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Late Cretaceous nautilid beaks from near-shore/shallow water deposits of the Bohemian Cretaceous Basin (Czech Republic)

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ABSTRACT:

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More than 30 isolated nautilid jaws have been discovered in washed samples of late Cretaceous (Turonian) near-shore/shallow water deposits located in the southern part of the Bohemian Cretaceous Basin (BCB). Upper and lower jaws discovered in genetically-similar early Turonian deposits are described in detail herein. The nautilid jaw apparatuses comprise rhyncholites (upper jaws) assigned to *Nautilorhynchus simplex* (Fritsch), and conchorhynchs (lower jaws) assigned to *Conchorhynchus cretaceus* Fritsch. Some rhyncholites show signs of abrasion and corrosion, and may also form a substrate for sessile organisms. In one specimen, signs of acid digestion in the stomach of a predator were recognized. *N. simplex* is synonymized with "*Rhyncholithus*" *bohemicus* (Till), "*R*." *curvatus*" (Till), "*R"*. *rectus* (Till) and "*R"*. *curtus* (Till). The significant morphological variability observed in *N. simplex* is supported by biometric data. Although the jaws were not found associated with body chambers, it is inferred from the extremely low nautilid biodiversity across the Cenomanian/Turonian boundary interval in the BCB, and from the range and relative abundance of the only early Turonian nautilid taxon present, that the jaws are probably referable to the genus *Eutrephoceras* Hyatt and specifically to the common and long-ranging species *E. sublaevigatum* (d'Orbigny).

Key words: Cephalopoda; Nautilid jaws; Rhyncholites; *Nautilorhynchus*; *Conchorhynchus*; Upper Cretaceous; Czech Republic.

INTRODUCTION

Nautilid beak remains are uncommon fossils in the Bohemian Cretaceous Basin (BCB – Text-fig. 1) and have been only infrequently reported to date. Fritsch (in Fritsch and Schloenbach 1872) described and figured a new species of rhyncholite (upper jaw) – *Rhyncholithus simplex* Fritsch – from the locality Kamajka (2 specimens) and the now unavailable locality "Zbislav" (= Zbyslav – 10 specimens). This species was later also recorded from Saxony (Germany) by Geinitz (1874, p. 181, pl. 35/9) as *R. simplex*.

Frič (1911) figured *Rhyncholithus simplex* Fritsch from Kamajka. According to him, this species occurred only rarely at this locality, which he believed to be exclusively Cenomanian in age. Fritsch (1910) introduced a new generic name, *Nautilorhynchus*, which is utilised herein.

Till (1906, 1907, 1909, 1910) reviewed the cephalopod beaks then known, and established their modern taxonomy. Till (1906) erected a new species – *Rhyncholithus bohemicus* on the basis of slight differences (Till 1906, p. 143–144) from *R. simplex* Fritsch (see Taxonomy section below). He reported this species from the locality "Čáslav" (probably Kamajka near Čáslav). Another specimen from the same locality, which he described as *R.* cf. *simplex*, was retained in open nomenclature. According to Till (1906), these specimens came from Cenomanian marls. The stratigraphic position of nautilid beak finds is reviewed here and we suggest an alternative early Turonian age.

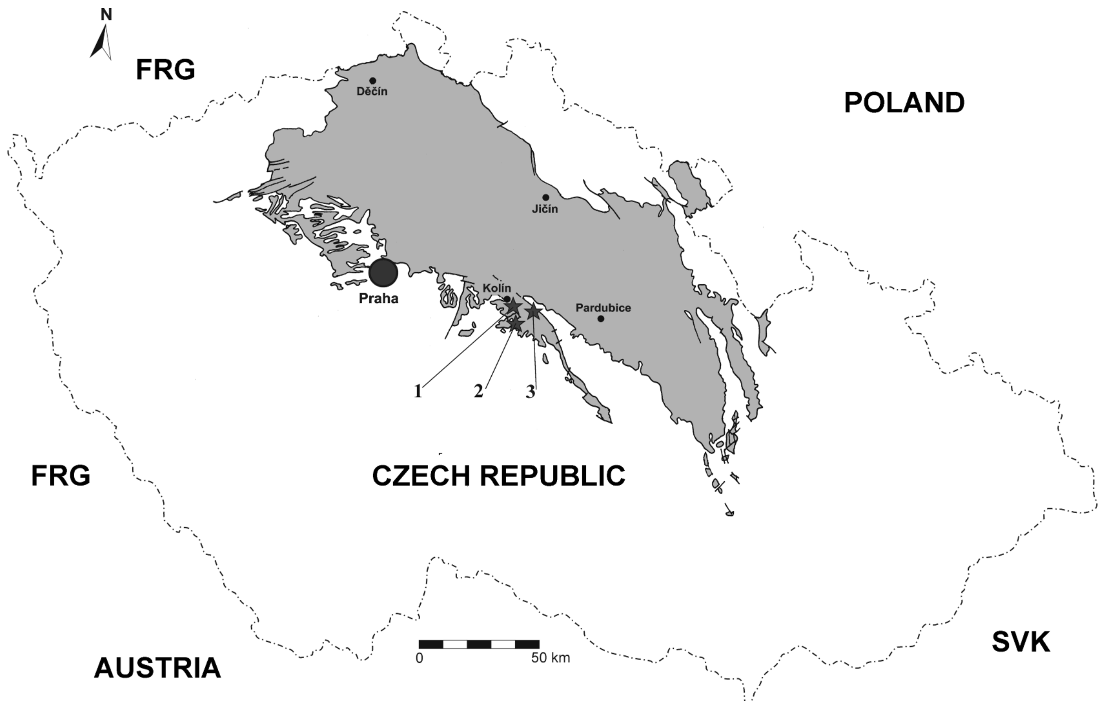
The conchorhynch (lower jaw) *Conchorhynchus cretaceus* Fritsch was described and figured for the first time by Frič (1897, fig. 61). The first valid name and short description must be ascribed to a monograph of Fritsch (1910). The holotype of Fritsch's *Conchorhynchus cretaceus* comes from the "Bílá Hora marls" ("Weissensteiner Schichten") located near Choceň and Vinary. Formerly, the Bílá Hora Marls (Bílá Hora Formation) were exclusively referred to as early Turonian. However, the Choceň and Vinary locations are now recognized as late Middle through to Late Turonian in age. In this respect, the specimen of *C. cretaceus* from the Lower Turonian succession of Velim described herein represents the earliest occurrence of this species.

There are four near-shore locations (including Zbyslav – not figured in Text-fig. 1) in the BCB where nautilid beaks have been recorded. A single rhyncholite specimen was quoted from the Upper Cenomanian deposits of the locality Předboj (Žítt *et al.* 1998). However, this specimen, reported by Nekvasilová (in Žítt *et al.* 1998) as *Rhyncholite* gen. et sp. indet., has been reviewed by the present authors, who find this indeterminate fragment resembles a rhyncholite in shape only and does not represent part of a cephalopod beak.

GEOLOGICAL SETTING

Cephalopod beaks have recently been collected from three localities in the southern margin of the BCB – Kamajka, Turkaňk and Velim (all approximately 60 km east of Prague, in the vicinity of Kolín – see Text-fig. 1), where near-shore sediments were deposited in depressions of the metamorphic basement. The sediments containing these cephalopod remnants are exclusively of early Turonian in age. The exact correlation between the localities is complicated by frequent non-sequences and the redeposition of earlier faunas. The sedimentation was also influenced by palaeo-hydrodynamics, palaeogeography, clast distribution and character, and the abundance of detrital material. (Žítt 1992; Žítt and Nekvasilová 1996). Biostratigraphy proved useful for correlation.

Generally, the horizons yielding cephalopod beaks are developed in a characteristic facies. Lithologically,



Text-fig. 1. Schematic map of the Bohemian Cretaceous Basin showing rhyncholite localities. 1 – Velim. 2 – Turkaňk. 3 – Kamajka these consist of organodetritic clayey limestones (Kamajka, Turkaňk) and/or calcareous siltstones with abundant organodetritus (Kamajka, Velim).

The rich fauna from the Velim locality was studied in detail by Žítt *et al.* (1997). The nautilid jaws were found to be associated with a particular faunal assemblage in each of the three localities (see Table 2). The components of these faunal assemblages are also comparable in their quantitative abundances. We therefore assume that the sedimentary units in question are either coeval or of broadly similar ages.

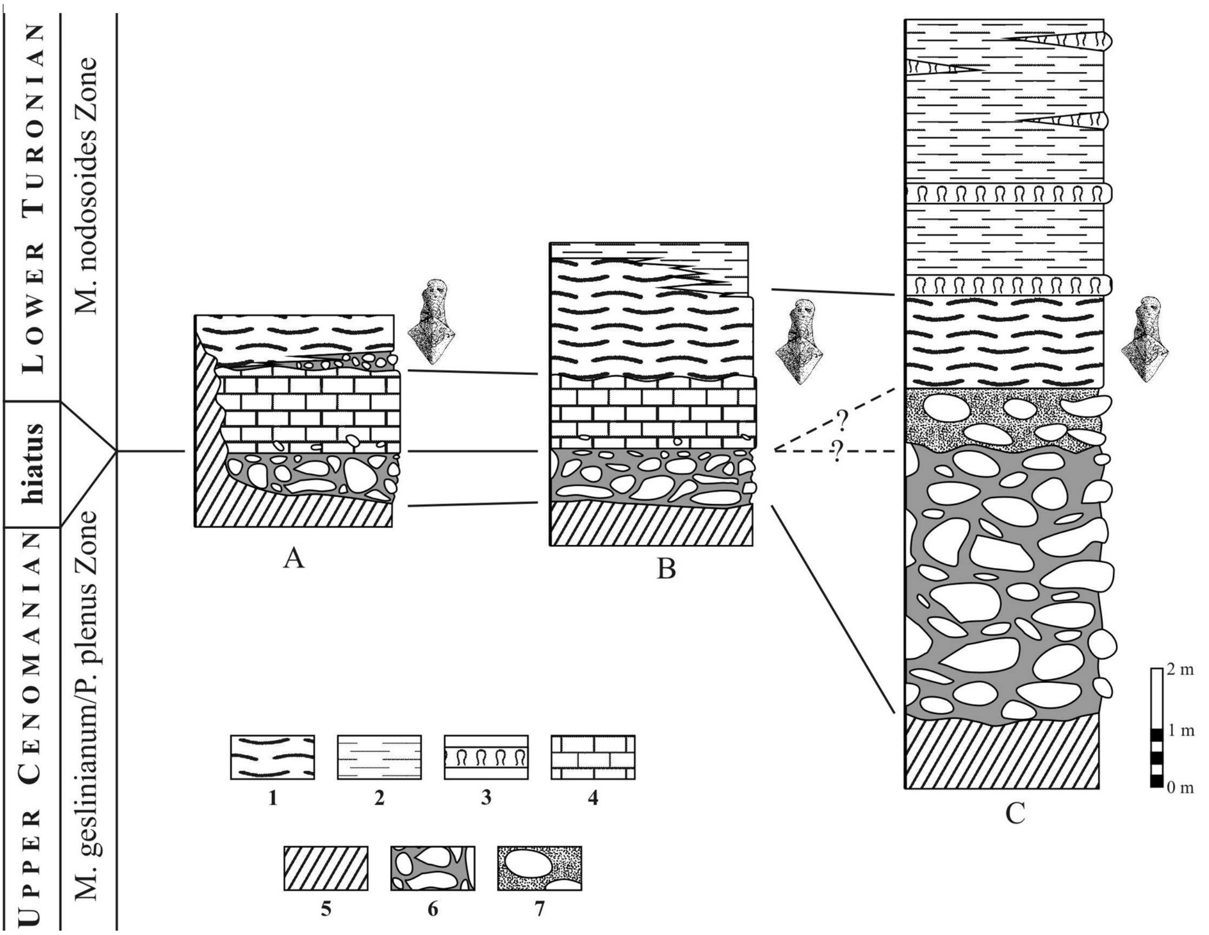
MORPHOLOGY AND TERMINOLOGY

The nautilid beak consists of upper (Text-fig. 3) and lower jaws. The relatively robust calcified beak part of the upper jaw (the so-called rhyncholite) is most commonly found fossil, while the less robust adjoining horny structures and wings are rarely preserved. Rhyncholite morphology was described in detail by Teichert *et al.* (1964), Gąsiorowski (1973a, b) and Klug (2001). Due to varying states of preservation, the variability of the shaft of the rhyncholite seems to be quite large.

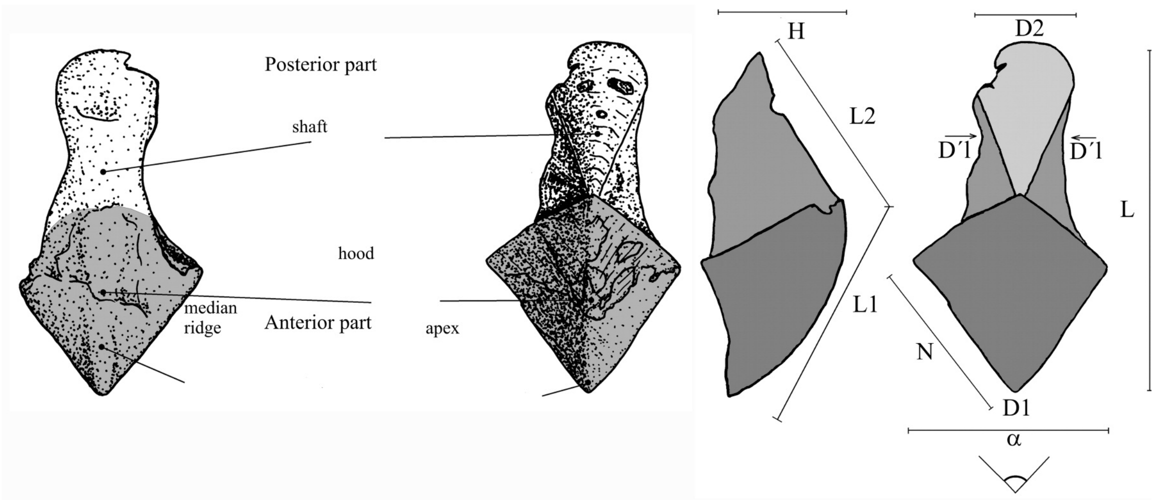
The lower jaw (conchorhynch) consists of horny material, which is usually only partly calcified. The walls of this jaw are thin. The conchorhynch consists of an anterior dentated cutting surface and a concave posterior extremity opposite the beak. The conchorhynch shape is usually nearly quadrangular. No shaft is present.

The upper and lower jaws are firmly joined together in life, and form a quadrangular projection (see also Teichert *et al.* 1964).

The morphology of the upper nautilid jaw from the BCB is shown in Text-fig. 3. The reconstruction of a complete beak (Text-fig. 8) is based on a pair of upper and lower jaws found very close to each other *in-situ* at Velim, which clearly represent the jaws of one nautilid beak.



Text-fig. 2. Stratigraphic position of rhyncholite localities. A – Turkaňk, B – Kamajka, C – Velim. 1 – Organodetritic clayey limestone. 2 – Marly siltstone with intercalation of phosphatized horizons. 3 – Sponge "meadows". 4 – Organodetritic limestone with calcitic-clayey matrix. 5 – Crystalline basement. 6 – Basal Cenomanian conglomerate. 7 – Redeposited Turonian conglomerate



Text-fig. 3. Morphology of the nautilid rhyncholite. A – Ventral view; B – Dorsal view. Position of measured dimensions: A – Lateral view; B – Dorsal view. L – rhyncholite length; L_1 – length of the hood; L_2 – length of the shaft; H – rhyncholite height; D_1– rhyncholite maximum width; D_2 – maximum width of the shaft; D'L – minimum width of the shaft; N – length of the hood margin; α – apical angle

TAXONOMY

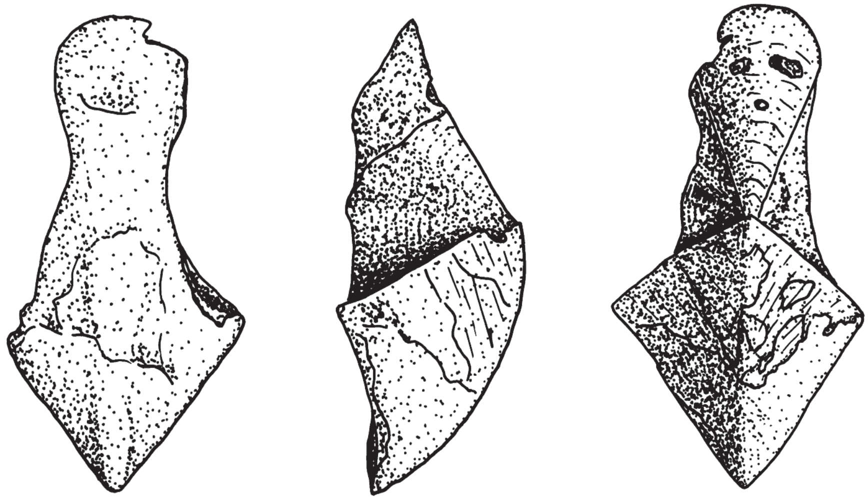
Class Cephalopoda Cuvier, 1797
Order Nautilida Agassiz, 1847
Family Nautilidae d'Orbigny, 1840

UPPER JAWS

Available names for nautilid upper jaws are *Rhyncholithes* de Blainville, 1827 (see discussion in Klug, 2001), *Scaptorhynchus* Bellardi, 1873 [Riegraf and Schmitt-Riegraf, 1995, 1998; (though unfortunately, the type species of *Scaptorhynchus* is established for a single corroded specimen – W. Riegraf, pers. com. in 2003)], *Nautilorhynchus* Fritsch, 1910 (which is followed in this paper), *Longocapuchones* Shimansky, 1947, and *Acutobeccus* Teichert and Spinosa, 1971 (written communication by I. Dieni (Padua) and W. Riegraf (Münster), 2003).

Nautilorhynchus Fritsch, 1910

DIAGNOSIS: Upper beak with relatively broad rhomb-shaped hood, elevated median upper part rounded to keel-like, lower surface with marked median ridge starting at the apex and widening in the middle part of the hood, gently to markedly concave, tip of the hood sharp. Shaft of equal length to the hood, dorsally convex, concave ventrally, triangular in side view.



Text-fig. 4. *Nautilorhynchus simplex* (Fritsch, 1872). Specimen No. IGP 01V001, A – Ventral view; B – Lateral view; C – Dorsal view. Length – 16 mm

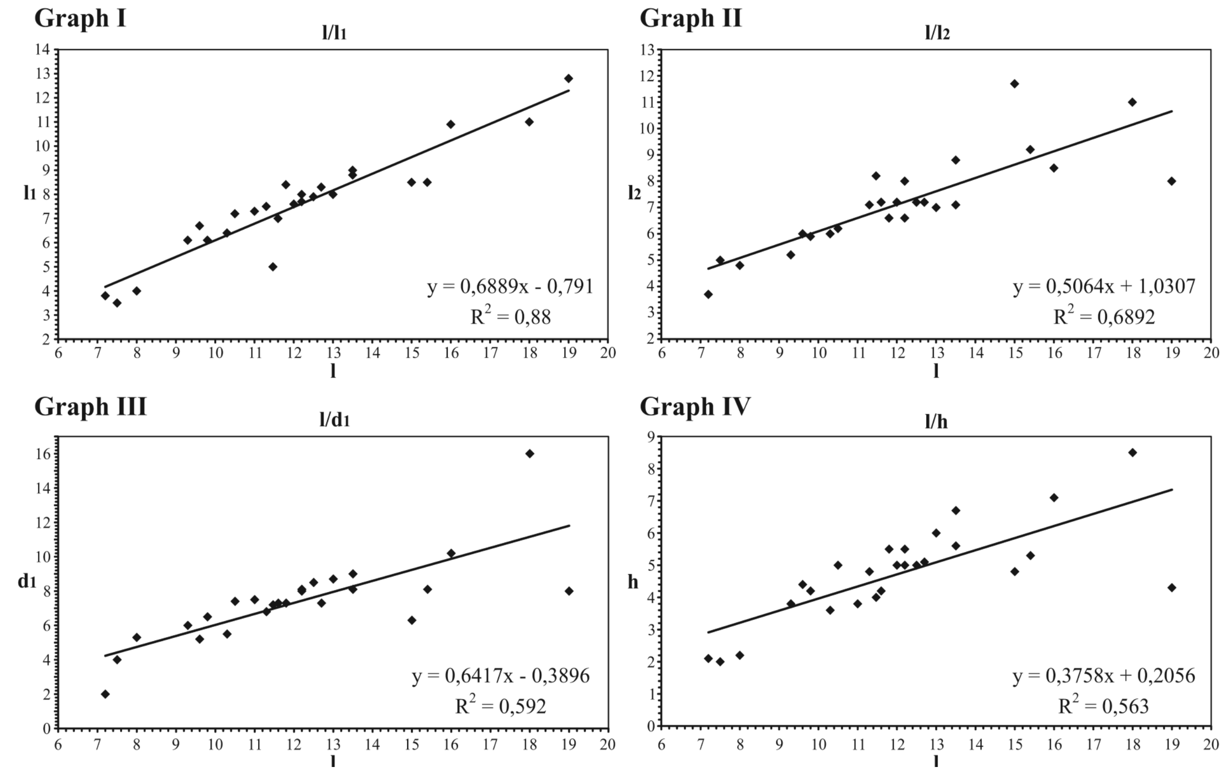
Nautilorhynchus simplex (Fritsch, 1872)
(Pl. 1, Figs 1–5, 8–13; Text-fig. 4)

1872. *Rhyncholithus simplex* Fritsch; Fritsch and Schlönbach, p. 25, pl. 11, figs 4, 5.
1874. *Rhyncholithus simplex* Fritsch et Schlönbach; Geinitz, p. 181, pl. 35, fig. 9 a–c.
1891. *Rhyncholithus simplex* Fritsch; Foord, p. 377.
1897. *Rhyncholithus simplex* Fritsch und Schlönbach; Leonhard, p. 57, pl. 6, fig. 1 a–c.
1906. *Rhyncholithes* cf. *simplex* Fritsch; Till, p. 144, pl. 5, figs 63–65.
1906. *Rhyncholithes bohemicus* nov. sp.; Till, p. 143–144, pl. 5, figs 59–61.
?1907. *Nautilus* (*Rh. curvatus*) nov. sp.; Till, p. 551–553, pl. 13, figs 3 a–c.
1907. *Nautilus* (*Rh. rectus*) nov. sp.; Till, p. 554–557, pl. 13, figs 4 a–c.
1907. *Nautilus* (*Rh. curtus*) nov. sp.; Till, p. 559, pl. 13, figs 5 a–c.
1911a. *Rhyncholithus simplex* Fritsch; Frič, p. 9, fig. 30.
1911b. *Rhyncholithus bohemicus* Till; Frič, p. 9.
1995a. *Rhyncolites curvatus* (Till); Riegraf and Schmitt-Riegraf, p. 50.
1995b. *Rhyncolites simplex* (Fritsch and Schlönbach); Riegraf and Schmitt-Riegraf, p. 53.
1995c. *Rhyncolites rectus* (Till); Riegraf and Schmitt-Riegraf, p. 52.

MATERIAL: 32 specimens from the localities of Kamajka, Velim and Turkaňk are housed in the collections of the Institute of Geology and Palaeontology, Charles University, Prague (Table 1).

DESCRIPTION: The length (**l**) of the rhyncholite varies between 7.5 and 16 mm, height (**h**) from 2 to 8.5 mm. The angle of the hood is usually between 70 and 90° (except for the abnormal specimen No. IGP 01T033 – Pl. 1, Figs 11–12). The complete biometric data are shown in Table 1.

The hood is rhomb-shaped, usually approximately the same length as the shaft, though in some specimens, the shaft is visibly longer than the hood (see Graphs I–II). The lateral sides of the hood are flat, becoming slightly elevated anteriorly (apically). The median dorsal hood crest is concave, becoming increasingly concave anteriorly. The lateral hood edges are straight in the posterior hood margin, becoming more concave apically. The marked median ridge on the ventral side of the rhyncholite begins at the apex and diverges posteriorly. At the transition of the hood and shaft, this median ridge forms a very flat elevation. Growth lines are



Text-fig. 5. Graphs I – IV. Scattergram plots of rhyncholite (*N. simplex*): 1) length (L) and length of the hood (L_1); 2) length (L) and length of the shaft (L_2); 3) length (L) and width (D_1); 4) length (L) and height (H). Regression lines are enclosed as the correlation coefficient (R). It shows high degree of intraspecific variation (namely marked in graphs II–IV)

Locality	L	L1	L2	D'L	D1	D2	H	α	N	Item
N. simplex										
1. Velim	16	10.9	8.5	4	10.2	5.2	7.1	76	6.9	IGP 01V001
2. Velim	13.5	9	8.8	3.7	9		6.7	87	7.3	IGP 01V002
3. Velim	18	11	11	5.6	16	5.7	8.5	72	9.2	IGP 01V003
4. Velim	13	8	7	4.2	8.7		6	82	7.1	IGP 01V004
5. Velim	15	8.5	11.7	3.6	6.3		4.8	73	6.3	IGP 01V005
6. Velim		12			12		5.8	92	10.2	IGP 01V006
7. Turkaňk	10.3	6.4	6	2.3	5.5	2.9	3.6	75		IGP 01T006
30. Turkaňk		10			9.7		7.3	74	8.3	IGP 01T031
31. Turkaňk	7.2	3.8	3.7	2	2	3.5	2.1	68	3.6	IGP 01T032
32. Turkaňk	9.6	6.7	6		5.2	2.6	4.4	56	5.6	IGP 01T033
8. Kamajka	19	12.8	8	3	8	2.6	4.3	74	5	IGP 01K008
9. Kamajka	8	4	4.8	2.6	5.3	2.4	2.2	88	4	IGP 01K009
10. Kamajka	12.2	8	6.6	3.3	8.1	3.7	5	80	6.7	IGP 01K010
11. Kamajka	12.5	7.9	7.2	4	8.5	4.3	5	75	6.9	IGP 01K011
12. Kamajka	12.7	8.3	7.2	3.1	7.3	3.4	5.1	78	6.9	IGP 01K012
13. Kamajka	15.4	8.5	9.2	3.3	8.1	4.5	5.3	71	7.7	IGP 01K013
14. Kamajka	11.3	7.5	7.1	3.3	6.8	2.8	4.8	76	5.9	IGP 01K014
15. Kamajka	9.8	6.1	5.9	3.3	6.5	3.5	4.2	80	5	IGP 01K015
16. Kamajka	11.8	8.4	6.6	2.5	7.3	3	5.5	72	6.4	IGP 01K016
17. Kamajka	12	7.6	7.2		8.2	2.8	5	72	6.8	IGP 01K017
18. Kamajka	9.3	6.1	5.2	2.9	6	3.4	3.8	78	5	IGP 01K018
19. Kamajka	12.2	7.7	8	4.2	8	4	5.5	89	6.4	IGP 01K019
20. Kamajka	7.5	3.5	5	1.9	4	1.5	2	79	3.7	IGP 01K020
21. Kamajka		11			8.4		6.2	70	8.3	IGP 01K021
22. Kamajka	11.6	7	7.2	2.3	7.3	2.3	4.2	80	5.9	IGP 01K022
23. Kamajka	11	7.3			7.5		3.8	80	7.5	IGP 01K023
24. Kamajka		7.3			7.6		4.7	71	6.7	IGP 01K024
25. Kamajka	10.5	7.2	6.2	2.6	7.4	2.3	5	76	6.1	IGP 01K025
26. Kamajka	11.5	5	8.2	2.8	7.2	3	4	85	6	IGP 01K026
27. Kamajka	13.5	8.8	7.1	3.7	8.1	3.9	5.6	81	6.6	IGP 01K027
28. Kamajka		5.5			6		3.7	90	4.8	IGP 01K028
29. Kamajka		8.1			8.6		5	80	6.9	IGP 01K029
N. cf. *simplex*										
1. Kamajka	6.3	4	3		3.6		1.4	25	6.4	IGP 01K02/1

Table 1. Measurements of the studied specimens; see Text-fig. 3 for explanation; all dimensions are in mm

apparent at the margins of the median ridge. The posterior margins of the hood are straight, and slightly oblique towards the apex, forming a divergent V-shape in cross-section. The wings are large, wide and sharply bordered. Growth lines are apparent in the lateral sides of the hood, though they are occasionally covered with mineralized organic matter. The hood growth lines demonstrate isometric growth of the rhyncholite. The tip of the hood is sharp. In some specimens, 'star'-like structures (probably caused by diagenesis or boring organisms) are developed at the tip.

The width of the shaft is markedly less than that of the hood. A median furrow is not developed. The opening angle of the shaft is smaller anteriorly. The shaft is laterally slightly convex. The contraction of the shaft is apparent approximately in the middle of the dorso-ventral view. The flanks of the shaft are smooth. Growth lines may be evident on the flanks of abraded specimens. Shallower ridges are developed on both flanks of the shaft and diverge towards the ventral shaft margins. The ventral edges of the shaft are sharply bordered on the ventral side. The shaft margin is bent towards the dorsal side. The posterior part of the shaft is dorsally regularly convex. The ventral side of the shaft is flat and smooth. It forms a shallow, very flat depression in the posterior part.

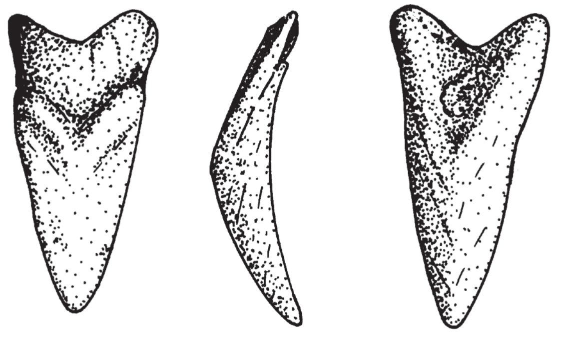
DISCUSSION: *N. simplex* (Fritsch, 1872) shows some morphological similarities to the Maastrichtian "*Rhyncolites*" *cretaceus* (v. Hagenow, 1842), "*Rhyncolites*" *compressus* (Giebel, 1851) and "*Rhyncolites*" *tilli* (Rüger, 1926). Till (1907) described several new species of "*Nautilus*" jaws which are synonymized herein (see below). Riegraf and Schmitt-Riegraf (1995) placed *R. rectus* (Till, 1907) and *R. curvatus* (Till, 1907) in synonymy. In this paper, we synonymize *R. curtus* (Till, 1907) with *R. simplex*. *R. curvatus* was described on the basis of a single specimen from Schöppenstedt (Germany, SE Lower Saxony). It is quite similar to our specimen IGP 01T033 (Pl. 1, Figs 11, 12) with regard to rhyncholite shape and size. The shaft is abraded in the specimen figured by Till (1907, p. 551). A comparable abrasion was observed in IGP 01T033 from Turkaňk (BCB). This specimen has a very acute apical angle (56˚) of the hood compared to more typical specimens of the same species (70–90˚). Thus, the variability of *R. simplex* is quite large, caused partly by the state of preservation and also by intraspecific variability – comparable to that of Recent *Nautilus pompilius* rhyncholites (see Saunders *et al.* 1978). The morphology of *R. rectus* and *R. curtus* fully corresponds to that of typical examples of *R. simplex*.

DISTRIBUTION: *N. simplex* is predominantly known from the Lower Turonian of the BCB and Saxony, however new finds from the BCB show a greater stratigraphic range from Lower to Upper Turonian (i. e. Úpohlavy quarry, NW Bohemia, *Subprionocyslus neptuni* Zone–authors' unpublished observation). Synonymized specimens figured and described by Till (1907) came from Germany (Lower Saxony) and England. Leonhard (1897) also described *N. simplex* from Upper Silesia (Poland). The synonymising of *R. curvatus* with *N. simplex* further extends its probable range to include the Albian of the UK (Till 1907, p. 553).

Nautilorhynchus cf. *simplex* (Fritsch, 1872)
(Pl. 1, Fig. 14; Text-fig. 6)

MATERIAL: A single rhyncholite from Kamajka. It is housed in the collections of the Institute of Geology and Palaeontology, Charles University, Prague, as item IGP 01K02/1.

DISCUSSION: This specimen is incomplete. However, the abrasion is not greater than in the specimens of *Nautilorhynchus simplex* (Fritsch) studied. The specimen shows a higher degree of corrosion, caused less by diagenesis, but rather by biological digestion. Similar finds were published by Riegraf and Schmitt-Riegraf (1995; pl. 3, fig. 3; pl. 4, fig. 3; pl. 9, fig. 2; pl. 19, figs 2–3; pl. 38, figs 2h–o; pl. 23, fig 6.). The resultant shape was created by acid digestion in fish, shark or marine reptile stomachs. Riegraf and Schmitt-Riegraf (1995) reported a specimen preserved in the gut area of a *Hybodus* from the Lower Toarcian Posidonienschiefer Formation, Holzmaden (SW Germany). The specimen from Kamajka was later exposed on the sea bottom, where it served as a hard substrate for the agglutinating foraminifera *Acruliammina longa* (Tappan) (Text-fig. 6).



Text-fig. 6. *Nautilorhynchus* cf. *simplex*. Specimen No. IGP01K02/1 showing traces of biological digestion. A – Ventral view; B – Lateral view; C – Dorsal view. Length – 6.3 mm

LOWER JAW

GENUS: *Conchorhynchus* de Blainville, 1827

TYPE SPECIES: *Conchorhynchus ornatus* de Blainville, 1827

Conchorhynchus cretaceus Fritsch, 1910
(Pl. 1, Figs 6–7, 13; Text-fig. 7)

?1870. *Rhynchotheutis* n. sp., Frič, p. 184.
1897. *Conchorhynchus cretaceus* Fr.; Frič, p. 223, fig. 61.
1910. *Conchorhynchus cretaceus* Fritsch; Fritsch, pl. 5, fig. 11.
?1910. *Conchorhynchus cretaceus* Fritsch; Fritsch, pl. 5, figs 10, 12.
non 1910. *Conchorhynchus cretaceus* Fr.; Fritsch, pl. 10, fig. 10.
1910. *Rhynchoteuthis cretacea* Fr.; Fritsch, p. 15.
1910. *Rhynchoteuthis cretacea* Fr.; Fritsch, pl. 10, fig. 8.
?1964. *Nautilorhynchus* Frič; Teichert *et al*., p. 478.

MATERIAL: A single conchorhynch from the locality of Velim, (personal collection of Mr. O. Karoušek), temporarily housed in the collections of the Institute of

Geology and Palaeontology, Charles University Prague under the registration number IGP 01K001.

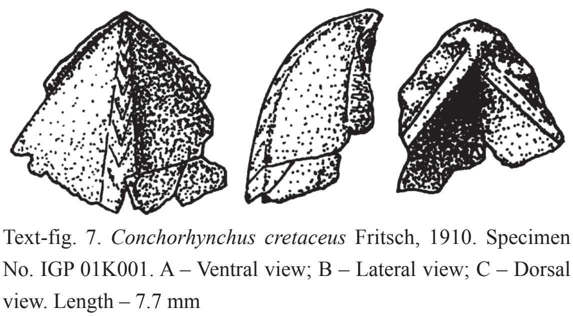
DESCRIPTION: The preserved portion of the conchorhynch (L – 7.7 mm, h – 4.7 mm, D – 6.8 mm) is beak-shaped. The anterior part is sharp, with a tubercle developed at the nose. The apex is bordered by a hem, and represents the rest remainder of the reflexed rim. The thickness of the anterior margin (i.e. from the conchorhynch margin through the whole margin = margin of the occludent surface), does not exceed 2 mm. In the middle of the lower side of the conchorhynch, the median ridge is fully developed. This ridge diverges slightly towards the posterior part. Biserial ribs and very shallow depressions between them are developed on its surface. They connect in the middle (axis) and form a recurrent V-shape. Two barely visible ribs are developed on the lateral sides of the conchorhynch surface. They start in the apex area and continue towards the posterior. They form an acute angle with the conchorhynch margin. Between these ribs and the conchorhynch margin, a rough surface is developed and very small parallel furrows are seen.

The occludent surface is largely smooth, with serrations developed only in the anterior part. Three small tubercles are apparent on both sides of the anterior part. In dorsal view, the anterior part is V-shaped (approximately 90°). The dorsal side of the conchorhynch (occludent surface) duplicates the shape of the rhyncholite (see Pl. 1, Fig. 13).

DISCUSSION: Mesozoic and Cenozoic conchorhynchs show a stable (conservative) morphology of the mineralized part. *Conchorhynchus cretaceus* Fritsch resembles the middle Triassic *C. ornatus* de Blainville and *Conchorhynchus avirostris* (von Schlotheim) in shape. It differs chiefly in the characters of the occludent surface. They are straight in *C. cretaceus* and slightly concave in *C. ornatus*. In addition, the serration preserved is slightly different. Marked differences are apparent in the median ridge. No keel is developed in the axial part in *C. cretaceous*. Small biserial ribs are developed in *C. cretaceus* as opposed to biserial pits in *C. ornatus*.

The illustrations of Fritsch's specimens (one figured 1910, pl. 10, fig. 10 as "*Nautilus* Oberkiefer" of *Rhynchoteuthis cretacea* Fritsch; and a second, 1910, pl. 5, fig. 12 as questionably *Conchorhynchus cretaceus* Fritsch) differ slightly from our specimen. The first-mentioned specimen (see above) has a smooth surface. The second differs in a slightly changed serration and in the angle of the occludent surface margins.

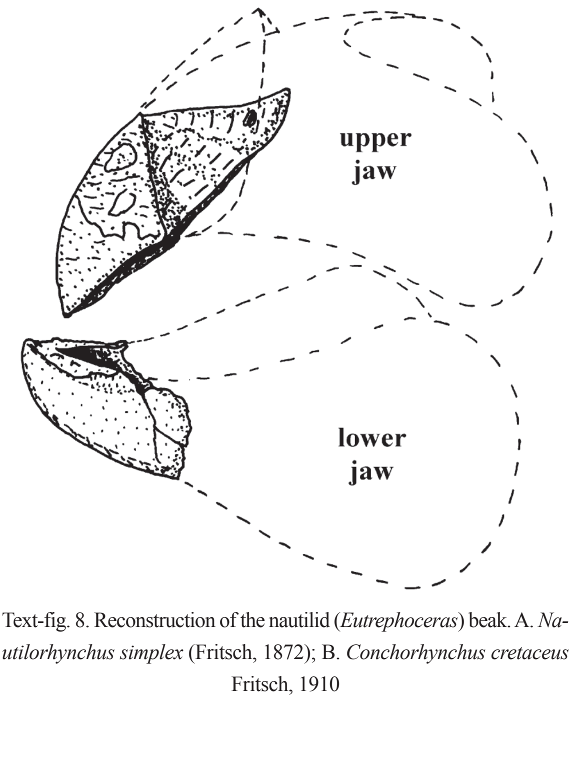
DISTRIBUTION: *Conchorhynchus cretaceus* Fritsch is known from the Lower (*Mammites nodosoides* zone) to Upper Turonian (*Subprionocyclus neptuni* Zone) in the BCB (Czech Republic). However, the stratigraphic range might be extended in future.



Text-fig. 7. *Conchorhynchus cretaceus* Fritsch, 1910. Specimen No. IGP 01K001. A – Ventral view; B – Lateral view; C – Dorsal view. Length – 7.7 mm

***Nautilorhynchus simplex* (Fritsch) and *Conchorhynchus cretaceus* Fritsch belong to one beak**

It is certain that *Conchorhynchus cretaceus* Fritsch and *Nautilorhynchus simplex* (Fritsch) belong to one nautilid cephalopod (cf. Recent *Nautilus pompilius* jaws, Saunders *et al.* 1978) and represent the lower and upper jaw respectively. Both jaws correspond perfectly (see Text-fig. 8; Pl. 1, Fig. 13). They were found together at the Velim locality in the same horizon, albeit the body chamber of the nautilid was not found. The two associated nautilid beak components from Velim supplement finds from the Toar-



Text-fig. 8. Reconstruction of the nautilid (*Eutrephoceras*) beak. A. *Nautilorhynchus simplex* (Fritsch, 1872); B. *Conchorhynchus cretaceus* Fritsch, 1910 cian and Kimmeridgian of SW Germany (*Cenoceras* Hyatt, *Pseudaganides* Spath) and the Cenomanian of the Lebanon (the cymatoceratid *Syrionautilus* Spath), where complete nautilid beaks were found *in-situ* (i.e. Riegraf *et al.* 1984; Riegraf and Schmitt-Riegraf 1995; Dietl and Schweigert l999; Schweigert and Dietl 2003). *C. cretaceus* and *N. simplex* are associated with the nautilid genus *Eutrephoceras* Hyatt (see below).

ASSOCIATED FAUNA

Invertebrates

Taxon	Kamajka	Turkaňk	Velim
Porifera:			
Diplodictyon heteromorphum Reuss	+	-	-
Laocoetis sp.	+	-	-
Pachytilodia bohemica Počta	+	+	+
Octocorallia:			
Moltkia foveolata (Reuss)	+	+	+
Scleractinia:			
Synhelia gibbosa (Goldfuss)	+	+	+
Anthophyllum cylindricum (Reuss)	+	+	+
Vermes:			
Glomerula solitaria Regenhardt	+	+	+
Spirorbis sp.	+	-	+
Pomatoceros sp.	+	+	+
Bryozoa:			
Cyclostomata indet.	+	+	+
Cheilostomata indet.	+	+	+
Brachiopoda:			
Praelacazella lacazelliformis (Elliot)	+	+	+
Terebratulina "chrysalis" (v. Schlotheim)	+	+	+
Cyclothyris zahalkai Nekvasilová	+	+	+
Ancistrocrania ? gracilis (v. Münster)	+	+	+
Bivalvia:			
Exogyra reticulata Reuss	+	+	+
Gryphaeostrea canaliculata (Sowerby)	+	+	+
Spondylus sp.	+	+	+
Inoceramus sp.	+	+	-
Atreta sp.	+	-	+
Gastropoda:			
Neritopsis sp.	+	+	-
Pleurotomaria geinitzi d'Orbigny	-	+	-
Arthropoda - Cirripedia:			
Pollicipes glaber Reuss	+	+	+
Scalpellum sp.	+	+	+
Echinodermata - Crinoidea:			
Cyathidium aff. *depressum* Sieverts-Doreck	+	-	+
Isocrinus sp.	+	+	+
Remesimetra discoidalis (Gislén)	+	+	+
Semiometra impressa (Carpenter)	+	-	+
Echinodermata - Echinoidea:			
Stereocidaris vesiculosa (Goldfuss)	+	+	+
Stereocidaris sorigneti (Desor)	+	+	+
Echinodermata - Asteroidea:			
Metopaster sp.	+	+	+

Table 2. Invertebrate fauna associated with the rhyncholites

Vertebrates

The vertebrate fauna at Velim is predominantly represented by sharks, e.g. *Scapanorhynchus raphiodon* (Agassiz), *Cretoxyrhina mantelli* (Agassiz), *Cretolamna appendiculata* (Agassiz), *Squalicorax falcatus* (Agassiz), *Squalicorax heterodon* (Agassiz) *Paranomotodon angustidens* (Reuss), and "*Carcharias priscus*" (Fritsch) *sensu* Žítt *et al.*, 2006 (a lamniform shark probably belonging to either *Lamna* and/or *Otodus*).

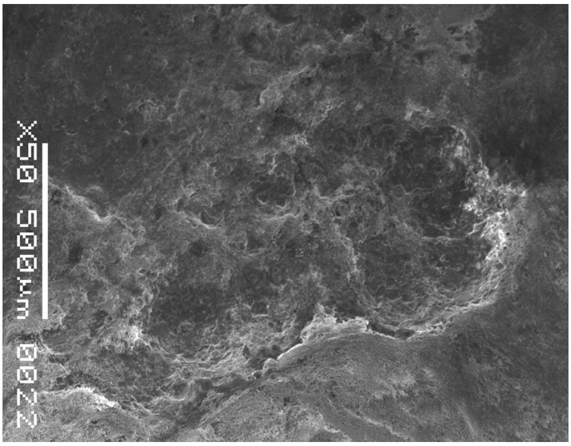
Lamniform sharks with a pelagic mode of life predominated. It is noteworthy that malacophagous sharks – i. e., hybodonts (genera *Ptychodus, Acrodus, Heterodontus*) – which are known from coeval Turonian successions, are largely lacking with the sole exception of *Ptychodus mammilaris* Agassiz, recorded from the locality of Turkaňk.

Epibionts

Epibiont occurrence is restricted to strongly abraded rhyncholites. This abrasion is apparently referable to organodetritic bioclast interaction, while the biologically digested rhyncholites often show soft part preservation on the shaft. At the Kamajka locality indeterminate epibionts (probably serpulid worms) and tests of cemented foraminifera *Acruliammina longa* (Tappan) were discovered (Text-fig. 9). These epibionts are currently under investigation by the authors.

NAUTILOIDS OF THE CENOMANIAN/TURONIAN BOUNDARY INTERVAL IN THE BCB

Only two nautilid taxa – *Cymatoceras columbinum* (Fritsch) and *Eutrephoceras sublaevigatum* (d'Orbigny) are known from the Upper Cenomanian – Lower Turonian interval in the BCB.



Text-fig. 9. Dorsal part of *Nautilorhynchus* cf. *simplex* (Fritsch) with the adherent foraminifer *Acruliammina longa* (Tappan)

C. columbinum is the earliest nautilid known in the BCB (Frank and Košťák 2004; Frank 2008). It has been recorded only in the Late Cenomanian deposits (Korycany Member of the Peruc-Korycany Formation *sensu* Čech *et al.* 1980) – i.e., the *Inoceramus pictus* inoceramid bivalve Zone and the *Calycoceras guerangeri* ammonite Zone. *C. columbinum* is known from only four specimens and it is currently under systematic revision by one of the authors (JF). Typical morphological features of this species are the deeper saddle on the umbilical wall and the centro-ventral position of the siphuncle. In these features, *C. columbinum* differs from *E. sublaevigatum.* However, the limited known stratigraphic range (Upper Cenomanian) excludes *C. columbinum* from discussions of the rhyncholites described herein.

E. sublaevigatum ranges from the Lower Turonian (Bílá Hora Formation sensu Čech *et al.* 1980; *Mytiloides labiatus* inoceramid bivalve Zone and *Mammites nodosoides* ammonite Zone) to the Lower Coniacian (Březno Formation sensu Čech *et al.* 1980; *Cremnoceramus crassus* inoceramid bivalve zone and *Forresteria petrocoriense* ammonite Zone; see also Košťák *et al.* 2004). *E. sublaevigatum* seems to be the most common nautilid species in the BCB. Its stratigraphic range and great abundance in the BCB (also in early Turonian deposits) correspond to rhyncholite occurrences in the near-shore facies. Our early Turonian rhyncholite specimens therefore probably belong to the genus *Eutrephoceras* (and to the common and long-ranging species *E. sublaevigatum*), since *Cymatoceras columbinum* is unknown from this stratigraphic interval and another common genus in the BCB – *Deltocymatoceras* Kummel – is not known before the early Middle Turonian.

CONCLUSIONS

Nautilorhynchus simplex (Fritsch) is the most common rhyncholite in the BCB. A considerable abundance of this species has been recorded here in the near-shore/shallow water facies of the Lower Turonian. Some of these rhyncholites form a hard substrate for sessile epizoans. The presence of epizoans suggests a prolonged residence time of some of the rycholites on the seafloor caused by a low sedimentation rate. A single specimen of *Nautilorhynchus* cf. *simplex* shows a greater degree of corrosion, caused probably by acid digestion in vertebrate (fish, shark and/or marine reptile) stomachs.

The generic name of *Nautilorhynchus* Fritsch is preferred for the Late Cretaceous nautilid beaks (upper jaw) from the BCB due to certain morphological characters (see above Part III: Diagnosis), notably the presence of a distinct median ridge on the ventral side of the hood.

Nautilorhynchus simplex (Fritsch) shows a marked variability, which is partly caused by the mode of preservation, partly by intraspecific variability comparable to Recent *Nautilus pompilius* rhyncholites (see Saunders *et al*. 1978).

Nautilorhynchus simplex (Fritsch) and *Conchorhychus cretaceus* Fritsch represent the upper and lower jaws respectively of the jaw apparatus of a fossil nautilid. In view of the fact that the only nautilid genus recorded to date from the Lower Turonian in the BCB is *Eutrephoceras*, represented by the long-ranging species *Eutrephoceras laevigatum* (d'Orbigny), we confidently assign the nautilid jaws under discussion to this taxon.

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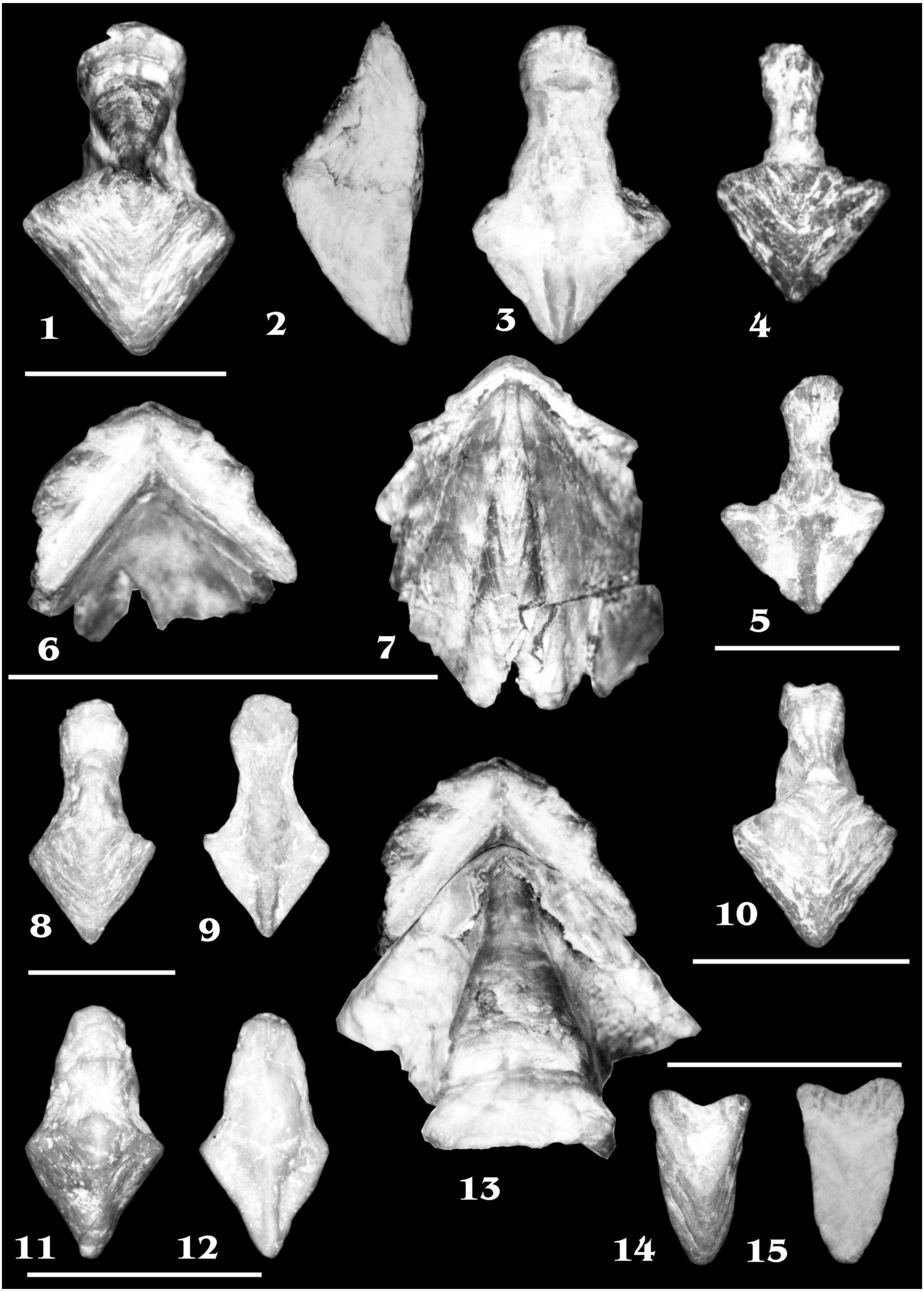
PLATE 1

PLATE 1

All specimens are housed in the collections of the Institute of Geology and Palaeontology, Charles University Prague

1-3 – *Nautilorhynchus simplex* (Fritsch, 1872). 1 – dorsal view, 2 – lateral view, 3 – ventral view. Locality of Velim. Specimen No. IGP 01V001, × 3.5.
4-5 – *Nautilorhynchus simplex* (Fritsch, 1872), abraded specimen. 4 – dorsal view, 5 – ventral view. Locality of Kamajka. Specimen No. IGP 01K017, × 3.6.
6-7 – *Conchorhynchus cretaceus* Fritsch, 1910. 6 – dorsal view, 7 – ventral view. Locality of Velim. Specimen No. IGP 01K001, × 6.5.
8-9 – *Nautilorhynchus simplex* (Fritsch, 1872). 1 – dorsal view, 2 – ventral view. Locality of Kamajka. Specimen No. IGP 01K013, × 2.8.
10 – *Nautilorhynchus simplex* (Fritsch, 1872). Dorsal view. Locality of Kamajka. Specimen No. IGP 01K016, × 3.5.
11-12 – *Nautilorhynchus simplex* (Fritsch, 1872). 1 – dorsal view, 2 – ventral view. Locality of Turkaňk. Specimen No. IGP 01T033, × 4.5.
13 – Dorsal view of jaws connection. *Nautilorhynchus simplex* (FRITSCH) – No. IGP 01V001 and *Conchorhynchus cretaceus* Fritsch – No. IGP 01K001, × 6.5.
14-15 – *Nautilorhynchus* cf. *simplex* (Fritsch, 1872). 1 – dorsal view, 2 – ventral view. Locality of Kamajka. Specimen No. IGP 01K02/1, × 2.8.

Scale bar 10 mm.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