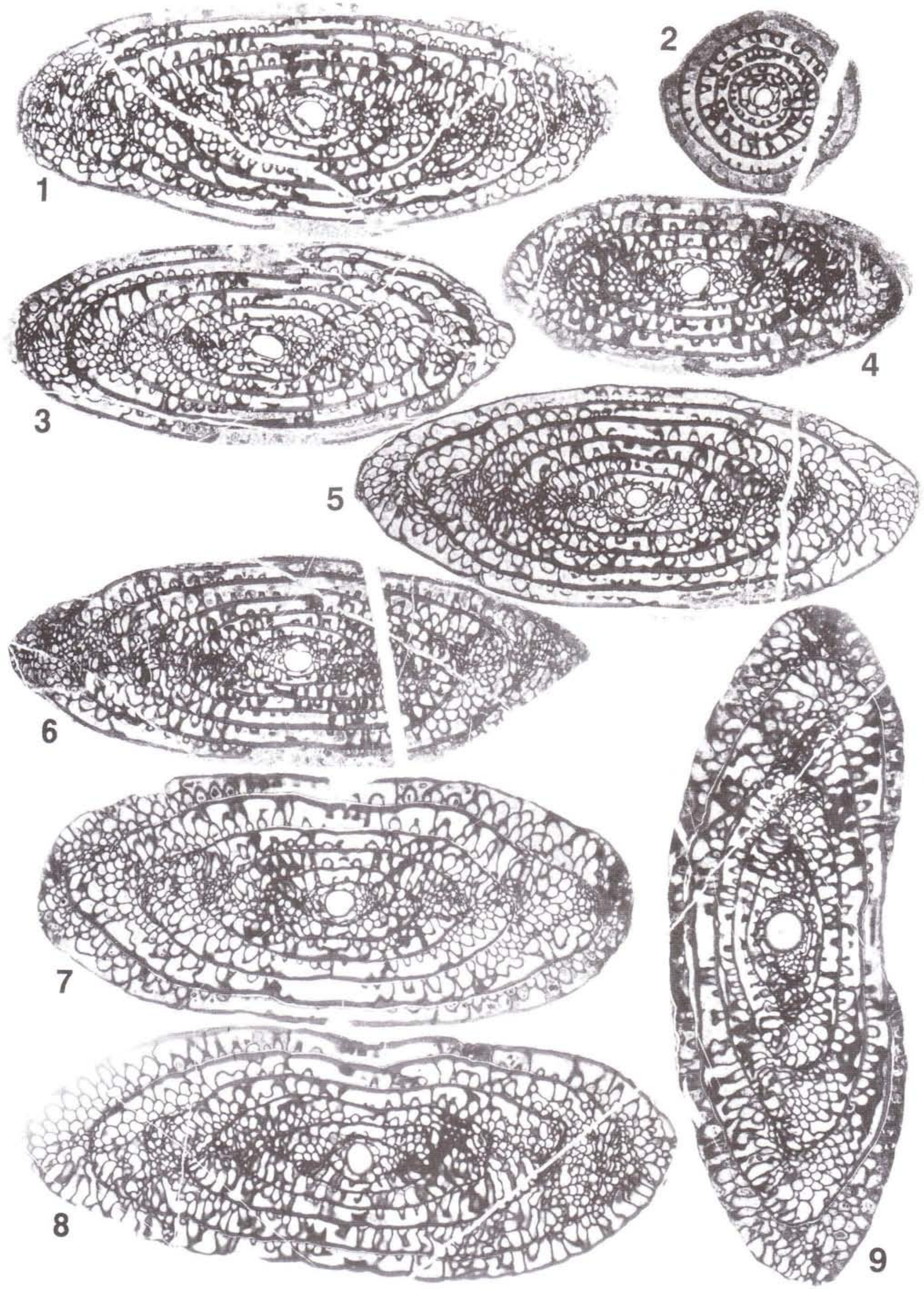
Keriotheca is not developed and septa are almost plane in their juvenile volutions so as to appear *Fusiella* or small-sized *Schubertella*. Septal fluting especially in the succeeding eight to ten volutions are closely similar to that in *Skinnerina*.

Discussion. Examination of Surmaq specimens reveals that many specimens from different localities are needed for understanding the intrapopulational variation and morphologic comparison of *Eopolydiexodina*. Most biocharacters are highly variable quantitatively and qualitatively, largely depending on the orientation of axial sections because of arched axis of coiling, and that of longer diameter of irregularly-shaped proloculus in thin sections.

PLATE 5

Fig. 1-6 - *Parafusulina tarazi* Kobayashi & Ishii n. sp. 5: holotype; others: paratypes, 1, 3-6: axial sections; 2: sagittal section, 1: HMNS-542; 2: HMNS-534; 3: HMNS-540; 4: HMNS-952; 5: HMNS-536; 6: HMNS-537, 4: N-5; others from N-4, all x 10.

Fig. 7-9 - *Parafusulina himalayensis* Ozawa & Gupta. Axial sections, 7: HMNS-702; 8: HMNS-697; 9: HMNS-691; all from R-3, x 10.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The present materials are tentatively named *Eopolydiexodina persica* which was first introduced among more than ten species of *Eopolydiexodina* in the Tethyan regions. As well as the Abadeh region, the type locality (Darreh-Duzden area) of this species is assignable tectonically to the Helmand-type Zone (Boulin 1988) of central Iran.

The Surmaq specimens seem to be alike to those identified with this species by Douglas (1950) from the southeastern Iran.

Further comparison of this species is postponed until diagnostic characters of the topotype specimens are made clear.

Stratigraphic distribution. Abundant to common in P-4, P-5, P-9, and N-1 in the N-R section (*Afghanella schencki* Zone), and K-2, K-3, K-5, K-7, and K-10 (*Eopolydiexodina persica* Zone), and K-20 (*Afghanella schencki* Zone) in the M-K section.

Subfamily Pseudoschwagerininae Chang, 1963

Genus *Rugososchwagerina* A. D. Miklukho-Maklay, 1959

Rugososchwagerina xanzensis Wang, Sheng & Zhang

Pl. 8, fig. 2-6

1981 *Rugosochwagerina xanzensis* Wang, Sheng & Zhang, p. 54, 55, pl. 6, fig. 1-3, 9, 10.

Material. Five tangential sections.

Discussion. The Surmaq specimens seem to be more closely similar to *Rugososchwagerina xanzensis* from South Tibet than the species of this genus known from Europe and South West Asia in lower height of volution of outer volutions, thicker spirotheca, and more weakly fluted septa, though no axial sections were prepared. Tightly coiled juvenile volutions with dense axial filling are well developed, and they are common between the two. These juvenile volutions are not so evident in *Rugososchwagerina* sp. A and *R.* sp. B as in this species.

Stratigraphic distribution. Rare to common in P-3, N-2, and N-4 in the N-R section (*Afghanella schencki* Zone), and in K-17 in the M-K section (the base of *Afghanella schencki* Zone).

Family Verbeekinidae Staff & Wedekind, 1910

Genus *Armenina* A. D. Miklukho-Maklay, 1955

Armenina karinae A. D. Miklukho-Maklay

Pl. 10, fig. 19-21

1955 *Armenina karinae* A. D. Miklukho-Maklay, p. 576, fig. 1e, 1g.

Material. Two tangential and one sagittal sections.

Discussion. The relatively thick spirotheca and well-developed parachomata of the present specimens are identical with those of the type species of this genus described from the Upper Permian of Transcaucasus by A. D. Miklukho-Maklay (1955). *Armenina wangi* from the Surmaq Formation and original ones from Guizhou of South China by Sheng (1963) are similar to this species, but *Armenina wangi* has more well-developed parachomata.

Stratigraphic distribution. Common to rare in N-10/11 and R-10 in the N-R section (*Neoschwagerina occidentalis* Zone).

Genus *Verbeekina* Staff, 1909

Verbeekina furnishi Skinner & Wilde

Pl. 11, fig. 5, 6

1966 *Verbeekina furnishi* Skinner & Wilde, p. 14, pl. 17, fig. 3-5; pl. 18, fig. 1-4.

Material. Illustrated two tangential sections.

Discussion. Skinner & Wilde (1966) distinguished *Verbeekina* of Sicily from *V. verbeeki* (Geinitz) by smaller size in the corresponding volutions, fewer volutions, thicker spirotheca, and more conspicuous parachomata. The Surmaq specimens resemble *V. furnishi* from Sicily in these characters.

Stratigraphic distribution. Common in N-10/11 and N-12 in the N-R section (*Neoschwagerina occidentalis* Zone).

Verbeekina heimi Thompson & Foster

Pl. 10, fig. 24-26; Pl.11, fig. 1-4

1937 *Verbeekina heimi* Thompson & Foster, p. 137, 138, pl. 23, fig.1-3; pl. 24, fig. 5; pl. 26, fig. 5, 6.

Material. Illustrated five axial to nearly axial, and two sagittal sections.

Discussion. *Verbeekina heimi* is closely similar to

PLATE 6

Fig. 1-8 - *Skinnerella abadehensis* Kobayashi & Ishii, n. sp. 1: holotype; others: paratypes, 1-4, 7, 8: axial sections; 5, 6: sagittal section, 1: HMNS-561; 2: HMNS-586; 3: HMNS-854; 4: HMNS-581A; 5: HMNS-577B; 6: HMNS-575, 7: HMNS-580A; 8: HMNS-569, 3: K-17; others from N-10, all x 10.


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V. verbeeki (Geinitz), but the former is distinct from the latter by thinner spirotheca, poorer chomata and more rapidly expanding test, as suggested by Thompson & Foster (1937).

Stratigraphic distribution. Common to abundant in N-4 in the N-R section (*Afghanella schencki* Zone), and in K-17 and K-20 (*Afghanella schencki* Zone), and K-41 (*Neoschwagerina haydeni* Zone) in the M-K section.

Family Neoschwagerinidae Dunbar & Condra, 1927

Subfamily Neoschwagerinidae Dunbar & Condra, 1927

Genus *Neoschwagerina* Yabe, 1903

Neoschwagerina haydeni Dutkevich

Pl. 11, fig. 15, 16

1934 *Neoschwagerina craticulifera* var. *haydeni* Dutkevich, in Dutkevich and Khabakov, p. 94-99, pl. 2, fig. 6-8; pl. 3, fig. 1, 2.

Material. One axial and one oblique sections are illustrated.

Discussion. The diagnostic characters of the test are uneasily understood from the original description based on one tangential and three oblique sections from eastern Pamir. However, this species is generally thought to be different from *Neoschwagerina craticulifera* (Schwager) by more well-developed septula and more volutions. *Neoschwagerina haydeni* is related to the Murgabian-Midian boundary in the Tethyan region. Biostratigraphic data, however, are incomplete in the Surmaq Formation to discuss this problem. This species, based on less number of well-oriented thin sections, differs from *N. occidentalis* Kochansky-Devide & Ramovs and *N. craticulifera* (Schwager) from the Surmaq Formation in having thicker spirotheca and septula, and more massive parachomata.

Stratigraphic distribution. Common in R-0 and R-10 in the N-R section (*Neoschwagerina occidentalis* Zone), and K-41 in the M-K section (*Neoschwagerina haydeni* Zone).

Neoschwagerina occidentalis

Kochansky-Devide & Ramovs

Pl. 12, fig. 1a, 1b, 2a, 2b, 3a, 3b, 4-13

1955 *Neoschwagerina occidentalis* Kochansky-Devide & Ramovs, p. 418, 419, pl. 7, fig. 1-6.

Material. Illustrated nine axial, three sagittal, and one parallel sections.

Discussion. The form ratio, thickness of spirotheca and septula, and development of transverse septula are considerably variable in many specimens contained in the same limestone sample. Some of these differences are evidently due to specimens of immature stage or abrasion of outer volutions. Wide variations in the present specimens are considered to be intraspecific. The Surmaq specimens are the closest to and safely identical with *Neoschwagerina occidentalis* originally described from the Murgabian of Slovenia by Kochansky-Devide & Ramovs (1955), and later described from the Murgabian of Croatia by Kochansky-Devide (1965). However, exact size of test, number of volution, and biocharacters of outermost parts of test are obscure in most illustrated spcimens from Slovenia and Croatia. Many other species of *Neoschwagerina* have been proposed from Mediterranean Sea regions and South West Asia. Some of them are closely similar to and thought to be junior synonyms of *N. occidentalis* as exemplified by *N. ventricosa* and *N. pinguis* from Turkey by Skinner (1969).

Stratigraphic distribution. Abundant to common in N-10/11, N-11, N-12, R-0, and R-10 in the N-R section (*Neoschwagerina occidentalis* Zone).

Subfamily Sumatrininae Silvestri, 1933

Genus *Afghanella* Thompson, 1946

Afghanella schencki Thompson

Pl. 13, fig. 1a, 1b, 2a, 2b, 3-17, 18a, 18b

1946 *Afghanella schencki* Thompson, p. 153-154, pl. 25, fig. 1-12.

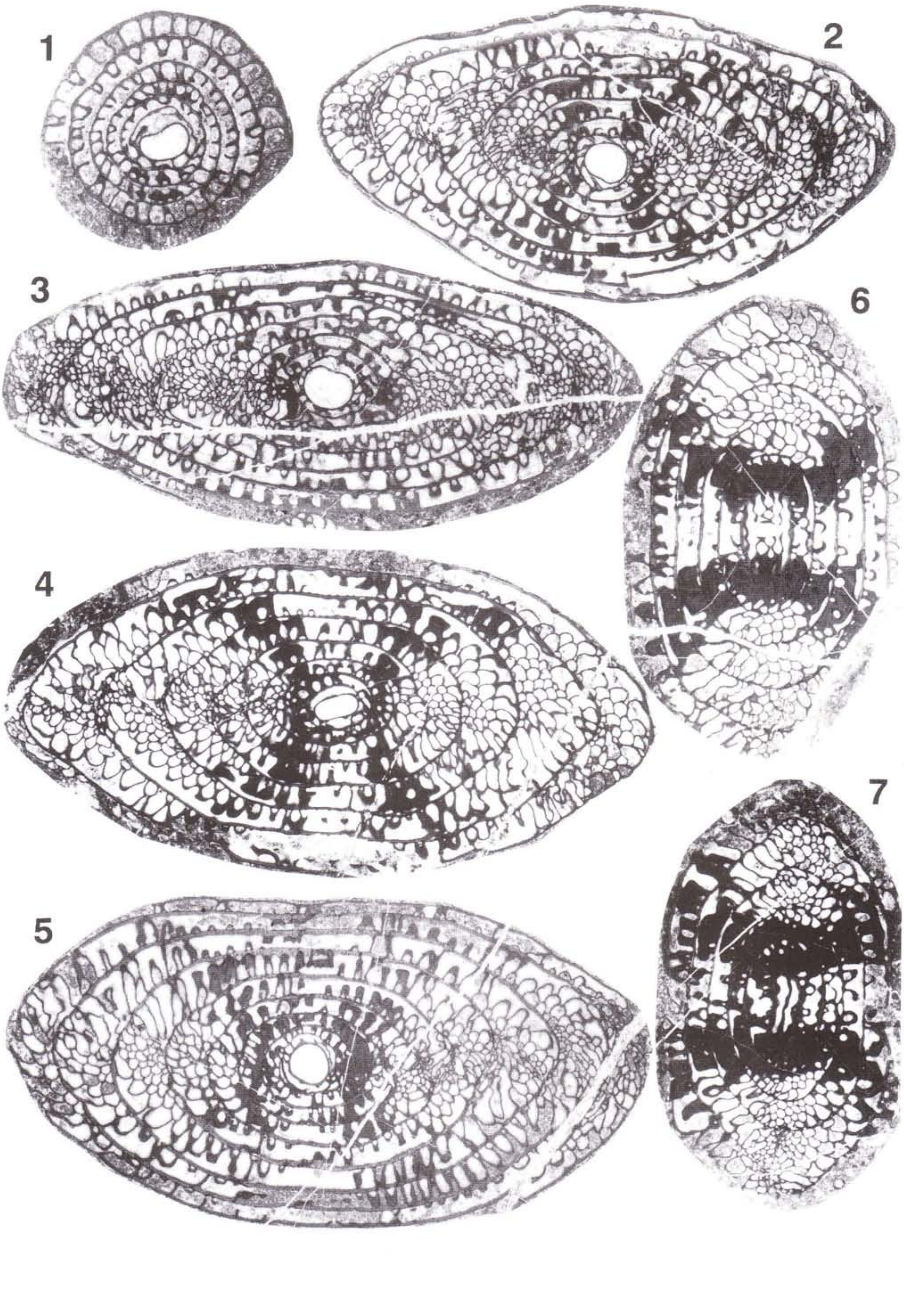
Material. Illustrated fifteen axial and three sagittal sections, including one axial section of the microspheric form (Pl. 13, fig. 2a, 2b).

Discussion. The Surmaq specimens are identical with the original ones described from the Bamian Limestone of Afghanistan by Thompson (1946) and many other ones, all of which have been reported from Provinces A and B. Variable appearances of many test characters in the present specimens are thought to be intraspecific variation.

Stratigraphic distribution. Abundant to common in P-4, N-2, N-4, and N-5 (*Afghanella schencki* Zone),

PLATE 7

Fig. 1-7 - *Skinnerella abadehensis* Kobayashi & Ishii n. sp. All paratypes, 1: sagittal section; 2-5: axial sections; 6, 7: tangential sections, 1: HMNS-852; 2: HMNS-525; 3: HMNS-523; 4: HMNS-570A; 5: HMNS-739; 6: HMNS-577A, 7: HMNS-570B; 1, 5: K-17; 2, 3: N-2; 4, 6, 7: N-10, all x 10.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and N-11 and N-12 (*Neoschwagerina occidentalis* Zone) in the N-R section, and in K-17, K-27, and K-35 in the M-K section (*Afghanella schencki* Zone).

Afghanella sumatrinaeformis (Gubler)

Pl. 13, fig. 19-24, 25a, 25b

1935 *Neoschwagerina sumatrinaeformis* Gubler, p. 123-127, pl. 5, fig. 3, 4, 10, 17; pl. 7, fig. 2.

Material. Illustrated four axial, two sagittal, and one tangential sections.

Discussion. This species is distinguished from *Afghanella schencki* by larger test and larger proloculus, and longer height and length in corresponding volutions.

Stratigraphic distribution. Common to rare in K-17, K-32/33, K-35, and K-37 in the M-K section (*Afghanella schencki* Zone).

Genus Sumatrina Volz, 1904

Sumatrina annae Volz

Pl. 11, fig. 7-14

1904 *Sumatrina annae* Volz, p. 98-100, fig. 27-31.

Material. Two axial, five tangential, and one parallel sections.

Discussion. This well-established species is thought to be distinct from and ascendant of *Sumatrina longissima* Deprat in having smaller test, smaller proloculus, and less well-developed transverse and axial septula.

Stratigraphic distribution. Common to rare in R-0 and R-10 of the Unit 1 (*Neoschwagerina occidentalis* Zone), and R-26 of Unit 2 (*Chusenella abichi* Zone) in the N-R section.

Family Staffellidae A. D. Miklukho-Maklay, 1949

Genus *Sphaerulina* Lee, 1934

Sphaerulina iranensis, n. sp.

Pl. 2, fig. 11-19

Origin of the name. After Iran where the Abadeh region is distributed.

Type specimens. Holotype HMNS-593A (Pl. 2, fig. 14). Paratypes HMNS-610A (Pl. 2 , fig. 11), HMNS-617A (Pl. 2, fig. 12), HMNS-603 (Pl. 2, fig. 13), HMNS-594A (Pl. 2, fig. 15), and HMNS-873 (Pl. 2, fig. 16), HMNS-601B (Pl. 2 , fig. 17), HMNS-610B (Pl. 2, fig. 18), and HMNS-601A (Pl. 2, fig. 19).

Material. Illustrated six nearly axial, one sagittal, and two tangential sections.

Diagnosis. Weakly-recrystallized subspherical species of *Sphaerulina* consisting of 6.5 to 7 volutions with two to three thickly lenticular inner volutions followed by minute proloculus.

Description. Test weakly recrystallized and consisting of 6.5 to 7 volutions. Subspherical test with smooth to slightly depressed polar regions, about 1.55 to 1.82 mm in length, about 1.44 to 1.71 mm in width, and about 1.0 to 1.2 in form ratio. Proloculus 0.04 (?) to 0. 06 mm. Inner two to three volutions thickly lenticular and tightly coiled. Later volutions expanding gradually and becoming subspherical. Half length ?, ?, 0.30, 0.49, 0.62, and 0.82 mm; and height of volution 0.09 (?), 0.17 (?), 0.26, 0.38, 0.55, 0.74 mm in the first to sixth volution of the holotype. Septa plane and not fluted throughout test. Spirotheca rather thick in comparison with test size, and of tectum and very finely alveolar keriotheca. Tunnel single bordered by low and asymmetrical chomata.

Discussion. This new species is closely similar to *Sphaerulina croatia* proposed by Kochansky-Devide (1965) from Croatia in many respects. However, the proloculus is smaller and juvenile lenticular volutions are less developed in this new species. The newly introduced *Sphaerulina iranesis* is distinguishable easily from *S. ellipsoidalis* originally decribed from Croatia by Kochansky-Devide (1965) by smaller and more spherical test, and from *S. ogbinensis* originally from Transcaucasus by Rozovskaya (1965) by smaller test and smaller number of volution.

Stratigraphic distribution. Abundant to common in N-10/11, N-12, N-13, and R-0 in the N-R section (*Neoschwagerina occidentalis* Zone), and K-17 in the M-K section (*Afghanella schencki* Zone).

Acknowledgements. We are grateful to three reviewers, Demir Altiner, Merlynd K. Nestell, and Galina P. Pronina-Nestell for their critical reading of the manuscript.

PLATE 8

Fig. 1 - *Rugosochusenella* sp. Oblique section, HMNS-744B, K-20, x 10.

Fig. 2-6 - *Rugososchwagerina xanzensis* Wang, Sheng & Zhang. Tangential sections, 2: HMNS-864; 3: HMNS-856; 4: HMNS-878; 5: HMNS-877; 6: HMNS-940, 6: N-2; others from K-17, all x 10.

Fig. 7-12 - *Chusenella brevipola* (Chen). 7: parallel section; 8: sagittal section; 9-12: axial sections, 7: HMNS-638B; 8: HMNS-655B; 9: HMNS-644; 10: HMNS-649; 11: HMNS-531; 12: HMNS-651; 7, 9, 10, 12: R-11; 8: R-14; 11: N-2, all x 10.

Fig. 13, 14 - *Rugososchwagerina* sp. A. 13: axial section, HMNS-953; 14: sagittal section, HMNS-546, both from N-5, x 10.

Fig. 15-19 - *Rugososchwagerina* sp. B. 15-17: tangential sections, 18: parallel section; 19: sagittal section, 15: HMNS-745; 16: HMNS-747; 17: HMNS-746; 18: HMNS-742B; 19: HMNS-742A, all from K-20, x 10.

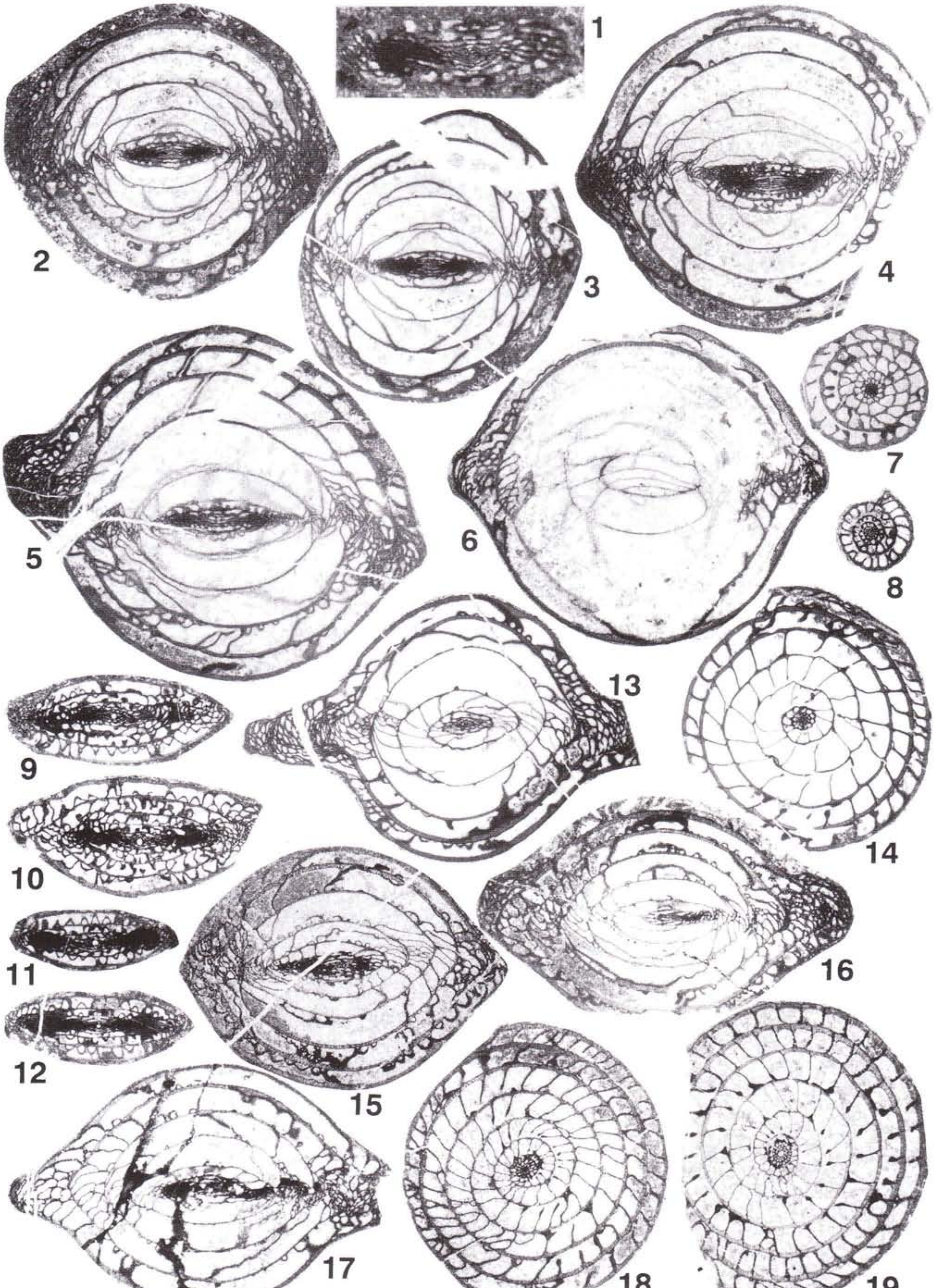
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PLATE 9

Fig. 1, 2 - *Chusenella conicocylindrica* Chen. Axial sections, 1: HMNS-890; 2: HMNS-897, both from K-37, x 10.

Fig. 3-14 - *Chusenella abichi* (A. D. Miklukho-Maklay). 3, 14: sagittal sections; 4, 13: parallel sections; 5, 7-9: tangential sections; 6, 10-12: axial sections, 3: HMNS-910A (= Pl. 12, fig. 15) ; 4: HMNS-918; 5: HMNS-919A; 6: HMNS-917A; 7: HMNS-914, 8: HMNS-926; 9: HMNS-929; 10: HMNS-928; 11: HMNS-921 (= Pl. 12, fig. 14); 12: HMNS-917B; 13: HMNS-910B; 14: HMNS-919B, all from L-16, x 10.

Fig. 15-26 - *Chusenella brevipola* (Chen). 15-22, 25, 16: axial sections; 23, 24: tangential sections, 15: HMNS-645; 16: HMNS-641; 17: HMNS-639; 18: HMNS-762; 19: HMNS-638A; 20: HMNS-643; 21: HMNS-798; 22: HMNS-640; 23: HMNS-650C; 24: HMNS-650B; 25: HMNS-655A; 26: HMNS-650A; 15-17, 19, 20, 22-24, 26: R-11; 18: K-33; 21: K-50; 25:R-14, all x 10.

PLATE 10

Fig. 1-16 - *Chusenella sinensis* Sheng. 1, 2, 4-12, 16: axial sections; 3: parallel section; 13, 15: sagittal sections; 14: tangential section, 1: HMNS-904; 2: HMNS-905; 3: HMNS-774; 4: HMNS-792; 5: HMNS-789A, 6: HMNS-906, 7: HMNS-772; 8: HMNS-795; 10: HMNS-626B; 11: HMNS-816; 12: HMNS-796, 13: HMNS-797, 14: HMNS-817; 15: HMNS-902B; 16: HMNS-626A; 1, 2, 5, 6, 9, 15: N-46/47; 3, 7: K-36-37; 4, 8, 12, 13: K-50; 10, 16: R-10; 11, 14: K-59, all x 10.

Fig. 17, 18 - *Pseudodoliolina* sp. Tangential sections, 17: HMNS-630D, R-10; 18: HMNS-555B, N-5, both x 10.

Fig. 19-21 - *Armenina karinae* A. D. Miklukho-Maklay. 19, 20: tangential sections; 21: sagittal section, 19: HMNS-982; 20: HMNS-971; 21: HMNS-979A, all from N-10/11, x 10.

Fig. 22, 23 - *Armenina wangi* Sheng. Axial sections, 22: HMNS-597A; 23: HMNS-991, both from N-12, x 10.

Fig. 24-26 - *Verbeekina heimi* Thompson & Foster. Axial sections, 24: HMNS-869; 25: HMNS-867; 26: HMNS-871, all from K-17, x 10.

PLATE 11

Fig. 1-4 - *Verbeekina heimi* Thompson & Foster. 1, 2: axial sections; 3, 4: sagittal sections, 1: HMNS-857; 2: HMNS-858; 3: HMNS-875; 4: HMNS-750, 1-3: K-17, 4: K-20, all x 10.

Fig. 5, 6 - *Verbeekina furnishi* Skinner & Wilde. Tangential sections, 5: HMNS-988; 6: HMNS-989, both from N-12, x 10.

Fig. 7-14 - *Sumatrina annae* Volz. 7, 8, 10, 11, 14: tangential sections; 9, 12: axial sections; 13: parallel section, 7: HMNS-628A; 8: HMNS-632A; 9: HMNS-629A; 10: HMNS-635A; 11: HMNS-770; 12: HMNS-767; 13: HMNS-632B; 14: HMNS-636; 7-10, 13, 14: R-10; 11, 12: K-35, all x 10.

Fig. 15, 16 - *Neoschwagerina haydeni* Dutkevich. 15: axial section, HMNS-779, K-41; 16: oblique section, HMNS-625, R-10, both x 10.

Fig. 17-19 - *Neoschwagerina craticulifera* (Schwager). 17, 18: axial sections; 19: sagittal section, 17: HMNS-985; 18: HMNS-990; 19: HMNS-592, all from N-12, 17a, 18, 19: x 10; 17b: x 25.

PLATE 12

Fig. 1-13 - *Neoschwagerina occidentalis* Kochansky-Devide & Ramovs. 1-5, 7, 8, 11, 12: axial sections; 6, 13: parallel sections; 9, 10: sagittal sections, 1: HMNS-614; 2: HMNS-588; 3: HMNS-565; 4: HMNS-591; 5: HMNS-563; 6: HMNS-610; 7: HMNS-613; 8: HMNS-590; 9: HMNS-561A; 10: HMNS-584A; 11: HMNS-572; 12: HMNS-568; 13: HMNS-597C; 1, 6, 7: R-0; 2, 4, 8, 13: N-12; 3, 5, 9, 11, 12: N-10/11; 10: N-11; 1a-3a, 4-13: x 10; 1b-3b: x 25.

Fig. 14, 15 - *Chusenella abichi* (A. D. Miklukho-Maklay). 14: HMNS-921 (the same specimen shown in Pl. 9, fig. 14), x 25; 15: HMNS-910A (the same specimen shown in Pl. 9, fig. 3), x 25.

Fig. 16, 17 - *Eopolydiexodina persica* (Kahler). 16: HMNS-518B (the same specimen shown in Pl. 4, fig. 3a, 3b), x 30; 17: HMNS-521 (the same specimen shown in Pl. 4, fig. 4a, 4b), x 30.

PLATE 13

Fig. 1-18 - *Afghanella schencki* Thompson. 1, 3-15: axial sections of the megalospheric form; 2: axial section of the microspheric form; 16-18: sagittal sections, 1: HMNS-964; 2: HMNS-589; 3: HMNS-952; 4: HMNS-526; 5: HMNS-967; 6: HMNS-852; 7: HMNS-962; 8: HMNS-531; 9: HMNS-957; 10: HMNS-959; 11: HMNS-876; 12: HMNS-851; 13: HMNS-941; 14: HMNS-872; 15: HMNS-554; 16: HMNS-949; 17: HMNS-966; 18: HMNS-965; 1, 3, 5, 7, 9, 10, 15-18: N-5; 2: N-12; 4, 8, 13: N-2; 6, 11, 12, 14: K-17; 1a, 2a, 3-17, 18a: x 10; 1b, 18b: x 25; 2b: x 40.

Fig. 19-25 - *Afghanella sumatrinaeformis* (Gubler). 19, 20: sagittal sections, 21-23, 25: axial sections; 24: tangential section, 19: HMNS-888; 20: HMNS-885; 21: HMNS-884; 22: HMNS-883; 23: HMNS-733; 24: HMNS-892; 25: HMNS-880; 21: K-17; others from K-37; 19-24, 25a: x 10; 25b: x 25.

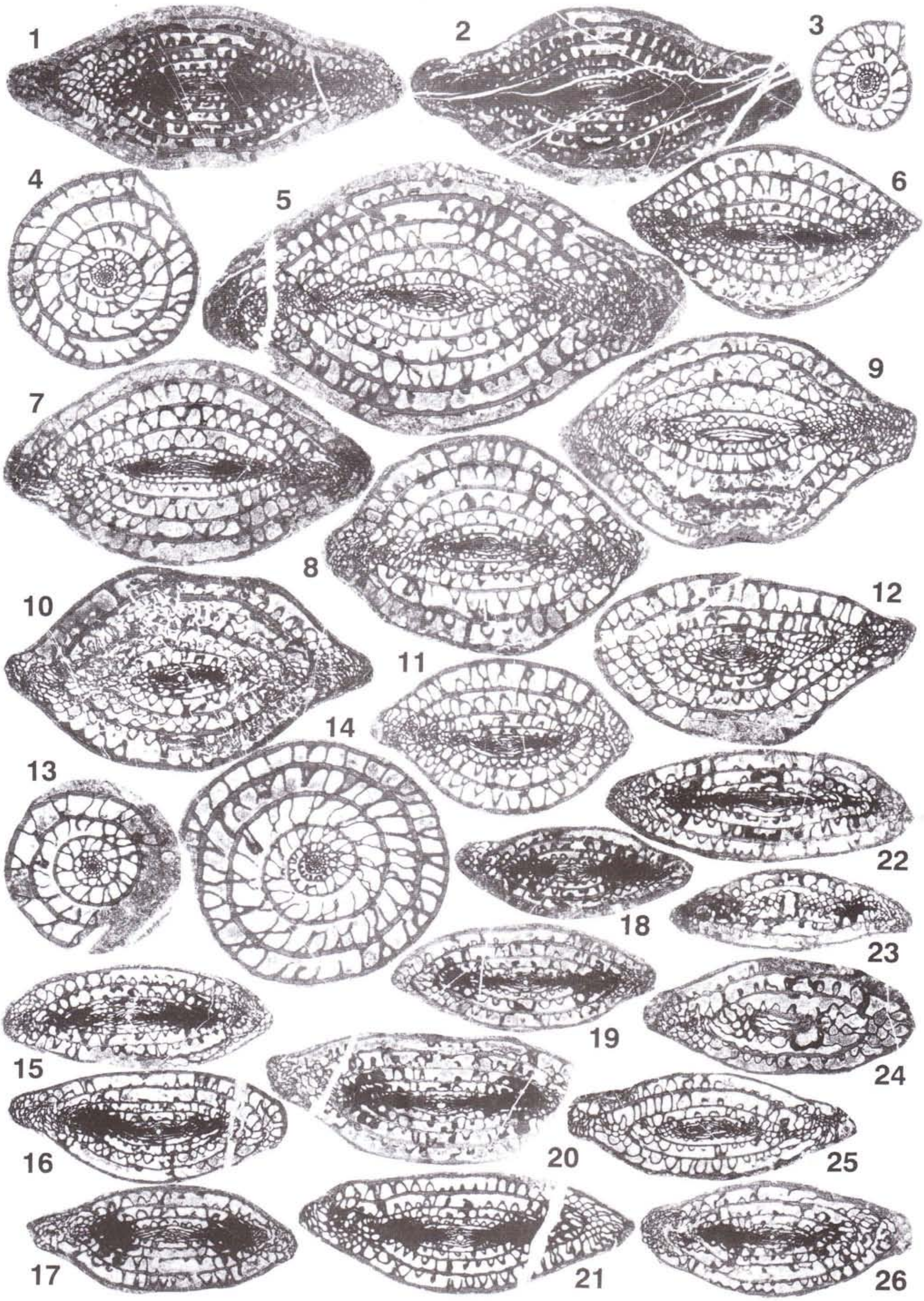


PLATE 9

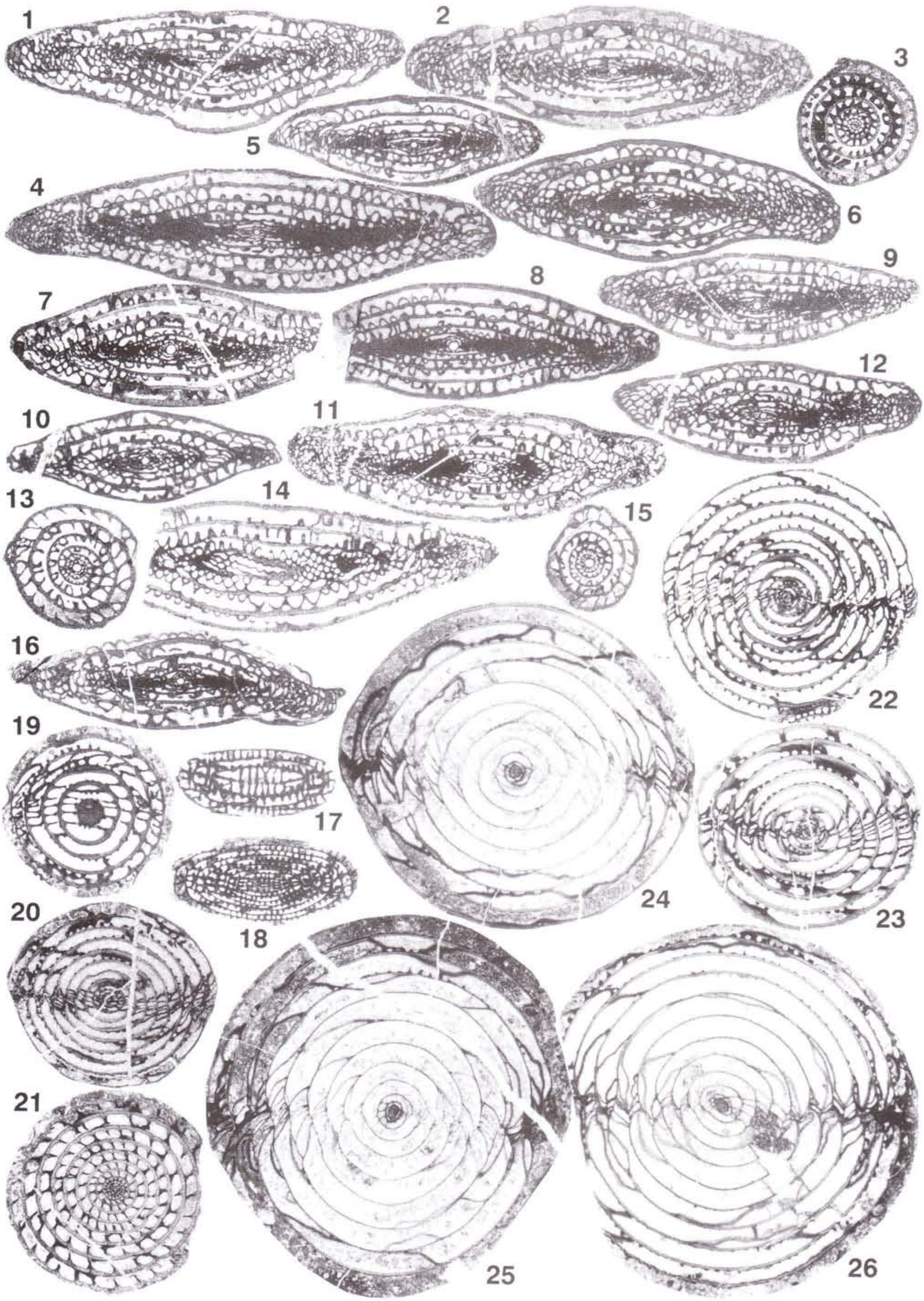


PLATE 10

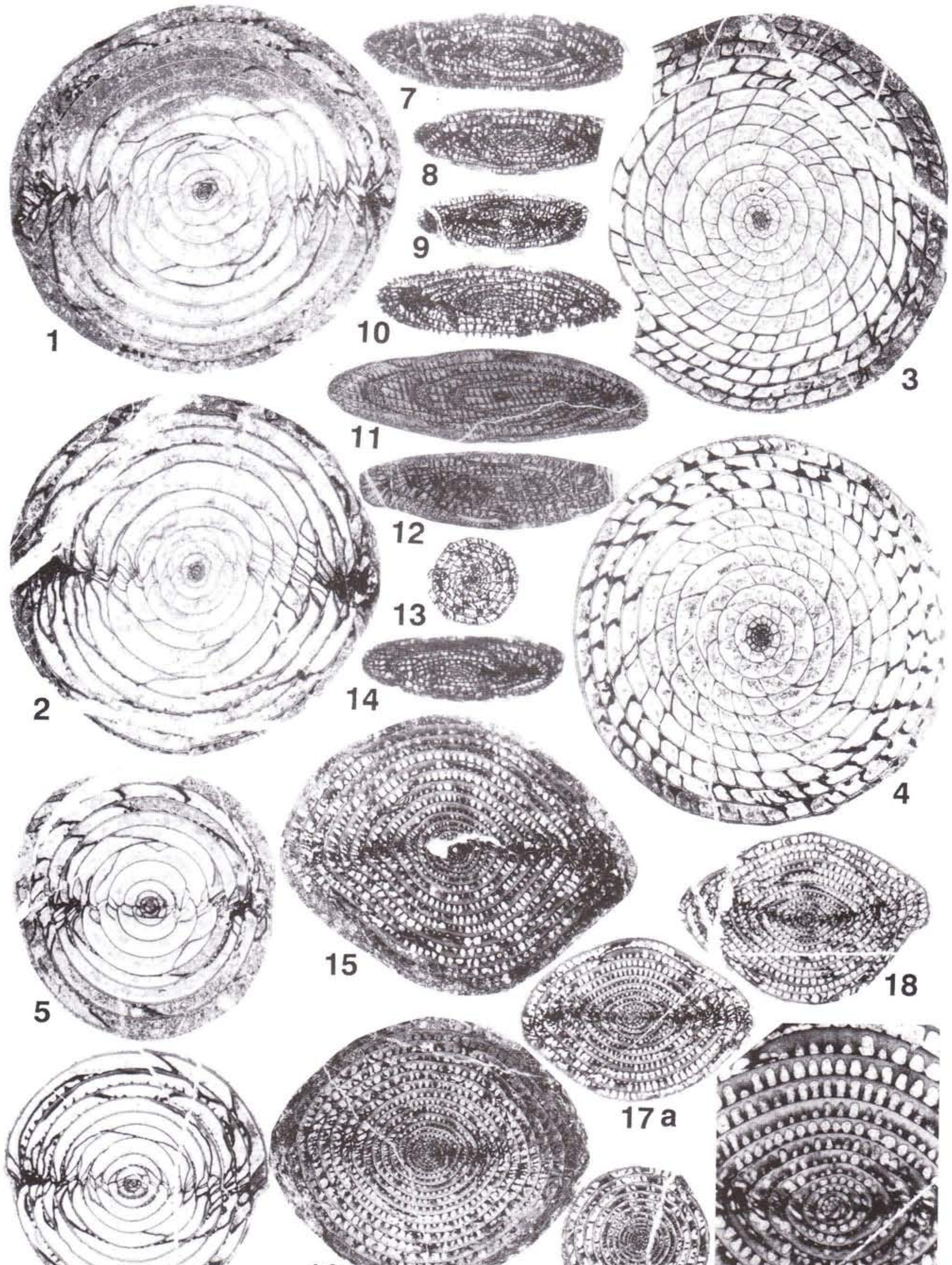
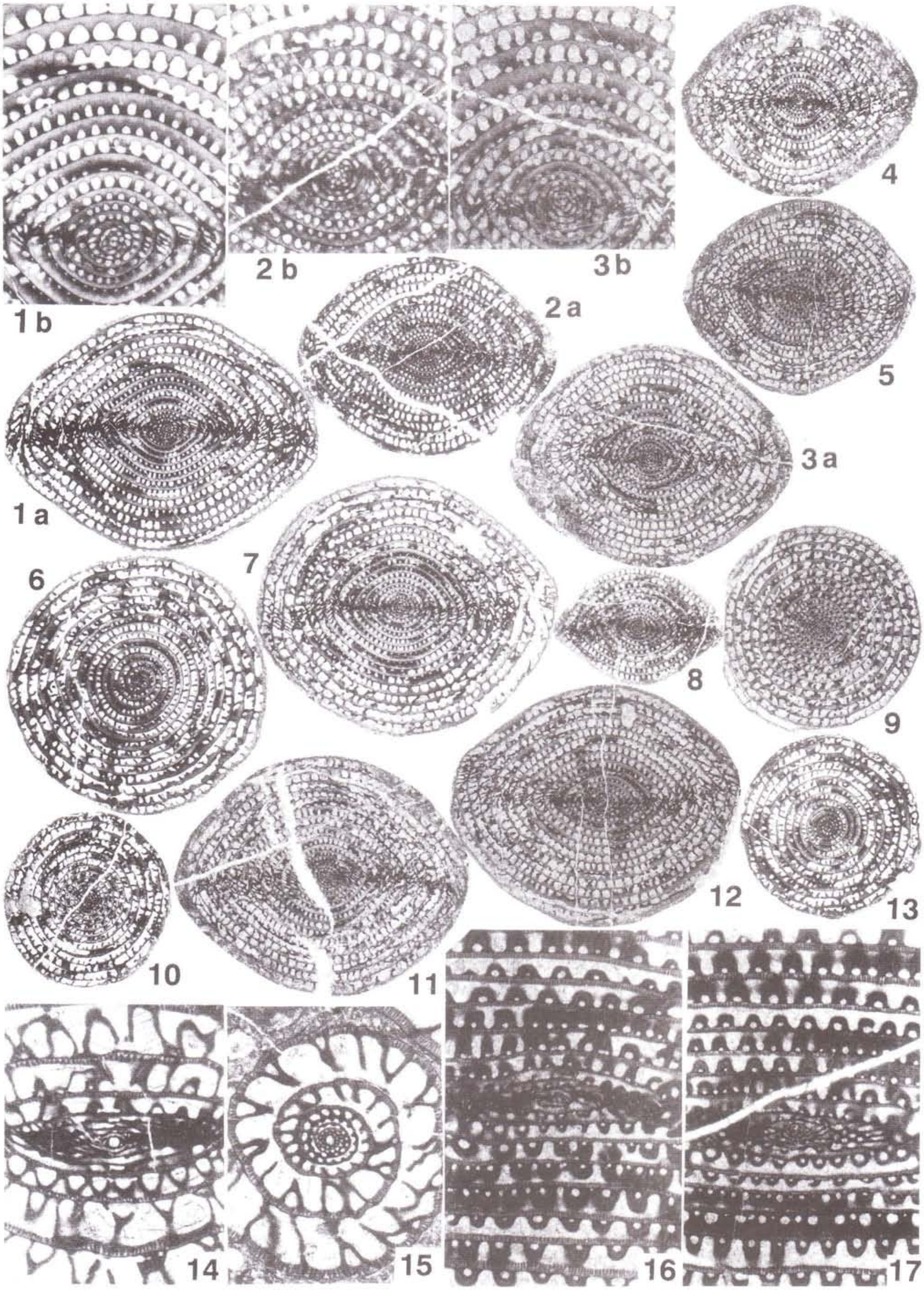


PLATE 11



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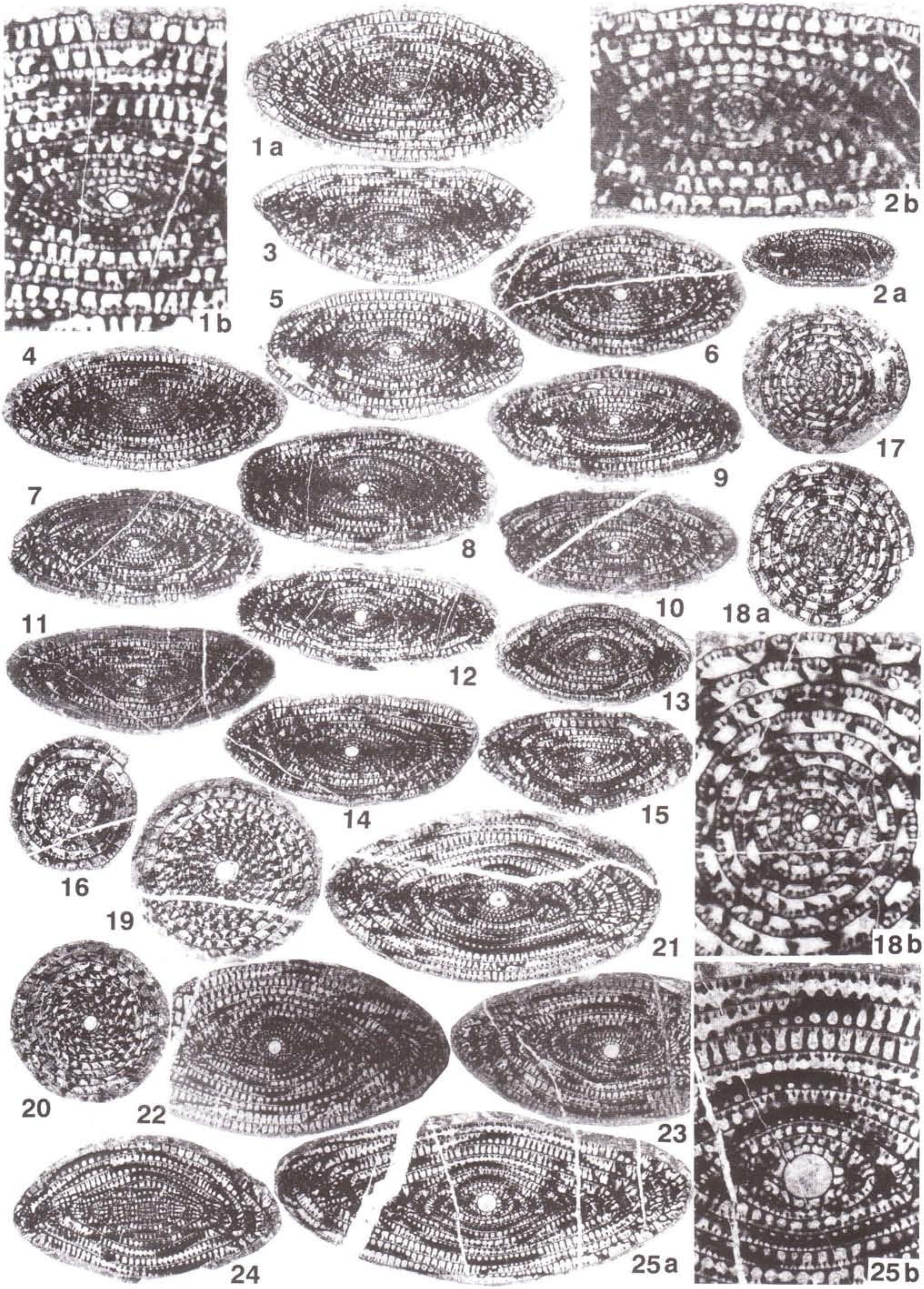
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PLATE 13

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