236. ON SOME RETICULATE SPIRIFERIDAE*

MASAO MINATO

Department of Geology and Mineralogy, Faculty of Science, Hokkaido University,
Sapporo, Japan.

The subfamily Reticularinae WAAGEN is divided into two groups based on the nature of spine bases which ornament the shell surface: one group with uniramous spine bases, the other with biramous. Several genera are also distinguished in each of these groups based upon the apical structure of shells. Thus the following classification of this subfamily is now presented.

I) With uniramous spine bases.

Without apical plates except delthyrial ridges

Squamularia GEMMELLARO, 1899; Reticularia McCoy 1844; Georgethyris nov. Sinothyris nov.; Phricadothyris G. 1832. Martinothyris nov.; Torynifer Hall and Clarke 1895; Kinkamithyris MINATO 1951; Spirolytha FREDERICKS 1919; Condrathyris nov.; and Nebenothyris nov. are treated in this note.

II) With biramous spine bases.

With dental plates in ventral and dorsal valves...

Phricadothyris G. 1932; Lower Carboniferous to Permian

With dental plates in ventral valve and median septum in the dorsal valve...

Martinothyris MINATO, nov.; Lower Carboniferous

With median septum in each valve...

Nebenothyris MINATO, nov.; Lower Carboniferous to Permian

With dental plates and median septum in ventral valve and median septum in the dorsal valve...

Torynifer CLARKE and HALL, 1895; Lower Carboniferous

With dental plates and median septum in ventral valve but without an apical plate in the dorsal valve...

Kinkamithyris MINATO, 1951; Lower Carboniferous

With pseudospondylium...

Spirolytha FREDERICKS, 1919; Permian

With any apical plates in the ventral valve but with socket plates in the dorsal valve...

Condrathyris MINATO, nov.; Middle Carboniferous

No dental plates and no median septum but with delthyrial ridges.

Genolectotype: Squamularia rotundata GEMMELLARO, 1899

Genus Squamularia GEMMELLARO, 1899

Squamularia GEMMELLARO, 1899; Reticularia McCoy 1844; Georgethyris nov. Sinothyris nov.; Phricadothyris G. 1832; Lower Carboniferous to Permian

Genus Reticularia McCoy, 1844

There are three species which have been regarded as genotypes of this

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genus, which are Anomites lineata, Terebratula imbricata and Reticularia reticulata. According to George, Buckmann considered that Reticularia reticulata, of which the specific name has the same meaning as the generic, must become automatically the genotype by the Rules of Nomenclature. However "reticulata" is said to be not literally the same word of "Reticularia" and the original specimen of R. reticulata McCoy, according to George, was lost, so we are at present unable to clarify the specific distinction of this genus from amongst the original syntypes of McCoy; therefore Reticularia reticulata should not be used as a genotype, until such time as the holotype be found. Then the priority of designation become the next problem. The matter is quite important, because these two types of "lineata" and "imbricata" are not congeneric, as will be stated. According to George, Anomites lineata has quite well developed dental plates, but no median septum, while Terebratula imbricata has median septum besides the dental plates; moreover, he mentioned that plates of the latter are parallel in arrangement toward the floor of the shell, instead of divergent as in the former. Waagen, Fredericks and others supposed Anomites lineata to be a genotype of the genus Reticularia.

However Davidson was the first, so far as the writer has been able to find, who designated unequivocally Terebratula imbricata Sowerby as the type of Reticularia, instead of Anomites lineata McCoy. The same view had also been stated by George formerly.

Thus the genotype is determined: the original description of McCoy well corresponds to the features of specimens designated by George as Reticularia imbricata.

The original description of McCoy runs as follows:

"General character: Hinge line shorter than the width of the shell; cardinal at a triangular; cardinal angles very obtusely rounded; mesial fold very slightly raised or none; surface ornamented with either fine longitudinal or transverse striae, or most usually reticulated by both; dental lamellae perfectly parallel."

"This beautiful little group includes all those spirifers analogous to S. imbricata, S. lineata, S. microgemna, S. reticulata, S. decussata, etc., having a reticulated or striated surface combined with the general form and cardinal area of Martinia McCoy, in which genus I formerly placed them, although they obviously formed a very marked group, distinguishable by its small size, reticulated or striated surface, and very remarkably by the entire absence of the mesial fold in most species (in one or two species which possess a trace of mesial fold, it is very slightly elevated). But the internal structure which I have recently seen in three of the species presents a very distinct and important character: the dental lamellae, instead of converging towards the beak (that is, having diverge plates towards the floor of the shell) as in all other forms of Spirifer, are in those specimens perfectly parallel to each other and to the central septum, in their whole length. The genus is Carboniferous and Devonian."

Thus McCoy laid special stress on the possession of dental plates, which are divergent towards the floor of the shell, to distinguish his newly established genus, from allied genera. However George considered later on that the importance of McCoy's statement rests only in its recognition of the development of dental plates, rather than in


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the manner of their arrangement as either parallel or divergent. The present writer wishes to emphasize the importance of M'Coy's diagnostic statement regarding the manner of the development of dental plates.

The next problem is the surface ornamentation of shell, especially in the spine base of the genotype. George formerly regarded to be important the shell surface of the genus Reticularia with uniramous spines, instead of biramous ones, though he was not entirely certain about it.

George described the spine bases of the genus Reticularia as follows: "Some of the nodes are divided by a feeble median furrow, and then distantly suggest the split spine-bases of species of Phricodothyris."

This description may indicate, in the writer's opinion, somewhat biramous nature of the spines. Notwithstanding this, George also offered some remarks in the description of Reticularia profecta that these types of spine bases are quite distinct from the definite biramous spines of Phricodothyris. His statement runs as follows: "The ornament is well preserved on part of the shell. The concentric lamellae occur about 6 to 8 in a length of 10 mm. What appear to be spines of split spines are well displayed on each lamella. These are by no means comparable with the biramous spine-bases of species of Phricodothyris, but are very similar to those occurring on Reticularia imbricata: that is, though divided posteriorly, the two elements appear to fuse along the anterior border of the lamellae. There are about 15 of such spine bases in a width of 10 mm."

Therefore the spines of the genotype of the genus Reticularia may be different from either the usual biramous or from the uniramous type, but they may be grouped rather in the category of the latter type from George's observation; the writer wishes here follow his view.

Thus the diagnostic character of the genus Reticularia may be summarized as follows: brachythrid shell in form, biconvex, hinge line shorter than the greatest width, provided with dental plates and median septum; the former two arranging in parallel but neither divergent nor convergent toward the floor of the ventral valve. The whole surface is covered by concentric lamellae with pustules which may possibly be uniramous.

Fig. 1. Showing the spine bases on the shell surface of Kitakamithyris hikonoritensis (Minato). Ca 12 times enlarged.

Genotype: Reticularia imbricata (M'Coy) 1844

Reticularia mesolobe (Phillips) may belong to the same category of the genotype of Reticularia in possession of dental plates in parallel, although its surface ornamentation, is not at all known to me at present. Other reticuloid shells as George designated in the genus Reticularia may have
uniramous spine bases. The dental plates of some species among them show slight divergence toward the floor of the ventral valve, especially at the apex of the valve. Moreover some species, such as R. alexandri, lacks median septum and bears dental plates divergent at an angle of about 20°. Such being the case, they may be more precisely subdivisible in the generic rank, and may hold each its own phylogenetic position regarding the development or arrangement of the dental plates as well as median septum.

Here the writer proposes to separate R. alexandri from the genus Reticularia, and wishes to establish for it a new genus Georgethyris MINATO.

Genus Georgethyris MINATO, nov.

Genotype: Reticularia alexandri

GEORGE, 1932

The internal structure of this genus is quite the same as that of genus Eoreticularia but in the surface ornamentation they are different from each other, the latter being quite deficient in every respect.

Genus Sinothyris MINATO, nov.

Without dental plates but with median septum in the ventral valve.

Genotype: Reticularia maurrei

(HOLZAPFEL)1)

The surface ornamentation of the shells at this species coincides well with the usual reticulate spirifers but it is without dental plates. Only the existence of median septum is indicated.

There are also rather strong radiating vascular grooves represented by faint ridges in the internal mold.

II) Group with biramous spine bases

Genus Phricodothyris GEORGE, 1932

The original definition by GEORGE runs as follows:

"Brachythyruid, relatively brephomorphic, primitive in shell form. Spiralia directed more or less laterally : jugum or jugal processes apparently absent. Surface ornament of biramous spines. Shell-structure fibrous, impunctate. Internal plates usually absent, but progressive, frequently attaining primary, and sometimes the basiliary stage, but never the intermediate stage."

Genotype: Phricodothyris lucerna

GEORGE, 1932

Thus GEORGE2) defined and included in his newly established genus such species as P. ericius, P. lineata, P. insolita, P. lucerna, P. paricosta, P. pariculosa and P. procerunda. Among them he offers no observation on P. insolita regarding the internal structure which should have further investigation. Other species except P. lineata lack, according to his observation, either dental plates or median septum. Only the so-called "Phricodothyris lineata" (MARTIN) of George has dental plates of ventral valve as well as socket plates of dorsal valve, though it is devoid of median septum. This species should be regarded, in the writer's opinion, as not congeneric with other species of the genus Phricodothyris. Therefore the definition of this genus should be corrected as follows: with no apical plates in both valves, except the delthyrial ridges.

In this respect, genus *Squamularia* is quite the same as *Phricodothyris* and the distinguishing criteria of these two genera are only in the nature of the spine bases; the former of which is uniramous in contrast to the biramous character of the latter. Although the shell ornament was said to be not originally precisely examined in the case of the genotype of *Squamularia*, the later investigators clarified this point. That is that the spine bases of this genus *Squamularia* are definitely uniramous.

DEMANET who believed the validity of this genus *Phricodothyris* added such three species as *P. tripustulosa*, *P. monopustulosa*, and *P. georgei* which came from the passage bed of the Dinantian to the Namurian in Belgium. All species described by both GEORGE and DEMANET may belong to the higher Lower Carboniferous in Western Europe, while this genus may be seen to range until a much later time in Eastern Asia, because *Squamularia echinata* described by CHAO from the Taiyuan Series of North China is nothing but *Phricodothyris*, which bears a distinct double barrelled type of spines but possesses neither dental plates nor median septum.

*Phricodothyris* is also found newly from the Japanese Permian.

Of the so-called *Reticularia lineata* of the Salt Range, described by WAAGEN, the internal structures are unfortunately unknown, although the spine bases, according to DAVIDSON, are of distinctly biramous type. In *Reticularia indica* WAAGEN, there are no median septum and no dental plates, so it may probably belong to the same category as *Phricodothyris*, though WAAGEN did not describe definitely the nature of the spine bases.

*Reticularia elegantula* WAAGEN, found in association with the last one from the Salt Range also bears biramous spines, while the internal structures of the pedicle valve were not investigated by him.

**Genus Condothyris Minato, nov.**

With no dental plates and no median septum in the ventral valve but provides distinct socket plates in the dorsal valve.

**Genotype: Squamularia perplex (McChesney) of Dunbar and Condra**

DUNBAR and CONDRA hesitated to assign their species to the genus *Squamularia*. This species has biramous spines on the shell surface and lacks dental plates as well as median septum in the ventral valve, therefore it should be regarded to belong to the genus *Phricodothyris* rather than to *Squamularia*.

However they pointed out the presence of a pair of lamellae in the dorsal valve, which they considered as serving as the supports of the crural plates. These are the present writer's socket plates. And the socket plates of this species are not parallel to the floor of the dorsal valve, but arranged in convergency. The writer supposes that this species may not be conspecific with the species reported under

4) WAAGEN, W.: op. cit. p. 542, pl. XLIII, fig. 2.
5) WAAGEN, W.: op. cit. p. 545, pl. XLIV, fig. 1.
the same name by GIRTY\(^1\) from the Wewoka formation of Oklahoma. GIRTY mentioned that there are no internal plates in his species. The writer wishes here to establish a new genus based upon DUNBAR and CONDRA’s specimens. This came, according to them, from the Middle Pennsylvanian in Nebraska.

Genus *Martinothyris* MINATO, nov.

With dental plates in the ventral valve, with socket plates and incipient median septum in the dorsal valve.

Genotype: *Phricodothyris lineata* (MARTIN), 1932 @ of GEORGE

According to GEORGE\(^2\), the type of "Reticularia lineata" was lost and he selected as neotype a specimen from the type locality, where MARTIN recorded the species as being particularly common. This agrees, in his opinion, with the specimens in MARTIN’s figure in proportions and general appearances. Diagnosis of this species stated by him was as follows: “A transverse species of *Phricodothyris*, typically rectimarginate, the anterior margin being semicircular in dorsal view. Apical plates variously developed between primitive and intermediate stages.

Thus GEORGE\(^3\) did not recognize the prime importance to distinguish the shells either specifically or generically in respect to the presence or absence of the apical plates of the valves.

He regarded all specimens with or without apical plates in one genus. But the present writer cannot agree with that view.

Of GEORGE’s specimens, the one illustrated by him on page 546 under the name *Phricodothyris lineata* is devoid of any apical plates and therefore that specimen is nothing but a *Phricodothyris*.

But the specimen on page 545 has dental plates in the ventral valve and two socket plates in the dorsal valve. The writer selects this specimen as the genotype and wishes to propose a new genus. In this new genus, dental plates are sub-parallel in arrangement, which is quite worthy of note, and, moreover, a short median septum is present, which is quite incipiently indicated in the dorsal valve.

Thus the apical apparatus of this genus is quite the same as that of the genus *Martinopsis*, except for the presence of a short median septum in the dorsal valve.

Genus *Torynifer* HALL and CLARKE, 1895

The exterior of the shell is ornamented by concentric lamellae and biramous spines like *Phricodothyris*, but this genus provides always strong dental plates and median septum in the ventral valve, and, besides this, it bears distinct median septum in the dorsal valve.

The Mississippian species described by WELLER\(^4\) under the names of *Reticularia pseudolineata*, *R. setiger* and *R. cooperensis* are assignable to this genus. M. A. STAINBROOK\(^5\) described

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2) Phricodothyris lineata, p. 545, fig. 6, GEORGE, op. cit.
3) Ibid., p. 555.
one species of this genus from the Lowest Member of the Mississippian in New Mexico.

Genotype: *Torynifer criticus*
Hall and Clarke

Genus *Kitakamithyris* Minato, 1952

With dental plates and a median septum in the ventral valve but no septate partitions in the dorsal valve.


A few species of this group from the Lower Carboniferous of Japan may be quite like genus *Torynifer* in the outer configuration of shells, external ornamentation and internal structures of the ventral valve, but they differ from the latter in possessing no median septum in the dorsal valve.

Fig. 2. *Kitakamithyris lyoanjiensis* (Minato)

a: showing traces of dental plates and median septum in the ventral valve. × 1
b: dorsal view of shell. × 1
c: spine bases, enlarged 10 times.
d: spine bases, enlarged 5 times.

All species mentioned by Hall and Clarke as members of the "Lamellosi dupliciplicati" may belong to the genus *Torynifer* except the Hamilton species. The so-called *Spirifer fimbriatus* Conrad of Hall and Clarke bears radial plications and may be rather regarded as allied with *Plactospirifer* than with *Reticularia*. But it bears biramous spines and must be not wholly congeneric with either of them. This species comes from the Devonian Hamilton Formation and the other species under the group of lamellosi dupliciplicati may come from the Mississippian and younger formations.

Thus such reticulate spirifers with biramous spines and dental plates as well as a median septum in the ventral valves as *Torynifer* and *Kitakamithyris* began to appear from the Lower Carboniferous but not from the Devonian in age.

Genus *Spirelytha* Fredericks, 1919

With pseudospondylium.

Genotype: *Spirifer schei* Tschernyschew 1916®

According to George, this genus from the arctic Permian is provided with biramous spines and pseudospondylium. According to Paeckelmann® there is an incipient median septum in this genus.


Genus *Nebenkothyris* Minato, nov.

Genotype: *Spirifer* (Reticularia) lineatus Neb, @@ non Martin

The species described and figured by Neb from the Culm formations of Haagen under the name of *Spirifer* (Reticularia) lineatus (Martin) has a prominent median septum in the ventral valve and moreover has such a septum in the dorsal valve.

There is no other apical plate in this specimen. Basing his opinion upon such peculiarity in the septated partitions of the apicals, the writer wishes to propose a new generic name for this species.

Neb described as follows: "Auffallend ist eine schmale, aber scharfe Medianlesiste der Stielklappe, die aber auch in der Armhülle angedeutet ist." Next the problem arises, whether this species is ornamented by the uniramous spines or by biramous ones, because Neb mentioned nothing about it. However Nebak regarded his species as being quite conspecific with the species described by Scut in his monograph under the name of Reticularia lineata. Meanwhile Scut’s specimens were said to be provided with distinct biramous spines. Therefore the diagnostic character of this genus may be summarized as: With median septa in the ventral as well as dorsal valves. Ornamented by concentric lamellae and biramous spines.

One species described and figured by Reed from the Paleozoic of Yunnan, S. China, under the name of Reticularia sublineata Reed, is specially worthy of note. It is ornamented with biramous spines on the whole surface of the shell with concentric lamellae, and possesses no dental plates, except divergent teeth in the ventral valve. But there is a prominent median septum in the ventral valve in this species. Besides this, the existence of one more septum in the dorsal valve is indicated by his illustration, though he did not mention such a structure.

The feature of the special plates of this species may accordingly be quite common with the genotype of this new genus just proposed above. However Reed did not offer any remarks on the existence of such a septum in the dorsal valve, as above stated, and the writer is very hesitant to consider this species as being wholly congeneric with Nebenkothyris. If the median septum is lacking in the dorsal valve, Reed’s species should be separated in subgeneric rank from Nebenkothyris. Reed’s description about his species runs as follows:

"Shell subcircular, gently biconvex. Pedicle-valve moderately convex, not inflated, with a narrow weak median groove extending from the beak to the anterior margin, but no sinus. Beak strongly incurved, and umbonal slopes rounded. Interior of valve with short small divergent teeth, but no dental plates; broad low ridge running forwards from apex of beak nearly to front margin, narrowing and decreasing in strength anteriorly, subangular and prominent between the narrow flabelliform ill-defined diductor scars. Whole of rest of interior (including muscle-scars) marked with fine radiating closely placed striae, somewhat sinuous and broken on inosculating in some places and occasionally deeping into pits.

1) Scut, J.: Spiriferen Deutschlands. p. 52, pl. 4, figs 11-13, 1900.
"External surface of shell covered with thin broad concentric laminae of subequal width, each bearing a submarginal single row of "double-barrelled" hollow spine-bases of laterally compressed oval or subcircular form, the "barrels" being longitudinally oval and lying side by side, small low sharp tubercles and spinules lie between and in front of each row of spine-bases on the laminae (leaving punctate on the internal cast)."

In concluding the writer is much indebted to Prof. I. HAYASAKA for his kind reading manuscript and criticism given by him during the course of this study.

Fig. 3. Showing the geological distribution of some reticulate spirifers, and apical structures of each genus. Above: ventral valve, below: dorsal valve, with or without dental plates, socket plates, median septum or pseudospondylium.