Zeitschrift: Bulletin der Vereinigung Schweiz. Petroleum-Geologen und -Ingenieure
Herausgeber: Vereinigung Schweizerischer Petroleum-Geologen und -Ingenieure
Band: 28 (1961-1962)
Heft: 74

Artikel: Middle Triassic hystrichosphaerids from salt-wells Riburg-15 and -17, Switzerland
Autor: Brosius, Marita / Bitterli, Peter
DOI: https://doi.org/10.5169/seals-191405

Bull. Ver. Schweizer. Petrol.-Geol. u. -Ing., Vol. 28, Nr. 74, Sept. 1961, p. 33—49,
3 tables, 8 figs., 2 plates

Middle Triassic Hystrichosphaerids from Salt-wells Riburg-15 and -17, Switzerland

by Marita Brosius and Peter Bitterli *

Summary

Hystrichosphaerids from the Muschelkalk and the overlying Lettenkohle (Triassic) are reported for the first time. They have been found in samples from salt-wells Riburg-15 and -17, Switzerland. Seven different species, including the new one: *Veryhachium? riburgense*, are described and illustrated.

Zusammenfassung

Es wird zum erstenmal über Hystrichosphären aus dem Muschelkalk und der hangenden Lettenkohle (Trias) berichtet. Sie stammen aus Kernen der Salzbohrungen Riburg-15 und -17 der «Vereinigte Schweizer. Rhein-Salinen». Sieben verschiedene Species, die den Gattungen *Veryhachium, Domasia* und *Micrhystridium* untergeordnet werden, werden beschrieben und abgebildet. Die neue Art *Veryhachium? riburgense* wird aufgestellt.

Introduction

In the course of an investigation of primary bituminous rocks in western Europe, attention was paid to the Muschelkalk (Middle Triassic) in the German facies development for two reasons: firstly, the occurrence of bituminous, shaly and dolomitic marls (Orbicularismergel) at the top of the Lower Muschelkalk and secondly, the presence of a dolomite-evaporite sequence, which is often connected with bituminous deposits.

Since evaporite beds, such as anhydrite and rock salt, are seldom exposed at the surface, an opportunity to obtain cores from bore holes was very welcome.

A series of selected samples was investigated petrographically, micro-palaeontologically, palynologically and geochemically. During the palynological study the presence of hystrichosphaerids was noticed; this induced us to repeat some of the sample preparations to check our findings and to investigate some additional cores.

The writers are much indebted to Prof. Dr. L. Vonderschmitt, director of the Institute of Geology and Palaeontology of the University of Basle, and to Dr. L.

* Koninklijke/Shell Exploratie en Produktie Laboratorium, Rijswijk-Z.H., The Netherlands. (Shell Internationale Research Maatschappij N. V.)

HAUBER, for their help in procuring the core material and for their assistance in stratigraphic matters. Many thanks are due to Ing. J. LEUTHOLD (†), and to Ing. K. SPINNLER, directors of «Vereinigte Schweizerische Rhein-Salinen», Schweizerhalle, for their generous permission to let us study and select the core material from test borings at the Riburg salt-works. As regards the systematics, we would like to thank particularly Prof. Dr. A. EISENACK, Tübingen, who was kind enough to discuss many questions with Miss BROSIUS.

Finally, our gratitude is expressed to the Koninklijke/Shell Exploratie en Produktie Laboratorium, Rijswijk-Z. H. (Shell Internationale Research Maatschappij), for their permission to publish this paper.

Location

From two shallow salt-wells drilled in the neighbourhood of the salt-works at Riburg, about 20 km E of Basle, a fairly complete set of cores was selected for study during 1959.

Well Riburg-15 is situated north of the Karsau fault about one mile NE of the works «Saline Riburg», while Riburg-17 is located at about the same distance to the south, and north of the Rheinfelden fault.

Location:	Coordinates:	
	north	east
Riburg-15	269.790	631.960
Riburg-17	266.490	629.175

Notes on stratigraphy

The samples discussed here originate with one exception from the Middle Triassic Muschelkalk.

Overlying the limestone and dolomite deposits of the Lower Muschelkalk (Wellendolomit, Wellenkalk, Wellenmergel, Orbicularismergel), the Middle Muschelkalk is represented by an anhydrite formation (saline-sulphate phase) with a dolomite zone at its top, while the overlying Upper Muschelkalk is known as Hauptmuschelkalk (Trochitenkalk, Nodosuskalk or Plattenkalk) and Trigonodusdolomit (E. BRAENDLIN, 1911; C. DISLER, 1914; K. STRUEBIN, 1900; R. SUTER, 1915; P. MERKI, 1961).

The stratigraphic position of the samples is given in tables 1 and 2.

Palaeogeographic outline

Following the terrestrial «red beds» of the Buntsandstein, comes the Lower Muschelkalk, which was laid down in a marine environment that probably showed occasional slightly reducing conditions, such as might be expected to occur in semi-circular bays, the first indication of a saline phase being near the top of the Lower Muschelkalk (E. STURMFELS, 1947). The main saline cycle, however, sets in at the base of the Middle Muschelkalk with a thin lower sulphate zone, followed by the rock salt deposit (up to 90 m thick) which is overlain by an upper sulphate and dolomite zone (together about 50—60 m thick). The Upper Muschelkalk limestone and dolomite

cycle is locally more than 60 m in thickness and is generally considered to be fully marine until a regression is indicated by the occurrence of bone beds and coaly material in the Lower Keuper.

Historical notes on hystrichosphaerids

Hystrichosphaerids, a groupe of planktonic organisms, whose systematic position is still unknown, are found in marine sediments of widely differing geological age.

The periods from which hystrichosphaerids have so far been recorded are listed below, together with the names of the principal authors.

? Quarternary:	ERDTMANN
Tertiary:	COOKSON, DEFLANDRE, EISENACK, GERLACH, GOCHT, KLUMPP, LEFEVRE, MAIER, PASTIELS, REISSINGER, WEILER, O. WETZEL
Cretaceous:	CONRAD, COOKSON, DEFLANDRE, EISENACK, GOCHT, LEJEUNE-CARPENTIER, MERCIER, PHILIPPOT, VALENSI, O. WETZEL, W. WETZEL
Jurassic:	COOKSON, DEFLANDRE, DOWNIE, EISENACK, KLEMENT, MERCIER, SARJEANT, VALENSI
Triassic:	KARA-MURZA
Permo-Triassic:	JEKHOWSKY
Permian:	WILSON
Carboniferous:	DEFLANDRE, SUJKOWSKY
Devonian:	DEUNFF, SANNEMANN
Silurian:	DEFLANDRE, DEUNFF, DOWNIE, EISENACK, SANNEMANN
Cambrian:	EISENACK, TIMOFEEW
? Algonkian:	CAYEUX

Regarding stratigraphical range and continuity, there still exists, between the Palaozoic and the Middle Mesozoic-Cenozoic occurrences, a rather little known period from which only a very few hystrichosphaerids have been recorded. Furthermore, systematic information about these forms is rather poor.

Thus, Carboniferous hystrichosphaerids are known only from two localities: DEFLANDRE (1946) described Visean forms in phosphatic nodules of the Montagne Noire, and SUJKOWSKY (1933) showed illustrations of similar organisms (mentioned under «incertae sedis») from the «Dinantian inférieur» of the Polish Swiety Krzyz mountains.

From the Permian, WILSON (1960) described one *Hystrichosphaeridium sp.* and in a recent paper, JEKHOWSKY (1961) reported on two Permo-Triassic species. In 1957 KARA-MURZA showed illustrations of some Triassic forms from Russian arctic regions but gave no names.

From Liassic sediments, EISENACK (1957) described large spineless forms belonging to the genera *Tasmanites, Tytthodiscus, Cymatiosphaera* and *Leiosphaeridia* which he assigned to the group of hystrichosphaerids on the basis of the common pyloms. Leiosphaeridae have also been mentioned by UTECH (1960) from the Buntsandstein

of Germany (unpublished Diss.). Apart from these problematic forms, no spined Liassic hystrichosphaerids have yet been described.

The descriptions of the Middle Triassic (Muschelkalk) hystrichosphaerids discussed in the present paper thus represent an advance in our knowledge of the Carboniferous/Liassic period, from which such organisms are comparatively little known.

Position of samples and description

The stratigraphic position of the samples, together with a brief description of their lithology, etc. is given in table 1 for the samples from Riburg-15 and in table 2 for those from Riburg-17.

Sample treatment

To avoid possible contamination, the cores were carefully cleaned before the usual palynological treatment with hydrofluoric and hydrochloric acids. Moreover, some samples have been investigated in duplicate in order to check the results. In addition, the findings are corroborated by the fact that typical forms occur only in one horizon in both wells.

About 200 hystrichosphaerids were isolated and fixed in single slides by Miss T. POSTMA. This material forms the basis for the following systematic part.

These Triassic organisms are almost colourless and of very small size. This may be the reason for their having remained unnoticed until now.

Systematic description

Veryhachium reductum (DEUNFF 1958) *

Pl. I, figs. 3—6, text figs. 1a—e

1958 *Veryhachium trisulcum* (DEUNFF 1951) reductum nov. var. — DEUNFF p. 27, Pl. I, figs. 1, 3, 8, 10, 12, 14, 16, 17, 22, 23.

1961 *Veryhachium reductum* (DEUNFF 1958) — JEKHOWSKY, B., p. 210, Pl. II, figs. 22—44.

The test of this species has the form of an equilateral triangle with sides that are normally convex but sometimes straight or even concave. The three corners are drawn out into spines of nearly equal length.

Diameter of test: 10—15 micron; length of spines: 5—12 micron.

Our specimens agree quite well with those described and illustrated by JEKHOWSKY (1961) from the Permo-Triassic. The most common form in our material is *V. reductum forma reductum* (Pl. I, fig. 6). Some other specimens (Pl. I, figs. 4, 5) may belong to JEKHOWSKY's *forma breve* while only a few (Pl. I, fig. 3) are to be regarded as *forma trispinosoides*. But between all his three formae exist transitional stages. One specimen found in the Trochitenkalk of Riburg-15 shows a doublespined process at one corner.

The species *Veryhachium reductum* (DEUNFF 1958) has been observed in the Upper Muschelkalk of both wells. One specimen occurs in the Wellenkalk of Riburg-15.

10 specimens have been fixed in single-grain slides.

* Determinations by M. BROSIUS. The single grain slides are deposited with: Naturhistorisches Museum, Augustinergasse 2, Basel. (Nos. C2723—C2741)

Table 1

Riburg-15

	Formation		Sample number	Well depth (m)	Petrographic description
		17 m			
Oberer Muschelkalk	Trigonodusdolomit (traces of bit Dol)		BIT 325	31	dol Lst, lt yel-gy, f suc *
		32 m			
	Nodosuskalk (Plattenkalk) (Hauptmuschelkalk)		BIT 326	34	dol Lst, yel-gy
			BIT 327	36	dol Lst, yel-gy, fish teeth *
			BIT 328	52	dol Lst, lt gy, dns
		57 m			
	Trochitenkalk (Hauptmuschelkalk)		BIT 329	57	arg Lst, lt gy
		82 m			
Mittlerer Muschelkalk (Anhydritgruppe)	Dolomit-Zone		BIT 330	83	Dol, lt, yel-gy
		98 m			
	Obere Sulfat-Zone (slightly bit Dol at 101, 147—151 m)		BIT 331	100	arg Dol, lt gy, pyr, rare c and OM *
			BIT 332	101	arg Dol, m gy, with Gyp
			BIT 333	108	dol Cl, lt gy + Anhd
			BIT 334	120	dol Cl, lt gy, pyr + bc Anhd; rare c and OM *
			BIT 335	128	lam Anhd + Cl, lt gy
			BIT 336	129	Anhd, m gy + Cl, slumping
			BIT 337	143	Anhd, blk-gy
			BIT 338	145	lam Dol, with Gyp
			BIT 339	147	calc Dol, m gy, with Gyp Len, rare c and OM, Pyr *
		147 m			
	Steinsalz und Untere Sulfat-Zone				absent
		147 m			
Unterer Muschelkalk	Wellenkalk und -mergel		BIT 340	148	aph Lst, m gy, lam; rare c and OM, Pyr*; bit smell on breaking
			BIT 341	149	dol Lst, dk gy
			BIT 342	150	aph Lst, dk gy; rare c and OM *
			BIT 343	153	arg Lst, lt-m gy, Gyp (Anh)
			BIT 344	161	arg Lst, m dk-gy
			BIT 345	167	arg Lst, m gy; rare c and OM, nod, mic, pyr *
			BIT 346	177	arg Lst, m gy
	Total depth: 177,33 m				

* Thin section examination by A. FEHR

Table 2

Riburg-17

Formation			Sample number	Well depth (m)	Petrographic description
		39 m			
Keuper	Lettenkohle		BIT 347	± 43	Cl, m dk-gy
		45 m			
Oberer Muschelkalk	Trigonodusdolomit		BIT 348	67	Dol, gy
		70 m			
	Hauptmuschelkalk		BIT 349	118	Lst, lt yel-gy
		119 m			
Mittlerer Muschelkalk (Anhydritgruppe)	Dolomit-Zone				no samples
		135 m			
	Obere Sulfat-Zone		BIT 350	139	Dol, lt yel-gy; weak bit smell
			BIT 351	143	Clst, gy
			BIT 352	145	Dol, yel-gy
			BIT 353	160	slt Cl, m gy, Anhd + Gyp; rare c and OM, Pyr *
		163 m			
	Steinsalz-Lager		BIT 354	195	Anhd
		255 m			
	Untere Sulfat-Zone				gy Anhd + Cl
		256 m			
Unterer Muschelkalk	Wellenmergel		BIT 355	256	Mrl, gy
			BIT 356	260	aph Lst, m gy, pyr *; bit smell
			BIT 357	261	Mrl, lt brn-gy + Gyp
	Total depth:	261 m			

List of abbreviations

Anhd	anhydrite	Clst	claystone	lt	light
aph	aphanitic	dk	dark	m	medium
arg	argillaceous	dns	dense	mic	micaceous
bc	brecciated	Dol	dolomite	Mrl	marl
bit	bituminous	f	fine	nod	nodular
blk	black	gy	grey	OM	organic material
brn	brown	Gyp	gypsum	Pyr	pyrite
c	coaly	lam	laminated	slt	silty
calc	calcareous	Len	lens	suc	sucrose
Cl	clay	Lst	limestone	yel	yellow

Note:
Only abbreviations of nouns are capitalised.
* Thin section examination by A. FEHR

Veryhachium aff. reductum (DEUNFF 1958)

Pl. I, fig. 1, text figs. 2a—b

The test has the form of an equilateral triangle. Each of the three processes of equal length seems to have a small cavity at the base.

Diameter of the test: about 20 micron; length of the processes: about 15 micron.

Rather close affinities exist with the species *Veryhachium reductum.* Because of their larger dimensions and the (?) cavities at the base of the processes, the two specimens found in the Trochitenkalk of Riburg-15 can without any doubt be distinguished from those described above under *V. reductum.* With only two specimens available it cannot be ascertained whether the (?) cavities are a constant characteristic feature or not.

Veryhachium? riburgense n. sp.

Pl. II, figs 7—12, text figs 4a—d, 5a—d

The test is polygonal, often folded, with 6 to 12 (normally 9) acute-angled processes merging with a widened base into the test.

D i a m e t e r of the test: about 10 micron.

L e n g t h of the processes: 2 to 6 micron.

H o l o t y p : BIT 327—16, Pl. II, fig 7.

D e r i v a t i o n o m i n i s : derived from the typ locality, well Riburg-15, Switzerland.

S t r a t u m t y p i c u m : Nodosuskalk (Upper Muschelkalk).

Two variants can be distinguished:

1. *forma regulare:*
   The polygonal test bears broad-based spines of which three together always seem to form an equilateral triangle (Pl. II, figs. 7—9, text figs. 5a—d).
2. *forma irregulare:*
   The test is pillow-shaped, polygonal. The processes are arranged irregularly and are normally shorter and wider at their base than those of the *forma regulare* (Pl. II, figs. 10—12, text figs. 4a—d).

Between both formae, there exist transitional stages.

This new species differs from *Veryhachium? irregulare* JEKHOWSKY 1961 in that it has more numerous and broader spines.

Some affinities also exist with the species *Micrhystridium polyedricum* VALENSI 1953, described from the Bajocian and Bathonian. From this, it differs, however, in the arrangement of the spines. The processes of our specimens are not restricted to the small sides of the test.

Veryhachium? riburgense n. sp. reveals in its variation forms belonging to two different genera. The extreme triangularpolygonal specimens clearly can be assigned to the genus *Veryhachium,* while the more rounded ones show the characteristics of the genus *Micrhystridium* or *Baltisphaeridium.*

While the *forma regularis* is concentrated in the Upper Muschelkalk, the *forma irregularis* seems to have its main occurrence in the Lower Muschelkalk.

26 specimens have been fixed in single-grain slides.

Domasia n. sp. *

Pl. I, fig. 2, text fig. 3

The test has almost the form of an isosceles triangle, with a single process at each corner. The corner with the acutest angle bears the longest process. The two shorter spines each seems to have a sort of cavity at the base.

Diameter of test: 11 x 5 micron, length of processes: 30, 20 and 12 micron.

The only specimen of this form so far found is from the Upper Muschelkalk of Riburg-17.

This form differs from all other species of the genus *Domasia* in that each of the three spines has a different length, the shape is more triangular than ellipsoidal and (?) cavities are present at the bases of the two shorter spines.

Close affinities also exist with the genus *Veryhachium*. But in this genus various forms with triangular to polygonal tests without a preferred direction of extension are lumped together.

Micrhystridium inconspicuum (DEFLANDRE 1935)

Pl. II, figs. 17, 18, text fig. 8

1935 *Hystrichosphaera inconspicua* — DEFLANDRE, p. 233, Pl. IX, figs. 11, 12.
1937 *Micrhystridium inconspicuum* — DEFLANDRE, p. 32, Pl. XII, figs. 11—13.

The globular test carries about 20 simple, pointed, hollow processes in open communication with the cavity of the test.

Diameter of the test: about 10 micron, length of the processes: 2—3 micron.

The length of the processes, a third of the test's diameter, corresponds best with those forms described and illustrated by VALENSI (1953) from the Bajocian; normally this species has longer spines. Though it is not mentioned in the original description that the processes are hollow, this can be assumed from the illustrations given by DEFLANDRE.

Specimens of *Micrhystridium inconspicuum* occur throughout the whole sections of Riburg-15 and -17, but are more numerous in the Nodosuskalk.

Micrhystridium parvispinum DEFLANDRE 1946

Pl. II, figs. 13, 14, text figs. 7a—b

1946 *Micrhystridium parvispinum* — DEFLANDRE, p. 516, Pl. II, figs. 6—9.

The globular test is covered with numerous, very small spines.

The diameter of the test varies from 8—16 micron, length of the processes: about 1 micron.

Though the stratum typicum of this species is Visean, there are no remarkable differences between the Carboniferous and our Triassic specimens. The similar short-spined *Baltisphaeridium multipilosum* (EISENACK 1931) shows many more spines.

Specimens of this form are quite common both in the Wellenkalk and in the Upper Muschelkalk.

* Only one specimen has so far been found and no name has therefore been given.

Micrhystridium aff. fragile DEFLANDRE 1947

Pl. II, figs. 15, 16, text figs. 6a—d

The test is globular, sometimes flattened and folded, with numerous slender curved and solid spines. Normally, there are about 15, but specimens with more than 30 spines have also been noticed. The processes hardly widen at their base. There is a great variation in dimension and number of spines.

The diameter of the test ranges from 10 to 28 micron, the length of the processes from 3 to 9 micron. Because the average diameter of this species is about 17 micron it is referred to the genus *Micrhystridium,* though some specimens of this species should be assigned to the genus *Baltisphaeridium,* because they transgress the genus limit of 20 micron which is, however, an entirely arbitrary boundary.

Specimens of this form are quite common in the Upper Muschelkalk but have also been noticed in the Wellenkalk.

Stratigraphic distribution of species

While the frequency of hystrichosphaerids in the Upper and Lower Muschelkalk is rather high, the samples derived from the Middle Muschelkalk are practically barren. Only a few specimens, of which two could be determined, have been noticed in samples BIT 330, 331, 333, 352 and 353. Perhaps it may be assumed that the high salinity was unsuitable for planktonic life. KICHHEIMER (1950) described some samples from the Lower Miocene; those containing gypsum show a reduction in hystrichosphaerids or are barren.

The richest samples are BIT 325, 327, 329 and 348, from the Upper Muschelkalk, and BIT 345, from the Lower Muschelkalk.

In table 3 the distribution of the different species of hystrichosphaerids is given. Forms of the genus *Veryhachium* are rather frequent in the Upper Muschelkalk.

In the Lower Muschelkalk, the pillow-shaped *Veryhachium? riburgense forma irregulare* is rather common, while the *forma regulare* occurs more frequently in the Upper Muschelkalk.

The different species of *Micrhystridium* are quite numerous both in the Lower and in the Upper Muschelkalk.

Table 3

Stratigraphic distribution of hystrichosphaerids

Riburg-15

Formation	Sample number	*Veryhachium reductum*	*Veryhachium aff. reductum*	*Veryhachium? riburgense*	*Domasia n. sp.*	*Micrhystridium inconspicuum*	*Micrhystridium parvispinum*	*Micrhystridium aff. fragile*
Trigonodusdolomit	BIT 325					x	x	x
	BIT 326						x	
Nodosuskalk	BIT 327	x		x		x	x	x
	BIT 328							x
Trochitenkalk	BIT 329	x	x	x		x	x	x
Dolomit-Zone	BIT 330							
	BIT 331							
	BIT 332							
	BIT 333						x	
	BIT 334							
Obere Sulfat-Zone	BIT 335							
	BIT 336							
	BIT 337							
	BIT 338							
	BIT 339							
	BIT 340							
	BIT 341							
Wellenkalk und	BIT 342							
Wellenmergel	BIT 343					x		
	BIT 344							
	BIT 345	x		x		x	x	x
	BIT 346			x				

Table 3 (cont.)

Riburg-17

Formation	Sample number	*Veryhachium reductum*	*Veryhachium aff. reductum*	*Veryhachium? riburgense*	*Domasia n. sp.*	*Micrhystridium inconspicuum*	*Micrhystridium parvispinum*	*Micrhystridium aff. fragile*
Lettenkohle	BIT 347						x	x
Trigonodusdolomit	BIT 348	x		x				
Hauptmuschelkalk	BIT 349	x			x			
Obere Sulfat-Zone	BIT 350							
	BIT 351							
	BIT 352						x	
	BIT 353							
Steinsalz-Lager	BIT 354							
Wellenmergel	BIT 355							
	BIT 356							
	BIT 357							

Conclusions

According to the literature available, this is the first time that hystrichosphaerids have been described from the Muschelkalk (Middle Triassic) and the Lettenkohle. Thus, with these occurrences, additional information on these planktonic organisms has become available from the Carboniferous-Liassic period, of whose hystrichosphaerids only little has been known until now.

The occurrence of these planktonic organisms seems to be mainly restricted to the limestones of the Muschelkalk and they are as a rule absent from the anhydrite-dolomite sequence.

List of selected references

Brändlin, E. (1911): Zur Geologie des nördlichen Aargauer Tafeljuras zwischen Aare- und Fricktal. Verh. Natf. Ges. Basel, 22, H. 1.

Cayeux, M. L. (1894): Les preuves de l'existence d'organismes dans le terrain précambrien. Premier note sur les Radiolaires précambriens. Bull. Soc. Géol. France, 22, 197—228, Paris.

Conrad, W. (1941): Notes protistologiques. Quelques Microfossiles des silex crétacés. Bull. Mus. roy. Hist. nat. Belgique, 17, No. 36, 1—10, Bruxelles.

Cookson, I. C. and *Eisenack A.* (1958): Microplankton from Australian and New Guinea Upper Mesozoic Sediments. Royal Soc. Vict., 70, 19—79, Melbourne.
— (1960): Microplankton from Australian Cretaceous sediments. Micropaleontology, 6, 1—18.
Deflandre, G. (1937): Microfossiles des Silex crétacés. Deuxième Partie. Ann. Paléont., 26, 51—103, Paris.
— (1938): Microplancton des mers jurassiques conservé dans les marnes de Villers-sur-mer (Calvados). Etude liminaire et considerations générales. Trav. Stat. zool. Wimereux, 13, 147—200, Paris.
— (1942): Le microplancton kiméridgien d'Orbagnoux et l'origine des huiles sulfurées naturelles. Mém. Acad. Sci. Inst. France, 65, 1—32, Paris.
— (1945): Microfossiles des calcaires siluriens de la Montagne Noire. Ann. Paléont., 31, 41—75, Paris.
— (1946): Radiolaires et Hystrichosphaeridés du Carbonifère de la Montagne Noire. C. R. Acad. Sci., 233, 515—517, Paris.
— and *Cookson I. C.* (1955): Fossil Microplankton from Australian Late Mesozoic and Tertiary Sediments. Austr. J. Mar. Freshw. Res., 6, 242—313, Melbourne.
Deunff, J. (1951): Sur la présence de microorganismes (Hystrichosphères) dans les schistes ordoviciens du Finistère. C. R. Acad. Sci., 233, 321—323, Paris.
— (1954): *Veryhachium,* genre nouveau d'Hystrichosphères du Primaire. C. R. Soc. Géol. France, 305—306, Paris.
— (1955): Un microplancton fossile Dévonien à Hystrichosphères du continent Nord-Américain. Bull. Microsc. appl., 5, 138—149, Paris.
Disler, C. (1914): Stratigraphie und Tektonik des Rotliegenden und der Trias beiderseits des Rheines zwischen Rheinfelden und Augst. Verh. Natf. Ges. Basel, 25, 1—96.
Downie, C. (1957): Microplankton from the Kimmeridge Clay. Quart. J. geol. Soc. London, 112, 413—434.
— (1959): Hystrichospheres from the Silurian Wenlock Shale of England. Palaeontology, 2, 56—71, London.
Eisenack, A. (1931): Neue Mikrofossilien des baltischen Silurs I. Paläont. Z., 13, 74—118, Berlin.
— (1938): Hystrichosphaerideen und verwandte Formen im baltischen Silur. Z. Geschriebeforsch. Flachlandsgeol., 14, 1—30, Leipzig.
— (1951): Hystrichosphaerideen und andere Kleinformen aus baltischem Silur und Kambrium. Senckenbergiana, 32, 187—204, Frankfurt/M.
— (1954): Mikrofossilien aus Phosphoriten des samländischen Unterologozäns und über die Einheitlichkeit der Hystrichosphaerideen. Palaeontographica (A), 105, 49—95, Stuttgart.
— (1957): Mikrofossilien in organischer Substanz aus dem Lias Schwabens (Süddeutschland). Neues Jb. Geol. Paläont., Abh., 105, 239—249, Stuttgart.
— (1958): Mikroplankton aus den norddeutschen Apt, nebst einigen Bemerkungen über fossile Dinoflagellaten. Neues Jb. Geol. Paläont., Abh., 106, 383—422, Stuttgart.
Erdtmann, G. (1954): On Pollen Grains and Dinoflagellate Cysts in the Firth of Gullmarn, SW Sweden. Botaniska Notiser, 103—111, Lund.
Gerlach, E. (1961): Mikrofossilien aus dem Oligozän und Miozän Nordwestdeutschlands unter besonderer Berücksichtigung der Hystrichosphären und Dinoflagellaten. Neues Jb. Geol. Paläont., Abh., 112, Stuttgart (in press).
Gocht, H. (1952): Hystrichosphaerideen und andere Kleinlebewesen aus Oligozänablagerungen Nord- und Mitteldeutschlands. Z. Geol., 1, 301—320, Berlin.

Gocht, H. (1957): Mikroplankton aus dem nordwestdeutschen Neokom (Teil I). Paläont. Z., 31, 163—185, Stuttgart.
— (1959): Mikroplankton aus dem nordwestdeutschen Neokom (Teil II). Paläont. Z., 33, 50—89, Stuttgart.
Jekhowsky, B. (1961): Sur quelques hystrichosphères Permo-Triasiques d'Europe et d'Afrique. Revue de Micropaléontologie, 3, 207—212, Paris.
Kirchheimer, F. (1950): Mikrofossilien aus Salzablagerungen des Tertiärs. Palaeontographica (B), 90, 127—160, Stuttgart.
Klement, K. W. (1960): Dinoflagellaten und Hystrichosphaerideen aus dem Unteren und Mittleren Malm Südwestdeutschlands. Palaeontographica (A), 114, 1—104, Stuttgart.
Klumpp, B. (1953): Beitrag zur Kenntnis der Mikrofossilien des Mittleren und Oberen Eozäns. Palaeontographica (A), 103, 377—406, Stuttgart.
Lefèvre, M. (1933): Les Peridinites des Barbades. Ann. Crypt. exot., 6, 215—229.
Lejeune-Carpentier, M. (1935): L'étude microscopic des silex I. Ann. Soc. Géol. Belgique, 59, 190—196.
Lotze, F. (1957): Steinsalz und Kalisalze. Gebr. Bornträger, Berlin.
Maier, D. (1959): Planktonuntersuchungen in tertiären und quartären marinen Sedimenten. Ein Beitrag zur Systematik, Stratigraphie und Ökologie der Coccolithophorideen, Dinoflagellaten und Hystrichosphaerideen vom Oligozän bis zum Pleistozän. Neues Jb. Geol. Paläont., Abh., 107, 278—340, Stuttgart.
Mercier, J. (1938): Microorganisme du Bajocien et du Bathonien. Note préliminaire. C. R. Soc. Géol. France, 114—115, Paris.
— (1938): Microplancton du Crétacé supérieur de l'Ouest du bassin de Paris. C. R. Soc. Géol. France, 95—96, Paris.
Merki, P. (1961): Der Obere Muschelkalk im östlichen Schweizer Jura. Eclogae geol. Helvet., 54, 1 (in press).
Pastiels, A (1948): Contribution à l'étude des microfossiles de l'éocène belge. Mém. Mus. roy. Hist. nat. Belgique, 109, 1—77, Bruxelles.
Philippot, A. (1949): Contribution à la paléontologie des silex crétacés. Trois nouveaux microfossiles. Bull. Soc. scient. Bretagne, 24, 55—58.
Reissinger, A. (1950): «Die Pollenanalyse», ausgedehnt auf alle Sedimentgesteine der geologischen Vergangenheit II. Palaeontographica (B), 90, 99—126, Stuttgart.
Sannemann, D. (1955): Hystrichosphaerideen aus dem Gotlandium und Mittel-Devon des Frankenwaldes und ihr Feinbau. Senck. leth., 36, 321—346, Frankfurt/M.
Sarjeant, W. A. S. (1960): New hystrichospheres from the Upper Jurassic of Dorset. Geol. Mag., 97, 137—144, Hertford.
Schachl, E. (1955): Schichtfolge, Gesteinsausbildung und Genesis des Muschelkalks in Südwestdeutschland. Z. deutsch. geol. Ges., 105, 103—105, Hannover.
Scherer, F. (1961): Hystrichosphaerideen und Dinoflagellaten aus der oligozänen, subalpinen Molasse des Entlebuchs und des Thunerseegebiets. Bull. Ver. Schweizer. Petrol.-Geol. und -Ing., 27, No. 73, 15—16.
Strübin, K. (1902): Beiträge zur Kenntnis der Stratigraphie des Basler Tafeljura. Verh. Natf. Ges. Basel, 13, 391—484.
Sturmfels, E. (1947): Gips-, Anhydrit- und Salzgesteine am Südostrande des Schwarzwalds. Mitteilungsbl. bad. geol. Landesanst., 21—23.
Sujkowski, Z. (1933): Radiolarites du Carbonifère inférieur du Massif de Ste-Croix. Bull. Serv. géol. Pologne, 7 (4), 637—711, Warschau.
Suter, R. (1915): Geologie der Umgebung von Maisprach. Verh. Natf. Ges. Basel, 26.

Timofeew, B. V. (1956): Die Hystrichosphaeridae des Kambriums. (Hystrichosphaeridae Kembrija — russ.) Dokl. Akad. Nauk. UdSSR, 106, 130—132.
Trümpy, R. (1959): Hypothesen über die Ausbildung von Trias, Lias und Dogger im Untergrund des schweizerischen Molassebeckens. Eclogae geol. Helvet., 52, 435—448, Basel.
Utech, K. (1960): Fazies, Biotope und Fauna des Mittleren Buntsandsteins in Niedersachsen. Diss. T. H. Braunschweig.
Valensi, L. (1953): Microfossiles des silex jurassiques moyen. Mém. Soc. Géol. France, 68, 1—100, Paris.
— (1955): Sur quelques microorganismes des silex crétacés du magdalénien de Saint-Amand (Cher.). Bull. Soc. Géol. France, 5, 35—40, Paris.
Weiler, H. (1956): Über einen Fund von Dinoflagellaten, Coccolithophoriden und Hystrichosphaerideen im Tertiär des Rheintalgrabens. Neues Jb. Geol. Paläont., Abh., 104, 129—147, Stuttgart.
Wetzel, O. (1936): Die Mikropaläontologie des Heiligenhafener Kieseltones (Ober-Eozän). Jbr. Niedersächs. Geol. Ver. Hannover, 27, 42—75, Hannover.
Wetzel, W. (1952): Beitrag zur Kenntnis des dan-zeitlichen Meeresplanktons. Geol. Jb., 66, 391—419, Hannover.
White, H. H. (1842): On fossil Xanthidia. Microsc. J., 2, 35—40, London.

Text figures 1—8

1a—e *Veryhachium reductum* (DEUNFF 1958)
2a, b *Veryhachium aff. reductum* (DEUNFF 1958)
3 *Domasia n. sp.*
4a—d *Veryhachium? riburgense n. sp., forma irregulare*
5a—d *Veryhachium? riburgense n. sp., forma regulare*
6a—d *Micrhystridium aff. fragile* (DEFLANDRE 1947)
7a, b *Micrhystridium parvispinum* (DEFLANDRE 1946)
8 *Micrhystridium inconspicuum* (DEFLANDRE 1937)

Text figures

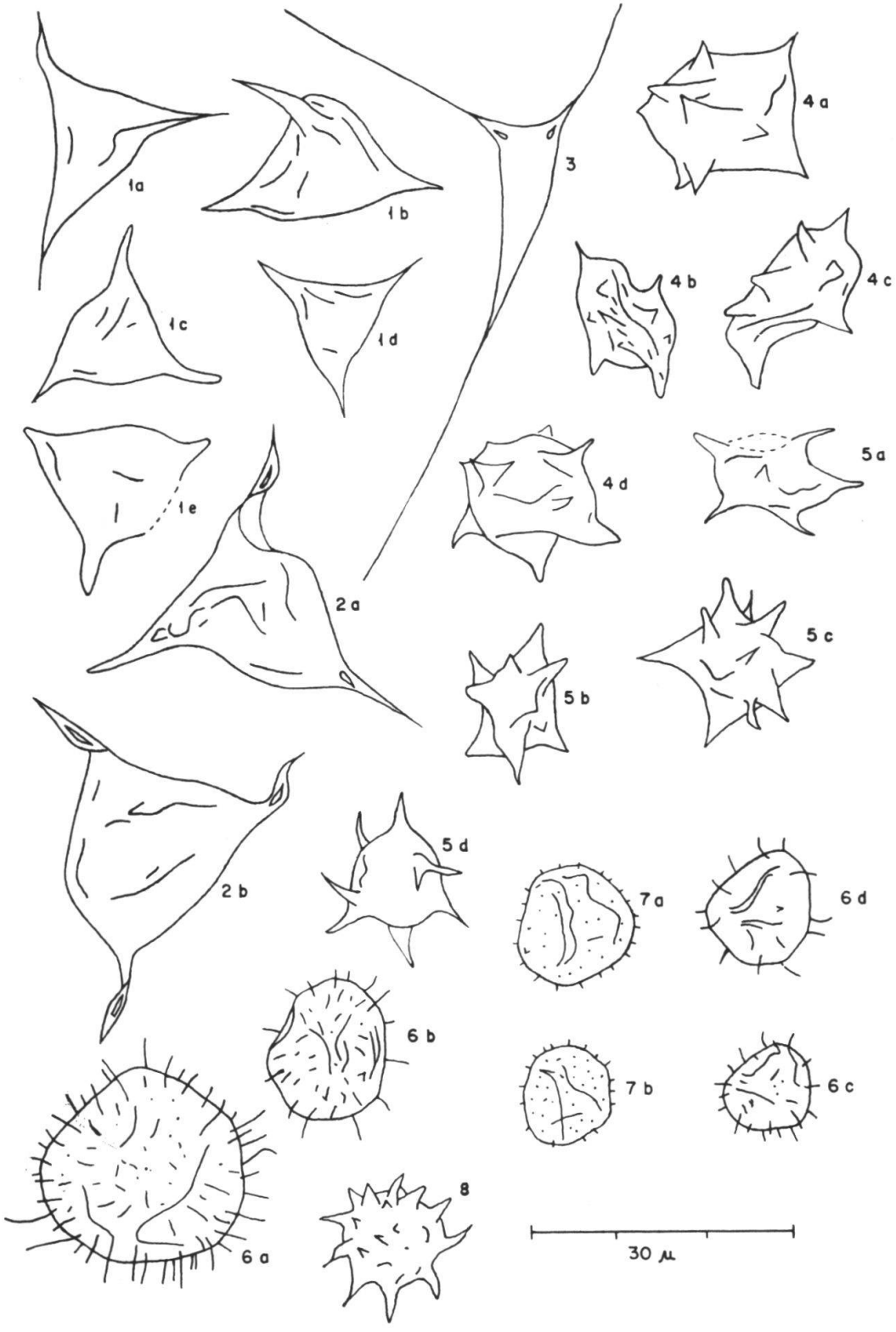


Plate I

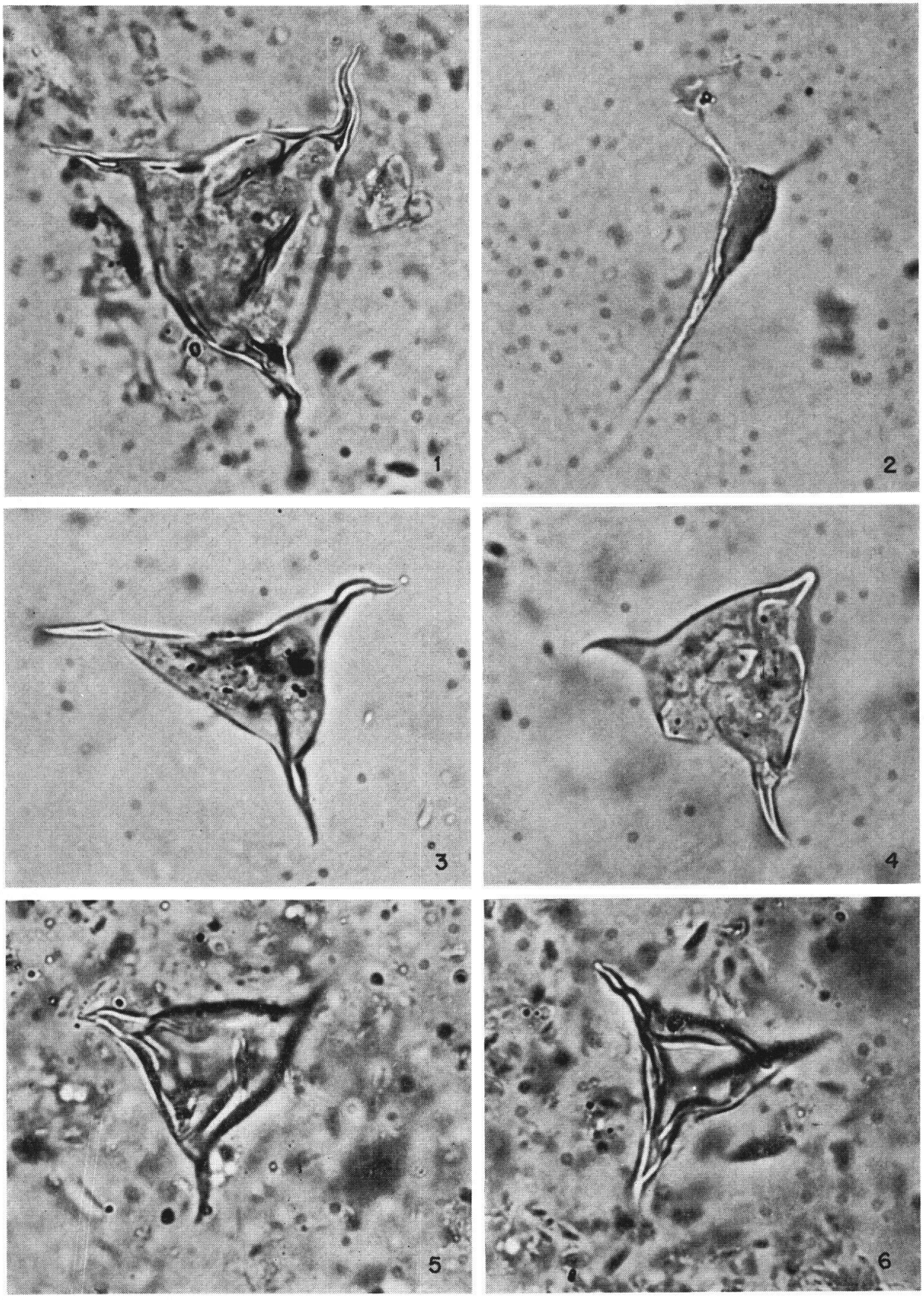
Fig. 1 *Veryhachium aff. reductum* (DEUNFF 1958), BIT 329—7, C 2733 *, Trochitenkalk.
Fig. 2 *Domasia n. sp.*, BIT 349—1, C 2735, Hauptmuschelkalk.
Fig. 3 *Veryhachium reductum* (DEUNFF 1958), BIT 348—5, C 2729, Trigonodusdolomit.
Fig. 4 *Veryhachium reductum* (DEUNFF 1958), BIT 348—6, C 2730, Trigonodusdolomit.
Fig. 5 *Veryhachium reductum* (DEUNFF 1958), BIT 348—4, C 2731, Trigonodusdolomit.
Fig. 6 *Veryhachium reductum* (DEUNFF 1958), BIT 348—2, C 2732, Trigonodusdolomit.

Plate II

Fig. 7 *Veryhachium? riburgense n. sp., forma regulare,* BIT 327—16, C 2723, Nodosuskalk; (Holotyp).
Fig. 8 *Veryhachium? riburgense n. sp., forma regulare,* BIT 348—9, C 2724, Trigonodusdolomit.
Fig. 9 *Veryhachium? riburgense n. sp. forma regulare,* BIT 327—22, C 2725, Nodosuskalk.
Fig. 10 *Veryhachium? riburgense n. sp., forma irregulare,* BIT 435—11, C 2726, Wellenkalk.
Fig. 11 *Veryhachium? riburgense n. sp., forma irregulare,* BIT 345—10, C 2727, Wellenkalk.
Fig. 12 *Veryhachium? riburgense n. sp., forma irregulare,* BIT 345—15, C 2728, Wellenkalk.
Fig. 13 *Micrhystridium parvispinum* (DEFLANDRE 1946), BIT 325—18, C 2736, Trigonodusdolomit.
Fig. 14 *Micrhystridium parvispinum* (DEFLANDRE 1946), BIT 352—1, C 2737, Obere Sulfat-Zone.
Fig. 15 *Micrhystridium aff. fragile* (DEFLANDRE 1947), BIT 345—1, C 2738, Wellenkalk.
Fig. 16 *Micrhystridium aff. fragile* (DEFLANDRE 1947), BIT 345—2, C 2739, Wellenkalk.
Fig. 17 *Micrhystridium inconspicuum* (DEFLANDRE 1935), BIT 325—10, C 2740, Trigonodusdolomit.
Fig. 18 *Micrhystridium inconspicuum* (DEFLANDRE 1935), BIT 327—4, C 2741, Nodosuskalk.

* Slides with C-numbers are deposited with:
Naturhistorisches Museum, Augustinergasse 2, Basel, Switzerland.

Plate I



50 μ

Plate II