

Ordovician conularids of Sardinia

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ABSTRACT — *A well preserved specimen of a conularid collected from the Upper Ordovician of Sardinia is described and illustrated. Two of Meneghini's species (1880), Conularia laqueata and Conularia tulipa, have been revised and invalidated as younger synonyms respectively of Archaeoconularia fecunda (Barrande) and Exoconularia exquisita tenella (Barrande).*

RIASSUNTO — *Viene descritto ed illustrato un esemplare eccezionalmente ben conservato di conularide proveniente dall'Ordoviciano superiore della Sardegna. E' stata inoltre eseguita la revisione degli esemplari sui quali Meneghini nel 1880 basò le sue due nuove specie Conularia laqueata e Conularia tulipa ed è stato dimostrato che queste sono sinonime rispettivamente di Archaeoconularia fecunda (Barrande) e di Exoconularia exquisita tenella (Barrande).*

INTRODUCTION

Although conularids are generally not rare in some Paleozoic areas of Europe (e.g. Bohemia) they are very rare in the Mediterranean basin. The only specimens of conularids found in Italy were the three ones reported by Meneghini (1880) from the Lower Paleozoic of Sardinia. He erected two new species that have been respectively named *Conularia laqueata* Meneghini and *Conularia tulipa* Meneghini.

During field collecting work in the Paleozoic of Sardinia carried out in the Summer of 1967, a beautiful specimen of conularid was found in the Upper Ordovician beds near Portixeddu.

The study of this new specimen and the revision of the material that Meneghini described about 90 years ago for the same formation constitute the aim of this work.

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LOCALITY, STRATIGRAPHIC POSITION, AGE

A detailed stratigraphic study of the Sardinian Paleozoic is still wanting and hence no authoritative statement of the precise stratigraphic situation exists.

Practically the only author who worked on the stratigraphy of the Fluminese was Taricco (1921) who, as far as concerns the Ordovician, distinguished this sequence of rocks as follows:

a) Upper Ordovician (« Scisti argillosi ad *Orthis actioniae*, Trepostomi, Cistoidi, *Dyctionema* (?) *corniculata* », ecc. ...).

b) Middle Ordovician (« Scisti argillosi ad *Asaphus nobilis*, *Dalmania*, *Trinucleus*, *Lingula*, *Schizophocrinus* »).

c) Lower Ordovician (« Puddinghe policrome con scisti intercalati a Filloclariidi », ecc.).

From this subdivision, also accepted by other Authors (Gortani, 1922; Novarese & Taricco, 1922) it seems evident that the distinction between a Middle and an Upper Ordovician is only paleontological. On the other hand, the same Taricco (1921, p. 12) had already noted « la stretta analogia litologica degli scisti dell'Ordoviciano medio con quelli dell'Ordoviciano superiore a cui passano insensibilmente senza alcuna discordanza ». It concerns, therefore, a single formation in which it is possible to differentiate a richly fossiliferous upper member (Scisti argillosi ad *Orthis actioniae*, trepostomi, ecc.) and a lower one poorer in fossils (Scisti argillosi ad *Asaphus nobilis*, ecc.).

The most known Ordovician fossiliferous outcrops of the Iglesiente (Portixeddu, Ponte su Amadori, Piscina Morta, Domusnovas, Gonnese, environs of Flumini, Perdas de

Fogu) belong to the upper member and have been considered Caradocian by almost all the Authors. Only Maccagno (1965) on the basis of the cystoids inclines towards an Ashgillian age even though she does not exclude the presence of the Caradoc in the lower part. The lower member, which outcrops, according to Gortani (1922), chiefly in the environs of Flumini, has, instead, been considered to be Llandeilian in age.

The new specimen of conularids was collected in the siltstone beds (upper member of « Scisti argillosi ») that outcrop into the sea not far from Portixeddu (Iglesiente), South-West Sardinia (text-fig. 1). A rich assemblage of fossils has been found in the beds of Portixeddu and related areas. Species of brachiopods, Bryozoa, graptolites, cystoids, Gastropoda, Stromatopora, Trilobita, Orthoceras, ostracods, etc., have been collected and studied chiefly by Meneghini (1857, 1880), Vinassa de Regny (1927, 1941) and Maccagno (1965). The conularids are perhaps the rarest representatives of the assemblage.

The present systematic study of conularids let us recognize the species *Exoconularia imperialis* (Barrande), *Exoconularia exquisita tenella* (Barrande) and *Archeoconularia fecunda* (Barrande).

The last two taxon had been previously reported by Meneghini (1880) as *Conularia tulipa* and *Conularia laqueata* respectively. These two species are not valid, for a survey of literature and a direct comparative examination of material from Bohemia indicates that both *C. tulipa* and *C. laqueata* are younger synonyms of Barrande's species (see next pages).

According to Boucek (1928, p. 102, 103) *Exoconularia imperialis* occurs only in the Ordovician (from the Llanvirn to the Caradoc) (dγ, dδ, dε), *Exoconularia exquisita tenella* is restricted to the Caradoc (dε) and *Archeoconularia fecunda* ranges from the Ordovician (Llanvirn) to the Upper Silurian (Ludlow) (dγ, dδ, dε, dζ, eα, eβ). Dating by conularids suggests therefore a Caradocian age for the upper member of the formation.

From a geographic point of view the three species had been reported from Bohemia and one (*A. fecunda*) also from Thuringia. So far none of them has been reported from the Mediterranean area.

as Kinderlein (1937) did, followed also by Moore & Harrington (1956a, b) in the « Treatise on Invertebrate Paleontology », but have to be considered as a group in themselves, as suggested by Kozłowski.

SYSTEMATIC DESCRIPTIONS

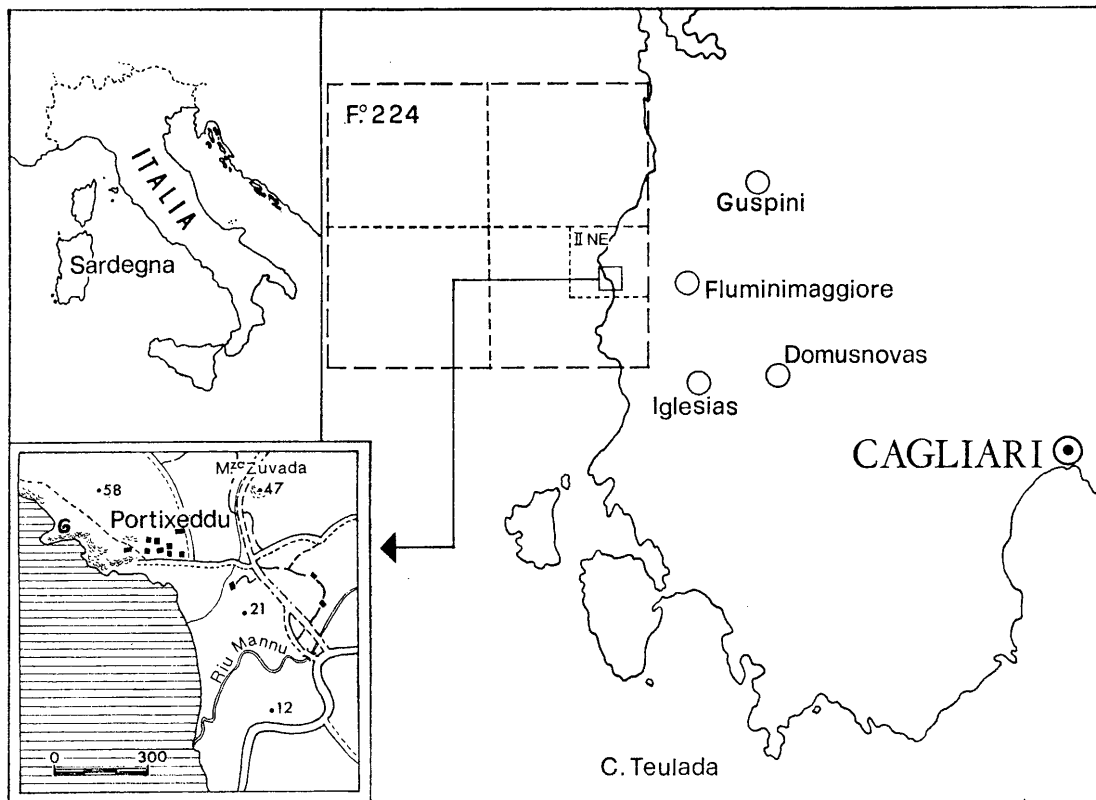
A review of the different interpretations given by the Authors on the zoological relationships of the conularids does not seem necessary. It is only important to point out that recently Kozłowski (1968) in his study of some exceptionally well preserved young specimens was able to demonstrate the existence of numerous apical spines and pores on the periderm. This implies that conularids can no longer be assigned to the Coelenterata

Gen. EXOCONULARIA Sinclair, 1952
EXOCONULARIA EXQUISITA TENELLA
(Barrande)

(Pl. 1, fig. 7; pl. 2, figs. 2-5)

Conularia tenella BARRANDE, 1867, *Système silurien du centre de la Bohême*, vol. 3, p. 54, pl. 4, figs. 15-18;

Conularia tulipa MENEGHINI, 1880, *R. Acc. Lincei, Atti, Serie 3, Mem. Cl. Sci. fis. matem. e naturali*, vol. 5, pp. 214, 215, pl. 1, figs. 3a-c;



Text-fig. 1 - Index map of SW Sardinia showing location of conularids described in this paper. Insert map showing the locality where was found the new specimen of conularid belonging to the species *Exoconularia imperialis* (Barrande).

- non *Conularia tulipa* R. RICHTER & E. RICHTER, 1930, Senckenbergiana, vol. 12, n. 2-3, pp. 161-162, fig. 1 (= *C. tulipina* R. RICHTER & E. RICHTER, 1939, Senckenbergiana, vol. 21, n. 1-2, p. 168); *Conularia exquisita* BARRANDE var. *tenella* BARRANDE, Boucek, 1928, Palaeontographica Bohemiae, Nr. 11, p. 73, pl. 2, fig. 11; *Archaeoconularia? tulipa* (Meneghini), SINCLAIR, 1944, Royal Soc. of Canada, Sect. IV, Transactions, ser. 3, vol. 38, p. 90.

Material available — A fragmentary specimen very crushed.

Description — Shell of medium size, apparently tapering uniformly. Periderm very thin and black in colour. Cross section highly distorted, a flattened rhomb in its present condition. Faces equal in shape, one concave and the others irregularly flat. Apical angle about 7° measured in the middle portion. Mid-line of the faces marked by a narrow longitudinal groove about 0.350 mm. wide. Marginal grooves well defined with shoulders broadly rounded. Surface of the faces marked by minute transverse threads studded with small slightly elongated pustules and crossed by faint longitudinal striae, closely spaced. Pustules prolonged upwards and downwards into the next interspace as fine projections that give rise to the striae. The number of the threads, in a length of one millimetre, is 7,5 on the lower preserved portion of the specimen and about 5 two

centimeters above. The number of the striae is about 12, on the same length. The transverse threads, forming a slight sigmoidal curve across each half face, are continuous at the mid-line and, on the whole, continuous at the corners as well. Here the situation was more difficult to state owing the bad preservation of the specimen. Aperture and apex unknown.

Dimensions — Length (of the preserved shell) about 45 mm.; width of the face 17 mm. at the larger end. Probable length of the whole shell about 95 mm.

Remarks — In 1880 Meneghini erected the species *Conularia tulipa* that was represented only by one specimen (the holotype). Later, in 1944, Sinclair (p. 90) dubtfully referred this species to the genus *Archaeoconularia*, but he could base his statements only on the pictures. From the study of both the Meneghini and the Barrande types I believe that *C. tulipa* may definitely be referred to the genus *Exoconularia* and to the species *E. exquisita tenella* (Barrande). Consequently the species of Meneghini is a *junior* synonym of that of Barrande.

The study of this problem was quite difficult because, as I said, the only type specimen is known and furthermore badly preserved being fragmentary, compressed and partly obliterated. The shell is more flattened in the lower preserved portion than in the upper. The ornamentation is very often obliterated by matrix and minute crystals of

EXPLANATION OF PLATE 1

- Figs. 1, 6 - *Archaeoconularia fecunda* (Barrande). Upper Ordovician. Domusnovas, Iglesiente, South-West Sardinia. Fig. 1, x 1; fig. 6, x 1,5. The specimen of fig. 1 is the same drawn by Meneghini (1880) in his fig. 4 as *C. laqueata*, while that of fig. 6 was not previously illustrated.
- 2-5 - *Exoconularia imperialis* (Barrande). Upper Ordovician. Portixeddu, Iglesiente, South-West Sardinia. Figs. 2, 3, 5, lateral views, fig. 4 oblique-lateral view. All figures x 2.
- 7 - *Exoconularia exquisita tenella* (Barrande). Upper Ordovician. Perdas de Fogu, Iglesiente, South-West Sardinia, x 1. The specimen is the same drawn by Meneghini (1880) in his fig. 3a as *C. tulipa*.

The photographs have been taken by the author.

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pyrites and thus it can only be properly seen on one face.

The horizontal and particularly the vertical striation appears clearly only by a lens.

It should be noted that Meneghini (1880, p. 214) supposed that the larger end of a face was 30 to 40 mm. wide instead of 20-23 as really is. Furthermore, he counted 20 longitudinal striae, in a length of one mm. (40 in two) instead of an average of 12. Finally, he states that the transverse threads are alternating and not continuous at the corners. As may be seen from fig. 3 pl. 2, however, the threads are continuous and show no alternation. Sometimes they may be fairly bifurcate.

Horizon and locality — Upper Ordovician (Caradoc). « Scisti argillosi », upper member. Perdas de Fogu near Flumini (South-West Sardinia, Italy).

Occurrence — Upper Ordovician of Bohemia (Barrande, 1867; Boucek, 1928).

Hypotype — Museum of Paleontology, Pisa University.

EXOCONULARIA IMPERIALIS (Barrande)

(Pl. 1, figs. 2-5; pl. 2, figs. 6-8)

Conularia imperialis BARRANDE, 1867, *Système silurien du centre de la Bohême*, vol. 3, pp. 42, 43, pl. 16, figs. 12-17; ZELIZKO, 1911, *Kaiserlich-Königlichen geologischen Reichsanstalt, Jahrbuch*, vol. 61, pars 1, p. 42, pl. 4, figs. 2-7; BOUCEK 1928, *Palaeontographica Bohemiae*, Nr. 11, pp. 73, 74, pl. 3, fig. 1-5, text-fig. 5;

Conularia hofmanni ZELIZKO, 1911, *Kaiserlich-Königlichen geologischen Reichsanstalt, Jahrbuch*, vol. 61, pars 1, p. 46, pl. 3, fig. 5, pl. 4, fig. 1;

Metaconularia? imperialis (Barrande), SINCLAIR, 1940, *Royal Soc. of Canada, Section IV, Trans.*, ser. 3, vol. 34, p. 118.

Material available — A complete free specimen, slightly crushed.

Description — Shell of medium size, slightly curved in a sinuous way near the

apex and tapering a little more rapidly at the apical end. Periderm very thin and black in colour. Cross section distorted, more or less rectangular in its present condition. Two adjacent faces concave, the others irregularly flat. Apical angle measured in the mature portion about 16°. Mid-line of the faces marked by a narrow longitudinal groove about 0.15 mm. wide. Accessory and secondary longitudinal lines unmarked on the outer surface. Corners with a shallow but evident furrow (0.30 mm. wide) without prominent margins. Edges sharply rounded. Surface with nearly horizontal rows of small rounded pustles the average frequency of which, in a length of one millimetre, is transversely six near the apex, four and one half near the middle and about five near the larger end. On vertical alignment the number of pustles, in the same length, is more or less identical with the exception of the apical end where the number may increase to 12 or 13. The transverse rows are very slightly convex towards the aperture in the middle part of the specimen. Ornamentation continuous across the mid-line and corner grooves. Aperture unknown.

Dimensions — Length, about 50 mm.; width of the face, 12 mm. at the larger end.

Remarks — This species is referred to the genus *Exoconularia* according to Sinclair (« This is the group of species that I left as *Metaconularia?* in 1940 »; 1952, p. 139).

The specimen is on the whole well preserved with the exception of the apertural and apical ends; thus certain characteristics, such as the possible presence of secondary longitudinal lines (sometime visible near the apex), the complete pattern of the mid-line and the rate of the apical angle, cannot be observed and described. Accurate measurement of the whole shell was also difficult.

One of the faces of the shell is irregularly bent inwards about 1/4 of the distance between the mid-line and the corner, but it is explained by the slightly crushed condition of the specimen. For this reason the frequency of the pustles on transverse rows is given in average rates because on the same

row the number of pustles varies according to the degree of crushing suffered at different points of the shell. It is impossible to see the internal structures because the shell is full of sediment. The present species is quite similar to *Exoconularia exquisita* (Barrande), but the ornamentation in *E. imperialis* is much coarser and always visible to the naked eye.

It should be noted that probably the specimen from Sardinia is not completely adult, for some of the specimens found in Bohemia by Barrande and Boucek are larger.

Horizon and locality — Upper Ordovician (Caradoc). « Scisti argilloso », upper member. Portixeddu (South-West Sardinia, Italy).

Occurrence — Ordovician of Bohemia (Barrande, 1867; Zelizko, 1911; Boucek, 1928).

Figured hypotype — Institute of Paleontology, Modena University, Coll. No. 15699.

Gen. ARCHAEOCONULARIA Boucek, 1939
ARCHAEOCONULARIA FECUNDA (Barrande)
(Pl. 1, figs. 1, 6; pl. 2, fig. 1)

Conularia fecunda BARRANDE, 1867, Système silurien du centre de la Bohême, vol 3,

p. 38, pl. 8, figs. 1-10, pl. 14, figs. 1-6; FREYBERG, 1922, Zeitschr. d. deutsch. geol. Gesellschaft, vol. 74, p. 254, pl. 5, fig. 4; BOUCEK, 1928, Palaeontographica Bohemiae, Nr. 11, pp. 66, 67, pl. 1, figs. 5-10, text-fig. 3;

Conularia hawlei BARRANDE, 1867, Système silurien du centre de la Bohême, vol. 3, pp. 41, 42, pl. 2, figs. 15-16;

Conularia sosia BARRANDE, 1867, Système silurien du centre de la Bohême, vol. 3, pp. 53, 54, pl. 8, figs. 15-16;

Conularia laqueata MENEGHINI, 1880, R. Acc. Lincei, Atti, Serie 3, Mem. Cl. Sci. fis. matem. e naturali, vol. 5, p. 215, pl. 1, fig. 4;

non *Conularia laqueata* CONRAD, 1841, State of New York, Assembly Paper 150, p. 57;

Archaeoconularia fecunda (Barrande), SINCLAIR, 1944, Royal Soc. of Canada, Sect. IV, Transactions, ser. 3, vol. 38, p. 90; *Eoconularia? sardinica* (*nomen novum*), SINCLAIR, 1944, Royal Soc. of Canada, Sect. IV, Transactions, ser. 3, vol. 38, p. 93.

Material available — Two incomplete specimens.

Description — Shell of medium size uniformly tapering. Periderm very thin and

EXPLANATION OF PLATE 2

Figs. 1 - *Archeoconularia fecunda* (Barrande). Badly preserved remain of ornamentation present only in one place of the upper part of the specimen illustrated in pl. 1, fig. 6. x 15.

2-5 - *Exoconularia exquisita tenella* (Barrande).

2 - Ornamentation in the lower preserved portion of the specimen. x 15.

3 - To show that the threads are continuous at the corners. x 15.

4 - Ornamentation in the middle portion of the shell. x 15.

5 - Same point of fig. 4 much more enlarged to show that the transverse threads are studded with small elongated pustles. x 40.

6-8 - *Exconularia imperialis* (Barrande).

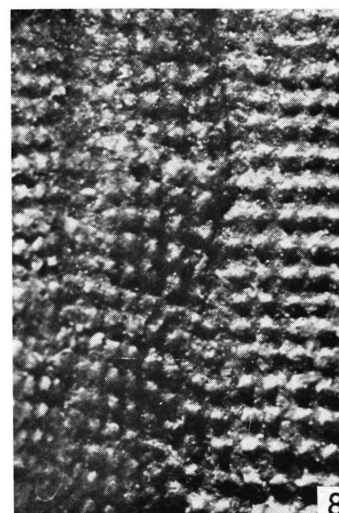
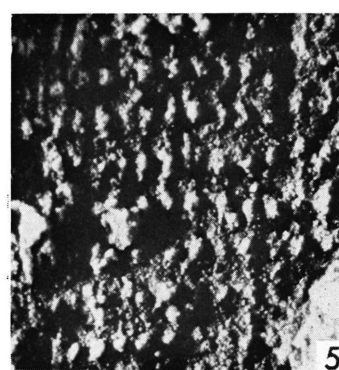
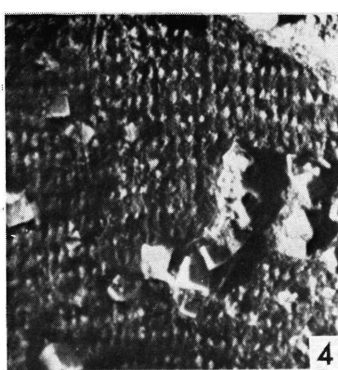
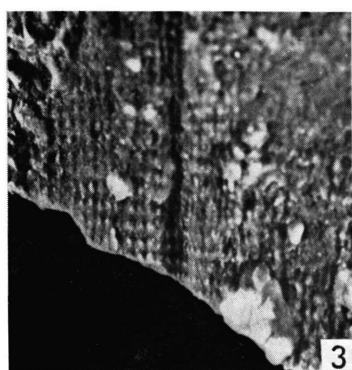
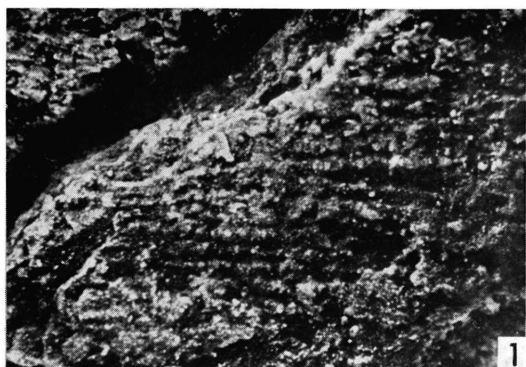
6 - Ornamentation of the apical end to show that here the number of pustles on vertical alignment is about twice as on trasversal one. x 15.

7 - Same point much more enlarged. x 40.

8 - Ornamentation in the middle-upper part of the shell to show that here the number of pustles is more or less identical on both vertical and transversal alignment. x 15.

The photographs have been taken by the author.

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black in colour. Cross section distorted: originally a square with the sides convex and the corners rounded. In its present condition more or less oval according to the degree of crushing suffered. Apical angle about 12°. Mid-line of the faces marked by a narrow longitudinal groove about 0.375 mm. wide. Accessory longitudinal lines unmarked on the outer surface.

Marginal grooves about twice as wide and deep as the mid-lines. Surface marked by faint transverse threads closely spaced (about 19 in one mm.) studded in fine pustles (about 25 in one mm.). Aperture and apical end unknown.

Dimensions — Length of the best preserved specimen, about 52 mm.; width of the face 10 mm. at the larger end.

Remarks — Meneghini in 1880 erected the species *Conularia laqueata* that was based on two fragmentary specimens of Sardinia. Sixty-four years later this species was doubtfully referred to the genus *Eoconularia* by Sinclair (1944, p. 93) who proposed the new name *sardinica* for the species because *laqueata* was a preoccupied name (see Conrad, 1841).

From the study of both types respectively of Meneghini and Barrande *C. laqueata* may definitely be referred to the genus *Archaeoconularia* Boucek and to the species *A. fecunda* (Barrande).

Therefore the species of Meneghini is a *junior* synonym of that of Barrande. This is according to Boucek who, through not having at this disposal the types of Meneghini, had observed (1928, p. 66) that *Conularia laqueata* Meneghini should be reassigned to the group of *C. fecunda*.

Both the specimens that I have restudied are more or less fragmentary and have the surface almost completely obliterated by minute crystals of pyrite and by matrix. A very little trace of ornamentation (pl. 2, fig. 1) appears only on the small specimen (upper part of the side imbedded in matrix).

Horizon and locality — Upper Ordovician (Caradoc). « Scisti argillosi », upper

member. Domusnovas (South-West Sardinia, Italy).

Occurrence — Ordovician and Silurian of Bohemia (Barrande, 1867; Boucek, 1928), Upper Ordovician of Thuringia (Freyberg, 1922).

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