



The conodont genus *Pseudooneotodus* Drygant from the Silurian and Lower Devonian of Sardinia and the Carnic Alps (Italy)

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ABSTRACT – More than one thousand and five hundreds specimens belonging to the squat coniform conodont Genus *Pseudooneotodus* from Sardinia and the Carnic Alps has been studied. All the specimens have one or two apical tips. On the basis of the unrelated distribution of the different morphologies the apparatus is reconstructed as unimembrate, and three species have been discriminated: *Ps. beckmanni*, *Ps. bicornis* and *Ps. linguicornis*. Morphological differences in the apical part of *Ps. bicornis* allow to distinguish the new subspecies *Ps. bicornis contiguus*, which evolved from the nominal species during the Ludfordian.

RIASSUNTO – [I conodonti del genere *Pseudooneotodus* Drygant nel Siluriano e Devoniano Inferiore della Sardegna e delle Alpi Carniche (Italia)] Il genere *Pseudooneotodus* è ampiamente diffuso in sedimenti di età compresa tra l'Ordoviciano Medio e il Devoniano Inferiore. Si tratta di conodonti di forma conica e tozza, con un numero di denticoli apicali variabile da uno a tre. Barrick (1977) ha ricostruito l'apparato del genere *Pseudooneotodus*, comprendente un elemento coniforme snello, un elemento tozzo con un denticolo apicale e un elemento tozzo con due o tre denticoli apicali. La distribuzione delle diverse morfologie nel materiale sardo e carnico non supporta tale ricostruzione, suggerendo un apparato unimembrato, o costituito da elementi con la stessa morfologia. Vengono così riconosciute e descritte tre specie *Ps. beckmanni*, *Ps. bicornis* and *Ps. linguicornis*. Inoltre, differenze morfologiche nella parte apicale di *Ps. bicornis* consentono di distinguere la nuova sottospecie *Ps. bicornis contiguus* dalla specie nominale.

INTRODUCTION

Pseudooneotodus Drygant is a conodont genus widely distributed from the Middle Ordovician to the Lower Devonian all over the world. The elements of the genus are short and conical, with similarities only with the Ordovician genus *Oneotodus* Lindström. Because of this peculiar shape, for a long time *Pseudooneotodus* was considered to be not a conodont, and different hypotheses were stressed out by several authors: Möstler (1968) referred to skeletal elements of the genus as "pseudoconodonts", Serpagli (1970) considered them as problematica, Flügel & Schönlaub (1972) regarded them as fish teeth, and Winder (1976) discussed possible similarities with gastropods and bryozoans. Nevertheless, other authors recognised morphological similarities to conodonts: Jentzsch (1962), overlapping growth lamellae in basal cavity, and Schulze (1968), basal filling like that of true conodonts. Finally, Drygant (1974) considered them as conodonts, and Barrick (1977) confirmed this on the basis of "the same colour, luster and type of the basal material as found in undoubted conodonts from the same residues" (p.57). Recently Sansom (1996) did an histological study on *Pseudooneotodus*, confirming the attribution to conodonts, and stressing conclusions on stratigraphic first appearances of vertebrate hard tissues.

STUDIED MATERIAL

The studied collection includes specimens from several sections and outcrops of Silurian and Early Devonian age from Sardinia and from the Italian side of the Carnic Alps (Fig. 1). During Lower Palaeozoic time

these regions represented two terranes in the Northern Gondwana margin. For geological settings refer to Ferretti & Serpagli (1996), Ferretti et al. (1998a) and Corradini et al. (1998a, 2002) for Sardinia, and to Histon & Schönlaub (1999) and Schönlaub & Histon (2000) for the Carnic Alps.

The biozonation schemes followed in this paper are those proposed by Corradini & Serpagli (1999) for the Silurian, and by Carls & Weddige (1996) for the Lower Devonian. For a correct interpretation of Pridoli data, it should be remarked that the *detortus* Zone is chronostratigraphically longer in Sardinia than elsewhere (Gouwy & Corradini, 2006); therefore in this paper have been distinguished a lower part, below the first occurrence of *Oz. eosteinhornensis* s.s., and an upper part of the zone.

The studied *Pseudooneotodus* collection includes more than 1500 short squat conical elements with one or two apical tips (Tab. 1). The claimed occurrence of *Ps. tricornis* in Sardinia from an unusually very high stratigraphic level (Olivieri & Serpagli, 1990, tab. 1) cannot be confirmed, since the specimen is not a conodont element.

The occurrence of *Pseudooneotodus* is very irregular: in some levels representatives of the genus are very abundant, while in others they are not present. This fact has been also observed in stratigraphically very close samples (i.e.: successive beds in the same section) for both the occurring taxa, and suggests a possible ecological control on the distribution of *Pseudooneotodus*, which may have been more affected by environmental variations than coeval conodont taxa.

Ps. beckmanni is very rare up to the Ludfordian, and from then on almost always present, with two acme during the Lochkovian and the Pragian. *Ps. bicornis* is very

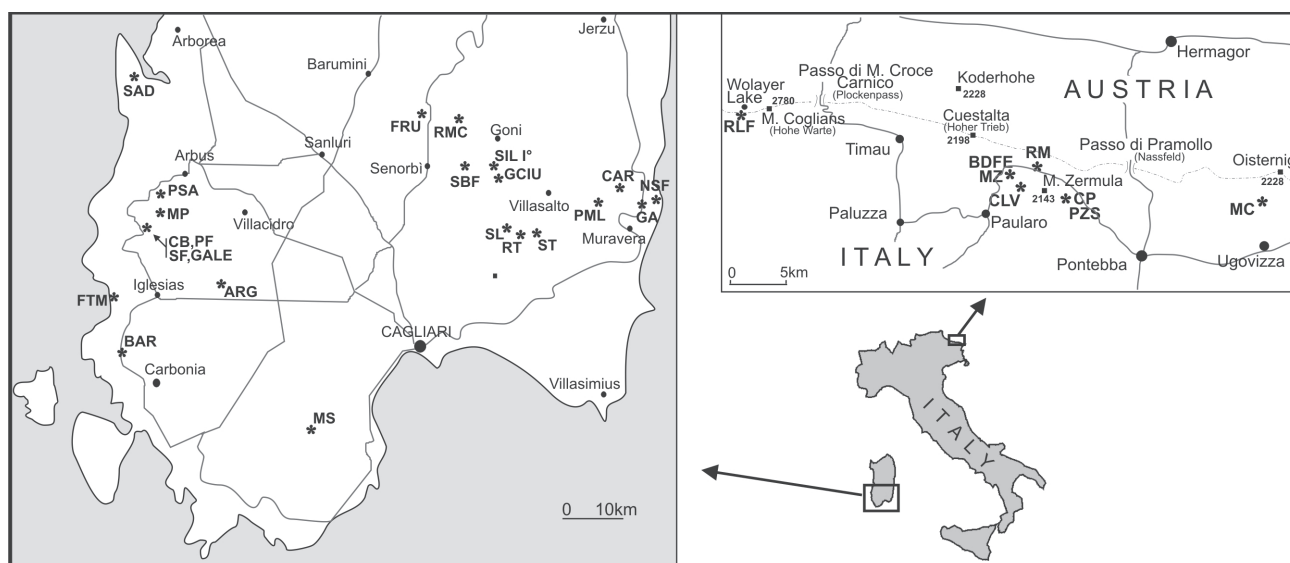


Fig. 1 – Location map of the localities yielding *Pseudooneotodus* in the Carnic Alps (top-right) and in Sardinia (left). Locality abbreviations: *Carnic Alps*. BDFE: Bosco del Floriz Est; CLV: Casera La Valute; CP: Cima Pizzul; MC: Monte Cocco; MZ: Monte Zermula; PZS: Monte Pizzul Sud; RLF: Rifugio Lambertenghi Fontana; RM: Rio Malinfier. *Sardinia*: ARG: Argiola; BAR: Barbusi; CAR: Punta Carroga; CB: Corti Baccas; FTM: Funtanamare; FRU: Monte Fruccas; GA: Genna Arrela; GALE: Galemму; GCIU: Genna Ciuerciu; MP: Mason Porcus; MS: Monte Santo-Monte Patenteddu; NSF: Nuraghe Su Franzesu; PF: Perd'e Fogu; PML: Ponte Monte Lora; PSA: Perda S'Altari; RMC: Rio Murru de Callus; RT: Rio Is Tintionis; SAD: Sant'Antonio Donigala; SBF: San Basilio Fenugu; SF: Sentiero Flumini; SIL I°: Silius I°; SL: Serra Luas; ST: Sa Tuvara.

abundant in the Homerian, almost missing in the Gorstian, then present in Ludlow and Pridoli where it is represented by two different morphologies. Based on the distance between the tips these morphologies are here regarded as two separate subspecies. A single specimen of *Ps. linguicornis* has been found in the Homerian.

SYSTEMATIC PALAEONTOLOGY

The studied material is stored in the Earth Science Department of the University of Cagliari and in the Department of the Palaeobiology Museum and Botanical Garden of the University of Modena and Reggio Emilia. Figured specimens are housed in the Palaeontological Museum of the University of Modena and Reggio Emilia (IPUM); horizons and catalogue numbers are given in the figure captions.

Genus *Pseudooneotodus* Drygant, 1974

- 1974 *Pseudooneotodus* DRYGANT, p. 66-67
- 1977 *Pseudooneotodus* Drygant - BARRICK, p. 57.
- 1977 *Pseudooneotodus* Drygant - COOPER, p. 1068.
- 1986 *Pseudooneotodus* Drygant - BISCHOFF, p. 230-234.
- 1990 *Pseudooneotodus* Drygant - ARMSTRONG, p. 112.
- 1997 *Pseudooneotodus* Drygant - JEPSSON, p. 105.

Type species - *Oneotodus? beckmanni* Bischoff & Sannemann, 1958, p. 98.

Diagnosis - Refer to Bischoff (1986).

Remarks - Drygant (1974), working on the Silurian

of Volyno-Podolia, introduced the genus name *Pseudooneotodus* and described three kinds of squat conical elements, placing them into three species according to the number of apical tips: *Ps. beckmanni* (Bischoff & Sannemann) - one tip, *Ps. bicornis* Drygant - two tips, and *Ps. tricornis* Drygant - three tips.

Bischoff (1986) stated that in case of the multiple tipped taxa, the number of denticles is a sufficiently diagnostic character, whilst the classification of one tipped elements presents some problems in view of the fact that the type species *Ps. beckmanni* (Bischoff & Sannemann) displays a certain range of morphological variability, but in the specimens from the type area "the outline of the basal margin is always subtriangular, although dimensions of the sides and the angles between them may change. Elliptical, circular, subquadrate, and subrectangular outlines do not occur and are therefore regarded to be outside the range of intraspecific variations" (Bischoff, 1986, p.233). On the basis of these considerations, the author introduced two new taxa from lower Silurian of Australia, *Ps. panuarensis* Bischoff, very close to *Ps. beckmanni*, and *Ps. borensis* Bischoff, that is definitely a different species. Jeppsson (in Calner & Jeppsson, 2003) described *Ps. linguicornis* Jeppsson, a species with strongly compressed oval basal outline and a tongue-like compressed tip from a very narrow stratigraphic interval in the Sheinwoodian.

Apart from the Silurian, *Pseudooneotodus* is also known from the Middle and Upper Ordovician and the Lower Devonian. In the upper Ordovician, a few one-tipped species have been discriminated: *Ps. mitratus* (Moskalenko), *Ps. mitrectus* (Moskalenko), *Ps. nostras* (Moskalenko), *Ps. humilis* Orchard, and *Ps. cf. beckmanni*; in the Lower Devonian only *Ps. beckmanni* is known.

Barrick (1977) reconstructed the apparatus of *Ps.*

element. The author argued also that the apparatus of *Ps. beckmanni* could have comprised a one-denticle squat element and slender conical elements. Armstrong (1990) confirmed Barrick's reconstructions. However,

Tab. 1 – Occurrence of *Pseudooneotodus* in the Carnic Alps (top row) and in Sardinia. For locality abbreviations see the caption of Fig.1.

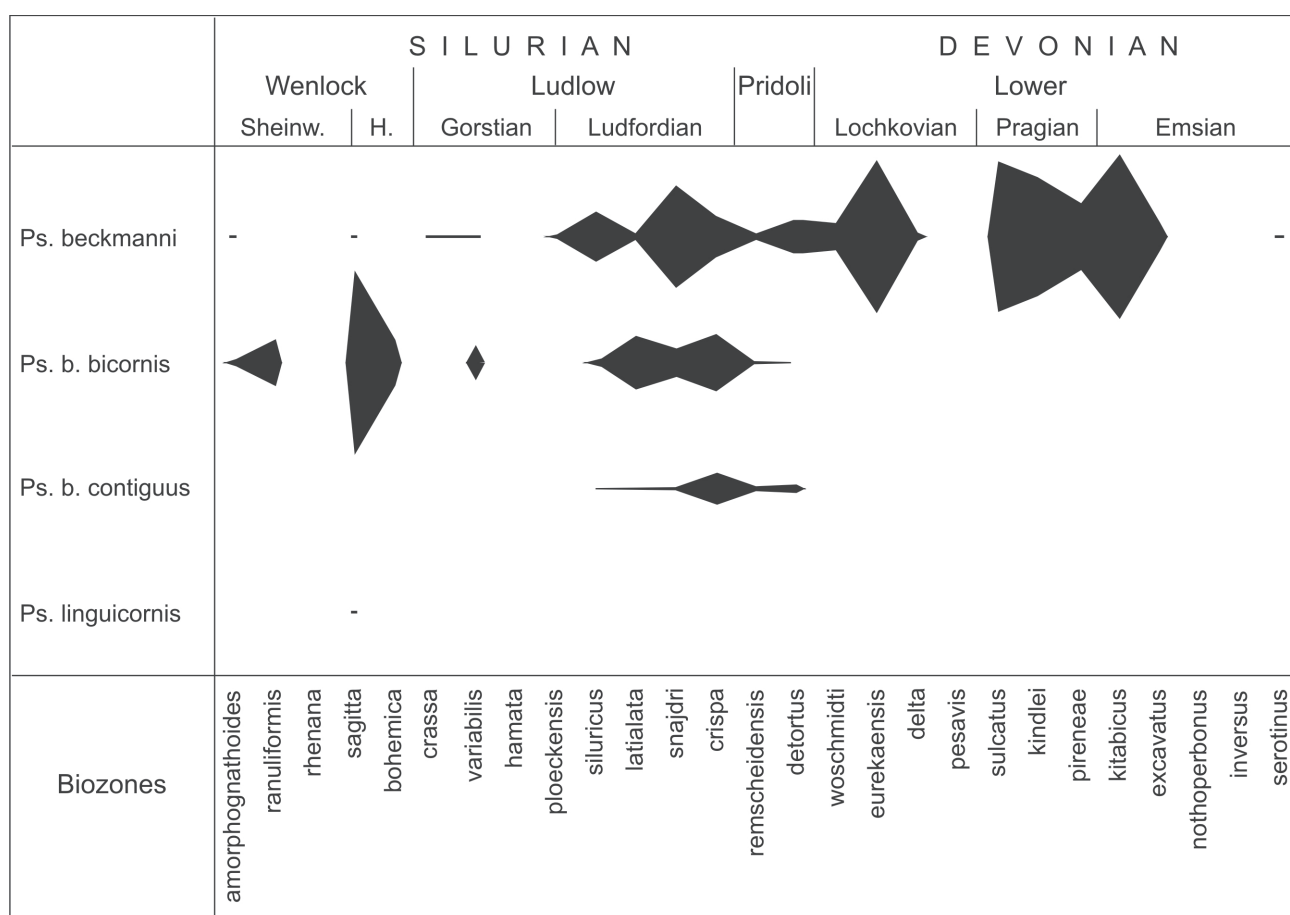


Fig. 2 – Distribution and relative abundance of the *Pseudooneotodus* taxa in the Silurian and Lower Devonian of Italy, plotted against the conodont zonation. The thickness of the line approximately indicates abundance. Abbreviations: Sheinw.: Sheinwoodian; H.: Homarian.

other authors (i.e. Bischoff, 1986; Jeppsson, 1997) disregard this reconstruction, because in their collections geographical and stratigraphical distribution of the three members are not concurrent; this fact supports an unimembrate apparatus. Another question is if the apparatus included several elements, so similar that we have not yet detected any character to distinguish them.

Material from Sardinia and the Carnic Alps supports an unimembrate reconstruction of the apparatus, since the occurrence of the different elements in samples (Tab. 1) and stratigraphical levels (Fig. 2) is not concurrent. In fact, the two tipped *Ps. bicornis* is abundant in upper Llandovery and Wenlock, when the one tipped form is very rare, and re-appears in the upper Ludlow, where forms with very close two tips become more abundant. *Ps. beckmanni* is rare below the Ludfordian, then always present up to the Lower Devonian, when it has an acme in the Pragian. Furthermore, in the studied material the conical slender element claimed to be part of the apparatus has never been recovered together with the squat elements: the single specimen found come from sample MC I 2 (*variabilis* Zone, Carnic Alps), where *Pseudooneotodus* is not present.

The suprageneric classification of *Pseudooneotodus*

is still an open question: Sweet (1988) assigned the genus to the order Protopanderodontida Sweet, Dzik (1991) placed it within the order Panderodontida Dzik, whilst Aldridge & Smith (1993) consider *Pseudooneotodus* to be member of a new family belonging to an unknown order.

Range of the genus - From Darriwillian (Middle Ordovician, *Histiodela holodentata* Zone; Stouge, 1984) to Emsian (Lower Devonian; Schulze, 1968). In the studied material, seven specimens of *Ps. beckmanni* come from a sample (SL B) dated as the *serotinus* Zone (upper Emsian; Barca et al., 1986).

Pseudooneotodus beckmanni (Bischoff & Sannemann, 1958)
(Pl.1, Figs. 1-7)

- 1958 *Oneotodus? beckmanni* BISCHOFF & SANNEMANN, p. 98, pl. 15, figs. 22-25.
- 1962 *Oneotodus? pilleolus* JENTZSCH, p. 968, pl. 4, fig. 1a-c.
- 1962 *Oneotodus? sp.1* JENTZSCH, p. 968, pl. 4, fig. 3.
- 1962 *Oneotodus? sp.2* JENTZSCH, p. 969, pl. 4, fig. 8, 10.
- 1965 Gen. et sp. indet. A PHILIPS, p. 113, pl. 8, figs 1-4.
- 1968 *Oneotodus? beckmanni* Bischoff & Sannemann - SCHULZE, p. 202, pl. 16, figs. 11.

- 1974 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - DRYGANT, p. 67, pl. 2, figs 34-39.
- 1977 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - COOPER, p. 1068, pl. 2, figs 14, 17.
- 1977 *Pseudooneotodus bicornis* Drygant - BARRICK, pl. 2, fig. 19 (only).
- 1979 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - LANE & ORMISTON, pl. 1, fig. 31.
- 1981 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - MCCracken & BARNES, p. 23, pl. 2, figs 30-31.
- 1984 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - DRYGANT, pl. 1, figs 3-7.
- 1985 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - MASTANDREA, pl. 1, fig. 10.
- 1985 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - WANG, pl. 2, fig. 19.
- 1986 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - BISCHOFF, pl. 27, figs 3-8.
- 1986 *Pseudooneotodus panuarensis* BISCHOFF, pl. 27, figs 9-12.
- 1986 *Pseudooneotodus* sp. a BISCHOFF, p. 240, pl. 28, figs 1-3.
- 1986 *Pseudooneotodus* sp. b BISCHOFF, p. 241, pl. 27, figs 38-39.
- 1986 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - WANG, pl. 2, fig. 5-6.
- 1987 *Pseudooneotodus bicornis* Drygant - KLEFFNER, fig. 5.14 (only).
- 1987 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - OVER & CHATTERTON, pl. 6, figs 25.
- 1988 *Pseudooneotodus* sp. A DEGARDIN, p. 261, pl. 2, fig. 7.
- 1990 *Pseudooneotodus bicornis* Drygant - ARMSTRONG, pl. 18, figs 11-12 (only).
- 1990 *Pseudooneotodus tricornis* Drygant - ARMSTRONG, pl. 18, fig. 17 (only).
- 1991 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - BARCA & OLIVIERI, pl. 3, fig. 14.
- 1994 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - MAWSON & TALENT, fig. 15J-L.
- 1995 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - FUREY-GREIG, pl. 1, fig. 3 T.
- 1996 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - SANSOM, fig. 11-m.
- 1996 *Pseudooneotodus bicornis* Drygant - SANSOM, fig. 1g,k.
- 1998 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - SERPAGLI et al., pl.1.2.1, fig. 14 (non pl. 1.2.2, fig. 3 = *Ps. bicornis contiguus*).
- 1998b *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - CORRADINI et al., pl. 3.3.1, fig. 16.
- 1998 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - MÄNNIK & MALKOVSKI, pl. 1, fig. 26.
- 1998 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - KOZUR, pl. 1, fig. 3.
- 1999 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - TALENT & MAWSON, pl. 13, figs 1-7.
- 1999 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - COCKLE, p.119, pl. 1, figs 1-2.
- 2000a *Pseudooneotodus* n.sp. GÖNCÜOĞLU & KOZUR, fig. 5.2.
- 2000a *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - GÖNCÜOĞLU & KOZUR, fig. 5.3, 5.5, 5.6, 5.7, 6.9, 6.10, 7.2.
- 2000b *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - GÖNCÜOĞLU & KOZUR, fig. 5.2, 5.5.
- 2001 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - CORRADINI p.25, pl. 1, figs 1-6.
- 2002 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - ZHANG & BARNES, p. 33-34, figs 17.21, 17.22, 17.25, 17.26.
- 2003 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - PYLE & BARNES, figs 17.24, 17.25.
- 2003 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - CORRADINI et al., pl. 1, figs 8.
- 2004 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - FARRELL, p.956, pl. 2, figs 15-17.
- 2005 *Pseudooneotodus bicornis* Drygant - METZGER, pl. 1, fig. 4 (only).
- 2006 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - ALBANESI et al., figs 5.K, 5.L.

Description - Short squat conical element with a single apical denticle, normally posteriorly reclined. The outline of the base is ovoidal to subtriangular, more rarely subrectangular. The deep basal cavity occupies the complete lower part of the element.

Remarks - Representatives of the species show a huge variability both in the width/height ratio and in the outline of the base, which can be more or less circular, elliptical, subtriangular, subquadrate, and subrectangular. Bischoff (1986) reports that the specimens from the type area always have a subtriangular outline of the basal margin, and suggests that only specimens with such feature belong to this species, whereas the others should be placed into different taxa. Therefore, he proposed the name *Ps. panuarensis* to specimens with an elongated subtriangular base outline and all the other features very close to *Ps. beckmanni*. The author left two more taxa, with a subcircular and an elongate basal outline respectively in open nomenclature: these forms are here synonymised with *Ps. beckmanni*.

Some authors, accepting the Barrick (1977) apparatus reconstruction, illustrated as *Ps. bicornis* specimens actually belonging to *Ps. beckmanni* (see synonymy list for details). Degardin (1988) described and illustrated in open nomenclature a specimen easily referable to the present species; Göncüoğlu & Kozur (2000a, fig. 5.2) illustrated as *Pseudooneotodus* n.sp. a specimens with a laterally elongated outline of the base: however it looks that their specimen is broken posterior close to the base, and that the basal outline was probably subtriangular, therefore fitting on the diagnosis of *Ps. beckmanni*.

In the studied material the outline of the base is more frequently elliptical or subtriangular, rarely circular and rectangular; all the intermediate forms have been observed, too. Furthermore, specimens with different basal outlines co-occur in the same sample, and no relationship between basal outline and stratigraphic levels occur. Therefore, it looks to be impossible to split the studied material in several taxa and all the specimens have been referred to as *Ps. beckmanni*.

Range - From Upper Ordovician to Lower Devonian (*serotinus* Zone, Emsian).

Studied material - 848 specimens.

Pseudooneotodus bicornis (Drygant, 1974)

Diagnosis (after Bischoff, 1986, slightly modified) - Unimembrate apparatus composed of squat conical elements with subtriangular to elliptical basal margin outline and with two apical tips.

Remarks - In the studied collections two well distinct morphologies are present, based on the distance between the apical tips. These two forms are proposed here as different subspecies: *Ps. bicornis contiguus*, with the tips very close to each other, is discriminated from *Ps. b. bicornis*, representing the "classical" form with discrete apical tips.

Pseudooneotodus bicornis bicornis (Drygant, 1974)
(Pl.1, Figs. 8-17)

- 1974 *Pseudooneotodus bicornis* n. sp. DRYGANT, p. 67, pl. 2, figs 40-48.
 1976 *Pseudooneotodus bicornis* Drygant - BARRICK & KLAPPER, p. 81, pl. 1, fig. 15.
 1977 *Pseudooneotodus bicornis* Drygant - COOPER, p. 1069, pl. 2, fig. 9, 11 (non fig. 8 = *Ps. b. contiguus*)
 1984 *Pseudooneotodus bicornis* Drygant - DRYGANT, p. 63, pl. 1, figs 8-11.
 1985 *Pseudooneotodus bicornis* Drygant - MABILLARD & ALDRIDGE, fig. 7e.
 1986 *Pseudooneotodus bicornis* Drygant - BISCHOFF, p. 234, pl. 27, figs 18-19, 21-27.
 1987 *Pseudooneotodus bicornis* Drygant - KLEFFNER, fig. 5.16 (non 5.14).
 1987 *Pseudooneotodus bicornis* Drygant - OVER & CHATTERTON, pl. 6, fig. 23 (only).
 1988 *Pseudooneotodus bicornis* Drygant - DEGARDIN, p. 260, pl. 2, figs 5-6.
 1990 *Pseudooneotodus bicornis* Drygant - ARMSTRONG, p. 114, pl. 18, figs 13-15 (non 10-12).
 1990 *Pseudooneotodus bicornis* Drygant - KLEFFNER, fig. 3.24.
 1995 *Pseudooneotodus bicornis* Drygant - BARCA *et al.*, pl. 4, fig. 14.
 1996 *Pseudooneotodus bicornis* Drygant - SANSOM, fig. 1i-j (only).
 1998a *Pseudooneotodus bicornis* Drygant - CORRADINI *et al.*, pl. 1.3.1, fig. 13.
 1998 *Pseudooneotodus bicornis* Drygant - FERRETTI *et al.*, pl. 2.2.1, fig. 10; pl. 2.2.2, fig. 13.
 1998b *Pseudooneotodus bicornis* Drygant - CORRADINI *et al.*, pl. 3.3.1, fig. 3.
 1998 *Pseudooneotodus bicornis* Drygant - MÄNNIK & MAŁKOWSKI, pl. 1, fig. 2.
 1999 *Pseudooneotodus bicornis* Drygant - COCKLE, p. 119, pl. 1, figs 3-4.
 2001 *Pseudooneotodus bicornis* Drygant - CORRADINI, p. 25, pl. 1, figs 7-13 (non figs 14-17 = *Ps. b. contiguus*).
 2003 *Pseudooneotodus bicornis* Drygant - CALNER & JEPSSON, p. 67, fig. 15m-q.
 2005 *Pseudooneotodus bicornis* Drygant - METZGER, pl. 1, fig. 2-3 (non fig. 4).

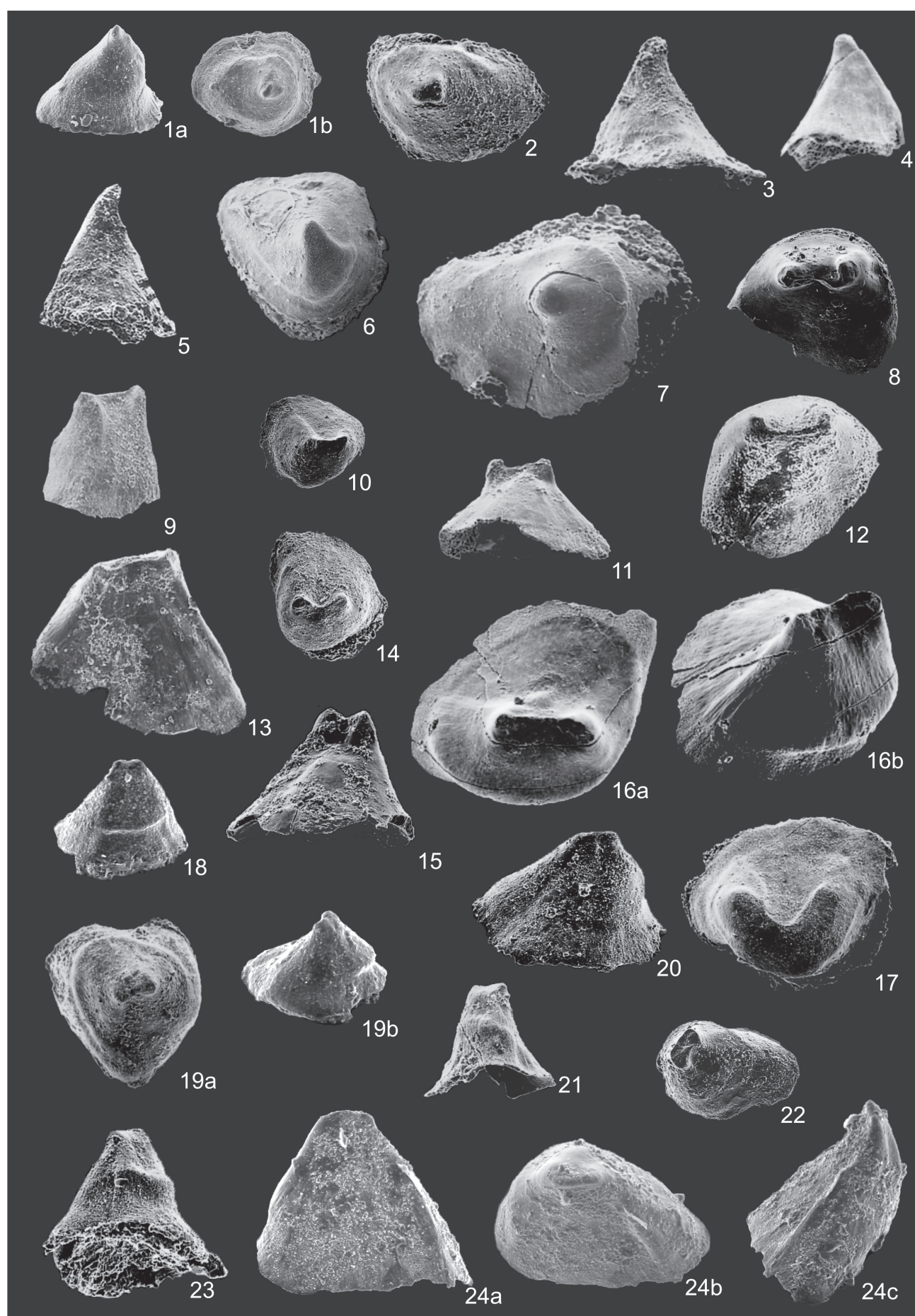
Description - Squat conical conodont element bearing two discrete tips in the apical part. The outline of the base is subtriangular to elliptical. In upper view, the tips of the apical part are located close to the anterior margin, therefore this part of the element is steeper than the posterior one. The apical tips may be separated, or connected by a ridge. The basal cavity is deep.

Remarks - The outline of the base is more frequently subtriangular or elliptical, but in a few specimens it is almost subcircular. A great variability in the apical part has been observed: in fact, the two tips are always well distinct, but they can be separated by a deep depression (Pl.1, figs. 8-10), or connected by a ridge; this ridge can be straight (Pl.1, figs. 13, 16), slightly (Pl.1, fig. 12), or strongly (Pl.1, fig. 17), curved, with the concavity facing the posterior side of the element. These apical features are present in specimens from all stratigraphic levels

EXPLANATION OF PLATE 1

- figs. 1-7 - *Pseudooneotodus beckmanni* (Bischoff & Sannemann).
 1 - Lateral (a) and upper (b) views of specimen IPUM 27678; sample MC II 1, *Oz. crispa* Zone.
 2 - Upper view of specimen IPUM 27971; sample GA 4A, *Pol. siluricus* Zone.
 3 - Lateral view of specimen IPUM 25868; sample SIL I° 7, *Pol. siluricus* Zone.
 4 - Lateral view of specimen IPUM 25870; sample ARG A, *Z. remscheidensis* Zone.
 5 - Lateral view of specimen IPUM 27972; sample NSF 1, *Z. remscheidensis* Zone.
 6 - Upper view of specimen IPUM 27973; sample MC II 6, *I. w. woschmidtii* Zone.
 7 - Upper view of specimen IPUM 27974; sample NSF 4, *Oul. el. detortus* Zone.
 figs. 8-17 - *Pseudooneotodus bicornis bicornis* Drygant.
 8 - Upper view of specimen IPUM 27976; sample SF 12, *Oz. sagitta* Zone.
 9 - Lateral view of specimen IPUM 25867; sample GCIU 9, *Oz. snajdri* Zone.
 10 - Upper view of specimen IPUM 27977; sample GA 7, *Oul. el. detortus* Zone.
 11 - Lateral view of specimen IPUM 25865; sample PF 6, *Oz. s. sagitta* Zone.
 12 - Upper view of specimen IPUM 25864; sample ARG 01, *Oz. s. sagitta* Zone.
 13 - Lateral view of specimen IPUM 25866; sample PF 1, *Oz. s. sagitta* Zone.
 14 - Upper view of specimen IPUM 27978; sample SIL I° 22, *Oz. snajdri* Zone.
 15 - Lateral view of specimen IPUM 27975; sample SAD BK 3, *Pt. amorphognathoides* Zone.
 16 - Upper (a) and upper-lateral (b) views of specimen IPUM 27980; sample SF BK 11, *Oz. s. sagitta* Zone.
 17 - Upper view of specimen IPUM 27979; sample SIL I° 23, *Oz. crispa* Zone.
 figs. 18-23 - *Pseudooneotodus bicornis contiguus* n.ssp.
 18 - Upper-lateral view of specimen IPUM 27985; sample SIL I° 26, *Z. remscheidensis* Zone.
 19 - Upper (a) and upper-lateral (b) views of the Holotype, IPUM 25869; sample SIL I° 23, *Oz. crispa* Zone.
 20 - Upper-lateral view of specimen IPUM 27983; sample SIL I° 23, *Oz. crispa* Zone.
 21 - Lateral view of specimen IPUM 27981; sample SIL I° 22, *Oz. snajdri* Zone.
 22 - Upper view of specimen IPUM 27982; sample GCIU 29, *Oz. crispa* Zone.
 23 - Lateral view of specimen IPUM 27984; sample SIL I° 23, *Oz. crispa* Zone.
 figs. 24 - *Pseudooneotodus linguicornis* Jeppsson.
 24 - Posterior (a), upper (b) and lateral (c) views of specimen IPUM 27986; sample SF 11, *Oz. sagitta* Zone.

All specimens x 100.



from which the taxon has been collected, therefore it cannot be interpreted as an evolutionary character, and its meaning is still unclear.

For discussion of differences with *Ps. b. contiguus* n.sp. see the latter subspecies.

In the studied collections, *Ps. b. bicornis* is abundant in the Wenlock, with an acme in the *Oz. s. sagitta* Zone; after that it is almost absent, and then reappear in the Ludfordian, slightly before the first occurrence of *Ps. bicornis contiguus*. The last record of *Ps. b. bicornis* is in the lower part of the *Oul. el. detortus* Zone.

Range - The species is known from the base of Wenlock (*Pt. amorphognathoides* Zone) to Přidoli (lower part of the *Oul. el. detortus* Zone).

Studied material - 551 specimens.

Pseudooneotodus bicornis contiguus n. ssp.
(Pl.1, Figs. 18-23)

- 1977 *Pseudooneotodus bicornis* Drygant - COOPER, pl. 2, fig. 8 (only)
1998 *Pseudooneotodus beckmanni* (Bischoff & Sannemann) - SERPAGLI et al., pl. 1.2.2, fig. 3 (only).
2001 *Pseudooneotodus bicornis* Drygant - CORRADINI, pl. 1, figs 14-17 (only).

Holotype - the specimen IPUM 25869, illustrated on Pl.1, fig. 19.

Locus typicus - Silius I Section, near the Silius village, SE Sardinia.

Stratum typicum - SIL I 23 (*Oz. crispa* Zone).

Derivatio nominis - from Latin *contiguus* = closely spaced.

Diagnosis - A subspecies of *Ps. bicornis* with the two tips very close each other.

Description - Squat conical conodont elements with two tips very close to each other in the apical part. The outline of the base is subtriangular to elliptical. The tips of the apical part are located closer to the anterior margin than to the posterior one, therefore this side of the element is much more steep than the posterior one. The basal cavity is very deep and occupies the complete lower part of the element.

Remarks - *Ps. bicornis contiguus* differs from the nominal species by having the two apical tips placed very close. In some specimens the tips are so close that they look similar to *Ps. beckmanni*, which has one single tip; however, a narrow trough in the upper part of the posterior side of the element allows to distinguish the two taxa.

Cooper (1977) and Jeppsson (1997) record the recovery of specimens of *Ps. bicornis* with very close apical tips. However, even if these authors do not indicate precisely the stratigraphic levels where their specimens have been recovered, their papers deal on Wenlock, therefore it is highly probable that this taxon appear

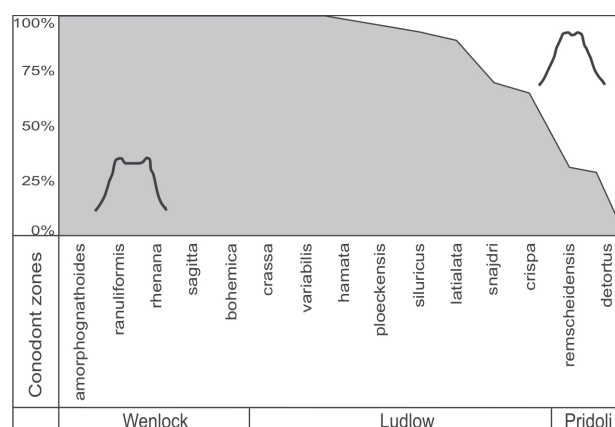


Fig. 3 – Relative abundance of *Ps. b. bicornis* (grey) and *Ps. b. contiguus* (white), plotted against biozones. Line drawings represent the oral outline of the two subspecies.

somewhere in lower Silurian.

In the studied material the First Occurrence of *Ps. bicornis contiguus* is in the upper part of the *siluricus* Zone, but the taxon is quite rare compared to *Ps. b. bicornis*. In the uppermost Ludlow (*snajdri* and *crispa* zones) it represents about one third of the collection of this Genus, while it is dominant during the Přidoli (Fig. 3).

Range - In the studied material *Ps. bicornis contiguus* occur from the upper part of the *P. siluricus* Zone to the upper part of the *Oul. el. detortus* Zone. An older occurrence can not be excluded.

Studied material - 164 specimens.

Pseudooneotodus linguicornis Jeppsson, 2003
(Pl.1, Figs. 24)

- 1998 *Pseudooneotodus* sp. n. L, MÄNNIK & MALKOVSKI, pl. 1, fig. 8.
2003 *Pseudooneotodus linguicornis* JEPSSON (in CALNER & JEPSSON), p. 194-196, fig. 15a-15l.

Remarks - *Ps. linguicornis* is characterized by a more or less elliptical cross section and a flattened posterior side. The apical tip is rounded and slightly recurved. The only specimen found fit well in the diagnosis and description of this species provided by Jeppsson (in Calner & Jeppsson, 2003).

Range - The species is known only from the *Oz. s. sagitta* Zone.

Studied material - 1 specimen.

CONCLUSIONS

The main results of this research are:

- the apparatus of *Pseudooneotodus* is reconstructed as unimembrate, on the basis of the unrelated distribution

of the different morphologies;

- three species (*Ps. beckmanni*, *Ps. bicornis* and *Ps. linguicornis*) have been discussed and illustrated;

- the new subspecies *Ps. bicornis contiguus* have been proposed: it is discriminated from the nominal species on the basis of morphological differences in the apical part.

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