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Permian Bryozoans from the Lihuirco-Quisuar Route near Abancay, Peru

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Abstract Twenty-four bryozoan species including one new species: *Fabifenestella abancaya*, in 12 genera are described from the Lihuirco-Quisuar route near Abancay. The geological age is Wolfcampian based on the bryozoan and fusuline faunas (including *Triticites*, *Pseudoschwagerina Dunbarinella*). These bryozoan and fusuline faunas emphasize a strong relationship with those of the Midcontinent province of USA. The fusulines are, however, not common in association with bryozoans because of different environmental adaptations. The sedimentary rock facies in this sequence support this interpretation.

Key words : Bryozoans, Fusulines, Lower Permian, Sedimentary facies, Abancay (Peru).

Introduction

In 1980 my colleagues and I started a field survey of the Paleozoic and Mesozoic groups in Central Andes of South America. On the first year of that project, we tried a traverse from Tarma to Cuzco in the Andean region of Peru, and we selected a more detailed survey area along the Lihuirco-Quisuar road, just north of Abancay, where Newell, *et al.* (1949, 1953) introduced the Upper Permian Copacabana Group which is well distributed there. My personal interest was to make a more detailed study of the bryozoan faunal assemblages because knowledge of the Paleozoic bryozoans in South America was very poor at that time. I introduced a biostratigraphic study based on bryozoans and fusulines (Sakagami, 1983). Unfortunately, our field research in Peru was interrupted after one year by the political situation in that country and we were compelled to change our main field work to Bolivia. The field work area and the location of Abancay are shown in Fig. 1. The surveyed area extends along the road from about 12 km to 16 km north of the town of Abancay. The area is identified as the upper part of Copacabana Group in "Mapa geologico del cuadrangulo de Abancay" (scale: 1/100,000) by Marocco *et al.* (1977). A view of the surveyed area is shown in Fig. 2.

This work presents a paleontological study on the bryozoans and fusulines and their relation to the sedimentary facies of the Copacabana Group.

Brief Note on Sedimentary Facies

(Free translation from K. Nagai, 1983)

Nagai (1983) made a preliminary report on the sedimentary rock facies of the Copacabana Group along the Liuirco-Quisuar route. His geological map and columnar sections are shown in Figs. 3 and 4. He divided lithologically the Copacabana Group into three formations in descending order as follows:

Upper Formation (more than 500 m thick): Consisting of mostly shale, rare in fossils, and cropping out in both sides of the synclinal axis recognized in the central part of the studied area.

Middle Formation (ca. 400 m thick): Consisting of alternating limestone and shale, containing rarely thin, fine sandstone layers. The limestone is dark grey to greyish black colored, characterized by micrite, fossiliferous micrite, biomicrite-micrudite containing many fossils such as fusulines, bryozoans, brachiopods and gastropods.

Lower Formation (more than 400 m thick): Consisting of alternating mainly thick, massive

Fig. 1. Map showing the field survey in Peru and Bolivia in 1980 and the location of Abancay.

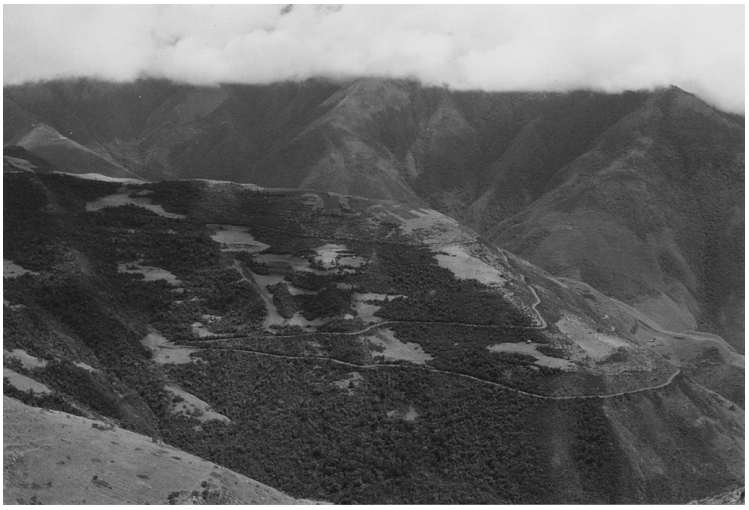

Fig. 2. Landscape from near Loc. Qu10 to the north, Lihuirco-Quisuar route, showing the hairpin turns in road. (photo by Sakagami, Oct. 9, 1980)

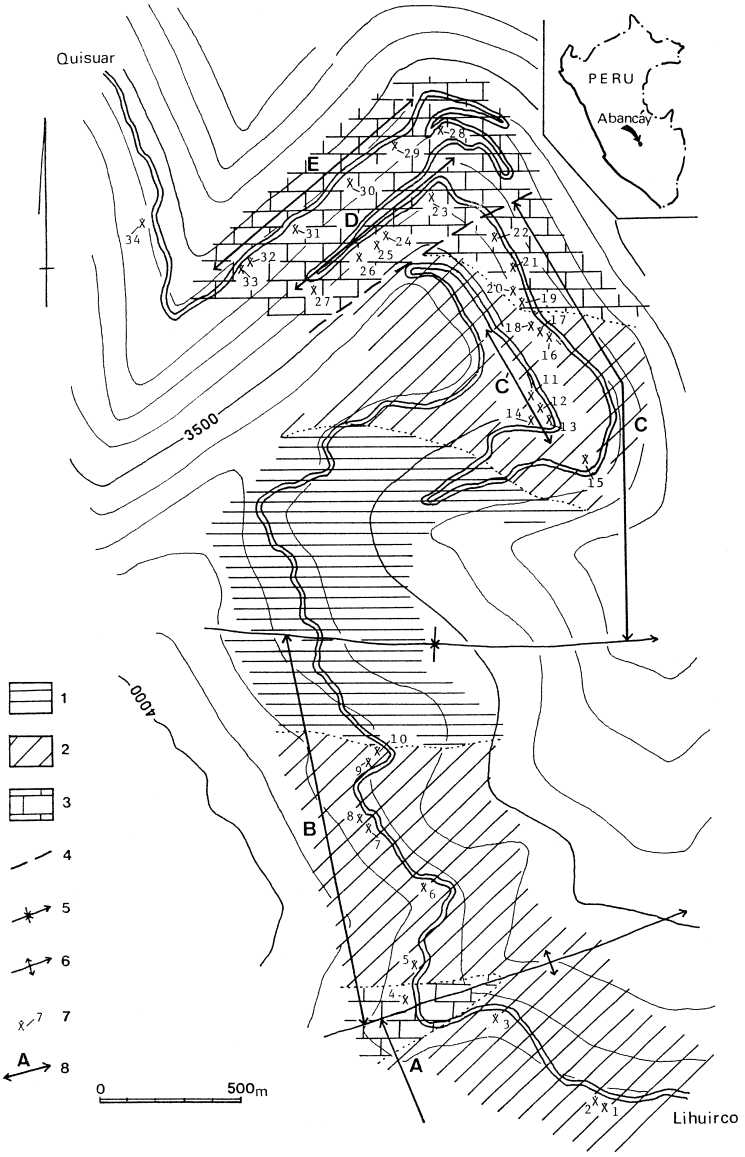

Fig. 3. Geological map along Lihuirco-Quisuar route, northern part of Abancay.
1–3. the Copacabana Group (1: upper Formation, 2: middle Formation, 3: lower Formation), 4. fault, 5. synclinal axis, 6. anticlinal axis, 7. collected localities of fossils, 8. symbols of columnar sections (see Fig. 4) (from Nagai, 1983).

limestone (usually several to about 10 m or more in thickness) intercalated with laminated, thin muddy limestone (1–2 m in thickness). The massive limestone mainly grey to greyish black, characterized by well-sorted oosparite, biosparite-sparrudite, pelsparite. The oosparite indicates the sedimentary paleoenvironment of a littoral to shoal deposit in agitated wave conditions. The muddy limestone grey to yellowish-colored, characterized by fossiliferous micrite, biomicrite-micrite and biolithite, contains many kinds of fossil remains such as bryozoans, brachiopods, crinoids and bioclasts but fusulines are very rare. The bryozoans and

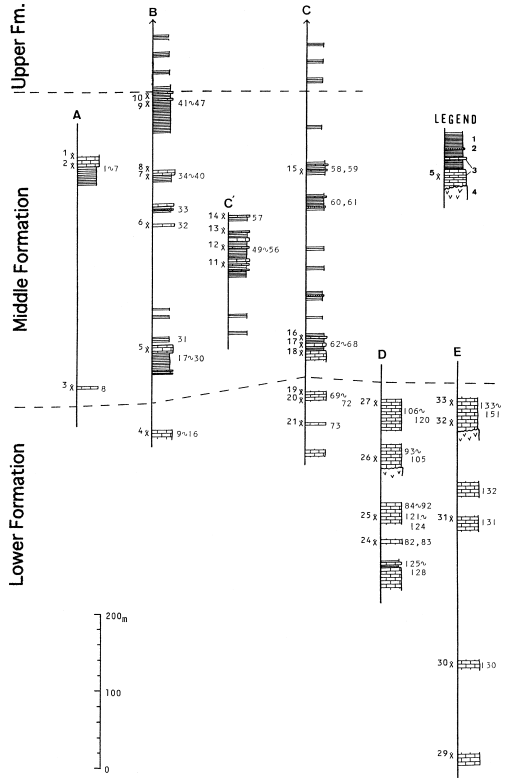

Fig. 4. Columnar sections of the Copacabana Group taken in Lihuirco-Quisuar route.

1. shale, 2. sandstone, 3. limestone, 4. intrusive rock (diabase), 5. nos. of points collected fossils (left side) and rock samples (right side) (from Nagai, 1983).

brachiopods are especially well-preserved and abundant in the muddy part.

The Copacabana Group distributed in this area is estimated to be deposited in a shallow, agitated open-sea environment in the early stage, changing gradually to gentle, non-wavy sea-bottom in the middle, and to thick mudstone environments in the later stage. This pattern was recognized broadly in the Copacabana Group in other areas of Peru by Newell *et al.* (1949, 1953).

The Fusuline Fauna

In total, six genera and fourteen species including two indeterminate species of fusulines were discriminated from 10 localities among 34 localities along the Lihuirco-Quisuar route as shown in Fig. 2 and Table 1. They are not described but some are illustrated in Fig. 5.

Of twelve species determined in the present study, ten species have been previously known from the Copacabana Group in the Central Andes of Peru and/or Bolivia. Of the other two species, one, *Dunbarinella* sp. cf. *D. americana*, was originally described from the Americus Limestone (Lower Wolfcampian) in Kansas (USA) by Thompson (1954), and another, *Schwagerina* sp. aff *S. patens* seems to differ from the originally described materials from the Copacabana Group of Yaurichambi, Bolivia and Cerro Pirhuate, Peru by Dunbar and Newell (1946) but it may be identical with the named species from Isla Tarlton in the Patagonian archipelago of southern Chile by Douglass and Nestell (1976).

Dunbar and Newell (1946) described seventeen fusuline species of Permian and one Pennsylvanian fusuline from the Central Andes, and pointed out the close similarities of fusuline faunas between the Lake Titicaca region (South

Fig. 5. Some fusulines from the Copacabana Group in the Lihuirco-Quisuar route (All are in ×10 except for 1 which is in ×30).

1. *Schubertella kingi* Dunbar and Skinner, NSM PA-18499 (Qu9); 2, 3. *Triticites nitens* Dunbar and Newell, NSM PA-18458a and b (Qu3); 4. *Triticites australis* Douglass and Nestell, NSM PA-18458c (Qu3); 5, 7. *Schwagerina*? sp. aff. *S. patens* Dunbar and Newell, NSM PA-18458d (Qu3) and 18457 (Qu3); 6. *Schwagerina tintensis* Roberts, NSM PA-18489 (Qu8); 8, 11, 12, 19. *Pseudoschwagerina d'orbignyi* Dunbar and Newell, NSM PA-18452 (Qu3), 18539 (Qu16), 18620a and b (Qu21); 9. *Pseudoschwagerina kozlowskii* Dunbar and Newell, NSM PA-18523 (Qu14); 10. *Triticites patulus* Dunbar and Newell, NSM PA-18490 (Qu8); 13, 14. *Schwagerina munaniensis* NSM PA-18527 (Qu15) and 18456 (Qu3); 15. *Triticites opimus* Dunbar and Newell, NSM PA-18453 (Qu3); 16. *Triticites* sp. indet. NSM PA-18494 (Qu8); 17, 18. *Pseudoschwagerina uddeni* (Beede and Kniker), NSM PA-18538 (Qu16); 20. *Chusenella?* sp. indet., NSM PA-18501 (Qu10); 21. *Dunbarinella* sp. cf. *D. americana* Thompson, NSM PA-18522 (Qu14).

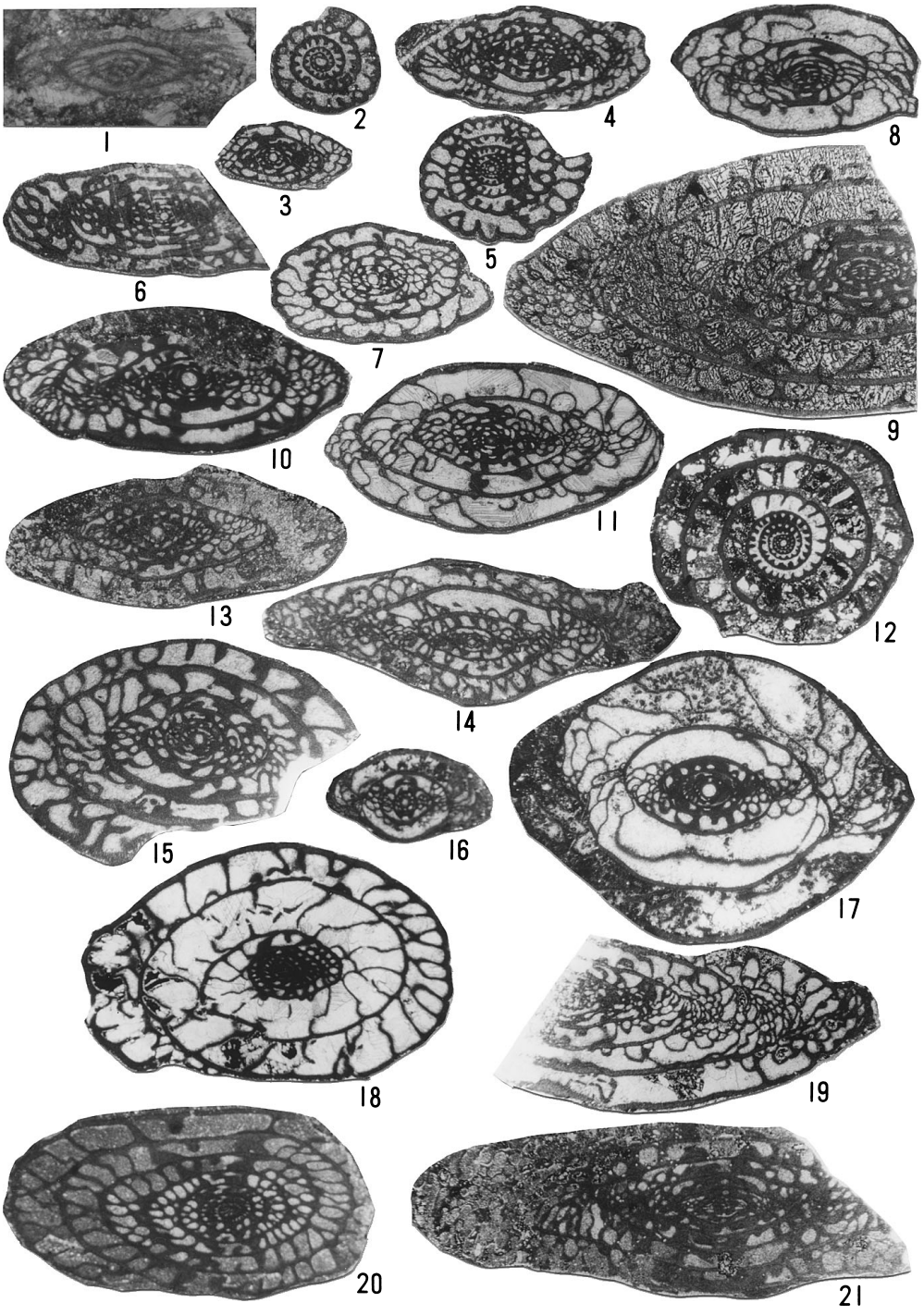
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Table 1. Distribution of the fusulines and bryozoans in the Lihuirco-Quisuar route, near Abancay.

Genus and Species \ Collection Localities		Lihuirco ⟵																																Quisuar
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Fusulines	*Schubertella kingi*									×																									
	Triticites nitens			×		×			×						×		×																		
	Triticites australis			×		×										×	×																		
	Triticites patulus								×								×																		
	Triticites opimus			×					×								×																		
	Triticites sp. indet.								×																										
	Pseudoschwagerina kozlowskii								×						×							×													
	Pseudoschwagerina uddeni															×	×					×													
	Pseudoschwagerina d'orbignyi			×													×					×													
	Schwagerina? sp. aff. *S. patens*			×																															
	Schwagerina tintensis								×						×																				
	Schwagerina munaniensis			×					×						×																				
	Dunbarinella sp. cf. *D. americana*														×																				
	Chusenella? sp. indet.										×			×		×																			
Bryozoans	*Fistulipora carbonaria*																			×		×													
	Fistulipora incrustans																																	×	
	Fistulipora sp. cf. *F. titicacaensis*												×																						
	Meekopora opima							×																											
	Meekopora prosseri				×							×								×	×	×					×			×			×	×	
	Tabulipora carbonaria		×			×			×									×		×	×											×?	×?	
	Rhombotrypella typica											×	×																		×		×		×
	Rhabdomeson sp. cf. *R. simulatum spissum*																					×?						×					×	×	
	Rhabdomeson sp. indet.																															×	×		
	Rhombopora lepidodendroides		×		×														×	×	×						×	×		×		×	×	×	
	Rhombopora sp. cf. *R. corticata*																		×	×							×	×		×					

Table 1. Distribution of the fusulines and bryozoans in the Lihuirco-Quisuar route, near Abancay.

Genus and Species \ Collection Localities		Lihuirco ←																															Quisuar →
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	25	27	28	29	30	31	32	33	34
Bryozoans	*Streblascopora* sp. cf. *S. biserialis*																				×							×					×		
	Streblascopora exillis																											×							
	Minilya sp. cf. *M. geminanoda*		×																×																
	Alternifenestella cervoides																		×	×	×										×		×		
	Alternifenestella picchuensis																											×							
	Alternifenestella sp. cf. *A. pajerensis*																								×										
	Alternifenestella? sp. indet.																																×		
	Fabifenestella abancaya, n. sp.																											×							
	Polyopora sp. cf. *P. elliptica* (s.s.)	×?																×		×		×			×?										
	Polypora andiana																			×		×													
	Polypora sp. cf. *P. cyclopora*																				×?	×													
	Septopora incaica	×	×																		×														
	Septopora sp. indet.																				×														

America) and especially the Early Permian (Wolfcampian) age of West Texas, Subsequently, Roberts (in Newell *et al.*, 1949, 1953) described 36 species (including one subspecies) of Pennsylvanian and Permian fusulines and recognized further faunal similarities between the Peru and the West Texas and Midcontinent region in the United States. Further, Douglass and Nestell (1976) reported Late Pennsylvanian and Early Permian foraminifers (mainly fusulines) from southern Chile, in which they described ten new and four previously described fusuline species referred to forms from the Wolfcampian of the Andean region of Peru and Bolivia.

The fusuline occurrence along the Lihuirco-Quisuar road covers the Early Permian (Wolfcampian), corresponding to the *Pseudoschwagerina uddeni* Zone recognized by Roberts (in Newell *et al.*, 1953). The environmental relationships between the fusulines, bryozoans and the sedimentary facies will be discussed in the next section.

The Bryozoan Fauna

In total, twelve genera and twenty-four species including three indeterminate species of bryozoans were identified from 23 localities among 34 localities along the Lihuirco-Quisuar road as shown in Fig. 2 and Table 1.

Among three species of the genus *Fistulipora*, *F. carbonaria* was described originally from the Upper Coal Measures of Kansas by Ulrich (1890), and *F. incrustans* was described originally from the Upper Graham Formation (Pennsylvanian) of Texas by Moore (1929) and from the *Pseudoschwagerina* zone of the Copacabana Group in the Lake Titicaca region of Bolivia by Sakagami (1995a). These two species occur in the Wreford Megacyclothem (Lower Permian) of Kansas (USA) and were discussed in detail by Warner and Cuffey (1973). Another species *F.* sp. cf. *F. titicacaensis* may be identical with the originally described material from the *Pseudoschwagerina* zone of the Copacabana Group in the Lake Titicaca region of Bolivia.

Two species of *Meekopora*, *M. opima* and *M. prosseri*, are closely similar to each other. Warner and Cuffey (1973) stated that "*M. opima* and *M. vesca* by Moore and Dudley (1944) require thorough study of type material before they can be synonymized with *M. prosseri*." *Meekopora prosseri* was originally described from the Coal Measures of Nebraska by Ulrich (in Condra, 1902, 1903), and is known widely in time (Pennsylvanian to Permian) and space (world-wide). Warner and Cuffey (1973) reported this species in association with *Fistulipora carbonaria* from the Wreford Megacyclothem (Lower Permian). *Meekopora opima* was originally described from the Lower Permian in Kansas. Warner and Cuffey (1973) concluded that the Wreford fistuliporaceans were restricted paleoecologically to quiet, offshore, normal-marine waters with a mixed clay-lime-mud bottom.

Cuffey (1967) discussed *Tabulipora carbonaria* (Worthen, 1875) in the Wreford Megacyclothem of Kansas. According to him, the geological range of *T. carbonaria* is widely distributed from the Late Pennsylvanian to Early Permian in the United States. This species has been known as a *confer* form of *T. carbonaria* from the lower part of the *Pseudoschwagerina* zone and middle part of *Eoparafusulina* zone of the Lake Titicaca region of Bolivia. Cuffey (1967) noted that "*T. carbonaria* is interpreted to have thrived most in waters which were relatively deep, far from shore, quiet, and of normal marine salinity."

Rhombotrypella typica was originally described from the "Carboniferous" of Chulpapampa in Bolivia by Bassler (1936), which is considered to be the Permian Copacabana Group, because this species is common in the Lower Permian Copacabana Group in the Andean region.

Two types of *Rhabdomeson*, but one of which is indeterminable, are discriminated. Another species: *Rhabdomeson* sp. cf. *R. simulatum spissum* is nearest to the type specimen from the Upper Graham Formation (Pennsylvanian) of north central Texas (USA) by Moore (1929).

Rhombopora lepidodendroides is most abun-

dant in the Wreford Megacyclothem (Wolfcampian) of the Midcontinent (USA). Newton (1971) discussed in detail and concluded that the total range of *R. lepidodendroides* was from the Early Pennsylvanian to Late Permian. This species is associated with *Meekopora prosseri* and/or *Tabulipora carbonaria* in many localities along this route. The sedimentary environment containing these bryozoans is considered to be relatively deep, quiet off-shore and of normal marine water.

The *Streblascopora* is rather poor in the present section, but only two species can be recognized, namely *S.* sp. cf. *S. biserialis* and *S. exillis*. The former is similar to the original material from the Permian of Timor island and the latter may be identical with *S. exillis* described from the Permian (most probably the late Artinskian in age) of Thailand by Sakagami (1970).

At least eleven fenestrate bryozoan species belonging to the five genera: *Minilya*, *Alternifenestella*, *Fabifenestella*, *Polypora* and *Septopora*, including one new and two indeterminable species, are recognized, but they are generally fragmentary.

Minilya sp. cf. *M. geminanoda* (Moore, 1929) described in this study may be identical with the originally described species from the Upper Graham Formation (Pennsylvanian) of north central Texas (USA).

Among four species of the genus *Alternifenestella*, three species: *A. cervoides*, *A. picchuensis* and *A.* sp. cf. *A. pajerensis* are identical or very similar to the originally described species from the Lower Permian Copacabana Group in Peru by Chronic (in Newell *et al.*, 1949, 1953). The other one is an indeterminable species.

Fabifenestella abancaya is the only new species in this study and is near to *F. spinulifera* from the Upper Graham Formation, the Pennsylvanian of north central Texas (USA) and *F. huascatayana* from the Lower Permian Copacabana Group in Pasaje Picchu of Peru.

Of three species of the genus *Polypora*, *P. cyclopora* in this study, which was described originally from the Lower Permian in European Russia and *P. andiana* which was from the Lower Permian Copacabana Group of Peru, are both identical with the named species from the Lower Permian Copacabana Group in Bolivia by Sakagami (1995b). And, the other one: *P.* sp. cf. *P. elliptica* (s.s.) Rogers is nearest to the named species which was described from the lower to middle part of *Eoparafusulina* zone at Yaurichambi, Bolivia by Sakagami (1995b).

Of two species of *Septopora*, one is indeterminable and another, *Septopora incaica*, has been known from the Copacabana Group in Peru by Chronic (Newell, *et al.*, 1949, 1953) and also by Sakagami (1995b).

The fenestrate bryozoans are considered to be adapted to shallow and more or less agitated environmental condition.

Of the named twenty-one species, one species is new, ten are common to those of the Midcontinent region (USA), seven are endemic Andean species and three are in the Tethyan province. Thus, it is remarkable that the bryozoan fauna in this route has close similarities with not only those of the Wolfcampian Wreford Megacyclothem of Kansas but also of the Upper Graham Formation of Texas, especially in the fenestrates.

These bryozoans are generally not in common association with any fusulines except for only 3 localities (nos. 5, 8 and 21). However, strictly, from the two of them (nos. 8 and 21), the two taxa are found in separate blocks. Such occurrence indicates clearly the different adaptations between the two taxa, namely, the bryozoans are considered to be adapted to a more or less agitated shallow open-sea and the fusulines are likely to be in a rather gentle, shallow sea bottom. Such faunal evidence of fusulines and bryozoans is concordant with the sedimentary facies discussed by Nagai (1983).

Systematic Paleontology on Bryozoa

All specimens in this study are deposited and registered in the Collections of the National Science Museum (NSM PA), Tokyo, Japan. Symbols and numbers (ex.: Qu1) in parentheses show

the fossils localities.

Order Cystoporata Astrova, 1964

Suborder Fistuliporina Astrova, 1964

Family Fistuliporidae Ulrich, 1882

Genus *Fistulipora* McCoy, 1850

Fistulipora carbonaria Ulrich, 1884

(Fig. 6-1, 2)

Fistulipora carbonaria Ulrich, 1884, p. 45, pl. 3, figs. 1, 1a; Warner and Cuffey, 1973, p. 11–14, pl. 2, figs. 1–10.

Cyclotrypa carbonaria (Ulrich), Moore and Dudley, 1944, p. 269–271, pl. 5, fig. 3; pl. 6, fig. 7; pl. 10, fig. 6; pl. 11, figs. 1–3; pl. 18, fig. 6; pl. 19, figs. 6, 7; pl. 20, fig. 5; pl. 24, figs. 5, 6; pl. 25, fig. 4; pl. 32, fig. 2; pl. 33, figs. 5, 6; pl. 34, fig. 5.

Material. NSM PA-18576a, 18577a, 18581a, b (Qu19); 18599, 18601, 18602, 18606, 18607, 18609, 18610a (Qu21).

Description. Encrusting zoarium growing upon foreign objects such as bryozoan colony of *Polypora*, brachiopod shell or soft body life such as seaweed obliterated now. The thickness of zoarium ranges from 2.0 to 2.5 mm.

In tangential section of mature zone, zooecial tube nearly circular, with weakly constricted parts which correspond to the edges of the lunarium. Longitudinal diameter excluding lunarium ranges from 0.38 to 0.51 mm and transverse diameter from 0.36 to 0.42 mm. Usually 3.5 to 4 zooecia per 2 mm diagonally. Lunarium poorly developed, occupying less than one-fourth of zooecial circumference, the maximum thickness usually about 0.04 to 0.06 mm. Vesicular tissue consists of coarse vesicles and regular in size, usually one vesicle between adjacent zooecia. Usually 4 to 5 vesicles per mm horizontally.

In longitudinal section, zooecial tubes parallel to coenelasma for a short distance and curved gradually upward, forming with outer surface of zoarium an angle of about 90°. Diaphragms abundant, usually 4 to 5 per mm in longitudinal section, horizontal or oblique in some tubes, but inclined in opposite directions or coalescing in others. Vesicular tissue bubble-like, regularly and coarsely developed in mature zone and becoming depressed quadrate.

Remarks. *Fistulipora carbonaria* was described originally from the Upper Coal Measure deposits at Kansas City, Missouri (USA) by Ulrich (1884). Among the detailed examination of fistuliporacean bryozoans of the Wreford Megacyclothem (Lower Permian) by Warner and Cuffey (1973), they described and illustrated *Fistulipora carbonaria* and indicated diagrammatically the geographic and stratigraphic distribution. Further, Warner and Cuffey (see p. 11–13, 1973) considered that some species placed as in the genus *Cyclotrypa* such as *C. abdita*, *C. acerba*, *C. carbonaria*, *C. decora*, *C.nebrascensis*, *C. pelagia*, *C. procera*, *C. repentis*, *C. simplicis*, *C. tenuicula* and *C. torosa* by Moore and Dudley (1944) are synonymous with *Fistulipora carbonaria*.

The present species is characterized in having a relatively wide diameter of zooecium, vesicular tissue consisting of coarse vesicles and poorly developed lunarium. The present form can be easily identified with *Fistulipora carbonaria* which Warner and Cuffey (1973) reexamined in detail in all essential characters.

The geological range of *F. carbonaria* has been considered to be from the Upper Pennsylvanian (Missourian) to Lower Permian (Wolfcampian) by Warner and Cuffey (1973).

Fistulipora incrustans Moore, 1929

(Fig. 6-3, 4)

Fistulipora incrustans Moore, 1929, p. 3, 4, pl. 1, figs. 1, 2, 6, 8; Warner and Cuffey, 1973, p. 8–11, figs. 1–7; Sakagami, 1995a, p. 242, figs. 9-1, 2.

Fistulipora confinis Perry and Horowitz, 1963, p. 19, 20, pl. 1, figs. 1–6.

Material. NSM PA-18748, 18749a, 18751, 18753, 18757 (Qu33).

Description. Zoarium encrusting, may have been attached to a foreign object such as seaweed that is obliterated now. The thickness of zoarium averaging 1.2 to 2.2 mm.

In tangential section of mature zone, zooecial

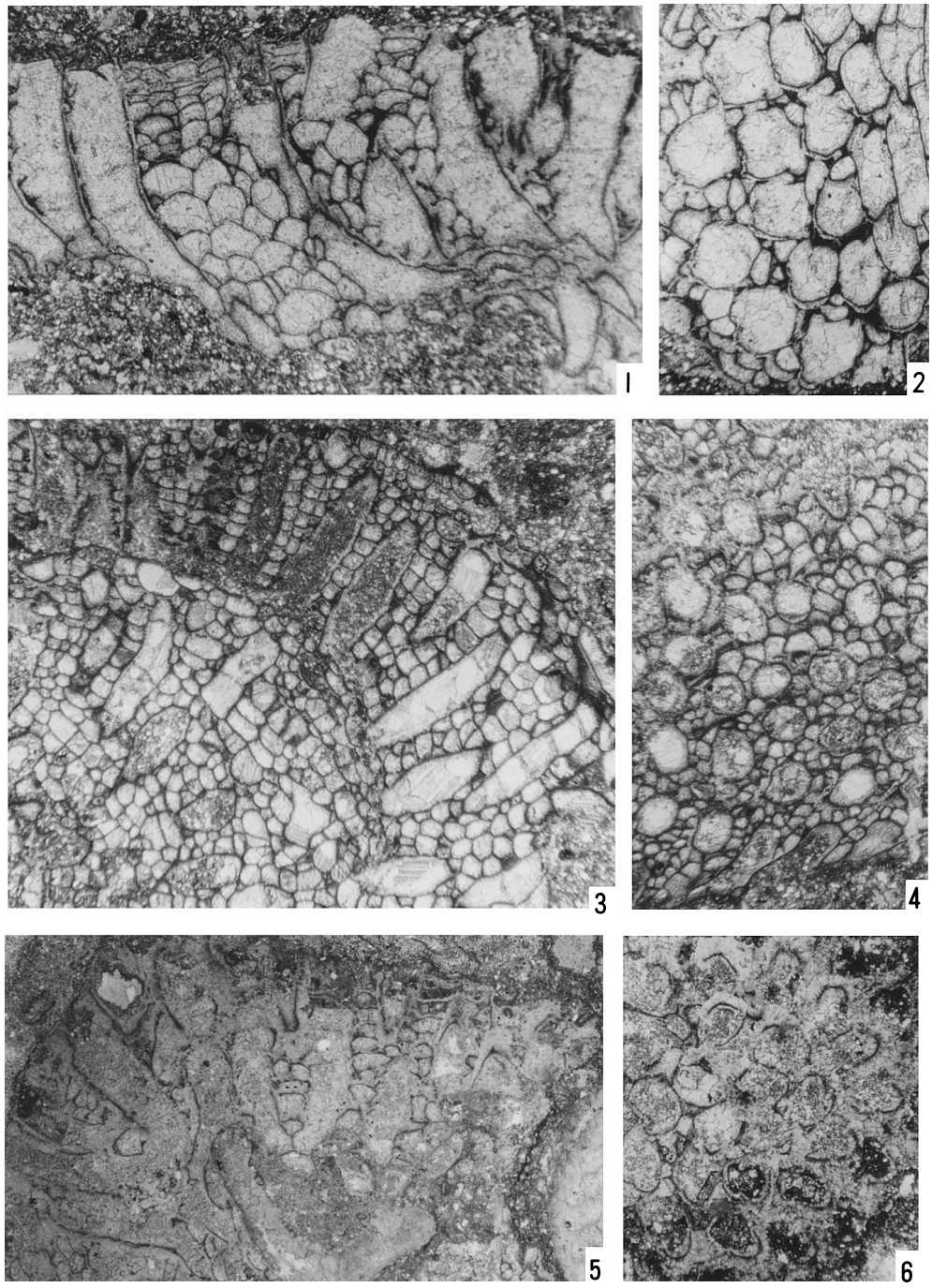

Fig. 6. *Fistulipora* (All are in ×20).

1, 2. *Fistulipora carbonaria* Ulrich, 1. Longitudinal section, NSM PA-18611 (Qu21); 2. Tangential section, NSM PA-18610a (Qu21). 3, 4. *Fistulipora incrustans* Moore, 3. Obliquely longitudinal section, NSM PA-18749a (Qu33); 4. Tangential section, NSM PA-18753 (Qu33); 5, 6. *Fistulipora* sp. cf. *F. titicacaensis Sakagami*, 5. Longitudinal section, NSM PA-18514a (Qu12), 6. Tangential section, NSM PA-18515 (Qu12).

tubes circular or broadly oval, longer diameter excluding lunarium ranges from 0.28 to 0.32 mm and shorter diameter from 0.21 to 0.28 mm. Usually 4 zooecia per 2 mm diagonally. Weakly developed lunarium occupies about one-fourth to one-third of zooecial circumference, its thickness is thin, about 0.03 to 0.04 mm. Vesicular tissue consists of fine vesicles regular in size, usually two, occasionally three vesicles between adjacent zooecia. Usually 8 to 9 vesicles per mm horizontally.

In longitudinal section, zooecial tubes parallel to coenelasma for a short distance and curved gradually upward, making a right angle to zoarial surface. Diaphragms unobservable in many cases but present one to two in a tube and a maximum of more than five. Interzooecial tissue consists of regularly arranged vesicles which are usually quadrate but some are depressed or elongated. Usually 9 to 11 vesicles per mm longitudinally.

Remarks. The present species was described originally from the Upper Graham Formation (Pennsylvanian) of north-central Texas (USA) by Moore (1929). Later, Warner and Cuffey (1973) restudied in detail this species in association with other fistuliporaceans: *Fistulipora carbonaria* and *Meekopora prosseri* from the Wreford Megacyclothem in Kansas (USA). According to them, the geological range of *Fistulipora incrustans* has been considered to be from the Upper Mississippian (Chesterian) to Lower Permian (Wolfcampian).

The present form in essential characters and measurements is considered to be identical with *Fistulipora incrustans* described from the Wreford Megacyclothem by Warner and Cuffey (1973).

Fistulipora sp. cf. ***F. titicacaensis*** Sakagami, 1995

(Fig. 6-5, 6)

Compared.

Fistulipora titicacaensis Sakagami, 1995a, p. 244, figs. 11-3, 4.

Material. NSM PA-18514a, 18515 (Qu12).

Description. Only two thin sections (obliquely tangential and longitudinal) of fragmentary specimens were examined. Encrusting zoarium growing upon foreign objects such as a brachiopod shell. The thickness is about 1.6 mm.

In tangential section, zooecial tubes broadly ovate or subcircular, gradually widening from the inner to outer zone; longitudinal diameter excluding lunarium ranges from 0.26 to 0.32 mm and transverse diameter from 0.23 to 0.28 mm. Usually 4 to 4.5 zooecia per 2 mm diagonally. Thin lunarium poorly developed, occupying about one-fourth of zooecial circumference.

In longitudinal section, zooecial tubes seems to be straight upward, making a right angle to zoarial surface. Diaphragms unobservable. Zooecial wall zigzag except for the side with lunarium which is straight. Interzooecial tissue consisting of regularly arranged vesicles. Vesicles usually depressed quadrate or scale-like in some cases; irregular in size and the arrangement obscure.

Remarks. Although a detailed comparison cannot be made because of the poorly preserved sections and insufficient material, the present form is closely similar to *Fistulipora titicacaensis*, which was described from the middle part of *Pseudoschwagerina* zone of the Copacabana Group in Cuyavi of the Lake Titicaca region, Bolivia by Sakagami (1995a).

Family Hexagonellidae Crockford, 1947

Genus *Meekopora* Ulrich, 1889

Meekopora opima Moore and Dudley, 1944

(Fig.s 7-1, 2)

Meekopora opima Moore and Dudley, 1944, p. 302, 303, pl. 37, fig. 10, pl. 38, fig. 9, pl. 39, fig. 9, pl. 41, fig. 8, pl. 42, figs. 5, 6, pl. 44, fig. 6, pl. 45, figs. 5–7.

Material. NSM PA-18476, 18477, 18478, 18479 (Qu7).

Description. Exact feature of zoarium is unknown, but may be thick undulating broad frond, about 4 to 5 mm in thickness.

In tangential section, zooecial tubes thick-walled, nearly circular or broadly oval with lunar-

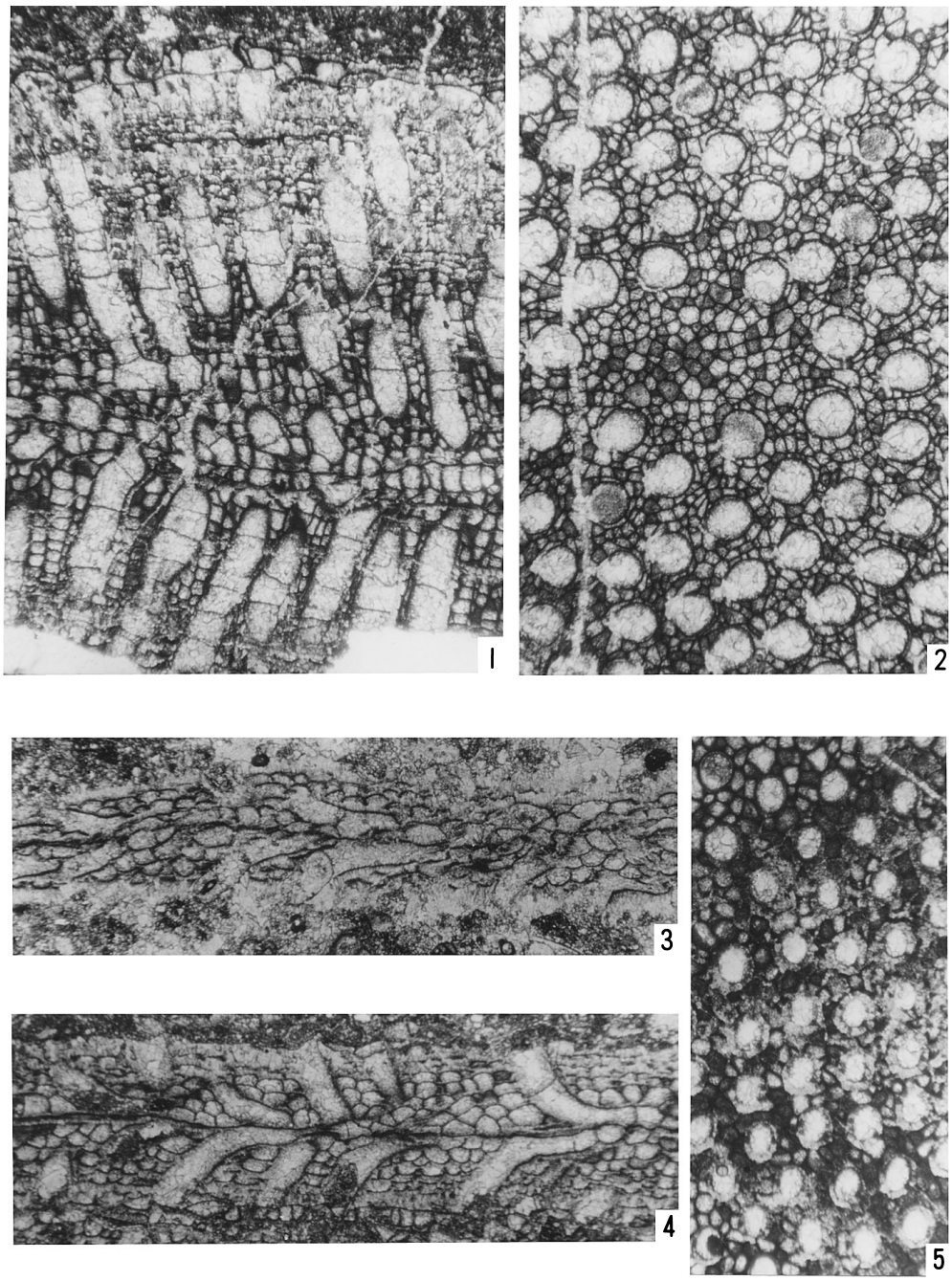

Fig. 7. *Meekopora* (All are in ×20).

1, 2. *Meekopora opima* Moore and Dudley, 1. Longitudinal section, NSM PA-18476 (Qu7), 2. Tangential section, NSM PA-18478 (Qu7); 3–5. *Meekopora prosseri* Ulrich, 3, 4. Longitudinal sections, NSM PA-18507 (Qu11) and NSM PA-18730 (Qu32); 5. Tangential section, NSM PA-18591 (Qu20).

ia. Longer diameter of zooecium excluding lunarium ranges from 0.26 to 0.32 mm and shorter diameter from 0.23 to 0.28 mm. Usually 4 to 4.5 zooecia per 2 mm diagonally. Lunarium developed and occupies about one-third of zooecial circumference, about 0.03 mm in thickest part.

In longitudinal section, zooecial tubes proximally parallel to mesotheca for short distance, then curved quickly upward, making a right angle with outer surface of zoarium. Many thin and straight or slightly concave diaphragms in zooecial tubes, irregularly spaced at intervals of usually 0.16 to 0.48 mm, but 0.05 mm in a special case. Interzooecial tissue consists of regularly arranged vesicles which are usually depressed quadrate. 7 to 9 vesicles per mm longitudinally.

Remarks. The present form in all essential characters is identical with *Meekopora opima* which was originally described from the Floren shale of the Beattie Formation (Lower Permian) in Kansas (USA). This species can be distinguished from *Meekopora prosseri* by the thicker zoarium, longer zooecial tubes and in having more numerous diaphragms and more distinct lunaria.

Meekopora prosseri Ulrich, 1902

(Fig. 7-3–5)

Meekopora prosseri Ulrich in Condra, 1902, p. 339, pl. 18, fig. 9, pl. 19, figs. 1–6; Condra, 1903, p. 36, pl. 3, figs. 1–7; Moore and Dudley, 1944, p. 299, 300, pl. 37, figs. 3, 4, pl. 38, figs. 1, 8, pl. 39, fig. 3, pl. 41, fig. 7, pl. 42, figs. 1–3, pl. 44, figs. 1, 2, pl. 45, figs. 1, 2, 4, pl. 46, figs. 4, 8; Warner and Cuffey, 1973, pl. 14–19, pl. 3, figs. 1–6; Yang and Xia, 1975, pl. 45, 46, pl. 3, figs. 5–7; Sakagami, 1995a, p. 246, 247, figs. 13-2–5.

Meekopora cf. *prosseri* Ulrich, Chronic in Newell et al., 1953, p. 111, pl. 21, figs. 1, 2; Termier and Termier, 1971, p. 27, pl. 11, figs. 1–3.

Material. NSM PA-?18461, ?18462 (Qu4); 18507 (Qu11); 18577b, 18582a, 18585a, 18587 (Qu19); 18591, 18593a (Qu20); 18608 (Qu21); 18655, 18659 (Qu26); 18689a, 18690, 18691a (Qu29); 18721, 18730, 18732 (Qu32); ?18734 (Qu33).

Description. Zoarium thick and broadly undulating, bifoliate frond, measuring about 1.0 to 1.5 mm thick and at least more than 8 mm wide in the present thin section.

In tangential section, zooecial tubes nearly circular or oval, thick-walled (nearly about 0.05 mm) in outer zone. Shorter diameter from 0.15 to 0.20 mm and longer diameter from 0.20 to 0.23 mm, usually 5 zooecia per 2 mm diagonally. Lunarium usually not observed but occasionally poorly developed. Vesicular tissue consists of fine vesicles regular in size, one to three vesicles between adjacent zooecia, and about 7 vesicles per mm horizontally in inner zone.

In longitudinal section, zooecial tubes proximally parallel to mesotheca for some distance and curving gradually upward and meeting surface of zoarium at an angle of about 90°. Usually 1 to 2 diaphragms in inner part of zooecial tube. Interzooecial tissue in inner zone consisting of regularly arranged vesicles which are usually depressed quadrate or bubble-like in shape, and covered with thin dense fibrous material in outer zone.

Remarks. Since *Meekopora prosseri* was described originally from the Coal Measures of Nebraska by Ulrich (in Condra, 1902, 1903), this species has been widely known from many places not only in the Pennsylvanian of North America but also from the Upper Pennsylvanian (Morrowan to Virgilian) to Lower Permian (Wolfcampian) of Kansas (USA) by Moore and Dudley (1944), the Lower Permian of Andean region of Peru (SA) by Chronic (in Newell, 1949, 1953) and Sakagami (1995a), Permian of Afghanistan by Termier and Termier (1971) and the Permian of the Everest region (SW China) by Yang and Xia (1975).

Among them, the following two papers are especially important. Namely, Moore and Dudley (1944) showed that *Meekopora prosseri* distributed stratigraphically in the Midcontinent region of USA is known from the Morrowan of Pennsylvanian to the Wolfcamian of the Permian, and Warner and Cuffey (1973) studied in detail the morphology and variability of *M. prosseri* associated with *Fistulipora incrustans* and *Fistulipo-*

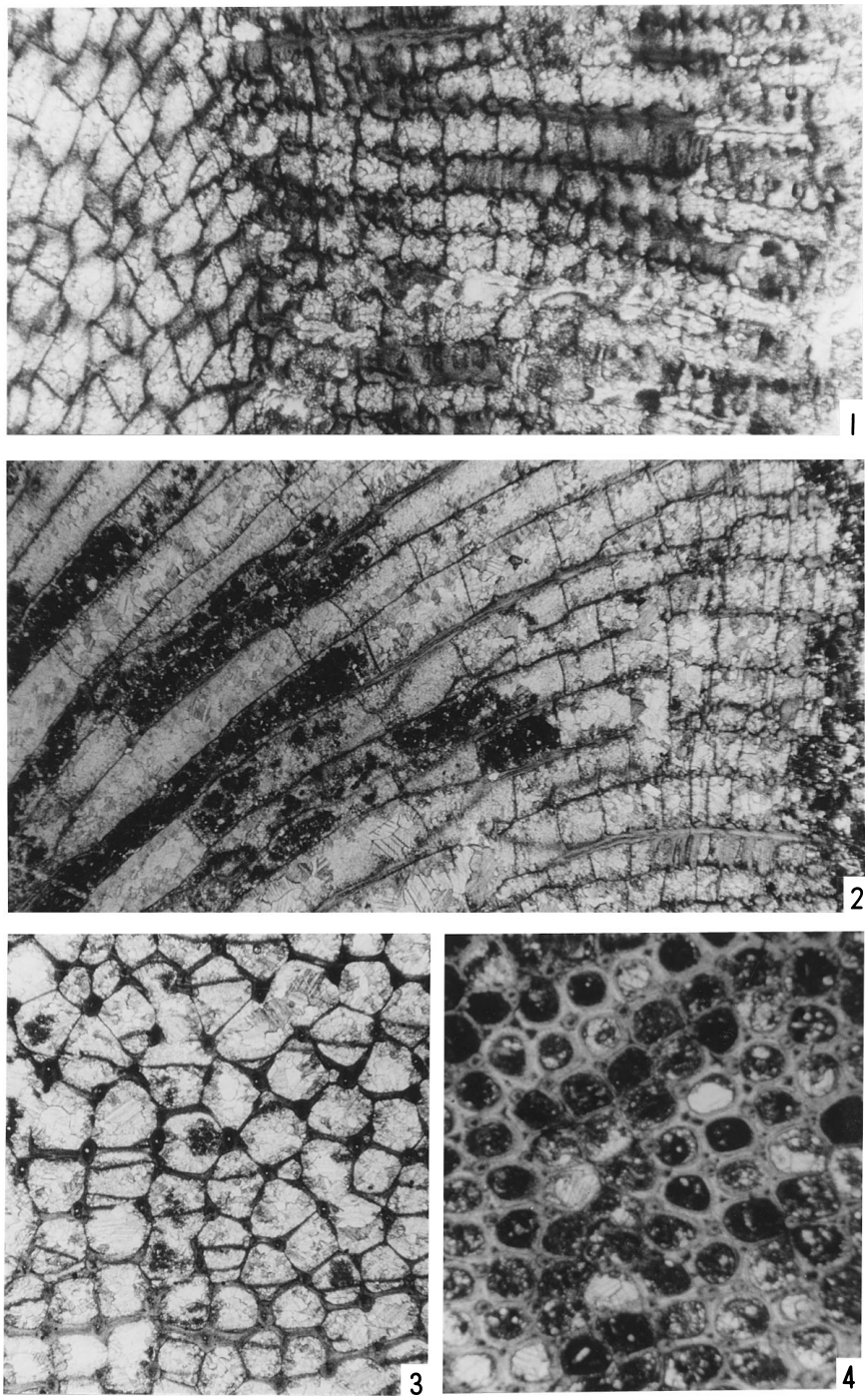

Fig. 8. *Tabulipora* (All are in ×20).

1–4. *Tabulipora carbonaria* (Worthen), 1. Transverse section, NSM PA-18464 (Qu5), 2. Longitudinal section, NSM PA-18551 (Qu17). 3, 4. Tangential sections, inner part, NSM PA-18552 (Qu17) and outerpart, NSM PA-18596 (Qu20), respectively.

ra carbonaria from the Wreford Megacyclothem (Lower Permian) in Kansas (USA).

The present form falls unquestionably under the category *Meekopora prosseri* in all its essential characters.

Order Trepostomata Ulrich, 1882

Family Stenoporidae Waagen and Wentzel, 1886

Genus *Tabulipora* Young, 1883

Tabulipora carbonaria (Worthen, 1875)

(Fig. 8-1–4)

Chaetetes? *carbonaria* Worthen, in Worthen and Meek, 1875, p. 526, pl. XXXII, fig. 5.

Stenopora carbonaria (Worthen), Ulrich, 1890, p. 445, pl. LXXIII, figs. 8, 8a; Condra, 1903, p. 45, 46, pl. 4, figs. 9–13; Condra and Elias, 1944, pl. 9, fig. 5.

Stenopora carbonaria var. *maculosa* Ulrich, 1890, p. 445, pl. LXXIII, figs. 10, 10a.

Stenopora carbonaria var. *conferta* Ulrich, 1890, p. 446, pl. LXXIII, figs. 9, 9a; Condra, 1903, p. 46, pl. 4, figs. 14, 15.

Tabulipora carbonaria (Worthen), Easton, 1943, p. 142; Gilmour, 1962, p. 1020; Perkins and Perry in Perkins, Perry and Hattin, 1962, p. 16, 17 (not illustrated).

Tabulipora carbonaria (Worthen), Cuffey, 1967, p. 1–96, pl. 1–9.

Tabulipora cf. T. *carbonaria* (Worthen), Sakagami, 1995a, p. 254, 256, figs. 17.1–5.

Material. NSM PA-18434, 18435 (Qu2); 18463, 18464, 18465, 18466 (Qu5); 18480, 18481, 18482, 18483, 18484, 18485, 18486, 18487 (Qu8); 18551, 18552a (Qu17); 18575a, 18581 (Qu19) (lamellate type, fragment); 18589, 18590, 18592a (Qu20); ?18722, ?18743 (Qu32); ?18749b (Qu33).

Description. Zoarium generally ramose, consisting of thick cylindrical bifurcating branches but occasionally encrusting, thin sheet-like such as in Specimens: Qu20(1)-1, 2 and 4. Usually 12 to 15 mm diameter but the thickest diameter reaches more than 25 mm in Specimen Qu17(1)-1. Diameter of endozone varies 5 to 10 mm (reaches about 20 mm in maximum) and width of exozone varies 2.5 to 5.8 mm.

In tangential section, zooecia circular to polygonal with rounded corners and irregularly arranged, 0.26 to 0.32 mm in diameter. Mesozooecia rarely present, 0.08 to 0.13 mm in diameter. Acantho styles usually located at intersections of zooecial walls, having laminated wall. Outside diameter ranging from 0.10 to 0.13 mm and inner diameter about 0.03 to 0.04 mm. Interzooecial tissue consisting of fine fibrous striations, and in some cases, very small granulated structures observed between acantho styles in central part of zooecial wall.

In transverse section, zooecial tubes thin-walled, irregularly arranged, polygonal in central part of endozone.

In longitudinal section, zooecial tubes parallel to longitudinal direction, gradually curving upward of endozone of cylindrical zoarium, but rather quickly bending upward from coenelasma in lamellate zoarium, and then straight, perpendicular to surface in exozone. Zooecial wall thin, slightly crenulate, forming arcuate rows of monilae in endozone, and rapidly thickening with well-developed and regularly arranged monilae in exozone. In exozone of zooecial tubes, both complete and centrally perforated diaphragms at very short interspaces. Intervals between diaphragms becoming very short in exozone, vary from 0.01 to 0.38 mm. Inner edges of many of perforated diaphragms swollen and extending proximally.

Remarks. The present species placed questionably in the genus *Chaetetes* by Worthen (in Worthen and Meek, 1875) was replaced in the genus *Tabulipora* by Easton (1943) and later students. The stratigraphical consideration and morphological variability of this species in the Wreford Megacyclothem (Lower Permian) of Kansas has been discussed in detail by Cuffey (1967).

The present form agrees perfectly with *Tabulipora carbonaria* in all essential characters and measurements.

Genus *Rhombotrypella* Nikiforova, 1933

Rhombotrypella typica (Bassler, 1936)

(Fig. 9-1–4)

Rhomboporella typica Bassler, 1936, p. 159, 160, figs.

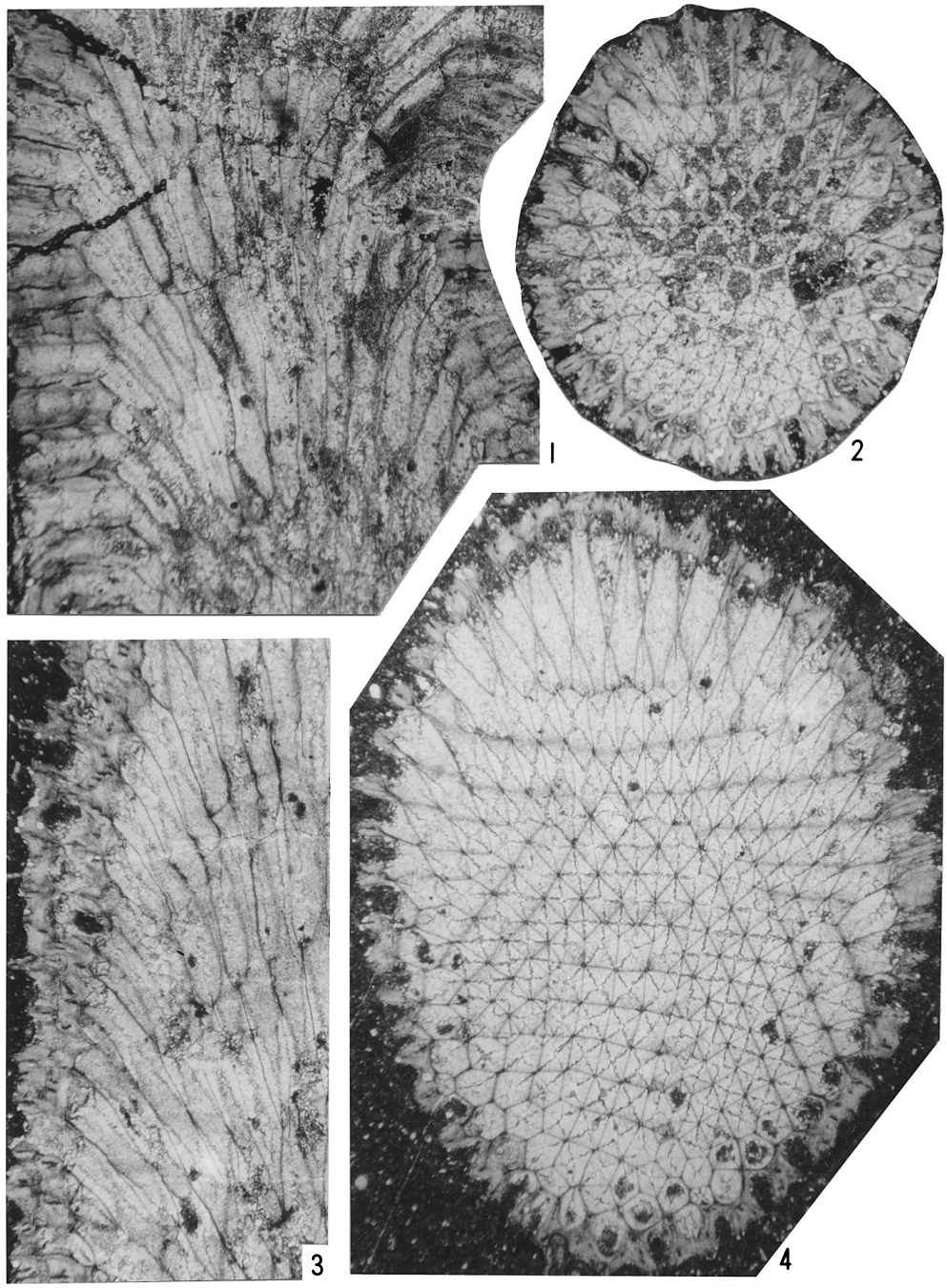

Fig. 9. *Rhombotrypella* (All are in ×20).

1–4. *Rhombotrypella typica* (Bassler), 1, 3. Longitudinal sections, NSM PA-18511 (Qu12) and NSM PA-18762 (Qu34), 2, 4. Transverse sections, NSM PA-18718 (Qu32) and NSM PA-18760 (Qu34).

9–12.

non *Rhomboporella typica* Bassler, Shulga-Nesterenko, 1955, p. 98, pl. 13, figs. 7–9, text-fig. 8a.

Rhombotrypella typica (Bassler). Sakagami, 1995a, p. 252–254, figs. 15-5, 6; 16-1–4.

Material. NSM PA-18505a, b, 18506, 18508 (Qu11); 18510, 19511, 18512, 18513, 18514b, 18515 (Qu12); [18692a, 18693, 18694, 18695 (Qu30); fragmentaries]; 18713, 18714a, 18715, 18716, 18717, 18718, 18719, 18720a, 18736, 18740, 18741, 18742a (Qu32); 18759, 18760, 18761, 18762 (Qu34).

Description. Zoarium ramose, consisting of cylindrical bifurcating branches, usually 3.0 to 5.0 mm diameter, but varies from 2.6 mm in minimum to 5.4 mm in maximum diameter. Diameter of endozone varying 2.0 to 3.5 mm. Width of exozone narrow, usually less than 0.6 mm.

In tangential section, zooecia oval, regularly patterned in longitudinal and diagonal directions. Usually 5 to 6 zooecia per 2 mm longitudinally. Longer and shorter diameters of zooecia range from 0.21 to 0.28 mm and 0.12 to 0.15 mm, respectively. Mesozooecia sporadically present, circular or oval, their shorter diameter from 0.06 to 0.09 mm. Megacanthostyles located at intersections of zooecial walls, composed of concentric fibrous calcite, their outside diameter ranges from 0.10 to 0.13 mm, and inner diameter very small, less than 0.01 mm. Usually 3 to 4 microcanthostyles arranged in a single series between megacanthostyles, their outside diameter about 0.02 mm.

In typical transverse section, zooecial tubes thin walled, regularly arranged, quadrate in central part and encompassed by a rhombic or polygonal pattern in outer part of endozone.

In longitudinal section, zooecial tubes parallel to longitudinal direction in inner part of endozone and rapidly curving outward at right angles at base of exozone. Zooecial walls thin, straight but slightly crenulate, with arcuate rows of monilae in endozone, and showing progressive bifurcations which occur at definite curved levels across zoaria and thickened moniliform composed of finely laminated fibrous tissue in exozone. Two kinds of diaphragms present in exozone of zooecial tube; one is a widely perforated diaphragm at the base and another is a non-perforated, terminal diaphragm near zooecial opening.

Remarks. The present species was described as the type species of the newly established genus *Rhomboporella* by Bassler (1936) from the "Carboniferous" of Chulpapampa, Bolivia, however, this species was commonly distributed in the lower part of *Pseudoschwagerina* zone to upper(?) part of *Eoparafusulina* zone of Permian of the Lake Titicaca region, Bolivia by Sakagami (1995a), and it has never been found in the Carboniferous of the Andean region. This species was described from the Gzelian (Upper Carboniferous) by Shulga-Nesterenko (1955), however, it can be distinguished clearly from the Bolivian species. Boardman and McKinney (1976) pointed out that *Rhomboporella* is a synonym of the genus *Rhombotrypella* Nikiforova (1933).

Order Cryptostomata Vine, 1883

Suborder Rhabdomesina Astrova and Morozova, 1956

Family Rhabdomesidae Vine, 1884

Genus *Rhabdomeson* Young and Young, 1874

Rhabdomeson sp. cf. ***R. simulatum spissum*** Moore, 1929

(Fig. 10-3)

Compared.

Rhabdomeson simulatum var. *spissum* Moore, 1929, p. 143, 144, pl. 17, fig. 22; text figs. 5-3, 3a.

Material. NSM PA-18613 (Qu21); ?18665a, 18666a, 18669a (Qu27); 18714b (Qu32); 18725a (Qu33).

Description. Typical longitudinal and obliquely oriented sections were examined. Zoarium consisting of cylindrical stem, having small diameter, ranging from 0.8 to 0.9 mm and central hollow of about 0.2 to 0.3 mm in diameter. Secondary branch occasionally diverged nearly at right angles from main branch.

In longitudinal section, zooecial tubes arise from wall of axial tubes at an angle of about 20°,

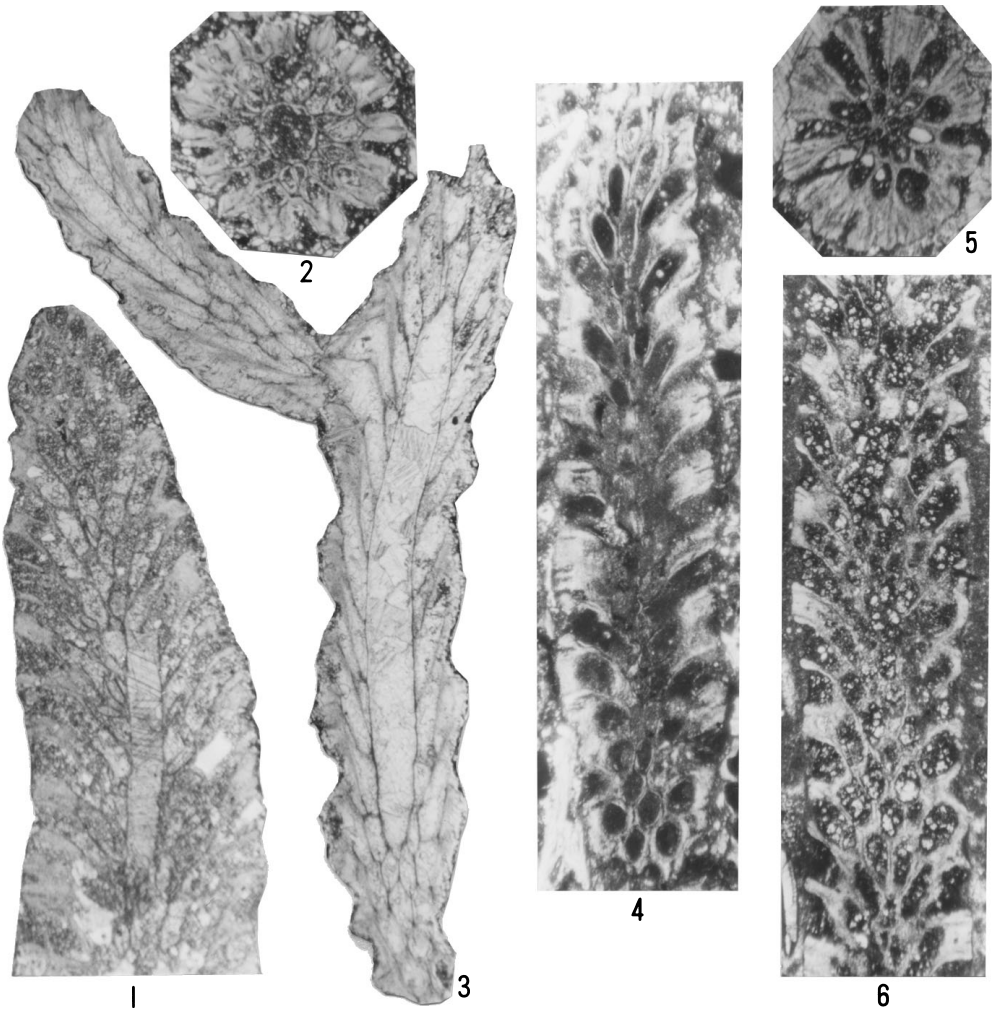

Fig. 10. *Rhabdomeson* and *Rhombopora* (All are in ×20).
1, 2. *Rhabdomeson* sp. indet., 1. Longitudinal section, NSM PA-18712 (Qu32), 2. Transverse section, NSM PA-18698 (Qu31); 3. *Rhabdomeson* sp. cf. *R. simulatum spissum* Moore, NSM PA-18666a (Qu27); 4–6. *Rhombopora lepidodendroides* Meek, 4, 6. Longitudinal sections, NSM PA-18436 (Qu2) and NSM PA-18657 (Qu26), 5. Transverse section, NSM PA-18742b (Qu32).

straight in endozone. Thickness of exozone very short, varying from 0.13 to 0.20 mm. Superior hemiseptum developed at inner edge of exozone, but inferior hemiseptum is obscured. Diaphragm unobservable.

In tangential section of central part of exozone, zooecial tubes elongated oval, shorter diameter ranges from 0.10 to 0.13 mm, probably regularly arranged in longitudinal and diagonal directions. Acanthostyle at each corner of zooecial tube and surrounded by concentric fibers, and paurostyles between acanthostyles but their detailed arrangements and measurements are not determinable.

Remarks. The present form in the essential characters and measurements is assigned to *Rhabdomeson simulatum* var. *spissum* which Moore (1929) described from the upper Graham Formation (Pennsylvanian) of north central Texas (USA).

Rhabdomeson sp. indet.

(Fig. 10-1, 2)

Material. NSM PA-18696, 18698 (Qu31); 18712a, b (Qu32).

Descriptive remarks. One longitudinal and two transverse sections were examined. Zoarium consisting of cylindrical stem, about 1.6 mm in diameter and has central hollow of 0.22 to 0.32 mm in diameter.

In longitudinal section, zooecial tubes arise from wall of axial tubes at angle of about 30° to 40°, straight in endozone and curved outward rapidly at inner edge of exozone. Thickness of exozone about 0.32 mm. Superior hemiseptum not so prominent but developed at inner edge of exozone. Zooecial wall rapidly thickened and consisting of laminated fibers in exozone. Diaphragm lacking.

Arrangement and measurements of acanthostyles and paurostyles are not distinct because of no tangential section at hand. With only fragmentary zoaria, the specific identification is deferred until more specimens are available.

Family Rhomboporidae Simpson, 1895

Genus *Rhombopora* Meek, 1872

Rhombopora lepidodendroides Meek, 1872

(Figs. 10-4–6)

Rhombopora lepidodendroides Meek. Newton, 1971, p. 28, 29, 31–35, pl. 1, figs. 1–6, 11, 12, pl. 2, figs. 1–8, 11, 16 (see the synonym list); Sakagami, 1995b, p. 261, 262, figs. 1-1–6.

Material. NSM PA-18436, 18437a (Qu2); 18461b (Qu4); 18563a (Qu18); 18580a (Qu19); 18593b (Qu20); 18657 (Qu26); 18665b (Qu27); 18689b (Qu29); 18697 (Qu31); 18728a, 18742b (Qu32); 18758 (Qu33).

Description. Zoarium consisting of cylindrical stem, having 1.1 to 1.4 mm in diameter among 13 specimens from 11 horizons.

In longitudinal section, axial region consists of a nearly straight axis and zooecial tubes making a small angle with longitudinal direction in endozone, but rapidly bending outward at posterior end of tubes in exozone. Diameter of endozone ranges from about 0.3 to 0.7 mm.

In tangential section of exozone, zooecial tubes oval, longer diameter ranges from 0.19 to 0.28 mm, shorter diameter ranges from 0.11 to 0.15 mm; arranged regularly longitudinally and diagonally, usually 3 zooecia per 2 mm longitudinally. Zooecial wall thin in endozone, but rapidly thickened in exozone. Usually one, occasionally two acanthostyles disposed at intersection of zooecial tubes surrounded by concentric fibers; outside diameter about 0.05 to 0.06 mm, and inside diameter very small, less than 0.005 mm. One row of two or three paurostyles between acanthostyles; outside diameter 0.02 to 0.03 mm and inside diameter is not measurable because they are too small.

In transverse section of zoarium, zooecial tubes straight and arising from central axis.

Remarks. The present form is identical with *Rhombopora lepidodendroides* which was widely known to be distribute in the Copacabana Group of the Lake Titicaca region, Bolivia by Sakagami (1995b) in all essential characters and measurements.

As Sakagami (1995b) noted, Newton (1971) discussed in detail *Rhombopora lepidodendroioides* which was abundantly occurred from the Wreford Megacyclothem (Wolfcampian, Permian) and he redefined the geological range of this species to the Virgilian (Late Pennsylvanian) through Wreford (Early Permian) time at least in the Mid-Continent region of USA. According to Newton (1971), the total stratigraphic range of this species is from the oldest, Morrowan to Atokan (Early Pennsylvanian) to the youngest, Guadalupian (Late Permian).

Rhombopora sp. cf. ***R. corticata*** Moore, 1929

(Figs. 11-1, 2)

Compared.

Rhombopora corticata Moore, 1929, p. 137, pl. 17, figs. 3, 4, text figs. 4i, j; Sakagami, 1995b, p. 262, figs. 1–7, 8; 2-1, 2.

Material. NSM PA-18565, 18566, 18567, 18568, 18569, 18570, 18571, 18572, 18573, 18574 (Qu18); 18575b, 18578, 18582b, 18583, 18584, 18585b (Qu19); 18656a (Qu26); 18667 (Qu27); 18689c, 18691b (Qu29).

Description. Zoarium consisting of nearly straight, cylindrical stem, varying from 1.6 to 3.2 mm in diameter as measured on 20 specimens mentioned above. Secondary branches occasionally diverge at 80° to 90° from main branch.

In longitudinal section, axial region has irregularly linear axis and straight zooecial tubes, making about 45° with longitudinal direction in endozone, bending rather rapidly outward at posterior end of tubes in exozone. Zooecial tubes in exozone straight and extending to outer surface of zoarium at an angle of about 90°. Diameter of endozone ranging from 0.8 to 1.3 mm. Thickness of exozone varies from 0.5 to 1.0 mm. Usually two diaphragms are present; one disposed at inner edge of exozone and another is near aperture of zooecial tube.

In tangential section of exozone, zooecial tubes oval; longer diameter ranges from 0.26 to 0.31 mm, shorter diameter ranges from 0.14 to 0.20 mm, regularly arranged in longitudinal and diagonal directions; 3 to 3.5 zooecia per 2 mm longitudinally and 5.5 to 6 per 2 mm diagonally. Zooecial wall thin in endozone, but sharply thickened in exozone. Usually one, occasionally 2 acanthostyles at each corner of zooecial tube and surrounded by concentric dark fibers; outside diameter ranges from 0.06 to 0.08 mm. One row of paurostyles between acanthostyles, relatively regular in size, less than 0.04 mm. Inner diameters of acanthostyles and paurostyles very small, and not measurable.

Remarks. The present form is abundantly found in Qu18. It may be identical with *Rhombopora corticata* which was originally described by Moore (1929) from the Upper Graham Formation (Pennsylvanian) in north central Texas (USA), and is also the same species described by Sakagami (1995b) from the *Pseudoschwagerina* zone in the Lake Titicaca region of Bolivia.

This species can be distinguished from *R. lepidodendroides* by the larger diameters in zoarium and zooecial tube and it differs also in the arrangements of acanthostyles and paurostyles.

Family Hyphasmoporidae Vine, 1886

Genus *Streblascopora* Bassler, 1952

Streblascopora sp. cf. ***S. biserialis*** (Bassler, 1929)

(Fig. 11-3)

Compared.

Streblotrypa biserialis Bassler, 1929, p. 68, pl. CCXXXIX (15), fig. 3; Morozova, 1970, p. 153, pl. XXVIII, fig. 3.

Streblotrypa sp. indet., Sakagami, 1995b, p. 262, 263, figs. 1-9, 10.

Material. NSM PA-18593c, 18594, 18595, 18596 (Qu20); 18668a, b (Qu27); 18714c (Qu32).

Description. Zoarium consisting of slender, straight or gently curved cylindrical stem, rarely bifurcated, 0.6 to 0.8 mm in diameter.

In longitudinal section, diameter of central bundle 0.13 to 0.16 mm; number of tubes in central bundle 2 to 3. Ratio of zoarial diameter to central bundle ranging from 4.5 : 1 to 5 : 1. Zooecial tubes arise from central bundle at an angle of about 20°, straight in endozone and curving rapidly at inner edge of exozone. Thickness of exozone ranging from 0.13 to 0.20 mm. Metapores arise from base of exozone, approximately parallel to endozone wall for a very short distance, then curving rapidly outward and parallel to zooecial tubes in exozone.

In tangential section, zooecial tubes oval, longer and shorter diameters about 0.18 mm and 0.12 mm, respectively. Zooecial apertures arranged regularly in longitudinal and diagonal series. Superior and inferior hemisepta unobservable. Metapores circular or polygonal with rounded corners, usually two rows with 4 to 5 in each longitudinal row with one metapore disposed at proximal end of zooecial tube. 9 to 11 metapores between zooecial tubes in one series. Diaphragm unobservable.

In transverse section, number of tubes in cen-

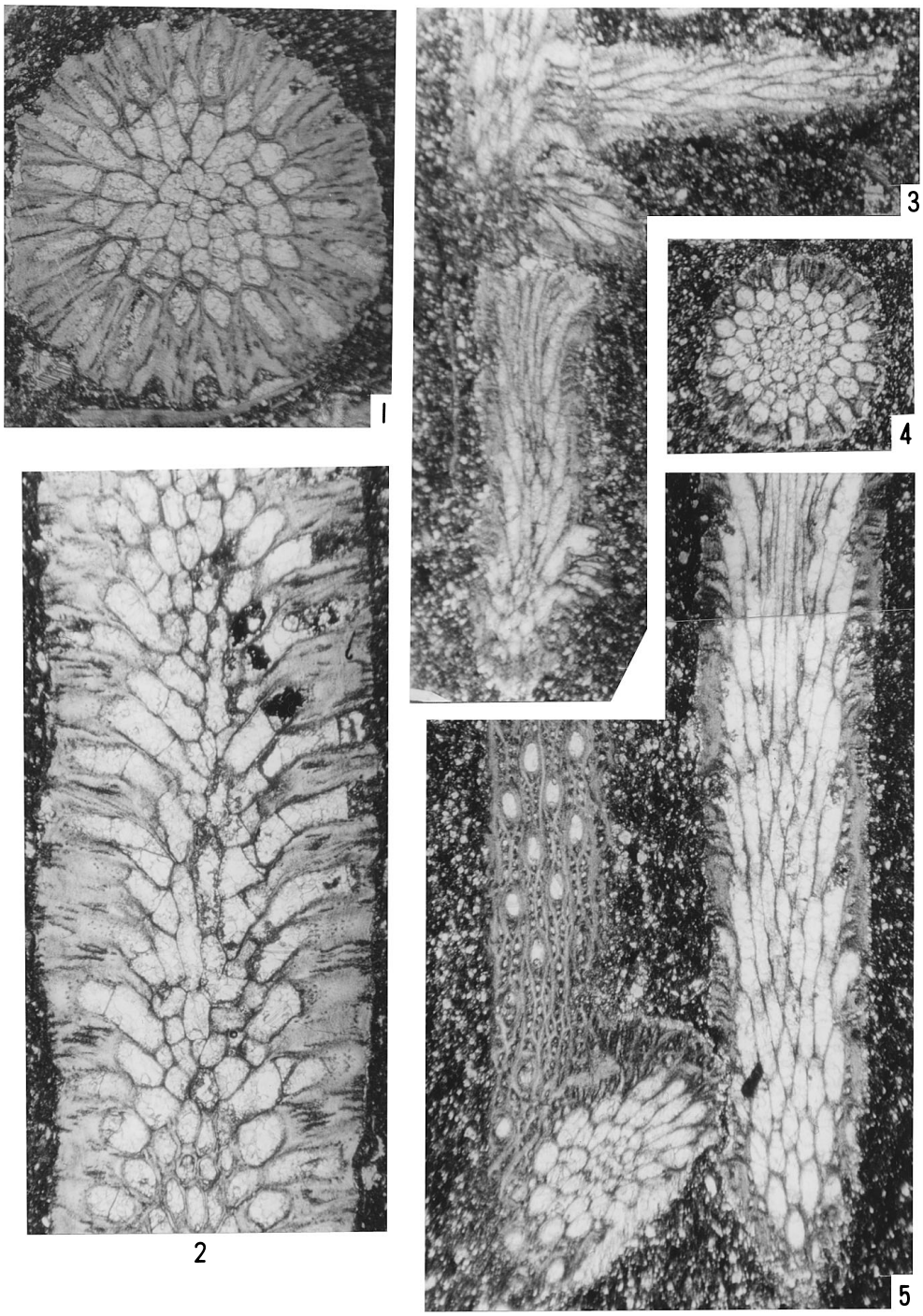

Fig. 11. *Rhombopora* and *Streblascopora* (All are in ×20).

1, 2. *Rhombopora* sp. cf. *R. corticata* Moore, 1. Transverse section, NSM PA-18565 (Qu18), 2. Longitudinal section, NSM PA-18569 (Qu18); 3. *Streblascopora* sp. cf. *S. biserialis* (Bassler), Longitudinal section, NSM PA-18668a (Qu27); 4, 5. *Streblascopora exillis* Sakagami, 4. Typical transverse section, NSM PA-18680 (Qu27), 5. Longitudinal and tangential sections, NSM PA-8678a.

tral bundle could not be counted exactly but may be less than 10. The other characters observed in transverse section are the same as in longitudinal section.

Remarks. The present form resembles *Streblascopora biserialis* (Bassler, 1929) which was originally from the Permian of Timor and later from the Upper Permian (Guadalupian) of Primorsk and Khabarovsk krays of Siberia (Russia) by Morozova (1970), especially in the slender branch. However, no detailed comparison could be made because there is no description and illustration on the internal structures of zoaria in the type specimen from Timor.

The present form may be identical with *Streblotrypa* sp. indet. described by Sakagami (1995b) from the upper part of *Pseudoschwagerina* zone of Yaurichambi, Bolivia, which was an indeterminable species because of poorly oriented thin sections of fragmentary zoaria.

Streblascopora exillis Sakagami, 1970

(Figs. 11-4, 5)

Streblascopora exillis Sakagami, 1970, p. 64, 65, pl. 12, figs. 4–8; Sakagami and Pillevuit, 1997, p. 212, figs. 5-2–4.

Material. NSM PA-18675, 18676, 18677, 18678, 18679, 18680, 18681, 18682 (Qu27).

Description. Zoarium consisting of straight or gently curved, cylindrical stem, rarely bifurcated, usually 1.0 to 1.3 mm in diameter.

In longitudinal section, diameter of central bundle 0.3 to 0.4 mm, ratio of zoarial diameter to central bundle ranging from 3.0 : 1 to 3.5 : 1, and number of tubes in central bundle in typical longitudinal section 4 to 5. Zooecial tubes arise from central bundle at an angle of about 20°, straight in endozone and curving rapidly outward at inner edge of exozone. Thickness of exozone ranging from 0.13 to 0.20 mm. Metapores arise from base of exozone, approximately parallel to endozone wall for a very short distance, then curving rapidly outward and parallel to zooecial tubes in exozone.

In tangential section of exozone, zooecial tubes oval, longer diameter 0.17 to 0.21 mm and shorter diameter 0.10 to 0.13 mm. Zooecial apertures arranged regularly in longitudinal and diagonal rows. Number of zooecia about 3.5 per 2 mm measuring lengthwise. Superior hemiseptum present but not prominent and inferior hemiseptum disposed at middle part of endozonal zooecial tube. Metapores irregular in shape and size, shorter diameter ranging from 0.016 to 0.025 mm, usually two rows with four in each longitudinal row with one metapore disposed at proximal end of zooecial tube. Total number of metapores disposed between zooecial tubes in one series usually 9. One straight, complete diaphragm disposed at zooecial opening.

In transverse section, number of tubes in central bundle counted as usually about 20, but about 10 in smallest zoarium.

Remarks. The present form is identical in all essential characters and measurements with *Streblascopora exillis* which was originally described from the Permian of Thailand by Sakagami (1970). The original specimens coming from Thailand have been considered to be most probably late Artinskian in age. This species has been known also from the Murgabian of Oman by Sakagami and Pillevuit (1997). The present form occurs exclusively only in the Qu27.

Order Fenestrata Elias and Condra, 1957

Family Fenestellidae King, 1849

Genus *Minilya* Crockford, 1944

Minilya sp. cf. ***M. geminanoda*** (Moore, 1930)

(Fig. 12-1)

Compared.
Fenestella geminanoda Moore, 1930, p. 150, 151, pl. 26, figs. 5, 6.

Material. NSM PA-18446 (Qu2); 18559a (Qu18).

Description. Zoarium consists of straight parallel branches connected by dissepiments at regular intervals. Bifurcation of branches are indistinct. Branch width ranges from 0.32 to 0.39 mm; 17 to 19 per 10 mm horizontally. Fen-

estrules oval in outline, narrower than that of branches; ranges from 0.13 to 0.26 mm (0.13 to 0.19 mm in the specimen from Qu2 and 0.23 to 0.26 mm in the specimen from Qu18), length 0.26 to 0.32 mm; about 15 fenestrules per 10 mm branch length. Dissepiments rather thick, width ranges from 0.26 to 0.28 mm. Zooecial tubes arranged in weakly alternating longitudinal series, kidney-shaped at middle level of branch, curved outward and circular at upper level, ranging from 0.10 to 0.12 mm in diameter. Intervals between zooecial apertures from center to center range from 0.26 to 0.30 mm. Zooecial apertures about 15 per 5 mm length of one range, usually consistently spaced in relation to dissepiment, 2 apertures per fenestrule. Two rows of zigzag nodes well developed on broad carina. Nodes about 0.05 to 0.06 mm in outside diameter, and spaced at same interval as apertures, namely one node to each zooecial aperture. Total number of nodes about 30 per 5 mm of branch length. Stereom covering reverse side of branch and consisting of inner semitransparent layer of colonial plexus with 2 to 3 capillary canals and outer sclerenchyma of dark fibers with coarse pores and granules.

Meshwork formula. 17–19/ca. 15//ca. 15/ca. 30* (*17–19: branches in 10 mm of zoarial width; ca. 15: fenestrules in 10 mm zoarial length; ca. 15: zooecia in 5 mm of branch length; ca. 30: nodes in 5 mm of branch length).

Remarks. The present form is nearest in the essential characters and measurements to *Fenestella geminanoda* Moore (1929) which was described from the Graham Formation in Texas (USA), and also resembles *F. plummerae* Moore (1930) which was described from the same formation in Texas (USA). However, detailed comparisons with these two Texas species are impossible because they were identified only by surface features instead of the present form by only thin sections.

The present form is also not unlike *Minilya binodata* (Condra) which was described by Sakagami (1995b) from the lower part of *Pseudoschwagerina* zone at Yaurichambi in Bolivia, however, the number of zooecial apertures per fenestrule is 2 in the present form but 3 in the Bolivian specimens.

Genus Alternifenestella Termier and Termier, 1971

Alternifenestella cervoides (Chronic, 1949)

(Figure 12-2)

Cervella cervoides Chronic in Newell *et al.*, 1949, p. 124; Chronic in Newell *et al.*, 1953, p. 118–119, p. 23, figs. 3a7; Sakagami, 1995b, p. 299, fig. 3-1.

Material. NSM PA-18563b (Qu18); 18585b, 18588a (Qu19); 18595 (Qu20); 18692b (Qu30); 18720b, 18724 (Qu32).

Description. Zoarium consists of straight parallel branches connected by dissepiments at regular intervals. Branches bifurcate at long intervals. Branch width ranges from 0.23 to 0.26 mm; 21 to 24 branches per 10 mm horizontally. Fenestrules quadrate with rounded corners, narrower than width of branch, ranging from 0.13 to 0.28 mm, length ranging from 0.26 to 0.51 mm; 18 to 20 fenestrules per 10 mm branch length. Width of dissepiment ranges from 0.12 to 0.19 mm. Zooecial tubes arranged in alternately intersecting longitudinal series, usually trigonal at middle level of branch, curved outward and circular at upper level of branch; diameter ranges from 0.08 to 0.10 mm. Intervals between zooecial apertures from center to center range from 0.28 to 0.32 mm. Zooecial apertures 18 to 20 per 5 mm longitudinally, usually consistent in position in relation to dissepiments; 2 apertures per fenestrule. Nodes arranged regularly in one row on straight carina, its outside diameter ranging from 0.05 to 0.07 mm; spaced at the same interval as apertures, namely 18 to 20 nodes per 5 mm of branch length. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus and outer sclerenchyma of darker fibers with well developed spicules.

Meshwork formula. 21–24/18–20//18–20/18–20.

Remarks. The present form may be identical

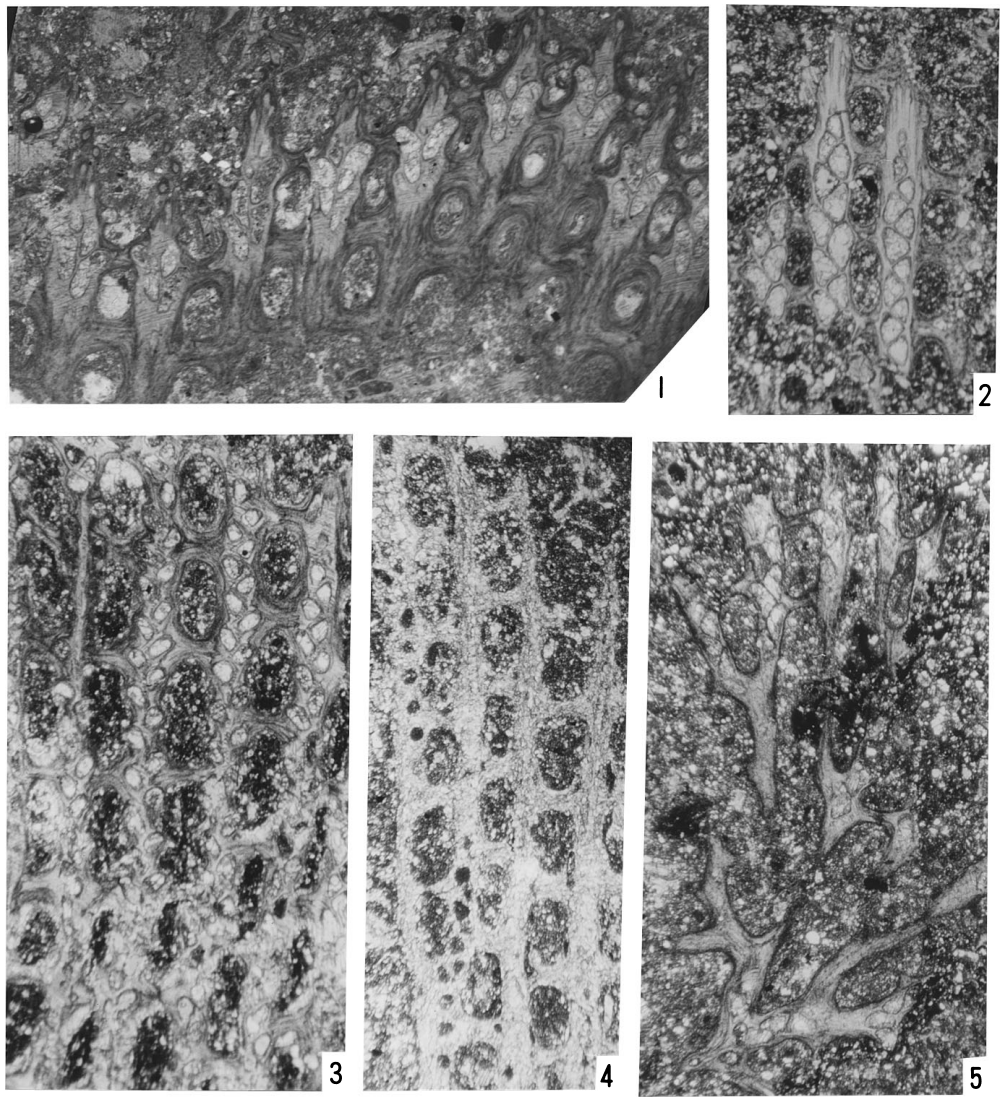

Fig. 12. *Minilya* and *Alternifenestella* (Tangential sections, all are in ×20).
1. *Minilya* sp. cf. *M. geminanoda* (Moore), NSM PA-18446 (Qu2); 2. *Alternifenestella cervoides* (Chronic), NSM PA-18585b (Qu19); 3. *Alternifenestella picchuensis* (Chronic), NSM PA-18669b (Qu27); 4. *Alternifenestella* sp. cf. *A. pajerensis* (Chronic), NSM PA-18648 (Qu24); 5. *Alternifenestella*? sp. indet., NSM PA-18749c (Qu33).

with *Alternifenestella cervoides* (Chronic, in Newell, *et al.*, 1949, 1953) which was originally described as the type species of a new genus *Cervella* from the *Silvaseptopora* zone of the Copacabana Group (Lower Permian) in the Pasaje-Picchu route which is not far from the present location. This species was also described by Sakagami (1995b) from the middle part of *Pseudoschwagerina* zone at Cuyavi and Yampupata, the Lake Titicaca region of Bolivia.

Alternifenestella picchuensis (Chronic, 1949)

(Fig. 12-3)

Fenestrellina picchuensis Chronic in Newell *et al*., 1949, p. 121; Chronic in Newell *et al*., 1953, p. 115, 116, pl. 22, figs. 4–5b.

Material. NSM PA-18662, 18663, 18664, 18665c, 18669b, 18671, 18672a (Qu27).

Description. Zoarium consisting of straight parallel branches connected by dissepiments at regular intervals. Branches rarely bifurcate at long intervals. Branch width ranging from 0.26 to 0.32 mm; 18 to 21 branches per 10 mm horizontally. Fenestrules quadrate with rounded corners, almost as wide as that of branch, width ranging from 0.26 to 0.32 mm, length ranging from 0.38 to 0.58 mm; 12 to 16 fenestrules per 10 mm of branch length. Dissepiments may be less than 0.13 mm. Zooecial tubes arranged in strongly alternating longitudinal series and usually triangular at middle level of branch, curved outward and circular at upper level of branch, 0.09 to 0.10 mm in diameter. Distance between zooecial apertures from center to center ranging from 0.20 to 0.26 mm; 18 to 24 zooecia per 5 mm longitudinally per range, usually consistent in position in relation to dissepiments, usually 3 but occasionally 3.5 apertures per fenestrule. Well developed nodes arranged regularly in one row on straight carina, about 0.08 mm in outside diameter; spaced at about the same interval as apertures, namely 18 to 24 per 5 mm of branch length. Stereom covers reverse side of branch, consists of semitransparent layer of colonial plexus with 2 to 3 capillary canals and outer sclerenchyma of darker fibers with very small granules.

Meshwork formula. 18–21/12–16//18–24/18–24?

Remarks. The present species was described originally from the Pennsylvanian? Tarma Group to Lower Permian Copacabana Group in Pasaje-Picchu route of Peru by Chronic (in Newell *et al.*, 1949, 1953). The present form can be identified with the type specimen in the principal measurements and other all essential characters, but the detailed comparison with the inner skeletal structures between them cannot be made.

Alternifenestella sp. cf. ***A. pajerensis*** (Chronic, 1949)

(Fig. 12-4)

Compared.

Fenestrellina pajerensis Chronic in Newell *et al.*, 1949, p. 123; Chronic in Newell *et al.*, 1953, p. 116, 117, pl. 22, figs. 1, 2.

Alternifenestella sp. aff. *A. pajerensis* (Chronic), Sakagami, 1995b, p. 265, 266, figs. 3–6.

Material. NSM PA-18643, 18644, 18648 (Qu24).

Description. Three thin sections from Qu24 are secondarily mineralized.

Zoarium consists of straight parallel branches connected regularly by dissepiments spaced at regular intervals. Branches bifurcate at very long intervals and not bifurcating points observed on 15 mm branch. Branch almost as wide as that of fenestrule, ranging from 0.23 to 0.26 mm; 24 branches per 10 mm horizontally. Fenestrules quadrate with rounded corners, width ranging from 0.19 to 0.26 mm, length ranging from 0.38 to 0.51 mm; 17 to 19 fenestrules per 10 mm length of branch. Width of dissepiment narrow, ranging from 0.13 to 0.15 mm. Zooecial tubes arranged in alternating longitudinal series; usually trigonal at middle level of branch, curved outward and circular at upper level of branch. Zooecial tubes near surface circular in tangential section, ranging from 0.09 to 0.10 mm in diameter. Distance between zooecial apertures from center to center ranges from 0.26 to 0.28 mm; about 28 zooecia per 5 mm longitudinally, usually 3 apertures per fenestrule. Nodes may be developed in straight carina but indistinct by secondary mineralization. Structure of stereom is also obliterated.

Meshwork formula. 24/17–19//28?/?

Remarks. The present form may be identical with *Fenestrellina pajerensis* which was originally described from the Copacabana Group in Huanta, Peru by Chronic (in Newell *et al.*, 1949, 1953) and later from the middle part of the *Trit-*

icites zone and the lower part of *Pseudoschwagerina* zone at the Lake Titicaca region, Bolivia by Sakagami (1995b).

The detailed comparison with the type, only a surface specimen by Chronic, however, cannot be made because the skeletal microstructures of present specimens are obliterated by secondary mineralization.

Alternifenestella? sp. indet.

(Fig. 12-5)

Material. NSM PA-18749c (Qu33).

Description. A single tangential section was examined. Zoarium fan-shaped, consists of straight, nearly parallel branches connected by dissepiments at regular intervals. Branches bifurcate frequently, width usually narrower than that of fenestrule, ranging from 0.15 to 0.20 mm (just before branching: 0.26 mm). Fenestrules elongate, oval to elliptical in outline, width ranging from 0.20 to 0.26 mm. Dissepiments probably thin and narrow, width 0.08 to 0.09 mm.

Zooecial tubes arranged in strongly alternating longitudinal series and trigonal at middle level of branch, curved outward and becoming parallel to tangential direction of zoarium in upper level. Zooecial tubes near surface circular in tangential section, ranging from 0.08 to 0.09 mm in diameter, consistent pattern of apertures in relation to dissepiment; 2 apertures per fenestrule. Nodes apparently present, about 0.04 mm in outside diameter, but indistinct arrangement. Stereom covering reverse side of branch consisting of darker fibers. Less than 10 small capillaries, about 0.005 mm in diameter, surrounded zooecial tubes near surface.

Meshwork formula. Indistinct.

Remarks. The present form can be easily distinguished from the other species of fenestellid bryozoans described in this article in the essential characters, especially in the zoarial form. However, comparison with previously described species is not possible because of only one fragmentary specimen.

Genus *Fabifenestella* Morozova, 1974

Fabifenestella abancaya Sakagami, n. sp.

(Fig. 13-1, 2)

Material. NSM PA-?18558 (Qu18), 18666b, 18668c, 18672b (holotype), 18673 (Qu27).

Description. Zoarium consists of straight parallel branches connected regularly by dissepiments spaced at long regular intervals. Branches bifurcate at long intervals. Branch usually as wide as that of fenestrule, ranging from 0.38 to 0.45 mm; 14 to 15 branches per 10 mm horizontally. Fenestrules elongate, quadrate with rounded corners; width ranging from 0.38 to 0.45 mm, length ranging from 0.80 to 0.90 mm, 9 to 10 fenestrules per 10 mm of branch length. Dissepiments relatively narrow, about 0.32 mm in width. Zooecial tubes arranged in alternating longitudinal series, usually quadrilateral or deformed pentagonal at lower to middle levels of branch, and circular in tangential section near surface, about 0.13 mm in diameter. Zooecial apertures 18 to 20 per 5 mm longitudinally per range, generally consistent spacing of apertures in relation to dissepiment, usually 4 apertures per fenestrule. Carina not prominent and node present but indistinct in arrangement. Stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus with some capillary canals and outer sclerenchyma of dark fibers with well developed fine granules.

Meshwork formula. 14–15/9–10//18–20/?

Remarks. This new species is nearest to *Fenestella spinulifera* Moore (1929) from the Upper Graham Formation, Pennsylvanian of north central Texas (USA) in the essential characters but is slightly different in meshwork formula: 12–13/12–16//22–24 in *F. spinulifera*, and also to *Fenestella huascatayana* Chronic (in Newell, *et al.*, 1949, 1953) from the Copacabana Group in Pasaje Picchu of Peru in the general appearances except for the number of zooecial apertures per fenestrule: 4 instead of 5 in *F. huascatayana*. The detailed comparisons with these two species, however, cannot be made, because *F. huas-*

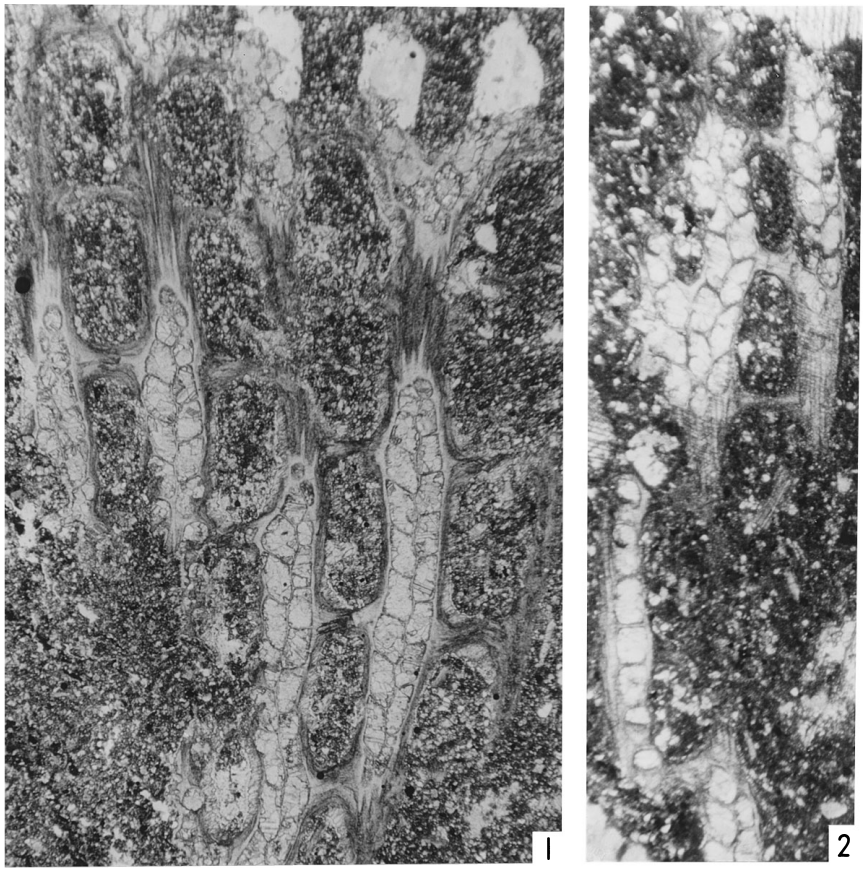

Fig. 13. *Fabifenestella* (Tangential sections, all are in ×20).
1. *Fabifenestella abancaya* Sakagami, n. sp., Holotype, NSM PA-18672b (Qu27); 2. Questionably referred to *F. abancaya*, n. sp., NSM PA-18558 (Qu18).

catayana is only known from surface features.

One specimen from Qu18 (no. NAM PA 18558) is questionably referred to this species because it agrees in all principal characters and measurements, but the number of zooecial apertures per fenestrules is 3 instead of 4 in the specimens from Qu27.

Genus *Polypora* McCoy, 1844

Polypora sp. cf. ***P. elliptica*** Rogers, 1900

(Fig. 14-1, 2)

Compared.

Polypora elliptica Rogers, 1900, p. 7, 8, pl. 4, fig. 2; Condra, 1903, p. 69, pl. 11, figs. 4–11, pl. 12, figs. 113, pl. 16, fig. 3; Moore, 1929, p. 23, 24, pl. 3, figs. 7, 8, 20; Sakagami, 1995b, p. 270, figs. 4-4, 5-1.

Polypora elliptica (s.s.) Rogers, Elias, 1937, p. 327, 328, fig. 3m.

Material. NSM PA-?18430 (Qu1); 18555 (Qu17); 18575c, 18588b (Qu19); 18598, 18606b (Qu21); ?18647 (Qu24).

Description. Zoarium consists of straight or nearly straight, parallel branches connected regularly by dissepiments spaced at regular intervals. Branches bifurcate at long intervals. Width of branch wider than that of fenestrule, ranging from 0.42 to 0.58 mm, before bifurcation: 0.80 mm, after bifurcation: 0.40 mm; 14 to 16 branches per 10 mm horizontally. Fenestrules oval in outline, width ranging from 0.26 to 0.38 mm; length ranging from 0.58 to 0.96 mm; 8

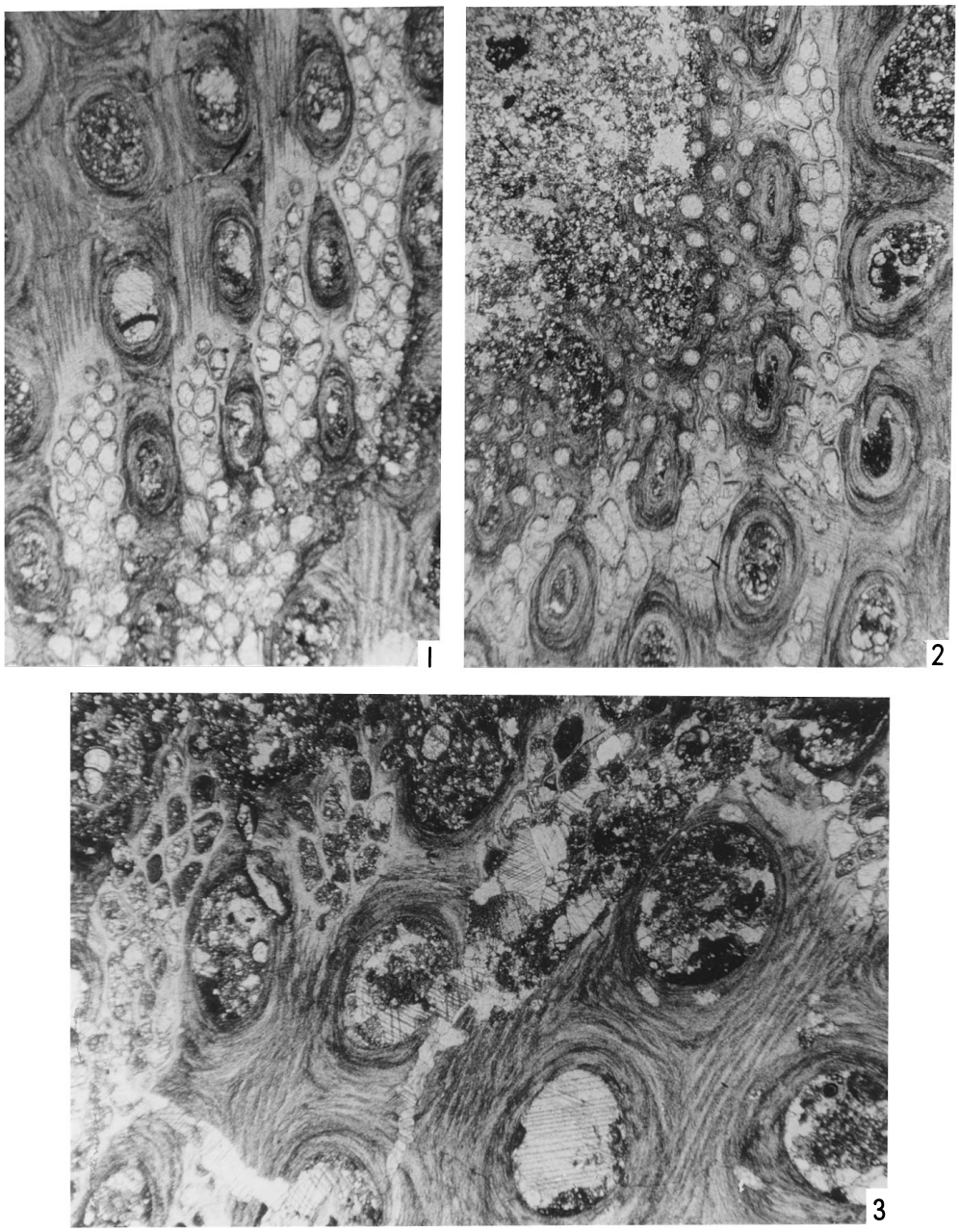

Fig. 14. *Polypora* (Tangential sections, all are in ×20).
1, 2. *Polypora* sp. cf. *P. elliptica* Rogers, NSM PA-18598 (Qu21) and NSM PA-18606 (Qu21); 3. *Polypora* sp. cf. *P. cyclopora* Eichwald, NSM PA-18597a (Qu21).

to 9 per 10 mm of branch length. Dissepiments broad, width ranging from 0.48 to 0.64 mm. Zooecial tubes in limited alternating longitudinal series, usually 3 rows, but before bifurcation 4 rows and just after 2 rows; elongate quadrate or elongate hexagonal at lower to middle levels of branch.

Number of zooecial apertures ranging from 16 to 18 per 5 mm length of one range, usually 4 apertures per fenestrule. Interspace between

zooecial apertures from center to center ranging from 0.26 to 0.32 mm longitudinally. Nodes disposed at about same interval as one longitudinal row of zooecial tubes. Stereom covering reverse side of branch consists of semitransparent layer of colonial plexus with some prominent capillary canals and outer sclerenchyma of darker fibers with well developed fine granules.

Meshwork formula. 14–16/8–9//16–18/3(2–49* (*14–16: branches in 10 mm of zoarial width; 8–9: fenestrules in 10 mm of zoarial length; 16–18: zooecia in 5 mm of branch length; 3(2–4): rows of zooecia).

Remarks. The present form seems to be nearest to *Polypora elliptica* (s.s.) Rogers which Elias (1937) described as one of the *Polypora elliptica* Group. *Polypora elliptica* (s.l.) has been known from the Missourian to Virgilian of the Pennsylvanian in Kansas by Elias (1937). This species was also described from the lower to middle parts of *Eoparafusulina* zone at Yaurichambi in Bolivia by Sakagami (1995b).

Polypora andiana Chronic, 1949

(Fig. 15-1)

Polypora andiana Chronic, in Newell *et al.,* 1949, p. 128; Chronic in Newell *et al*., 1953, p. 122, 123, pl. 25, figs. 1a–2.

Material. NSM PA-18580b (Qu19); 18605, 18607 (Qu21).

Description. Zoarium fan-shaped, consists of straight or gently curved, robust branches connected by dissepiments at regular intervals. Branches bifurcate frequently, 0.96 to 1.28 mm in width; 5 to 6 branches per 10 mm horizontally. Fenestrules elongate, oval to elliptical in outline; width varying from 0.64 to 1.28 mm; length ranging from 1.28 to 2.56 mm; about 4 per 10 mm length of branch. Width of dissepiments robust, ranging from 0.64 to 0.77 mm. Zooecial tubes arranged in strongly alternating longitudinal series, usually rhomboidal at middle level of branch, usually 7 rows on each branch; about 14 per 5 mm length of one range. Diameter of zooecial tube near surface ranging from 0.12 to 0.13 mm and distance between zooecial apertures from center to center 0.26 to 0.32 mm longitudinally. Thick stereom covering reverse side of branch consists of inner semitransparent layer of colonial plexus with many capillary canals and thick outer sclerenchyma of dark coarser fibers with fine granules.

Meshwork formula. 5–6/ca. 4//14/7.

Remarks. The present form is identical with *Polypora andiana* which Chronic (in Newell *et al.*, 1949, 1953) described from the Copacabana Group (Lower Permian) of Peru in all essential characters and measurements.

As mentioned by Chronic (1953, p. 123), the present species is similar to some species of *Polypora* from the North American Mid-Continent, and is especially nearest to *Polypora rudis* which Moore (1930) described from the Upper Pennsylvanian Graham Formation of Texas (USA).

Polypora sp. cf. ***P. cyclopora*** Eichwald, 1860

(Fig. 14-3)

Compared.

Polypora cyclopora Eichwald, 1860, p. 375, pl. 30, fig. 1; Stuckenberg, 1895, p. 156, pl. 12, fig. 4; Nikiforova, 1938, p. 140–142, 250, pl. 33, figs. 1–6, pl. 34, figs. 1, 2; Shulga-Nesterenko, 1941, p. 161, 1642, pl. 44, figs. 1–3, text-figs. 125, 126; Sakagami, 1995b, p. 272, figs. 5-5, 6-1.

Material. NSM PA-?18589b (Qu20); 18597a (Qu21).

Description. Zoarium consists of straight, nearly parallel branches connected by dissepiments at regular intervals. Branches bifurcate infrequently. Branch width almost as wide as or slightly wider than that of fenestrule, ranging from 0.74 to 1.04 mm; 7 branches per 10 mm horizontally. Fenestrules oval in outline, width ranging from 0.70 to 0.96 mm; length from 0.96 to 1.28 mm, usually 6 per 10 mm of branch length. Dissepiments broad, width varying from 0.64 to 1.22 mm. Zooecial tubes arranged in strongly alternating longitudinal series, usually 5 to 6 rows on each branch, rhomboidal at middle

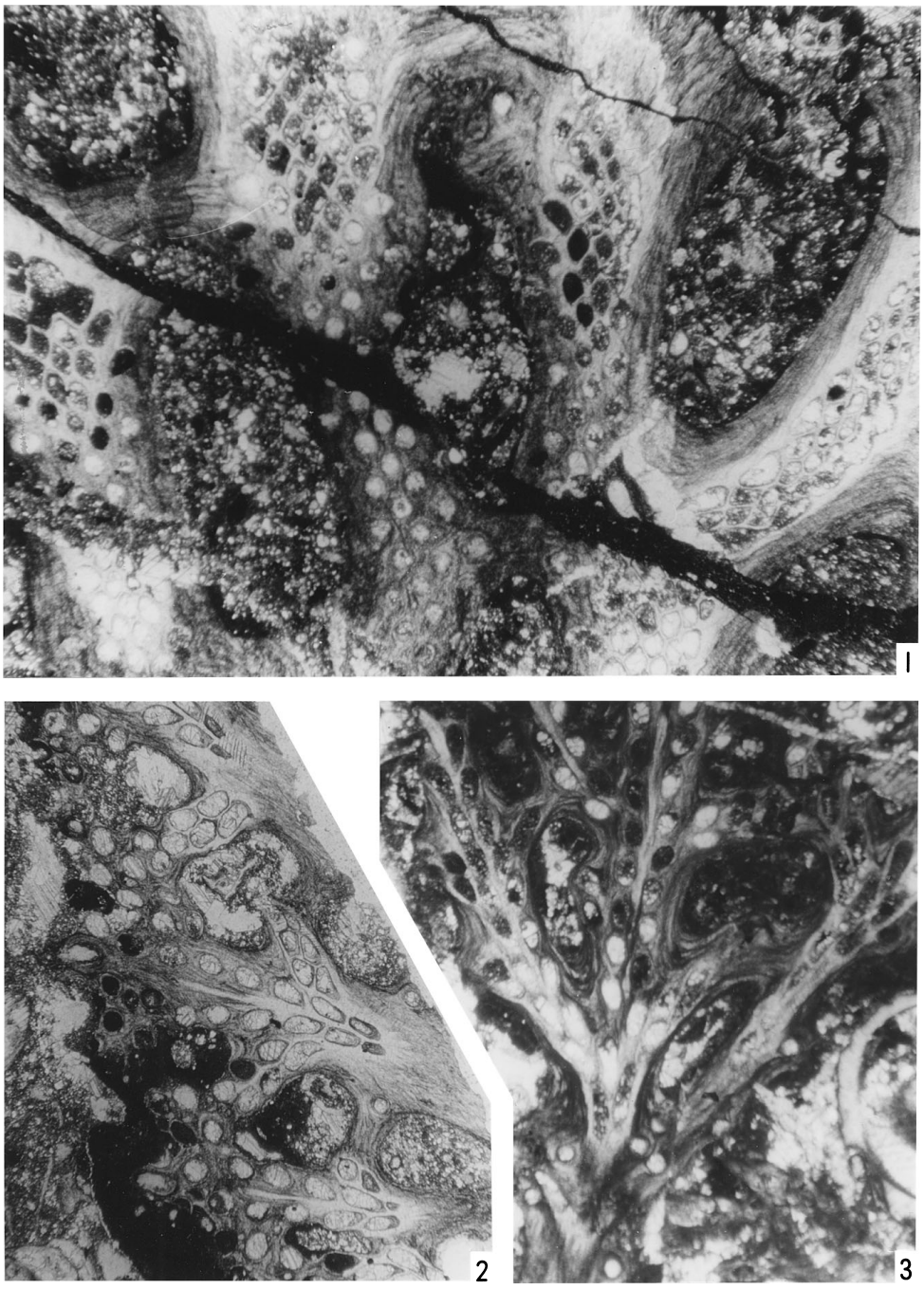

Fig. 15. *Polypora* and *Septopora* (Tangential sections, all are in ×20).
1. *Polypora andiana* (Chronic), NSM PA-18605 (Qu21); 2. *Septopora incaica* (Chronic), NSM PA-18439a (Qu2); 3. *Septopora* sp. indet., NSM PA-18597b (Qu20).

level of branch. Zooecial tubes circular in tangential section near surface, ranging from 0.13 to 0.15 mm in diameter. Number of zooecial apertures about 18 per 5 mm length of one range, probably 5 apertures per fenestrule. Interspaces between zooecial apertures from center to center 0.30 to 0.32 mm longitudinally. Stereom covering reverse side of branch, consisting of inner thin semitransparent layer of colonial plexus with many capillary canals and outer thick darker fibers with very fine granules.

Meshwork formula. 7/6//18/5–6.

Remarks. The present form is identical with *Polypora cyclopora* Eichwald in the essential characters and measurements. This species was reported from some horizons of Lower Permian in European Russia, and also from the Lower Permian (the upper(?) part of *Pseudoschwagerina* zone and lower to middle part of *Eoparafusulina* zone) at the Lake Titicaca region of Bolivia by Sakagami (1995b).

Family Septoporidae Morozova, 1962

Genus *Septopora* Prout, 1859

Septopora incaica (Chronic, 1949)

(Fig. 15-2)

Silvaseptopora incaica Chronic in Newell *et al*., 1949, p. 132; Chronic in Newell *et al*., 1953, p. 125–127, pl. 26, figs. 2–8b.

Septopora incaica (Chronic), Sakagami, 1995b, p. 276, 278, figs. 8-4, 5.

Material. NSM PA-18431 (Qu1), 18439a, 18450 (Qu2), 18592b (Qu20).

Description. Only one thin section of fragmentary specimen was examined. Zoarium fan-shaped, consisting of straight branches connected by dissepiments at regular intervals. Pinnate branches with primary and secondary patterns. Branches ranging from 0.48 to 0.64 mm in width; usually about 8 to 10 branches per 10 mm horizontally. Fenestrules variable in form and size, irregularly polygonal with rounded or somewhat crescentic corners where large in size; width 0.38 to 0.80 mm; probably about 10 fenestrules per 10 mm of branch length. Dissepiments having usually about 10 zooecial apertures in 2, occasionally 3 intersecting rows, ranging from 0.40 to 0.58 mm in width. Zooecial tubes arranged usually in 2 rows on each branch, about 20 per 5 mm length of one range, parallelogram or elongated quadrate in shape at lower to middle levels of branch because of no intercalated zooecial tubes in longitudinal series; usually 4 to 5 zooecia per fenestrules. Diameter of zooecial tubes near surface ranging from 0.11 to 0.14 mm and distance between zooecial apertures from center to center 0.26 to 0.32 mm longitudinally. Nodes in one row on straight carina, but distance between nodes and number of nodes per 5 mm length are indistinct because of fragmentary material.

Meshwork formula. 8–10/prob.10//ca. 20.

Remarks. The present species is characterized by dissepiments having occasionally 3 rows of zooecial apertures. The present form in essential characters and principal measurements is assigned to *Silvaseptopora incaica* which Chronic (in Newell *et al.* 1949, 1953) described originally from the Copacabana Group in Peru. The present species is known also from the lower part of *Eoparafusulina* zone (Lower Permian) of the Lake Titicaca region of Bolivia by Sakagami (1995b).

Septopora sp. indet.

(Fig. 15-3)

Material. NSM PA-18597b (Qu20).

Description. This single zoarium widespread, fan-shaped, consists of nearly straight branches connected by dissepiments at regular intervals. Pinnate branches with primary and secondary patterns. Branches bifurcate frequently and width varies from 0.48 to 0.64 mm. Fenestrules variable in form and size, circular where small in size and irregularly polygonal with rounded corners or crescentic when larger; varying from 0.38 to 0.96 mm, length more than about 0.50 mm. Dissepiments having zooecial tubes, narrower than those of branches, width ranging from 0.42 to 0.48 mm. Zooecial tubes arranged in 2 rows on each main branch, elongated oval in outline at middle level of branch be-

cause of no intercalated zooecial tubes in longitudinal series; probably 4 zooecia per fenestrule. 2 rows of zooecial tubes on each dissepiment but the total numbers on dissepiment are variable. Diameter of zooecial tube near surface 0.10 to 0.13 mm. Distance between zooecial apertures from center to center ranges from 0.26 to 0.32 mm. Nodes in one row on straight carina, but distance between nodes and number of nodes per 5 mm are unknown. Stereom covers reverse side of branch, consists of inner thin semitransparent layer of colonial plexus with capillary canals and outer sclerenchyma of darker coarse fibers with granules.

Meshwork formula. Not determined because of small fragmentary specimen.

Remarks. The present form can be easily distinguished from the preceding species *S. incaica* by the more frequent bifurcation of zoarium and other microscopic measurements. However, because of only one thin section of a fragmentary specimen, detailed comparison with previously described species is not possible.

Acknowledgments

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