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The fusulinid genus Yangchienia Lee.

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With 1 plate (XVII).

It has recently become desirable that a critical study be made of the fusulinids of the Middle and Upper Permian of Europe and Asia which have been referred to the Lower Pennsylvanian (Middle Carboniferous) genus *Fusulinella* Möller. At least eight species of fusulinids of these upper Paleozoic horizons have been referred to this Lower Pennsylvanian genus, but representatives of *Fusulinella* are not known to occur in the intervening Upper Pennsylvanian and Lower Permian strata. Although the general physiognomy of these Middle and Upper Permian forms resembles that of the type of *Fusulinella, F. bocki* Möller, a critical study of their internal structures indicates that they represent genera which are quite distinct biologically from this genotype and that at least three of them are referrable to the Permian genus *Yangchienia* Lee.

Through the courtesy of the Museum of Natural History of Basel I have had the opportunity to study a collection made by Professor C. Renz from the Middle Permian of the Egean Islands, Greece, that contains a form which resembles very closely in general appearance the type of *Fusulinella* and which was previously referred to this genus. A detailed study of the internal structures of this form shows clearly that it is referrable to the genus *Yangchienia* Lee. I am describing it below as a new species and I am proposing the name *Yangchienia tobleri* for it in honor of the late Dr. Aug. Tobler.

I wish to take this opportunity to thank Dr. R. Rutsch for the opportunity to study this material and for permission to use it in this publication.

The type of the genus *Fusulinella* Möller, *F. bocki* Möller, was originally described in 1878 from the Moscovian (Lower Pennsylvanian) of Russia, but until 1913 no other forms were described which are congeneric with this genotype. At this latter date Deprat [1]) de-

[1]) Deprat, J., Les fusulinidés des calcaires Carbonifériens et Permiens du Tonkin, du Laos et du Nord-Annam. Mém. Serv. Géol. Indochine, vol. 2, fasc. 1, 1913.

scribed the type of *Neofusulinella* DEPRAT, *N. lantenoisi* DEPRAT, of the Middle Permian of French Indo-China and at the same time he referred two other species, *N. schwagerinoides* and *N. praecursor*, of the Moscovian of French Indo-China to this same genus, both of which are congeneric with *Fusulinella bocki*[2]). At this time DEPRAT was restricting the name *Fusulinella* to forms now referred to the genera *Staffella*, "*Orobias*", and *Ozawainella* and he did not apply it to any forms congeneric with the genotype *F. bocki*. Most subsequent authors have referred all three of DEPRAT's species just mentioned, which were described in 1913 and referred to *Neofusulinella*, to the genus *Fusulinella* and hence they have believed that this genus ranges throughout the Pennsylvanian and Lower and Middle Permian. In 1915 DEPRAT[3]) described three additional species, *N. giraudi*, *N. elongata*, and *N. minima*, of the Permian of Indo-China and referred them to *Neofusulinella*. Much later OZAWA[4]), assuming that *Neofusulinella* was a synonym of *Fusulinella*, made one of these species, *N. giraudi*, the type of the genus *Depratella* OZAWA. Careful studies of the description and illustrations of the type of the genus *Neofusulinella* indicate clearly that in this form the spirotheca is composed of a tectum and a "diaphanotheca" and does not have layers of tectorium; that its chomata are of moderate development; and that its septa are unfluted across the mid-portion of the shell and are very weakly fluted in the extreme polar regions of only the outermost volution. A study of the description and illustrations of the type of *Depratella* shows clearly that in this form the spirotheca is composed of a tectum and a diaphanotheca and does not have layers of tectorium; that its chomata are of moderate development; that its septa are very thin and are unfluted throughout the length of the shell; and that its juvenarium is tightly coiled and has a large form ratio (is endothyroid). The diameter of the proloculum of *N. lantenoisi* is given by DEPRAT as 72 microns and that of *N. giraudi* as 13 microns, and hence the juvenarium of *N. lantenoisi*, which is not shown in any of DEPRAT's published illustrations, possibly is quite different from that of *N. giraudi*. Also, the spirotheca of *N. lantenoisi* is much

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[2]) *Neofusulinella praecursor* apparently has an "endothyroid" juvenarium, but as well as I can determine from the illustrations of this form, the spirothecal structure is not different from that of the genotype of *Fusulinella* and I am accordingly referring it to *Fusulinella*. The form described and illustrated by COLANI (Mém. Serv. Géol. Indochine, vol. 11, fasc. 1, pp. 101—103, pl. 16, figs. 6, 11, 17, 23—43, pl. 17, figs. 1—22, 1924) as *N. praecursor* is definitely referrable to *Fusulinella*, but its juvenarium is not very closely similar to that described by DEPRAT of the cotypes of *N. praecursor*.

[3]) DEPRAT, J., Les fusulinidés des calcaires Carbonifèrens et Permiens du Tonkin, du Laos et du Nord-Annam. Mém. Serv. Géol. Indochine, vol. 4, fasc. 1, 1915.

[4]) OZAWA, Y., A new genus, *Depratella*, and its relation to *Endothyra*. Contrib. Cushman Labor. Foram. Research, vol. 4, pt. 1, pp. 9—10, 1928.

thicker than that of *N. giraudi* and the shells of these two forms are quite different in size, but the close similarity of these two genotypes suggests that *Depratella* is a synonym of *Neofusulinella*, which has priority. In any case, the above listed data will serve to definitely distinguish representatives of these two Permian genera from those of the Lower Pennsylvanian genus *Fusulinella*.

The type of the genus *Schubertella* STAFF and WEDEKIND, *S. transitoria* STAFF and WEDEKIND, was described from Spitzbergen. Its associated forms were not listed and the type locality was not given. The only other fusulinids described from this region are of Permian age and this form may well be Permian. However, OZAWA[5]) illustrated a section of fusulinid-bearing limestone from Spitzbergen that contains many sections of *Fusulinella*-like specimens which resemble in general appearance Lower Pennsylvanian forms and, as I have previously suggested[6]), the type of *Schubertella* may be congeneric with the type of *Fusulinella*, but if the type species of *Schubertella* is Permian in age then very probably *Depratella* is a synonym of *Schubertella*, which has priority. However, the type of *Schubertella* must be restudied before this question can be answered.

In 1925 LANGE[7]) described and illustrated three *Fusulinella*-like forms of the Middle Permian of Sumatra as *Fusulinella terebra*, *Schubertella simplex*, and *S. plana*. Later YABE and HANZAWA[8]) have reversed the generic designations of these forms as follows: *Schubertella terebra*, *Fusulinella simplex*, and *F. plana*. The description and illustrations of *Fusulinella terebra* are such that I am not able to determine the specific or generic affinities of this form. *Schubertella simplex* and *S. plana* are beyond a reasonable doubt congeneric with *Neofusulinella giraudi*, the type of the genus *Depratella* OZAWA.

Neofusulinella phairayensis COLANI of the Permian, probably Middle Permian, of French Indo-China is apparently congeneric with the genotype of *Depratella*. In 1925 OZAWA[9]) briefly described and illustrated a small fusulinid from Tahara, Japan, as *Fusulinella praecursor* (DEPRAT) and he gave its age as Permian. I am not able to determine the generic affinities of this form from the illustrations

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[5]) OZAWA, Y., On the classification of Fusulinidae. Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 45, art. 4, p. 10, pl. 4, fig. 8, 1925.

[6]) THOMPSON, M. L., Fusulinids from the Lower Pennsylvanian Atoka and Boggy formations of Oklahoma. Jour. Paleontology, vol. 9, pp. 291—306, 1935.

[7]) LANGE, E., Eine mittelpermische Fauna von Guguk Bulat (Padanger Oberland, Sumatra). Verh. Geol.-Mijnb. Gen. Ned. en Kol., Geol. Ser., Deel VII, pp. 254—255, 1925.

[8]) YABE, H., and HANZAWA, S., Palaeozoic and Mesozoic Foraminifera (in: Onze Palaeontologische Kennis van Nederlandsch Oost-Indië in 1930). Leidsche Geol. Mededeel., Deel V (Feestb. K. Martin), pp. 23—34, 1931.

[9]) OZAWA, Y., A brief critical revision of the *Fusulina*-species recently described, with additional studies on Japanese *Fusulinae*. Jour. Geol. Soc. Tokyo, vol. 32, pp. 19—27, pls. 9, 10, 1925.

and brief description, but if its age is truly Permian, then this form is almost certainly not conspecific with the cotypes of *F. praecursor* (DEPRAT) from the Moscovian of French Indo-China and it does not represent the genus *Fusulinella*. OZAWA's specimens should be re-studied by modern methods.

The genus *Yangchienia* was established by LEE[10]) in 1933 with *Y. iniqua* LEE designated as the genotype. This genus was diagnosed by LEE in his description of the genotype and I am quoting this description in full.

Diagnosis of Yangchienia. "Test small, more ellipsoidal than fusiform; axial length 1.4 mm., median width 0.9 mm. when fully grown; whorls compact, 7 to 8 in number; first three whorls nautiloid with their axis of convolution nearly perpendicular to that of the later or fusiform whorls; wall [spirotheca] consisting of a layer of tectum and an exceedingly thin layer of diaphanotheca; tectoria absent; antethecae [septa] unfluted; chomata extraordinarily strong, thick and extensive, widespread towards the umbilical regions; tunnel nearly rectangular; proloculum small."

As can be seen from this description, the spirothecal structure, the septal fluting, and the juvenarium of the type of this genus agree rather closely with those of the type of the genus *Depratella* OZAWA, and possibly with those of the types of the genera *Neofusulinella* and *Schubertella*. However, the chomata of the type of *Yangchienia* are so very much more strongly developed than are those of the type of *Depratella* (as well as those of the types of *Neofusulinella* and *Schubertella*) that, even if there is no other marked difference between them, they should be referred to different genera. I am therefore referring the following Permian forms, which are closely similar to *Yangchienia iniqua* LEE, to the genus *Yangchienia* LEE:

Fusulinella itoi OZAWA, 1925;
Fusulinella compressa OZAWA, 1927; and
Yangchienia tobleri, n. sp.

The general appearance and the shape of the shell of the genotype and of other representatives of *Yangchienia* resemble remarkably closely those of the type of *Fusulinella* and unless the spirotheca is studied in detail it is very easy to confuse representatives of these two genera. The juvenarium of the illustrated representatives of the genotype of *Yangchienia* is endothyroid and its axis of coiling is at a large angle to the axis of the outer fusiform volutions, but it is not at all certain that this character is of generic significance and some representatives of these two genera probably have similar

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[10]) LEE, J. S., Taxonomic criteria of *Fusulinidae* with notes on seven new Permian genera. Mem. Nat. Research Institute Geol., no. 14, p. 14, pl. 1, figs. 1, 1a, 1933.

juvenaria. However, the tectoria found in *Fusulinella* are entirely missing in *Yangchienia* and even though the chomata in these two genera are very closely similar, those of *Yangchienia* are much better developed than are those of *Fusulinella*. Although the genotype of *Yangchienia* is strikingly similar to that of *Fusulinella*, the two are probably not very closely related for the genus *Fusulinella* is confined to the Lower Pennsylvanian whereas *Yangchienia* is confined to the Middle and Upper Permian—no forms closely similar to either have been found in the intervening strata. It therefore seems probable that *Yangchienia* developed from *Depratella* (or a closely similar form) rather than from *Fusulinella*.

In 1924 COLANI[11]) described and illustrated a form from Yunnan, China, as *Neofusulinella praecursor pusilla*. COLANI's description was apparently based on only three specimens, and she considered the variety " incomplètement fixée ". The spirothecal structure and the development of the juvenarium of this form are very closely similar to those of the type of *Yangchienia*, but the chomata are not as well developed as are those of any other known representatives of this genus. However, the chomata are apparently better developed than are those of the type of *Depratella* or of *Neofusulinella*. It may represent *Yangchienia* and is somewhat intermediate between typical *Depratella* and typical *Yangchienia*.

The form which OZAWA[12]) illustrated in 1925, and later[13]) described and illustrated as *Fusulinella itoi* resembles very closely in general outline representatives of the Lower Pennsylvanian genus *Fusulinella*. OZAWA stated that this form was associated with " the Upper Permian *Fusulinae* such as *Neoschwagerina shiraiwensis* n. sp., *Neos. douvillei* OZAWA and *Sumatrina annae* ", which are undoubtedly Permian in age, and this supposed Upper Permian *Fusulinella* has caused much discussion among paleontologists. The illustrated sagittal section of this species (see fig. 5 on plate XVII) shows a structure of the spirotheca which seems to be identical with that of the type of *Fusulinella*. However, this section is immediately over the highest portion of the chomata which probably spread onto the lower part of the spirotheca to give the appearance of tectoria. A very close study of the illustrated axial section (see fig. 6 on plate XVII) of this form indicates that poleward from the tunnel the spirotheca are composed only of a tectum and a diaphanotheca. The chomata

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[11]) COLANI, M., Nouvelle contribution a l'étude des fusulinidés de l'Extrême-Orient. Mém. Serv. Géol. Indochine, vol. 11, fasc. 1, p. 104, pl. 29, figs. 22, 23, 27, 1924.

[12]) OZAWA, Y., On the classification of Fusulinidae. Jour. Coll. Sci., Imp-Univ. Tokyo, vol. 45, art. 4, pl. 1, figs. 1, 2, 1925.

[13]) OZAWA, Y., Paleontological and stratigraphical studies on the Permo. Carboniferous limestone of Nagato, Part II, Paleontology. Jour. Coll. Sci., Imp. Univ. Tokyo, vol. 45, art. 6, p. 19, pl. 3, figs. 6, 8, 1925.

of this form are very large and are comparable in development with those of the type of *Yangchienia* and, even though the juvenarium is not very closely similar to that of the type of this genus, I am referring this form to the genus *Yangchienia* LEE. OZAWA's types should be restudied in the light of modern methods.

In 1927 OZAWA[14]) described a form from limestone Nn at Akasaka, Japan, as *Fusulinella compressa* which is apparently congeneric with the type of *Yangchienia*, and I am referring it to that genus. OZAWA stated that this form is associated with *Verbeekina verbeeki* (GEINITZ), *Cancellina nipponica* OZAWA, and *Parafusulina granum-avenae* (ROEMER) and hence it is probably Middle Permian in age. The juvenarium of this form is endothyroid and the spirotheca is apparently composed of a tectum and a diaphanotheca. The chomata are very well developed and they extend completely to the poles. The "deposition" layers which OZAWA describes as being well developed are very probably the well developed chomata.

Yangchienia tobleri THOMPSON, n. sp.

Plate XVII, figures 1, 2, 7.

Fusulinella sp. OZAWA and TOBLER, 1929, Eclogae geol. Helv., vol. 22, p. 47, pl. 5, fig. 3.

Fusulinella bocki SILVESTRI, 1933, Mem. Istituto Geol. R. Univ. Padova, vol. 10, pp. 31—32, pl. 2, fig. 7, pl. 3, fig. 6.

The form illustrated by SILVESTRI as *Fusulinella bocki* MÖLLER came from the Sosio beds of Sicily and SILVESTRI's illustrations resemble remarkably closely the specimen from the Middle Permian of the Island of Katakupho, Greece, on which the following description of this species is mainly based. SILVESTRI's illustrated axial section (see fig. 2 on plate XVII) shows a layer on the spirotheca below the diaphanotheca in some parts of the specimen which resembles tectorium but this probably is the upper portion of the chomata which extend up the septa. These Sicilian specimens are associated with representatives of high Middle Permian genera such as *Sumatrina* and *Neoschwagerina* and the slide of the limestone from Greece which contains the specimen on which the following description is mainly based also contains representatives of these same two genera. There seems little doubt that these two forms represent the same genus, but since I have not seen the Sicilian specimens I am referring them to this species with question.

Shell small, short, tumid, fusiform. Poles bluntly pointed. Lateral slopes steep. Mature forms consist of at least nine volutions

[14]) OZAWA, Y., Stratigraphical studies of the Fusulina limestone of Akasaka, Province of Mino. Jour. Faculty Sci., Imp. Univ. Tokyo, Sect. 2 (Geology), vol. 2, part 3, pp. 142—143, pl. 37, fig. 6f, pl. 38, figs. 2b, 10, 13b, 16b, pl. 39, figs. 3, 7, 1927.

and are about 3.6 mm in length and 1.6 mm in width, giving a form ratio of about 1 : 2,3. The septa are very thin and they are composed of the downward deflection of the tectum and diaphanotheca of the spirotheca. Also, the lower part of the diaphanotheca extends at least part of the way down the anterior side of the tectum of the septa. The septa are very numerous. They are unfluted throughout the length of the shell.

The spirotheca is rather thin and it is composed of a tectum and a very clear thin diaphanotheca. However, there is a suggestion of a third layer immediately over the tectum which is very thin and which is only slightly if any denser than the diaphanotheca. The diaphanotheca measures about 9.6 microns in the fourth volution, 10.5 microns in the fifth volution, 11.4 microns in the sixth volution, 12.3 microns in the seventh volution, and 14.0 microns in the eighth volution.

The tunnel is rather narrow and it is very high. Its intersection with axial sections forms a very irregular path in the inner volutions but in the outer three volutions its path becomes essentially straight. The chomata are very large and they extend with very little change in development completely to the poles. In the eighth volution they are about five-sixths as high as the chambers about half way between the tunnel and the poles. The tunnel angle measures about 15 degrees in the ninth volution.

The third to the fourth volutions of the specimens from Sicily are ellipsoidal and beyond the fifth volution the poles become more extended and the lateral slopes become slightly concave near their lower limits.

This species resembles rather closely the type of this genus, *Y. iniqua* LEE, but the tunnel of the latter is much wider, its chomata are not as well developed as are those of *Y. tobleri*, and the shapes of the shells of these two species are different.

Occurrence. The type specimen on which the above description is mainly based came from the Middle Permian near Pesulia, Katakupho, of the Egean Islands, and, according to OZAWA and TOBLER, the fusulinid-bearing rocks occur there as blocks between a yellowish marble-like limestone of the Westcap and the Neogene of the eastern part of the island. SILVESTRI's specimens came from the isolated mass of Middle Permian limestone in the valley of the Sosio River, in the southern part of the province of Palermo, Sicily, known as the Pietra di Salomone.

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Explanation of plate XVII.

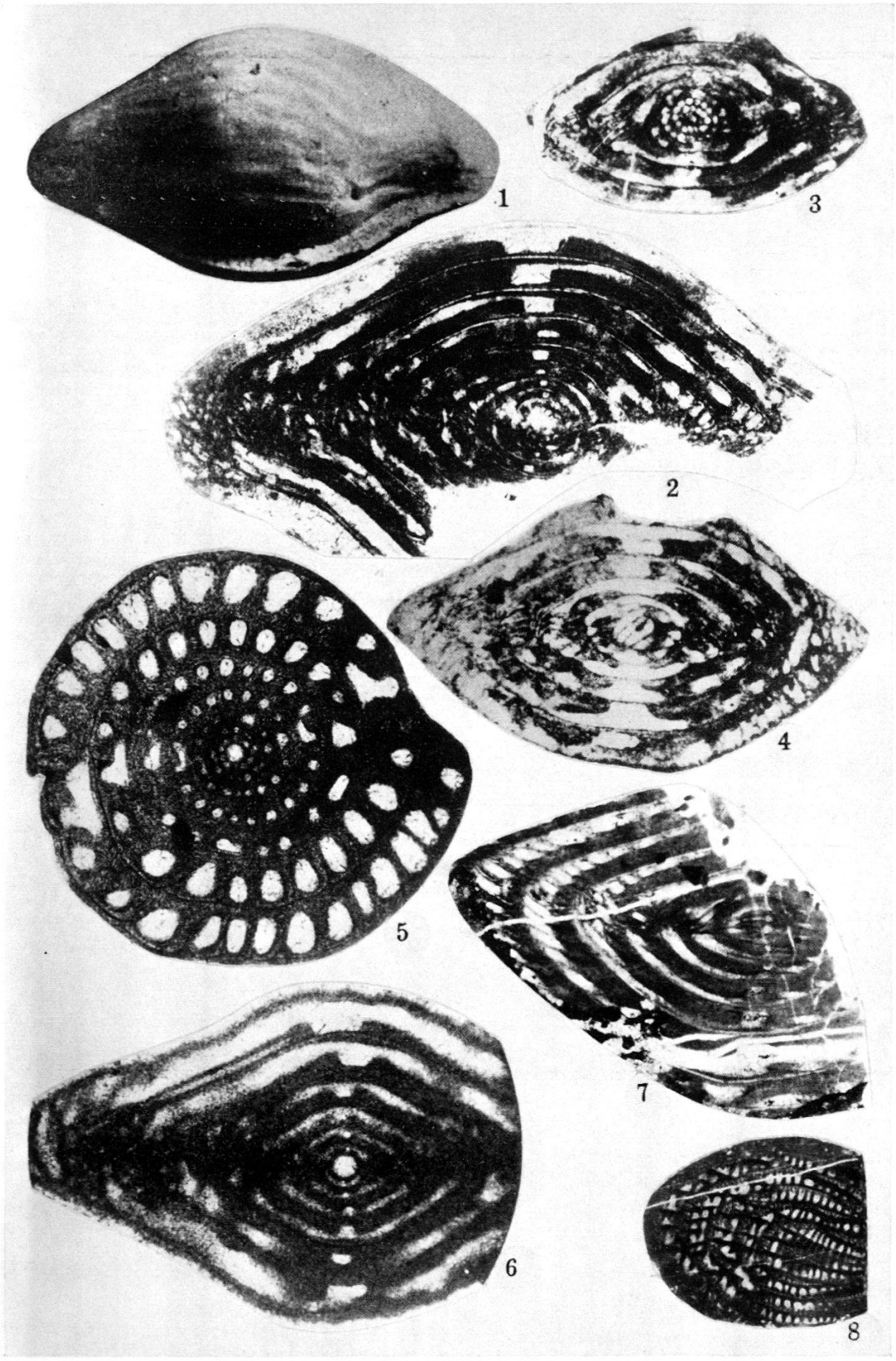
Figs. 1, 2: *Yangchienia tobleri* THOMPSON, n. sp. 1, External view, × 18.5; and 2, axial section, × 27.4, from the Sosio beds (Pietra di Salomone) of Sicily. (After A. SILVESTRI.)

Fig. 7: *Yangchienia tobleri* THOMPSON, n. sp. Slightly tangential axial section, × 30, from the Island of Katakupho, Greece.

Figs. 3, 4: *Yangchienia iniqua* LEE. Axial sections, × 40, from the Chihsia limestone, near Nanking, China. (After LEE.)

Figs. 5, 6: *Yangchienia? itoi* (OZAWA). Sagittal and axial sections, × 45, from the Upper Permian near Shiraiwa, Japan. (After OZAWA.)

Fig. 8: *Sumatrina pesuliensis* OZAWA and TOBLER. Tangential section of a specimen in the same slide with *Yangchienia tobleri*, n. sp., × 10.



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