LOWER JURASSIC RADIOLARIA FROM THE GÜMÜŞLÜ ALLOCHTON OF SOUTHWESTERN TURKEY (TAURIDES OCCIDENTALES)

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ABSTRACT. — Until recently Mesozoic Radiolaria were ignored in biostratigraphic investigations. This group of planktonic microfossils was neglected because most workers considered them to be too small and difficult to work with and to be universally long ranging.

Investigations now in progress indicate that Radiolaria evolved very rapidly during Mesozoic times. In fact, many genera and species are short ranging, cosmopolitan, and quite distinctive. Because it is now possible to separate matrix-free specimens from radiolarian cherts. Radiolaria are rapidly becoming the most important group of fossils in interpreting the stratigraphy and in turn the structure of many complex orogenic belts (e.g., Semail Ophiolite and Hawasina Complex of Oman) throughout the world.

In the present report eleven new species and three new genera are described from the Lover Jurassic of Turkey and two new species are described from the Jurassic of North America.

INTRODUCTION

Ten years ago with the advent of the Deep Sea Drilling Project (DSDP) the geologic community suddenly became more aware of the importance of planktonic microfossils in stratigraphy. Although the symmetrical arrangement of magnetic anomalies with respect to midocean ridges seemed to confirm the validity of the sea floor spreading hypothesis, the biostratigraphic'data resulting from the actual drilling of the interface between the igneus and sedimentary oceanic crust offered the first direct geotogic evidence for the existence of sea floor spreading. The data resulting from the study of planktonic foraminifera, nannofossils, and other fossil planktonic organisms in fact elevated the sea floor spreading hypothesis to a well founded theory.

Largely as a result of the Deep Sea Drilling Project investigations of all planktonic microfossils have greatly accelerated within the past ten years. Prior to this time practically nothing was known about Mesozoic Radiolaria. However, through the studies of De Wever, *et al.* (1979), Dumitrica (1978), Foreman (1973, 1975), Kozur and Mostler (1972), Pessagno (1976, 1977a, 1977b), Pessagno, Finch, and Abbott (1979), Riedel and Sanfilippo (1974) and others, the geologic history of this group of organisms is gradually unfolding.

In addition to the impetus gained in the study of Radiolaria from the Deep Sea Drilling Project a great deal of impetus has also been gained through advances in technology. For example, the introduction of the scanning electron microscope in the late 1960's allowed the rapid and accurate illustration of microfossil specimens. The development of hydrofluoric acid technique (Dumitrica, 1970; Pessagno and Newport, 1972) made it possible to extract matrix-free Radiolaria from radiolarian cherts. Previously all Radiolaria occurring in cherts had to be studied in rock thin-section. Now radiolarian cherts of Mesozoic and even Paleozoic age can be accurately dated in most major orogenic belts. As a result the geologic history of many major orogenic belts is more clearly understood (See Irwin, Jones, and Pessagno, 1977; McLaughlin and Pessagno, 1978).

Table - 1

	Occurrence in North America
Hagiastrum infinitum, n. sp.	X
Crucella sp. A	X
Orbiculiforma multifora, n. sp.	
Orbiculiforma sp.aff. *O. mclaughlini* Pessagno	CR
Protopsium ehrenbergi, n. sp.	
Protopsium ispartaense, n. sp.	X
Protopsium sp. A	
Protopsium sp. B	
Protopsium sp. C	
Pseudoheliodiscus yaoi, n. sp.	
Pseudoheliodiscus sp. A	
Pseudoheliodiscus sp. B	
Pantanellium inornatum, n. sp.	CR
Praeconocaryomma parvimamma, n.sp.	CR
Canoptum annulatum, n. sp.	X
Canoptum poissoni, Pessagno	X
Canoptum rugosum, n. sp.	
Katroma neagui, n. sp.	CR
Natoba minuta, n. sp.	

Note: X : occurrence in North America.
CR : occurrence of a closely related form in North America.

A detailed system of radiolarian zonation has been proposed for strata of Late Jurassic (Tithonian) to Late Cretaceous (Maestrichtian) age (Pessagno, 1976, 1977a, 1977b). Studies by Pessagno and Blome in western North America, by Tippit and Pessagno in Oman, by Dumitrica in Romania, and by De Wever in the Mediterranean offer the promise of equally detailed zonal schemes for older (pre-Tithonian) Mesozoic strata.

The purpose of this report is to describe some of the more distinctive elements in a radiolarian assemblage from Lower Jurassic limestones in the Gümüşlü allochton of southwestern Turkey (Taurides Occidentales) (Poisson, 1977). No attempt at this time will be made to describe the entire radiolarian assemblage.

STRATIGRAPHY

The details of the lithostrstigraphy and the tectonic history of the Gümüşlü allochtonous unit are discussed elsewhere in this report (all the detail *in* Poisson 1977).

Pessagno and Blome are in the process of studying well preserved Upper Triassic (Norian) to Upper Jurassic (Caliovian) radiolarian faunas from eastern Oregon and the Queen Charlotte

Islands. Because the radiolarian-bearing strata in these areas also contain megafossils such as ammonites, it has been possible to integrate the radiolarian biostratigraphy to that of the ammonites and in turn to the European stages. Although most of the species level taxa in the Lower Jurassic assemblage remain undescribed, a sufficient number of genera and families have been described to establish broad, easily recognizable biohorizons based on these superspecific taxa.

The more significant of these biohorizons are as follows:

Biohorizon 1: Final appearance of *Paraentactinia* Dumitrica, Upper Hettangian.

Biohorizon 2: First appearance of *Crucella* Pessagno s. s., Lower Sinemurian.

Biohorizon 3: First appearance of *Hsuum* Pessagno, Lower Pliensbachian.

Biohorizon 4: First appearance of *Praeconocaryomma* Pessagno, Lower Pliensbachian.

Biohorizon 5: First occurrence of *Archaeodictyomitridae* Pessagno, Upper Pliensbachian.

Biohorizon 6: Final appearance of *Pseudoheliodiscus* Kozur and Mostler, Post Pliensbachian, pre-Lower-Middle Bajocian.

Biohorizon 7: Final appearance of *Canoptum* Pessagno, Toarcian -? Lower Bajocian.

Biohorizon 8: First appearance of *Parvicingula* Pessagno (= base of Zone 1, Pessagno, *1971 a, b;* revised herein), Lower Bajocian (P)-Lower-Middle Bajocian.

Biohorizon 9: First appearance of *Emiluvia* Foreman, Lower Bajocian (?)-Lower-Middle Bajocian.

Utilizing the biohorizons cited above and the biostratigraphic data presented in Table 1, it can be first surmised that the Turkish assemblage occurs below Biohorizon 5, the first occurrence of the Archaeodictyomitra'dae. In western North America Archaeodictyomitrids have been found in the Upper Pliensbachian Nicely Formation of eastern Oregon. According to Imlay (1968, p. C9) the entire Nicely Formation is assignable to the Upper Pliensbachian and contains an ammonite assemblage that is correlative with the European *Amaltheus margaritatus* and *Pleurococeras spinatum* Zones.

Secondly, it can be established that the Turkish sample occurs at or above Biohorizon 4, the first occurrence of *Praeconocaryomma* Pessagno and the Praeconocaryommidae Pessagno. In North America *Praeconocaryomma* seems to make its first appearance in strata of Early Pliensbachian age. It has been observed, for example, in the uppermost part of the type Maude Formation (QC 537; Queen Charlotte Island, British Columbia; see Locality Descriptions). The Maude Formation according to Frebold ,(1970, pp. 444.445) contains an ammonite assemblage correlative with the European *Tragophylloceras ibex* Zone. *Praeconocaryomma* has not been observed in samples below the top of the Maude Formation or from the underlying Kunga Formation (Rhaetian to Sinemurian).

At the species level *Hagiastrum infinitum,* n. sp., has been observed in the type Maude Formation (QC 532, 534, 537), in late early to early Late Pliensbachian cherts from the Franciscan Complex (NSF 960) of California, and from the Late Pliensbachian Nicely Formation of eastern Oregon (OR 536; see Locality Descriptions). *Protopsium* (?) *ispartaense,* n.sp., and C. *annulatum,* n.sp., have been observed from tfye Franciscan Complex (NSF 960) and *Crucella* sp. A has been observed in the type Maude Formation (QC 532). Other species such as *Katroma neagui,* n.sp., *Praeconocaryomma parvimamma,* n.sp., and *Orbiculiforma* sp. aff. *0. mclaughlini* Pessagno are closely related to forms that occur in North American Pliensbachian samples.

On the basis of the data presented above the.Turkish Lower Jurassic radiolarian assemblage is tentatively assigned to the Lower Pliensbachian. This interpretation largely depends on whether the Maude Island samples record the real first occurrence of *Praeconocaryomma*. At this early stage in our study of Lower Jurassic Radiolaria a Late Sinemurian age can not be ruled out completely. It should also be noted that the radiolaria'n limestone from which our sample (1662-D) was derived occurs below limestone strata (Ammonitico-rosso facies) containing Upper Pliensbachian ammonites.

The Turkish radiolarian assemblage is also of interest in that it is a bona fide Tethyan assemblage dominated by Spumellariina. Given the fact that the fauna is Tethyan and hence a low latitude assemblage, it is surprising that it is not as diversified as those of Pliensbachian age from the Queen Charlotte Island and eastern Oregon (45 species level taxa versus 90+ species level taxa). Jones, *et al.* (1977), on the basis of both convincing paleomagnetic and stratigraphic evidence, demonstrated that Queen Charlotte Islands' structural block is allochthonous and was displaced from low to high latitudes during Mesozoic times. Hence, the diverse Pliensbachian faunas from the Maude Formation are likewise low latitude assemblages. It is conceivable that the Turkish assemblage reflects a more closed system of oceanic circulation which perhaps prevailed during Early Jurassic times.

SYSTEMATIC PALEONTOLOGY

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The designation USNM in this section refers to the deposition of type specimens at the U.S. National Museum, Washington, D.C.

Phylum: PROTOZOA

Subphylum: SARCODINA

Class: RETICULARIA

Subclass: RADIOLARIA

Order: POLYCYSTIDA

Suborder: SPUMELLARIINA

Superfamily: SPONGODISCACEA HAECKEL, 1881, emend. PESSAGNO, 1971, 1973

Range: Paleozoic to Recent.

Subsuperfamily: PSEUDOAULOPHACILAE RIEDEL, 1971, emend. PESSAGNO, 1971

Range: Paleozoic to Recent.

Family: HAGIASTRIDAE RIEDEL, 1967, emend. PESSAGNO, 1971

Type genus: Hagiastrum HAECKEL, 1881

Range and occurrence: Mesozoic; world-wide.

Subfamily: HAGIASTRINAE RIEDEL, 1967, emend. PESSAGNO, 1971, 19770

Type genus: Hagiastrum HAECKEL, 1881

Range and occurrence: Mesozoic; world-wide.

Genus: Hagiastrum HAECKEL, 1881, emend. PESSAGNO, 1971, 19770

Type species: *Hagiastrum plenum* RUST, 1885

Range and occurrence: Triassic to Cretaceous, world-wide.

Hagiastrum infinitum PESSAGNO and POISSON, n. sp.
(PL I, fig.1-4, 6, 8)

Description: Test comprised of irregular triangular, tetragonal, and pentagonal pore frames with nodes at vertices. Pore frames somewhat less irregular on ray tips. Pores dominally elliptical. Primary spines spongy at least proximally; distal portions usually broken.

Remarks: *H. infinitum,* n. sp., differs from *H. augustum* Pessagno (1979) by having much slender rays and coarser, more irregular meshwork.

Infinitus-a-um (Latin, adj.): infinite, unbounded.

Measurements: Length of rays exclusive of spines: Holotype: 180 microns, paratypes and hypotypes: maximum 220 microns, minimum 180 microns (7 specimens).

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 263993, paratypes: USNM 263994 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Upper Sinemurian (?)-Lower Pliensbachian) of Turkey. To date this species has only been found in Pliensbachian strata in North America. It has been recovered from Upper Pliensbachian cherts from the Franciscan Complex of California (NSF 960); from the Lower Pliensbachian part of the Maude Formation of the Queen Charlotte Islands (QC 532; QC 534; QC 537);and from the Upper Pliensbachian Nicely Formation of eastern Oregon (OR 536) (See Locality Descriptions). *H. infinitum* is most abundant in the Franciscan sample.

Genus: Crucella PESSAGNO, 1971

Type species: *Crucella messinae* PESSAGNO, 1971

Range and occurrence: Lower Jurassic (Sinemurian) to Upper Cretaceous (Upper Campanian).

Crucella sp. A
(PI. II, fig. 6)

Remarks: This form is characterized by having triangular pore frames except on the distal portion of its four rays.

Range an4 occurrence: *Crucella* sp. A is rare in the Turkish material. It has been observed in the type Maude Formation (Queen Charlotte Island, British Columbia) in strata containing Lower Pliensbachian ammonites (QC 532;.-see Locality Descriptions).

Family: ORBIC&LIFORMIDAE PESSAGNO, 1973

Type genus: *Orbtculiforma* PESSAGNO, 1973

Range: Triassic to Cretaceous so far as known.

Occurrence: World-wide.

Genus: *Orbiculiforma* PESSAGNO, 1973

Type species: *Orbiculiforma quadrat a* PESSAGNO, 1973

Range and occurrence: Same as for family.

Orbiculiforma multifora PESSAGNO and POISSON, n. sp.
(PI. I, fig. 5, 7, 9, 10)

Description: Test with angled periphery having twenty or more peripheral spines; spines circular in axial section lacking alternating grooves and ridges. Central cavity relatively shallow, about half diameter of test; test sloping from edge of central cavity to periphery. Meshwork comprised of pentagonal and tetragonal pore frames; pore frames smaller in central cavity than outside central cavity.

Remarks: *0. multifora*, n. sp.,by virtue of its angled periphery is most similar to *0. maxima* Pessagno (1976) of the Upper Cretaceous. It differs from *0. maxima* (1) by having massive, relatively long peripheral spines which are circular in axial section; (2) by having a mixture of tetragonal and polygonal pore frames; and (3) by having a shallower central cavity. The peripheral spines of *0. maxima* are very short and appear to be predominantly spongy.

Muliforus-a-um (Latin, adj.): pierced with many holes.

Measurements: Holotype: Test diameter 280 microns, diameter of central cavity 140 microns. Measurement of six specimens: Maximum diameter of test 300 micron, minimum diameter of test 120 microns, maximum diameter of central cavity 140 microns, minimum diameter of central cavity 120 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 263995, paratypes: USNM 263996 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey.

Orbiculiforma sp. aff. *0. mdaughlini* PESSAGNO, 1977a
(PL II, fig. 7-9)

Remarks: This form differs from *0. mdaughlini* Pessagno (NSF 960 Pliensbachian. See Locality Descriptions) by having a slightly narrower rim around the central cavity and by having tetragonal and pentagonal rather than pentagonal and hexagonal pore frames. It is apparent that the two forms are closely related.

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey.

Family: SPONGURIDAE HAECKEL, 1862, emend. PESSAGNO, 1973

Type genus: **Spongurus** HAECKEL, 1862

Range and occurrence: Paleozoic? Mesozoic to Recent.

Subfamily: ARCHAEOSPONGOPRUNINAE PESSAGNO, 1973

Type genus: Archaeospongopnmum PESSAGNO, 1973

Range and occurrence: Jurassic to Recent.

Genus: Protopsium PESSAGNO and POISSON, n. genus.

Type species: *Protopsium ehrenbergi,* n. sp.

Description: Primary test ellipsoidal (sometimes somewhat flattened) with two polar spines, Patagium-like mass of irregularly shaped and distributed pore frames occurring in one plane. Secondary spines of variable size radiating out from primary test into patagium-like mass seemingly offering support for the irregular meshwork. Polar spines with or without alternating grooves and ridges, occasionally bifurcating.

Remarks: *Protopsium,* n. gen., differs from *Archaeospongoprunum* Pessagno (1973): (1) by possessing a patagium-like mass supported by secondary spines; (2) by having polar spines which may or may not have alternating ridges and grooves and which sometimes bifurcate; and (3) by sometimes displaying a somewhat compressed test. *Protopsium* like *Archaeospongoprunum* possesses meshwork arranged in concentric layers. *Protopsium* is a name formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, Pt. IV, Recommendation 40, p. 113).

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey. Lower Jurassic (Lower Pliensbachian) cherts from Franciscan Complex. Upper Pliensbachian Nicely Formation of eastern Oregon.

Protopsium ehrenbergi PESSAGNO and POISSON, n. sp.
(PL II, fig. 1-3)

Description: Primary test small, ellipsoidal flattened slightly with tetragonal pore frames with small nodes at vertices. Secondary spines extending from primary test into flattened, rectangular patagium-tilje mass. Polar spines long, triradiate with three narrow grooves alternating with three narrow ridges; ridge tops rounded not sharp. Ridges and grooves of equal width.

Remarks: *P. ehrenbergi,* n. sp., is compared to *P. ispartaense,n.* sp., under the latter species.

This species is named after C.G. Ehrenberg, whose pioneering work in the early to middle 1800's, laid the foundation for micropaleontology.

Measurements: System of measurements after Pessagno (1973). Holotype: dd' = 20 microns, cc' = 20 microns, AA' = 100 microns, BB' = 70 microns. Maximum six specimens: dd' = 20 microns, cc' = 20 microns, AA' = 100 microns, BB' = 70 microns. Minimum for six specimens: dd' = 20 microns, cc' — 20 microns, AA' = 80 microns, BB' = 50 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 263997, paratypes: USNM 263998 and Pessagno Collectionv

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey.

Protopsium ispartaense PESSAGNO and POISSON, n. sp.
(PI. II, fig. 4-5; PI., Ill, fig. 1-9; PI XIII, fig. 4)

Description: Test ellipsoidal with massive tetragonal to pentagonal pore frames and thick, massive polar spines which are circular in axial section. One spine shorter than other, greater in diameter. No patagium-like mass observed.

Remarks: *P.ispartaense,* n. sp., differs from *P.ehrenbergi* by having thick, massive polar spines which are circular in axial section rather than possessing alternating grooves and ridges.

This species is named for the town of Isparta in the type area.

Measurements: System of measurements after Pessagno (1973). Holotype: A'S and AS = 55 microns, cc' = 30 microns, dd' =15 microns, AA' = 80 microns, BB' = 70 microns. Maximum for eight specimens: A'S and AS both = 70 microns, cc' = 30 microns, dd' = 15 microns, AA' = 95 microns, BB' = 75 microns. Minimum for eight specimens: A'S and AS both = 45 microns, cc' = 20 microns, dd' = 15 microns, AA' = 70 microns, BB' = 60 microns.

Protopsium sp. A
(PI. IV, fig. 1, 4)

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian(?)-Lower Pliensbachian) of Turkey. Lower Jurassic (Pliensbachian) cherts from the Franciscan Complex of California (NSF 960). See Locality Descriptions.

Protopsium sp. B
(PI. IV, fig. 2)

Remarks: This form is characterized by a bifurcation of one polar spine.

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?), - Lower Pliensbachian) of Turkey. See Locality Descriptions.

Protopsium sp. C
(PI. IV, fig. 3, 5-8)

Remarks: Note flattening displayed by this form.

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?) - Lower Pliensbachian) of Turkey. See Locality Descriptions.

Subsuperfamily: SPONGODRUPPILAE HAECKEL, 1887, emend. PESSAGNO, 1973

Range and occurrence: Paleozoic to Recent.

Family: PARASATURNALIDAE KOZUR and MOSTLER, 1972, emend. PESSAGNO, 1979

Type genus: Parasaturnalis KOZUR and MOSTLER, 1972

Range and occurrence: Upper Triassic to Upper Cretaceous; world-wide.

Subfamily: HELIOSATURNALINAE KOZUR and MOSTLER, 1972, emend. PESSAGNO, 1979

Type genus: Heliosaturnalis KOZUR and MOSTLER, 1972, emend. PESSAGNO, 1979

Range and occurrence: Upper Triassic to Lower Jurassic; world-wide.

Genus: Pseudoheliodiscus KOZUR and MOSTLER, 1972 emend. PESSAGNO, 1979

Type species: *Pseudoheliodiscns riedeli* KOZUR and MOSTLER, 1972

Range and occurrence: Karnian (?) - Norian to Toarcian; world-wide.

Pseudoheliodiscus yaoi PESSAGNO, n. sp.
(PI. IV, fig. 9; PI. V, fig. 1, 4, 7-9; PI. XIII, fig. 2)

Description: Test with extremely broad, flat ring having thirteen to fourteen peripheral spines and about twelve auxiliary spines. Central spongy cortical shell occupying most of ring on most specimens; cortical shell comprised of concentric layers of irregular polygonal (triangular, tetragonal, pentagonal) pore frames.

Remarks: *Pseudoheliodiscus yaoi*, n. sp., differs from *P. riedeli* Kozur and Mostler (1972) by having a much broader ring with shorter peripheral spines. It differs from *P.finchi* Pessagno (1979) by having a somewhat wider ring and thirteen to fourteen as opposed to ten or eleven peripheral spines.

This species is named for Dr. Akira Yao (Osaka City University) in honor of his contributions to the study of the Parasaturnalidae.

Measurements: Holotype: Diameter of spongy cortical shell 140 microns; diameter of test including cortical shell and ring, excluding peripheral spines on ring 230 microns; width of ring, exclusive of peripheral spines 30 microns.

Maximum and minimum measurements for eight specimens: Diameter of cortical spongy cortical shell: maximum 150 microns, minimum 135 microns. Diameter of test including cortical shell and ring, excluding peripheral spines on ring: maximum 260 microns, minimum 230 microns. Width of ring, exclusive of peripheral spines: maximum 45 microns, minimum 30 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264001, paratypes: USNM 264002 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Upper Sinemurian (?)-Lower Pliensbachian) of Turkey.

Pseudoheliodiscus sp. A
(PL V, fig. 2,3)

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian(?)-Lower Pliensbachian) of Turkey. See Locality Descriptions.

Pseudoheliodiscus sp. B
(PI. V, fig. 5,6)

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey. See Locality Descriptions.

Superfijmily: SPHAERALLACEA HAECKEL, 1881, emend. PESSAGNO, 1977a

Range and occurrence: Paleozoic to Recent.

Family: PANTANELilbAE PESSAGNO, *1917 b*

Type genus: *Paritanellium* PESSAGNO, 1977a

Range and occurrence: Triassic to Lower Cretaceous. World-wide.

Subfamily: PANTANEUINAE PESSAGNO, *1977b*

Type genus: Pantanellium PESSAGNO, *1977a*

Range and occurrence: Same as for family.

Genus: Pantanellium PESSAGNO, 1977a

Type species: *Pantanellium riedeli* PESSAGNO, 1977c

Range and occurrence: Upper Triassic (Upper-Middle Norian) to Lower Cretaceous (Upper Valanginian?). World-wide.

Pantanellium inornatum PESSAGNO and POISSON, n. sp.
(PI. VI, fig. 1-9)

Description: Cortical shell, thin, spherical with relatively slender triradiate bipolar spines; triradiate bipolar spines with three rounded, narrow ridges alternating with three narrow grooves. Meshwork of cortical shell comprised of equal number of hexagonal and pentagonal pore frames. Pentagonal pore frames slightly smaller than hexagonal pore frames. Meshwork of first medullary shell thick likewise comprised of hexagonal pentagonal pore frames. Secondary radial beams between cortical shell and first medullary shell circular in axial section.

Remarks: *Pantanellium inornatum* Pessagno, n.sp., differs from *P. riedeli* Pessagno (1977a) (1) by having longer, slender polar spines with narrow ridges separated by narrow grooves; (2) by having smaller, narrower ridges separated by narrow grooves; (2) by having smaller, more numerous pore frames; and (3) by having a thinner walled cortical shell and a thicker walled first medullary shell.

Inornatus-a-um (Latin, adj.): unadorned.

Measurements: System of measurements after Pessagno, (1973). Holotype: A'S = 110 + microns, AS = 85 microns, cc' = 25 microns, dd' = 20 microns, AA' = 85 microns, BB' = 80 microns. Maximum (measurement of specimens): A'S = 110 microns, AS = 85 microns, cc' = 30 microns, dd' = 25 microns, AA' = 90 microns, BB' = 85 microns. Minimum (measurement of nine specimens): A'S = 85 microns, AS = 55 microns, cc' = 25 microns, dd' = 20 microns, AA' = 85 microns, BB' = 75 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264003, paratypes: USNM 264004 and Pessagno Collection.

Range and occurrence: Unnamed forms from Upper Sinemurian and Lower Pliensbachian strata in western North America appear closely related to *P.inornatum.* However, this species is presently known only from its type locality in Turkey.

Family: PRAECONOCARYOMMIDAE PESSAGNO, 1976

Type genus: Praeconocaryomma PESSAGNO, 1976

Range and occurrence: Lower Jurassic (Pliensbachian) to Upper Cretaceous (Campanian). World-wide.

Genus: Praeconocaryomma PESSAGNO, 1976

Type species: *Praeconocaryomma unhersa* PESSAGNO, 1976

Range and occurrence: Lower Jurassic (Pliensbachian) to Upper Cretaceous (Campanian). *Praeconocaryomma-likc* forms occur as low as the Upper Paleozoic (Mississippian). However, in all cases where specimens are well enough preserved to permit examination of internal morphology, these forms have proven to be Enactinids.

Pracconocaryomma immodica PESSAGNO and POISSON, n. sp.
(PI. VII, fig. 2-9)

Praeconocaryomma magnimamma (RUST). PESSAGNO, 19770, p. 77, PI. 5, figs. 14-16; PL 6, fig. 1

Description: Cortical shell with prominent mammae which tend to be exceedingly high in relief. Distal surfaces (tops) of mammae imperforate, somewhat flattened, pentagonal in outline; mammae with radially arranged primary spines that are circular in axial section. Each face of pentagonal mammae with large pores; pores separated by stout rays which project into intermammary areas; individual rays bifurcate or trifurcate linking up with rays of adjoining mammae and forming triangular intermammary pore frames. Massive nodes present at point of bifucation or trifucation. Well preserved specimens with thinner rays projecting from bottom side of rays at nodal points forming subsidiary triangular pore frames. Primary radial beams (circular in axial section) continuous with radial beams connecting cortical shell with first medullary shell and first medullary shell with second medullary shell. First medullary shell with triangular meshwork comprised of equilateral triangular pore frames; second medullary shell with polygonal pore frames.

Remarks: *P. immodica*, n. sp., differs from *P. media*, n. sp., (1) by having mammae which are pentagonal rather than hexagonal in outline and which are considerably higher in relief; (2) by having mammae which are more closely spaced; and (3) by having more complex intermammary areas. *P. media* has triangular mammary pore frames closed by a bar at their base; however, the mammary pore frames of *P. immodica* lack the basal bar and are open basally.

This species seems to be the most advanced form in the *P. parvimamma*, n. sp., lineage group. At present it is not possible to link it directly to earlier and simpler forms such as *P. media*. It would, however, appear that the basal bar of the *P. media* mammary pore frames has been lost in the course of the evolution of this lineage.

Immodictis-a-um (Latin, adj.): immoderate, excessive.

Measurements: Holotype: Diameter of cortical shell 206 microns; height of mammae 44 microns. Measurement of ten specimens: Maximum diameter of cortical shell 225 microns, minimum diameter of cortical shell 193 microns, maximum height of mammae 44 microns, minimum height 25 microns.

Type locality: BK 605. Franciscan Complex. See Locality Descriptions.

Deposition of types: Holotype: USNM 264005, paratypes: USNM 264006 and Pessagno Collection.

Range and occurrence: Toarcian to Lower Tithonian-Upper Kimmeridgian in California. Franciscan Complex of California Coast Ranges and North Fork Terraine of Klamath Mountains. Cherts associated with Coast Range Ophiplite at Stanley Mountain, California Coast Ranges.

Praeconocaryomma, media PESSAGNO and POISSON, n. sp.
(PL-VIII, fig. 1-4)

Description: Cortical shell with mammae having radially arranged primary spines which originate in their center. Primary spines circular in axial Section. Distal (top) surfaces of mammae convex, hexagonal in outline. Six sides of each mamma with six very large equilateral pore frames (mammary pore frames) inclined away from faces of mammae. Mammary pore frames with massive bars comprising legs and thinner bars comprising base's; two massive nodes occurring at juncture between legs arid base of each mammary pore frame. Legs of mammary pore frames bowed inwards, aligned with legs of pore frames of opposing mammae forming large equilateral triangular areas. Smaller, less massive equilateral triangular pore frames (intermammary pore frames) inserted in center of large triangular area formed by bases of mammary pore frames (PI. VIII, figs. 1-3). First medullary shell comprised of equilateral triangular pore frames with nodes at vertices,; radial beams circular in axial section and continuous with primary spines in center of each mamma, connecting with first medullary shell at nodal points of triangular pore frames. Second medullary shell with polygonal pore frames.

Remarks: *P. media,* n. sp., has been compared to *P. parvimamma,* n.sp., under the latter species. It differs from *P. immodica,* n. sp., (1) by having mammae which are considerably lower in relief and more widely separated and (2) by having less complex intermammary pore structure.

Medius-a-um (Latin, adj.): middle.

Measurements: Holotype: Diameter of cortical shell 238 microns, height of mammae 25 microns. Measurement of nine specimens: Maximum diameter 244 microns, minimum diameter 213 microns, maximum height of mammae 28 microns, minimum height of mammae 19 microns.

Type locality: NSF 960. Franciscan Complex. See Locality Descriptions.

Deposition of types: Holotype: USNM 264007. paratypes: USNM 264008 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Pliensbachian) so far as known. Franciscan Complex of California (NSF 960).

Praeconocaryomma parvimamma PESSAGNO and POISSON, n. sp.
(PI. VIII, fig. 5-8; PI. IX, fig. 2)

Description: Cortical shell with mammae having radially arranged relatively long primary spines originating from the center of their flat distal (top) surfaces. Primary spines relatively long, circular in axial section. Distal flattened surfaces of mammae hexagonal in outline; six sides of each mamma with massive triangular mammary pore frames at their base; mammary pore frames with massive nodes at their base only; pore frames and sides of mammae sloping gently outward. Six rays originating from position of nodes at base of mammary pore frames, aligned with legs of each mammary pore frame and interconnecting with rays of adjoining mammae. Large subelliptical pores occurring between rays. Cortical shell and two medullary shell connected by radial beams which are circular in axial section. First medullary shell with triangular pore frames having nodes at their vertices; second medullary shell with polygonal (pentagonal?) pore frames.

Remarks: *P. parvimamma,* n. sp., differs from *P. media,* n. sp., (1) by having much smaller, less inclined mammary pore frames and (2) by having mammae which are smaller with flattened distal (top) surfaces.

P. parvimamma appears to be the earliest and simplest form of a lineage group (termed the *P. parvimamma* lineage group herein) which includes at least four morphotypes. The data at hand indicate that the *P. parvimamma* lineage group makes its first appearance in the Lower Pliensbachian (PUpper Sinemurian) and its final appearance in the Lower Tithonian. During the period from Early Pliensbachian to Early Tithonian times this lineage tends to change through an increase in the width and height of mammae and by developing more complex structure in the intermammary areas. All members of this group display a first medullary shell with equilateral triangular pore frames.

It should be noted that the form figured by Pessagno (1977) as *P. magnimamma* (Rust) is assigned to *P. immodica*, n. sp., herein. Rust's (1898, PI. IV, fig. 1) illustration of *A. magnimamma* shows a form with mammae and intermammary areas perforated by numerous small pores. Pessagno originally assumed that the small pores were a figment of Rust's imagination and that the extremely large mammae with long smooth (circular in axial section) primary spines were the distinguishing feature of *P. magnimamma.* Unfortunately, however, a form quite similar to Rust's form occurs in Pliensbachian cherts from the Franciscan Complex. This form is referred to *P.* sp. aff. *P. magnimamma* (Rust) herein.

Parvus-a-um (Latin,adj.): small + *mamma (-ae,* F.) = breast

Measurements: Holotype: Diameter of cortical shell 235 microns, height of mammae 20 microns. Measurement of nine specimens: maximum diameter of cortical shell 260 microns, minimum diameter of cortical shell 200 microns. Maximum height of mammae 20 microns, minimum height 12 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264009, paratypes: USNM 264010 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)-Lower Pliensbachian) of Turkey. Forms like the Turkish specimens but having broader mammae occur in Lower Jurassic (Pliensbachian) cherts from the Franciscan Complex of California (NSF 960; see Locality Descriptions and PI. IX, fig. 1). Such forms are referred to *P.* sp. aff. *P. parvimamma* herein.

Praeconocaryomma sp. aff. *P. magnimamma* (RUST), 1898
(PI. IX, fig. 3-5)

Remarks: This form may well be the same form figured by Rust (1898, PI. IV, fig. 1) as *Acanthosphaera magnimamma.* Rust illustrates a form (1) with prominent mammae penetrated everywhere by small pores; (2) with long spines which are circular in axial section; and (3) with abundant small pores in the intermammary areas. Unfortunately his illustrations are too schematic to make precise identification possible.

Range and occurrence: Lower Jurassic (NSF 960; Pliensbachian) cherts from the Franciscan Complex. See Locality Descriptions.

Praeconocaryomma sp. aff. *P.parvimamma* PESSAGNO and POISSON, n. Sp.
(PI.-IX, fig. 1)

Remarks: This form appears to be closely related to *P. parvimamma.* Both forms display the same sort of mammary and intermammary pore frames. However, *P.* sp. aff. *P. parvimamma* has considerably broader mammae. In that One of the phylogenetic trends characteristic of the *P. parvimamma* lineage is an increase in the size of the mammae, this form is interpreted as being somewhat more advanced than is *P. parvimamma.*

Range and occurrence: Lower Jurassic (Pliensbachian; NSF 960). See Locality Description.

Suborder: NASSELLARIINA EHRENBERG, 1875

Superfamily: CYRTOIDEA HAECKEL, 1862

Range and occurrence: Paleozoic?; Triassic to Recent.

Subsuperfamily: EUCYRTIDILAE EHRENBERG, 1847

Range and occurrence: Triassic to Recent.

Family: CANOPTIDAE PESSAGNO, 1979

Type genus: Canoptum PESSAGNO, 1979

Range: Upper Triassic (KarnianP-Norian) to Lower Jurassic (Pliensbachian-Toarcian?)

Occurrence: World-wide.

Genus: Canoptum PESSAGNO, 1979

Range and occurrence: Same as for family.

Canoptum anulatum PESSAGNO and POISSON, n. sp.
(PI. IX, fig. 6-9; PI. X, fig. 1-9; PI. XV, fig. 2,4)

Description: Cephalis dome-shaped, lacking a horn. Subsequent chambers trapezoidal in outline, numerous; closely spaced except for final chambers. Post-abdominal chambers eleven to fifteen in number, separated by prominent circumferential ridges; ridges with short, discontinuous costae; approximately fifteen costae visible on a given ridge laterally. Short costae at right angles to circumferential ridges, forming linked-H pattern. Single small, circular pores occurring between two given costae and adjacent to ridge. Pores, ridges, and costae usually buried by microgranular outer layer of shell material except when specimen is excessively etched. Pores in area between ridges usually elliptical in shape, set in linearly arranged, rectangular pore frames; usually buried by outer layer of shell material. Final two post-abdominal chambers (segments) decreasing in width, increasing in height; pentultimate chamber often with tubular extension.

Remarks: *Canoptum anulatum,* n. sp., possesses circumferential ridges that are significantly different from those of the type species of *Canoptum, C. poissoni* Pessagno (1979). The linked-H circumferential ridge structure displayed by *C. anulatum* is shared by a number of yet undescribed forms from the Lower Jurassic. Forms with this sort of structure have not been observed below the Hettangian. *C. anulatum* is tentatively included in *Canoptum* in this report. However, it may be desirable in the future to include it under a new genus.

C. *anulatum* also differs from C. *poissoni* by having a slender, more elongate test with more closely spaced post-abdominal chambers (segments).

Anulatus-a-um (Latin, adj.): Beringed, ornamented with rings.

Measurements: Holotype: Length 310 microns, width 95 microns. Measurement of seven specimens: Maximum length 435 microns, minimum length 310 microns, maximum width 100 microns, minimum width 90 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264011, paratypes USNM 264012 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Upper Sinemurian (?)-Lower Pliensbachian) of Turkey. Pliensbachian cherts in Franciscan Complex of California (NSF 960; see Locality Descriptions). Forms similar to C. *anulatum*, n. sp., have been observed in the Hettangian Graylock Formation of eastern Oregon. These forms differ from C. *anulatum* by having seventeen to twenty chambers (segments) and somewhat wider tests.

Canoptum poissoni PESSAGNO, 1979
(PI. XI, fig. 1-4)

Canoptum poissoni PESSAGNO, 1979
(PI. X, fig. 2-3)

Range and occurrence: Lower Jurassic (Poisson 1662D; Upper Sinemurian (?)) of Turkey.

Canoptum rugosum PESSAGNO and POISSON, n. sp.
(PI. XI, fig. 5-9; PI. XIII, fig. 3; PL XIV, fig. 1-2)

Description: Test as with genus. Cephalis hemispherical; post-cephalic chambers trapezoidal in outline increasing relatively rapidly in width and height as added. Circumferential ridges absent between cephalis and thorax and between abdomen and thorax; present between abdomen and first post-abdominal chamber and each of subsequent four or five post-abdominal chambers. Circumferential ridge when stripped of outer layer of microgranular shell material displaying linked-H pattern identical to that described for C. *anulatum,* n. sp. Post-abdominal chambers constricted medially, giving rise to lobulate test outline. Inner layer of post-abdominal chambers comprised of two rows of massive tetragonal pore frames between circumferential ridges. Outer microgranular layer on well preserved specimens with rugose surface; rugosities probably a reflection of massive of inner layer.

Remarks: *Canoptum rugosum,* n.sp., differs from C. *anulatum,* n.sp., (1) by having a shorter, broader test with one half to one third the nummer of post-abdominal chambers; (2) by having widely rather than closely spaced circumferential ridges; (3) by having post-abdominal chambers with a rugose surface; and so forth. Both species share the same linked-H circumferential ridge structure.

Rugosus-a-um (Latin, adj.): wrinkled.

Measurements: Holotype: Length 140 microns, width 75 microns. Measurement of eight specimens: Maximum length 165 microns, minimum length 140 microns, maximum width 95 microns, minimum width 65 microns.

Type locality: *Poisson* 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264013, paratypes: USNM 264014 and Pessagno Collection.

Range and occurrence: Lower Jurassic (Upper Sinemurian(?)-Lower Pliensbachian) of Turkey so far as known.

Family: SYRINGOCAPSIDAE FOREMAN, 1973

Type genus: Syringocapsa NEVIANI, 1900

Range and occurrence: Triassic to Cretaceous World-wide.

Genus: Katroma PESSAGNO and POISSON, new genus

Type species: *Katroma neagui* PESSAGNO and POISSON, n.sp.

Description: Test multicyrtid, comprised of cephalis, thorax, abdomen, and with type species one post-abdominal chamber. Post-abdominal chamber terminating in long, cylindrical, open, tubular extension. Cephalis hemispherical with horn; thorax and abdomen trapezoidal in outline. First post-abdominal chamber subspherical, considerably larger than previous chambers and with variable number of medially arranged circumferential spines.

Remarks: *Katroma* differs from *Podobursa* Wisniowski by haying an open tube on its final post-abdominal chamber.

The name *Katroma* is formed by an arbitrary combination of letters (ICZN, 1964, Appendix D, pt. IV, Recommendation 40, p. 113). Its gender is feminine.

Range and occurrence: Lower Jurassic (Upper Sinemurian(?)-Lower Pliensbachian) of Turkey. Lower Jurassic (Lower Pliensbachian) part of Maude Formation of the Queen Charlotte Islands (British Columbia). Lower Jurassic (Upper Pliensbachian), Nicely Formation of eastern Oregon.

Katroma neagui PESSAGNO and POISSON, n. sp.
(PI. XII, fig. 1-5; PI. XV, fig. 3)

Description: Test as with genus. Meshwork consisting of massive tetragonal to pentagonal pore frames (predominantly pentagonal); pores becoming larger on tubular extension of first post-abdominal chamber. Cephalis with crown-like horn with four branches; branching components of horn circular in axial section. Row of short spines (approximately 12 in number) occurring circumferentially around medial portion of post-abdominal chamber; spines circular in axial section. Length of tubular extension on first post-abdominal chamber more than half of total length of test.

Remarks: *Katroma neagui*, n. sp., differs from Late Jurassic and Early Cretaceous species of *Podobursa* (e.g., *P. berggreni* Pessagno) by having twelve rather than three circumferentially arranged spines around the medial portion of the final post-abdominal chamber and by having an open, tubular extension on its final post-abdominal chamber.

This species is named for Dr. Teodor Neagu, University of Bucharest (Romania) in honor of his contributions to Mesozoic stratigraphy and micropaleontology.

Measurements: Holotype: Width abdomen 70 microns, length cephalis-abdomen 110 microns, length first post-abdominal chamber 100 microns, width firts post-abdominal chamber 120 microns, length tube on post-abdominal chamber 310 microns. Measurement of eight specimens: Maximum width of abdomen 70 microns, minimum width of abdomen 50 microns, maximum length cephalis-abdomen 115 microns, minimum length cephalis-abdomen 65 microns, maximum width first post-abdominal chamber 120 microns, minimum length firts post-abdominal chamber 50 microns, maximum length tube on first post -abdominal chamber 310 microns, minimum length tube on first post-abdominal chamber 235 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264015, paratypes: USNM 264016 and Pessagno Collection.

Range and occurrence: Forms closely related to *K. neagui* occur in Pliensbachian cherts (NSF 960) from the Franciscan Complex of California; in the Nicely Formation (Upper Pliensbachian; OR 536) of eastern Oregon; and in the Maude Formation (Lower Pliensbachian; QC 534) of British Columbia (See Locality Descriptions). All of these forms share a branched, crown-like horn, but differ in the structure of their meshwork and in the shape of their tests.

CYRTOIDEA *incertae sedis*

The genus listed below cannot be assigned to a family yet.

Genus: Natoba PESSAGNO and POISSON, n. gen.

Type species: *Natoba minuta* PESSAGNO and POISSON, n. sp.

Description: Test tricyrtid comprised of microgranular silica; sparsely perforate. Cephalis with short, rod-like horn; thick-walled, separated from subspherical thorax by pronounced stricture. Abdomen tubular thin-walled; separated from thick-walled thorax by slight stricture. Large subcircular pores in stricture between cephalis and thorax; large slit-like pores in stricture between thorax and abdomen. Abdomen irregularly perforate proximally. Pores on all segments not set in discrete pore frames.

Remarks: *Natoba*, n. gen., is grossly similar to *Ectonocorys* Foreman (1968) from the Upper Cretaceous (Maestrichtian). It differs from this genus by being sparsely perforate, by lacking discrete pore frames, and by having a cylindrical, tubular abdomen. *Natoba* is a name formed by an arbitrary combination of letters (ICZN, 1964, p. 113, Appendix D, pt. 10, Recommendation 40).

Range and occurrence: Lower Jurassic (Upper Sinemurian(?)-Lower Pliensbachian) of Turkey so far as known.

Natoba minuta PESSAGNO and POISSON, n. sp.
(PI. XII, fig. 6-10? PI. XIV, fig. 3-4; PI. XV, fig. 1)

Description: Test as with genus. Abdomen on well preserved specimens comprising half of test length. Pores in stricture between cephalis and thorax, large and circular about eight in number. Pores in stricture between thorax and abdomen, large slit-like, elongate parallel to axis of test growth. Pores on proximal part of abdomen medium sized, irregular in shape and distribution. Weakly developed coste on thorax of well preserved specimens.

Remarks: *Natoba minuta*, n. sp., differs from *Ectonocorys scolia* Foreman (1968, PI. V, figs. 8a-c) by the characteristics cited under the genus and by having a less pronounced stricture between the thorax and abdomen.

Minutus-a-um (Latin, adj.): minute, small.

Measurements: Holotype: Length cephalis 25 microns, width cephalis 30 microns, length thorax 70 microns, width thorax 60 microns, length abdomen 50 microns, width abdomen 60 microns. Measurement of nine specimens: Maximum length cephalis 30 microns, minimum length cephalis 20 microns, maximum width cephalis 30 microns, minimum width cephalis 25 microns, maximum length thorax 70 microns, minimum length cephalis 45 microns, maximum width thorax 70 microns, minimum width thorax 60 microns, maximum length abdomen 80 microns, minimum length abdomen" 50 microns, maximum width'abdomen 70 microns, minimum width abdomen 50 microns.

Type locality: Poisson 1662D. See Locality Descriptions.

Deposition of types: Holotype: USNM 264017, paratypes USNM 264018 and Pessagno Collection.

Range and occurrence: This species is presently known only from the Lower Jurassic (Upper Sinemurian(?)-Lower Pliensbachian) of Turkey.

LOCALITY DESCRIPTIONS

TURKEY

Poisson sample 1662D. — Domuz Dağ Massif, N of Korkuteli, vilayet (Department) of Antalya, Turkey. Gümüşlü unit, Söğütlü dere formation, outcroping in the Söğütlü gorge situated 1 km NW of Gümüşlü village at an altitude of 1400 m (Fig. 1).

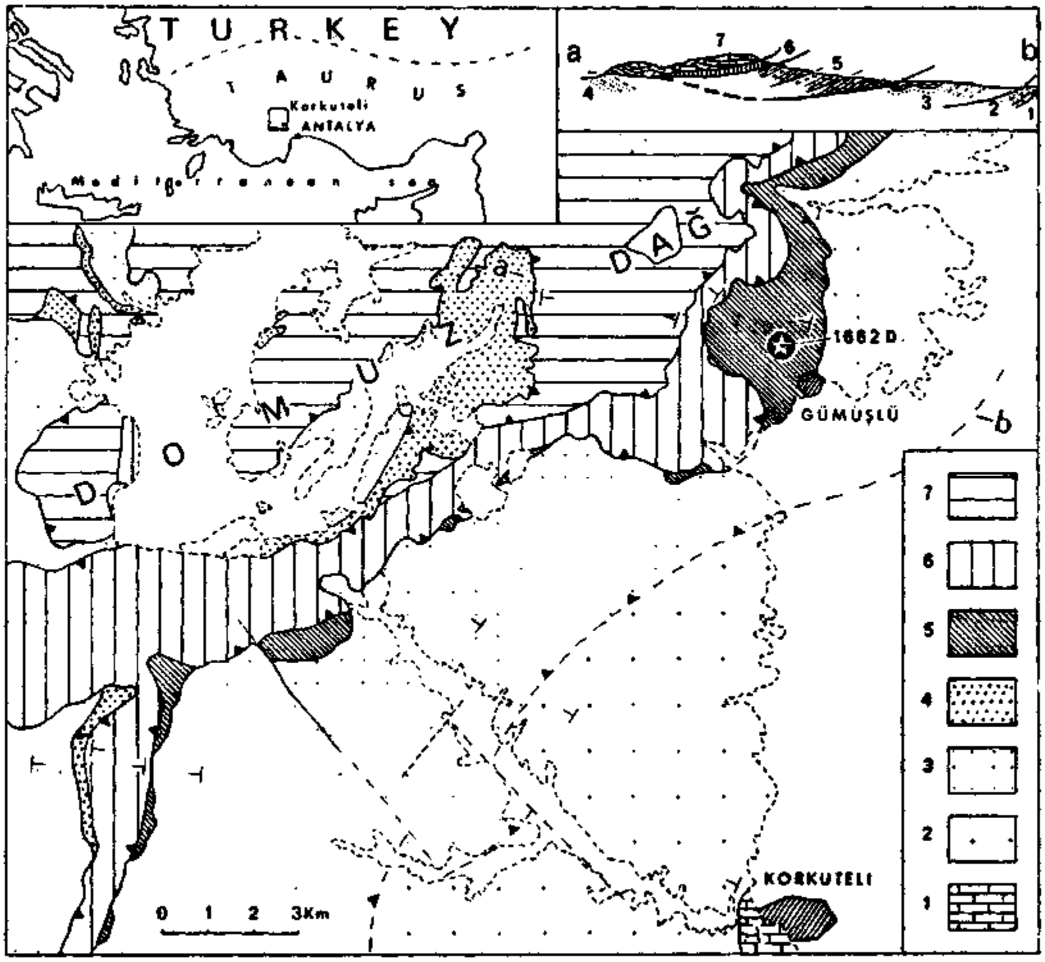

Fig. 1 - Domuz Dağ massif - Location map of the Gümüşlü unit.
Autochtonous (Bey Dağları massif); 1 - Mesozoic neritic limestones; 2 - Miocene flysch.
Allochtonous (Domuz dağ massif); 3 - Yavuz unit (mainly Paleogene flysch); 4 - Yeleme unit (wild flysch and olistostrome of Upper Cretaceous to Paleogene); 5 - Gümüşlü unit; 6 - Gülbahar unit (dolomite and cherty limestones of Upper Triassic age, and pelagic limestones of Upper Jurassic to Senonien, and ophiolitic detritals of Maestrichtian age.

Description of the Söğütlü dereformation

Limits: the base of the formation is limited by a tectonic contact (important thrusting). The formation is overlain by a bioclastic and oolithic member of the Sinekli dere Formation (Dogger-Malm).

Subdivisions and facies: The Söğütlü dere Formation include two members:

Upper member: the Ayıburnu tepe limestones: These are red and yellow «ammonitico rosso» facies rich in ammonites and microscopically rich in «filaments» (thin-valved molluscs) and Protoglobigerina. These limestones represent condensed stratigraphic sequences whose five ammonite zones are reduced to several meters thickness: Margaritatus zone (Middle Domerian), Bifrons, Bayani, and Meneghini zones (Toarcian) and Opalinum (Aalenian) zone. They thin from 20 m in the N to 1 m some 25 km to the S.

Lower member: The Radiolaria limestones: These are an alternance of 10-20 cm thick limestones beds and 1-10 cm thick marls, these latter being dark coloured and containing a quartz and feldspath silt fraction plus carbonaceous plant debris. These limestones are well stratified, regular beds exhibiting light beige weathering colours and grey fresh surfaces. Certain of these beds include a basal layer of vertically graded, neritic calcareous elements (algal tufts and molluscan debris), with turbiditic characteristics. The mudstone texture of these limestones beds includes numerous, well preserved siliceous Radiolaria and fine carbonaceous debris.

The depositional environment of the Söğütlü dere Formation seems to have been that of a basin located near the edge of a carbonate platform.

NORTH AMERICA

California

NSF 960. — San Rafael Mountain area, Santa Barbara County. Red radiolarian cherts overlying pillowed greenstone; normal sedimentary contact. Greenstone with minor recrystallized interpillow limestone. Franciscan Complex. USGS Figueroa Mountain Quadrangle (7.5'): T7N; R29W; section 9; 1.32 miles (2.1 kilometers) west of Cachuma Camp (section 11), adjacent to Happy Canyon Road.

BK 605 — Red radiolarian chert mass in melange. Franciscan Complex. USGS Potter Valley Quadrangle'(7.5'): T16N;R11W; section 8 (Northeast corner) along Potter Valley Road; 0.18 miles (0.3 kilometers) southwest of junction Guntley Ranch Road with Potter Valley Road and California Route 20. Sample from Dr. James Berkland, University of California, Davis.

Eastern Oregon

OR 536— Nicely Formation. Silty, dark gray to reddish brown mudstones and shales containing abundant limestone nodules ranging in size from two inches to three feet. Nodules comprised of dark gray to black calcilutite containing abundant calcified and pyritized Radiolaria. Headwaters of Elkhorn Creek; northeast side of Morgan Mountain. USGS Izee Quadrangle (15'); SW 1/4 of section 12.

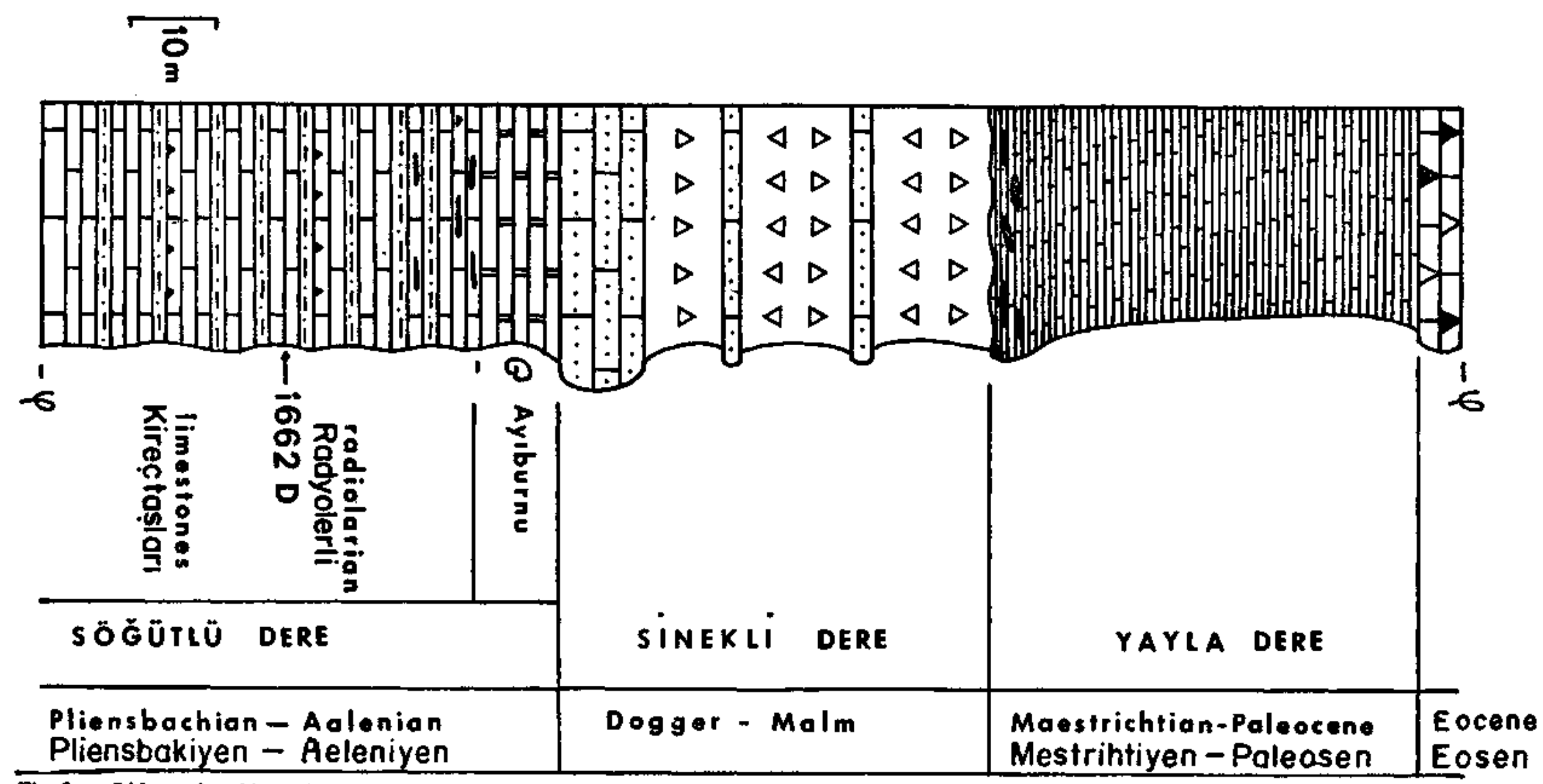

Fig. 2 - Lithostratigraphic section of the unit of Gümüşlü.

Söğütlü dere formation; radiolarian limestones member (Pliensbachian; Ayıburnu member (Pliensbachian; to Aalenian) ammonitico rosso limestones with Ammonites fauna.

Sinekli dere formation; neritic limestones with oolithes (intrabio-oosparites) and *Protopeneroplis striata* Weynschenk (Dogger-Malm); pillow lavas interbedded with oolithic limestones.

Yayla dere formation (Maestrichtian to Paleocene; pelagic limestones with Globotruncaniidae and Heterohelicidae in the lower beds, and Globorotalidae in the upper beds; Brechic limestones (Lower Eocene).

Queen Charlotte Islands, British Columbia

Kunga Island

Type section of the Kunga Formation. See Brown (1968).

QC 550. — Kunga Formation, Black Argillite member (upper part). Flaggy black argillite containing limestone nodules comprised of black calcilutite with abundant silicified Radiolaria. North shore of Kunga Island.

Maude Island

Type section of Maude Formation. See Brown (1968).

QC 509-537. — Maude Formation. Dark gray, medium gray and greenish gray mudstones, shales, siltstones, calcilutites, and sandstones with common limestone nodules (black calcilutite). South shore of Maude Island.

QC 532. — Dark gray calcilutite layer 8 to 10 inches (20 to 25 cm's.) thick containing abundant silicified Radiolaria. About 35 feet (10.6 meters) below contact with overlying Yakoun Formation.

QC 534. — Dark gray calcilutite layer 10 inches (25 cms.) thick containing abundant silicified Radiolaria. About 27 feet (8.2 meters) below contact with Yakoun Formation.

QC 537. — Dark gray calcilutite layer, 6 inches (15 cms) thick containing abundant silicified Radiolaria; 3 feet (0.91 meters) below contact with the Yakoun Formation.

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T.C.
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PLATES

PLATE - I

All figures are scanning electron micrographs of Lower Jurassic Radiolaria. Figures 1,3-10 illustrate Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions). Figure 2 illustrates a specimen from a Lower Jurassic Franciscan radiolarian chert (NSF 960; see Locality Descriptions).

Fig. 1,4 - *Hagiastrum infinitum* Pessagno and Poisson, n. sp.

Holotype (USNM 263993). Scales: 132 microns and 66 microns respectively.

Fig. 2 - *Hagiastrum infinitum* Pessagno and Poisson, n. sp.

Scale: 100 microns.

Fig. 3,6 - *Hagiastrum infinitum* Pessagno and Poisson, n. sp.

Fig. 8 - Paratype (USNM 263994). Scales: 130, 80, and 40 microns respectively.

Fig. 5,7 - *Orbiculiforma multifora* Pessagno and Poisson, n. sp.

Fig. 9,10 - Holotype (USNM 263995). Scales: 100, 100, 50, and 40 microns respectively.

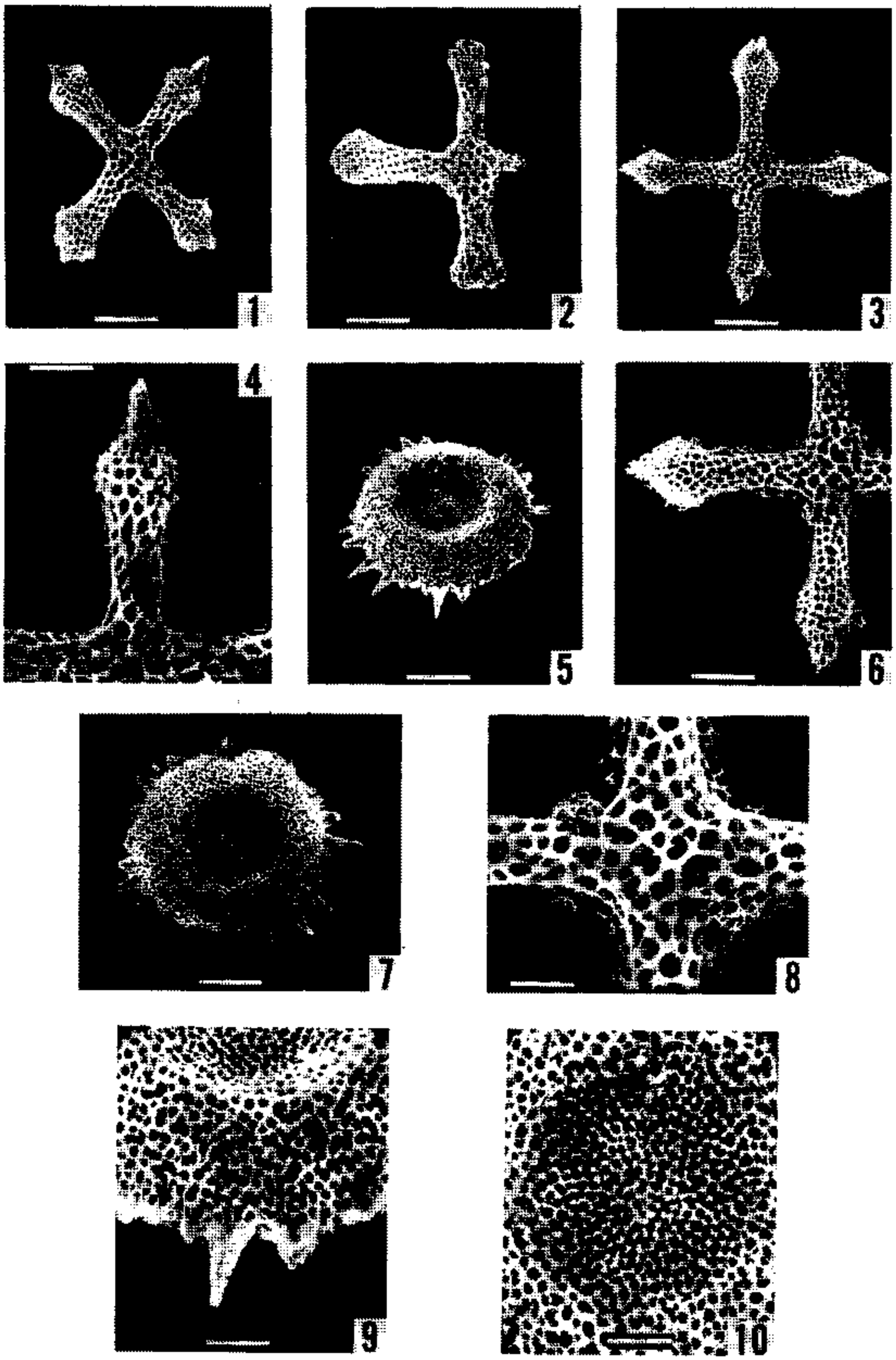
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PLATE - II

All figures are scanning electron micrographs of Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1,2 - *Protopsium ehrenbergi* Pessagno and Poisson, n. sp.

Paratypes (USNM 263998). Scales: 66 microns each.

Fig. 3 - *Protopsium ehrenbergi* Pessagno and Poisson, n. sp.

Holotype (USNM 263997). Scale: 66 microns.

Fig. 4,5 - *Protopsium ispartaense* Pessagno and Poisson, n. sp.
Holotype (USNM,263999). Scales: 44 and 20 microns respectively.

Fig. 6 - *Crucella* sp. A

Scale: 80 microns.

Fig. 7-9 - *Orbiculiforma* sp. aff. *O. mclaughlini* Pessagno

Scales: 50, 100, and 100 microns respectively.

Emile A. PESSAGNO, Jr. and Andre POISSON PLATE-II

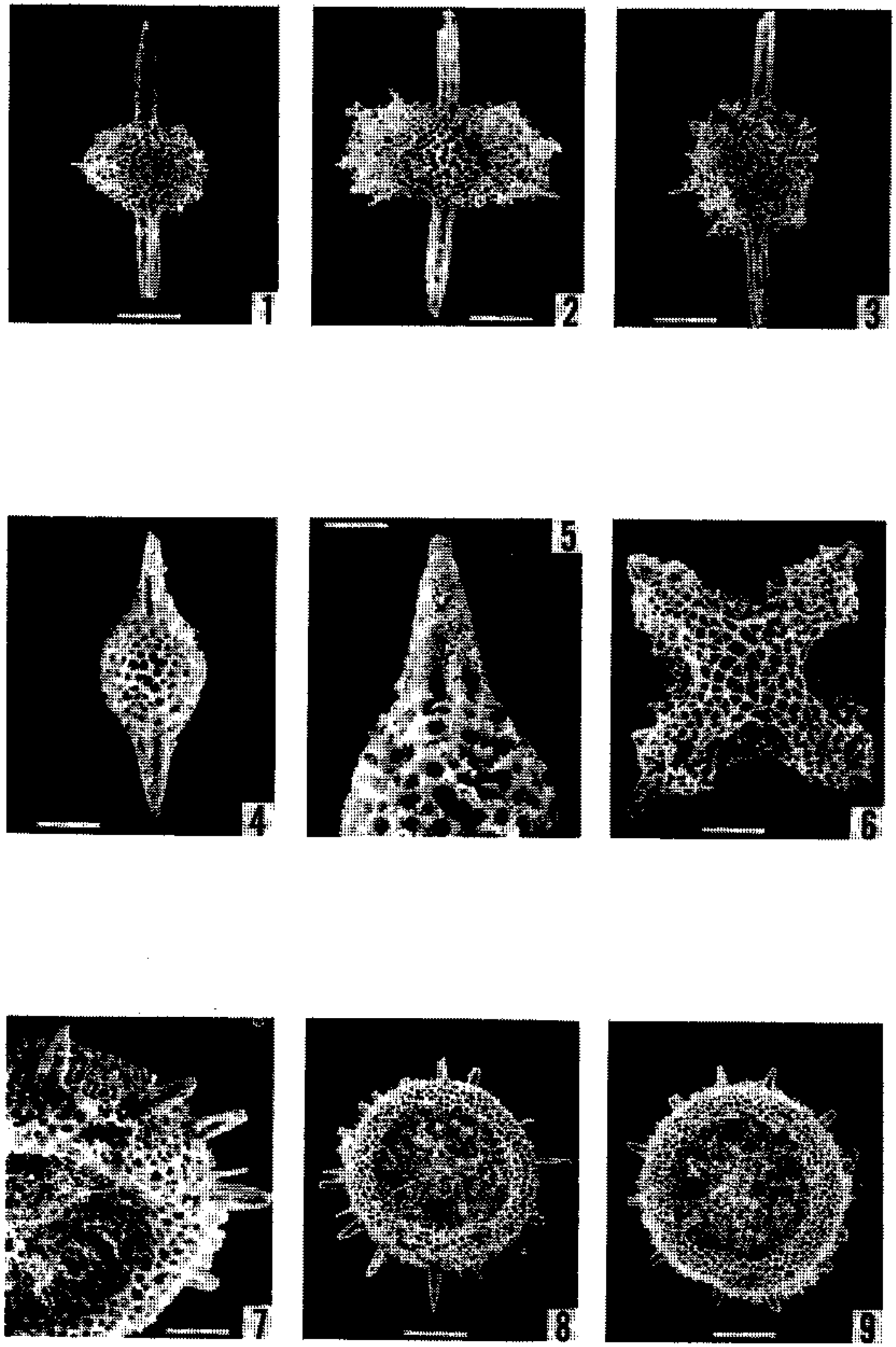

PLATE - III

All figures are scanning electron micrographs of the Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1-6 - *Protopsium ispartaense* Pessagno and Poisson, n. sp.

Fig. 8,9 - Paratypes (USNM 264000). Scales in figures 1-3: 50, 44, and 44 microns respectively. Scales in figures 4-6: 20, 40, and 2,0 microns respectively. Scales in figures 8 and 9: 20 microns each.

Fig. 7 - *Protopsium* (?) *ispartaense* Pessagno and Poisson, n. sp.

Holotype (USNM 263999). Scale: 20 microns. See plate II, fig. 4, 5.

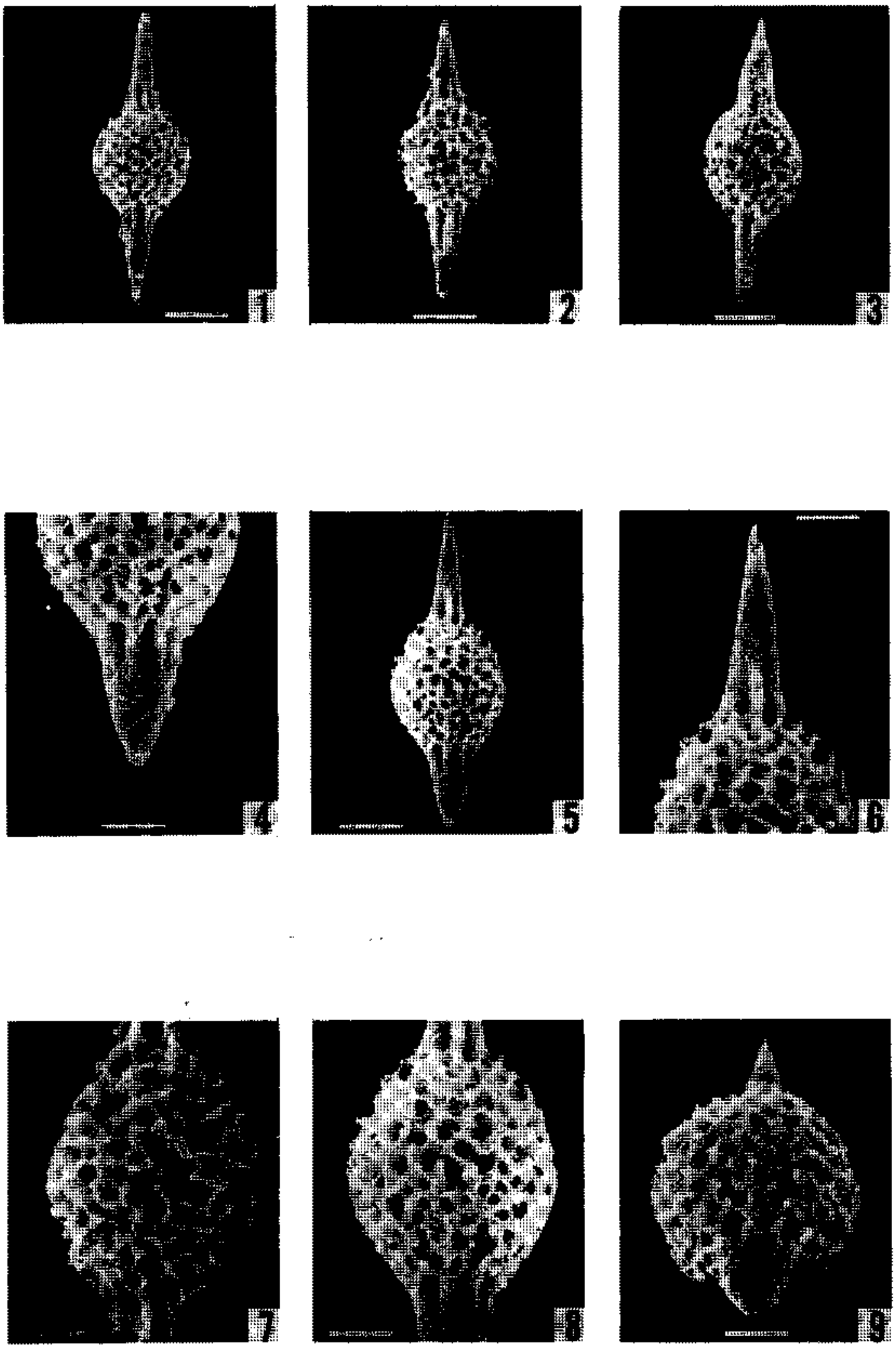

PLATE - IV

All figures are scanning electron micrographs of Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1,4 - *Protopsium* sp. A

Scales: 66 and 32 microns respectively.

Fig. 2 - *Protopsium* sp. B

Scale: 44 microns.

Fig. 3,5-8 - *Protopsium* sp. C

Scale in figure 3: 80 microns. Scales in figures 5-8: 40 microns each.

Fig. 9 - *Pseudoheliodiscus yaoi* Pessagno and Poisson, n. sp.

Holotype (USNM 264001). Scale : 220 microns.

Emile A. PESSAGNO, Jr. and Andre POISSON PLATE-IV - IV

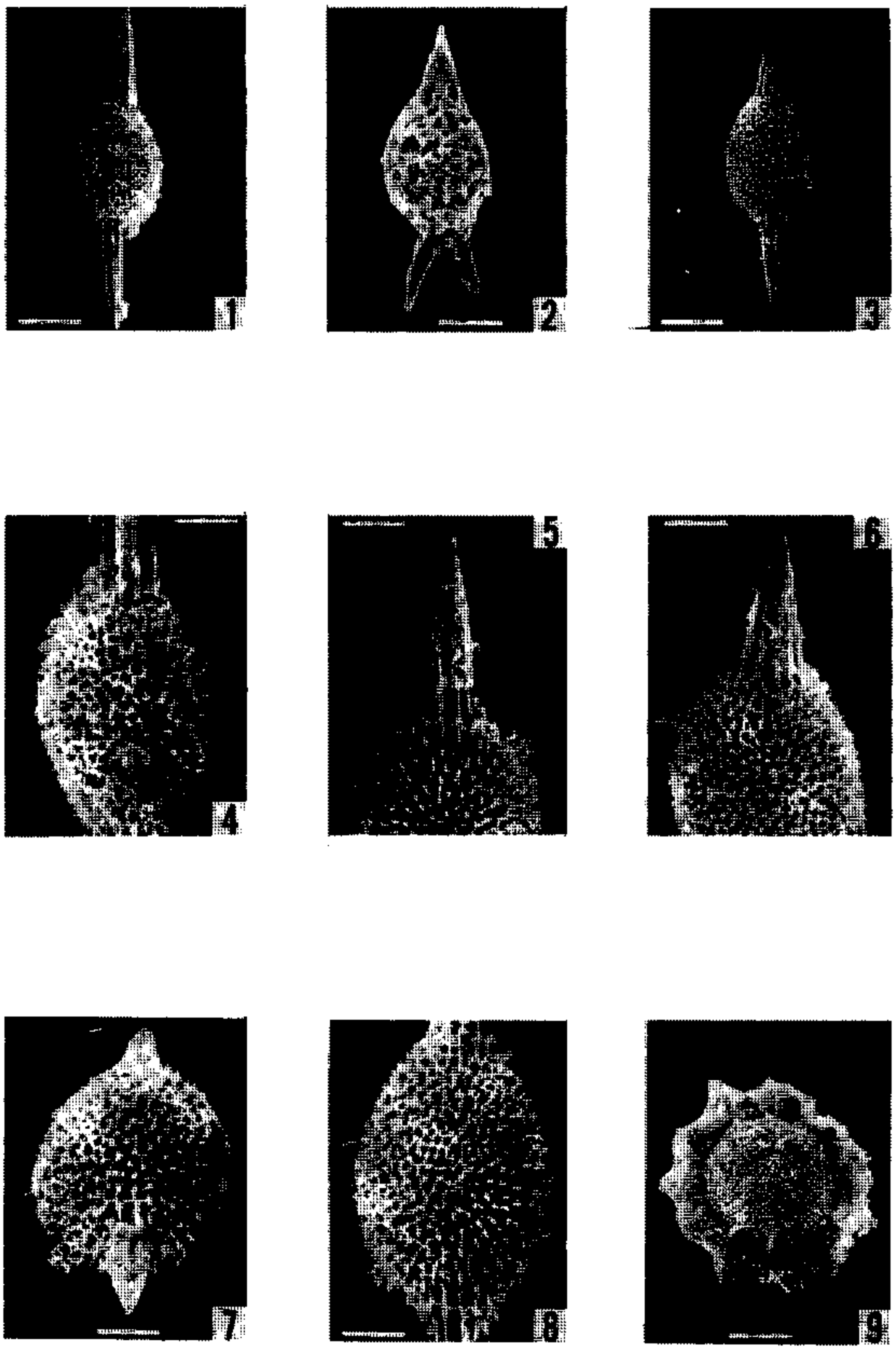

PLATE - V

All figures are scanning electron micrographs of Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1,8 - *Pseudoheliodiscus yaoi* Pessagno and Poisson, n. sp.

Fig. 9 - Paratypes (USNM 264002). Figures 1,8: Same specimen; scales: 80 and 32 microns. Scale in figure 9: 32 microns.

Fig. 2,3 - *Pseudoheliodiscus* sp. A

Scales: 80 and 50 microns respectively.

Fig. 4 - *Pseudoheliodiscus yaoi* Pessagno and Poisson, n. sp.

Topotype. Scale: 66 microns.

Fig. 5,6 - *Pseudoheliodiscus* sp. B

Scales: 66 and 36 microns respectively.

Fig. 7 - *Pseudoheliodiscus yaoi* Pessagno and Poisson, n. sp.

Holotype (USNM 264001). Scale: 40 microns. See plate IV, fig. 9.

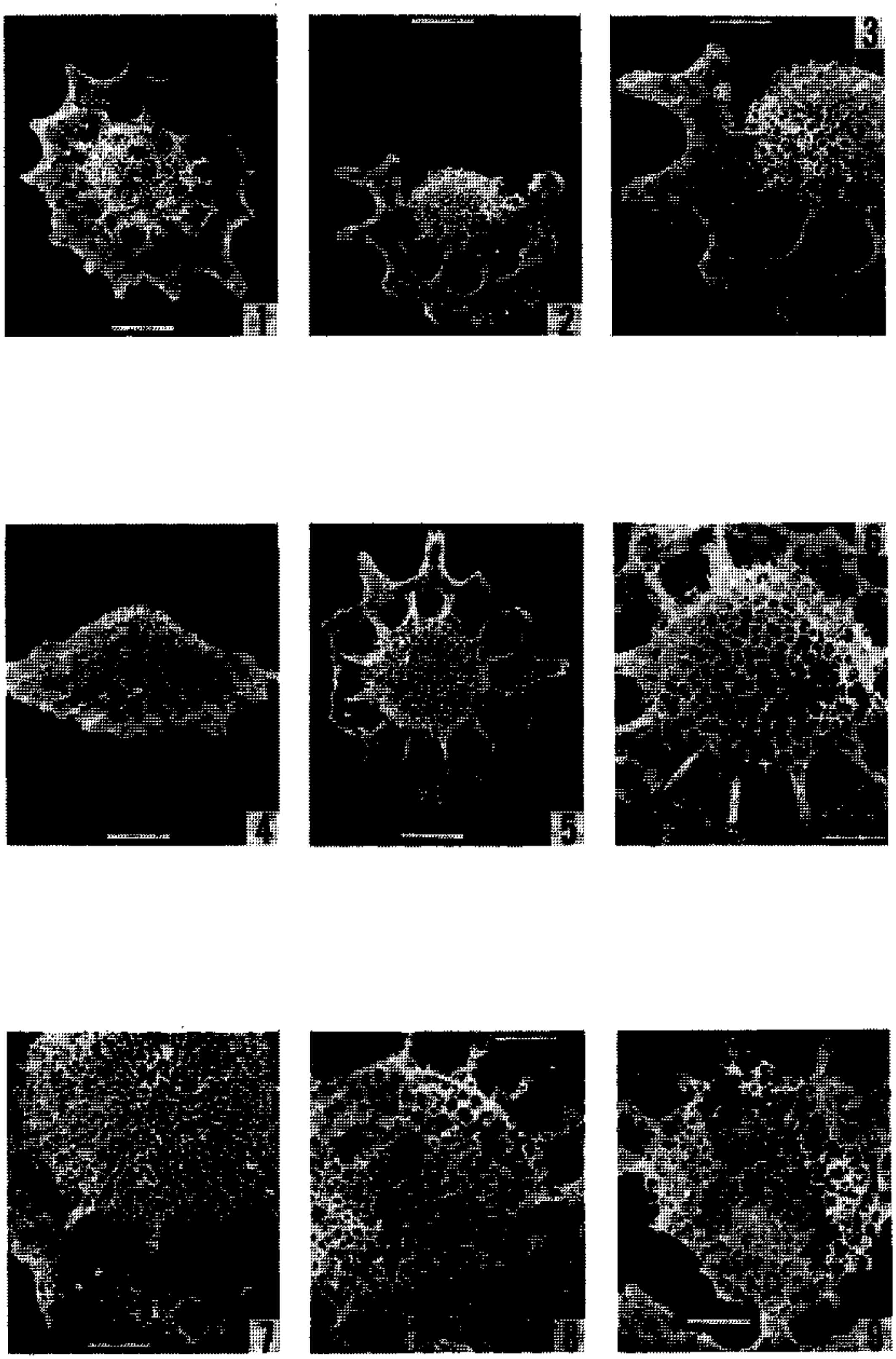

PLATE - VI

AH figures are scanning electron micrographs of Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1-4 - *Pantanellium inornatum* Pessagno and Poisson, n. sp.

Holotype (USNM 264003). Scale in figure 1: 56 microns. Scales in figures 2-4: 28 microns each.

Fig. 5-7 - *Pantanellium inornatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264004). Scales: 56,32 and 32 microns respectively.

Fig. 8-9 - *Pantanellium inornatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264004). Scales: 44 and 20 microns respectively.

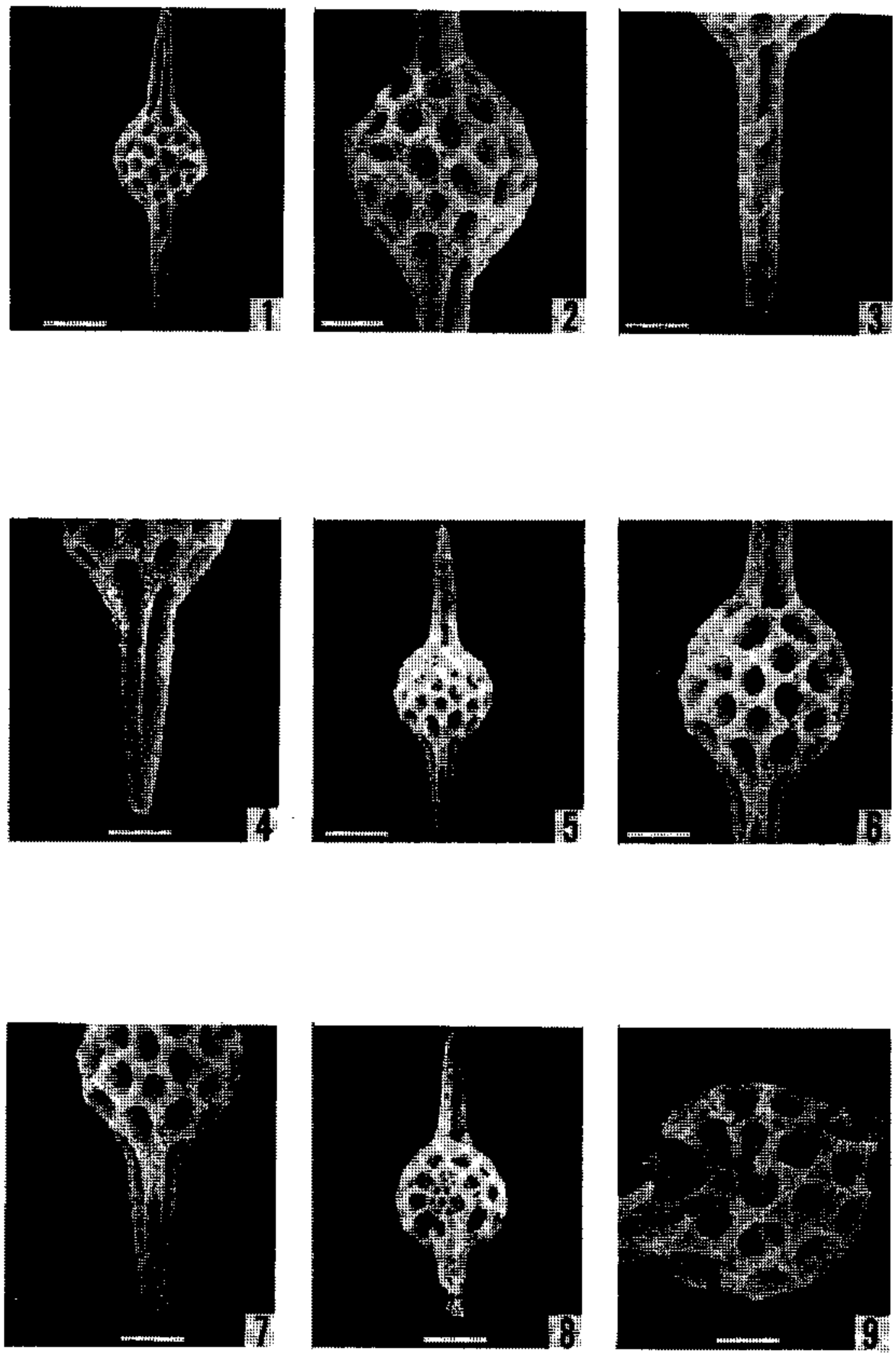
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PLATE - VII

All figures are scanning electron micrographs of Radiolaria from the Jurassic of North America.

Fig. 1 - *Panlanellium* sp.

QC 550. Black argillite member of the Kunga Formation, Queen Charlotte Islands, British Columbia (Sinemurian). This form appears to be closely related to *P. inornatum*, n. sp.

Scale: 56 microns.

Fig. 2-3 - *Praeconocaryomma immodica* Pessagno and Poisson, n.sp.

Holotype (USNM 264005). BK 605. Franciscan Complex, California Coast Ranges; Upper Jurassic (Zone 1) radiolarian chert.

Scales: 50 and 40 microns respectively.

Fig. 4-6 - *Praeconocaryomma immodica* Pessagno and Poisson, n. sp.

Paratype (USNM 264006). BK 605. Franciscan Complex, California Coast Ranges.

Fig. 7 - *Praeconocaryomma immodica* Pessagno and Poisson, n. sp.

Paratype (USNM 264006). BK 605. Franciscan Complex, California Coast Ranges; Upper Jurassic (Zone 1) radiolarian chert. Scale : 50 microns.

Fig. 8-9 - *Praeconocaryomma immodica* Pessagno and Poisson, n. sp.

NSF 973. Early Tithonian cherts, limestones, siliceous mudstones, and minor tuff breccias overlying Stanley Mountain Ophiolite, California Coast Ranges (See Pessagno, 1977a). Sample from lenticular mass of gray, radiolarian-rich calcilutite. Scales: 26 and 40 microns respectively.

Emile A. PESSAGNO, Jr. and Andre POISSON PLATE-VII

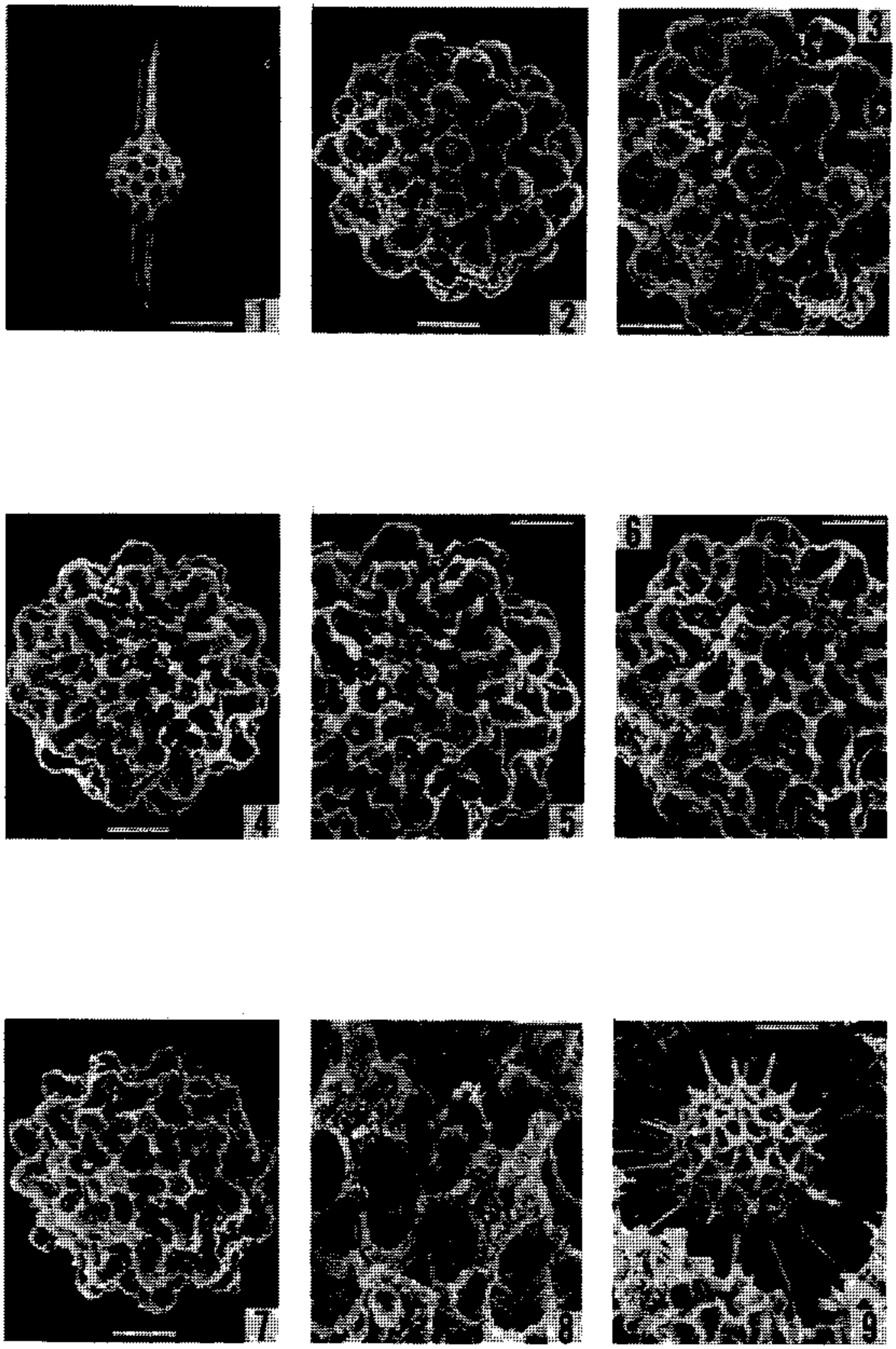

PLATE - VIII

All figures are scanning electron micrographs of Lower Jurassic Radiolaria. Specimens in figures 1-4 are from NSF 960, Franciscan Complex, California Coast Ranges. Specimens in figures 5-9 are from the Lower Jurassic of Turkey (Poisson Sample 1662D). See Locality Descriptions.

Fig. 1-3 - *Praeconocaryomma media* Pessagno and Poisson, n. sp.

Holotype (USNM 264007). Scales: 56, 40, and 32 microns respectively.

Fig. 4 - *Praeconocaryomma media* Pessagno and Poisson, n. sp.

Paratype (USNM 26/W08). Scale: 56 microns.

Fig. 5-7 - *Praeconocaryomma parvimamma* Pessagno and Poisson, n. sp.

Holotype (USNM 264009). Scales: 66, 66, and 32 microns respectively.

Fig. 8-9 - *Praeconocaryomma parvimamma* Pessagno and Poisson, n. sp.

Paratypes (USNM 264010). Figure 9 showing internal structure; triangular pore frames of first medullary shell barely visible. Scales: 66 and 56 microns recpectively.

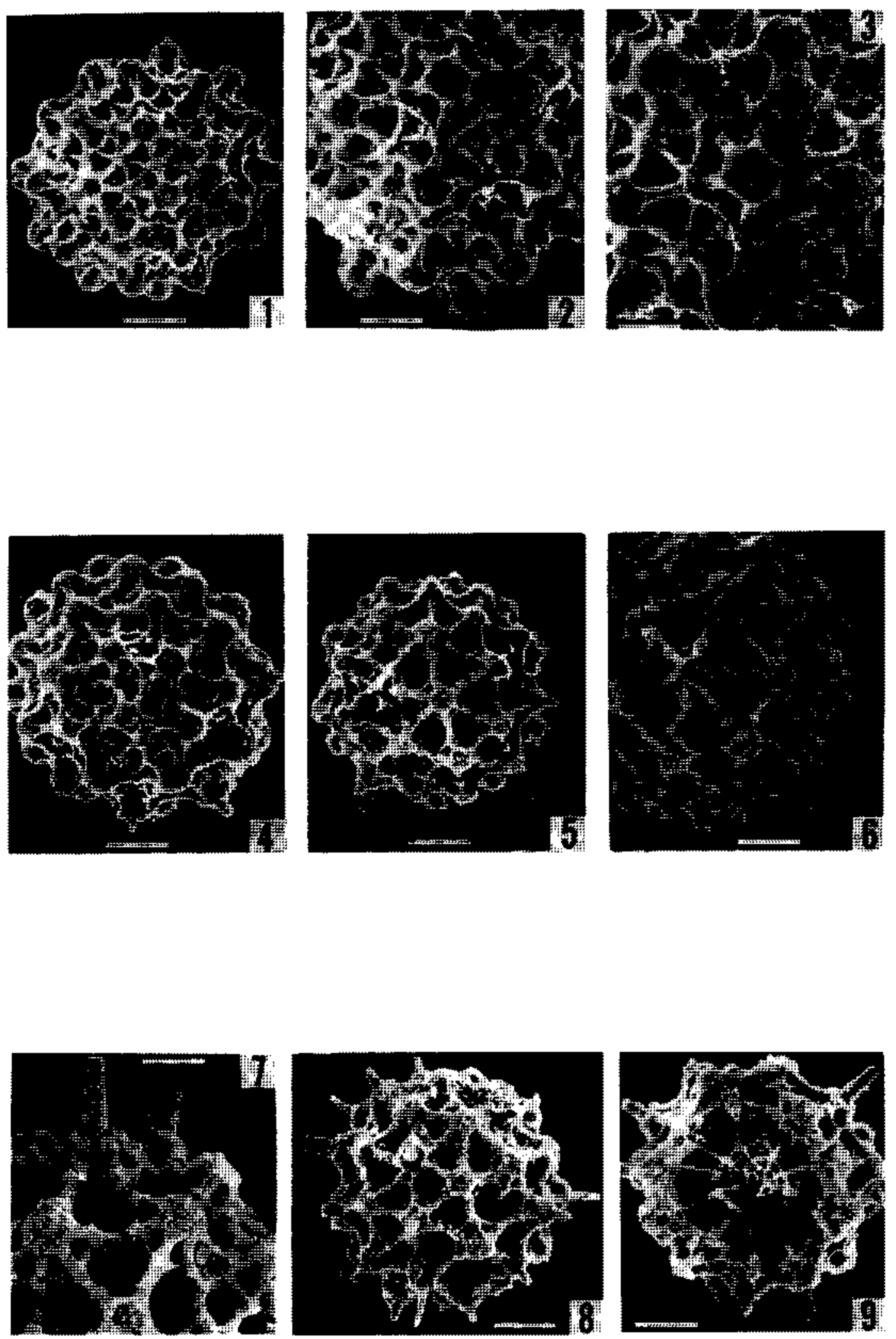
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PLATE - IX

All figures are scanning electron micrographs of Lower Jurassic Radiolaria. Specimens in figures 1, 3-5 are from Franciscan cherts (NSF 960), California Coast Ranges. Specimens in figures 2,6-9 are from the Lower Jurassic of Turkey (Poisson Sample 1662D). See Locality Descriptions.

Fig. 1 - *Praeconocaryomma* sp. aff. *P. parvimamma* Pessagno and Poisson, n. sp. This form differs from *P. parvimamma*, n. sp., by having broader, flatter mammae. Scale: 66 microns.

Fig. 2 - *Praeconocaryomma parvimamma* Pessagno and Poisson, n. sp.

Paratype (USNM 264010). Internal structure. Same specimen as figured in plate VIII, fig. 9, but at higher magnification. Scale: 40 microns.

Fig. 3-5 - *Praeconocaryomma* s,p. aff. *P. magnimma* (Rüst)

This may well be the same form figured by Rüst (1898). However, Rust's illustrations are far too generalized to permit certain correlation. Scales: 66, 40, and 40 microns respectively.

Fig. 6-9 - *Canoptum anulatum* Pessagno and Poisson, n. sp.

Holotype (USNM 264011). Scale in figure 6: 100 microns; scales in figures 7-9: 40 microns each.

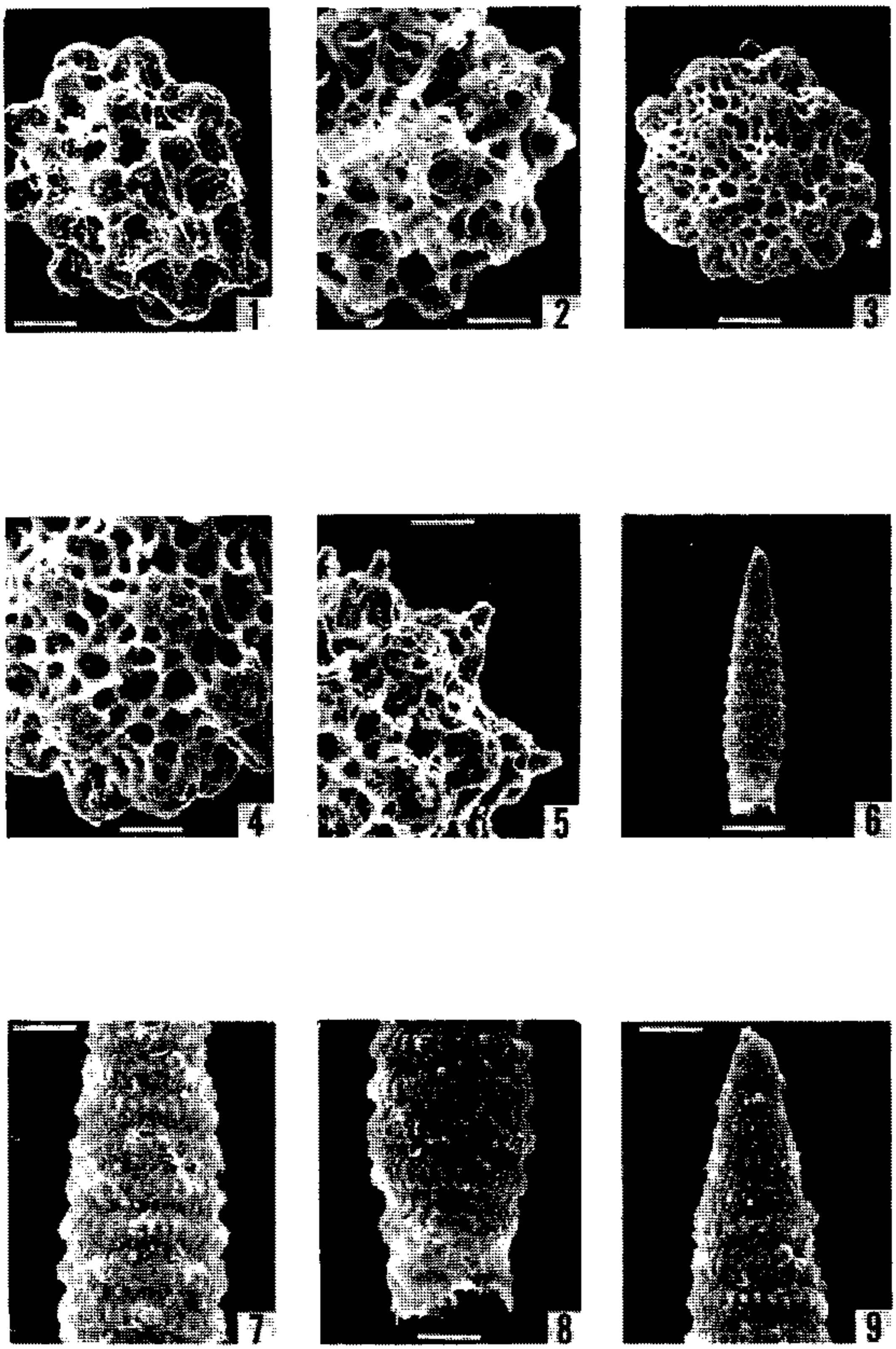
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PLATE - X

All figures are scanning electron micrographs of Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1-4 - *Canoptum anulatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264012). Scales in figures 1-3: 100, 28, and 28 microns. Figure 4 shows interior of test. Note coarse polygonal pore frames comprising inner layer of two layered test; scale: 20 microns.

Fig. 5-6 - *Canoptum anulatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264012). Scales: 100 and 32 microns.

Fig. 7-9 - *Canoptum anulatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264012). Figure 7: natural section of test; scale: 28 microns. Figures 8-9: Note linked-H pattern of circumferential ridges. Normally this pattern is obscured by outer layer of microgranular silica with specimens that are better preserved. Scales: 80 and 40 microns respectively.

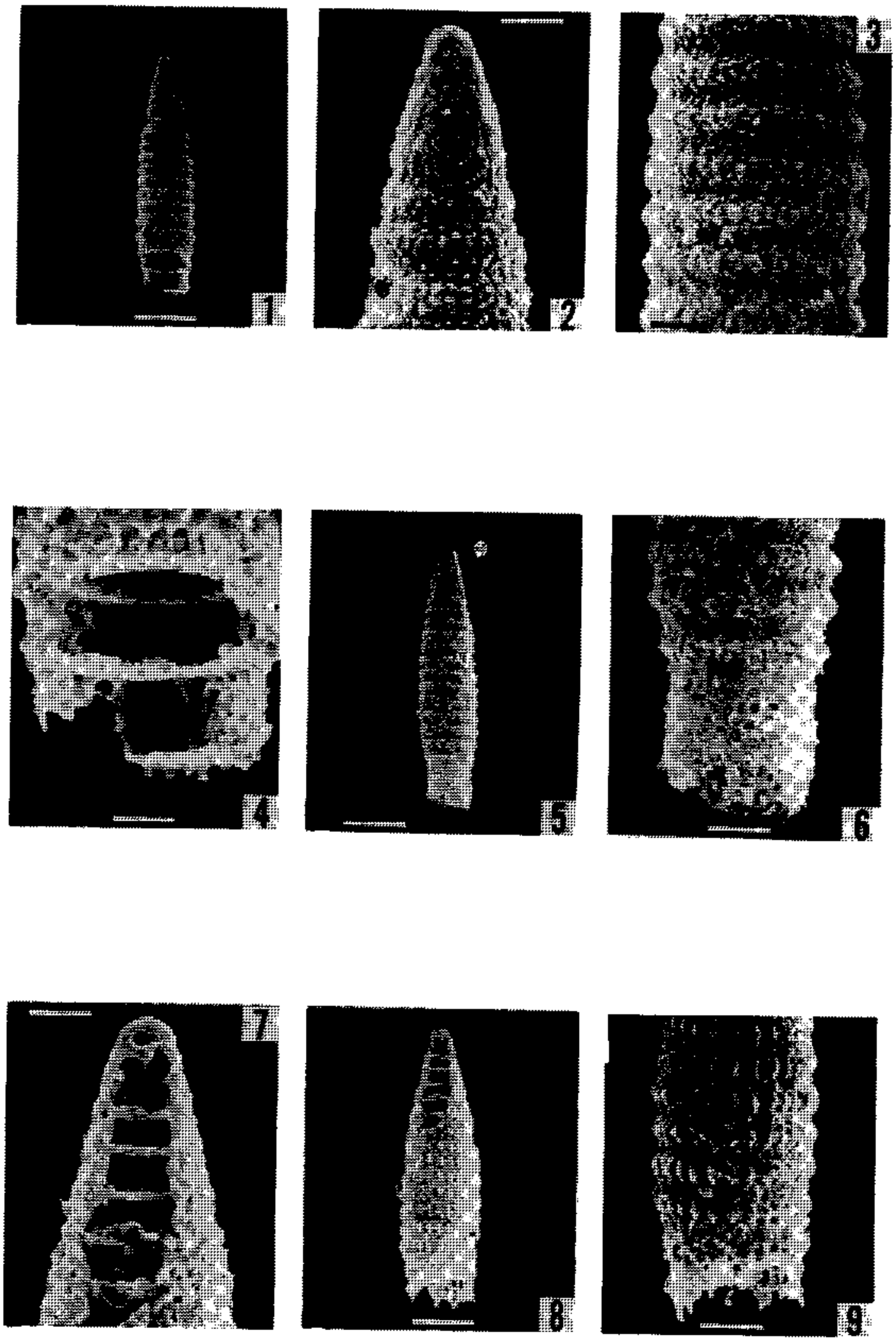
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PLATE - XI

All figures are scanning electron micrographs of Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1-3 - *Canoptum poissoni* Pessagno

Holotype (USNM 251862). Figure 3 shows interior of test with inner layer comprised of coarse polygonal pore frames. Scales: 66, 32, and 13.2 microns respectively.

Fig. 4 - *Canoptum poissoni* Pessagno

Paratype (USNM, 251862). Scale: 80 microns.

Fig. 5,6 - *Canoptum rugosum* Pessagno and Poisson, n. sp.

Holotype (USNM 264013). Scales: 40 and 24 microns respectively.

Fig. 7-9 - *Canoptum rugosum* Pessagno and Poisson, n. sp.

Topotype. Specimen destroyed during electron microscopy. Microgranular layer mostly eroded away from ridges. Note linked - H pattern of circumferential ridges.

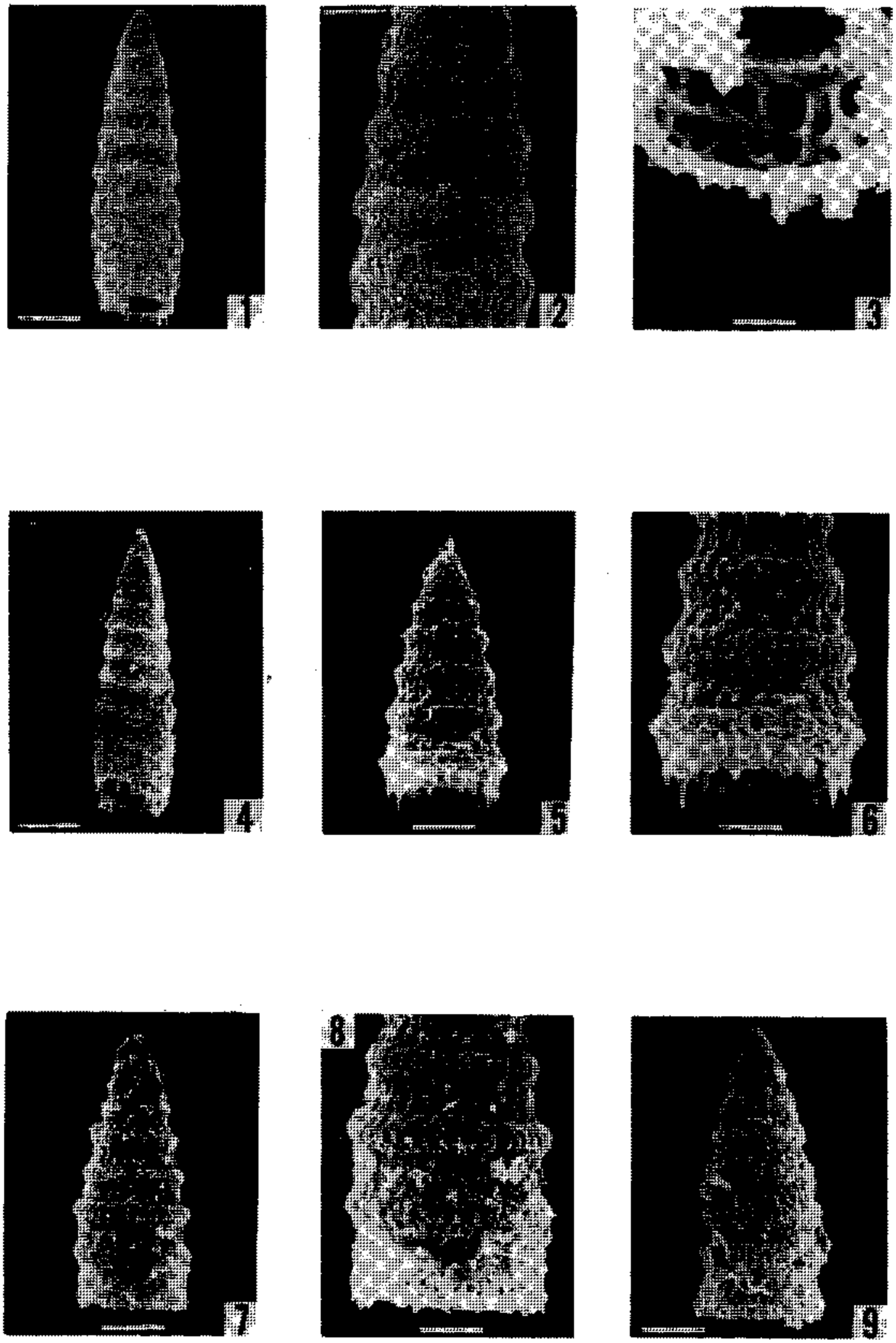

PLATE - XII

All figures are scanning electron micrographs of Radiolaria from the Lower Jurassic of Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1-4 - *Katroma neagui* Pessagno and Poisson, n. sp.

Holotype (USNM 264015). Scale in figure 1 : 132 microns. Scales in figures 2-4: 50 microns each.

Fig. 5 - *Katroma neagui* Pessagno and Poisson, n. sp.

Paratype (USNM 264016). Scale: 100 microns.

Fig. 6,7 - *Natoba minuta* Pessagno and Poisson, n. sp.

Holotype (USNM 264017). Scales: 36 and 20 microns respectively.

Fig. 8 - *Natoba minuta* Pessagno and Poisson, n. sp.

Paratype (USNM 264018). Scale: 36 microns.

Fig. 9,10- *Natoba minuta* Pessagno and Poisson, n. sp.

Paratype (USNM 264018). Note large pore (cephalopyle ?) at base fo cephalis and slightly costate nature of abdomen. Scales: 36 and 20 microns respectively.

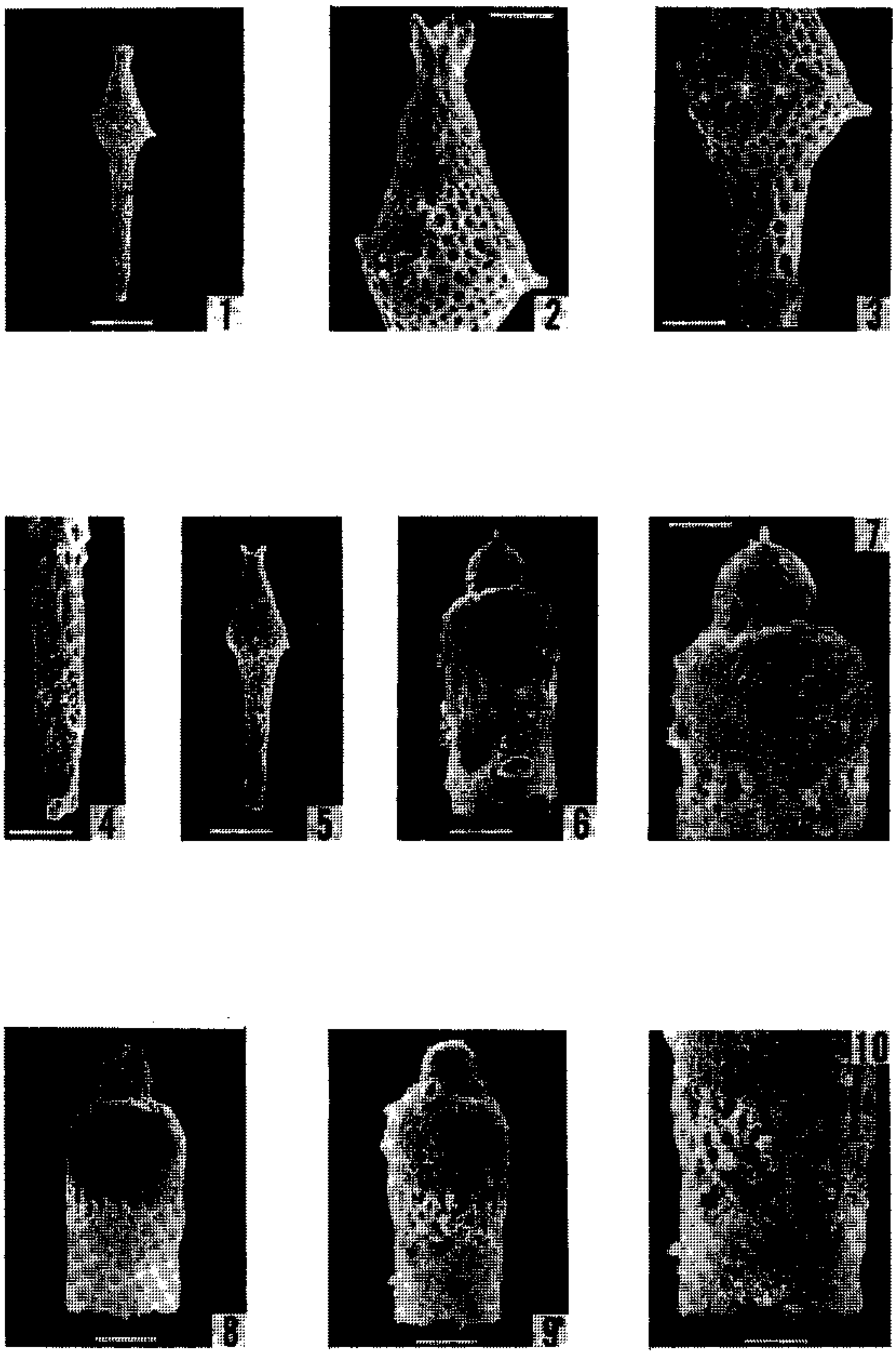

PLATE - XIII

Transmitted light photomicrographs of Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1 - *Protopsium ehrenbergi* Pessagno and Poisson, n. sp.

Paratype (USNM 263998). Scale: 32 microns.

Fig. 2 - *Pseudoheliodiscus yaoi* Pessagno and Poisson, n. sp.

Paratype (Pessagno Collection). Note concentric nature of spongy meshwork comprising the cortical shell. Scale: 76 microns.

Fig. 3 - *Canoptum rugosum* Pessagno and Poisson, n. sp.

Paratype (USNM 264014). Scale: 72 microns.

Fig. 4 - *Protopsium ispartaensf* Pessagno and Poisson, n. sp.

Paratype (USNM 264000). Note concentric nature of spongy meshwork. Scale : 68.5 microns.

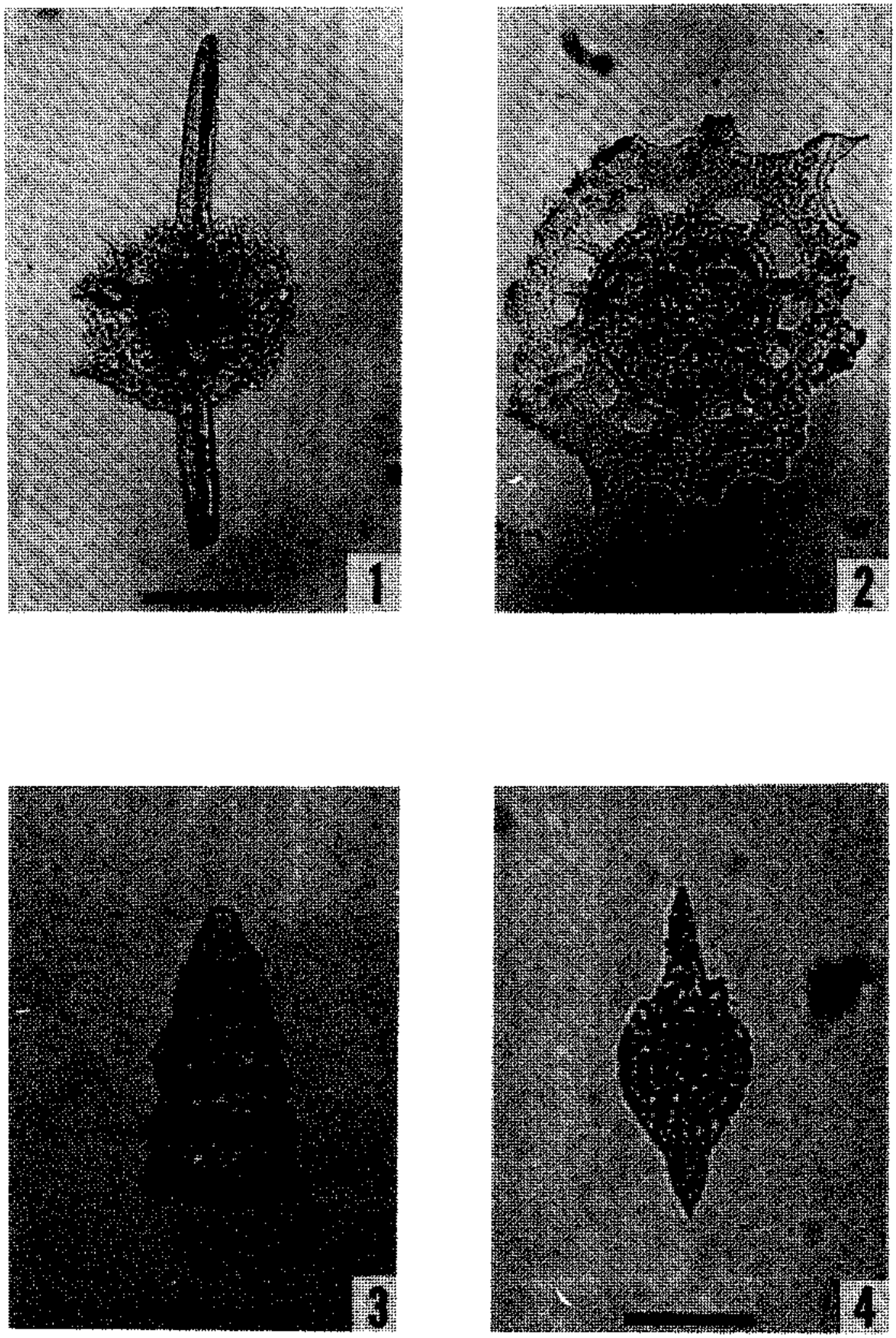
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PLATE - XIV

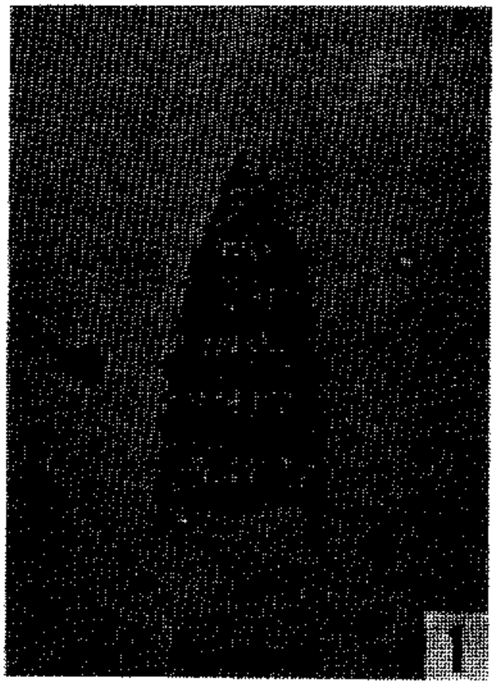
Transmitted light photomicrographs of Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1,2 - *Canoptum rugosum* Pessagno and Poisson, n. sp.

Paratype (Pessagno Collection). Scales: 66 and 33 microns respectively.

Fig. 3,4 - *Natoba minuta* Pessagno and Poisson, n. sp.

Paratype (Pessagno Collection). Scales: 72 and 36 microns respectively.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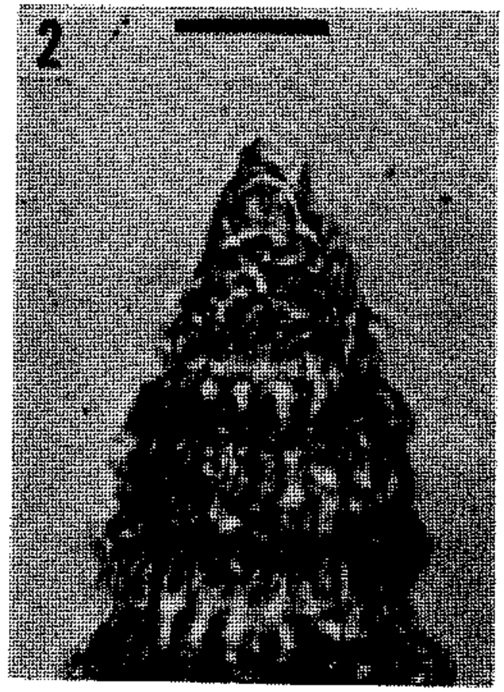
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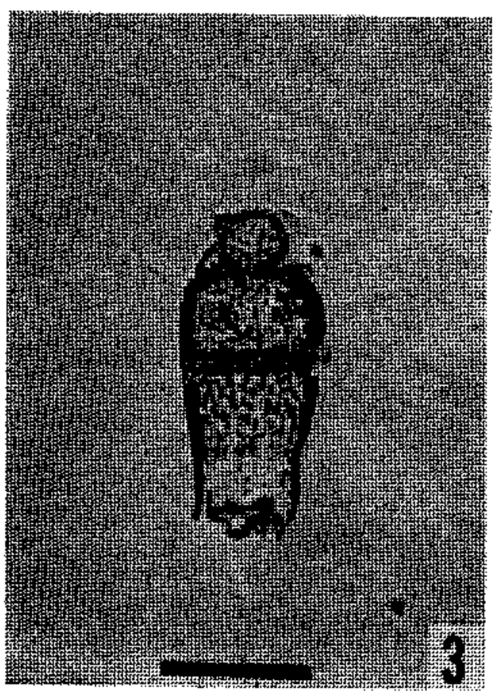
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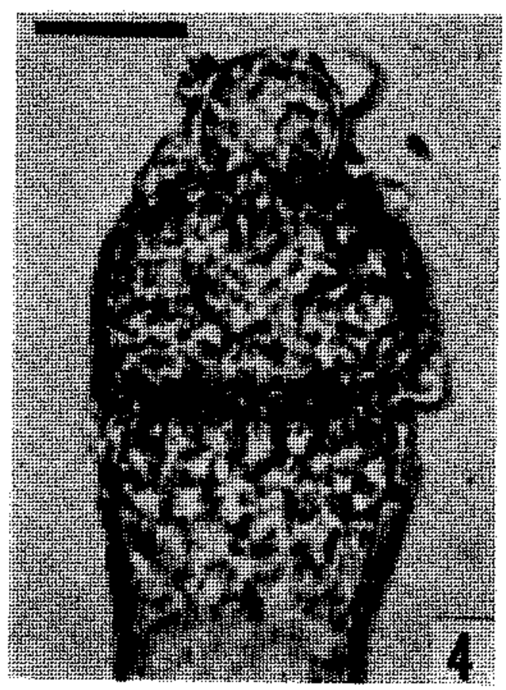
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PLATE - XV

Transmitted light photomicrographs of Lower Jurassic Radiolaria from Turkey (Poisson Sample 1662D; see Locality Descriptions).

Fig. 1 - *Natoba minuta* Pessagno and Poisson, n. sp.

Paratype (USNM 264018). Part of cephalis appears to be enclosed by thorax. Scale: 71 microns.

Fig. 2,4 - *Canoptum anulatum* Pessagno and Poisson, n. sp.

Paratype (USNM 264012). Scales: 35 and 70 microns respectively.

Fig. 3 - *Katrotna neagui* Pessagno and Poisson, n. sp.

Paratype (Pessagno Collection). Scale: 71 microns.


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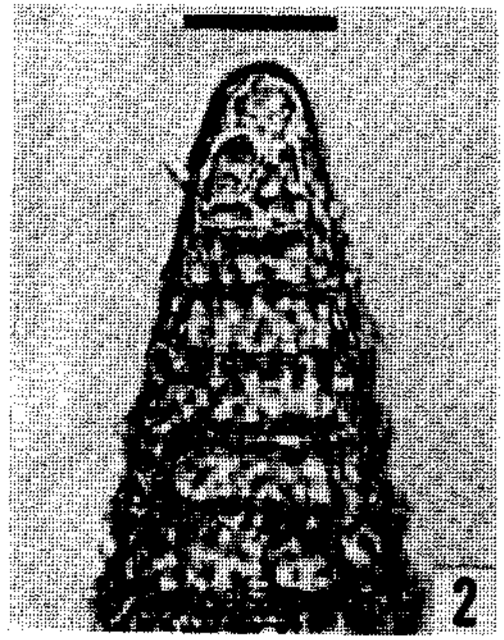
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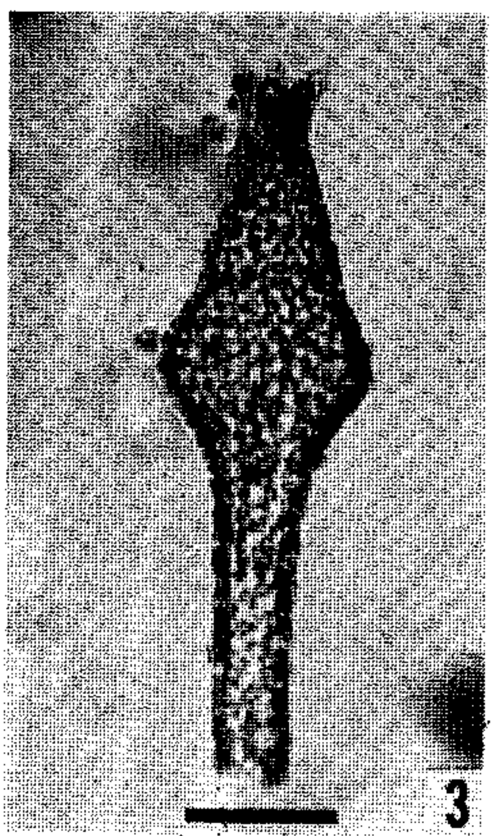
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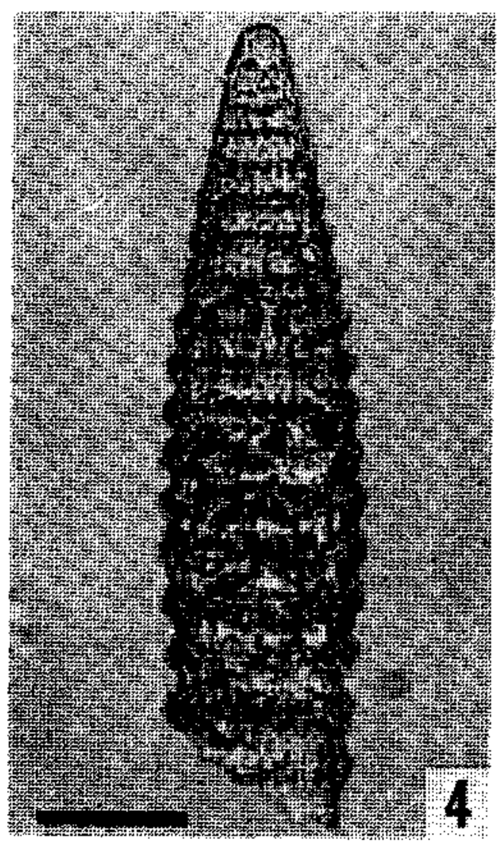
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