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THE CRINOID FAUNA OF THE *DIPLOPORA* DOLOMITE (MIDDLE MUSCHELKALK, UPPER ANISIAN) AT PIEKARY ŚLĄSKIE IN UPPER SILESIA

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With 8 figures and 6 plates

Abstract:
The diverse crinoid fauna described from the *Diplopora* Dolomite (Middle Muschelkalk, Triassic, Anisian, Lower Illyrian; assemblage zone with *Neoschizodus orbicularis* and *Judicarites*; *silesiacus* zone) of Piekary Śląskie (Upper Silesia, Poland) is represented by isolated sclerites exclusively. The fauna comprises at least 5 crinoid genera. With 87% of the sclerites, encrinids are dominating, while holocrinids (7%) and millericrinids (1%) are less abundant. The encrinids *Encrinus aculeatus* and *Chelocrinus carnalli* may be only distinguished by their cup and arm elements. Their columnals are distributed into 5 morphotypes belonging to definite parts of the stalk. Descriptions of the holocrinids *Holocrinus meyeri* (stalk, cup, arms) and *Eckicrinus radiatus* (stalk) and of the millericrinid *Silesiacrinus silesiacus* are given in more details. Relations and occurrence of these taxa in the Germanic and the Alpine Triassic are extensively discussed. They are useful index fossils for biostratigraphic correlation of different Peritethys basins. Finally, several indefinite crinoid sclerites are described.

Zusammenfassung:
Aus dem Diploporendolomit des Mittleren Muschelkalks (Trias, Anis, Unterillyr; Assemblagezone mit *Neoschizodus orbicularis* und *Judicarites*; *silesiacus*-Zone) von Piekary Śląskie (Oberschlesien, Polen) wird eine ausschließlich in isolierten Skleriten vorliegende, diverse (mindestens 5 Gattungen) Crinoidenfauna beschrieben. Mit ca. 87% der Sklerite dominieren darin die Encriniden, während Holocriniden mit ca. 7% und Millericriniden mit ca. 1% stark zurücktreten. Von den Encriniden *Encrinus aculeatus* und *Chelocrinus carnalli* lassen sich nur Kelch- und Armelemente sicher bestimmen. Ihre Stielglieder werden nach 5 Formtypen gegliedert und, soweit möglich, bestimmten Stielabschnitten und Taxa zugeordnet. Eingehender beschrieben und diskutiert sowie mit weiteren Vorkommen aus der Germanischen und Alpinen Trias verglichen werden die Holocriniden *Holocrinus meyeri* (Stiel, Kelch, Arme) und *Eckicrinus radiatus* (Stiel) sowie der Millericrinide *Silesiacrinus silesiacus* (Stiel). Diesen Formen kommt als Indexfossilien bei der Korrelation unterschiedlicher Peritethys-Becken biostratigraphischer Leitwert zu. Schließlich werden noch einige unbestimmte Crinoidensklerite beschrieben.

Introduction

Eight years before the city of Beuthen in Upper Silesia received German Right, the Dominican monk St. Hyacinth was acting as a missionary at Rossberg on a hill close to a fountain. Once, when he was praying at this fountain, the string of his rosary broke and the beads rolled into the yellow sand mixing up with its grains. So he was not able to sort them out again. The saint then spoke: "Grow, until once the fountain will dry up!" After these words he arose and moved to Kraków to the Dominican monastery which he had founded. There he died on the 15th August 1253 at the age of 74. Since those days the fountain has thrown out the multiplied beads of St. Hyacinth's rosary.

This legend is reported by Gramer (1863). He writes that such beads, which he regarded as "natürliche Dendriten", are still to be found, but sparsely. At the same time Prussian pioneers of Silesian Geology identified the legendary beads from St. Hyacinth's rosary as columnals of encrinid sea lilies.

In his monograph on the Muschelkalk in Silesia Eck (1865: 81) reports that the extremely well-preserved yellow, dolomitized crinoid columnals

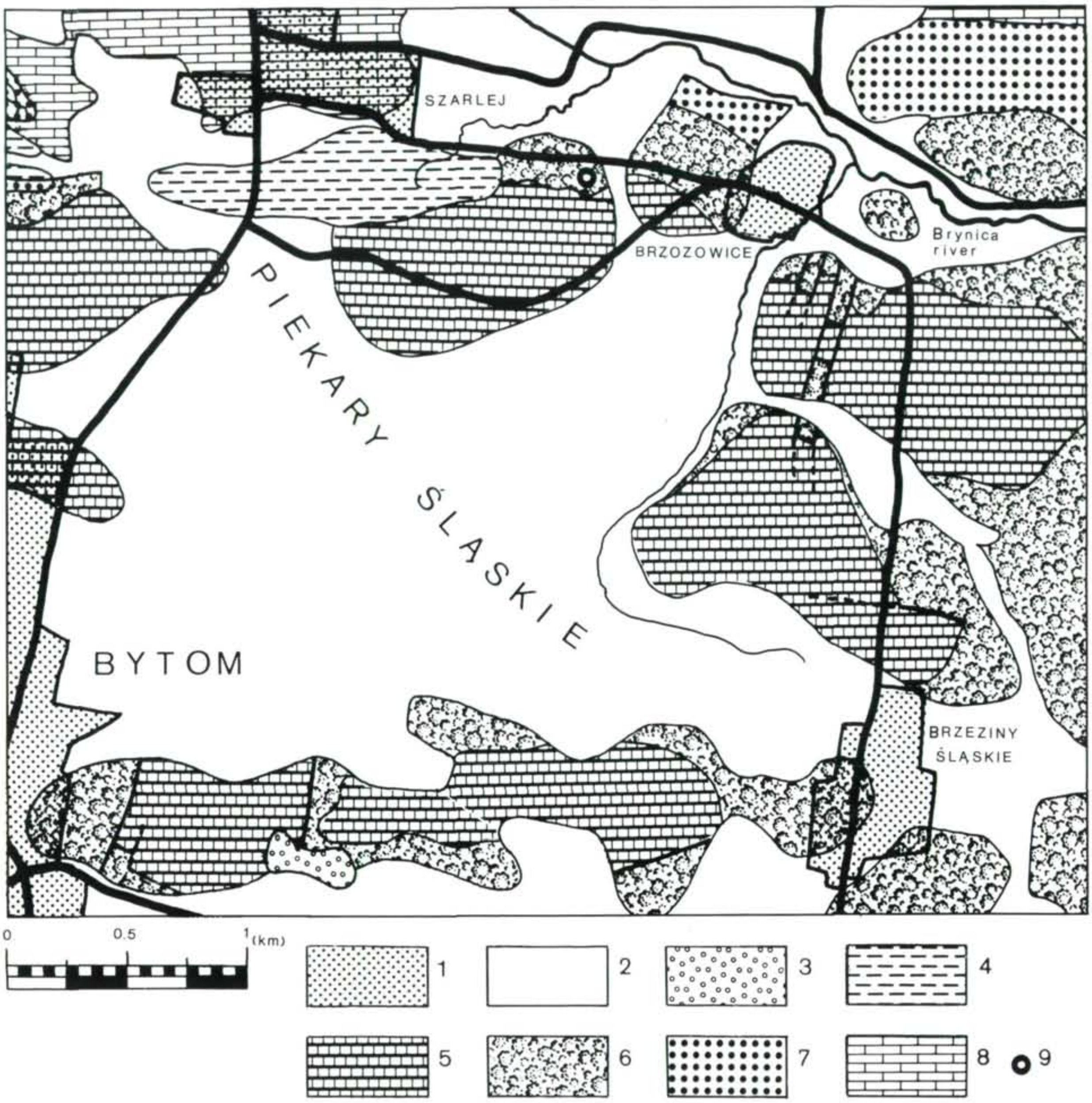

Fig. 1: Geological sketch of Piekary Śląskie (simplified after BIERNAT, 1954).
1 Built up area; **2** Quaternary; **3** Miocene (clays, marls); **4** J1 - Hettangian (fireproof clays, gravels, conglomerates); **5** T2 - Tarnowice Beds (marly dolomites); **6** T2 - *Diplopora*-Dolomite (algal and oolitic dolomites); **7** T2 - Ore-bearing Dolomite (crystalline dolomites); **8** T2 - Gogolin Beds (organodetrital, marly and conglomeratic limestones); **9** fossil site.

thrown out by St. Hyacinth's fountain together with echinoid spines and plates, came from the Lower Muschelkalk Mikultschützer Schichten (= Karchowice Beds). The fountain itself had already dried up in ECK's days. The place of the fountain must have been situated near St. Hyacinth's church in Beuthen-Rossberg (now Bytom). Since the last century the fossil site has been unproductive, but specimens from St. Hyacinth's fountain are still kept in some of the older Muschelkalk collections.

They were described by QUENSTEDT (1835), ECK (1865), BEYRICH (1856), ROEMER (1870) and figured most thoroughly and classified by QUEN-

STEDT (1876). BATHER (1909) discussed the systematic position of some of the Beuthen crinoids in his great monograph on the Triassic crinoids from Bakony and compared them with material from the Tethydian Triassic. New collections of Silesian Muschelkalk fossils led ASSMANN (1926, 1937, 1944) to his revisions of the crinoid fauna, but he focused his interest on complete crowns and rather disregarded isolated ossicles. In recent papers on Triassic crinoids from Silesia (HAGDORN, 1985, 1986, HAGDORN & GŁUCHOWSKI, 1993) Beuthen specimens have been figured and discussed, but a systematic description of this most diverse Middle Triassic crinoid fauna is still lacking.

Locality and Stratigraphy

In the 1970s the junior author (A. B.) discovered a fossil site near Piekary Śląskie, former Deutsch Piekar, which contained exactly the same dolomitized echinoderm fauna as that from St. Hyacinth's fountain. This locality is situated not more than 3.5 km NE from St. Hyacinth's church in Bytom, close to the road from Piekary Śląskie-Szarlej to Katowice through Brzozowice. The exposure is a road cut about 150 m long and several meters deep made in 1971 during construction work. Since 1977, the exposure has been covered with soil and by 1987 the fossil bearing beds were overgrown with vegetation.

The rocks directly exposed on the surface are strongly weathered, porous, dolomitic limestones and dolomites of yellow and orange colour mixed up with clay and quartz. The fossiliferous beds belong to a sequence of oolitic and porous dolomites. They occur a few meters below the marly dolomites of the Tarnowice Beds and represent the topmost part of the *Diplopora* Dolomite at the base of the Middle Muschelkalk (GŁUCHOWSKI & BOCZAROWSKI, 1986). However, porous dolomites with an echinoderm fauna almost the same as that of the *Diplopora* Dolomite, also occur in the Karchowice Beds (ASSMANN, 1926, 1937, 1944 and personal observations). Moreover, in the Bytom Basin, secondary dolomitization of the Muschelkalk (Ore Bearing Dolomite) has affected the *Diplopora* Dolomite and the Lower Muschelkalk down to the base of the Górażdże Beds and locally to the Gogolin Beds (ASSMANN, 1944). Therefore the position of the fossiliferous beds from Piekary Śląskie a few meters below the marly dolomites of the Tarnowice Beds is the most convincing argument for their attachment to the *Diplopora* Dolomite. On the other hand, the brachiopod *Coenothyris vulgaris*, of which uncertain shell fragments have been found in the Piekary Śląskie fauna, is not known from the *Diplopora* Dolomite, but quite common in the Karchowice Beds. According to KOZUR (1974), the lower part of the *Diplopora* Dolomite belongs to the Upper Anisian (Illyrian) assemblage zone with *Judicarites* and *Neoschizodus orbicularis*. The upper part of the *Diplopora* Dolomite is characterized by the first occurrence of *Diplopora annulatissima*, a dasycladacean alga, which is absent from the Piekary Śląskie locality. Their absence, however, may simply be the result of dolomitization or to the fact that echinoderm and dasycladacean facies are always mutually exclusive (for example, in western Upper Silesia, ASSMANN, 1944), either for stratigraphic or facies reasons.

Composition of the Piekary Śląskie fauna and palaeoecology

In the highly fossiliferous Upper Muschelkalk crinoidal limestones (Trochitenkalk) of Germany, crinoids are the main faunal element, and are almost always monospecific consisting only of *Encrinus liliiformis*. In contrast to this highly advanced encrinid, other species, such as *Encrinus greppini* or *Chelocrinus schlotheimi*, are restricted both regionally and stratigraphically (HAGDORN, 1982, 1985, 1986). Examination of many well-preserved, complete specimens of *Encrinus liliiformis*, has revealed broad intraspecific variability of morphological characters. This allows easy identification of isolated ossicles from the Trochitenkalk as *Encrinus liliiformis*.

In sediments containing a more diverse crinoid fauna, like the *Diplopora* Dolomite from Piekary

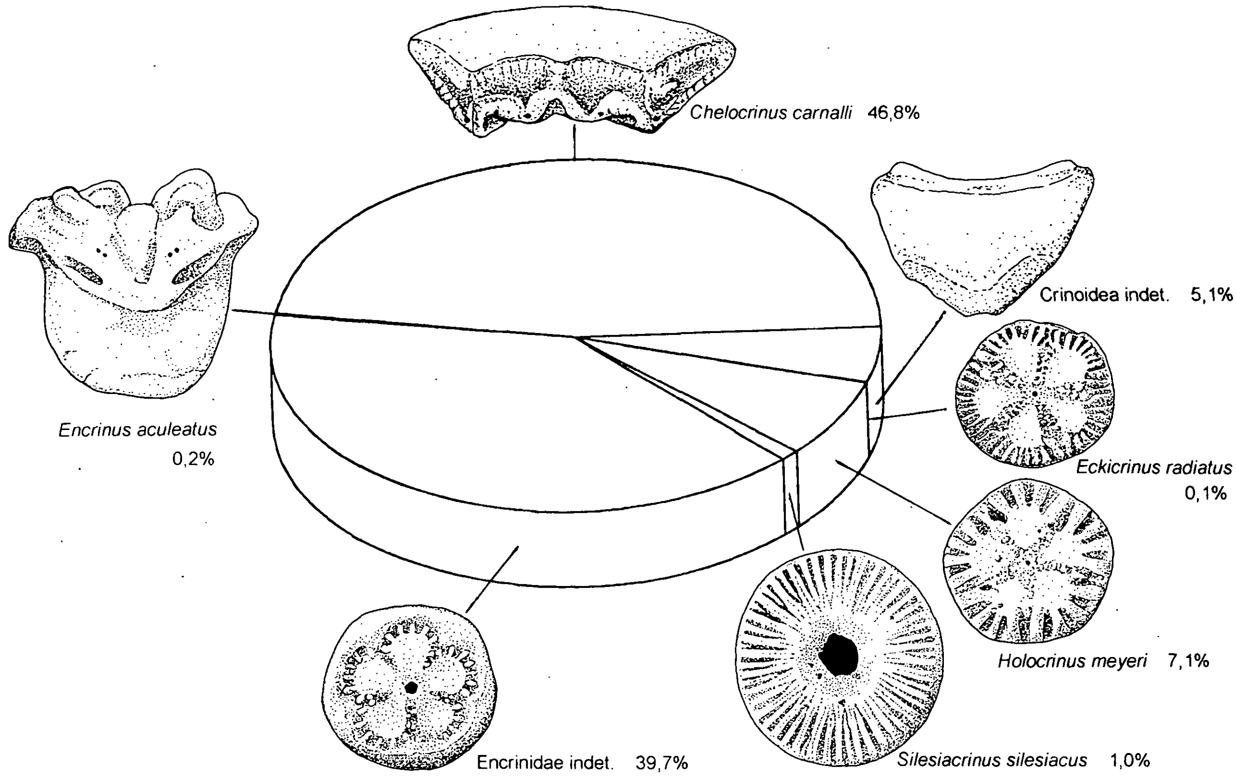

Fig. 2: Composition of the Piekary Śląskie crinoid fauna.

Śląskie, which yield no complete specimens, it is often difficult to correctly reconstruct complete individuals without running the risk of mixing up ossicles belonging to different crinoid groups. However, because many of the isolated elements have characters unique to particular families, it is often possible to determine affinities of isolated ossicles to the genus or even the species level.

Like other Middle Triassic crinoid assemblages, the fauna of the *Diplopora* Dolomite is strongly dominated by the remains of encrinids. In the fossil record of the Piekary Śląskie fossil site, more than 86% of the ossicles belong to encrinids, which are represented by at least 2 species in 2 genera. Holocrinids, represented by 2 species in 2 genera, are relatively rare: they constitute no more than 7% of the ossicles. The large multiradiate columnals of the millericrinid *Silesiacrinus silesiacus* comprise less than 1% of the ossicles. The remaining 5% could not be identified with any of these groups (Fig. 2).

Every species of echinoderms in the *Diplopora* Dolomite has also been found in the Karchowice beds at the top of the Lower Muschelkalk (QUENSTEDT 1876, ASSMANN 1926, 1937, 1944, SENKOWICZOWA & KOTAŃSKI 1979, HAGDORN 1985, HAGDORN & GŁUCHOWSKI 1993). Comparably to the crinoid facies of the *Diplopora* Dolomite in the western part of Upper Silesia at Kamień Śląski/Groß Stein, the Karchowice Beds yielded several specimens of complete encrinid crowns. Identification of the disarticulated material from Piekary Śląskie is thus facilitated. In addition to the crinoid ossicles, numerous isolated sclerites of ophiuroids and echinoids have been collected. The latter belong to *Serpianotiaris longispina* (ASSMANN, 1937), *Triadocidaris transversa* (V. MEYER, 1846), *Triadocidaris remifera* (ASSMANN, 1937), *Miocidaris* sp. and *"Triadotiaris" grandaeva* (V. ALBERTI, 1834). With at least 7 species in 5 genera and 4 families of articulate crinoids, 5 echinoid species in 4 genera and 3 families, ophiuroids, 1 asteroid and holothurians, the Karchowice Beds and the *Diplopora* Dolomite yielded the most diverse echinoderm fauna of Anisian times.

In addition to the echinoderms, the Piekary Śląskie fossil site contains the brachiopod *Coenothyris vulgaris* (v. SCHLOTHEIM), the myophoriid bivalve *Lyriomyophoria elegans* (DUNKER) and the small gastropod *Omphaloptycha submersa* ASSMANN. The occurrence of the stenohaline articulate brachiopods and the diverse echinoderms suggest a fully marine environment. In the fossil assemblage, epibenthic filter feeders are dominant. *Lyriomyophoria* is an endobenthic filter feeder; its shell morphology, shell sculpture consisting of coarse concentric ribs, and its large trigoniacean foot made it well adapted to rapid burrowing in coarse, shifting shallow water sediments, such as the biogenic oolitic and pseudoolitic calcareous sands of the *Diplopora* Dolomite. In the *Diplopopra* Dolomite, the grazers are represented by the gastropod and the echinoids. The extreme rarity of mollusks in the fauna may be an artefact of their lower fossil potential in the dolomitized sediment. In other outcrops of the *Diplopora* Dolomite and the Karchowice Beds, the accompanying mollusk fauna is much more diverse (ASSMANN, 1937, 1944; BODZIOCH, 1989, 1991). The dominance of encrinids which lived attached to hard substrates such as terquemiid shells or basal stems of other encrinids (HAGDORN, 1978; BODZIOCH 1991), demonstrates that some areas of cemented or lithified substrates must have been present among the carbonate sands and that these could become colonized by fixosessile epibionts. Sponge/coral bioherms like those described by BODZIOCH (1991) from the Karchowice Beds of western Upper Silesia have not been discovered in eastern Upper Silesia or the Kraków Upland until now, but sponges collected near Tarnowitz (non Tarnowskie Góry) during the last century suggest that sponge bioherms also existed in the eastern part of Upper Silesia.

In the transgressive/regressive cycle of the Lower Muschelkalk sequence (AIGNER & BACHMANN, 1993; SZULC, 1993), the maximum flooding surface, corresponding to the *Terebratula* Beds (Pelsonian, *decurtata* Zone), is overlain by the Karchowice Beds and the *Diplopora* Dolomite which represent the beginning of the highstand systems tract. However, at this time Upper Silesia was situated close to the Silesian-Moravian Gate connecting the Germanic Muschelkalk basin with the open marine Tethys. The stenohaline benthic communities of the Karchowice Beds and the *Diplopora* Dolomite were thus strongly influenced by the East-Mediterranean Triassic faunal province (ASSMANN, 1937, 1944; SENKOWICZOWA & KOTAŃSKI, 1979; KOZUR, 1974; TRAMMER, 1975; HAGDORN, 1985; HAGDORN & GŁUCHOWSKI, 1993). While Upper Silesia remained influenced by the Tethys sea, marly dolomites and evaporites of the Middle Muschelkalk were being deposited in the more western and central parts of the Muschelkalk basin. In their lower part, these beds contain an extremely widespread, yet environmentally restricted fauna of euryhaline bivalves and gastropods. In Brandenburg (Rüdersdorf), for example, euryhaline faunal elements occur in several fossil horizons (marker beds) of the Middle Muschelkalk (PICARD, 1916). In Upper Silesia it is only in the unfossiliferous dolomitic marls of the Tarnowice Beds, a few meters above the Piekary Śląskie fossil horizon, that there is an ample evidence for restricted water exchange.

Systematic Paleontology

New taxa which have been introduced by HAGDORN & GŁUCHOWSKI (1993) in the appendix of their study on echinoderm stratigraphy of the Silesian Muschelkalk are fully described and discussed in this paper. These include the holocrinids and *Silesiacrinus*. Because the Piekary Śląskie encrinid species are represented incompletely and are better represented by articulated specimens from other localities, they will be described and discussed in more detail in a revision of the Lower Muschelkalk encrinids which is being planned by the first author.

Concerning the higher taxa, this paper still follows the arrangement of the Treatise on Invertebrate Paleontology.

As a result of a cladistic analysis, SIMMS & SEVASTOPULO (1993) include the Articulata as an infraclass within the subclass Cladida. Omitting the subclass Articulata, KLIKUSHIN (1992) divides the post-palaeozoic crinoids in two new subclasses, the Dadocrinoidea with the orders Millericrinida, Cyrtocrinida, Bourgueticrinida, and the Holocrinoidea comprising the orders Encrinida, Pentacrinida, Comatulida, Roveacrinida and Tulipacrinida.

Class Crinoidea MILLER, 1821
Subclass Articulata MILLER, 1821
Order Encrinida MATSUMOTO, 1929
[nom. transl. HAGDORN, 1987]
Family Encrinidae DUJARDIN & HUPÉ, 1862

In the Piekary Śląskie echinoderm horizon, encrinid ossicles represent the bulk of all crinoid remains (Fig. 2). They belong to 2 different genera, *Encrinus* and *Chelocrinus*. Identicationof the isolated ossicles was facilitated by comparison with several articulated crowns from the Karchowice Beds of western Upper Silesia, which have been collected recently (MHI). In the synonymy lists only the major works presenting new material or important opinions will be considered. For more complete synonymy compare BIESE 1934 and SIEVERTS-DORECK & BIESE, 1939.

Genus *Encrinus* LAMARCK, 1801

Diagnosis: Encrinids with regularly 10 arms. Pinnules smooth or pectinate

Encrinus aculeatus v. MEYER, 1847
(Pl. 1 a–e)

- V * 1847 – *Encrinus aculeatus* – v. MEYER: 576, 577
- V 1849 – *Encrinus aculeatus* – v. MEYER: 262–265, pl. 32, fig. 1
- V 1857 – *Encrinus aculeatus* MEY. – BEYRICH: 38–39, Pl. 1, fig. 16
- 1865 – *Encrinus* cf. *liliiformis* – ECK: 48–49, 87 [partim]
- non 1886 – *Encrinus aculeatus* v. MEYER – WAGNER: 26–28, pl. 2, fig. 14 [*Encrinus koeneni*]
- 1879 – *Encrinus liliiformis* – ECK: 257–259 [partim]
- 1887 – *Encrinus aculeatus* H. v. M. – KOENEN: 24–25
- 1888 – *Encrinus aculeatus* v. MEY. – ECK: 543–550, 554–555
- 1891 – *Encrinus aculeatus* – ECK: 739–741 [partim]
- ? 1891 – *Encrinus aculeatus* v. MEYR. – WAGNER: 890–896, pl. 49, fig. 5
- 1893 – *Encrinus* sp. – MICHAEL: 500–502, Fig. 1, 2
- 1894 – *Encrinus spinosus* n. sp. – MICHAEL: 23
- 1903 – *Encrinus aculeatus* - WYSOGORSKI in: PHILIPPI: 37, 59, 60, pl. 6, fig. 3
- V 1926 – *Encrinus aculeatus* v. MEYER – ASSMANN: 509-511, pl. 8, figs. 1–4
- 1926 – *Encrinus spinosus* MICHAEL – ASSMANN: 507–508, Abb., Taf. 9, Fig. 11
- non 1929 – *Encrinus aculeatus* v. M. – HILDEBRAND: 134, fig. 1
- V 1937 – *Encrinus aculeatus* H. v. MEYER – ASSMANN: 17–18, pl. 4, figs. 4–7
- non 1939 – *Encrinus aculeatus* MEYER – GASCHE: 89–96, pl. 4, fig. 2
- 1979 – *Encrinus aculeatus* MEYER, 1847 – SENKOWICZOWA & KOTAŃSKI: 128, pl. 35, fig. 1
- ? 1986 – *Encrinus aculeatus* + *brahli* - GŁUCHOWSKI & BOCZARAROWSKI: 193, pl. 1, figs. 1–3
- ? 1986 – *Encrinus* + *Chelocrinus* – GŁUCHOWSKI & BOCZAROWSKI: 193, pl. 1, figs. 4–9
- 1993 – *Encrinus aculeatus* – HAGDORN & GŁUCHOWSKI: Fig. 10: 2, 5

Diagnosis: An *Encrinus* with flat bowl shaped cup with subhorizontal base. Radials and first primibrachials with strongly inflated dorsal sides. Interradial and basal/radial articula synostosial with distinct ligament pits. In adults, arms uniserial up to the 8th secundibrachial. Dorsal side of proximal brachials with sharp, blade shaped spines in juveniles, in adults inflated. Median and distal brachials with straight spines, which may bear knobs. Pinnules smooth.

Description: In the Piekary Śląskie fauna *E. aculeatus* is a rare species. No more than 35 ossicles (0.2% of the whole material) can be referred to this species, which is found much more abundant in the Karchowice beds of western Upper Silesia. Isolated brachials of *E. aculeatus* are easily recognized by their dorsal ornaments, while isolated columnals do not have any diagnostic characters.

R – 3 poorly preserved radials, 3.5 to 5.4 mm wide. Dorsal side with long spine or tongue shaped ornament closely below distal margin.

IBr1 – 3 first primibrachials, 5.3 to 5.5 mm wide (Pl. 1 a, c). Dorsal side with tongue shaped ornament directed upward. Lateral facets synostosial. Radial facets straight muscular, distal facets smooth zygosynostosial (no marginal crenulation observed).

IBr2Ax – 3 axillaries, 4.5 to 5.4 mm wide (Pl. 1 b). Dorsal side with extreme long, tongue shaped ornament, which may bend slightly upward. Proximal facet zygosynostosial, distal facets straight muscular with angle of transverse ridges of 90–100°.

IIBr– 8 uniserial brachials of proximal arm, 2.4 to 3.6 mm wide (Pl. 1 d). On the wedge shaped dorsal sides blade shaped spines. Faces straight muscular and synostosial. 17 biserial brachials of middle to distal arm, up to 3 mm wide (Pl. 1 e). Dorsal sides with long spines which may bear 1 or 2 knobs on their tips. Synostosial faces with marginal granulation or crenulation. Paired axial canal piercing the zigzag suture which includes an angle of approximately 70°. Pinnular articulum with distinct ridge and ligament pit.

Genus *Chelocrinus* v. MEYER, 1835

Diagnosis: Encrinids with regularly 20 arms. Pinnules smooth, pectinate or hooked.

Chelocrinus carnalli BEYRICH, 1856

(Fig. 3, Pl. 1 f–s)

V * 1856 – *Encrinus (Chelocrinus) Carnalli* – BEYRICH: 10
V * 1857 – *Encrinus Carnalli* – BEYRICH: 32–33, Taf. 1, fig. 14
non 1877 – *Encrinus carnalli monostichus* – DALMER: 387–391, 398–401, Taf. 23, Fig. 1–3
1887 – *Encrinus carnalli* BEYR. – KOENEN: 36–42 [partim], Taf. 1, fig 15
1894 – *Encrinus Carnalli* BEYR. – JAEKEL: 155–162, Fig. 1, 2
1903 – *Encrinus carnalli* – LANGENHAN: Taf. 3, Fig. a, b; 4, Fig. 1-3
1911 – *Encrinus carnalli* – LANGENHAN: Taf. 4, Fig. 1–6; 7, Fig. 1–2
1927 – *Encrinus carnalli* Beyrich – BIESE: 7–65, 72–116, Taf. 2–3, 4, Fig. 1–19
1952 – *Encrinus carnalli* – ENGELKING: 277–288, Fig. 1–5
1956 – *Encrinus carnalli* BEYR. – MÜLLER: 26–29, Taf. 1, Fig. 1–3
1980 – *Chelocrinus carnalli* (BEYRICH) – HAGDORN: 499–502, Fig. 2, 4B
1982 – *Chelocrinus carnalli* (BEYRICH) – HAGDORN: 27–28, Abb. 20A
? 1986 – *Encrinus* + *Chelocrinus* – GŁUCHOWSKI & BOCZAROWSKI: 193, pl. 1, figs. 4–9
1993 – *Chelocrinus carnalli* (BEYRICH, 1856) – ERNST & LÖFFLER: 224–228, Abb. 4

Diagnosis: A large *Chelocrinus* with bowl-shaped to low cone-shaped cup and convex base. Basals moderately to very long. Faces of cup elements synostosial. Dorsal sides of cup and arm elements smooth. Arms uniserial up to IIIBr10 or farther distal, then becoming biserial. Brachials with low wedge shaped dorsal sides. Pinnules smooth, rarely pectinate.

Remarks: The holotype of *Ch. carnalli* (MB E. 274), a large fragmentary crown from the Schaumkalk of Rüdersdorf (Brandenburg, Germany), has a bowl shaped cup with moderately

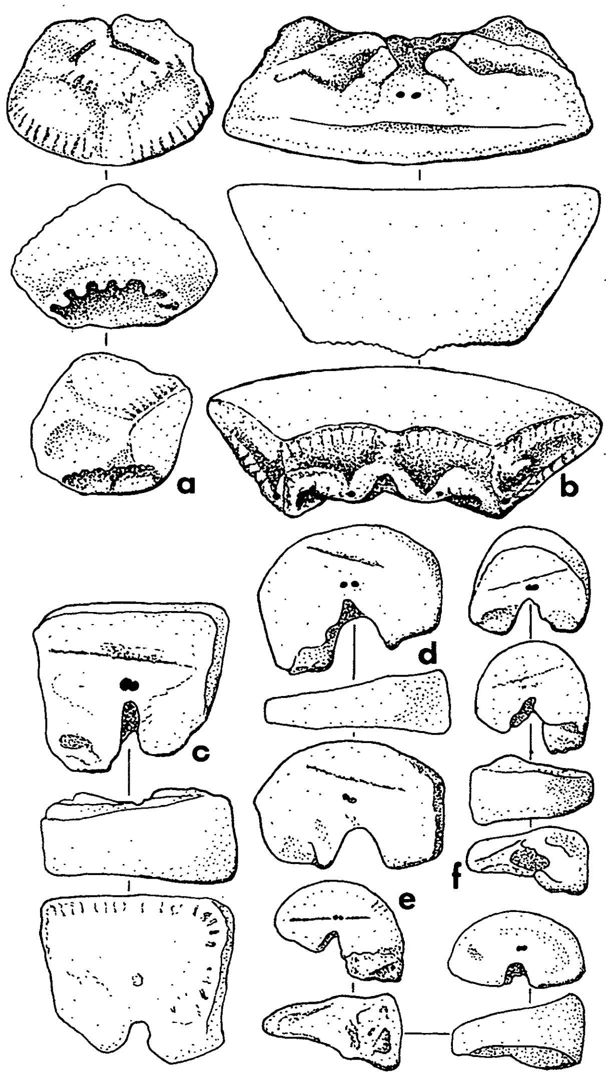

Fig. 3: *Chelocrinus carnalli* BEYRICH, 1856. *Diplopora* Dolomite, Piekary Śląskie.
a Basal, from distal, aboral, lateral (top to bottom); GIUS-7-59/29. **b** Radial, from distal, aboral, proximal (top to bottom); GIUS-7-59/30. **c** Proximal tertibrachial with synostosial proximal and muscular distal face; GIUS-7-59/31. **d** Tertibrachial with two muscular faces; GIUS-7-59/32. **e** Tertibrachial from middle to distal arm with a muscular and a synostosial face; GIUS-7-59/33. **f** Tertibrachial from middle to distal arm with two muscular faces; GIUS-7-59/34. Scale 2 mm.

long basals which are visible in side view. The complete specimens from the Schaumkalk Member of Freyburg/Unstrut (Sachsen-Anhalt, Germany) have low cone-shaped cups with very long basals and nodals without cirri. A second Lower Muschelkalk *Chelocrinus* occurring in the Terebratelbank Member has a flat bowl-shaped cup with slightly depressed base and the basals invisible in side view; this species may bear cirri on its proximal nodals (ERNST & LÖFFLER, 1993). The holotype of *Ch. carnalli* occupies an intermediate state between the Freyburg specimens and the still unnamed Terebratelbank *Chelocinus*. Extensive discussion and taxonomic decisions will be given in a revision of the Lower Muschelkalk encrinids.

Description: The bulk of the encrinid sclerites from Piekary Śląskie may be attributed to *Chelocrinus*. This determination is supported by the ratio of 321 second axillaries to 156 first axillaries. Morphology of cup and arm elements agrees with the diagnostic characters of the holotype of *Chelocrinus carnalli*, although they are distinctly smaller. Among these elements a certain percentage may also belong to *Encrinus robustus* which is a common species in the Karchowice Beds.

Cup – 1 poorly preserved, fragmentary cup of 7.3 mm diameter, bowl-shaped with convex base; basals visible in side view. Infrabasals rhomboid. Basals medium sized, with sublobate, crenulated stem pit. Radials dorsally smooth, trapeziform. Basal/radial and interradial facets synostosial. This type of cup does not allow definite species or genus determination. Due to the abundance of definite *Chelocrinus carnalli* sclerites, it is attributed to this species.

B – 67 basals 2.0 to 3.7 mm wide (Fig. 3 a; Pl. 1 f). Angle between stem pit and free dorsal side indicating subhorizontal base and bowl-shaped cup. Very thick. Dorsally visible side trapeziform. Stem pit deep with rounded, crenulated margin. Interbasal and basal/radial facets synostosial with delicate marginal crenulae or vermiculae. Y-shaped nerve canal may be visible on ventral side. This most abundant type of basals is most similar to those of the holotype of *Ch. carnalli*, however, it could also belong to several *Encrinus* species.

2 very large basals (3.9/4.8 mm wide and 3.5/5.5 mm long) with pentagonal dorsal side (Pl. 1 g). Angle between stem pit and free dorsal side indicating convex base and low cone-shaped cup. Relatively thin plate. Stem pit deep, rounded with marginal crenulae. Interbasal and basal/radial facets synostosial with short margi-

nal crenulae. Dorsal side smooth. Size and shape of this type is most similar to those *Ch. carnalli* from the Schaumkalk Member of Freyburg/Unstrut.

R – 275 radials, 1.8 to 8.2 mm wide (Fig. 3 b; Pl. 1 h–i). Dorsal side smooth or with slight transverse depression close to the radial/basal suture. Interradial and basal/radial facets synostosial with crenulated margin. Radial facet with straight muscular articulation. Adoral groove may be closed by adoral wings for muscular attachment. This radial type matches with the shorter basals. It could also belong to several *Encrinus* species.

IBr1 – 178 first primibrachials, 1.7 to 10.8 mm wide (Pl. 1 j–l). Dorsal side smooth, low rectangular, only slightly arched. Radial facets with long, straight transverse ridge and dorsal ligament pit; adoral groove may be enclosed by adoral wings for muscular attachment. Distal facet zygosynostosial with delicate crenulation on dorsal margin. No distinct lateral faces.

IBr2Ax – 156 primaxillaries, 2.6 to 9.5 mm wide (Pl. 1 m–o). Dorsal side smooth, slightly arched. IBr1/IBr2 facet zygosynostosial with marginal crenulation. Axillar distal facets symmetrical, straight muscular articulations, angle of transverse ridges < 100°, distinct ventral wings for muscular attachment. Central crista distinct.

IIBr1 – 361 first secundibrachials, 2.3 to 12 mm wide (Pl. 1 q). Dorsal side smooth or slightly concave; outline due to oblique facet of primaxillary in shape of a parallelogram. Proximal face straight muscular, oblique to long axis. Distal facet zygosynostosial with delicate marginal crenulation.

IIBr2Ax – 144 secundaxillaries from the right and 176 from the left part of the brachial ray (Pl. 1 q). Dorsal side smooth, due to distal facet of IIBr1 oblique pentagonal. Proximal facet oblique to longitudinal axis, zygosynostosial. Distal, axillar facet muscular, asymmetrical, with outer facet larger than inner facet.

IIIBr - Nearly 10 000 brachials. IIIBr1 almost as high as wide with muscular proximal facet and synostosial distal facet. The subsequent brachials lower, dorsal side always without ornaments. Proximal, uniserial brachials with low rectangular dorsal outline and sharp lateral edges (Fig. 3 c; Pl. 1 s); facets straight muscular or zygosynostosial. Towards the mesial and distal arm, brachial arrangement becomes immature biserial (wechselzeilig; Fig. 3 d–f; Pl. 1 r). Dorsal sides wedge-shaped and dorsal outline rounded. Facets syzygial or oblique muscular (indistinct transverse ridges). Pinnule facets oblique muscular.

Encrinidae gen. et sp. indet.
(Pl. 2)

Although particular characters of the encrinid stem may be diagnostic, it is extremely difficult to determine isolated encrinid columnals correctly. This is especially true for those polyspecific faunas containing no complete articulated sceletons. However, in samples of Pelsonian or Illyrian age without dadocrinids, encrinid columnals may be easily identified and distinguished from holocrinids and millericrinids. Only among proximal columnals with petaloid crenulation patterns and very small (juvenile) columnals there may arise determination problems. The main diagnostic characters are the following:

- the encrinid lumen is markedly wider than the holocrinid lumen, but not as wide as the millericrinid lumen.
- encrinids have short and coarse crenulae
- encrinid columnals with petaloid pattern have rounded interradii and wide, rounded areolae.

In the flexible proximal stalk of encrinids all columnals are low and may be circular to subpentagonal. Nodals and low order internodals are higher and wider than high order internodals and normally have a distinct inflated epifacet. Towards the middle and distal stem, columnals become cylindrical with straight lateral sides and multiradiate crenulation patterns. As a consequence of their lifelong radial and longitudinal growth, nodals and internodals become equally sized and morphologically undiscernible.

The encrinid columnals from the Piekary Śląskie fauna comprise the following morphotypes:

1. Low columnals with cirrus scars

a. With petaloid crenulation pattern (Pl. 2 a).

Medium sized columnals (diameter usually more than 3 mm), circular to subcircular, low (height index up to 60), with inflated epifacet; inflation usually irregular. Crenulation pattern petaloid with wide, rounded petal floors. Marginal culmina very short, adradial culmina or granulae irregular, often becoming indistinct towards the perilumen. Lumen circular to pentagonal. Perilumen smooth or weakly granulated. Epifacet with 1 or up to 5 circular cirrus scars, usually depressed with weakly inflated rim, occasionally weakly protruding; transverse ridge not observed.

b. With multiradiate crenulation pattern (Pl. 2 b–d, i)

Small columnals (diameter less than 3 mm), circular to subcircular or irregular, due to cirrus sockets. Epifacet rounded. Crenulation pattern circular to subcircular multiradiate with very short culmina. Lumen wide, circular. Perilumen smooth, sometimes lacking. Epifacet with 1 to 5 protruding cirrus sockets which may bend upwards. Cirrus scars circular, no transverse ridge.

2. Low columnals with epifacet without cirrus scars (Pl. 2 e–h)

Small to medium sized columnals, circular to subcircular, low (height index usually less than 50), with regularly inflated epifacet. Crenulation pattern petaloid with wide, rounded floors. Marginal culmina very short, adradial culmina or granulae irregular, often becoming indistinct towards the perilumen. Lumen circular to pentagonal. Perilumen smooth or weakly granulated.

3. Low Columnals without epifacet (Pl. 2 j–n)

Small to medium sized columnals, subcircular to subpentagonal with rounded interradii, very low (height index of adult columnals less than 30). Sides straight or only weakly inflated, no epifacet. Crenulation pattern petaloid, with very short marginal culmina. Immature internodals being extremely low may lack marginal crenulae. Adradial culmina or granules may be arranged irregularly or along distinct intercolumnal fossulae (stem pores) reaching the perilumen. Lumen circular to pentagonal.

4. Cylindrical Columnals (Pl. 2 o–s)

Circular to weakly subcircular (in very small specimens) columnals, small to medium sized. Height index usually more than 60. Latera straight (cylindrical) or weakly concave or convex. Crenulation pattern multiradiate with short to moderately long culmina. Perilumen, if present, smooth or weakly granulated, circular to subpentalobate. Lumen wide, circular.

5. Cylindrical columnals with knoblike ornaments (Pl. 2 t)

Circular to subcircular columnals, small. Latera straight with up to 5 small knoblike ornaments. Crenulation pattern multiradiate with short culmina.

Morphotype 1 columnals represent cirrinodals from the proximal stem part. Such isolated cirrinodals from the Karchowice Beds and from the *Diplopora* Dolomite of St. Hyacinth's well have been attributed to *Encrinus aculeatus* by Eck (1887: 555). However, several complete crowns with their proximal stem preserved from the Karchowice Beds of western Upper Silesia have no cirrinodals (Assmann, 1926, 1937, and unpublished material in MHI). The same is true for *Chelocrinus carnalli*. Among encrinids, cirrinodals have been reported for *Chelocrinus schlotheimi* (Hagdorn, 1982), *Chelocrinus* sp. (Ernst & Löffler, 1993) and for several *Encrinus brahli* populations, e.g. from the *Terebratula* Beds of Sondershausen (Eck, 1887; Koenen, 1887; Biese, 1927). These

Encrinus differ in several characters from the types of *E. brahli* which has no cirri. They probably belong to *E. koeneni*, a species established by ASSMANN, 1926, which has been united with *E. brahli* by BIESE (1927). Although *E. koeneni* is obviously the most abundant *Encrinus* in the Lower Muschelkalk of Germany, complete specimens have not been found in Upper Silesia. The cirrinodals from Piekary Śląskie may thus belong to *Encrinus koeneni* or to *Chelocrinus* sp.

All other encrinid columnals are not diagnostic for certain species or genera. As they make up the bulk of the encrinid columnals (approx. 98%), most of them may belong to *Chelocrinus carnalli*, a smaller number to *Encrinus aculeatus*. Morphotype 2 columnals represent nudinodals or first order internodals. Morphotype 3 columnals represent more or less mature internodals from the proximal stem. The dominating morphotype 4 columnals belong to the middle and distal stem. Morphotype 5, which is extremely rare, may represent rudimentary cirrus sockets and belong to one of the above discussed encrinids with cirrinodals.

Order Isocrinida SIEVERTS-DORECK, 1952
Family Holocrinidae JAEKEL, 1918

This study still follows the classification of RASMUSSEN (1978) used in the Treatise. It is planned by the first author to give the holocrinids the rank of an order.

Genus *Holocrinus* WACHSMUTH & SPRINGER, 1887

Diagnosis: Holocrinids with subcircular to pentalobate stem and 2 to 5 long cirri. Proximal cirrals with elliptical, synarthrial articulations. Noditaxis moderately long. Cup barrel- to high cone-shaped or subcylindrical with extremely narrow lumen. 5 to 15 long arms, branching irregularly.

Holocrinus meyeri HAGDORN & GŁUCHOWSKI, 1993

(Fig. 4, Pl. 3, 4)

? 1847 – Säulenglied – V.MEYER: 274, Taf. 32, Fig. 19
V 1865 – *Entrochus dubius* BEYRICH – ECK: 88 [partim]
V 1876 – *Pentacrinus dubius* – QUENSTEDT: 199, Taf. 97, Fig. 20–22
1909 – an *Isocrinus* - BATHER: 16
V 1977 – *Pentacrinus* - GŁUCHOWSKI: 71, Fig. 1 f
V 1977 – *Isocrinus* – GŁUCHOWSKI: 71, Fig. 1 i
V 1977 – *Balanocrinus* – GŁUCHOWSKI: 73, Fig. 1 l
V 1986 – *Holocrinus doreckae* HAGDORN, 1983 - GŁUCHOWSKI & BOCZAROWSKI: 192, Pl. 2, Figs. 1–4, 7
V 1986 – *Isocrinus* cf. *dubius* (GOLDFUSS, 1831) GŁUCHOWSKI & BOCZAROWSKI: 191 [partim], Pl. 2, Figs. 6 a, b
V 1986 – *Holocrinus* cf. *doreckae* – HAGDORN: 717, Taf. 4, Fig. 6–8
V 1986 – *Isocrinus*? cf. *dubius* (GOLDFUSS, 1831) HAGDORN: 717, Taf. 4, Fig. 9, 10
V * 1993 – *Holocrinus meyeri* n. sp. – HAGDORN & GŁUCHOWSKI: 171, 174, Fig. 10: 6; 12:1
V 1993 – "*Isocrinus*" *assmanni* n. sp. – HAGDORN & GŁUCHOWSKI: 171, 175, Fig. 10: 7; 12: 2

Types: Holotype is the nodal from the *Diplopora* Dolomite of Piekary Śląskie figured in HAGDORN & GŁUCHOWSKI(1993), Fig. 12, 1. GIUS-7-59/6c (Pl. 3 a). Paratypes are the sclerites from the same locality (Pl. 3, 4).

Diagnosis: A large *Holocrinus* with pentalobate to circular columnals. Nodals with 5 moderately large elliptical cirrus scars. Cirri directed outward and slightly upward. Proximal columnals with marginal triangles in the radii and epifacet; tubuli around petal floors. Cup high cone-shaped to subcylindrical.

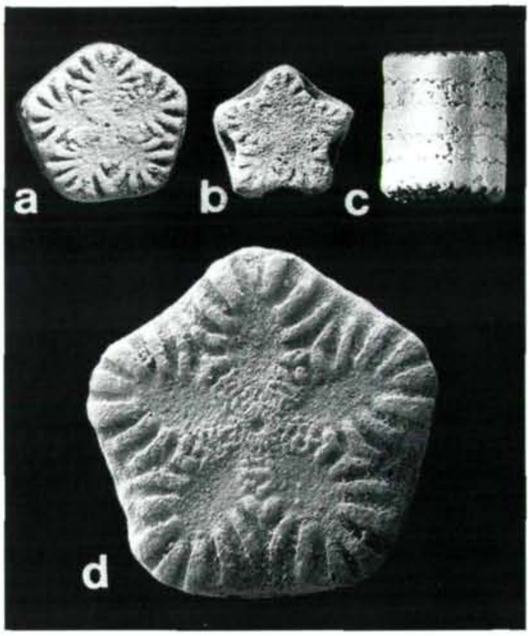

Fig. 4: *Holocrinus meyeri* HAGDORN & GŁUCHOWSKI, 1993, columnals. *Diplopora* Dolomite, St. Hyacinth's fountain, Beuthen. Quenstedt collection, **a–c** originals of QUENSTEDT, 1876, Taf. 97, Fig. 20–22 (x 4), **d** Proximal internodal IGPT 1623/6 (x 10).

Derivation of the name: In honour of Hermann von Meyer (1801–1869), the first worker on Upper Silesian Muschelkalk fossils.

Stratigraphical and geographical range: Middle Triassic. Upper Silesia: Lower and Middle Muschelkalk (Karchowice Beds and *Diplopora* Dolomite), Pelsonian (upper part of *decurtata* zone) to Lower Illyrian (assemblage zone with *Judicarites* and *Neoschizodus orbicularis*) = *silesiacus* zone.

Material: Piekary Śląskie: 498 internodals, 72 nodals, 13 pluricolumnals, 5 of these with a nodal, 463 cirrals, 4 basals, 5 radials, 505 brachials (GIUS-7-59/6, 8). 15 internodals, 2 nodals, 6 brachials (MHI 1166/1). St. Hyacinth's well, Beuthen: 1 nodal, 2 pluricolumnals (Quenstedt's originals) and further columnals (BGR, IGPT 1623/6, MB.E.1425.1-94, MB.E.1426, MB.E.1427.1-29). Blachówka quarry (S Tarnowskie Góry) and Kamyce (E' Piekary Śląskie): more than 50 columnals and pluricolumnals (GIUS). Karchowice Beds of western Upper Silesia: More than 150 columnals and pluricolumnals (GIUS-7-59/43, 513; MHI 1263/2, 1264/1, 1265/1).

Description: Stem – In the proximal stem columnals are pentagonal to pentalobate. Towards the distal stem, internodals become subcircular to circular. Due to cirrus scars, the upper facet of adult nodals from the dististele is subpentagonal to subpentalobate, while the lower facet is subcircular to subpentagonal. The few pluricolumnals with nodals indicate that nodals are moderately wider and higher than adjacent internodals; this is especially true in the proxistele. Internodals measure 1.3–6.3 mm; their height index is between 12 (large proximal internodals) and 107 (juvenile internodals). In the Karchowice Beds of western Upper Silesia, internodals of up to 7.7 mm have been found. The latera of internodals are straight in the distal stem and convex with epifacet in the proximal stem. Nodals measure 1.8–6.9 mm and have height indices between 29 (adult proximal nodals) and 88 (juvenile distal nodals).

Articular facets are usually symplectical. Distal columnals have long marginal culmina which may be wedge-shaped. Secondary or bifurcating culmina occur in large columnals. Radial culmina may be arranged in shape of a Y or a V. Granulated radial bands extending from a raised granulated perilumen are grading into a radial culmen or ending in the open angle between 2 culmina. The petal floors are pyriform to wide lanceolate.

Pentalobate columnals from the proxistele generally have shorter crenulae arranged in a typically isocrinid pattern; their radial bands may be very short and grade into regular adradial crenulae. Radial triangles and radial spaces regularly occur in very low columnals. These have an epifacet distinctly separated from the articulum. Petal floors are lanceolate to pyriform. The lumen is circular and extremely narrow. Tubuli around the petal floors may occur in the most proximal columnals. Stem pores (intercolumnar fossulae) have also been observed.

In larger nodals the crenulation pattern of lower and upper facets differs depending on the outline produced by the cirrus scars. In 3 medium sized distal nodals (diameter 3.8, 4.9 and 5.1 mm) the lumen on the lower facet is sealed. The largest of these nodals shows faint marginal crenulation and no radial bands. This pattern is interpreted as a cryptosymplexy.

Nodals have 5 moderately sized cirrus scars the height of which may reach the columnal height in the very proximal stem. The ratio of cirrus scar width to nodal diameter is 35–40; the ratio of cirrus scar height to nodal height varies between 38 in juvenile nodals and 100 in adult proximal nodals, mostly it is 50–60.

The position of the cirrus scars is closer to the upper than to the lower edge of the nodal. In nodals with height indices less than 45, the cirrus scars extend to the supranodal thus causing the more pentalobate outline of the upper nodal face and very short and shallow cupules on one adjacent supranodal. The deeply impressed cirrus scars are elliptical and may have a weak rim or lip at their lower margin. Their transverse ridge may be inflated on both sides of the oval or round lumen. The cirrus scar articulum is directed outwards and slightly upwards.

Due to the high disarticulation degree, the number of internodals per noditaxis is unknown. The material from the Karchowice beds includes pluricolumnals with up to 6 internodals (GIUS-7-513). The internodal/nodal relations of 6.9 to 1 in the Piekary Śląskie material indicates noditaxes similar to those of *Holocrinus dubius* (normally 7).

Cirrals – Proximal cirrals (elliptical outline) are low (height index less than 50) and have inflated latera. Towards the distal end the cirri become higher (height index more than 110) and cylindrical with straight latera. Proximal cirrals have slightly curved articular faces with transverse ridge (synarthrial articulation). Among distal cirrals the transverse ridge on the proximal facet protrudes fitting with an embayment on the distal facet of the neighbouring cirral. Thus the sutures between distal cirrals are oblique to the cirrus axis. Articular facets of distal cirrals are also synarthrial. Claw-shaped distal cirrals have not been found.

Crown – Isolated holocrinid cup elements and brachials in the Piekary Śląskie material most probably belong to *H. meyeri*, which is the more abundant holocrinid in the sample. However, it cannot be excluded that ossicles of *Eckicrinus* or *Silesiacrinus* are mixed up with *H. meyeri* in the following description.

Cup – There are no complete cups known. The isolated basals and radials suggest a high cone-shaped to almost cylindrical cup with its greatest width slightly above the basal/radial suture. The length of the cup probably exceeded its diameter 2.5 to 3.0 times. The body cavity was extremely narrow, only slightly widening towards the radial facets. The area of arm articulation (circle of the radial facets) was distinctly less in diameter than the maximum radial diameter. The sutures between the basals are not depressed, those between radials are weakly depressed towards the radial facets.

IB – No material.

B – 4 long, compact basals with dorsal side widening slightly towards the radials (Pl. 3 a). The basals are up to 2.4 times longer than wide. Dorsal side rounded, smooth. Interbasal facets zygosynostosial, smooth, forming an angle of 72 resp. 68°. Distinct groove along ventral side. Infrabasal/basal and basal/radial facets on both sides of interradial ridge pyriform zygosynostosial. In dorsal view, angle between basal/radial sutures 115°. Nerve canal paired, running close to the ventral groove and reaching the surface at basal/-radial facet on both sides of interradial ridge.

R – 5 moderately long radials (between 1.13 and 1.68 times longer than wide, on average 1.46) with dorsal side slightly narrowing towards the radial facet (Pl. 3 b). Dorsal sides rounded, smooth. Interradial facets zygosynostosial, vermiculated, forming an angle of 70°. Groove along ventral side. Radial/basal facets synostosial. Radial facet very small, directed upwards, pyriform in outline, straight muscular. Ventral groove deep, transverse ridge distinct, divided by paired nerve canal. Aboral ligament pit excavated, directed weakly outwards, forming a lip on dorsal side.

IBr – Because complete *Holocrinus* crowns indicate that the number of primibrachials before the first arm branching at an axillary may be 1, 2 or even more, the distinction of these ossicles is almost impossible, especially if the articulation facets are poorly preserved. They may be easily distinguished from secundibrachials, because they lack a pinnular articulation facet and have a rectangular or trapezoidal outline. The material comprises 24 primibrachials 1.3 to 2.5 mm long and 2.0 to 3.4 mm wide (Pl. 3 c). The dorsal side in outline is rectangular to trapezoid with the wider facet on the distal end. Dorsal side slightly convex, along longitudinal axis concave, smooth or delicately vermiculated. Ventral side with adoral groove widening distally. Interbrachial facets synostosial. Proximal facet straight muscular with adoral muscle fields in an angle to transverse ridge and aboral ligament pit; muscle fields may be indistinct. Distal facet synostosial with deep ligament pit which may be bipartite by a distinct aboral/adoral median ridge indicating synarthrial articulation; the dorsal margin may be crenulated with crenulate suture visible in dorsal aspect (syzygial articulation). Nerve canal paired or fused uniaxial.

Axillary – Most axillaries are primaxillaries. However, secondary arm branching as observed in several complete *Holocrinus* crowns cannot be excluded. The material comprises 40 axillaries measuring 1.5 to 2.8 mm in length and 1.9 to 4.4 mm in width (Pl. 3 d, e); the larger the ossicle, the greater its relative width. The smooth or slightly vermiculated dorsal side is convex, its outline pentagonal with lateral sides always longer than in encrinid axillaries; lateral facets have not been observed. The ventral side shows a distinct adoral groove and a transverse ridge produced by the margins of the adoral muscle fields at the distal facets. The proximal facet normally is synostosial, often with its dorsal margin crenulated. In some cases the paired or fused nerve canal is opening on a distinct aboral/adoral median ridge dividing the ligament pit in two parts (synarthrial articulation). One axillary shows a straight muscular proximal facet with adoral muscle fields visible from ventral side. The distal facets including an angle of 90 to 100° are always muscular with very deep aboral pit and large adoral muscle fields. Normally the 2 facets are equally sized, however, one of them may also be wider (Pl. 3 e).

Secundibrachials – Brachials may have a smooth or a delicately vermiculated dorsal surface.

The first secundibrachials (IIBr1, 22 specimens; Pl. 3 g) with slightly convex dorsal side of rhomboidal outline and with a shallow ventral groove has an oblique muscular proximal facet and a synostosial distal facet with distinct crenulation along the dorsal margin. The nerve canal normally is fused uniaxial, more rarely it is paired. A cirrus scar is lacking.

The IIBr1 (Pl. 3 f) forms a syzygial pair with the IIBr2, the dorsal side of which has also trapezoid outline (22 specimens up to 3.5 mm long and 3.2 mm wide). The ventral groove is very shallow or even lacking, proximal facets are syzygial with crenulated dorsal margin, and distal facets oblique muscular. The elliptical pinnular articulation facet with fulcral ridge is situated distally close to the ventral side on the longer latera and directed upwards and slightly outwards.

Among the more distal brachials, most specimens (222) have one syzygial and one oblique muscular articulation facet. 46 brachials have 2 syzygial or synostosial facets and 106 have 2 oblique muscular faces. The distal brachials have strongly convex dorsal sides with trapezoidal to wedge-shaped outline. Synostosial facets may have deep ligament pits and an opening of the nerve canal lying raised on an aboral/adoral ridge thus forming an articulation pattern similar to a synarthry. Typical syzygial pairs are convex/concave and have long, slightly vermiculating crenulae. Muscular facets have strong oblique fulcral ridges and mostly deep aboral ligament pits. Their adoral muscle fields differ in size and shape. The pinnule sockets are situated at the distal facet on the longer latera. The ventral groove may be very deeply excavated. The nerve canal is fused or, more often uniaxial.

Pinnulars unequivocally belonging to *Holocrinus* have not been found.

Discussion: Since columnals of *Holocrinus meyeri* from Beuthen have been figured by QUENSTEDT (1876), they were attributed to *H. dubius* by most authors. Only when *H. doreckae* from the Upper Muschelkalk of SW-Germany was described, the Beuthen holocrinid was also compared with this species (HAGDORN, 1985; GŁUCHOWSKI & BOCZAROWSKI, 1986). Against the decision to keep those pentalobate columnals with isocrinid articulum, radial triangles and tubuli as a separate species "*Isocrinus*" *assmanni*, we are now convinced that these columnals represent the most proximal stem elements of *H. meyeri* (comp. HAGDORN & GŁUCHOWSKI, 1993).

Obviously, the somewhat older *H. dubius* (Pelsonian) and the younger *H. doreckae* (Lower Ladinian) are the next relatives of *H. meyeri*. *H. dubius* usually does not reach the size of *H. meyeri*. Only the latest populations of *H. dubius* in the basal Karchowice beds of Strzelce Opolskie/Großstrehlitz comprise columnals as large as those of *H. meyeri* (MHI 1264/1). The most significant diagnostic characters of *H. meyeri* in the distal stem are its subpentalobate to circular columnals with rounded interradii versus the pentalobate to pentagonal (basaltiform) columnals of *H. dubius* with distinct interradial edges. Additionally the cirrus scars of *H. dubius* never extend to the supranodal. Proximal columnals with tubuli and an epifacet setting off sharply from the articulum have not been found among *H. dubius*. The cup of *H. dubius* may also be subcylindrical. However, length/width relations of the holocrinid cup seem to be rather variable. *H. doreckae* is smaller than *H. meyeri* and has circular to subcircular columnals. Its cirrus scars are wider and higher than those of *H. meyeri*.

Cup and arm sclerites are very similar to those of other holocrinid species. At present a clear distinction of holocrinid crown elements down to species level is not yet possible. This is especially true because the holocrinid cup is so extremely variable in shape and relative size relations of its elements.

Among the Muschelkalk holocrinids, from the earliest (Lower Anisian) *H. acutangulus* to *H. dubius* and *H. meyeri*, the size gradually increased. The simultaneous development of more rounded interradii extends to the Upper Muschelkalk *H. doreckae*. However, the latter is not a member of a gradual lineage which developed in the Germanic Basin, but was a short term immigrant from outside the basin, probably from the Westmediterranean Tethys (HAGDORN 1983, HAGDORN & SIMON 1993).

Genus *Eckicrinus* HAGDORN & GŁUCHOWSKI, 1993

Diagnosis: Columnals very low, circular to subcircular, cylindrical. Proximal columnals with marginal crenulae and granulated radial bands, petal floors pyriform. Distal columnals with long marginal crenulae, petal floors very small. Bifurcation and intercalation of extra culmina towards the periphery. Nodals not wider than internodals, only slightly higher. Up to 5 round cirrus scars, fulcral ridge indistinct or lacking; enlarged cirri with multiradiate articulation. Noditaxis very short.
Type species: *Encrinus*? *radiatus* SCHAUROTH, 1859.
Derivation of name: In honour of Heinrich Eck (1837–1925), the pioneer of Upper Silesian Muschelkalk stratigraphy.
Range: Middle Triassic (Pelsonian to Lower Illyrian); Europe (Alps, Poland), Asia (Amur Basin).
Discussion: The petaloid articular facet pattern with symplectical lower nodal facets suggests that *Eckicrinus* has to be attached to the holocrinids. From all other holocrinid genera it differs with its extremely low columnals and its round cirrus scars. These are usually very small but may extend to both infranodals and supranodals and then show a multiradiate articulation pattern. As long as the cup of *Eckicrinus* is unknown, assignment to the Holocrinidae is uncertain. Striking similarity with the isocrinids *Laevigatocrinus insignis* (TOULA) (Carnian, Tethys) and *Austinocrinus* (Upper Cretaceous) both in articulation facet pattern and in size and morphology of cirrus scars is regarded as a convergency depending on the low cylindrical columnals. Being isocrinids, these taxa have cryptosymplectical or synostosial lower nodal articulations. The circular cirrus scars of *Austinocrinus* may also cover several columnals and may have multiradiate crenellae additionally to a transverse ridge indicating synarthrial articulation (KLIKUSHIN, 1985).

Because of its articulation facet pattern, *E. radiatus* has been included by KLIKUSHIN (1979) into his isocrinid genus *Laevigatocrinus*. From this genus, however, it may be easily distinguished by its small, circular cirrus scars, low height index and symplectical lower nodal facet.

Eckicrinus radiatus (SCHAUROTH, 1859)
(Fig. 5, 6, Pl. 5)

? 1846 – *Pentacrinites*? *subteres* MÜNSTER – CATULLO: 243, Taf. 3, Fig. 4 a, b

non 1849 – *Encrinus* sp. – v. MEYER: 264, 269, Taf. 31, Fig. 17–19 [=*Dadocrinus*], Taf. 32, Fig. 12 [=*Silesiacrinus silesiacus*]

* 1859 – *Encrinus*? *radiatus* n. sp. – SCHAUROTH: 288, Taf. 1, Fig. 4 a–c

non 1861 – *Encrinus radiatus* SCHAUROTH var. *verrucosus* GÜMBEL – GÜMBEL: 220 [according to BATHER, 1909: 243 to *Encrinus cancellistriatus*]

1864 – *Encrinus radiatus* SCHAUROTH – v. ALBERTI: 58, 263, 304

1865 – *Encrinus radiatus* SCHAUROTH – SCHAUROTH: 53

1865 – *Entrochus silesiacus* BEYRICH – ECK: 88 [partim]

1868 – *Entrochus silesiacus* BEYRICH – BENECKE: 41, Taf. 4, Fig. 12 a–c

V 1876 – bei den Pentacrinen – QUENSTEDT: 479, Taf. 107, Fig. 67

V 1876 – dünne *Silesiacus*-ähnliche Glieder – QUENSTEDT: 481, Taf. 107, Fig. 83–87

1877 – *Encrinus*? *radiatus* SCHAUROTH – TOULA: 502

1883 – *Encrinus radiatus* SCHAUROTH – BITTNER: 571

1887 – *Encrinus radiatus* SCHAUROTH – ECK: 558

non 1899 – *Austinocrinus radiatus* n. sp. – ANTHOULA: [*Austinocrinus erckerti* (DAMES, 1885)]

1909 – *Balanocrinus radiatus* (SCHAUROTH) – BATHER: 15

1977 – *Balanocrinus* – GŁUCHOWSKI: 73, Fig. 1 m

1979 – *Laevigatocrinus radiatus* (SCHAUROTH) – KLIKUSHIN: 89, Fig. 1

1982 – *Laevigatocrinus radiatus* (SCHAUROTH, 1859) – KLIKUSHIN: 302

1983 – *Encrinus*? *radiatus* SCHAUROTH – HAGDORN: 362, Abb. 5 b

? 1986 – *Laevigatocrinus radiatus* (SCHAUROTH), 1859 – KLIKUSHIN: 103, Taf. 34, Fig. 7

V 1986 – "*Encrinus*"? *radiatus* SCHAUROTH 1859 – HAGDORN: 718, Taf. 4, Fig. 11–14

V 1986 – "*Encrinus*"? *radiatus* SCHAUROTH, 1859 – GŁUCHOWSKI & BOCZAROWSKI: 194, pl. 1, fig. 10

1992 – *Laevigatocrinus radiatus* (SCHAUROTH, 1859) – KLIKUSHIN: 90

1993 – *Eckicrinus radiatus* (SCHAUROTH, 1859) - HAGDORN & GŁUCHOWSKI: 170, 174, Fig. 8: 5

Types: The specimens from SCHAUROTH's collection in the Coburg Naturkundemuseum have only recently been located by Dr. E. Mönnig. 3 internodals are labelled in Schauroth's hand as "*Encrinus*? *radiatus* SCHAUR. Trigonellenkalk vom Sasso della Limpia bei Recoaro. No. 2682". The poor quality of Taf. 1, fig. 4, in SCHAUROTH's paper does not allow the identification of one of the specimens as the original. However, among the syntypes the best specimen (NMC 2682-L) is designated as lectotype. Unfortunately, none of the Coburg specimens is a nodal.

Diagnosis: As for genus.

Type locality: Isolated blocks from Calcare di Recoaro at Sasso della Limpia near Mte. Spitz, 1000 m south of Recoaro, Vicentinian Alps.

Type stratum: Calcare di Recoaro (Brachiopodenkalk), Anisian, Pelsonian.

Geographical and stratigraphical range: Italy, Southern Alps (Recoaro; Prags and Olang Dolomites, Cadore, Mte. Rite), Balaton, Pelsonian. Poland, Upper Silesia: Uppermost Gogolin beds (basal Pelsonian, *decurtata* zone) to *Diplopora* Dolomite (Lower Illyrian, assemblage zone with *Judicarites* and *Neoschizodus orbicularis*); Holy Cross Mts., *Lima striata* beds (Pelsonian, *decurtata* zone). Russia, Amur Basin, Siberia (Ladinian) (?).

Material: Calcare di Recoaro, Recoaro: Lectotype (NMC 2682-L) and paralectotypes (NMC 2682-P); several columnals and pluricolumnals (IGPT 1623/7 - 1623/8, 1623/10 - 1623/12), some

50 columnals and brachials (MHI 1266/1). Upper Gogolin Beds, Upper Silesia, Wojkowice 3 columnals (GIUS-7-512). Górażdże Beds, Górażdże : 5 columnals and pluricolumnals (MHI 1257). *Terebratula* beds, Górażdże : 4 columnals (MHI 1163/2). Karchowice beds, several localities in western Upper Silesia: some 130 columnals and pluricolumnals (GIUS-7-43, 5/3, MHI 1263/3, 1264/2, 1267/3). *Diplopora* Dolomite, St. Hyacinth's well, Beuthen: QUENSTEDT's (1876) originals and IGPT 1623/9), further columnals (BGR, MB.E.1418.1-25). *Diplopora* Dolomite, Piekary Śląskie: 18 columnals GIUS 7-59-9, 13; further columnals from Kamyce (GIUS-7-514) and Blachówka quarry (GIUS-7-517). *Lima striata* Beds, Wolica (Holy Cross Mts.): several 100 columnals and brachials (MHI 1164/1).

Description: Stem – Columnals circular, only in the proxistele weakly subcircular, measuring 1.3 to 6.6 mm in diameter. Nodals not wider than internodals, only a little higher than adjacent internodals. Height index of internodals 18 to 25 (juveniles up to 69), of nodals 23 to 27. Latera straight. Noditaxis as measured from a few pluricolumnals with 2 nodals: 3 to 7. Number of nodals versus internodals among 239 columnals like 1 : 3.9).

Articular facets symplectical. Proximal columnals with undividing crenulae with culmina length 8 to 24% of columnal diameter. Granulated radial bands with granules sometimes arranged in two rows, confluent with narrow, less coarsely granulated perilumen. Radial bands may become somewhat wider towards the periphery, grading into a single culmen or in the open angle of 2 marginal culmina. Distal columnals have very long multiradiate culmina which in larger columnals may bi- or trifurcate towards the periphery; further, secondary culmina may be intercalated. The culmina number of columnals wider than 4.5 mm may exceed 60 at the periphery, while being less than 40 around the areolae. Culmina length up to 43% of columnal diameter. Areola very small, pyriform to indistinct lanceolate, 35% to as little as 14% of columnal diameter. Radial bands and perilumen irregularly granulated. Lumen narrow, circular.

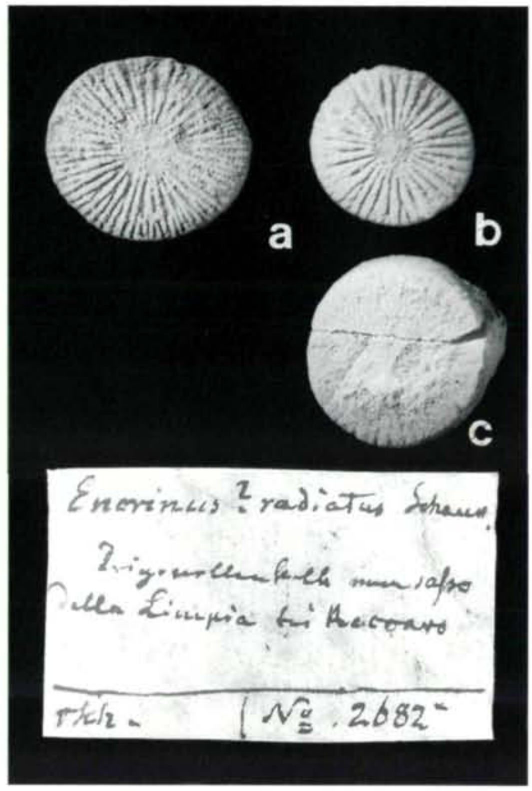

Fig. 5: *Eckicrinus radiatus* (SCHAUROTH, 1859). Trigonellitenkalk (Recoaro Formation), Recoaro, Sasso della Limpia. **a** Lectotype NMC 2682-L; **b**, **c** Paralectotypes NMC 2682-P; (x5).

Nodals with 2 to 5 (mostly 5) very small, deeply depressed circular cirrus scars. Cirrus scar diameter in adult nodals 10 to 15% of nodal diameter. Articulation facet of cirrus scar mostly indistinct, rarely with a faint transverse ridge. Cirrus scars may also protrude with an irregular callus lip overgrowing the proximal cirral. Single cirri may then be extremely enlarged expanding to infra- and supranodals and thus reaching up to 150% of nodal height. The outline of these columnals becomes irregular. Proximal cirrals of enlarged cirri may be overgrown by irregular columnal callus. Cirri normally directed outwards. Enlarged cirri usually restricted to one to three radii, while cirri of the other radii normal-sized; such cirrals have not been identified. Enlarged cirrals which are still attached to the stem by callus overgrowth, are circular, cylindrical or wedge-shaped; articulation facets with long multiradiate crenulae; lumen circular.

Crown: Unknown.

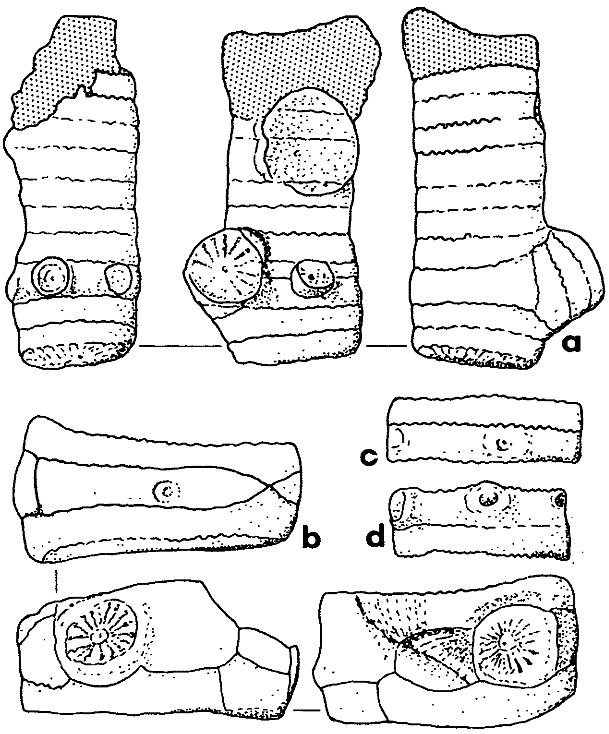

Fig. 6: *Eckicrinus radiatus* (SCHAUROTH, 1859). Calcare di Recoaro, Recoaro, Rovegliana; **a** Pluricolumnal comprising a complete noditaxis, enlarged cirri; MHI 1266/1/1; **b** Irregular pluricolumnal with one enlarged cirrus scar; Orig. QUENSTEDT, 1876, Taf. 107, Fig. 87; **c, d** Pluricolumnals with normal cirrus scars; MHI 1266/1/2, 1266/1/3. Scale 2 mm.

Discussion: Since these very characteristic Muschelkalk crinoid columnals have been described by v. SCHAUROTH (1859), they have often been mixed up with those of *Silesiacrinus silesiacus* which has also very long multiradiate crenulae. Therefore many mentions of *S. silesiacus* have to be referred to *E. radiatus*. *Silesiacrinus*, probably a millericrinid, is clearly different with its wide lumen, lack of cirrus scars and of petaloid pattern on articulation facet. Although he exactly recognized the diagnostic characters of *E. radiatus*, ECK (1865: 88) regarded this taxon as a junior synonym of *Entrochus silesiacus*. It was QUENSTEDT (1876:480) who clearly kept apart two types of columnals among his *E. silesiacus* material from St. Hyacynth's well. Some of them he attributed to the pentacrinids: "feinen kreisrunden Blättchen..., um welche sich die Gelenkleisten etwas büschelig gruppieren. Nahrungskanal außerordentlich fein. Diese mögen daher wohl besser, trotz ihrer Rundung, bei den Pentacriniten ihr Unterkommen finden". Obviously, QUENSTEDT did not know SCHAUROTH's species. The isocrinid character of *E. radiatus* and its strict distinction from *S. silesiacus* was established by BATHER (1909:15), who attributed it to *Balanocrinus*. *Entrochus rotiformis* KOKEN from the (Upper?) Triassic of South China which has also long crenulae and circular cirrus scars, lacks petaloid articular facet pattern and has heigher nodals.

E. radiatus is a characteristic crinoid indicating Pelsonian to lowest Illyrian age. *Silesiacrinus* does not occur in the Pelsonian Calcare di Recoaro or in the *Lima striata* Beds of the Holy Cross Mts. *E. radiatus* seems to be widely dispersed in the Anisian of the Southern Alps, but its exact stratigraphical and geographical range can not be ascertained before the two genera are generally clearly kept apart. *E. radiatus* has not yet been found in the typical Germanic Muschelkalk West of Upper Silesia.

In Piekary Śląskie, *E. radiatus* is a rather rare faunal element. This is also true for the Karchowice Beds of Western Upper Silesia, while it is the dominating crinoid in the *Lima striata* Beds of the Holy Cross Mts.

Order Millericrinida SIEVERTS-DORECK, 1952
Family indet.

Genus *Silesiacrinus* HAGDORN & GŁUCHOWSKI, 1993

Diagnosis: Columnals low, circular, with straight to convex latera. Articular facet multiradiate; culmina long, often with delicate longitudinal groove. Granulated radial bands may occur. Areola very narrow or lacking. Axial canal wide, circular or weakly pentalobate, simple or complex with lensoid spatia. Holdfast irregular discoid, consisting of single elements.

Type species: *Entrochus silesiacus* BEYRICH, 1857

Derivation of name: Because of its occurrence in Silesia.

Range: Middle Triassic (uppermost Pelsonian, lowest Illyrian); Europe (Alps, Poland, Hungary).
Discussion: The diagnostic characters are indicative for millericrinids. Among the crinoid material from the *Diplopora* Dolomite and from the Karchowice Beds, however, there are no cup elements similar to any of the Jurassic or younger millericrinid genera. Therefore, these Muschelkalk millericrinid columnals are regarded to represent a new genus.

Silesiacrinus silesiacus (BEYRICH, 1857)
(Pl. 6)

- ? 1834 – *Apiocrinus mespiliformis* - KLÖDEN: 324
- V 1835 – Entrochiten aus dem Schlesischen Muschelkalk, vielleicht zum *E. Schlottheimii* gehörig – QUENSTEDT: 227, Taf. 4, Fig. 3
- ? 1837 – *Apiocrinites rotundus* MIL. – PUSCH: 7
- 1849 – *Encrinus liliiformis* – V. MEYER: 264, Taf. 32, Fig. 9, 12
- * 1857 – *Entrochus silesiacus* n. sp. – BEYRICH: 46
- 1862 – *Entrochus silesiacus* BEYR. – ECK: 298, 300
- 1864 – *Entrochus silesiacus* V. QUENSTEDT: V. ALBERTI: 59 [partim]
- 1865 – *Entrochus silesiacus* BEYR. – ECK: 88 [partim]
- non 1868 – *Entrochus silesiacus* BEYRICH – BENECKE: 41, Taf. 4, Fig. 12a–c [zu *Eckicrinus radiatus*]
- 1870 – *Entrochus silesiacus* BEYR. – ROEMER: 140, Taf. 11, Fig. 9, 10
- 1872 – *Entrochus silesiacus* BEYR. – ECK: 83, 122, 172
- V 1876 – *Encrinus silesiacus* BEYR. – QUENSTEDT: 479, Taf. 107, Fig. 62–66, non Fig. 67
- V non 1876 – *Encrinus* cf. *silesiacus* BEYR. – QUENSTEDT: 480, Taf. 107, Fig. 67, 83–87 [zu *Eckicrinus radiatus*]; S. 486, Taf. 107, Fig. 98–102 [zu "*Encrinus*" *granulosus*]
- ? 1877 – *Entrochus silesiacus* BEYR. – TOULA: 501
- ? 1877 – *Entrochus* cf. *silesiacus* BEYR. – TOULA: 502, Taf. 4, Fig. 13
- ? 1885 – *Encrinus* cf. *silesiacus* BEYRICH – Blanckenhorn: 209, 249
- 1885 – *Entrochus silesiacus* BEYR. – QUENSTEDT: 935
- 1887 – *Entrochus silesiacus* BEYR. (wahrscheinlich *Encrinus*) – Eck: 557
- ? 1895 – *Entrochus silesiacus* BEYR. – PHILIPPI: 717
- 1900 – *Encrinus silesiacus* QU. – KOKEN: 213
- 1903 – *Entrochus silesiacus* – Langenhan: 8, Taf. 4, Fig. 5
- ? 1906 – *Encrinus* cf. *granulosus* WISSM. sp. – AHLBURG: 83, Taf. 3, Fig. 3
- 1906 – *Entrochus silesiacus* BEYR. – AHLBURG: 51, 83, 129
- ? 1909 – *Entrochus silesiacus* – BATHER: 11, 12, 14, 237, 256, Taf. 1, Fig. 24–25
- [1911] – *Encrinus silesiacus* BEYR. - LANGENHAN: Taf. 3, Fig. 11 [partim]
- 1913 – *Encrinus silesiacus* BEYR. – MICHAEL: 321, 324, 326 [partim]
- 1926 – *Entrochus silesiacus* BEYR. – ASSMANN: 515
- 1928 – *Entrochus silesiacus* QU. – SCHMIDT: 127, Fig. 244
- 1934 – *Entrochus silesiacus* QUENST. – SCHNETZER: 6, 145
- 1937 – *Entrochus silesiacus* BEYR. – ASSMANN: 19, 113
- 1944 – *Entrochus silesiacus* BEYR. – ASSMANN: 44, 45, 54, 56, 64, 71
- 1965 – *Entrochus silesiacus* BEYRICH – LINCK: 33, 34
- ? 1967 – *Entrochus silesiacus* BEYRICH – KRISTAN-TOLLMANN & TOLLMANN: 5, 9, 22, 26, 27, Taf. 1, Fig. 8, 9, Taf. 8, 14, 15, 17, Taf. 9, Fig. 7–12

? 1970 – *Entrochus silesiacus* BEYR. – BECHSTÄDT & BRANDNER: 47, 48, 56
? 1972 – *Entrochus silesiacus* QUENST. – SUMMESBERGER & WAGNER: 531
1974 – *"Entrochus" silesiacus* QUENST. – KOZUR: 14, 23
V 1977 – *Entrochus silesiacus* BEYRICH – GŁUCHOWSKI: 72, Fig. 1j
1979 – *Entrochus silesiacus* BEYRICH, 1857 – SENKOWICZOWA & KOTAŃSKI: 129, Pl. 35, fig. 4
1985 – *Entrochus silesiacus* - HAGDORN: 248, 250
V 1986 – *Entrochus silesiacus* BEYRICH – GŁUCHOWSKI & BOCZAROWSKI: 194, pl. 2, fig. 5
V 1986 – *Entrochus silesiacus* BEYR. – HAGDORN: 718
1987 – *Encrinus silesiacus* BEYRICH – Klikushin: 325, 326
V 1993 – *Silesiacrinus silesiacus* (BEYRICH) – HAGDORN & GŁUCHOWSKI: 171, 175, Fig. 10: 1

Types: A pluricolumnal of 9 elements on a slab of yellowish, dolomitic, oolitic limestone from Kamin, Oberschlesien, housed in the Paläontologisches Museum Berlin (MB. E. 713) has been identified with the original of QUENSTEDT's (1835) "Entrochiten aus dem Schlesischen Muschelkalk" figured on Taf. 4, Fig. 3. BEYRICH (1857: 46) referred to this specimen when he established the new species *Entrochus silesiacus*. Therefore it has to be treated as the holotype by designation herewith.

Diagnosis: As for genus.

Type locality: Kamin, Oberschlesien; now Kamień Śląski.

Type stratum: Uppermost Karchowice Beds or lower part of *Diplopora* Dolomite (Anisian, uppermost Pelsonian or lowest Illyrian)

Geographical and stratigraphical range: Poland, Upper Silesia, Kraków Upland: Upper part of Karchowice Beds and lower part of *Diplopora* Dolomite (Anisian, uppermost Pelsonian to lowest Illyrian, upper part of *decurtata* zone to assemblage zone with *Judicarites* and *Neoschizodus orbicularis*, *silesiacus* zone); Holy Cross. Mts., Middle Muschelkalk; Tatra Mts.: Anisian. Germany, Brandenburg, Rüdersdorf(?): Schaumkalk (assemblage zone with *Judicarites* and *Neoschizodus orbicularis*; *silesiacus* zone). Austria, Northern Kalkalpen, Karwendel, Salzburg (Saalfelden, top of the Steinalmkalk, lower Illyrian), Radstädter Tauern, Steiermark, Leithagebirge: Anisian. Italy, Grigna, Giudicaria: Anisian, Pelsonian. Hungary, Bakony: "Lower Muschelkalk age"; Mecsek Mountains.

Material: The holotype and further columnals and pluricolumnals from Kamin (MB.E.1423.1-142). Some 150 specimens and 2 holdfasts from the Karchowice Beds and the *Diplopora* Dolomite of several localities in western Upper Silesia (GIUS-7-43, 513, MB.E.1420, MB.E.1422.1-2, MHI 1262/1, 1263/1, 1265/4, 1267/4). Some 300 columnals and pluricolumnals from the *Diplopora* Dolomite of St. Hyacinth's well, Beuthen (BGR, IGPT 1766/1 - 1766/6, MB.E.1419, MB.E.1421.1-3, MB.E.1424.1-84). 231 columnals and pluricolumnals from the *Diplopora* Dolomite of Piekary Śląskie (GIUS-7-59/7, MHI 1166/6). 2 columnals from the Middle Muschelkalk of Kraków Upland, Stare Gliny (MHI 1258) and 4 pluricolumnals from the Chrzanów region (GIUS-7-58). A few columnals from the Middle Muschelkalk of Witulin, Holy Cross Mts. (MHI 1259). A sectioned slab with stem elements from the Tatra Mts. (MHI 1260). One pluricolumnal from the Steinalmkalk at Saalfelden (Austria) (MHI 1261).

Description: Stem – Columnals circular, cylindrical, measuring 2.5 to 13.5 mm. Proximal columnals low, with straight latera and almost undepressed intercolumnar sutures; height index 17-33, 37-60 in juveniles. Distal columnals extremely low, with epifacet and deepened sutures; height index 11-20. Nodals indistinct from internodals, neither higher nor wider than internodals.

Articular facets multiradiate with long culmina which may bear a delicate longitudinal groove. Culmina may originate at the lumen or at a narrow areola. With lateral growth of columnal, the number of culmina increases by bifurcation and by intercalation of separate culmina. The number of culmina at the periphery of large columnals may exceed 60, while being less than 30 at the areola. Culmina length is up to 43% of columnal diameter. Due to the wide crenularium, a smooth areola is very narrow or may even be lacking. A narrow, granulated perilumen with granulated radial bands has been observed among a few proximal (?) columnals. The lumen is wide (up to 18% of columnal diameter), circular or weakly pentalobate in proximal columnals. In the proxistele (?) the axial canal is complex with lensoid spatia. Internal moulds of pluricolumnal axial canals, which are occasionally found, look like screws ("Schraubensteine"). The spatium may reach up to 46% of the columnal diameter. Presumably among most proximal columnals, it may show a pattern of radial ridge pairs with narrow radial grooves inbetween, confluent with the lumen, and with rounded interradial pits. Among other specimens, the spatium is delicately crenulated.

Holdfast – In a couple of holdfasts (Pl. 6 t), the articulated stem ends with very low columnals with irregular outline, formed by callus expansion. Towards the distal end with the attachment area, the intercolumnar suture lines become gradually indistinct. Weathering and damage at one end of the specimen reveals the multiradiate articulation pattern throughout the composite holdfast. On the unweathered surface, the external root callus does not show sutures.

Crown – Completely unknown. There are neither articulated nor isolated remains which could be attributed to *Silesiacrinus* unequivocally. A full description has to be postponed until more complete material will be available. However, the radials described below might belong to *Silesiacrinus*.

Discussion: The distinction of *Silesiacrinus silesiacus* from *Eckicrinus radiatus* has been demonstrated by QUENSTEDT (1876) and, more forcefully, by BATHER (1909). Nevertheless, the two crinoids are still being mixed up. Therefore many notations of *Silesiacrinus* have to be referred to *Eckicrinus*. Major reasons for this treatment may have been the attribution of *Silesiacrinus silesiacus* to the parataxonomic genus *Entrochus* and the lack of good illustrations.

Silesiacrinus is regarded to be an early millericrinid. This is suggested by the following characters. (1) columnals share similar general shape and dimensions, articulation facet pattern and wide axial canal with Jurassic millericrinids, e. g. *Millericrinus, Pomatocrinus, Liliocrinus*. (2) among several millericrinids the axial canal in the proxistele may have lensoid spatia, occasionally with radial grooves (comp. QUENSTEDT, 1876, Taf. 102, Fig. 12, 18, Taf. 103, Fig. 71, Taf. 104, Fig. 38, 50, 51). Among the Articulata, this character is found only in millericrinids and never among encrinids. (3) the millericrinid root consists of single, laterally enlarged, low columnals with extensively branching multiradiate facet pattern, covered by irregular callus crusts (KLEINERT 1969). Such holdfasts also occur among undescribed Norian millericrinids from Hallstatt Limestones of the Steinbergkogel near Hallstatt, Austria (MHI). KRISTAN-TOLLMANN & TOLLMANN (1967: 23) mention branching roots ("verzweigte Wurzeln") among *Silesiacrinus silesiacus* from the Alpine Muschelkalk, but did not illustrate any. The encrinid holdfast normally does not incorporate longer parts of the distal stem but rather consists of a single, enlarged distal element (discoid holdfast, encrusting holdfast, comp. HAGDORN 1978). (4) low height indices of distal columnals are quite common among millericrinids. Increasing lateral growth of columnals towards the dististele is required for large millericrinids which need a thick, rigid stem for erecting them high above the seafloor. In these distal columnals, the axial canal remains "juvenile" and narrow, while in the adult proxistele the axial canal is more spaceous.

Silesiacrinus probably was less advanced than Jurassic millericrinids. Fused proximalia or other specialized proximal columnals have not been found. Its cup was presumably similar to a dadocrinid or encrinid cup and would not be easily identified with *Silesiacrinus* unless it would be preserved together with the stem.

After all, when discussing incompletely known crinoids in respect to their stem characters, one should not forget that among the stem, convergencies caused by functional constraints may lead to

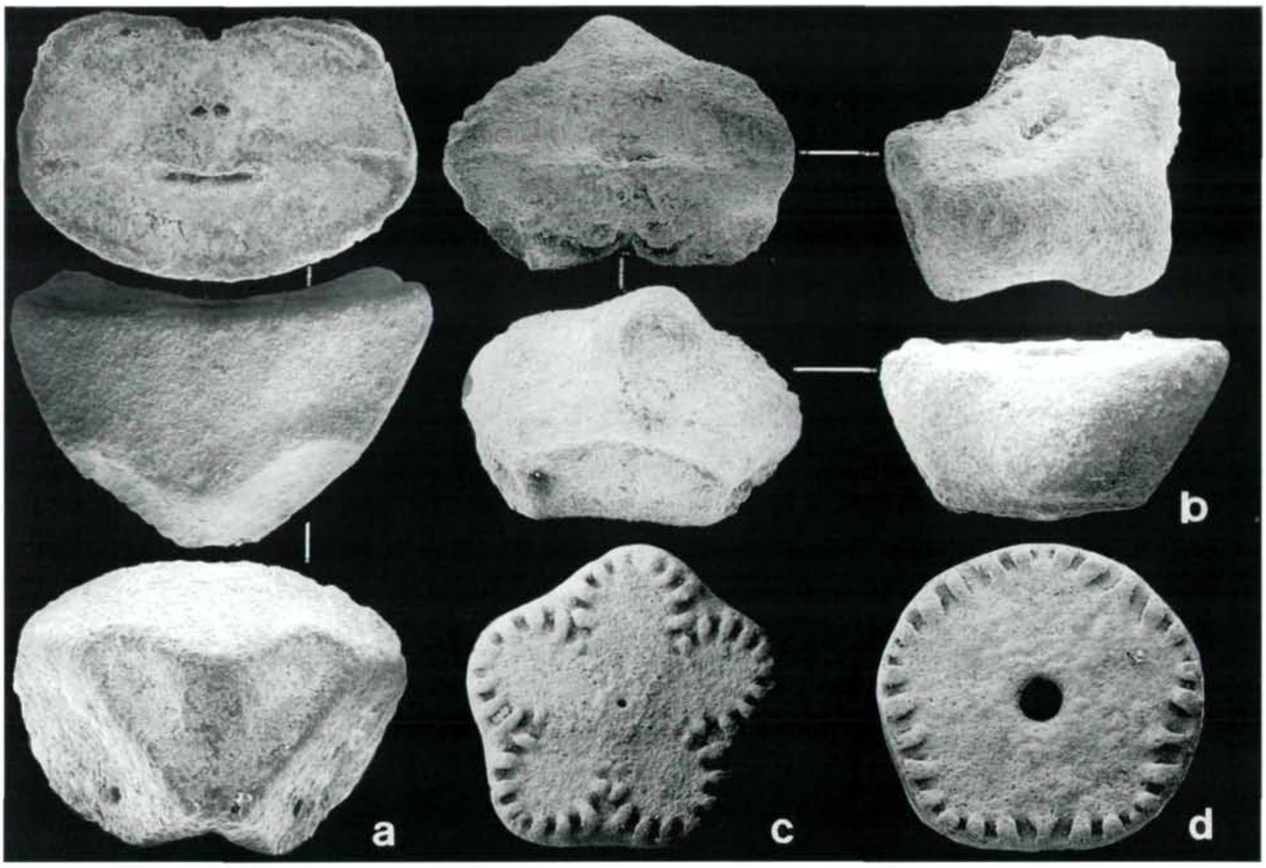

Fig. 7: Indetermined crinoid sclerites. *Diplopora* Dolomite, Piekary Śląskie.
a Radial; radial face, aboral side, radial/basal faces (top to bottom); GIUS-7-59/35 (x15). **b** Radial; radial face (top left), radial/basal faces (bottom left), radial face from obliquely aboral (top right), aboral side (bottom right); GIUS-7-59/36 (x18). **c** Proximal columnal with tubuli and very short crenulae; GIUS-7-59/37 (x11,5). **d** Juvenile columnal with wide lumen and short crenulae; GIUS-7-59/38 (x23).

similar patterns. Thus among palaeozoic crinoids, several types of columnals are similar with *Silesiacrinus* (MOORE & JEFFORDS, 1968; GŁUCHOWSKI, 1993).

Silesiacrinus probably is a descendant of the Lower Anisian *Dadocrinus* which was widely distributed in the Alps, Hungary, the Tatra Mts., the Holy Cross Mts. and in Upper Silesia (Gogolin Beds). *Dadocrinus* is much smaller than *Silesiacrinus*, however, pluricolumnals of a fairly large crinoid, probably a dadocrinid, have been found in the Lower Gogolin Beds of Upper and Lower Silesia. Among dadocrinid columnals, the multiradiate culmina may also be fairly long and bifurcating. *Silesiacrinus* has given rise to Upper Triassic millericrinids, which have not been adequately described yet. *Entrochus multifurcatus* LINCK, 1965, with similar columnal facet pattern is the laterally enlarged distal stem part of *Encrinus liliiformis*, (comp. HAGDORN, 1978).

With its limited stratigraphic range and its wide distribution, *Silesiacrinus* is a good index fossil indicating uppermost Pelsonian to lowest Illyrian. HAGDORN & GŁUCHOWSKI (1993) established the *silesiacus* zone in their crinoid stratigraphy of the Polish Muschelkalk.

Crinoidea indet.
(Fig. 7, 8)

Radial. Type 1 – 3 specimens (Fig. 7 a, 8 a) of a thick radial with almost triangular dorsal side, extremely long basal/radial facets visible in dorsal view, with a basal/radial sutur radially strongly

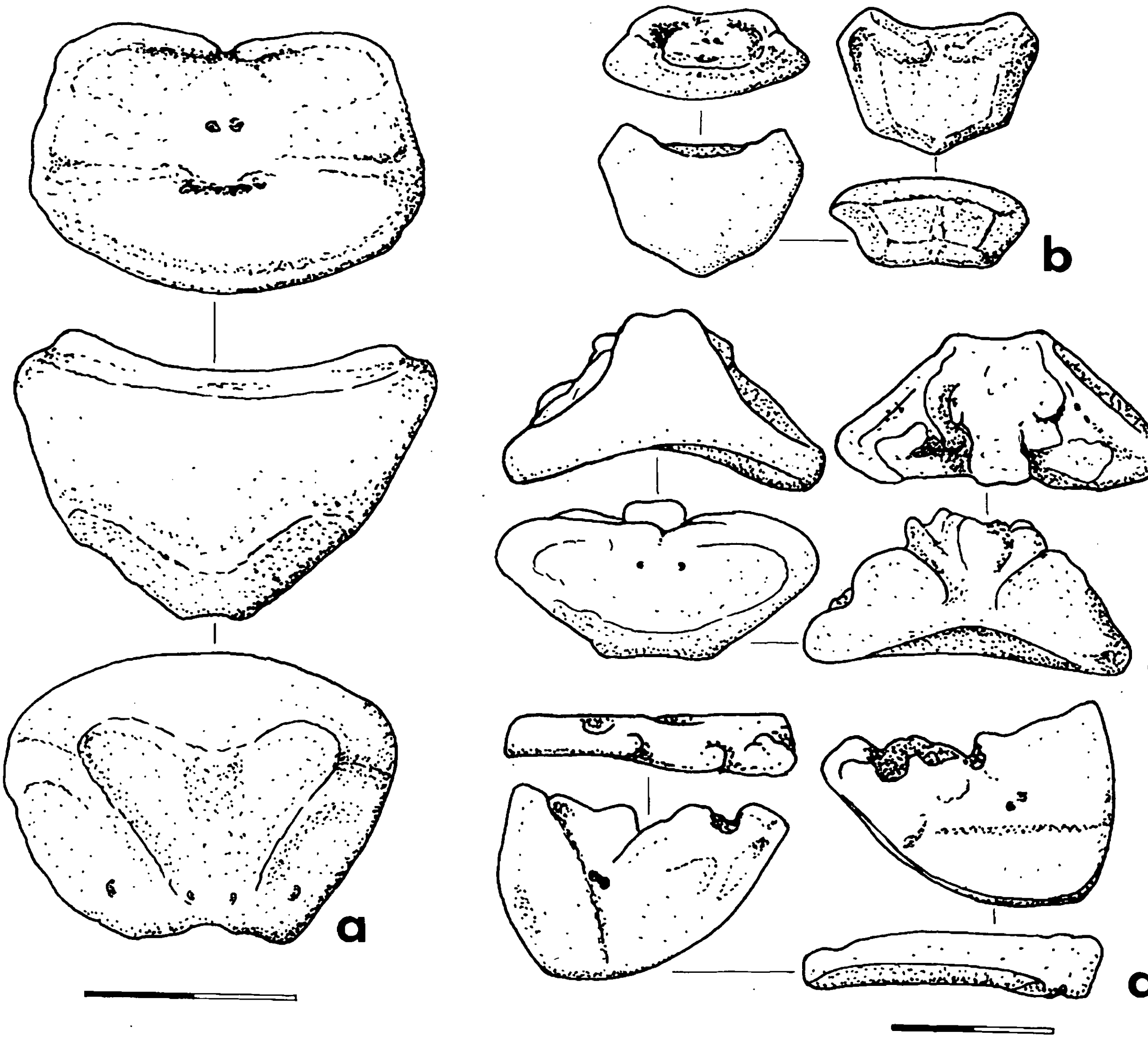

Fig. 8: Indetermined crinoid sclerites.
a Radial; radial facet, aboral side, radial/basal facets (top to bottom); GIUS-7-59/35. **b** Radial; radial facet, dorsal side (left), ventral side, basal facets (right); GIUS-7-59/39. **c** Axillary; dorsal side, proximal synostosis (left), muscular distal facets, ventral side (right); GIUS-7-59/40. **d** Brachial; ventral side (left), dorsal side (right), oblique muscular articulation facets; GIUS-7-59/41. Scale 2 mm.

embayed. Interradial facets synostosial with shallow ligament pits and weak marginal crenulation. Radial facet straight muscular, dorso-ventrally very wide, directed upward, almost even, with small adoral wings for muscular attachment, paired nerve canal.

The cup reconstructed from these radials is low cone-shaped or low bowl-shaped, has a narrow lumen and a strongly pentalobate basal circlet the height of which is about 30% of the whole cup.

Similar cups are found among isocrinids. However, the paired nerve canals rather indicate encrinid affinity. As the proximal stem of this crinoid, due to the shape of the basal circle should be distinctly pentalobate, and as these radials are very small, they probably do not belong to *Eckicrinus* or *Silesiacrinus*.

Radial. Type 2 – 1 very small, thin radial (Fig. 8. b) with heptagonal dorsal side. Basal/radial and interradial facets synostosial. Width of radial facet only half of whole radial width, depressed.

The cup reconstructed from this radial is high bowl-shaped or low cone-shaped with a wide lumen. The proximal arms are distinctly less wide than the radials; thus the tegmen must have been visible in lateral view. Tight closure of the arms as among encrinids was impossible. Similar cups are found among Hyocrinidae or Plicatocrinidae.

Radial. Type 3 – 1 very small radial (Fig. 7 b) with trapezoidal dorsal side and knob-shaped dorsal inflation.

Although radials of small individuals of *Encrinus aculeatus* usually have wide, blade-shaped dorsal ornaments, this obvious encrinid radial may be included within *Encrinus aculeatus*.

Axillary – 1 small axillary (Fig. 8 c) with a blunt tip of the distal angle and without dorsal ornaments. Probably, this axillary belongs to an encrinid.

Brachials – 9 extremely low brachials with oblique muscular articulation facets and an edge along dorsal side. Outline and low height index are similar to Jurassic millericrinid brachials, which may rarely have a paired nerve canal. *Dadocrinus* brachials with a dorsal edge usually are higher. These brachials may belong to *Silesiacrinus*.

Columnals – Among the Piekary Śląskie material several columnals are difficult to determine. Fig. 7 c has an encrinid petaloid pattern with very short crenulae and wide pyriform petal floors. Its narrow axial canal and the tubuli are more indicative for holocrinid affinity.

Fig. 7 d is a juvenile columnal with extremely wide axial canal and very short (encrinid) crenulae, the arrangement of which, the straight latus and its height are more indicative for holocrinid affinity.

Final Remarks

The extremely diverse fauna of the Karchowice Beds and the *Diplopora* Dolomite in Upper Silesia is rather a Tethys than a Germanic Muschelkalk fauna (ASSMANN, 1937, 1945; TRAMMER, 1975; HAGDORN & GŁUCHOWSKI, 1993). This is indicated by a diversity of stenohaline faunal elements such as corals, sponges, cephalopods, brachiopods and echinoderms which do not occur in the typical Muschelkalk of more central parts of the Germanic Basin. As indicated by *Eckicrinus* and several brachiopods (*Tetractinella, Punctospirella, Hirsutella, Mentzelia, Silesiathyris*) this fauna is related with the classical South Alpine Muschelkalk fauna of Recoaro (Vicentinian Alps). However, the Recoaro Brachiopodenkalk (Calcare di Recoaro) does not yield *Silesiacrinus* and *Holocrinus meyeri* but the somewhat older *Holocrinus dubius*, and must therefore have Pelsonian age (*dubius* zone). Other Middle Triassic Alpine crinoid assemblages have not been analyzed exactly enough to allow age indications.

In Upper Silesia, close to the Silesian-Moravian Gate which connected the Germanic Basin with the Tethys, favourable, fully marine conditions during the highstand of the first Muschelkalk sequence (AIGNER & BACHMANN, 1993) lasted longer than in other parts of the Germanic Basin. At the southern margin of the Holy Cross. Mts., the *silesiacus* zone is represented by unfossiliferous marly dolomites and limestones of the Middle Muschelkalk (TRAMMER, 1975), deposited in deeper and hypersalinar environments. At the north-eastern margin *Silesiacrinus* has been found in dolomitized oolitic limestones at Witulin (MHI 1259) indicating very shallow and normal marine water. In the central and western parts of the basin, hypersalinar conditions with deposition of marly dolomites and evaporites prevented stenohaline benthic life. However, *Eckicrinus* in Upper Silesia appears as early as lower Pelsonian (Górażdże Beds), still earlier than *Holocrinus dubius*. Unlike the latter crinoid, *Eckicrinus*, *Silesiacrinus* and several echinoids did not spread over the whole basin but remained restricted in its eastern parts to the Austroalpine Tethys realm.

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Depository of specimens

BGR – Wissenschaftliche Sammlungen der Außenstelle Berlin der Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover
GIUS – Laboratory of Paleontology and Stratigraphy Silesian University in Sosnowiec
IGPT – Institut und Museum für Geologie und Paläontologie der Universität Tübingen
MB – Museum für Naturkunde der Humboldt-Universität zu Berlin. Geologisch-paläontologisches Museum
MHI - Muschelkalkmuseum Hagdorn Ingelfingen
NMC - Naturkundemuseum Coburg

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Plate 1

Encrinid cup and arm sclerites. *Diplopora* Dolomite, Piekary Śląskie. **a-e** *Encrinus aculeatus* v. MEYER, 1847. **a** First primibrachial with large aboral ornament, proximal facet (left), side view (right); GIUS-7-21c (x9); **b** Primaxillary with large aboral ornament, distal muscular facets (left), proximal zygosynostosial facet (right); GIUS-7-21d (x8); **c** First primibrachial with smaller aboral ornament, distal zygosynostosial facet; GIUS-7-21e (x8); **d** Brachial from proximal arm with straight muscular facet; GIUS-7-59/21b (x12); **e** Brachial from distal, biserial arm with zygosynostosial facets; GIUS-7-21f (x8). **f-s** *Chelocrinus carnalli* BEYRICH, 1856. **f** Short basal, showing nodal articulation (stem pit); GIUS-7-59/42 (x10); **g** Tall basal from distal (top), aboral (left), adoral (right) and stem pit (bottom), synostosial articulations; GIUS-7-59/43 (x10); **h** Radial, proximal facets; GIUS-7-59/44 (x9); **i** Radial, distal facet (top) and aboral side; GIUS-7-59/45 (x8); **j** First primibrachial, distal zygosynostosis (top) and three views from oblique adoral; GIUS-7-59/46 (x10). **k** First primibrachial, proximal muscular facet with adoral groove enclosed by wings for muscle attachment; GIUS-7-59/47 (x7); **l** First primibrachial from aboral; GIUS-7-59/48 (x12); **m** Primaxillary, distal muscular facets (top), aboral side (bottom); GIUS-7-59/49 (x7,5); **n** Primaxillary, aboral side; GIUS-7-59/50 (x5); **o** Primaxillary, zygosynostosial proximal facet with marginal crenulation; GIUS-7-59/51 (x6); **p** Primibrachial pair from aboral; GIUS-7-59/52 (x12); **q** Secundibrachial pair, from adoral (left), from aboral (right); GIUS-7-59/53 (x13); **r** Brachials, showing adoral groove and pinnular articulation; GIUS-7-5954 (x17); **s** Brachial from proximal arm, straight muscular facet; GIUS-7-59/55 (x11,5).

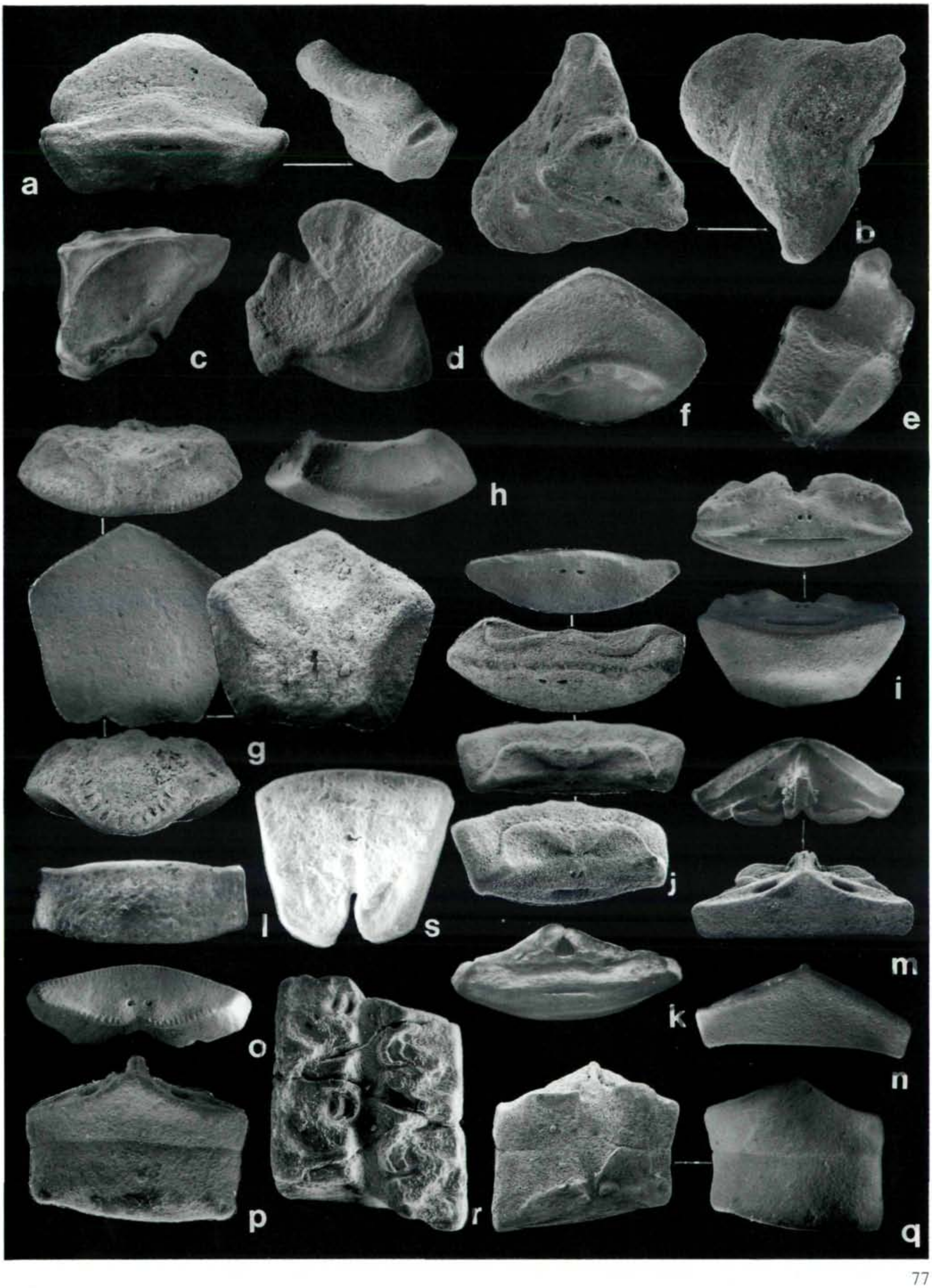
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Plate 2

Encrinid columnals. *Diplopora* Dolomite, Piekary Śląskie. **a** Morphotype 1 a, cirrinodal with petaloid crenulation pattern and three cirrus scars; GIUS-7-59/1a (x17); **b-d, i** Morphotype 1 b, cirrinodals with multiradiate crenulation pattern; **b** With one cirrus scar; GIUS-7-59/1b (x16); **c** With two cirrus scars; GIUS-7-59/1d (x20); **d** With three cirrus scars; GIUS-7-59/1c (x14); **i** Pluricolumnal with a cirrinodal; GIUS-7-59/1e (x11); **e-h** Morphotype 2, proximal nudinodals or first order internodals; **e** GIUS 7-59/2c (x12); **f** GIUS-7-59/2a (x8); **g** Pluricolumnal; GIUS-7-59/4 (x17); **h** GIUS-7-59/2b (x10); **j-n** Morphotype 3, proximal internodals; **j** With radial fossulae; GIUS-7-59/3a (x11); **k** Immature internodal without marginal crenulation; GIUS-7-59/3b (x15); **l** With radial fossulae; GIUS-7-59/3c (x11); **m** GIUS-7-59/3d (x26); **n** GIUS-7-59/3e (x12); **o-s** Morphotype 4, columnals from middle to distal stalk; **o** GIUS-7-59/5a (x8); **p, q** GIUS-7-59/5b (x7); **r** GIUS-7-59/5c (x11); **s** GIUS-7-59/5d (x5); **t** Morphotype 5, columnal with knobshaped ornament; GIUS-7-59/10a (x12).

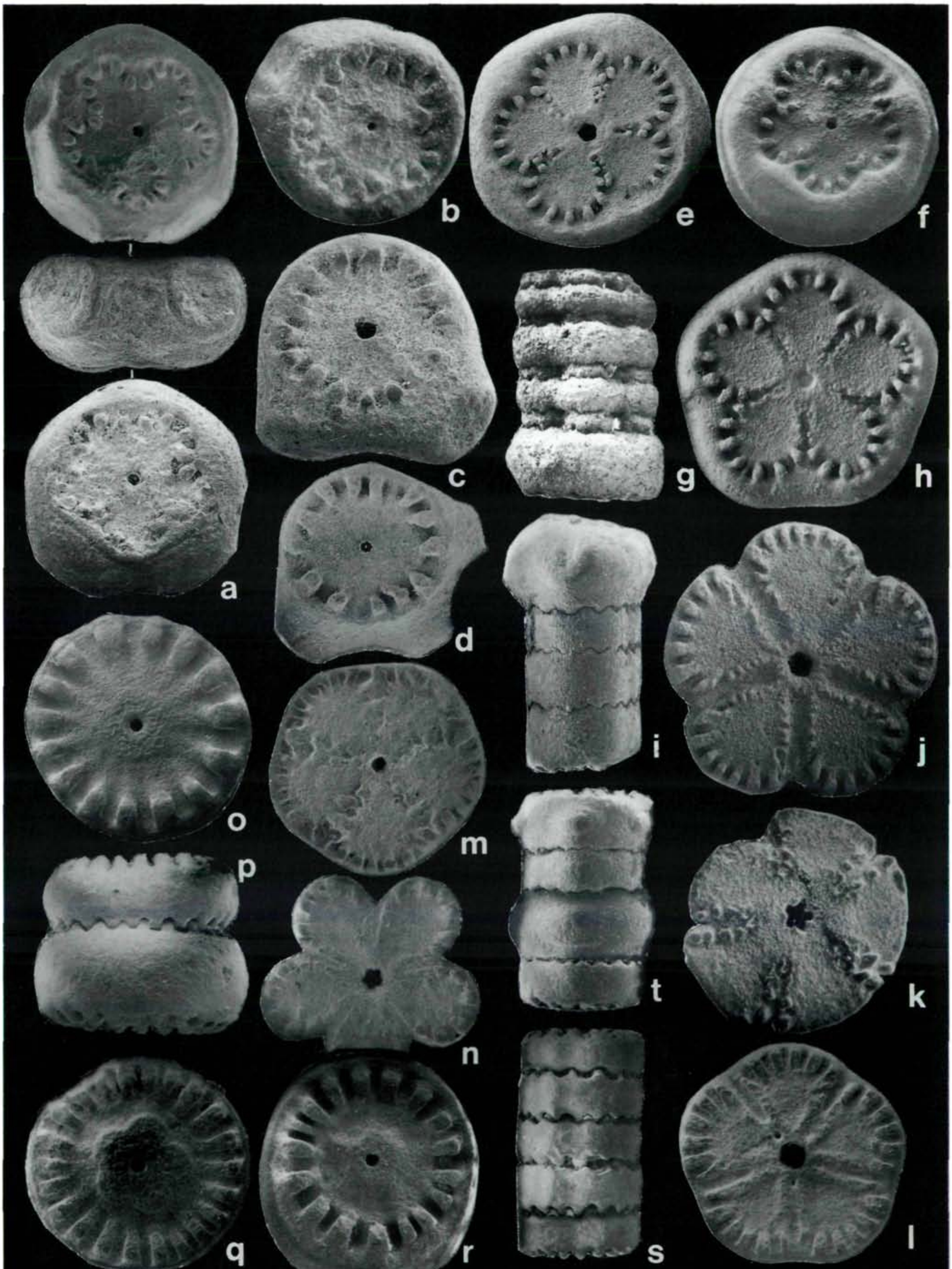
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Plate 3

Holocrinus meyeri HAGDORN & GŁUCHOWSKI, 1993. *Diplopora*-Dolomite; Piekary Śląskie. Columnals and cirrals. **a** Nodal from the middle stem part, proximal facet; GIUS-7-59/6c; holotype; **b** Proximal internodal with tubuli and epifacet; GIUS-7-59/8b (x10); **c** Proximal nodal from distal and lateral; GIUS-7-59/8d (x11); **d** Proximal nodal with epifacet, proximal, lateral and distal view (top to bottom); GIUS-7-59/8e (x12); **e** Nodal from middle stem part, proximal, lateral and distal view (top to bottom); GIUS-7-59/8f (x6.5); **f** Proximal pluricolumnal with nodal; GIUS-7-59/8b (x11); **g** Proximal cirral; GIUS-7-59/56 (x18); **h** Distal internodal; MHI 1166/1/2 (x11); **i** Juvenile internodal; GIUS-7-59/6g (x26); **j** Juvenile internodal; GIUS-7-59/6h (x13); **k** Distal nodal, oblique from proximal and from lateral; GIUS-7-59/6d (x10, x15); **l** Distal nodal; pentagonal proximal facet and lateral; MHI 1166/1/1 (x11); **m** Internodal with very short crenulae; GIUS-7-59/8i (x8); **n** Distal internodal with long crenulae; GIUS-7-59/6i (x11.5); **o** Middle to distal internodal; GIUS-7-59/6j (x9.5); **p** Juvenile internodal; GIUS-7-59/6k (x17).

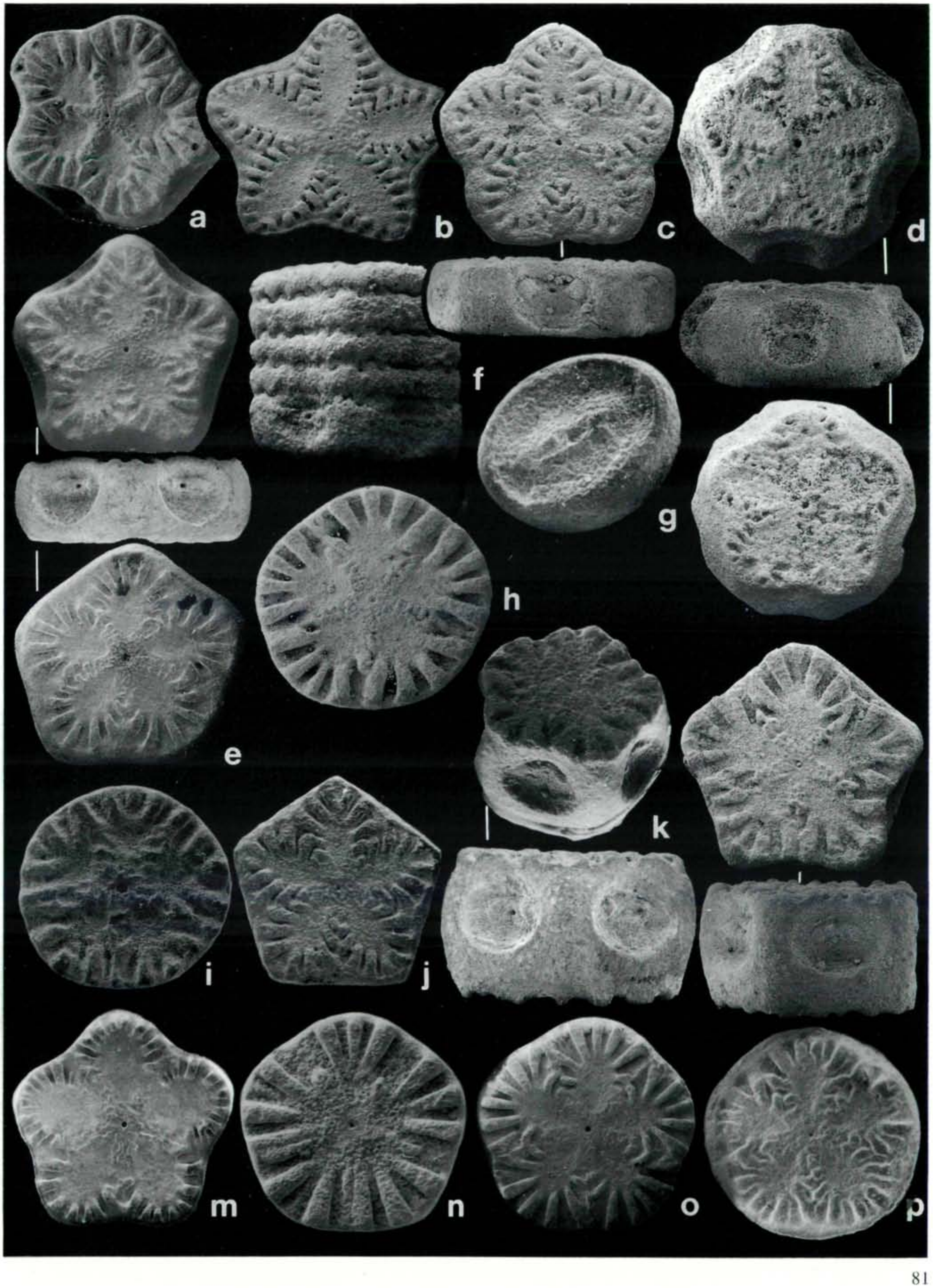
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Plate 4

Holocrinus meyeri HAGDORN & GŁUCHOWSKI, 1993. *Diplopora*-Dolomite; Piekary Śląskie. Cup and arm sclerites. **a** Basal; basal/radial facets (top) and ventral side with longitudinal groove; GIUS-7-59/57 (x18); **b** Radial; radial facet (left) and ventral side (radial facet top right); GIUS-7-59/58 (x14); **c** First primibrachial; synarthrial distal facet, ventral side, proximal facet (top to bottom); GIUS-7-59/59 (x15); **d** Primaxillary; muscular distal facets (left), dorsal side (top), proximal facet (bottom); GIUS-7-59/60 (x13,5); **e** Axillary with left distal facet wider (? second axillary); dorsal side, proximal facet, distal facets (top to bottom); GIUS-7-59/61 (x13); **f** Second secundibrachial; oblique muscular distal facet (top), ventral side with pinnular articulation facet (bottom); GIUS-7-59/62 (x15); **g** First secundibrachial; distal synostosis, ventral side, oblique muscular proximal facet (top to bottom); GIUS-7-59/63 (x16); **h** Brachial with muscular distal and synostosial proximal facet; distal facet, dorsal side, ventral side with pinnular articulation (top to bottom); GIUS-7-59/64 (x16); **i** Brachial with syzygial articulations without pinnular articulation; GIUS-7-59/65 (x13); **j** Brachial with 2 oblique muscular articulation facets; distal facet, from oblique distal, lateral side with pinnular articulation (top to bottom); GIUS-7-59/66 (x16); **k** Brachial; synostosial facet (top), muscular facet (bottom left), ventral side (bottom right); GIUS-7-59/67 (x20).

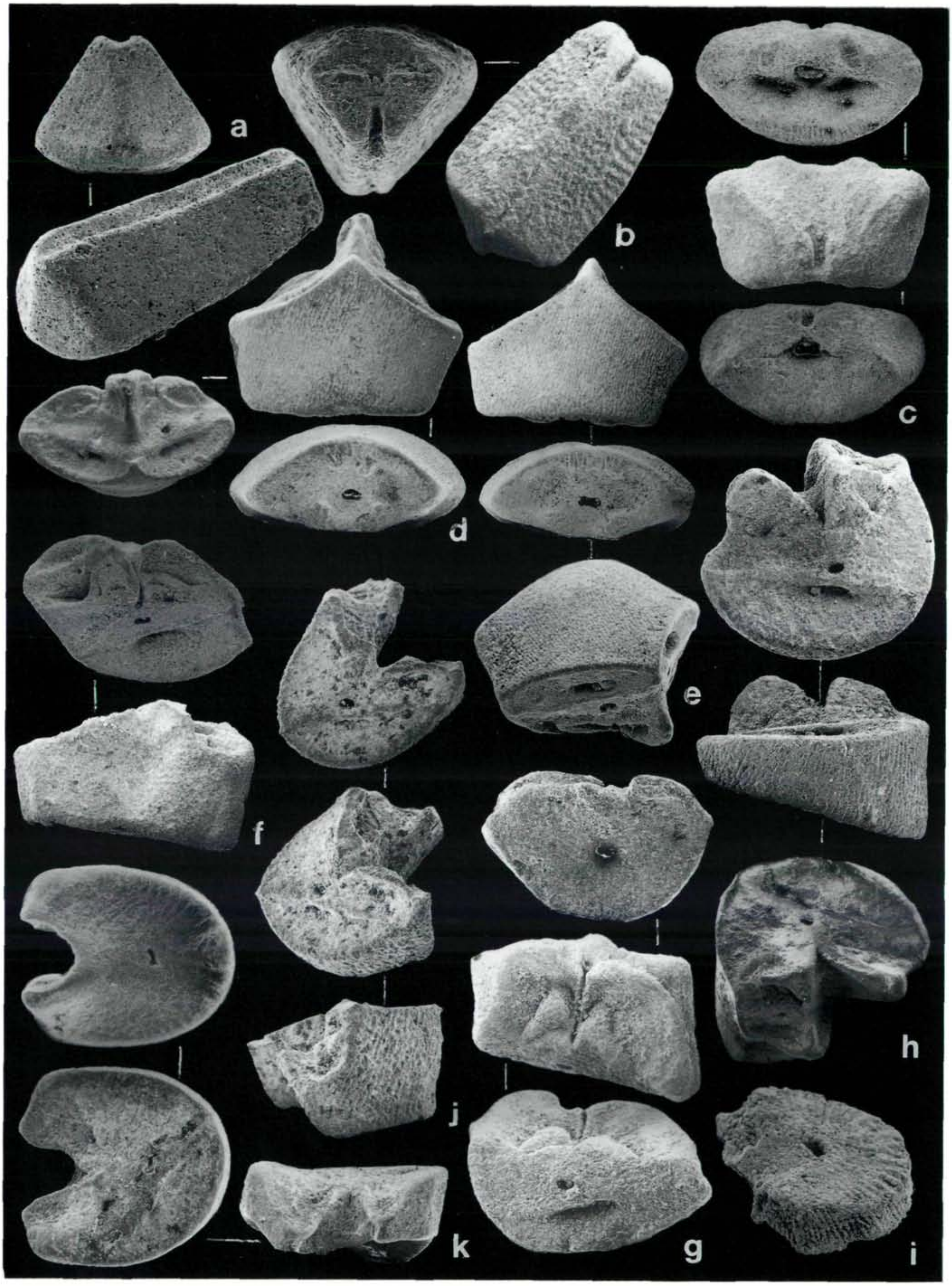
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Plate 5

Eckicrinus radiatus (SCHAUROTH, 1859). **a-k** Calcare di Recoaro, Recoaro; **l-m** *Diplopora*-Dolomite, Beuthen, St. Hyacinth well; **n-q** *Diplopora*-Dolomite, Piekary Śląskie; **r-u** *Lima striata* Beds, Wolica, Holy Cross Mts. **a**, **d** Pluricolumnal with two enlarged cirrus scars; Orig. QUENSTEDT 1876, Taf. 107, Fig. 87 (x3.5); **b** Internodal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 83 (x3.5); **c** Pluricolumnal with one nodal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 85 (x3.5); **e** Pluricolumnal with one nodal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 84 (x3.5); **f** Pluricolumnal with two nodals (full noditaxis); Orig. QUENSTEDT 1876, Taf. 107, Fig. 86 (x3.5); **g** Proximal internodal with large petal floors; IGPT 1623/8 (Quenstedt-Sammlung) (x12); **h** Internodal with very long crenulae and extremely small petal floors; IGPT 1623/11 (Quenstedt-Sammlung)(x12); **i** Nodal with small petal floors and normal, small cirrus scars; IGPT 1623/7 (Quenstedt-Sammlung) (x12); **j** Pluricolumnal with a nodal with normal cirrus scars; IGPT 1623/10 (Quenstedt-Sammlung) (x12); **k** Nodal with normal cirrus scars; IGPT 1623/12 (x12); **l** Internodal;IGPT 1623/9 (Quenstedt-Sammlung) (x8); **m** Internodal with strongly splitting and intercalating culmina; Orig. QUENSTEDT 1876, Taf. 107, Fig. 67 (x6.5); **n** Proximal internodal with large petal floors; GIUS-7-59/9a (x15); **o** Proximal internodal with very large petal floors; GIUS-7-59/9b (x12); **p** Juvenile distal internodal with very small petal floors; GIUS-7-59/13a (x18); **q** Internodal; GIUS-7-59/9c (x10); **r** Proximal internodal; MHI 1164/1/1 (x13); **s** Internodal; MHI 1164/1/2 (x13); **t** Distal internodal; MHI 1164/1/3 (x11); **u** Distal internodal; MHI 1164/1/4 (x15).

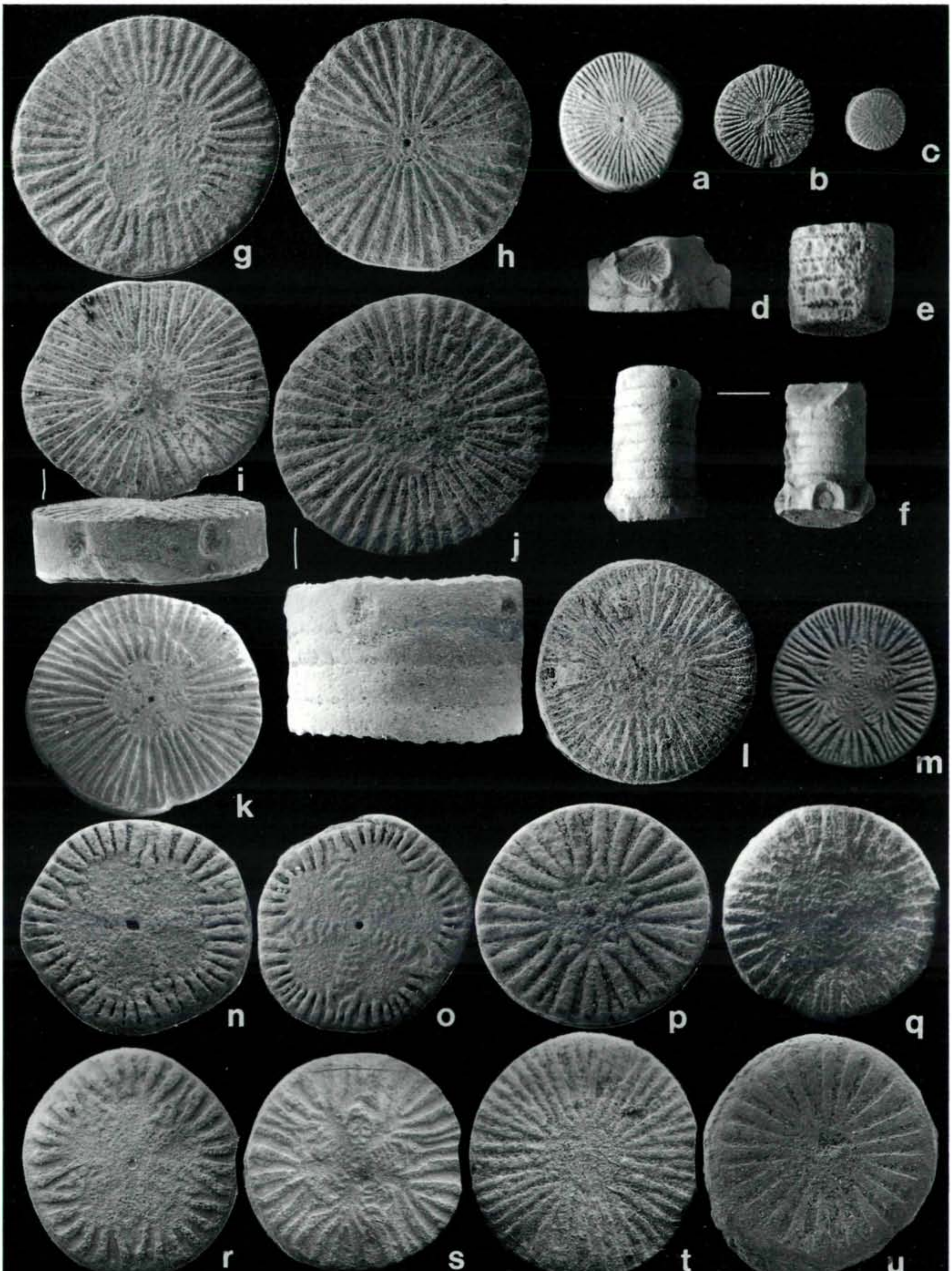
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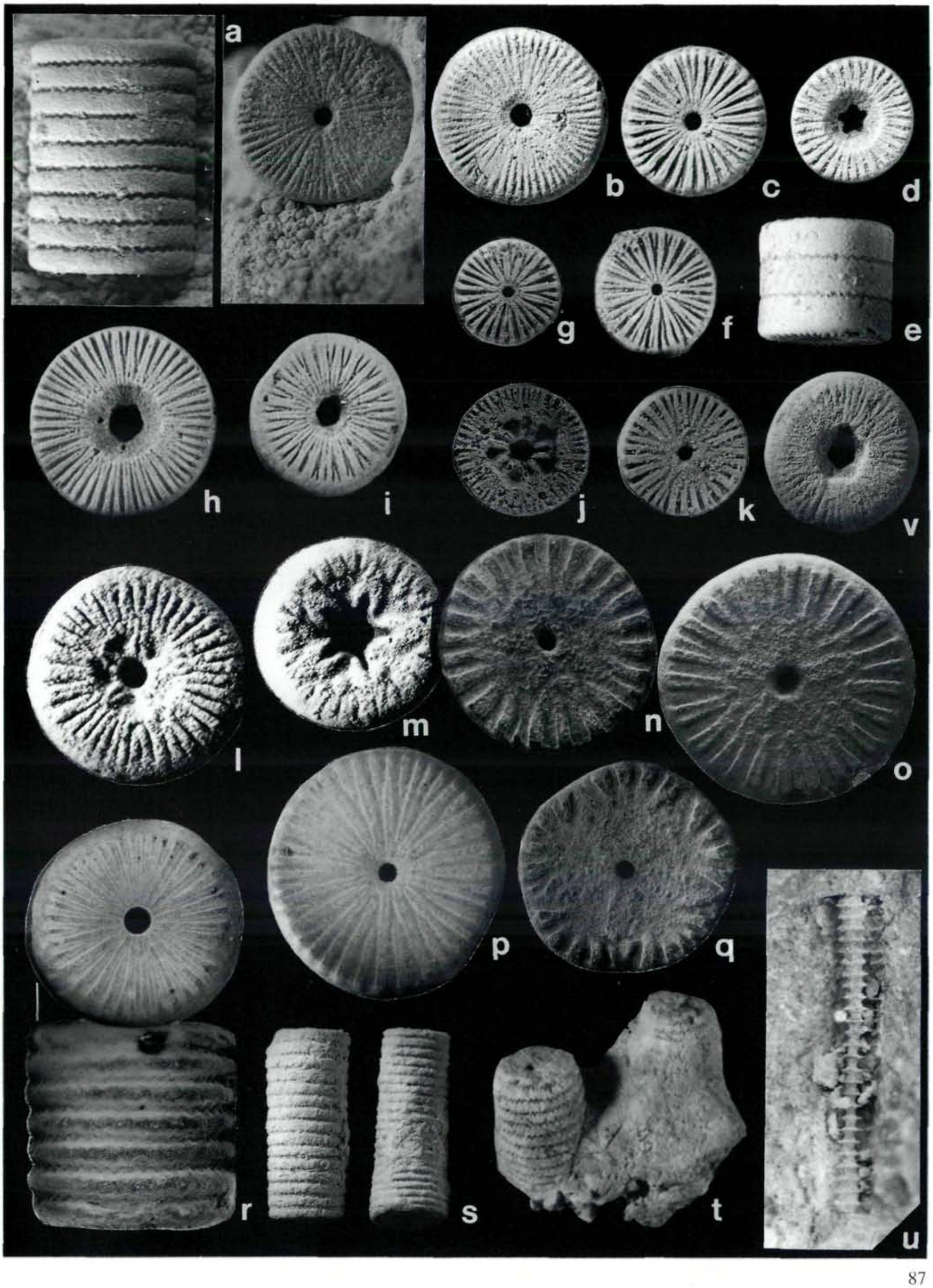
Plate 6

Silesiacrinus silesiacus BEYRICH 1857. **a, t** Muschelkalk, Kamin, Oberschlesien. **b–k, v** *Diplopora* Dolomite, Beuthen, St. Hyacinth well. **l-r** *Diplopora* Dolomite, Piekary Śląskie. **s, u** Karchowice Beds, Tarnów Opolski (formerly Tarnau). **a** Pluricolumnal. Orig. QUENSTEDT 1835, Taf. 4, Fig. 3 and BEYRICH 1857, p. 46. Holotype; MB.E.713 (x3.5). **b** Pluricolumnal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 63 (x4); **c** Columnal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 62 (x4); **d** Columnal with pentagonal lumen and spatium; Orig. QUENSTEDT 1876, Taf. 107, Fig. 64 (x4); **e** Pluricolumnal; Orig. QUENSTEDT 1876, Taf. 107, Fig. 65 (x4); **f** Pluricolumnal; IGPT 1766/1 Quenstedt-Sammlung (x5); **g** Pluricolumnal; IGPT 1766/2 Quenstedt-Sammlung (x4.5); **h** Columnal with enlarged lumen; Original HAGDORN & GŁUCHOWSKI 1993, Fig. 10, 1; IGPT 1766/3 Quenstedt-Sammlung (x5); **i** Pluricolumnal with crenulated spatium; IGPT 1766/4 Quenstedt-Sammlung (x5.4); **j** Columnal with radial spatium pattern; IGPT 1766/5 Quenstedt-Sammlung (x4.5); **k** Pluricolumnal; IGPT 1766/6 Quenstedt-Sammlung (x4.5); **l** Columnal with radial spatium pattern; GIUS-7-59/7d (x8); **m** Columnal with radial spatium pattern; GIUS-7-59/7b (x8); **n** Proximal columnal with radial bands; GIUS-7-59/7c (x11); **o** Proximal columnal with granulated radial bands; GIUS-7-59/7e (x9.3); **p** Columnal; GIUS-7-59/7a (x9.3); **q** Proximal columnal with granulated radial bands; GIUS-7-59/7g (x9); **r** Pluricolumnal; GIUS-7-59/7f (x5.5); **s** 2 pluricolumnals from dististele; MHI 1265/4/1, 1265/4/2 (x1,6); **t** Holdfasts; MHI 1262/1/1 (x2); **u** Internal mould of pluricolumnal; MHI 1267/4/1 (ca.x2); **v** Pluricolumnal; Original QUENSTEDT 1876, Taf. 107, Fig. 66 (x4).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