Festschrift zum 60. Geburtstag von Helfried Mostler
Geol. Paläont. Mitt. Innsbruck, ISSN 0378–6870, Bd. 20, S. 407–435, 1995

RÜST'S RADIOLARIANS FROM URSCHLAU (LATE JURASSIC, CHIEMGAU ALPS, BAVARIA)

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With 3 figures, 2 plates and 1 geological map

Abstract:
Dr. David RÜST's collection of Late Jurassic radiolarians from the Aptychus beds of the Urschlau were part of 1350 thin sections donated to the Bavarian Academy of Science in 1898. This material was destroyed during World War II. In order to redescribe this important fauna, published in 1885, profiles were taken at the type locality near Ruhpolding in the Northern Calcareous Alps. A more precise designation of the type locality in the Sulzenmoos Graben in the Roethelmoos area was necessary. In the samples radiolarians are rare and rich faunas are moderately preserved. Therefore, a valuable redescription including the designation of neotypes was not possible. The purpose of the paper is to compare RÜST's illustrations and descriptions with etched radiolarians from the Aptychus beds of the type locality and to discuss which forms could be assigned to RÜST's pictures. From 60 new species described from the Urschlau by RÜST 34 species were selected to be useful for a possible redescription. These remaining species were evaluated in terms of modern radiolarian paleontology. This includes a translated original description, an interpretation of RÜST's figures, a discussion of the remaining paleontological value and a scanning microscope picture.

Zusammenfassung:
Die oberjurassischen Radiolarien der Aptychenschichten von Urschlau von Dr. David RÜST wurden in einer Sammlung von 1350 Dünnschliffen 1898 der Bayerischen Akademie der Wissenschaften geschenkt. Das Material wurde im Zweiten Weltkrieg zerstört. Für eine Neubeschreibung der 1885 veröffentlichten Fauna wurden an der Typlokalität in der Nähe von Ruhpolding in den Nördlichen Kalkalpen Profile aufgenommen. Eine genauere Beschreibung der Typlokalität des Sulzenmoosgrabens auf dem Röthelmoos war notwendig. Die Proben führten selten Radiolarien, und reiche Faunen waren mittelmäßig erhalten. Dadurch war eine Revision, die auch eine Beschreibung von Neotypen einschließen sollte, nicht möglich. Ziel der Arbeit war es, RÜSTs Abbildungen und Beschreibungen mit herausgeätzten Radiolarien der Aptychenschichten der Typlokalität zu vergleichen und zu diskutieren, welche Formen RÜSTs Illustrationen zugeordnet werden können. Von 60 Arten, die RÜST von Urschlau neu beschrieb, wurden 34 für eine mögliche Revision als geeignet erachtet. Diese verbleibenden Arten wurden nach den Kriterien heutiger Radiolarien-Paläontologie bewertet. Diese Bewertung besteht aus einer Übersetzung der Original-Beschreibung in das Englische, einer Interpretation der RÜSTschen Abbildungen, einer Diskussion des heutigen paläontologischen Wertes und einer rasterelektronenmikroskopischen Abbildung.

1. Introduction

RÜST published 4 monographs of fossil radiolarians from the Carboniferous, the Jurassic and the Cretaceous systems. Two of these publications concentrate on Jurassic radiolarians of different localities inside and outside Europe. In his volume of 1885 he described 67 species from the locality of "Urschlau" including species named by PANTANELLI (1880) and GÜMBEL (1861). The fauna is embedded in "Aptychus-Schiefer", which means "Aptychus slate". These lithologies are non-metaphorphic sediments representing a marly limestone with chert nodules of Late Jurassic age. Purpose of the project was to evaluate RÜST's radiolarians, of which at least

7 species are still in use, comparing the illustrations of the monograph with modern Late Jurassic radiolarian data as far as possible. 4 profiles were taken at the type locality in order to find a well-preserved fauna corresponding to RÜST's radiolarians. All species names are nomina oblita, which have not been used for 50 years after their first publication. Some of the names, however, have been "reanimated" in the recent literature (FOREMAN, 1973, PESSAGNO, 1977). They are still in use and should be accepted as nomina conservanda.

2. Designation of the type locality: the "Sulzenmoos" Graben

One of the striking problems to revise RÜST's radiolarians is to find the type locality. The name "Urschlau" given in the figure captions of the plate is specified in the text referring to the "Sulzenmoos" Graben in the area of the "Röthelmoos" (fig. 1) which is swamp in the center of a syncline of bedded limestones and marls of Mesozoic age. The Sulzenmoos Graben is a creek located at the northern flank of the syncline). The creek is oriented east-west and is about 3 km long running parallel to the strike of the beds. RÜST did not specify a type profile and did not give any description of the places, where he took his samples. Also no informations about the number and the size of the samples are available. Recent analyses of four profiles (BÖCK, 1991; STEIGER & STEIGER, 1993), measured along the entire Sulzenmoos Graben indicate, that the Late Jurassic limestones are barren in silicified radiolarians – except one place: three little occurrences of Aptychus beds separated by fractures located at the beginning of the creek in the center of the northern Röthelmoos area. It seems that RÜST took his samples at the first outcrops of white limestone occurrences as he walked from the entrance of the Röthelmoos on a track coming from the little village of Urschlau.

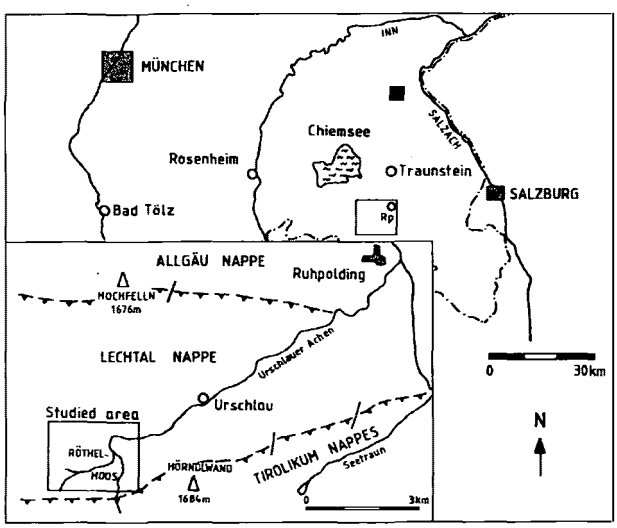


Fig. 1: Geological setting and geological position of the Röthelmoos area SW of Urschlau.

Redescription of the radiolarian locality of the "Sulzenmoos Graben" southwest of Urschlau:

Three little occurrences of white bedded Aptychus Beds bearing black chert nodules and cherty layers. The lithologies are located about 40 to 60 meters east of the road bridge over the creek of the Sulzenmoos Graben (H: 52 85 58, R: 45 41 33). The limestones do not form outcrops with profiles but small hills covered by grass with randomly distributed rocky areas. The Aptychus beds are laterally bordered by fractures and covered by Pleistocene sediments.

As the fauna of the Sulzenmoos-Graben is moderately preserved, a different locality might be assigned as a new type locality of the Urschlau (see IRZN, KRAUS, 1970). The only rich, well-preserved fauna found by the author close to the Sulzenmoos Graben is from the Gschwendlbach, about 2 km southwest of the type locality (STEIGER & STEIGER, 1993, 1994). These radiolarians, however, occur in the "Ruhpoldinger Marmor", a red and green mottled nodular limestone, which is different in facies and slightly older than the Aptypchus beds. This fauna is not regarded to be comparable with the original fauna described and illustrated by RÜST.

3. Lithology und stratigraphy

The area of the Röthelmoos is part of a sequence of synclines in the Lechtal nappe system of the Northern Calcareous Alps. The lithologic sequence is composed of mesozoic calcareous sediments ranging from dolomite and limestones of various color to gray marls (fig. 2). The most rigid lithologies are Late Triassic dolomite, the "Hauptdolomit" forming the northern flank of the syncline. Above the Norian Hauptdolomit the Triassic sequence is followed by dark limestone beds of the "Plattenkalk" (Norian) and calcareous marls of the "Kössener Schichten" of Rhaetian age. The Jurassic interval consists of red thick-bedded limestones of "Hierlatz"-type which is rich in echinoderm remains. This lithology grades into red nodular limestones of the "Adnet"-type laterally. Both calcareous rock types are overlain by siliceous lithologies: the "Radiolarit" which is the ribbon radiolarite and the "Dogger-Kieselkalk" representing a thick-bedded diagenetic chert-breccia. The age of the siliceous interval is Late Liassic to Early Tithonian. Laterally the siliceous beds change into calcareous reddish and greenish limestones called the "Ruhpoldinger Marmor". The age of the "Ruhpoldinger Marmor" is Kimmeridgian to Middle Tithonian containing rich radiolarian faunas (STEIGER & STEIGER, 1993, 1994). Above a distinct change from reddish to white colors Late Jurassic "Aptychus-Beds" occur, composed of white bedded limestones. These limestones represent the radiolarian bearing lithologies of RÜST's monographs. The Mesozoic sequence of the Röthelmoos area terminates with gray bedded marls of Lowermost Cretaceous age. These marls are called "Cretaceous Aptychus Beds" containing ammonites of the Berriasian and Valanginian (DOBEN, 1970).

The lithologies of the the Lechtal Nappe are deposited asymetrically, because of the influence of block tilting during the passive margin period of the austroalpine depositional environment (LACKSCHEWITZ, GRÜTZMACHER & HEINRICH, 1992).

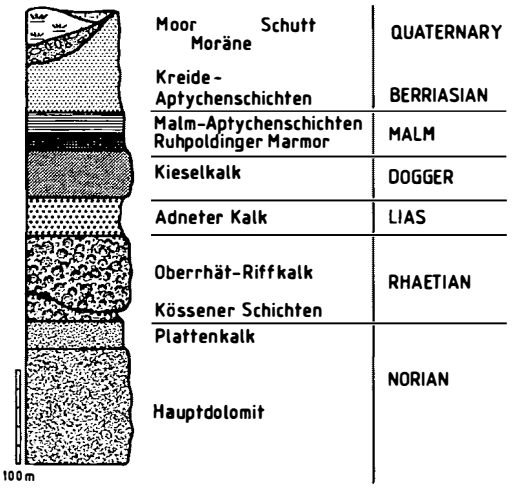


Fig. 2: Lithostratigraphic sequence and sediment age in the Lechtal Nappe.

4. Methods

This study follows the rules in the IRZN (KRAUS, 1970). The purpose is to evaluate RÜST's presentation and the scientific value of the monograph. It is known that RÜST's illustrations include both figures from thin-sections and three-dimensional tests. Current radiolarian research is based on the analysis of three-dimensional investigations.

Many pictures are very rough not showing enough characters for exact determination. Most of these pictures display two-dimensional sections. Therefore, forms which are not useful, mostly named and illustrated from thin-sections are excluded in this paper.

The useful species are treated as follows: original description, description and interpretation of the figures and discussion and evaluation of RÜST's documentation.

5. The problem of HAECKEL's genera used by RÜST

A severe problem in radiolarian paleontology is the conflict of the generic names given by

HAECKEL for cenozoic radiolarians without the designation of type species in 1882. RÜST used some of HAECKEL's names attributing new, Jurassic species to these genera, giving the first paleontological status to them. This affects the genera *Hagiastrum* HAECKEL, 1882, with type species *Hagiastrum plenum* RÜST, 1885, *Xiphosphaera* HAECKEL, 1882 with type species *Xiphosphaera tredecimporata* RÜST, 1885, *Tripocyclia* HAECKEL, 1882 with type species *Tripocyclia trigonum* RÜST, 1885, *Trigonactura* HAECKEL, 1882, with type species *Trigonactura weissmanni* RÜST, 1885, *Heliodiscus* HAECKEL, 1882, with type species *Heliodiscus inchoatus* RÜST, 1885, *Spongoplegma* HAECKEL, 1882, with type species *Spongoplegma urschlauense* RÜST, 1885, *Tricolocampe* HAECKEL, 1882 with type species *Tricolocampe clepsydra* RÜST, 1885, and *Acotripus* HAECKEL, 1882, with type species *Acotripus urceolus* RÜST, 1885, all described from the Urschlau. The species *Acotripus urceolus* and *Tricolocampe clepsydra* are considered not to be useful because of the bad illustration. In consequence of the above problem (KOZUR, pers. comm.) all genus names of HAECKEL used by RÜST are related to Jurassic species described by RÜST (1885) (CAMPBELL, 1954). RÜST's illustrations of some Hagiastrids give the impression that they bear pronounced spherical central areas, which are defined by HAECKEL for cenozoic radiolarians, but are not so large in Jurassic material.

6. List of radiolarians:

	RÜST, 1885, Plates/Figures		not useful	useful
Spumellaria:				
Cenosphaera marginata	Pl. XXVI (I)/	Fig. 4	x	
Cenosphaera regularis	Pl. XXVI (I)/	Fig. 5	x	
Cenosphaera stellata	Pl. XXVI (I)/	Fig. 7	x	
Cenosphaera lacunosa	Pl. XXVI (I)/	Fig. 8	x	
Cenosphaera gregaria	Pl. XXVI (I)/	Fig. 10	x	
Cenosphaera pachyderma	Pl. XXVII(II)/	Fig. 2,3	x	
Cenellipsis rappi	Pl. XXVII(II)/	Fig. 10	x	
Xiphosphaera tredecimporata	Pl. XXVII (II)/	Fig. 15		x
Staurosphaera gracilis	Pl. XXVII (II)/	Fig. 18		x
Staurosphaera sedecimporata	Pl. XXVIII (III)/	Fig. 1		x
Staurosphaera antiqua	Pl. XXVIII (III)/	Fig. 2		x
Triactoma tithonianum	Pl. XXVIII (III)/	Fig. 5		x
Carposphaera distincta	Pl. XXVIII (III)/	Fig. 8	x	
Stylosphaera resistens	Pl. XXVIII (III)/	Fig. 10	x	
Staurolonche robusta	Pl. XXIX (IV)/	Fig. 2	x	
Staurolonche extensa	Pl. XXIX (IV)/	Fig. 3	x	
Spongoplegma urschlauense	Pl. XXIX (IV)/	Fig. 9		x
Heliodiscus inchoatus	Pl. XXIX (IV)/	Fig. 13		x
Tripocyclia trigonum	Pl. XXX (V)/	Fig. 3		x
Trigonactura weissmanni	Pl. XXX (V)/	Fig. 5		x
Porodiscus simplex	Pl. XXX (V)/	Fig. 6	x	
Rhopalastrum contractum	Pl. XXXII (VII)/	Fig. 10		x
Rhopalastrum proavitum	Pl. XXXII (VII)/	Fig. 11		x
Rhopalastrum tuberosum	Pl. XXXIII(VIII)/	Fig. 1		x
Rhopalastrum tumidum	Pl. XXXIII(VIII)/	Fig. 3		x
Rhopalastrum terebra	Pl. XXXIII(VIII)/	Fig. 4		x
Rhopalastrum dilatatum	Pl. XXXIII(VIII)/	Fig. 5		x
Rhopalastrum rotundatum	Pl. XXXIII(VIII)/	Fig. 6		x
Rhopalastrum paenorbis	Pl. XXXIII(VIII)/	Fig. 8		x
Dictyastrum singulare	Pl. XXXIII(VIII)/	Fig. 9		x

Hagiastrum plenum	Pl. XXXIII(VIII)/	Fig. 10			x
Hagiastrum subacutum	Pl. XXXIV (IX)/	Fig. 1			x
Dictyocoryne heimi	Pl. XXXIV (IX)/	Fig. 10			x
Nassellaria:					
Lithobotrys uva	Pl. XXXV (X)/	Fig. 2	x		
Cyrtocalpis eurystoma	Pl. XXXV (X)/	Fig. 4	x		
Cytrocalpis oblongula	Pl. XXXV (X)/	Fig. 5	x		
Cyrtocalpis minima	Pl. XXXV (X)/	Fig. 6	x		
Tripilidium debile	Pl. XXXV (X)/	Fig. 18	x		
Podocapsa guembeli	Pl. XXXVI (XI)/	Fig. 5,6			x
Podocapsa haeckeli	Pl. XXXVI (XI)/	Fig. 7			x
Podocapsa hantkeni	Pl. XXXVI (XI)/	Fig. 8			x
Sethocapsa globosa	Pl. XXXVI (XI)/	Fig. 16			x
Sethocapsa collaris	Pl. XXXVI (XI)/	Fig. 18			x
Tricolocampe clepsydra	Pl. XXXVII (XII)/	Fig. 3	x		
Acotripus urceolus	Pl. XXXVIII(XIII)/	Fig. 18	x		
Tetracapsa zinckeni	Pl. XXXVIII(XIII)/	Fig. 20			x
Tetracapsa jucunda	Pl. XXXVIII(XIII)/	Fig. 21	x		
Tetracapsa ixodes	Pl. XXXIX (XIV)/	Fig. 2			x
Lithocampe aptychophila	Pl. XXXIX (XIV)/	Fig. 4	x		
Lithocampe pervulgata	Pl. XXXIX (XIV)/	Fig. 6	x		
Lithocampe exaltata	Pl. XXXX (XV)/	Fig. 1	x		
Lithocampe ananassa	Pl. XXXX (XV)/	Fig. 3			x
Lithocampe impervia	Pl. XXXX (XV)/	Fig. 4			x
Lithocampe nerinea	Pl. XXXX (XV)/	Fig. 5			x
Lithocampe trochus	Pl. XXXX (XV)/	Fig. 7			x
Eucyrtis conoidea	Pl. XXXX (XV)/	Fig. 10			x
Stichocapsa imminuta	Pl. XXXXII (XVII)/	Fig. 4	x		
Stichocapsa conglobata	Pl. XXXXII (XVII)/	Fig. 5			x
Stichocapsa grandis	Pl. XXXXII (XVII)/	Fig. 6	x		
Stichocapsa rostrata	Pl. XXXXII (XVII)/	Fig. 9	x		

7. Description of individual species

Spumellaria:

Xiphosphaera tredecimporata
Pl. XXVII (II)/Fig. 15

(Pl. 2, fig. 7)

Original description: Oval lattice sphere with two very stout spines and 13 pores on the surface, which are arranged in three rows. Full length 0.35 mm. Width 0.147 mm. Diameter of the pores 0.021 mm.
Frequent.

Description and interpretation of the figures: The figure is composed of a slightly ellipsoidal disc showing 13 pores of equal size. The margin of the disc is of dark color grading into the white interior of the structure, which could represent a documentation of a sphere. The pores are arranged in straight longitudinal rows. Two very stout triradial spines arise from both ends of the ellipsoid. The length of the spines corresponds to the length of the porous part.

Discussion and evaluation of RÜST's documentation: The spumellarian described by RÜST most probably is *Pantanellium lanceola* (PARONA), which was described as *Stylosphaera lanceola* by PARONA, 1890. A difference in the illustrations of both authors is the number of pores in the vertical pore row. Similarities are two stout polar spines which are triradiate.

Problems in the interpretation of RÜST's figure result from the pore located below the frontal ridge of each spine, which normally does not occur in the

way drawn. If these two pores are ignored the pore number of a typical *Pantanellium lanceola* is illustrated in this figure.

In the case that *Pantanellium lanceola* is synonym with *Xiphosphaera tredecimporata* the latter species name would have priority. But as the taxon *Pantanellium lanceola* is in common use it should be kept as a nomen conservandum, and it is not necessary to establish a new type material of *Xiphosphaera tredecimporata* RÜST because it should be seen as a nomen oblitum.

Staurosphaera gracilis
Pl. XXVII (II)/Fig. 18

(Pl. 2, fig. 4)

Original description: Round latticed sphere with 55 to 60 round pores and four pointed slender spines. Towards the periphery the pores increase in size. Diameter of the sphere 0.23 mm. Length of spines 0.38 mm to 0.42 mm.
Not uncommon.

Description and interpretation of the figures: RÜST's picture shows a circular porous disc with four spines arranged crosswise. The porous disc is divided into two parts, an outer rim with two rings of equal pores and an inner part with pores getting smaller from the center to the outer porous rim. The outer rim has a dark gray background, whereas the inner part is light gray.

This should give the impression of a sphere possibly possessing a thick porous wall. The slim spines are triradiate. Their length exceeds the diameter of the sphere. Opposite spines have corresponding morphologies:

Two spines have opposite grooves, the other spines have opposite ridges of the three-bladed outline of the spine cross section.

Discussion and evaluation of RÜST's documentation: Similar forms are described as *Staurosphaera amplissima* by FOREMAN (1973). A spherical cortical shell bears four long triradiate spines. Differences are in the equatorial row of larger pores which occur between the spines. *Staurosphaera glebulosa* FOREMAN (1973) is distinguished from the other *Staurosphaera* species by a mamillate cortical shell.

Staurosphaera sedecimporata
Pl. XXVIII (III)/Fig. 1

Original description: Rather a square than a sphere with edges which are elongated as stout spines. The approximately square lattice pores are arranged in four rows each with four pores. Diameter of the square 0.156 mm. Length of spines 0.16 mm. Diameter of the pores 0.032 mm.
Not uncommon.

Description and interpretation of the figures: The figure is a four-rayed test with a square to trapezoidal part in the center. The central part consists of sixteen pores which are arranged rectangularly. The large pores are located in the corners of the trapezoid where the spines arise. The other twelve pores, arranged in rows displaying a two-rowed cross are of equal size.

Four relatively thick tridadiate spines are located at the edges of the trapezoid. Their length corresponds to the diagonal diameter of the trapezoid.

Discussion and evaluation of RÜST's documentation: This species is still frequently in use by modern biostratigraphers under the name *Emiluvia sedecimporata* (RÜST) (BAUMGARTNER, 1984; KOCHER, 1981). These authors describe a typical outline of the test, which shows a pillow-like test with concave sides and a square central area covered by square to rounded pores. Length of spines is medium reaching the diagonal diameter of the test. The spines are triradiate. The arrangement of the spines is like in the illustration prepared by RÜST. *Emiluvia sedecimporata* (RÜST) is absent in the observed material, but is frequent in the nearby "Gschwendlbach fauna" (STEIGER & STEIGER, in prep.).

Staurosphaera antiqua
Pl. XXVIII (III)/Fig. 2

(Pl. 2, fig. 6)

Original description: Almost the outline of the above species, however distinguished by 24 irregularly polygonal lattice pores of unequal size. Diameter of the test 0.175 mm. Length of the spines 0.15 mm.
Not uncommon.

Description and interpretation of the figures: RÜST's illustration consists of two pictures. The first picture shows a porous square with four spines at the edges. The second picture displays a side view with three spines and a slightly flattened sphere. The sides of the porous square are concave grading laterally into the spines. The largest pores are located at the basis of the spines where they form the corners of a marginal pore ring along the edges of the square. Within this ring two smaller pores occur between the large pores. The inner part of the square is filled with pores of the same size as the smaller pores of the outer pore ring. They form two circles: a central circle composed of three pores, an external circle with 9 pores. This circle has an indentation towards the inner pore ring at the lower side of the picture. Four spines grow from the corners of the square. Their length is slightly different. The surface of the spines only indicates that it could be triradiate in cross section. Grooves and ridges cannot be differentiated.

The second picture is a spiny sphere which is hardly comparable to the previous. It shows triradiate polar spines sitting on an ellipsoidal sphere with a bulbous upper and a flattened lower side. A third spine is located at the front side, very close to the right polar spine. The orientation of grooves and ridges of the third spine seems to be different from the polar spines. A fourth spine is not illustrated, but is obviously covered by the spherical upper surface of the central part of the test. The strange position of the third spine gives the impression that the sphere should be a pillow-like body corresponding to the square of the first picture. Further information about the pore distribution is not given in the second picture.

Discussion and evaluation of RÜST's documentation: This species is subject of intense discussion in recent literature. The form is placed into the genus *Emiluvia* FOREMAN by PESSAGNO (1977). The genus Emiluvia differs from *Staurosphaera* by a pillow-like cortical shell. The illustration given by RÜST corresponds to the definition of *Emiluvia*. BAUMGARTNER (1984) refused the use of *Emiluvia* because very little was known about the organisation of the test of *Staurosphaera antiqua*. Some indications of the nature of the species antiqua were given by STEIGER (1992) who investigated the pattern of pores and nodes in the course of the description of his species *Emiluvia tecta*. The basal pattern of nodes corresponds exactly to the pore pattern of *Emiluvia antiqua* illustrated by PESSAGNO (1977).

Triactoma tithonianum
Pl. XXVIII (III)/Fig. 5

(Pl. 1, fig. 3)

Original description: Round latticed sphere with three long, slender spines, which are situated in a plane. The round pores are arranged in 10 rows each containing 10 pores. Diameter of the sphere 0.204 mm. Length of spines 0.265 mm. Diameter of the pores 0.013 mm.
Not frequent.

Description and interpretation of the figures: The illustration is composed of a porous disc representing a sphere with almost regularly distributed pores of equal size. The margin of the sphere is darker emphasizing the spherical charakter of the test. The pore distribution is somewhat regular displaying curved pore rows. Three triradiate spines arise from the sphere. The angle between the spines is almost 120 degrees. The curved pore rows are not related to the position of the spines.

Discussion and evaluation of RÜST's documentation: This very famous Jurassic species is frequently used. A recent monograph of triactomids and related genera was given by PESSAGNO, SIX, & YANG (1989). The genus *Triactoma* is here restricted to a spherical cortical shell. The illustration of RÜST corresponds to the definition given by these authors. Minor problems arise from the presence of very long, slender spines in the illustration by RÜST, which are extremely rare in Triactomas in the sediments investigated. *Triactoma tithonianum* accepted by other authors (PESSAGNO, 1977; BAUMGARTNER, 1984) have shorter and thicker spines.

Spongoplegma urschlauense
Pl. XXIX (IV)/Fig. 9

(Pl. 1, fig. 1, 2)

Original description: Large outer shell, which is made of spongy material, encloses a small lattice shell, showing densly placed round pores. Diameter of the outer shell 0.438 mm, diameter of the inner shell 0.076 mm.
Rare.

Description and interpretation of the figures: The picture gives the impression of a spongy disc with three distinct concentrically arranged zones. 1. An outer zone which represents an inflated finely porous rim around the central part. 2. A darker, intermediate zone without pores. 3. A central part with larger pore-like structures, which also could be nods of irregular size and distribution. This part of the test seems to be slightly elevated similar to the outer rim.

Discussion and evaluation of RÜST's documentation: *Spongoplegma urschlauense* is an orbiculiformid radiolarian. The diagnosis of the genera *Orbiculiforma* PESSAGNO (1973) and *Spongoplegma* HAECKEL, 1882, are very similar. *Orbiculiforma* contains more variable morphologies of the tests. Comparison of the illustrations of both forms indicates that *Spongoplegma urschlauense* is synonym with *Orbiculiforma mclaughlini*. The younger name is in common use and should be seen as a nomen conservandum. Orbiculiformid radiolarians are extremely rare in the material observed.

Heliodiscus inchoatus
Pl. XXIX (IV)/Fig. 13

Original description: Juvenile specimen with shell hemispheres, which are not closed yet. The lattice pores are irregularly distributed. The spines are not visible. Diameter of the outer shell 0.1 mm, diameter of the inner shell 0.035 mm.
Unique specimen.

Description and interpretation of the figures: The figure shows a dumbbell-like structure with two polar hemispheres and a sphere in the center. All surfaces are porous. The drawing gives a three-dimensional impression.

Discussion and evaluation of RÜST's documentation: RÜST's figure shows the remain of a spumellarian, which hardly can be assigned to the genus *Heliodiscus* HAECKEL, 1882. The species resembles recent radiolarians e.g. *Larnacilla* HAECKEL, 1887. According to the above problem concerning HAECKEL's generic names used by RÜST the genus *Heliodiscus* is based on the Jurassic type species *H. inchoatus*. Due to the fact that Cenozoic heliodiscids are quite different from *H. inchoatus* and no further similar forms are present in the Urschlau material the genus *Heliodiscus* should be emended.

Tripocyclia trigonum
Pl. XXX (V)/Fig. 3

(Pl. 1, fig. 9)

Original description: Almost triangular disc with three stout spines. The surface of the disc

shows round pores. Height of the disc 0.396 mm. Length of spines 0.144 mm.
Not frequent.

Description and interpretation of the figures: The drawing is a porous triangle with three triradial spines at each corner. The length of the spines corresponds to the longest side of the triangle. The pores of the test are marginally arranged in pore rows. In the center of the triangle they are distributed randomly. The angle between the spines is more than 120 degrees at the longest side of the triangle. The other two angles are less than 120 degrees.

Discussion and evaluation of RÜST's documentation: The genus *Tripocyclia* (emended definition by PESSAGNO et al., 1989) has subspherical to subtriangular cortical shell. The base of the spines is characterized by cortical buttresses. The illustration by RÜST gives the impression of cortical buttresses which generate a triangular outline of the cortical shell.

Trigonactura weissmanni
Taf. XXX (V)/Fig. 5

Original description: Large round lattice disc with three long latticed arms, which end with small lattice discs. Diameter of the central disc 0.296 mm. Length of the arms 0.35 to 0.39 mm. Diameter of the small terminal discs 0.092 mm.
Rare.

Description and interpretation of the figures: The figure shows a discoidal central area with three arms extruding from the margin of the disc. The circular central area seems to represent a section of a sphere with a porous wall and a wide central lumen. The arms are porous possessing bulbous porous arm ends. On each arm two longitudinal single pore rows are visible.

One arm end is cut showing the hollow interior, the end of the second arm shows pores symmetrically distributed, the end of the third arm (lower right) gives no information about the surface structure. The diameter of the central part of the test corresponds to the length of the arms. The angles between the arms are 90, 135 and 135 degrees.

Discussion and evaluation of RÜST's documentation: The figure represents a hagiastrid radiolarian, which is not described by any other author. *Trigonactura weissmanni* is not present in the Urschlau material.

Rhopalastrum contractum
Pl. XXXII (VII)/Fig. 10

(Pl. 2, fig. 3)

Original description: Starting from their junction three arms taper gradually to the ends, which are spherical. The arms contain 4 longitudinal rows of large pores. The terminal spheres have 5 transversal rows of small pores. Length of the arms 0.204 mm. Medium width of the arms 0.082 mm.
Not uncommon.

Description and interpretation of the figures: Three-armed porous test with bulbous arm ends. No distinct central area: the arms are developed equally showing two single pore-rows on the upper surface. The margins of the arms are darker which gives a threedimensional impression. The diameter of the arms decreases towards the arm-ends. The bulbous ends have smaller pores which are arranged in concentric rings around the arm axis. The angle between the arms is 120 degrees.

Discussion and evaluation of RÜST's documentation: *Rhopalastrum contractum* is possibly a three-armed hagiastrid. Three-armed forms with single pore rows are described as *Archaeotritrabs* STEIGER. The known species of the genus, however, have proportions which are different to those of the test illustrated by RÜST. But also the pore pattern drawn by RÜST could be a thin-section effect of a tritrabid radiolarian, which is characterized by double pore rows. Late Jurassic radiolarian faunas of the Northern Calcareous

Alps are rich in tests of a small subspecies of *Tritrabs ewingi* which is described as *Tritrabs ewingi minima* by STEIGER, 1992. In the re-examined material of the Urschlau these forms are frequent.

Rhopalastrum proavitum
Pl. XXXII (VII)/Fig. 11

Original description: The arms sligthly widen towards their end and start from a round disc, which is densely covered with concentrically arranged rings of pores. The arms have 5 parallel rows of small round pores. Length of the only preserved arm 0.227 mm. Diameter of the central disc 0.12 mm. Width of the arm 0.07mm. Diameter of pores 0.004 to 0.005 mm.
Rare and mostly as fragments.

Description and interpretation of the figures: The picture of this form shows an incomplete skeleton of a three-armed porous test. Three arms arise from a discoidal central area. The pores of the arms are small, arranged in several pore rows longitudinally between the outer margin of the central area and the surface of the arm ends. The arm drawn completely has five pore rows, the upper left arm has four and the upper right arm, only showing the base, has three pore rows. The width of the arms increases towards the end. The only arm end documented is rounded like a hemisphere. The central area is composed of a noddy surface and numerous concentrically arranged pore rings. The diameter exceeds the width of the arms. The arms are 2.5 times longer than the diameter of the central area.

Discussion and evaluation of RÜST's documentation: The illustration of RÜST's species shows a broken test which is similar to hagiastrids of the genus *Homoeoparonaella*. The central disc, however, is different to *Homoeoparonaella*. Another possibility to interpret the figure is, that the central disc is a simplified central structure of *Angulobracchia mediopulvilla* STEIGER which is frequent in the Northern Calcareous Alps and in the observed material. But this species has clavate arms, a character which is not drawn by RÜST. Because of recrystallization effects tests of *Rhopalastrum proavitum* are not clearly recognizable in the re-examined material of the Urschlau.

Rhopalastrum tuberosum
Pl. XXXIII (VIII)/Fig. 1

(Pl. 1, fig. 4-6);

Original description: Characterized by arm ends, which show two lateral indentations; in the center a small disc. Length of the arms 0.26 mm. Width of the arms 0.046 mm.
Not frequent.

Description and interpretation of the figures: This three-dimensional picture shows a three-armed hagiastrid. The surfaces of the arms are covered with four rows of simple pores. Neighboring rows have alternating pores. The arm ends are characterized by blunt tips and round lateral protrusions. Pores tend to be randomly distributed at the arm ends. The angles between the arms are 110, 110 and 140 degrees. The central area has larger pores arranged in a hexagonal ring with a pore in the center. The edges of the hexagon are located symmetrically to the arms and the angles between the arms.

Discussion and evaluation of RÜST's documentation: This illustration generates the same problems as *Rhopalastrum contractum*. The interpretation of the true nature of the pore rows is difficult. Accepted as rows of single pores the form belongs to the genus *Archaeotritrabs* or *Homoeoparonaella*. The pore pattern of the central field in the illustration is not typical of species of both genera. It is similar to that of *Tritrabs casmaliaensis* (PESSAGNO). The outline of the test is too general and is found in species of different genera like *Tritrabs* (*Tritrabs ewingi worzeli* (PESSAGNO), *Homoeoparonaella* (*Homoeoparonaella*

tricuspidata (RÜST)), and *Archaeotritrabs* (*Archaeotritrabs gracilis* STEIGER).

Rhopalastrum tumidum

Pl. XXXIII(VIII)/Fig. 3

Original description: Three long arms of almost equal length are strongly widened showing minor roundness at the ends, like beeing cut straightly, with 4 longitudinal pore rows, which converge slightly to the center. Length of arms 0.204. Width of arms 0.088 mm.
Not uncommon.

Description and interpretation of the figures: Three-armed form with wide club-shaped arms. The surface of the arms is covered with four parallel rows of simple pores. The diameter of the pores increases towards the arm ends. Maximum width of the arms in the external half. The length of the arms is slightly different. The angle between the arms is about 120 degrees.

Discussion and evaluation of RÜST's documentation: This form belongs to the family *Angulobracchiidae*, which is close to *Angulobracchia portmanni* BAUMGARTNER. The illustration, however, is extremely simplified and cannot give any impression of the complex construction of the test of this species. The description and illustration of the form is too simple compared with the modern state of hagistrid investigation.

Rhopalastrum terebra

Pl. XXXIII(VIII)/Fig. 4

(Pl. 2, fig. 2)

Original description: Test with two club-shaped arms, which adjoin with a wide angle, and a thick longer bodkin-like arm. The former with 3, the latter with 5 pore rows. Length of the large arm 0.296 mm, width of this arm 0.075 mm. Length of the short arms 0.125 mm, width of the short arms 0.045 mm.
Rare.

Description and interpretation of the figures: Bilateral test with one thick and two thinner arms. The outline of the large arm is characterized by convex lateral sides and a pointed tip at the arm end. The surface of the arm shows four parallel rows of simple pore rows. The diameter of the pores varies somewhat with the width of the arm. The other two arms are shorter and have about half of the length of the large arm. Their pores are small and randomly distributed. The arm ends are rounded. The angle between the two short arms is about 160. between the large arm and the short arms about 100 degrees.

Discussion and evaluation of RÜST's documentation: *Rhopalastrum terebra* is similar to the species named *Rh. tumidum* comparing the pore pattern on the larger arm.This arm is different in terms of the contour, which is clavate. Such forms are frequent in the re-examined material.

Rhopalastrum dilatatum

Pl. XXXIII(VIII)/Fig. 5

Original description: Three unequal arms, two of them strongly widened towards the end and being like cut straightly, the third terminating with a pointed club. The former with densely arranged large pores, the latter with 6 to 7 longitudinal rows of small pores. Length of the arms 0.265 mm. Largest width 0.152 mm.
Rare.

Description and interpretation of the figures: Three-armed hagiastrid with bilateral symmetry. Two arms have a trapezoidal outline, the third arm is club-shaped. The trapezoidal arms show slightly concave sides. The club-shaped arm shows a pattern of 7 parallel rows of single pores. The diameters of the pores in the central row exceed those of the lateral rows. The central

pore row seems to end at the opposite side of the central area in the middle of the angle between the trapezoidal arms. The pore pattern of the club-shaped arm continues on the proximal part of the trapezoidal arms. The external two thirds are different, characterized by numerous rows of alternating rings which apparently represent pore frames. At the lower left arm the maximum number of rows is eight, at the lower right arm six rows are developed. The lower left arm has a stout lateral spine, whereas the rest of the ends of the trapezoidal arms are without spines. The angle between the arms is about 120 degrees.

Discussion and evaluation of RÜST's documentation: The designation of this illustration to the re-examined material is difficult. Its bilateral symmetry and the outline of the larger arms are similar to forms of the genus *Halesium* PESSAGNO. An additional character of *Halesium* drawn by RÜST is the angular cross section of the larger arms indicated by sharp dark margins in the picture. The third arm has a blunt tip which possibly is the bracchiopyle of this type of hagiastrid first described by PESSAGNO, 1971. Species of *Halesium* are abundant in the re-examined material, but forms similar to *Rhopalastrum dilatatum* are not present. Furthermore *Rhopalastrum dilatatum* RÜST should be regarded invalid because of the fact, that RÜST's drawing gives no specific details about morphological characters which are necessary to assign the species to a hagiastrid genus.

Rhopalastrum rotundatum
Pl. XXXIII(VIII)/Fig. 6

(Pl. 2, fig. 5)

Original description: Three arms and the angles between them unequal. Two arms strongly club-shaped, the third slender with minor thickened end. The former with 4 to 5 pore rows, which are diagonally directed to the longitudinal axis. The latter with two rows. Length of the arms 0.26 mm. Largest width of the arms 0.125 mm. Rare.

Description and interpretation of the figures: Hagiastrid with three arms. Two arms are club-shaped, the third arm is straight possessing a spherical arm end. The club-shaped arms show a rectangular pore pattern composed of four longitudinal rows of single pores. The pore rows are arranged diagonally to the arm axis. The orientation of the pore pattern on both arm forms a bilateral symmetry with the plane in the middle of the angle between the arms. The third arm is as long as the previous arms. The pores are arranged in two rows of alternating pores. The end of the third arm is poreless. The angle between the club-shaped arm is 90 degrees, between the lower left and the straight arm is 110 degrees, and between the straight arm and the lower right arm 160 degrees. The central area is poreless and not distinct.

Discussion and evaluation of RÜST's documentation: The bilateral symmetry indicated by the relations of the pore patterns of the larger arms to each other is a morphological character of the genus *Foremanella* MUZAVOR (1977). In Late Jurassic sediments of the Northern Calcareous Alps forms, which have a smaller third arm not oriented perpendicularly to the angle between both larger arms, are not uncommon. These radiolarians, however, show dichotomous branches at the ends of the larger arms. Such tests are generally assigned to *Foremanella diamphidia* (FOREMAN). But the present skeletons are larger and have longer arms. These are yet undescribed. The samples of the Urschlau contain very few of the above discussed forms.

Rhopalastrum paenorbis
Pl. XXXIII(VIII)/Fig. 8

Original description: Three, rather equally developed arms, which are strongly widened at the ends and rounded, giving an outline of a

round disc where three circles would have been cut out of it in the marginal area. Length of the arms 0.117 to 0.127 mm. Largest width 0.123 to 0.15 mm.
Not uncommon.

Description and interpretation of the figures: Three-armed porous form with wide arm ends and without distinct central area. The outline of the arms is concave. The external surface of all three arm ends forms a circle. The pores are distributed regularly with a central pore row on the top of the arm surface. The general pore pattern is hexagonal. In the area of the arm ends the pores are arranged in diagonal, partly curved rows. The drawing gives a three-dimensional impression.

Discussion and evaluation of RÜST's documentation: Tests with such a significant outline are abundant in Late Jurassic sediments, but characterized by a spongy meshwork. The porous surface drawn by RÜST is finer than the large pores he normally uses for porous radiolarians. It is possible that the pores illustrated in *Rhopalastrum paenorbis* should correspond to a spongy surface. In this case the description seems to be exact enough to keep the name of the species. As a spongy hagiastrid the species then has to be assigned to the genus *Paronaella* PESSAGNO.

Dictyastrum singulare
Pl. XXXIII(VIII)/Fig. 9

(Pl. 2, fig. 1)

Original description: Three, rather unequally developed arms are connected in the center by a small disc and terminally widened as small rounded discs, each bearing two laterally directed tips. The arms with 4 parallel longitudinal rows of round pores. Length of the arms 0.408 mm. Width of the arms 0.058 mm. Diameter of the central disc 0.088 mm. Length of terminal tips 0.045 to 0.062 mm.
Rare.

Description and interpretation of the figures: Three-armed hagiastrid with straight arms, a spherical central area and spiny arm ends. The arms are porous and have equal length. On their upper surface four rows of simple pores are visible. The pores alternate longitudinally. One arm seems to have superficial ridges between the pore rows. The arm ends are bulbous, each with two lateral spines. The length of these spines exceeds the length of the arms. Some of them are drawn triradiate. The arm ends are poreless. The central area has a somewhat concentrically arranged pore pattern. The angle between the arms is about 120 degrees.

Discussion and evaluation of RÜST's documentation: This hagiastrid contains many morphological characters of *Tritrabs casmaliaensis* (PESSAGNO): 1. The upper arm is drawn with ridges between the pore rows. 2. The arm ends bilaterally show secondary spines. 3. The angle between the arms is 120 degrees. 4. The central area contains small pores.

However, the central area is drawn slightly bulbous, which is unknown from the genus *Tritrabs*. A further problem is, that the two other arms have no ridges and seem to be round as it occurs in the genus *Homoeoparonaella* BAUMGARTNER. The genus *Dictyastrum* EHRENBERG is characterized by a spherical central area, which is missing among Jurassic hagiastrids. The illustration by RÜST comprises a mixture of morphological characters of two genera: *Dictyastrum* and *Tritrabs*.

Hagiastrum plenum
Pl. XXXIII (VIII)/Fig. 10

Original description: Four arms of unequal length adjoin with right angles and a medium central inflation, and slightly taper towards the end, which possesses a small terminal disc. The arms with 3 longitudinal rows of rather large pores. Entire length 0.641 mm. Entire width 0.554 mm.
Not uncommon.

Description and interpretation of the figures: Four-armed hagiastrid having straight arms with spherical arm ends. The arms arise from a porous central area. The pores of the arms are arranged in rectangular rows. Three of them occur on the upper surface between two ridges. The pores of the arm ends are smaller, forming a pattern of concentrically distributed rings around the arm axis. The length of the arms is unequal. The central area shows a pore pattern which is different from the arms. It is composed of diagonal rows of simple pores. The angle between the arms is 90 degrees.

Discussion and evaluation of RÜST's documentation: The type species for the genus *Hagiastrum* generates problems because *Hagiastrum plenum* was never found in other places, except for a questionable one in the Gschwendlbach fauna. The problem is discussed by BAUMGARTNER (1980, 1984). RÜST's illustration is confusing, because it shows rows of simple pores. According to the interpretation of other hagiastrids described by RÜST the pore rows could include double rows of alternating pores which are typical of tritrabids. The corresponding genus is *Tetratrabs* BAUMGARTNER.

Hagiastrum subacutum
Pl. XXXIV (IX)/Fig. 1

(Pl. 1, fig. 7, 8)

Original description: Four unequal arms are slightly club-shaped and somewhat pointed at the end. They adjoin with right angles in a moderate central inflation. The arms with 4 longitudinal rows of pores. Entire length 0.583 mm. Entire width 0.446 mm.
Not uncommon.

Description and interpretation of the figures: Four-armed hagiastrid with club-shaped arms of unequal length, and pointed arm ends. The pores on the armes are arranged in four parallel rows. The pores alternate on three arms. On the fourth arm they form a rectangular pore pattern. In the central area the pore rows grade into a network of diagonally arranged rows. The arm ends are not distinct with respect to the pores. The angle between the arms is 90 degrees.

Discussion and evaluation of RÜST's documentation: Forms described above are not abundant in the examined material. They correspond to the genus *Higumastra* BAUMGARTNER. A second group which is more frequent shows a spongy meshwork with a discrete rectangular pore pattern. The arms of these skeletons are clavate as drawn by RÜST. The loss of a distinct pore pattern could be due to diagenetic alteration of the tests.

Dictyocoryne heimi
Pl. XXXIV (IX)/Fig. 10

Original description: Test with three short arms of unequal length which terminate in large round discs. The surface of the arms is covered with large mesh holes. The complete specimen is enclosed in a patagium of very delicate spongy siliceous mass. Height of the whole test 0.326 mm. Length of the arms 0.12 to 0.16 mm. Diameter of the terminal discs 0.088 mm.
Rare.

Description and interpretation of the figures: Three-armed hagiastrid with short arms and bulbous arm ends. The central area shows randomly distributed pores. Most of the upper surface of the arms is drawn poreless, except for a marginal row of single pores. The arm ends show concentrically arranged pores. All pores are of equal size. The porous test is embedded in a dark matrix, which could be interpreted as a patagium.

Discussion and evaluation of RÜST's documentation: In the Urschlau hagiastrids bearing a patagium have not been observed in the re-examined material.

Nassellaria:

Podocapsa guembeli
Pl. XXXVI (XI)/Fig. 5, 6

Original description: Rounded lattice shell, which is extended into three long prolongations with large round pores, also perforating the prolongations. The basal prolongations are located opposite to each other and show a tapered, pyramidal form. The apical process larger and conical. The pores are arranged in curved transversal rows, which are directed to the basal prolongations. Height 0.23 mm. Width 0.3 mm. Length of apical process 0.08 mm. Length of the basal prolongations 0.06 to 0.066 mm. Diameter of pores 0.025 mm.
Not frequent.

Description and interpretation of the figures: The two pictures given by RÜST show different views of probably the same form. The orientation of the apparently nassellarian test is upside down.

The upper drawing (no. 5) displays the proximal to central part of a eucyrtidiid possessing a stout apical horn, an unsegmented cephalis or thorax and a porous large segment (thorax or abdomen) having two lateral spines. These are also poreless and located opposite to each other. Structures on the right spine give the impression of a triradiate cross section. The pores of the test are round and large. They are arranged in alternating horizontal rows.

The lower drawing (no. 6) shows the distal part of the skeleton starting with the large porous segment which bears the two lateral triradiate spines. The test terminates with a long postabdominal pore tube. The pores of the tube are arranged in two longitudinal rows. The pore tube seems to be closed.

Discussion and evaluation of RÜST's documentation: The definition of the genus *Podocapsa* was given by RÜST (1885) based on the type species *Podocapsa guembeli* found in the Urschlau.

The upper drawing (no. 5) probably represents a fragment of *Dibolachras chandrika* FOREMAN. The lower illustration (no. 6) shows the lower part of a two-armed podocapsid composed of two short porous arms and a long porous postabdominal tube. The two different figures in RÜST's monograph represent two different species. This problem was first recognized by CAMPBELL (1954), where he designated fig. no. 5 as the lectotype of *Podocapsa guembeli*. FOREMAN (1973) emended the definition of the genus and changed the lectotype to fig. no. 6.

Podocapsa guembeli is reported by SCHMIDT-EFFING (1980) and ERBACHER (1994). Forms corresponding to *Podocapsa guembeli* RÜST (fig. no. 6) are not present in the Urschlau material.

Podocapsa haeckeli
Pl. XXXVI (XI)/Fig. 7

Original description: Almost triangular lattice shell due to a strong development of basal prolongations, which grade widely and without boundaries into the central body; they are rounded at the ends. The apical prolongation is short and widened at the end. Large pores are diagonally arranged in 12 rows. Height 0.23 mm. Width 0.476 mm. Diameter of the pores 0.023 mm.
Rare.

Description and interpretation of the figures: The picture shows a triangular porous test. The basis of the triangle is composed of two porous arms which are opposite to each other forming a bilateral symmetry. The upper part represents the beginning of a third porous arm-like structure which ends with a poreless widened protrusion having irregular outline. The nassellarian origin is uncertain because no signs of segmentation are detectable.

Discussion and evaluation of RÜST's documentation: The figure of *Podocapsa haeckeli* includes two possible taxa: 1. A two-armed hagiastrid with a perpendicular short arm base, which is frequent in Late Jurassic sediments of the Northern Calcareous Alps. 2. A not very well illustrated *Parapodocapsa furcata* STEIGER, which

is present in the Urschlau material. This form is characterized by two opposite curved arms forming an arc-like outline and a straight third arm. The third arm is located in the middle of the arc perpendicular to the convex side.

Radiolarian tests documented above are absent in the Urschlau material.

Podocapsa hantkeni
Pl. XXXVI (XI)/Fig. 8

Original description: The test is rounded and tetragonal. The basal prolongations are big, moderately tapered at the end. They join with a wide angle. Instead of an apical prolongation two short rounded prolongations occur, one at each side. The large pores are arranged in rows parallel to the axis of the basal prolongations. Height 0.296 mm. Width 0.583 mm. Length of the basal prolongtions 0.26 mm. Diameter of the pores 0.023 mm.
Rare.

Description and interpretation of the figures: The figure shows a spherical test with two porous arms at the lower side of the sphere. The upper side bears short protrusions. A plane of bilateral symmetry is developed between the protrusions and the porous arms.

The arms are pointed and have three alternating rows of single pores. The length of the arms exceeds the diameter of the sphere. The surface of the sphere partly shows large pores comparable to the arms. The nassellarian character of the form is not obvious.

Discussion and evaluation of RÜST's documentation: The illustration of RÜST's species is not comparable with other *Podocapsa* species. In addition the form does not correspond to the emended definition of the genus given by FOREMAN (1973).

The radiolarian described by RÜST was never found in Late Jurassic sediments again. The material of the Urschlau does not contain any similar forms.

Sethocapsa globosa
Pl. XXXVI (XI)/Fig. 16

Original description: Round spherical shell with short, conical first segment. Large round pores are densely arranged in straight rows. Diameter of the sphere 0.214 mm. Diameter of the pores 0.027 mm. Length of the first segment 0.11 mm.
Not frequent.

Description and interpretation of the figures: Nearly three-dimensional picture of a sethocapsid radiolarian possessing a cone-like proximal part and a spherical terminal part. The proximal cone is poreless. The large last segment is porous characterized by longitudinal rows of alternating pores. The lower end is closed.

Discussion and evaluation of RÜST's documentation: *Sethocapsa globosa* is frequent in Late Jurassic sediments. It is very similar to *Sethocapsa leiostraca* FOREMAN.

Sethocapsa collaris
Pl. XXXVI (XI)/Fig. 18

Original description: The first segment is oval. The second, spherical segment follows with a neck-like stricture. Round pores of medium size are arranged in 10 diagonal rows. Length 0.26 mm. Thickness of the sphere 0.174 mm.
Not frequent.

Description and interpretation of the figures: Two-segmented porous nassellarian with an oval proximal segment and a spherical terminal segment. The pores of the test are small and have wide spaces between them. The pores are arranged in curved diagonal rows. The picture seems to be drawn from a thin section.

Discussion and evaluation of RÜST's documentation: This species represents a dicyrtid nassellarian. Comparable forms are not present in Late Jurassic sediments of the Urschlau.

Tetracapsa zinckeni
Pl. XXXVIII(XIII)/Fig. 20

Original description: Four segments as almost round spheres gradually increasing in size. The pores are arranged in somewhat diagonal rows. Length 0.214 mm. Width 0.106 mm.
Not frequent.

Description and interpretation of the figures: The figure shows a four-segmented nassellarian. Pores are present on all segments. The segments gradually increase in length and width. The pore pattern is composed of diagonal rows of medium size pores.

Discussion and evaluation of RÜST's documentation: Three of the four segments possess a regular pore pattern of more or less horizontal rows. This form is absent in the observed Urschlau material.

Tetracapsa ixodes
Pl. XXXIX (XIV)/Fig. 2

Original description: First three segments very small, fourth segment very large and longitudinally oval. The second and third segment with 2 rows of small pores, the fourth with 10 to 12 diagonal rows of large pores. Length 0.476 mm. Total length of first three segment together 0.095 mm. Width of last segment. 0.35 mm.
Rare.

Description and interpretation of the figures: This large radiolarian has a spherical last segment and a conical proximal part. The pores on the last segment are arranged in diagonal rows. The proximal part is composed of three segments, which are poreless.

Discussion and evaluation of RÜST's documentation: This form strongly resembles sethocapsids ranging from *Sethocapsa dorysphaeroides* NEVIANI (1900) to *Sethocapsa (?) orca* FOREMAN (1975). The drawing shows a very short proximal part, probably because of a thin section effect.

Lithocampe ananassa
Pl. XXXX (XV)/Fig. 3

(Pl. 2, fig. 10)

Original description: With 9 segments. The fifth segment is the largest. Each segment in the middle slightly concave, so that the rings which connect the segments surround the longitudinally ovate shell as elevated bars. Length 0.326 mm. Width 0.23 mm.
Rare.

Description and interpretation of the figures: This multicyrtid nassellarian is longitudinally composed of 5 segments which increase in width and 4 segments which decrease in width. The outline of the test is similar to a pineapple. The segments are laterally concave and linked by ridges. The surface of the test has a uniform gray color without any information about pores.

Discussion and evaluation of RÜST's documentation: The illustration clearly represents the outline of *Parvicingula boesii* (PARONA, 1890). RÜST's monograph would have priority, but the species is described and illustrated insufficiently to be able to recognize what was defined later under *Parvicingula boesii.*

Lithocampe ananassa RÜST is regarded to be synonym to *Parvicingula boesii. Parvicingula boesii* is well-defined and illustrated by PARONA (1890) and is in common use.

Lithocampe impervia
Pl. XXXX (XV)/Fig. 4

Original description: With 9 to 10 segments of irregular size. Very small pores in 10 transversal rows which have a large distance from each other. Length 0.26 mm. Width 0.117 mm.
Rare.

Description and interpretation of the figures: The test is composed of a short proximal part, which is a shallow cone and a long distal

part which is a cylinder. The proximal part has four segments, the distal part seven segments. Starting from the third segment all segments have a basal horizontal pore row which is very close to the strictures between the segments.

Discussion and evaluation of RÜST's documentation: This illustration represents a multicyrtid nassellarian of *Pseudodictyomitra* or *Archaeodictyomitra* type indicated by the row of single pores at the base of each segment and the strictures between the segments.

Further information of the surface structure would be required for the exact determination.

Lithocampe nerinea
Pl. XXXX (XV)/Fig. 5

(Pl. 2, fig. 9)

Original description: Long, conical, with 11 to 12 segments. Last segments slightly widened to the aperture. Each segment with three transversal rows of pores. Length 0.534 mm. Width 0.175 mm.
Not uncommon.

Description and interpretation of the figures: Conical test with 12 segments. The first three segments without pores. All other segments show three horizontal rows of alternating pores.

Discussion and evaluation of RÜST's documentation: The species can be assigned to the genus *Parvicingula* PESSAGNO. It is very close to the Jurassic-Cretaceous species *P. cosmoconica* (FOREMAN).

Lithocampe trochus
Pl. XXXX (XV)/Fig. 7

Original description: With 8 segments, which strongly increase in size. Therefore test wider than high. Each segment with two rows of pores. Length 0.408 mm. Width 0.476 mm. Very rare.

Description and interpretation of the figures: Multicyrtid test with conical form. The lateral sides are straight and smooth. The number of segments is 8. The proximal part, however, seems to be divided into two parts by a lateral stricture. The abdomen and postabdominal segment bear two pore rows, each of them with alternating pores.

Discussion and evaluation of RÜST's documentation: Conical shells as described by RÜST are absent in the examined material and lack in other Jurassic sediments of the Northern Calcareous Alps. In literature this type of form is unknown in this time interval. Morphologically close is the genus *Andromeda* BAUMGARTNER, which has fewer segments.

Eucyrtis conoidea
Pl. XXXX (XV)/Fig. 10

Original description: With 7 to 8 segments and a small apical spine. The upper segments with 2, the lower segments with 3 rows of pores. Length 0.307 mm. Width 0.133 mm.
Not uncommon everywhere.

Description and interpretation of the figures: Multicyrtid nassellarian with convex outline of the cylindrical test. The cephalis is poreless and bears a small curved horn. The thorax is also poreless. Abdomen and 6 postabdominal segments have pores: The abdomen shows one horizontal pore row. The first postabdominal segment has two pore rows. Four postabdominal segments possess three pore rows each. The last segment seems to be uncomplete and shows one pore row. The outline of this segment is dentate at the lower end. The form has an open base.

Discussion and evaluation of RÜST's documentation: Except the asymmetric apical horn, this form resembles nassellarians of *Parvicingula* or *Ristola* type. The figure seems to reflect a thin section picture, where the concave outline of

the segments is converted strictures. The illustration might be assigned to *Parvicingula boesii* (PARONA) or *Ristola procera* (PARONA).

Stichocapsa conglobata
Pl. XXXXII (XVII)/Fig. 5

(Pl. 2, fig. 8)

Original description: All 6 to 7 segments are almost spherical and densely covered by round pores of medium size. Length 0.446 mm. Width of the last segment 0.326 mm.
Not uncommon.

Description and interpretation of the figures: Stichocapsid nassellarian with 7 segments. Cephalis, thorax and abdomen increasing rapidly in width. From abdomen through last segment minor but constant increase of width and lenght of single segments. Distinct strictures between segments. All segments seem to be porous. The pore pattern is complete on the last segments displaying diagonally arranged rows of small round pores.

Discussion and evaluation of RÜST's documentation: This stichocapsid nassellarian is characterized by a regular pattern of tiny pores on the last segment. These stichocapsids are generally rare in Late Jurassic sediments and co-occur with tests of the genus *Spongocapsula* PESSAGNO. Similar forms are assigned to the genus *Sethocapsa* HAECKEL.

8. Summary

Results of the investigation of the Late Jurassic radiolarians from the Sulzenmoos Graben south-west of Urschlau are:

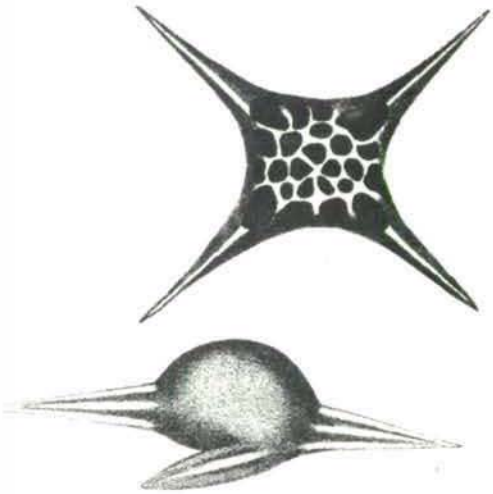
1. The fauna of the redescribed type locality is moderately preserved and is not useful for a valuable revision.
2. All illustrations of RÜST's radiolarians described from the Urschlau are made from thin sections representing two-dimensional pictures partly modified to three-dimensional more interpretative figures.
3. About half of the number of the Urschlau species are not good enough for further paleontological use because of the minor information derived from a two-dimensional thin section picture.
4. Due to the advanced stage of paleontological research the figures, even the three-dimensional pictures in addition to the descriptions do not contain sufficient information for an exact determination of the species.

In general, radiolarian faunas of significant abundance are rare and their preservation is very moderate in the Jurassic Aptychus beds. In older strata, which represent greenish-reddish nodular limestones known as "Ruhpoldinger Marmor", radiolarians are abundant and well-preserved. These lithologies are slightly older than the Aptychus beds. The "Ruhpoldinger Marmor" is of Kimmeridgian (possibly Oxfordian) to lower Late Tithonian age just below the occurrence of Calpionellids, wheras the Aptychus beds comprise Late Tithonian through Berriasian age.

9. Acknowledgements

This paper is dealing with problems of historical paleontology in the early years of radiolarian research. I hope it will not contribute to further confusion. It should give some information about the quality of the famous radiolarian fauna of the Urschlau. For intense and important discussions I am grateful to the professors Dr. H. HAGN (Munich), Dr. J.Th. GROISS (Erlangen), Dr. E. FLÜGEL (Erlangen), Dr. H. KOZUR (Budapest) and Dr. W. RESCH (Innsbruck). The project was funded by the German Science Foundation (Ste 348/5). Special thanks to Mrs. M. TESSADRI-WACKERLE for her patience and the endeavours of scanning RUEST's pictures.

Lithocampe ananassa



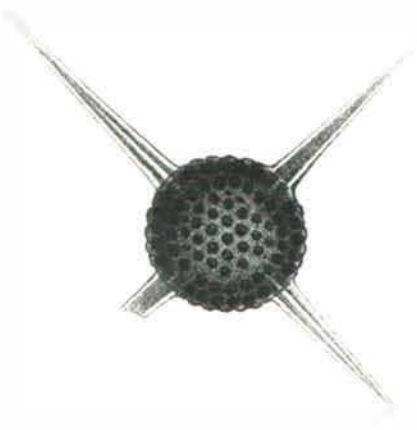
Staurosphaera antiqua

Sethocapsa collaris

Stichocapsa conglobata

Eucyrtis cenoidea

Rhopalastrum contractum



Staurosphaera gracilis

Rhopalastrum dilatatum

Sethocapsa globosa

Fig. 3: Collection of RÜST's illustrations of radiolarians described from the Urschlau (all figures are 75% in size compared to RÜST, 1885). The number of species is limited to those which are useful for redescription.

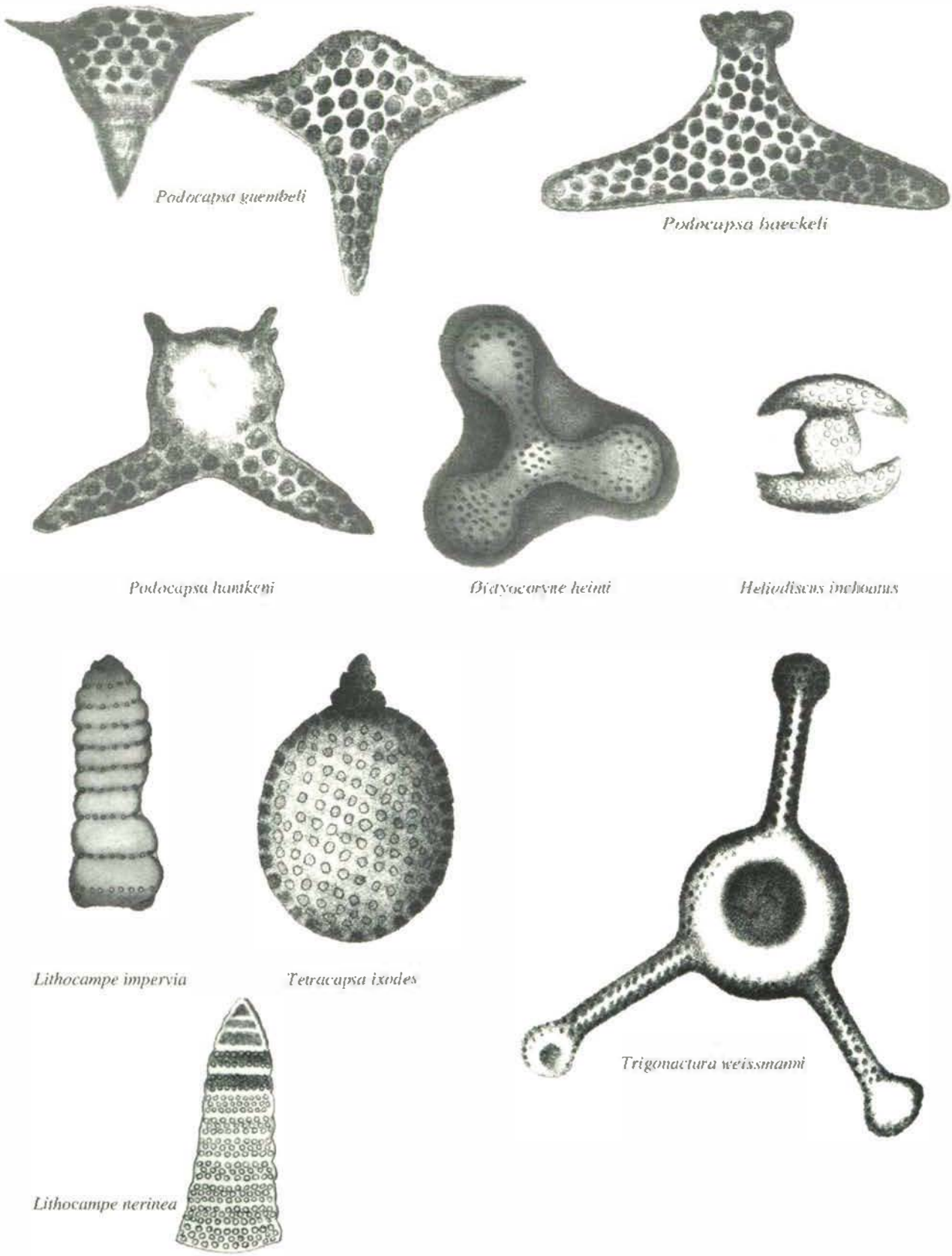


Fig. 3. continued

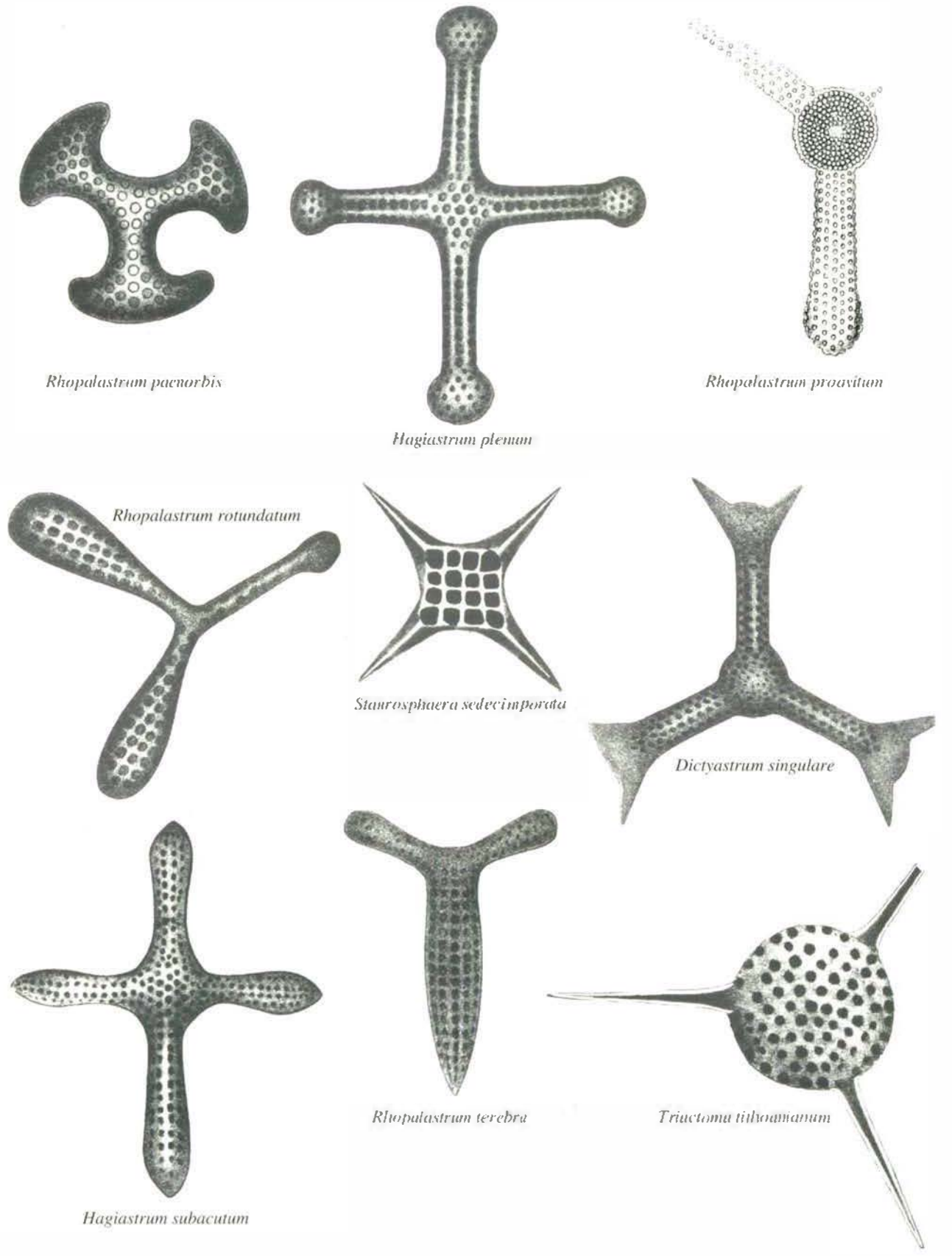
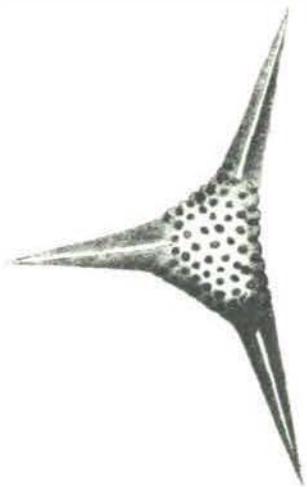


Fig. 3. continued

Xiphosphaera tredecimporata



Tripocyclia trigonum

Lithocampe trochus

Rhopalastrum tuberosum

Rhopalastrum tumidum

Spongoplegma urschlauense

Tetracapsa zinckeni

Fig. 3. continued

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Manuscript submitted: April 25, 1995

Addendum:

In the IRZN (Appendix D/III/16) species names created in honour of persons are recommended not to end with -ii (e.g. *Podocapsa haeckelii*). As RÜST inconsequently used both ways (e.g. *Dictyocoryne heimi* and *heimii*) such names are uniformly used with -i in this paper.

Plate 1

Fig. 1, 2: Discoidal radiolarian probably representing *Spongoplegma urschlauense* RÜST, which is an orbiculiformid taxon. Length of the scale bar 100 microns.

Fig. 3: *Triactoma tithonianum* RÜST, showing relatively long slender, triradiate spines and pointed tips. Length of the scale bar 100 microns.

Fig. 4–6: Three varations of *Rhopalastrum tuberosum* RÜST. Fig. 4 is close to *Archaeotritrabs gracilis* STEIGER. Fig. 5 shows a diagenetically recrystallized three-armed hagiastrid with bulbous arm ends and short pointed primary spines. Fig. 6 is a hagiastrid of *Tritabs ewingi* (PESSAGNO) to *Tritrabs worzeli* (PESSAGNO) type. Length of the scale bar 100 microns.

Fig. 7, 8: Four-armed hagistrids possibly representing *Hagiastrum subacutum* RÜST. Fig. 7 shows a distinct rectangular pore pattern on the upper right arm, which is diagenetically altered on the other arms. This radiolarian corresponds to *Higumastra inflata* BAUMGARTNER. The radiolarian in fig. 8 has clavate arms as shown in RÜST's illustration and a severely recrystallized cortical shell giving the impression of a spongy surface. Length of the scale bar 100 microns.

Fig. 9: Radiolarian test, most similar to *Tripocyclia trigonum* RÜST. The cortical shell of these forms varies from spheres to subtriangular outlines. The base of the spines is complicated like in *Triactoma jonesi* (PESSAGNO). Tests with concave outline of the cortical shell between the spines are never observed. Length of the scale bar 100 microns.

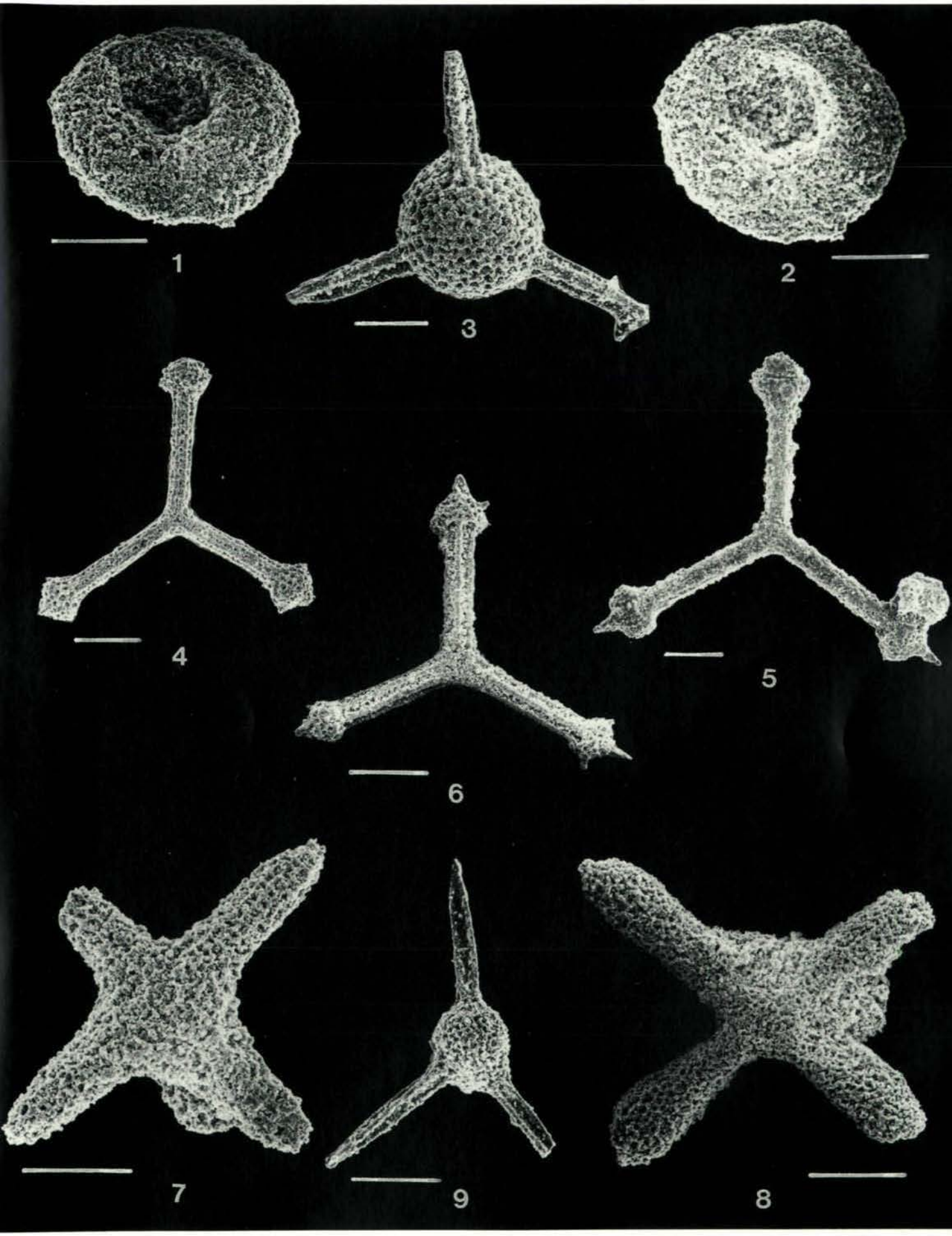
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Plate 2

Fig. 1: Three-armed patulibracchiid radiolarian, probably corresponding to *Dictyastrum singulare* RÜST. This form corresponds to *Halesium sexangulum* PESSAGNO, bearing a bracchiopyle missing in RÜST's illustration. A further difference is a spherical central area lacking in *Halesium sexangulum*. Length of the scale bar 100 microns.

Fig. 2: Angulobracchiid radiolarian probably corresponding to *Rhopalastrum terebra* RÜST and *Rhopalastrum tumidum* RÜST. Such forms are recently described as *Angulobracchia* (?) *portmanni* BAUMGARTNER and *Angulobracchia mediopulvilla* STEIGER, both characterized by clavate arms bearing a longitudinal pore pattern at the arm ends. Length of the scale bar 100 microns.

Fig. 3: Tritrabid hagiastrid resembling *Rhopalastrum contractum* RÜST. This form represents *Tritrabs exotica* BAUMGARTNER, characterized by alternating double pore rows between the primary beams of the cortical shell. This is not shown in RÜST's illustration, but the proportions of the pore rows and the entire test correspond to this very frequent form. Length of the scale bar 100 microns.

Fig. 4: *Staurosphaera gracilis* RÜST. Except the missing fourth spine and the diagenetically recrystallized cortical shell the test corresponds to RÜST's illustration. Length of the scale bar 100 microns.

Fig. 5: *Foremanella diamphidia* (FOREMAN), possibly representing *Rhopalastrum rotundatum* RÜST. The bilateral symmetry of the pore pattern of both larger arms leads to this opinion, although *Foremanella hipposidericus* (FOREMAN) would fit better but was not observed in the Urschlau material. Length of the scale bar 100 microns.

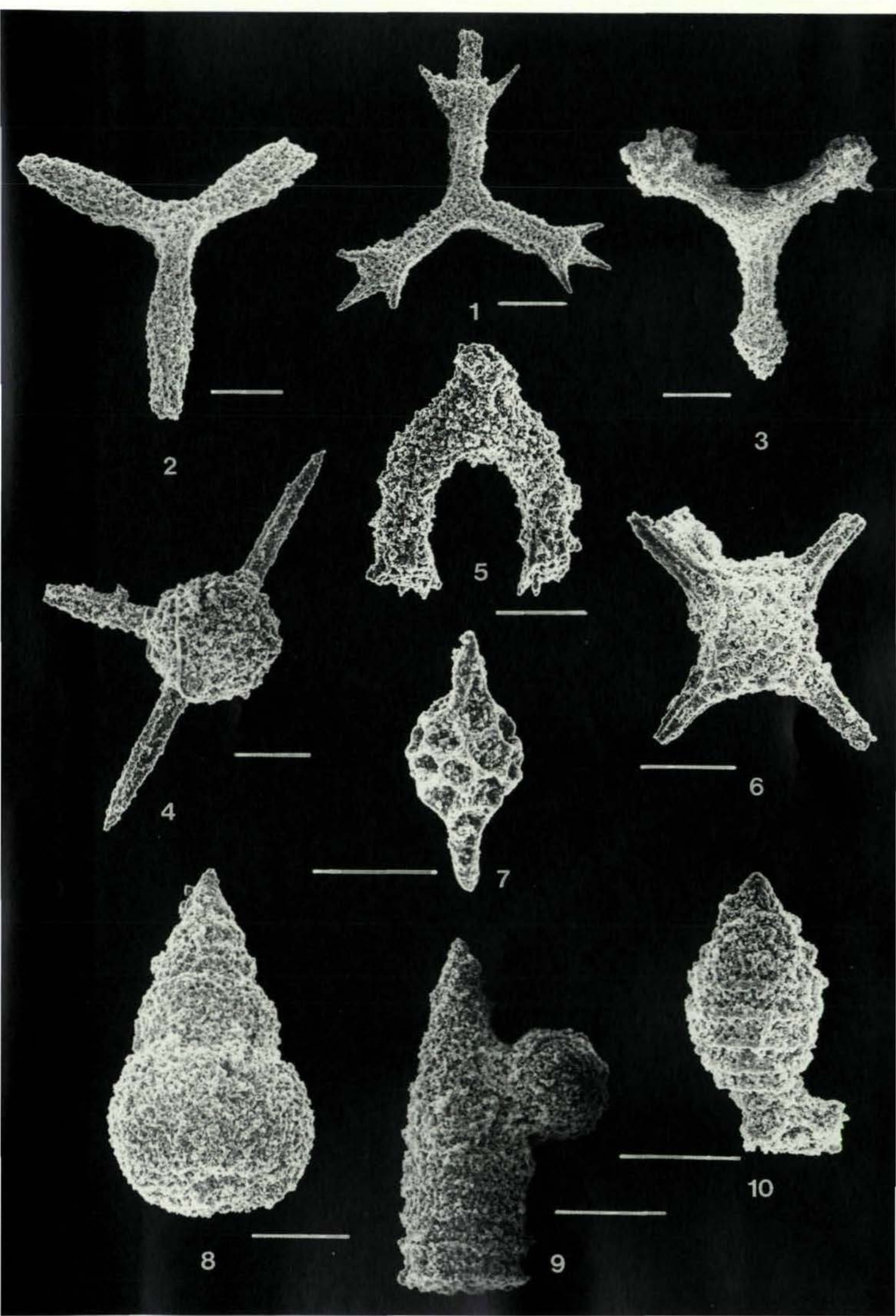
Fig. 6: *Staurosphaera antiqua* RÜST. Only strongly recrystallized tests of this problematic species could be found discussed in the paleontological chapter. Length of the scale bar 100 microns.

Fig. 7: *Xiphosphaera tredecimporata* RÜST. This form probably belongs to the *Pantanellium lanceola* (PARONA) group. Length of the scale bar 100 microns.

Fig. 8: *Spongocapsula palmerae* PESSAGNO. Rare multicyrtid nassellarians bear recrystallized surfaces of the outer wall. They questionably may correspond to *Stichocapsa conglobata* RÜST. Length of the scale bar 100 microns.

Fig. 9: *Lithocampe nerinea* RÜST. This recrystallized long nassellarian is probably synonym with *Parvicingula cosmoconica* (FOREMAN). Length of the scale bar 100 microns.

Fig. 10: *Lithocampe ananassa* RÜST. Recystallized fusiform nassellarian which is identical with *Parvicingula boesii* (PARONA). Length of the scale bar 100 microns.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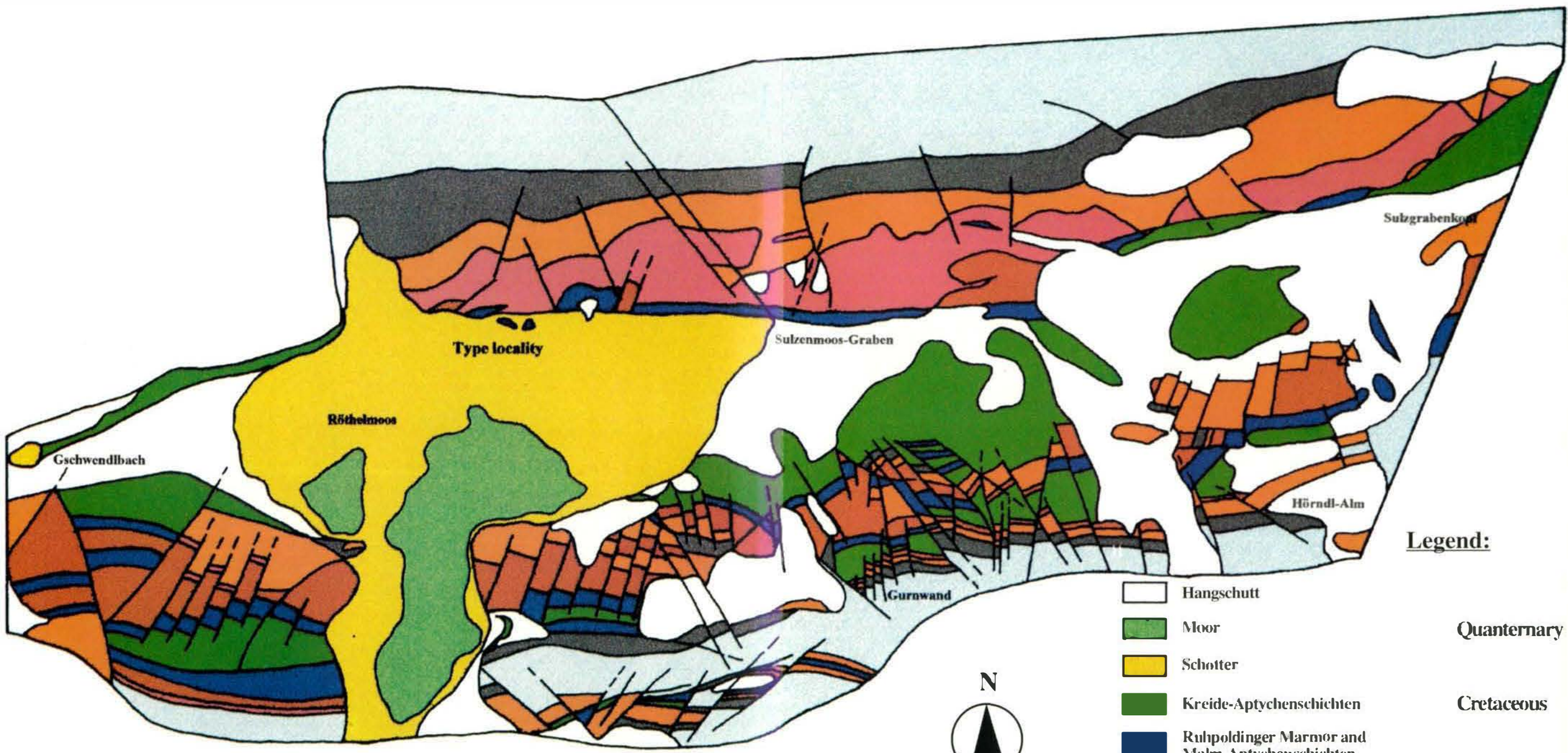
Geological map of the Röthelmoos



Legend:

Hangschutt	Quaternary
Moor	
Schotter	
Kreide-Aptychenschichten	Cretaceous
Ruhpoldinger Marmor and Malm-Aptychenschichten	Jurassic
Dogger-Kieselkalk	
Adneter Kalk	
Rhät-Riffkalk and Kössener Schichten	Triassic
Plattenkalk	
Hauptdolomit	

Geol. Paläont. Mitt. Innsbruck, edition 20, pages 407 - 435, 1995