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ENTACTINARIA SUBORDO NOV., A NEW RADIOLARIAN SUBORDER

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Summary

The Entactinaria subordo nov. have an inner spicular system homologous with that of the Nassellaria and a single, double or multiple shell homologous with that of the Spumellaria. One branch of the Nassellaria (including almost alle forms living today) has developed directly from pylomate Entactinaria. Therefore the recent Entactinaria and Nassellaria have similar cytoplasmas.

The Entactinaria are the clearly dominating radiolarian group throughout the whole Paleozoic. In the Middle Triassic they are still very frequent, partly even still dominating. In the Upper Triassic the Entactinaria are moderately frequent, but no longer dominating. They occur rarely to very rarely from the Rhaetian up to recent.

Within the Entactinaria three superfamilies, the Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979, the Thalassothamnacea HAECKER, 1906, and the Palaeoscenidiacea RIEDEL, 1967, can be distinguished.

Zusammenfassung

Die Entactinaria subordo nov. besitzen ein Spicularsystem, das jenem der Nassellaria homolog ist, während die einfache, doppelten oder mehrfachen Schalen mit jenen der Spumellaria homolog sind. Ein Zweig der Nassellaria (einschließlich fast aller heute noch lebenden Nassellaria-Arten) hat sich direkt aus pylomaten Entactinaria entwickelt. Daher weisen die rezenten Entactinaria und Nassellaria ähnliches Zytoplasma auf.

Die Entactinaria sind die eindeutig dominierende Radiolariengruppe während des gesamten Paläozoikums. In der Mitteltrias sind sie noch sehr häufig, z.T. sogar noch dominieren. In der Obertrias sind die Entactinaria mäßig häufig, aber nicht mehr dominierend. Vom Rhät bis rezent sind sie selten bis sehr selten.

Drei Oberfamilien, die Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979, die Thalassothamnacea HAECKER, 1906, und die Palaeodiscenidiacea RIEDEL, 1967, können innerhalb der Entactinaria unterschieden werden.

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The knowledge about the fossil radiolarians has rapidly increased in the last years. More and more the inner structures of the radiolarians were also investigated and used for taxonomic subdivisions.

Until now most of the Paleozoic Radiolaria were assigned to the Spumellaria, some to the Albaillellaria and to the Nassellaria. The Mesozoic Radiolaria were almost exclusively assigned to the Spumellaria and Nassellaria. But among the Spumellaria most Paleozoic representatives and some Mesozoic to recent ones are clearly different from the typical Spumellaria, because they have an inner spicular system homologous with that of the Nassellaria. Recent representatives of these Radiolaria have a cytoplasma like that of the Nassellaria (HOLLANDE & ENJUMET, 1960). These "Spumellaria" with inner spicular system are separated here as an independent suborder from which both the Spumellaria and the Nassellaria have derived.

Subclass Radiolaria MÜLLER, 1858

Order Polycystina EHRENBERG, 1838

Suborder Entactinaria n. suborder

Diagnosis: Spicular system neither in position nor in arrangement fixed, but always present and never consisting of several isolated spicules in one radiolarian cell. 3-5 spines, rarely more, begin at the end of a median bar (Mb). If Mb is quite reduced, all spines begin in one point. The spicular system may also form a pentactine with 1-4 mostly smooth apical spines and 4 sculpturated basal spines. If one shell is present, the centre of the pentactine always lies at or near to one pole. The basal spines may be included in the wall of the shell. If there is more than one shell, the pentactine spicular system is always connected with the inner shell.

Shell(s) mostly present, often coarsely latticed. In higher evolved representatives the wall of the outer shell may be double-layered (outer layer with large pores and inner one with smaller pores). Pylome(s) sometimes present.

Distribution: ? Cambrian, Ordovician to recent. Dominating radiolarian group from the Ordovician to the Upper Permian. Very frequent, sometimes even still dominating in the Middle Triassic., Frequent, but no longer dominating in most of the Upper Triassic. Rare to very rare from the Rhaetian up to recent.

Remarks: The Entactinaria are the basic group of most of the radiolarians. In the Silurian primitive Nassellaria (Archocyrtiidae KOZUR & MOSTLER, 1981) have derived from pylomate Entactinaria, already present since the Middle Ordovician. The primitive Paleozoic Triospyridacea HACKEL, 1882 (Archocyrtiidae KOZUR & MOSTLER, 1981, Pylentonemidae DEFLANDRE, 1963) are all connected with the Entactinaria by transitional forms. On the other side the Pylentonemidae are the basic group of one stock within the Nassellaria. Nearly all recent Nassellaria belong to this stock. For this reason the cytoplasma of the recent Nassellaria is similar to that of the recent Entactinaria.

Most probably the second stock of the Nassellaria begins with the Popofskyellacea DEFLANDRE, 1964. This stock is clearly related to the Albaillellaria DEFLANDRE, 1953. The relations of this stock to the Entactinaria are unknown. The Popofskyellacea could be the basic group of the Parvicingulacea PESSAGNO and the Archaeodictyomitracea PESSAGNO. If these closely related superfamilies really derived from the Popofskyellacea then either the Albaillellaria would have to be included in the Nassellaria or the Nassellaria would have to be subdivided into two suborders.

It seems to be highly probable that the Albaillellaria are aberrant primitive Nassellaria, because the stratigraphically younger Albaillellaria became more and more multisegmented like multicyrtid Nassellaria and the shell of some of the youngest representatives is already corasely latticed. Moreover, there are some Jurassic Nassellaria related to *Cornutella* EHRENBERG, 1838, which are morphologically very similar to the Albaillellaria and, like this group, have no inner spicular system. They are only distinguishable by the absence of the two opposite columnellae always present in the Albaillellaria. This radiolarian group could be the direct descendant from the Paleozoic Albaillellaria. In this case also the Albaillellaria would have to be assigned to the Nassellaria.

The above mentioned second stock of the Nassellaria disappears at the top of the Cretaceous.

The spicular system of the Entactinaria is homologous with that of the Nassellaria. The median bar may be present or missing in both groups, the nassellarian spines A, D, 2 l, V and 2 L can be recognized in the same position also in the Entactinaria (see KOZUR & MOSTLER, 1981, plate 39). But the arrangement of the inner spicular system is still not stabilized in the Entactinaria. The shell(s) of the Entactinaria are of spumellarian type. The most characteristic type of the nassellarian shell with large aperture (only secondarily narrowed or closed in some taxa) opposite to the cephalis bearing the spicular system, is never present in the Entactinaria. So not only the arrangement of the spines within the inner spicule, but, in contrast to the Nassellaria, also the position in the inner spicule within the shell is not yet fixed in the Entactinaria. On the other hand there are transitional forms between the Entactinaria and Nassellaria (Ordovician pylomate Entactinaria).

The shape and structure of the entactinarian shell is quite identical with that of the spumellarian shell. Even the types of symmetry in the main spine arrangements are the same. But the inner prolongations of the spumellarian main spines do not join each other in a bar or point within the spumellarian shell(s).

The Spumellaria have either evolved from the Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979, by reduction of the spicular system or both Spumellaria and Entactinaria have the same ancestors. Even an iterative development of the Spumellaria from the Entactinaria cannot be quite ruled out until now.

The Collodaria HAECKEL, 1882, have either no skeleton or their skeleton consists of isolated spicules within protoplasm. Moreover, the Collodaria are often colonial. The Collodaria are used here in the original definition by HAECKEL, 1882. The later included Orosphaeridae HAECKEL, 1887 do not belong to the Collodaria, but to the Entactinaria. Only the Thalassothamnacea HAECKER, 1906, (without shell) and to a lesser degree primitive Palaeoscenidiacea RIEDEL, 1967, show some similarities with the Collodaria, but even the Thalassothamnacea (most closely related to the

Collodaria) have always a complete spicular system, whereas the Collodaria have no skeleton or an incomplete skeleton consisting of isolated spicules with one cell. Only some small Paleozoic spicular Radiolaria are uncertain in their relations to the Collodaria or Entactinaria. They may represent either small but complete skeletons of primitive Entactinaria without shell or parts of an incomplete skeleton consisting of small isolated spicules.

Superfamily Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979

Diagnosis: Entactinaria with latticed, rarely also with spongy shell(s). Spicular system always inside the shell(s), mostly in central position. Sometimes all spines branch off from one central point. More frequently 4 resp. 3 spines branch off from both ends of a median bar. These spines are homologous with A, D, V, I and L of the nassellarian spicule.

Outer shell mostly globular, with strong main spines which are arranged in the same types of symmetry as in the Spumellaria. Sometimes the main spines are latticed between their lateral ridges and thus form latticed arms. Pylome(s) may be present.

Distribution: ? Cambrian, Ordovician - recent. Very frequent in the Paleozoic, frequent in the Triassic, rare to very rare from the Rhaetian up to recent.

Remarks: Primitive pylomate Ordovician Hexastylacea are the forerunners of main branch within the Nassellaria.

On the other hand also the Spumellaria are morphologically closely related to the Hexastylacea. But they never have an inner spicular system. Most probably the Spumellaria and the Hexastylacea have derived from the same basic group, but it is also possible that the Spumellaria have derived (perhaps even iteratively) from the Hexastylacea by reduction of the inner spicule. The first possibility seems to be more probable. In this case the Hexastylacea would be more closely related to the Nassellaria than to the Spumellaria. The similar outer morphology of the Hexastylacea and Spumellaria does not contradict this opinion, because even such unrelated Radiolaria like the Acantharia HAECKEL, 1862, have typical spumellarian type shells.

The Thalassothamnacea HAECKER, 1906, have no shell and the skeleton consists of the spicular system only. This spicular system is similar to that of the Hexastylacea.

The Palaeoscenidiacea RIEDEL, 1967, have a different spicular system which is always a (sometimes modified) pentactine spicule with 1-4 mostly smooth apical spines and 4 always sculpturated basal spines. With the exception of the most primitive representatives the Palaeoscenidiacea also have latticed shells. But unlike the Hexastylacea the pentactine spicule is often partly or wholly included in the wall of the shell.

Family Hexastylidae HAECKEL, 1882 emend. KOZUR & MOSTLER, 1981

Distribution: Higher Paleozoic to recent.

Remarks: Maybe the Triposphaeridae VINASSA de REGNY, 1898 emend. KOZUR & MOSTLER, 1981, are a younger synonym of the Hexastylidae HAECKEL, 1882 emend. KOZUR & MOSTLER, 1981. The higher symmetry in the Hexastylidae certainly has some taxonomic value, but it is uncertain, whether this taxonomic value is so high that two families can be distinguished. As both families have recent representatives and the recent representatives are also separated in two families until now, we do not unite both families.

Family Triposphaeridae VINASSA de REGNY, 1898 emend. KOZUR & MOSTLER, 1981

Synonyma: Dorysphaeridae VINASSA de REGNY, 1898
Centrolonchidae CAMPBELL, 1954
Entactiniidae RIEDEL, 1967

Remarks: Subdivisions of this family in subfamilies and tribus see KOZUR & MOSTLER, 1981.

? Family Parasaturnalidae KOZUR & MOSTLER, 1972 emend.

Diagnosis: Equatorial ring always narrow with roundish to elliptical cross section. Outer spines of ring tend to join and build up an outer narrow ring separated from the inner ring by a ring of large pores. Still a further outer ring may be built up in this manner. 2-5 strong long spines connect the (inner) ring with the coarsely spongy shell. These spines join each other in a central spicular system.

Distrivution: Carnian - Cretaceous.

Included genera:
Parasaturnalis KOZUR & MOSTLER, 1972
? *Japonisaturnalis* KOZUR & MOSTLER, 1972
? *Spongosaturnaloides* KOZUR & MOSTLER, 1972

Remarks: *Spongosaturnaloides* KOZUR & MOSTLER and the Triassic *Japonisaturnalis* species have a well developed inner spicular system. Therefore they clearly belong to the Hexastylacea.

No shell structures are known from the Jurassic species of *Japonisaturnalis* KOZUR & MOSTLER and *Parasaturnalis* KOZUR & MOSTLER including their type species. Therefore it is unknown, whether these species also belong to the Hexastylacea. As these species are partly even identical with Triassic ones it is assumed that they have similar shell structures.

Spongosaturnaloides KOZUR & MOSTLER certainly and the other parasaturnalids probably belong to a completely different radiolarian stock than the other radiolarians with equatorial ring. The equatorial ring has therefore iteratively evolved in different lines and it does not indicate near relations in all cases. The other Triassic Radiolaria with equatorial ring belong to the Triarcellinae KOZUR & MOSTLER, 1981 (probably also Entactinaria) and to the Saturnalidae DEFLANDRE, 1953 (Spumellaria).

Family Eptingiidae DUMITRICĂ, 1978

Eptingium DUMITRICĂ, 1978
Cryptostephanidium DUMITRICĂ, 1978
Perispyridium DUMITRICĂ, 1978
Polystephanidium DUMITRICĂ, 1978
Spongostephanidium DUMITRICĂ, 1978
Triassostephanidium DUMITRICĂ, 1978
? *Turanta* PESSAGNO & BLOME, 1982
Tetrastephanidium n.gen.

Distribution: Anisian to Upper Jurassic.

Remarks: The youngest representative of this family, *Perispyridium* DUMITRICĂ from the Upper Jurassic, has a medullary shell, completely absent in all Nassellaria. DUMITRICĂ, 1978, regarded this medullary shell as cephalis, but unlike a cephalis, it shows no bipolarity. The inner spicule of the Eptingiidae is identical with those of other hexastylacea (see KOZUR & MOSTLER, 1981). Arches between the spines are present in many highly evolved Triassic Hexastylacea.

In this respect, also *Tetrastephanidium* n.gen. (description in KOZUR & MOSTLER, in press) is of special interest. This genus has four main spines in tetrahedral position. We find such an arrangement also in other Paleozoic and Triassic Hexastylacea.

Family Hexaporobrachiidae KOZUR & MOSTLER, 1979

Hexaporobrachia KOZUR & MOSTLER, 1979
? *Hexapyramis* SQUINABOL, 1903
Tetraporobrachia KOZUR & MOSTLER, 1979
Pentaporobrachia KOZUR & MOSTLER, 1981
Renila KOZUR & MOSTLER, 1981

Distribution: Longobardian - Norian, ? Cretaceous.

Family Multiarcusellidae KOZUR & MOSTLER, 1979

Multiarcusella KOZUR & MOSTLER, 1979
Baloghisphaera KOZUR & MOSTLER, 1979
Beturiella DUMITRICA, KOZUR & MOSTLER, 1980

Distribution: Anisian to Lower Carnian.

? Subfamily Triarcellinae KOZUR & MOCK, 1981

Triarcella KOZUR & MOCK, 1981.

Distribution: Lower Norian.

Remarks: The position of the Triarcellinae is unclear. Most probably they represent an independent family within the Hexastylacea.

Family Heptacladidae DUMITRICA, KOZUR & MOSTLER, 1980

Heptacladus DUMITRICĂ, KOZUR & MOSTLER, 1980
? *Paraheptacladus* KOZUR & MOSTLER, 1981

Distribution: Middle Triassic.

Remarks: *Paraheptacladus* KOZUR & MOSTLER, 1981, is perhaps not related to *Heptacladus* DUMITRICĂ, KOZUR & MOSTLER, 1980. At present it is impossible to assign this genus to any other family of the Hexastylacea. Further new representatives of the Heptacladidae have now been found in Ladinian sediments. These species have only 6 main spines with terminal secondary spines. The inner structure is quite the same as in *Heptacladus*.

Superfamily Thalassothamnacea HAECKER, 1906

Diagnosis: Entactinaria without shell. 3-5 spines branch off from the end of a median bar. This median bar may be also reduced or quite absent. In the latter case 6-12 spines begin in one point. Sometimes the median bar is very strong, like a central axis that rises above the branching point of the other spines at one or both ends. All spines of the spiculae have apophyses in one or more levels. Sometimes a differentiation in apical and basal spines may be observed.

Distribution: Devonian - Lower Carboniferous, Middle Triassic, recent.

Included families:
Thalassothamnidae HACKER, 1906
Archaeosemantitidae KOZUR & MOSTLER, 1981
? Palhindeolithidae KOZUR & MOSTLER, 1981
Subfamily Palhindeolithinae KOZUR & MOSTLER, 1981
Subfamily Palacantholithinae KOZUR & MOSTLER, 1981

Remarks: The Thalassothamnacea HAECKER, 1906, are a transitional group between the Entactinaria n.suborder and the Collodaria HAECKEL, 1882. The latter have no skeleton or an incomplete skeleton of small isolated spicules. In typical Thalassothamnacea there is always a complete skeleton consisting of a large spicule.

The spicular system of the Thalassothamnacea HAECKER, 1906, is identical or at least very similar to the spicule of the Hexastylacea, 1882 emend. PETRUŠEVSKAJA, 1979. The similarity to the Hexastylacea is also shown by the fact, that apophyses are present in all spines. But in all Hexastylacea at least one shell is present. Transitional forms occur. In *Haplentactinia* FOREMAN, 1963, only an incomplete shell is present that originates from apophyses of a strong spicular system.

The Palaeoscenidiacea RIEDEL, 1967, are also similar. In most of the primitive representatives of this superfamily the shell is also absent. But there are some differences in the spicular system. The Palaeoscenidiacea never have in all spines the same kind of apophyses. In the apical spines the apophyses are mostly missing or they are - if present - by far weaker than in the basal spines. The apophyses of the basal spines are not restricted to one or two levels as is the case with most Thalassothamnacea.

Family Thalassothamnidae HAECKER, 1906

Thalassothamnus HAECKER, 1906
Cyrtocladus SCHRÖDER, 1906
Triassothamnus KOZUR & MOSTLER, 1981
Synonym: *Archaeothamnulus* DUMITRICA, 1982

Distribution: Middle Triassic, recent.

? Family Palhindeolithidae KOZUR & MOSTLER, 1981

Palhindeolithus DEFLANDRE, 1973
? *Conostylus* POPOFSKY, 1907
Palacantholithus DEFLANDRE, 1973
Palaeothalomnus DEFLANDRE, 1973
Xiphachistrella DEFLANDRE, 1973
? *Xiphocabrium* DEFLANDRE, 1973
Xiphocladiella DEFLANDRE, 1973
Bissylentactina NAZAROV, 1975 emend. KOZUR & MOSTLER, 1981
Arrhiniella KOZUR & MOSTLER, 1981

Distribution: Devonian - Lower Carboniferous, Middle Triassic, ? recent.

Remarks: The systematic position of the mostly small spicules assigned to different genera of the Palhindeolithidae KOZUR & MOSTLER, 1981, is unclear. Because of the small size these spicules may be isolated spicules of an incomplete skeleton of the Collodaria. But it is also possible that the first primitive Thalassothamnacea had small complete skeletons. In this case the Palhindeolithidae would be real, but very primitive Thalassothamnacea. In all cases the Palhindeolithidae seem to be the missing link between the Collodaria and Entactinaria.

Subfamily Palhindeolithinae KOZUR & MOSTLER, 1981

Palhindeolithus DEFLANDRE, 1973
? *Conostylus* POPOFSKY, 1907
? *Xiphachistrella* DEFLANDRE, 1973
? *Xiphocabrium* DEFLANDRE, 1973
? *Xiphocladiella* DEFLANDRE, 1973
Bissylentactinia NAZAROV, 1975 emend. KOZUR & MOSTLER, 1981
Arrhiniella KOZUR & MOSTLER, 1981

Distribution: Devonian - Lower Carboniferous, Middle Triassic, ? recent.

Subfamily Palacantholithinae KOZUR & MOSTLER, 1981

Palacantholithus DEFLANDRE, 1973
Palaeothalomnus DEFLANDRE, 1973

Distribution: Lower Carboniferous.

Family Archaeosemantididae KOZUR & MOSTLER, 1981

Archaeosemantis DUMITRICĂ, 1978
Tandarnia DUMITRICĂ, 1982

Distribution: Middle Triassic.

Remarks: *Archaeosemantis* DUMITRICĂ, 1978, has a spicular system very similar to that of the Palaeoscenidiacea RIEDEL, 1967, but all spines, also the apical ones, have strong apophyses.

Tandarnia DUMITRICĂ, 1982, shows some similarities to the Zamolxinae DUMITRICĂ, 1982 (Plagiacanthidae HERTWIG, 1879, Nassellaria), but as in *Archaeosemantis* the 4 basal spines (homologous to the primary and secondary lateral spines of the Nassellaria) are completely the same and no spine like D is present.

Superfamily Palaeoscenidiacea RIEDEL, 1967

Diagnosis: 4 strong sculpturated basal spines branch from a point or from the ends of a very short median bar. The 1-4 smaller apical bars are unsculpturated or considerably weaker sculpturated than the basal spines. This pentactine or modified pentactine (if more than one apical spine is present) is the basic spicular system, present in all Palaeoscenidiacea. In the most primitive representatives of this superfamily only this spicular system is present. All other representatives have one or two, rarely three, shells. If a single shell is present, the pentactine is situated either immediately inside the shell or - most frequently - it is partly included in the wall of the shell. The branching point of the pentactine spicule is always situated at or near to one pole of the shell. If a medullary shell is present, the pentactine spicule is always included in the wall of the medullary shell (or innermost medullary shell, if more than one medullary shell is present). In this case only the branching point and the apical spine are free.

Shell often coarsely latticed. In higher evolved forms the shell is composed of an outer layer with large pores and an inner layer with smaller pores. In these highly evolved forms the symmetry of the arrangement of the main spines is identical with those of the Spumellaria: one or two opposite polar spines, three spines in one plane, four spines in two nearly perpendicular axes in one plane, six spines in 3 perpendicular axes or even more spines.

Distribution: Silurian to Neogene, ? recent. From the Upper Carboniferous to the middle part of the Lower Triassic unknown till now. Highest diversity in the Middle Triassic, still frequent in the Upper Triassic. From the Rhaetian to the Neogene very rare.

Included families:
Palaeoscenidiidae RIEDEL, 1967 emend. HOLDSWORTH, 1977
Pentactinocarpidae DUMITRICĂ, 1978 emend. KOZUR & MOSTLER, 1981
Hexapylomellidae KOZUR & MOSTLER, 1979
Subfamily Hexapylomellidae KOZUR & MOSTLER, 1979
Naninae n. subfam.
Hindeosphaeridae KOZUR & MOSTLER, 1981
Parentactiniidae KOZUR & MOSTLER, 1981
Sepsagonidae KOZUR & MOSTLER, 1981

Remarks: The pentactine or modified pentactine spicule with 4 strong sculpturated basal spines of the same length and 1-4 smaller, smooth to weakly sculpturated apical spines is most characteristic for the Palaeoscenidiacea. Thus they are discernible from both the Thalassothamnacea HAECKER, 1906, and the Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979. Only the most primitive Palaeoscenidiidae RIEDEL have no shell. All other families have loose or even mostly well developed shells and are therefore clearly to be distinguished from the Thalassothamnacea, in which, apart from that, all spines of the spicule are equally sculpturated.

The Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979, have always one or more shells and a completely different spicular system, homologous with that of the Nassellaria.

Family Palaeoscenidiidae RIEDEL, 1967 emend. HOLDSWORTH, 1977

Palaeoscenidium DEFLANDRE, 1953 s.l.

Distribution: Silurian - Lower Carboniferous.

Remarks: *Palaeoscenidium* DEFLANDRE, 1953, comprises several different genera.

Family Pentactinocarpidae DUMITRICĂ, 1978 emend. KOZUR & MOSTLER, 1981

Pentactinocarpus DUMITRICĂ, 1978
Synonyma: *Oertlisphaera* KOZUR & MOSTLER, 1979
? *Praedruppatractylis* KOZUR & MOSTLER, 1979
Pentactinocapsa DUMITRICĂ, 1978
Pentactinorbis DUMITRICĂ, 1978

Distribution: Rare in the Illyrian, frequent from the Ladinian to the Upper Sevatian.

Family Hexapylomellidae KOZUR & MOSTLER, 1981

Hexapylomella KOZUR & MOSTLER, 1979
Nanina n.gen.

Distribution: Lower Carnian, Miocene.

Subfamily Hexapylomellinae KOZUR & MOSTLER, 1981

Hexapylomella KOZUR & MOSTLER, 1979

Distribution: Lower Carnian.

Subfamily Naninae n. subfam.

Diagnosis: Very thick-walled shell with large pores. Inner pore walls with some thin lamella. Pentactine spicule enclosed in a medullary shell with very large pores. Apical spine, 4 basal spines and antapical spine well developed, partly with delicate apophyses. Apical and antapical spines as well as the prolongations of the 4 basal spines end at the inner margin of the outer shell.

Distribution: Miocene of Japan.

Included genus: *Nanina* n.gen.

Remarks: In the Hexapalomellidae, too, a pentactine spine is enclosed in a coarsely latticed medullary shell and, in general, the spines of the pentactine spicules have no prolongation beyond the outer shell. But all these spines end in a small pylome of the outer shell. Sometimes the 6 spines of the spicule rise a little above the outer shell as thin spines in the centre of the 6 pylomes or some of them. No pylome is present in *Nanina* n.gen. Moreover, the outer shell is not double-walled but has an outer layer with large pores and an inner layer with smaller pores.

In the Hindeosphaeridae KOZUR & MOSTLER, 1981, always strong main spines are present outside the wall of the outer shell. Besides, the shell is double-walled like the Hexapylomellinae KOZUR & MOSTLER, 1979.

Genus *Nanina* n.gen.

Derivatio nominis: In honour of NAKASEKO, NISHIMURA and NAGATA, who, in NAKASEKO, 1982, described the internal structure of this genus for the first time.

Type species: *Melittosphaera hokurikuensis* NAKASEKO, 1955

Diagnosis: As for the subfamily.

Remarks: *Nanina* n.gen. is the youngest certain representative of the Palaeoscenidiacea RIEDEL, 1967, known so far.

Family Hindeosphaeridae KOZUR & MOSTLER, 1981

Hindeosphaera KOZUR & MOSTLER, 1979
? *Lobatactinocapsa* DUMITRICĂ, 1978
? *Dumitricasphaera* KOZUR & MOSTLER, 1979
Mulderella KOZUR & MOSTLER, 1981
Pseudostylosphaera KOZUR & MOSTLER, 1981
Weverisphaera KOZUR & MOSTLER, 1981

Distribution: Very frequent from the Anisian to the Lower Carnian, rare from the higher Carnian to the Upper Jurassic.

Family Sepsagonidae KOZUR & MOSTLER, 1981

Sepsagon DUMITRICĂ, KOZUR & MOSTLER, 1980
Parasepsagon DUMITRICĂ, KOZUR & MOSTLER, 1980
? *Kahlerosphaera* KOZUR & MOSTLER, 1979

Distribution: Lower Triassic to Jurassic.

Family Parentactiniidae KOZUR & MOSTLER, 1981

Parentactionia DUMITRICĂ, 1978

Distribution: Middle Triassic.

Superfamily inc.

Family Orosphaeridae HAECKEL, 1887

Orosphaera HAECKEL, 1882
Orona HAECKEL, 1887
Oroplegma HAECKEL, 1887
Oroscena HAECKEL, 1887

Distribution: Recent.

Remarks: The inner spicule of the Orosphaeridae is still not known well. But it seems to be similar to that of the Palaeoscenidiacea. There is also a remarkable similarity between some orosphaerids and *Pentactinocapsa* DUMITRICĂ, 1978. If the position of the Orosphaeridae HAECKEL, 1887, within the Palaeoscenidiacea RIEDEL can be confirmed by future work, then the latter taxon has to be regarded as younger synonym of Orosphaeridacea HAECKEL, 1887. But in the moment it cannot be excluded that the Orosphaeridae HAECKEL, 1887, belong to the Hexastylacea HAECKEL, 1882 emend. PETRUŠEVSKAJA, 1979.

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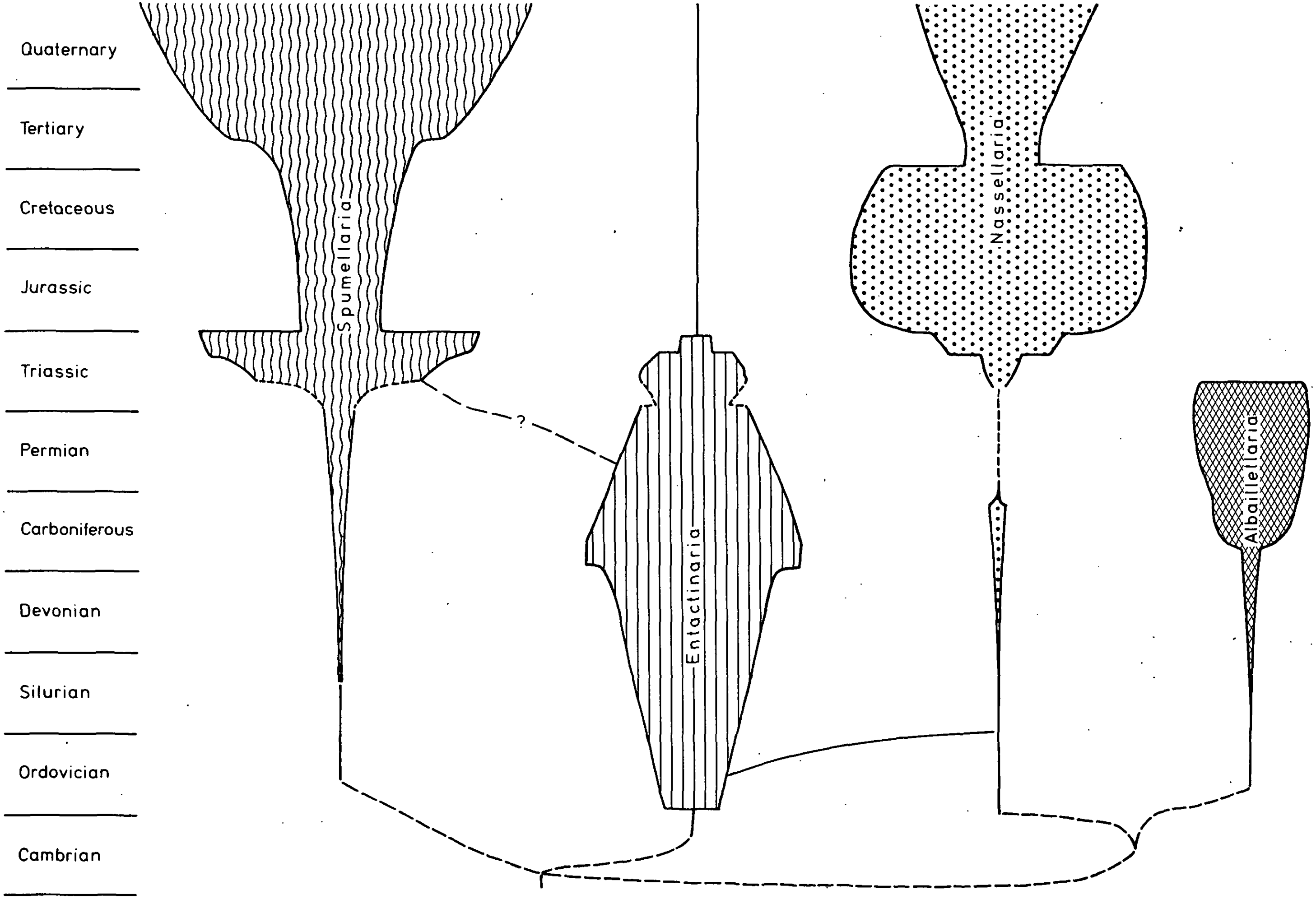
Explanation of fig. 1

Distribution and frequency of the most important suborders of the Radiolaria


Quaternary
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Spumellaria
?
Entactinaria
Nassellaria
Albaillellaria