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Belemnites of the genus *Actinocamax* Miller, 1823, from the Cenomanian of Poland

ABSTRACT: The belemnites of the genus *Actinocamax* Miller, 1823, and representing its subgenus *Praeactinocamax* Najdin, 1964, recorded from the Upper Cenomanian conglomerates from Glanów, Polish Jura Chain, are described. Two subspecies, *Praeactinocamax plenus plenus* (Blainville, 1827) and *P. primus primus* (Arkhangelsky, 1912) were identified. The stratigraphic ranges of these belemnites and some problems connected with the Actinocamax plenus Zone are discussed. Borings of the ichnospecies *Dendrina anomala* Mägdefrau, 1937, and *Calcideletrix breviramosa* Mägdefrau, 1937, found on the surface of the guards are interpreted as formed postmortally, when the guards were partly buried in the sea bottom.

INTRODUCTION

The present paper deals with paleontologic-stratigraphic problems concerning belemnites belonging to the subgenus *Praeactinocamax* Najdin, 1964, of the genus *Actinocamax* Miller, 1823, recorded from the Upper Cenomanian conglomerates at Glanów (Fig. 1), during studies on the transgressive Cretaceous deposits in the Polish Jura Chain. The preservation of the rostra collected, which was effected both by processes active in sedimentary environment and diagenetic processes, was also taken into consideration.

The surfaces of the rostra are partly corroded by pits of quartz grains and fine pebbles, like other skeletal remnants occurring in Cenomanian sandstones at Korzkiew near Cracow (*cf.* Radwański 1965, p. 187).

Besides pits, some borings belonging to the ichnospecies *Dendrina anomala* Mägdefrau, 1937 (*cf.* Pl. 1, Fig. 2) and *Calcideletrix breviramosa* Mägdefrau, 1937 (*cf.* Pl. 2, Fig. 2) were noted. It is of interest here, that these borings are limited to the ventral side of one specimen (Pl. 1, Fig. 1*a*)

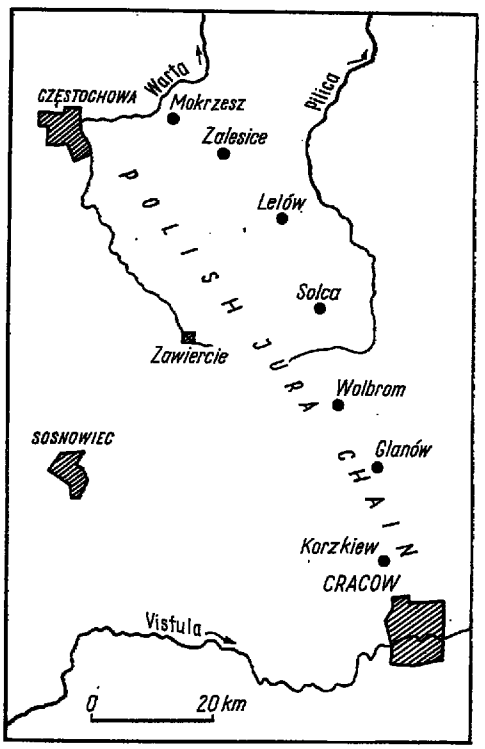

Fig. 1

Location map showing some Cenomanian exposures (dark circled) in the Polish Jura Chain

and to the dorsal and apical part of the rostrum of the other specimen (Pl. 2, Fig. 1*b*—*c*). Such distribution, as well as pelecypod encrustations (Pl. 1, Fig. 3) indicate that for a long time the guards were only partly buried in the sediment after the animal's death (*cf.* Fig. 2). This made

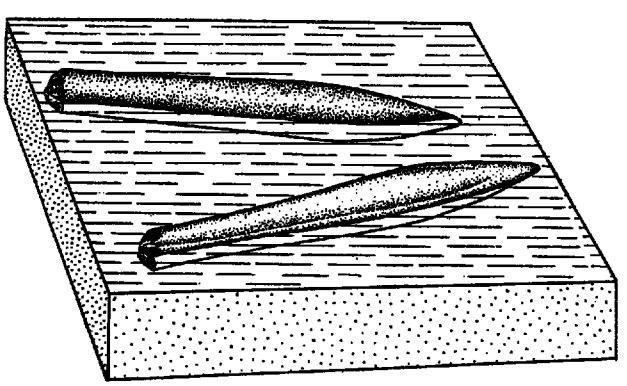

Fig. 2

Taphonomic situation presenting the investigated guards when lying, partly buried, in the bottom and partly exposed to the activity of boring organisms (further explanation in the text)

possible the boring activity of rather unknown organisms over the part of the rostrum stretching out of the deposit. In the view of the above facts, the opinion of Mägdefrau (1937) and Pugaczewska (1965) that borings of the ichnogenus *Dendrina* Mägdefrau, 1937, were made by parasites during the life of the belemnite, seems strongly questionable (*cf.* also Najdin 1969, Radwański 1972). The discussed borings *Dendrina anomala* Mägdefrau and *Calcideletrix breviramosa* Mägdefrau were not hitherto known from deposits older than Senonian (*cf.* Mägdefrau 1937, Häntzschel 1962, Pugaczewska 1965); the latter ichnogenus supposedly may also occur in the Cenomanian of England (Kennedy 1970).

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SYSTEMATIC DESCRIPTION

In this chapter the taxonomy used by Jeletzky (1948) and Najdin (1964) is applied.

The biometrical data of the specimens are abbreviated as follows (*cf.* Fig. 3*A*, *B*):

S — total length of rostrum,
LL — maximal width of rostrum, measured between sides,
DV — maximal width of rostrum, measured from dorsal to ventral side,
ll — rostrum width measured between sides close to pseudoalveola,
dv — rostrum width measured from dorsal to ventral side close to pseudoalveola,
$\frac{LL}{DV}$ — index of dorso-ventral flatteness of rostrum, measured in its widest section,
$\frac{ll}{dv}$ — index of dorso-ventral flatteness of rostrum, measured close to pseudoalveola,
$\frac{LL}{ll}$ — index of difference in rostrum thickness,
$\frac{S}{LL}$ — index of rostrum elongation.

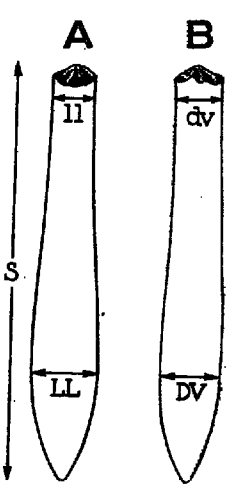

Fig. 3

Biometric measurements of the investigated belemnite guards
A dorsal or ventral view, *B* side view

Family **Belemnitellidae** Pavlov, 1914
Genus *ACTINOCAMAX* Miller, 1823
Subgenus *PRAEACTINOCAMAX* Najdin, 1965
Praeactinocamax plenus plenus (Blainville, 1827)
(Pl. 1, Fig. 1*a*—1*c*)

1853. *Belemnitella plena*, Blainv.; Sharpe, pp. 9—10, Pl. 1, Figs 12—16.
1872. *Belemnites lanceolatus*, Sow.; Fritsch, p. 18, Pl. 11, Fig. 6 (*non* Fig. 7).
1876. *Actinocamax plenus*, Blainv.; Schlüter, pp. 186—188, Pl. 52, Figs 16—19.
?1899. *Actinocamax plenus* Blainv.; Semenow, p. 93, Pl. 2, Fig. 2.
1964. *Praeactinocamax plenus plenus* (Blainville), 1827; Najdin, pp. 43—46, Pl. 1, Figs 1—2; Pl. 2, Figs 1—2.
1965. *Actinocamax plenus* (Blainville, 1827); Schmid, pp. 518—519, Pl. 53, Figs 2—3.

Material. — One, nearly complete rostrum and one fragment.
Biometry (all linear measurements in *mm*):

Specimen	*S*	*LL*	*DV*	$\frac{LL}{DV}$	*ll*	*dv*	$\frac{ll}{dv}$	$\frac{LL}{ll}$	$\frac{S}{LL}$
figured in Pl. 1, Fig. 1	76.4	10.9	9.9	1.10	7.8	8.7	0.90	1.40	7.01
(partly figured in Pl. 1, Fig. 3)		10.5	9.6	1.09					

Description. — Rostrum cylindrical in ventral view, attaining maximal thickness one-third of the length from the apical end, narrowing from here towards the front (*i.e.* pseudoalveolar part). In lateral view, rostrum is weakly asymmetrical, somewhat lanceolate. Dorsal margin straight; apical end shifted somewhat towards the dorsal side. Ventral side flat, whereas dorsal slightly convex close to pseudoalveola due to lateral flatteness of subalveolar part of the rostrum. Anterior and median, dorsal parts of the rostrum ornamented with indistinct, longitudinal striae. Pseudoalveola subtriangular in cross-section and developed in form of low cone with shallow, and very small cavity near the top. Surface of pseudoalveola covered with radial depressions and elevations. Pseudoalveola distinctly separated from the remaining parts of the rostrum; pseudoalveolar margin particularly sharp on the dorsal side and descends here a few milimeters posteriorly. Lack of ventral fissure. Dorso-lateral furrows wide, flat and very indistinct; continue posteriorly over one-third of the rostrum length.

Affinities. — Najdin (1964) established three subgenera of the genus *Actinocamax* Miller, 1823, *viz.* nominative subgenus *Actinocamax* Miller, 1823, and two new subgenera, *Praeactinocamax* Najdin and *Paractinocamax* Najdin, differing in a number of features and stratigraphic ranges. Forms belonging to the subgenus *Praeactinocamax* Najdin are characterized by a significant individual variability due to wide geographic distribution and, perhaps, sexual dimorphism (Najdin 1964). The subgenus *Praeactinocamax* Najdin includes two species, *P. plenus* (Blainville, 1827) and *P. primus* (Arkhangelsky, 1912). The species *P. plenus* (Blainville) differs from *P. primus* (Arkhangelsky) in generally larger size and more lanceolate shape of the rostrum (Jeletzky 1948, Birkelund 1957), smaller index of rostrum elongation $\left(\frac{S}{LL}\right.$ equal 4.5—7, rarely more, in *P. plenus* in comparison to 7—12.5 in *P. primus*), and larger apical angle (Najdin 1964). Moreover, the stratigraphic range is different, because *P. primus* (Arkhangelsky) is confined to the Middle Cenomanian and lower parts of the Upper Cenomanian, whereas *P. plenus*, derived from the former, is

known from the Upper Cenomanian and Lower Turonian (Jeletzky 1948, Birkelund 1957, Najdin 1964, Christensen 1970) [1].

Remarks. — The specimens studied correspond to descriptions and figures given by Fritsch (1872, Pl. 11, Fig. 6), Schlüter (1876, Pl. 52, Fig. 19), and Najdin (1964, Pl. 1, Figs 1—2), hence (*cf.* synonymy) their affiliation with the subspecies *Praeactinocamax plenus plenus* (Blainville) is confirmed. Their index of rostrum elongation is high, thus they represents forms with slender rostrum within this subspecies.

Moreover, forms figured by Schmid (1965, Pl. 53, Figs 2—3), corresponding to the author's specimens in shape and size of the rostrum, are also included in the synonymy. The author reexamined the specimen identified by Cieśliński (1959, Pl. 3, Fig. 2) as *Actinocamax plenus* (Blainville), housed in the Museum of the Polish Geological Survey, but the specimen is unsufficiently preserved for subspecific determination. The same may be said in the case of *Actinocamax plenus* (Blainville) previously cited from Zalesice by the present author (Marcinowski 1970).

Occurrence. — *Praeactinocamax plenus plenus* (Blainville) was found in the Upper Cenomanian conglomerates at Glanów, 1 meter below the occurrence site of *Inoceramus labiatus* Schlotheim (locality no. 108*c*, set 2*c*) [2]. This subspecies has not hitherto been reported from Poland. Forms generally identified as *Actinocamax plenus* (Blainville) were cited in Poland from the Cretaceous deposits of the Lwówek Basin (Löwenberger Mulde) in Lower Silesia (Williger 1881, Scupin 1912—1913, Häntzschel 1933) [3], from the Upper Cenomanian and lowermost Turonian of the northern margin of the Holy Cross Mts (Cieśliński 1959, 1965; Cieśliński & Pożaryski 1970), from the Upper Cenomanian of Burzenin area, western part of the Łódź synclinorium (Cieśliński 1958) and from the Upper Cenomanian at Poręba Dzierżna and Sławniów (Sujkowski 1929), and Zalesice in the Polish Jura Chain (Marcinowski 1970) [4].

Praeactinocamax plenus plenus (Blainville) is also known from the Upper Cenomanian and Lower Turonian of England (Sharpe 1853), Saxony and Bohemia (Fritsch 1872, Schlüter 1876, Schmid 1965) and Kazakhstan (Semenow 1899, Najdin 1964). It should be noted that although this subspecies is known both from Western Europe and Poland and from Kazakhstan, it has not been recorded from the European part of the Soviet Union (*cf.* Najdin) [5].

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[1] Najdin (1964) defined the range of *P. primus* (Arkhangelsky) as upper part of the Lower Cenomanian to lower part of the Upper Cenomanian, but he applied bipartite subdivision of the Cenomanian. Hence, it more or less corresponds to the stratigraphic range given by Birkelund (1957) and Christensen (1970), applying tripartite subdivision.

[2] The number of localities and lithologic members are taken from the author's paper (*in preparation*) on the transgressive Cretaceous deposits of the western margin of the Miechów synclinorium, from Częstochowa to Glanów (Polish Jura Chain).

[3] Of these authors it was only Scupin who figured (Scupin 1912—1913, pp. 92—93, Text-fig. 8) a broken and poorly preserved guard of *Actinocamax plenus* (Blainville) from the Upper Cenomanian (Plenus-Mergeln) at Jaglarz (Hirseberg) near Lwówek; its subspecific determination is however impossible.

[4] Schlüter (1876, p. 187) after Pusch (1837) stated that this species is known in Poland under the name of *Belemnites lanceolatus* Sow., which evidently is a mistake, because Pusch (1837, p. 162) cited *Belemnites lanceolatus?* Sow. from the Dogger of the Częstochowa area and therefore these forms surely cannot belong to the genus *Actinocamax* Miller.

[5] The forms recorded from the Upper Cenomanian and Lower Turonian of the European part of the Soviet Union belong to different subspecies (see below)

Praeactinocamax primus primus (Arkhangelsky, 1912) (Pl. 2, Fig. 1*a*—1*c*)

1912. *Actinocamax primus* Arkh.; Arkhangelsky, pp. 578—581, Pl. 10, Figs 1—2, 4—5 (*non* Fig. 3).
1948. *Actinocamax primus* Arkhangelsky; Jeletzky, p. 340, Text-fig. 1.
1957. *Actinocamax primus primus* Arkhangelsky, 1912; Birkelund, pp. 9—12, Pl. 1, Figs 1—2, 4.
1964. *Praeactinocamax primus primus* (Arkhangelsky), 1912; Najdin, pp. 56—60, Pl. 1, Fig. 9; Pl. 2, Figs 3—4, 7.
?1970. *Actinocamax primus* Arkhangelsky, 1912; Christensen, pp. 70—73, Text-fig. 2.

Material. — One, nearly complete rostrum (partly destroyed by diagenetic pits).
Biometry (all linear measurements in *mm*):

Specimen	*S*	*LL*	*DV*	$\frac{LL}{DV}$	*ll*	*dv*	$\frac{ll}{dv}$	$\frac{LL}{ll}$	$\frac{S}{LL}$
figured in Pl. 2, Fig. 1	7.2	8.7	7.7	1.13	6.5	6.9	0.94	1.34	8.27

Description. — Rostrum elongated, with index of elongation relatively high $\left(\frac{S}{LL} = 8.27\right)$, spindle-like in ventral view, attaining maximal width at one-third of the length from the apical end, gradually narrowing towards the anterior (*i.e.* pseudoalveolar part). Ventral side flat. Rostrum somewhat lanceolate in lateral view and dorso-ventrally flattened. Dorsal side slightly flattened in the widest section, becoming convex in its upper part, particularly close to the pseudoalveola. Where sculpture is preserved, fine, longitudinal striae may be observed on both dorsal and ventral side. Pseudoalveola in form of low cone with small depression on the top, rounded, trapezoidal in cross-section; longer axis of the trapezoid marks dorso-ventral direction. Surface of pseudoalveola covered with radial depressions and elevations, and concentrical rings (somewhat obliterated in the investigated specimen). Pseudoalveola separated from the rest of rostrum with distinct margin. Ventral fissure very weakly developed, in the from of short incision of pseudoalveolar margin, passing posteriorly in flat depression, about 5 mm long. Dorso-lateral furrows well developed, continue up to half of the rostrum length, slightly posteriorly bending towards the ventral side.

Affinities. — *Praeactinocamax primus primus* (Arkhangelsky, 1912) is similar to the subspecies *P. primus elongatus* (Arkhangelsky, 1912) differing in smaller index of rostrum elongation $\left(\frac{S}{LL}\right)$ and higher apical angle (Arkhangelsky 1912, Jeletzky 1948, Birkelund 1957, Najdin 1964). The subspecies *P. primus curtus*, established by Najdin (1964), differs from two above subspecies in commonly shorter rostrum (Najdin 1964, p. 61).

Remarks. — The author's specimens are most comparable to forms figured by Birkelund (1957, Pl. 1, Fig. 1) and Najdin (1964, Pl. 2, Fig. 3).

A fragment of a very slender rostrum, characterized by a very low apical angle, found by the author, seems to be related to *P. primus elongatus* (Arkhangelsky) but it is too incomplete for determination with certainty.

Birkelund (1957) suggested that all specimens figured by Arkhangelsky (1912) as *Actinocamax primus* Arkh. (Arkhangelsky 1912, pp. 578—581, Pl. 10, Figs 1—5)

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and differ from typical *P. plenus plenus* (Blainville) in pseudoalveola indistinctly separated from the rest of rostrum, and commonly in a narrower subalveolar part and a slightly cancave anterior part of the rostrum (Najdin 1964).

belong to the subspecies *Praeactinocamax primus primus* (Arkhangelsky). However, according to Najdin (1964), Arkhangelsky's specimen figured in his Pl. 10, Fig. 3 should be included to the subspecies *P. primus elongatus* (Arkhangelsky); the latter viewpoint is accepted by the present author.

Christensen (1970) gives no reason for identifying his specimens to specific rank only; it follows from the synonymy and description of the material that these specimens most probably should be included to the subspecies *P. primus primus* (Arkhangelsky).

Occurrence. — *Praeactinocamax primus primus* (Arkhangelsky) was recorded from the same layer of the Upper Cenomanian conglomerates at Glanów as *P. plenus plenus* (locality no. 108c, set 2c). The species and subspecies under discussion is cited for the first time from Poland.

Praeactinocamax primus primus (Arkhangelsky) was hitherto known from the Middle and lower part of the Upper Cenomanian of Denmark (Birkelund 1957), Scania (Christensen 1970) and number of localities in the European part of the Soviet Union and Kazakhstan (Arkhangelsky 1912; Najdin 1960, 1964).

STRATIGRAPHIC SETTING OF DEPOSITS YIELDING *PRAEACTINOCAMAX PLENUS* (BLAINVILLE)

Stratigraphic setting of deposits with *Praeactinocamax plenus* (Blainville) and hence the vertical range of this species is still controversial. Some authors include all deposits yielding this species, *i.e.* the Actinocamax plenus Zone, to the Upper Cenomanian (Barrois 1875, Petrascheck 1905, Hancock 1969), whereas others include these deposits to the Lower Turonian (Hébert 1874, Spath 1926, Häntzschel 1933, Jefferies 1963). In turn, the third group of authors, particularly those studying the Cretaceous of Bohemia and Saxony, hold that *P. plenus* (Blainville) occurs in transitional beds between the Cenomanian and Turonian (Pietsch, *fide* Schmid 1965) and regard these beds as the separate Actinocamax plenus Zone (*cf.* Tröger 1967—1969), as do some English authors (*cf.* Kennedy 1969).

Moreover, correlation of deposits of the Actinocamax plenus Zone raises certain doubts. Tröger (1969) states that *Metoicoceras geslinianum* (d'Orbigny) has been occasionally recorded in Saxony and Bohemia from the upper part of this zone; hence, that upper part would correlate with the lower part of this zone in south-western and south-eastern England (*cf.* Hancock 1969, Table 1; and Kennedy 1969, Table 1).

In Najdin's opinion (1964), more accurate evaluation of the stratigraphic range of *P. plenus* (Blainville) will be possible after paleontologic elaboration of this index species, which comprises several subspecies differing in stratigraphic ranges. For example (*cf.* Najdin 1964), *Praeactinocamax plenus plenus* (Blainville), *P. plenus longus* Najdin, *P. plenus acutus* Najdin occur in the Upper Cenomanian and Lower Turonian, whereas the occurrence of *P. plenus triangulus* Najdin, *P. plenus crassus* Najdin

and *P. plenus contractus* Najdin is limited to deposits with *Mammites nodosoides* (Schlotheim) and *Inoceramus labiatus* Schlotheim of the Lower Turonian.

At Glanów, *P. plenus plenus* (Blainville) was recorded in deposits yielding *Schloenbachia* cf. *lymensis* Spath, the species known from the Upper Cenomanian only (*cf.* Spath 1926, Wright & Wright 1951, Cieśliński 1959, Kennedy 1969), and *P. primus primus* (Arkhangelsky). Co-occurrence of *P. plenus plenus* (Blainville) and *P. primus primus* (Arkhangelsky) indicates that these deposits belong to the lower part of the Actinocamax plenus Zone, since the former subspecies is known exclusively from the Upper Cenomanian and Lower Turonian, and the latter from the Middle and lower part of the Upper Cenomanian (*cf.* Jeletzky 1948, Birkelund 1957, Najdin 1964, Christensen 1970).

At Glanów, the upper part of the lithological member yielding the belemnites under discussion exhibits distinct traces of scouring and is overlied by laminated limestones. Therefore it may be presumed that deposition was impeded for a period of time in the sedimentary basin in the Glanów area, which resulted in a partial removal of the deposits, and this process was followed by a rapid change of lithofacies in the latest Cenomanian.

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BELEMNITY Z RODZAJU *ACTINOCAMAX* MILLER, 1823, Z CENOMANU POLSKI

(Streszczenie)

W pracy opisano belemnity (pl. 1, fig. 1*a*—1*c*; pl. 2, fig. 1*a*—1*c*) z rodzaju *Actinocamax* Miller, 1823, należące do podrodzaju *Praeactinocamax* Najdin, 1964, a mianowicie *Praeactinocamax plenus plenus* (Blainville, 1827) i *P. primus primus* (Arkhangelsky, 1912), które znalezione zostały w górnocenomańskich zlepieńcach w Glanowie (fig. 1). Omówiono zasięgi stratygraficzne tych belemnitów oraz zagadnienia związane z pozycją stratygraficzną poziomu Actinocamax plenus. Analizując występujące na powierzchni badanych rostrów drążenia (pl. 1, fig. 2; pl. 2, fig. 2) należące do ichnogatunków *Dendrina anomala* Mägdefrau, 1937, oraz *Calcideletrix breviramosa* Mägdefrau, 1937, zwrócono uwagę, iż utworzone one zostały po śmierci belemnitów, wówczas gdy rostrum spoczywało na dnie, częściowo pogrążone w osadzie (fig. 2).

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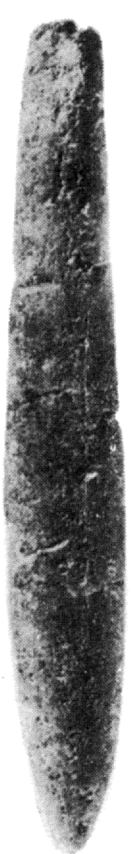
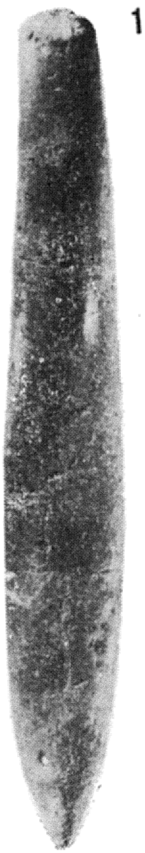
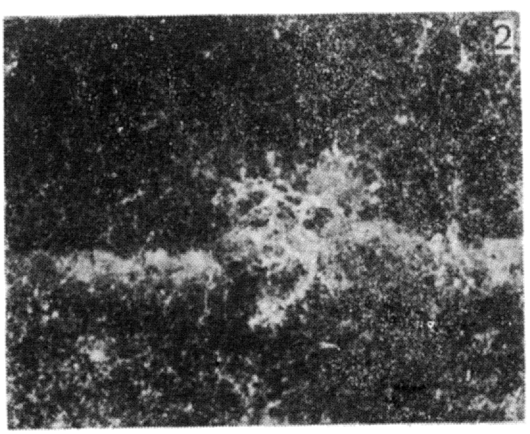




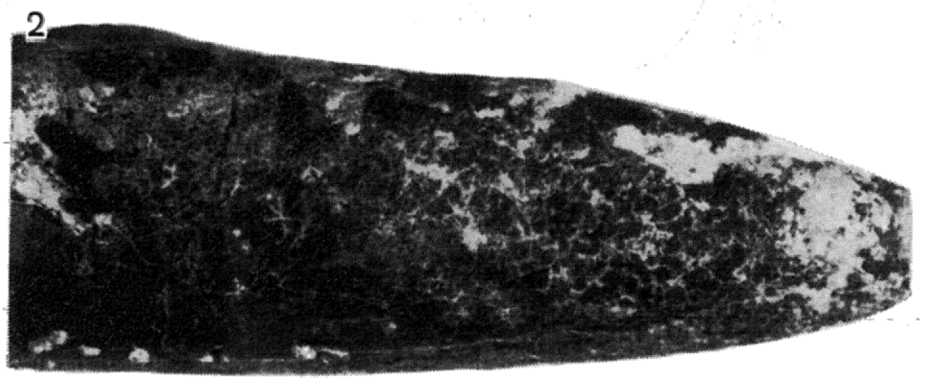


1a—c — *Praeactinocamax plenus plenus* (Blainville); Glanów, Upper Cenomanian — *a* ventral view, *b* side view, *c* dorsal view; × 1.5.

2 — Boring *Dendrina anomala* Mägdefrau in the guard of *Praeactinocamax plenus plenus* (Blainville) presented in Fig. 1 of this plate, × 10.

3 — Epizoic pelecypod, *Dimyodon nilssoni* (v. Hagenow), on the other guard of *Praeactinocamax plenus plenus* (Blainville); Glanów, Upper Cenomanian, × 3.

All photos taken by B. Drozd, M. Sc.



1a—c — *Praeactinocamax primus primus* (Arkhangelsky); Glanów, Upper Cenomanian — *a* ventral view, *b* side view, *c* dorsal view (the guard partly corroded by diagenetic pits); × 1.5.

2 — Borings *Calcideletrix breviramosa* Mägdefrau in the apical part of the guard of *Praeactinocamax primus primus* (Arkhangelsky) presented in Fig. 1 of this plate, × 5.

All photos taken by B. Drozd, M. Sc.