JAHRBUCH DER GEOLOGISCHEN BUNDESANSTALT

Jb. Geol. B.-A.	ISSN 0016–7800	Band **139**	Heft 1	S. 21–28	Wien, April 1996

Upper Permian Richthofeniid Buildups of Chios Island (Aegean Sea)

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2 Abbildungen, 2 Tafeln

Greece
Chios Island
Upper Permian
Calmwater Reef
Richthofeniid Brachiopods

Inhalt

Oberpermische Richthofenien von der Insel Chios (Ägäis)

Zusammenfassung

Die oberpermischen Gymnocodiaceen-Kalke nahe Marmaro in Chios (Griechenland) beinhalten Massenvorkommen von Richthofenien. Paläobiologische und ökofazielle Untersuchungen weisen diese als Stillwasserriff-Entwicklung aus. Geländebeobachtungen und Schliffuntersuchungen autochthoner Richthofenien geben Anlaß zu neuen funktionsmorphologischen Konzepten.

Abstract

Gymnocodiacean limestones of lower Upper Permian age from the northern part of the island of Chios (Greece) include mass occurences of richthofeniid brachiopods. Paleobiological and ecological data indicate a calm water environment for these reefs. Field observations as well as conclusions from the investigation of thin sections provide new evidence for the life stile of richthofeniids. In contrast to previous functional models, which saw richthofeniids as encrusters or mudstickers, they are recliners in our interpretation.

1. Introduction

TELLER (1880) was the first who identified Palaeozoic successions in Chios Island. He presumed a nappe structure and indicated a metamorphic basement on the island Oinaussai.

In the 1960ties the island was mapped by a group of geologists from the Marburg university (Germany). A compilation of the results of several doctoral theses as well as a geological map 1 : 50.000 were published by BESENEKKER et al. (1968 cum lit., 1971). More detailed results of the investigation area can be obtained from KAUFFMANN (1969).

According to these publications, Chios can be divided – apart from a small metamorphic region and the so-called Parautochtonous and the „Schürfling-Gruppe" – into two main geological units:

1) The autochtonous series comprise, above a basal flysch of unknown age, a predominantly clastic Palaeozoic sequence from the Lower Silurian to the Upper Carboniferous, and a predominantly carbonatic Triassic.
2) the allochtonous nappe unit is built up by a clastic-carbonatic Lower Carboniferous to an Upper Permian

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series, a rudimentary Triassic and clastic to carbonatic Lower Jurassic.

2. Area of Investigation

The working area belongs to the nappe unit. The Upper Carboniferous is represented by a mixed siliciclastic (containing plants)/ marine carbonatic facies. In the Lower Permian the terrestrial influence prevails, while some limestone intercalations with corals, fusulinids, algae and sponges indicate marine influence. The Upper Permian is represented by a carbonate sequence, the "Gymnocodiacean limestones" (KAUFFMANN 1969) containing the mass occurrences of *Richthofenia* cf. *lawrenciana* (DE KONINCK) (det. by BRUNTON in KAUFFMANN 1969). The Gymnocodiacean limestones are overlain by Lower Jurassic sediments, starting with red clastics passing into a cyclic sequence of thick-bedded limestones with dolomites.

Permian sections in the working area were investigated by GRANT (1993) with special regard to silicified brachiopods, but GRANT gives no description of the Marmaro section discussed in this paper.

The section is exposed for more than 300 m laterally and shows no important tectonic complications.

The lowermost part of the Gymnocodiacean limestones, not exposed in the Marmaro section, may start in the Artinskian (Leonardian) but the main part belongs to the "*Verbekiina* Zone". This corresponds with the stratigraphic position of the "*Neoschwagerina* Zone" in the Lower Guadalupian. The exact stratigraphic position within the "*Neoschwagerina* Zone" is unknown yet.

The Marmaro section, approximately 32 meters thick, can be divided into 5 units.

Unit 1

The dark grey to black or brown thin bedded limestones with individual layers from 1 to 30 cm often show high bitumina contents. The most typical fossil is the syringoporid coral *Multithecopora* sp., which forms biostromes. The dome shaped colonies are generally in life position and in most cases associated with non-richthofeniid brachiopods, predominately productids. The amount of corals decreases to the top of the unit and brachiopods can be accumulated to coquina beds suggesting tempestite deposits. Bryozoans together with microbial mats are locally abundant forming encrusting meshworks.

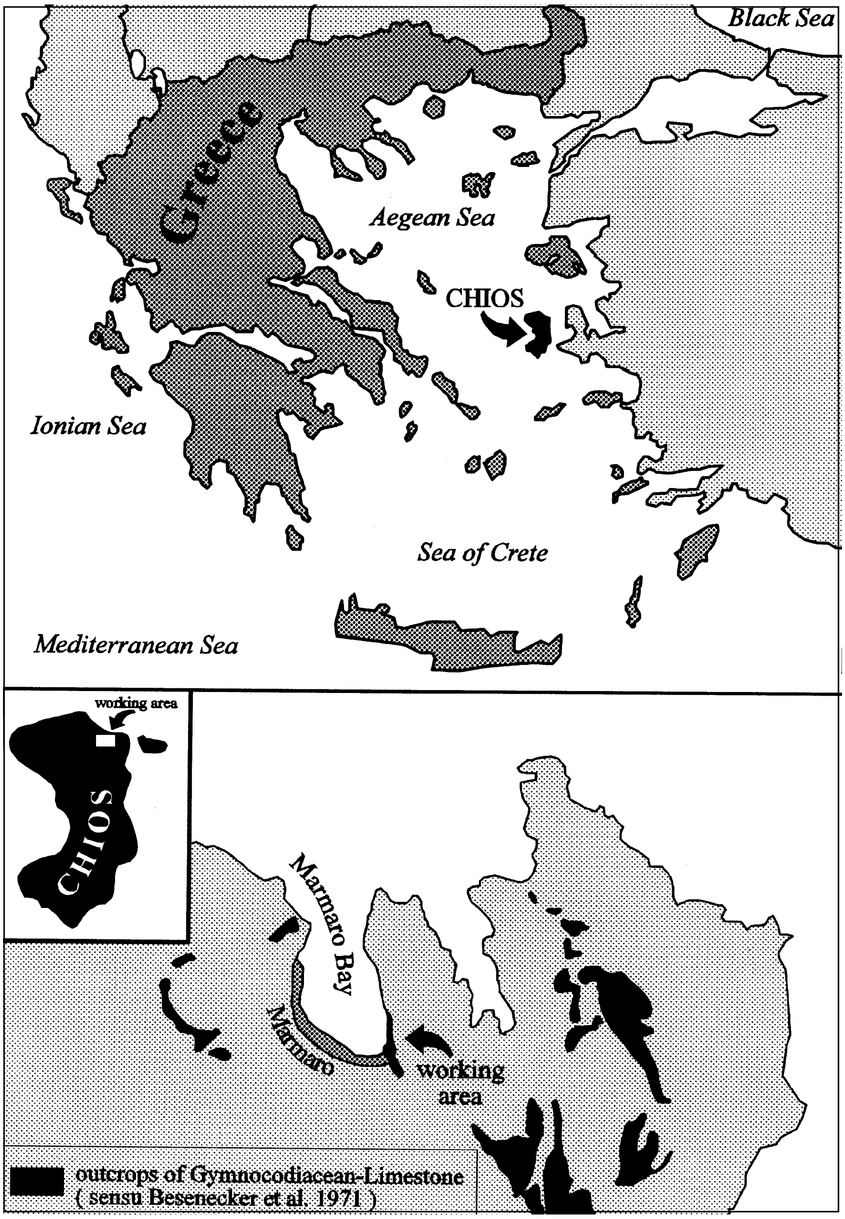
Locally massive limestone lenses up to 1 m in diameter are intercalated in the upper part of this unit. They contain the first mass occurrences of *Richthofenia* and other brachiopods, as well as bryozoans and crinoid debris. This can be interpreted as the first but rapidly interrupted beginning of the *Richthofenia* reef formation.

Unit 2

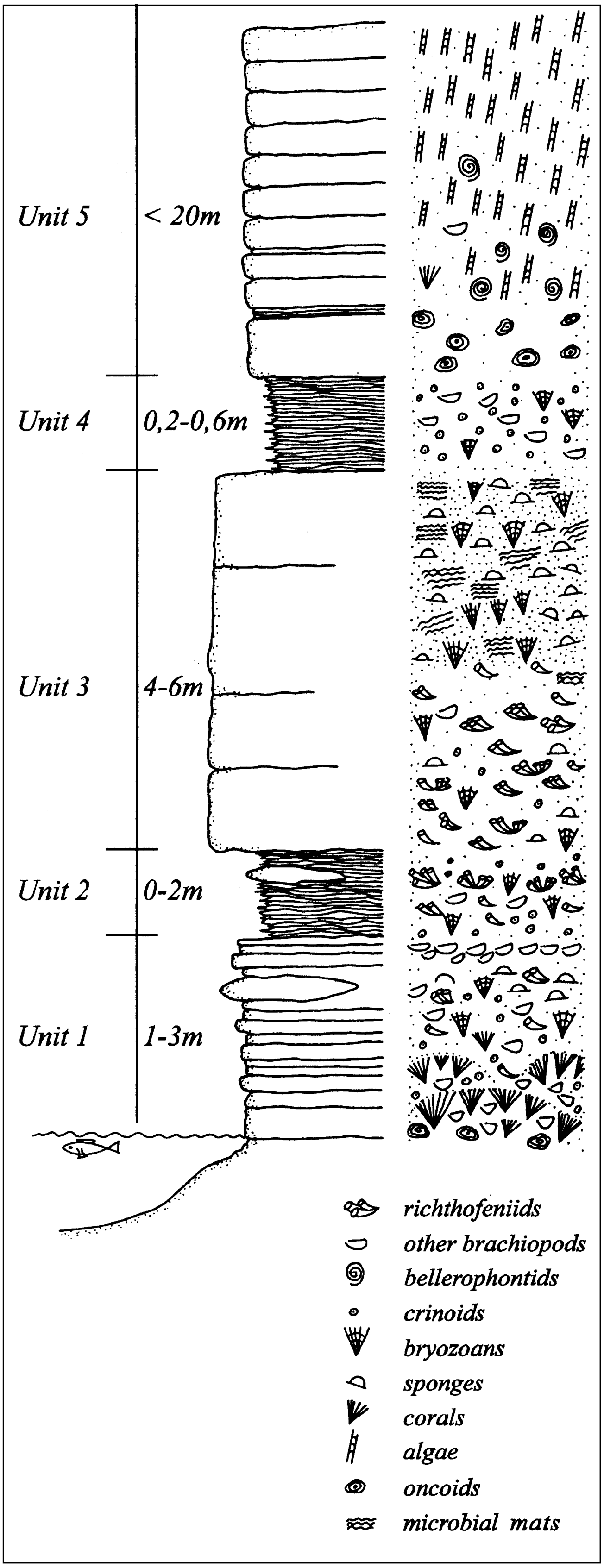
The lower marl horizon shows a sharp contact to the underlying unit 1 and consists mainly of grey to brown calcareous marls. The fossil content is very high. Besides bryozoans, crinoid debris and non-richthofeniid brachiopods, *Richthofenia* is abundant. The richthofeniids occur as individual specimens or form fan-like clusters.

"*Ammodiscus*" sp. is the main element among the foraminifera. The large correspondence of foraminifera faunas from the marls to those in the limestones (see MAMET in KAUFFMANN 1969) – except for the abundance of encrusters in the latter – is surprising.

According to a preliminary information kindly provided by Dr. M. BLESS, the low diversity of the ostracod fauna is dominated by monospecific associations of Bairdiacea and Kirkbyacea. It consists exclusively of phytophil and kymatophobe benthic shallow-water forms. Despite normal marine conditions the joint presence of juvenile forms and adults indicates autochtony and excludes transport caused by currents.



Text-Fig. 1.
Location maps of the working area



Text-Fig. 2.
Schematic profile and vertical macrofaunal sequence of the "Marmaro section".

Unit 3

The *Richthofenia* limestone shows also a sharp boundary to the underlying marls. Its lower part, in particular, contains mass occurrences of densely packed *Richthofenia*'s. It is a monospecific accumulation of *Richthofenia* cf. *lawrenciana*. Towards the top the *Richthofenia* frequency decreases whereas Inozoa, Sphinctozoa, Sclerospongia as well as Demospongia and Silicispongia together with bryozoans, encrusting foraminifera and problematics of *Tubiphytes*-type increase in number. This upper part shows also intensive microbial activities sometimes connected with Stromatactis-structures. Productids are the dominating brachiopods in the upper part of this unit.

Unit 4

There is a sharp boundary between *Richthofenia* limestones and the upper marl horizon. This horizon is very similar to the Lower Marl Horizon as far as the high fossil content (microfossils, brachiopods, bryozoans and crinoid debris) is concerned. The main difference is the complete lack of richthofenids.

Unit 5

After a thin transition zone regularly bedded limestones start with dark grey beds containing numerous oncoids (with *Hedraites plummerae*) up to 5 cm in diameter. Above this horizon the limestones gets very regularly bedded, sometimes alternating with thin marl intercalations, which are rich in foraminiferas of "*Glomospira*"-type and sometimes contain *Skolithos*-ichnofossil and scaphopods.
Individual beds of this up to 20 m thick unit are rich in bellerophontid gastropods. Solitary corals are rare. This sequence represents algal meadows dominated by gymnocodiaceans. The most frequent algae are *Gymnocodium bellerophontis, Permocalculus texanum, Mizzia velebitana* and *Pseudovermiporella sodalica*. Fusulinids are rare.

3. "Reef-Structure"

1) The richthofeniids as well as other reef organisms like the high divers sponges, bryozoans, sometimes solitary corals, *Tubiphytes*, encrusting foraminifera and microbial mats, exert a major control over the depositional processes.
2) The reef-limestones are predominantly bafflestones, bindstones and occasionally framestones. Practically all non-reefal limestones are packstones which exhibit no major physical control during their deposition.
   Skeletal grains of the reef-limestones are usually larger than in the non-reefal limestones. These skeletal grains provided shelter for micrite matrix or enhanced its production. Moreover the fossils show hardly any sign of transportation.
   Most probably the Permian reefs of Chios were calm water reefs and did not need a wave resistant framework.

All observations suggest a formation of the unit 1 to 5 in a shallow near shore though predominantly low energy environment. The approximate symmetry of the sedimentary evolution during that time mainly indicated by the marl horizons suggests a TR-cycle as controlling factor. As pointed out by ROSS & ROSS (1987, 1988) the second order regression at Guadalupian time is subdivided by several third-order TR-cycles. The biostratigraphic resolution is at present not accurate enough to correlate our *Richthofenia*-reef-formation with one of these short-time transgression pulses within the *Neoschwagerina* zone.

The interpretation given here fits very well with the general development of the Upper Palaeozoic of the nappe unit of Chios Island as described by BESENECKER et al. (1968).

The Upper Carboniferous is characterised by a sedimentation with predominantly shallow marine limestones containing abundant algae, calcisponges, crinoids etc, and some plant-bearing clastic horizons. In the Lower Permian the clastic/terrestrial influence prevails but short time limestone formation is well documented. In this conception the Gymnocodiacean limestones could represent a major transgressive phase culminating most probably in the upper part of the *Richthofenia* limestones. The lower and upper marls could indicate two minor regressive phases leading to increased clastic influx into the marine realm.

4. Functional Analysis of *Richthofenia*

Concerning the biostratigraphy of Richthofeniids with the subfamilies Richthofeniinae, Prorichthofeniinae and Gemellaroiinae it should be mentioned, that their species are typically for the Lower Permian but currently only *Richthofenia* is also known in the Upper Permian. The distribution of the latter is confined to Europe (Sicily, Chios, Caucasus) and Asia (China, Japan, Pakistan, Timor).

The type species of *Richthofenia, R. lawrenciana* was described by DE KONINCK (1863) as *Anomia lawrenciana*. DE KONINCK thought that *lawrenciana* has some affinities to pelecypods. The generic name *Richthofenia* was created by KAYSER (1891). The assignment to the brachiopods and the reasons for it were given by WAAGEN (1882). Since that date, the brachiopod nature of *Richthofenia* is out of discussion.

Current questions are the substratum, the life-position and functional morphology (for instance ZAPFE 1937).

With regard to the substratum there is no evidence, that the Chios richthofenids prefered hard substratum, but there are indications that they were anchored by their spines. The spines are not only important for anchoring in the sediment, they have also a function for felting up individual specimens. This promotes the formation of aclonal colonies.

Also, the vertical upright life position as illustrated in most paleontological papers, is not compelling. Most richthofeniids especially the individual specimens and the specimens in the fan-like clusters, lie in subhorizontal position with the convex side (hinge side) on the bottom. They seem to be recliners rather than mudstickers; this opinion is supported by well preserved encrusted spines.

RUDWICK (1961) and RUDWICK & COWEN (1967) stated that the feeding mechanism of Richthofeniidae and Lyttoniidae is powered by rhythmic flow induced by flapping of the dorsal valve and not by ciliary pumping of the lophophore. This concept (”paradigmatic method”) was rejected by GRANT (1972, 1975) by studying a special specimen of *Hercosestria* (richthofenid genus characterized by its ventral valve with a net developed over the aperture). This special specimen exhibits a brachiopod (*Composita*) setteled between the apertural meshwork and/on the dorsal valve preventing an unimpeded oscillation of the ventral valve.

Acknowledgements

The authors are very grateful to Mrs. Dr. F. POMONI-PAPAIOANNOU and to Dr. A. MAVRIDIS (IGME, Athens) as well as to Dr. M. PIPIDIS (Chios) for their kind help in various respects. G. FLAJS and H. HÜSSNER are indebted to the Deutsche Forschungsgemeinschaft for financial support of the project Fl 131/8 within the priority program ”Regional and Global Controls of Biogenic Sedimentation – Evolution of Reefs”.

A travel grant provided by the Senate Committee of International Relations of the Karl-Franzens-University, Graz/Austria is kindly acknowledged by A. FENNINGER and B. HUBMANN.

Plate 1

Richthofenia cf. *lawrenciana* DE KONINCK, 1863
from the Lower Marl Horizon.

Fig. 1: Fig. 1: Typical specimen.
Magnification: 2.0×.

Fig. 2: Specimen with involute early ontogenetic stage of the pedicle valve.
Magnification: 3.0×.

Fig. 3: Erect specimen.
a = lateral view; x, b = view from above showing the excellently preserved brachial valve and hinge.
Magnification: 3.4×.

Fig. 4: Specimen, view from above.
Magnification: 3.4×.

Fig. 5: Specimen showing a bundle of attachment spines.
Magnification: 2.8×.

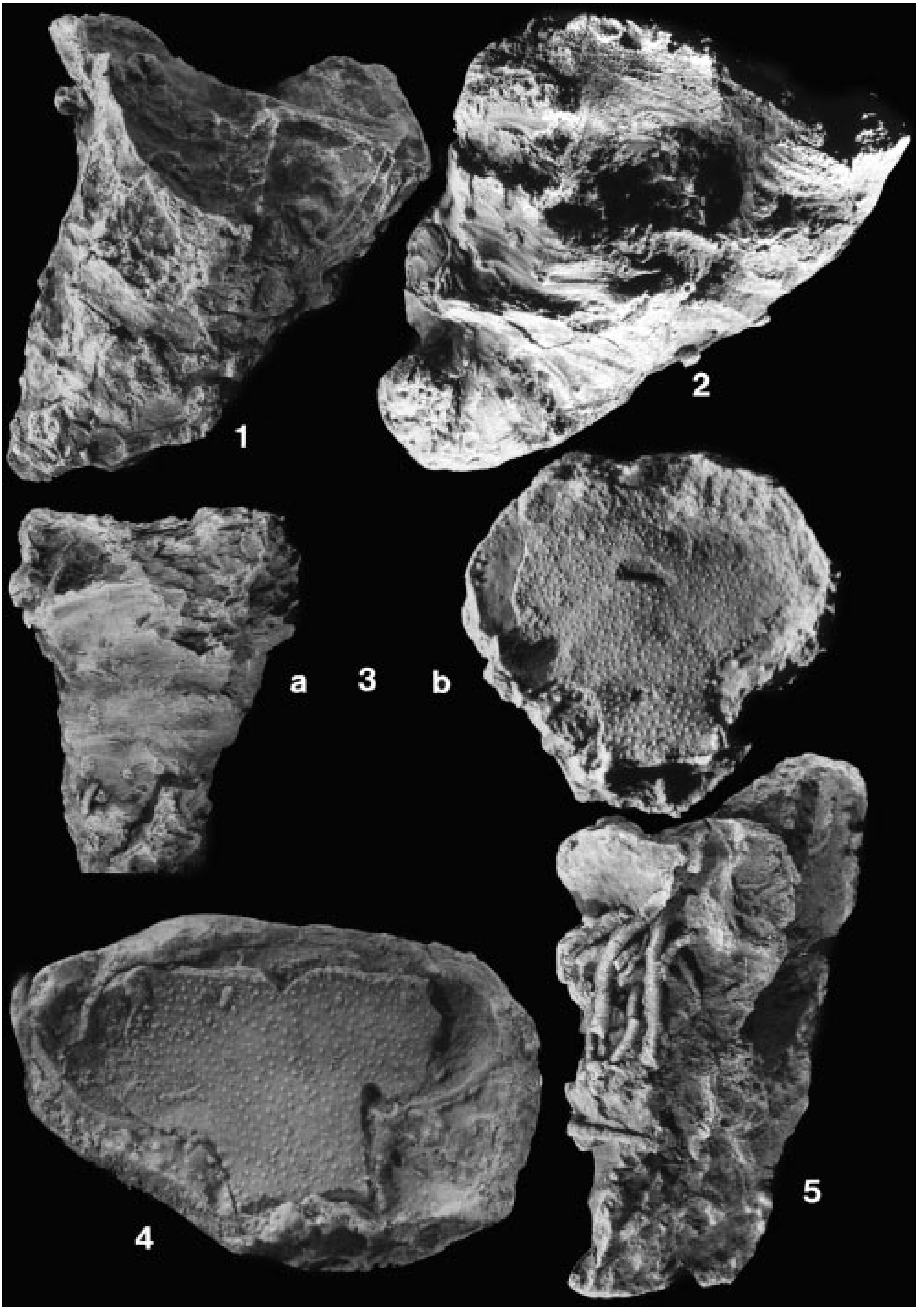

1
2
a 3 b
4
5

Plate 2

Fig. 1: Fan-like cluster of *Richthofenia* on the top of the lens in the upper part of unit 1. Approx. natural size.

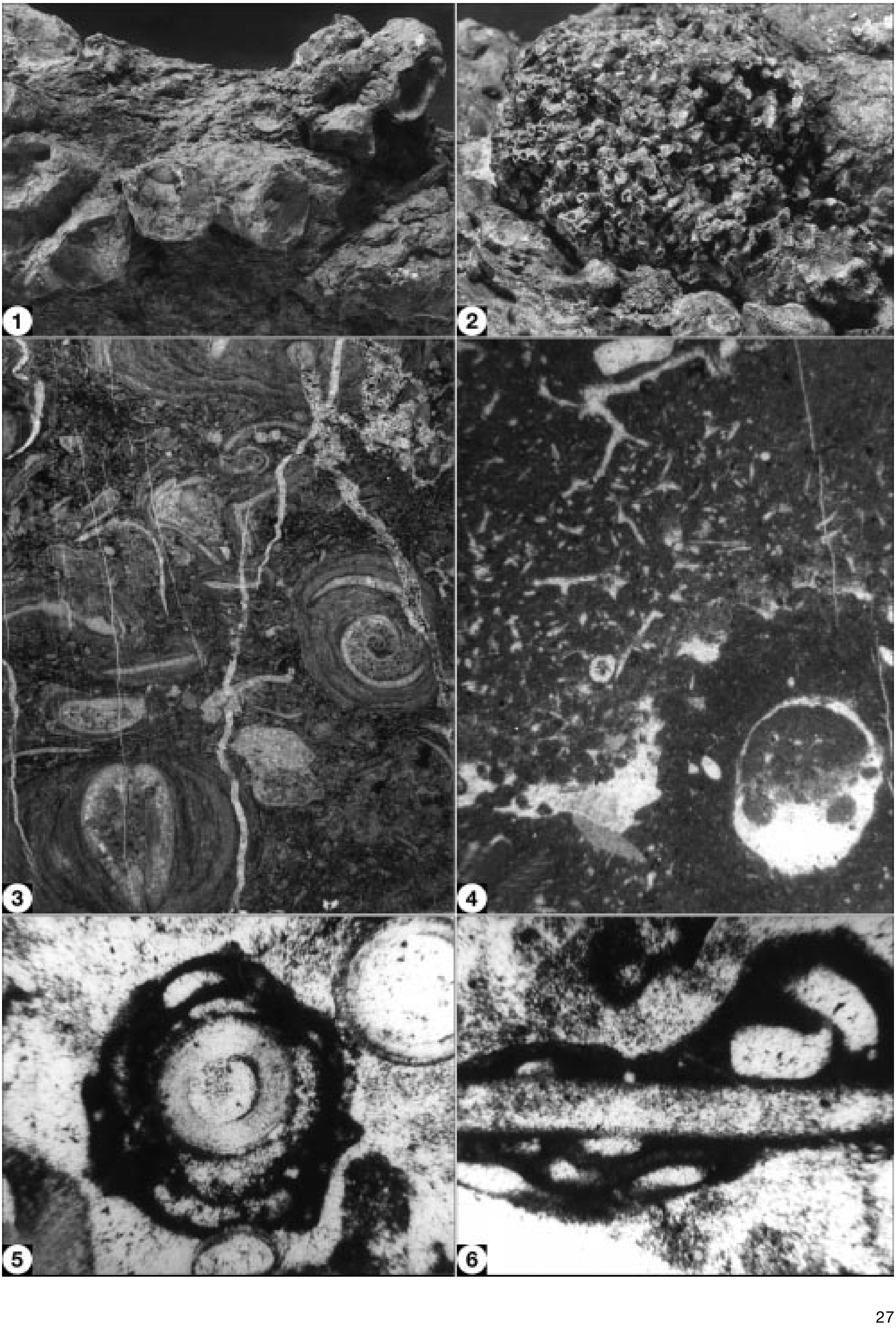
Fig. 2: Colony of *Multithecopora* sp. (overgrown by cystoporid bryozoans), unit 1. Approx. natural size.

Fig. 3: Oncoids with nuclei of bellerophontide gastropods and pelecypods, unit 5. Magnification: 2.6×.

Fig. 4: Microfacies at the top of unit 3 with sponges and microbial activities. Magnification: 16.9×.

Fig. 5: Brachiopod spine in cross section with *Tubiphytes*-like encrusters, unit 3. Magnification: 43.2×.

Fig. 6: Brachiopod spine in longitudinal section with *Tubiphytes*-like encrusters, unit 3. Magnification: 36.5×.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Manuskript bei der Schriftleitung eingelangt am 15. Jänner 1996