ANAPTYCHUS AND APTYCHUS LATELY ACQUIRED FROM THE UPPER CRETACEOUS OF HOKKAIDO, JAPAN

By

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With 1 Plate

Very recently the present author reported the occurrences of two aptychi and several anaptychi in the Upper Cretaceous deposits of Hokkaidô in the following notes:

1. Occurrences of *Anaptychus*-like Bodies in the Upper Cretaceous of Japan. Proceedings of the Imperial Academy, 1931.
2. New Discovery of *Aptychus* in Two Species of Ammonites from the Upper Cretaceous of Japan. Ibid.

In the first note, the author briefly described a dark-coloured fossil contained in the last whorl of a specimen of *Gaudryceras tenuiliratum* YABE. Having concluded that this fossil might be nothing other than the operculum, *Anaptychus*, of the ammonite in which it is preserved, he proposed a new type-name *Neoanaptychus* and called this specimen *N. tenuiliratus*. In the second note, two aptychi of two different subtypes of the ammonite-opercula, were very briefly illustrated. One of them, being found in the body of an indeterminable species of *Yezoites* or *Scaphites* and agreeing well with many specimens of *Scaphites* aptychi, was named *Striaptychus* (s. str.) sp. without a form-name. The other which is in the last chamber of an imperfect specimen of *Hamites* (*Polyptychoceras*) *yabei* NAGAO and SASA, represents a new subtype of *Striaptychus* (s. lat.), for which the name *Substriaptychus* has been proposed. In the present paper is intended to give the descriptions of these fossils together with some additional specimens acquired from the same deposits.

Anaptychus

Neoanaptychus NAGAO

Type: *Neoanaptychus tenuiliratus* NAGAO

Neoanaptychus tenuiliratus NAGAO

Pl. XV, Figs. 1, 1a

Ad *Gaudryceras tenuiliratum* YABE.[1]

Thin anaptychus, consisting of black, transversely elongate-elliptical and somewhat kidney-shaped plate which is broadly expanded. Each wing-like portion, that is one half of the whole plate, subquadrate, broader than high, being 13 mm. in breadth and 9 mm. in height. Lateral margins rounded, and the ventral or external broadly convex, forming a rather abrupt curve with the lateral margins; dorsal or internal margin divergent from the median portion under the beak dorsally and laterally, slightly excavated and subparallel to the ventral margin, evenly passing into the lateral ones on both sides. Plate convex from the median vertical towards the lateral margins and more weakly so from the beak to the ventral margin. Beak prominent, being produced to form a mamillate process, pointed at the apex and turned somewhat anteriorly.

Surface ornamented with numerous, crowded, narrow and rounded concentric ribs, parallel to the ventral and lateral margins, and becoming broader and more irregular in strength and distance near the ventral margin; no visible radial ornamentation.

Locality and geological horizon: The *Parapachydiscus* Bed of the Upper Ammonites Beds[2] (Senonian) exposed along the Ikushumbets, Province of Ishikari, Hokkaidô, at a cliff just above the junction of this river with its tributary Kikumenzawa. R. SAITO coll.

Structure of the plate: Thin sections of some other specimens in hand show that the plate is composed of a dark-brownish layer apparently of horny or chitinous substance. The apical region is provided with a calcareous layer placed on the outer side, which is thickened toward the apex but soon thins out downwards. The plate is recurved

(1) H. YABE: Cretaceous Cephalopoda from Hokkaidô, Pt. I, Jour. Coll. Sci. Imperial Univ. Tôkyô, Vol. XVIII. Art. 2, 1903, p. 19, Pl. III, figs. 3, 4.

(2) H. YABE: Zur Stratigraphie und Palaeontogie der oberen Kreide von Hokkaidô und Sachalin. Zeit. d. deutsch. geol. Gesell., Vol. LXI, No. 4, 1909; Cretaceous Stratigraphy of the Japanese Islands. Sci. Rep. Tôhoku Imp. Univ., Second Ser., Vol. XI, No. 1, 1927.

inwards and downwards for a short distance from the apical portion and consequently the calcareous layer covers also the anterior part of this recurved portion. (Pl. XV, figs. 3a, 5a).

Almost all anaptychi consist of a thin horny or chitinous layer except that of *Asteroceras* cf. *turneri* (SOW.) reported by H. E. STRICKLAND[3] from the Lower Liassic of England. This anaptychus, however, is composed of two layers, a horny inner and a calcareous outer one. Our specimen is thus quite different from Strickland's in the mode of calcification.

That the present specimen probably represents the operculum of the ammonite in which it is preserved was demonstrated from various points in another paper. There are before the author seven specimens of this sort obtained by Mr. R. SAITO; they are enumerated below:

1. F. 1. A roled block derived from the *Scaphites* Bed (?) of the Upper Ammonites Beds exposed along the Yûbari-gawa, Province of Ishikari. (Pl. XV, figs. 2, 2a.)
2. F. 2. A roled block derived from the Upper Ammonites Beds developed along the Ikushumbets, Province of Ishikari. (Pl. XV, fig. 7.)
3. F. 3. The lower part of the *Parapachydiscus* Bed of the Upper Ammonites Beds exposed along the Kikumenzawa, a tributary of the Ikushumets, ibid. (Pl. XV, figs. 5, 5a.)
4. F. 4. A roled block derived from the *Parapachydiscus* Bed of the Kikumenzawa. (Pl. XV, figs. 3, 3a.)
5. F. 5. Ibid. (Pl. XV, fig. 4.)
6. F. 6. Ibid.
7. F. 7. Ibid. (Pl. XV, figs. 6, 6a.)

These specimens are all very similar to one another, almost agreeing in the form, thickness and colour of the plate, the produced apex and the surface sculpture. Some of them, however, are more convex and provided with broader and more distant concentric ribs than in others, and moreover, the ratio between height and breadth is slightly variable among them. These differences seem to be of rather minor importance and are certainly due to deformation to some extent. There is no doubt about their belonging to one and the same group of ammonite, if all of them might not be referrable to one species or genus.

(3) H. F. STRICKLAND: On certain Calcareo-corneous Bodies found in the outer Chambers of Ammonites. Quart. Jour. Geol. Soc., Vol. I, 1845, p. 232.

As above described, the known anaptychi of this type range in Hokkaidô from the *Scaphites* Bed (partly Turonian?) to the next younger *Parapachydiscus* Bed (Senonian), of the Upper Ammonites Beds. Ammonites most frequently met in these beds are various species of *Gaudryceras*, *Parapachydiscus* and *Desmoceras*. *Puzosia* and *Mortoniceras* are also found in these deposits, though far more rarely. The opercula have never been found in Japan in association with these genera, but are known in foreign countries. According to F. TRAUTH,[4] certain species of *Parapachydiscus* are provided with *Pseudostriaptychus* TRAUTH and, though there is left some doubt, the other genera are also considered to have different types of opercula, viz. *Mortoniceras* with *Spinaptychus* TRAUTH and *Desmoceras* with *Pteraptychus* TRAUTH respectively. *Puzosia* has its ally *Parapuzosia* with *Lissaptychus* TRAUTH.

Our specimens are very closely similar to some Goniatites-anaptychi described by H. WOODWARD[5] from the Devonian of Bicken in Eifel, Germany, and now known to belong to *Manticoceras*, for example, *M. intumescens* BEYR., and especially akin to the specimen referred by J. M. CLARKE[6] to *Cardioceras lata* of WOODWARD. Moreover, the specimens before us agree in many features with *Anaptychus* of *Lytoceras cornu copiae* YOUNG and BIRD from the Upper Liassic of Germany.[7]

Anaptychus is found in the Paleozoic and more commonly in the Lower and Middle Liassic. *Anaptychus* of *Lytoceras cornu copiae*, above cited, is a unique one described from the Upper Liassic, and from the later geological ages we have no record of its occurrence. The author wishes to propose the name *Neoanaptychus* for the Upper Cretaceous form of Japan.

It is very noticeable that no *Anaptychus* or *Aptychus* were found in Lytoceratidae except some degenerate genera which will be referred to later. This family was sometimes thought to be devoid of a real operculum and some specimens ascribed to the opercula of this family were doubted by some authors. For example, the aptychus contained in the body chamber of *Lytoceras* cf. *quadrisulcatum* D'ORB. from the

(4) F. TRAUTH: Aptychenstudien. I, Ueber die Aptychen im Allgemeinen. Ann. Naturhist, Mus. Wien, 1927; II, Die Aptychen der Oberkreide, ibid, 1928.

(5) H. WOODWARD: On a Series of Crustacean. Shields from the Upper Devonian of Eifel, etc. Geol. Mag., New Ser. Dec. II, Vol. IX, 1882.

(6) J. M. CLARKE: Ueber deutsche oberdevonische Crustaceen. Neues Jahrb. f. Min. etc. 1884, Vol. I, p. 181, Pl. IV, fig. 2.

(7) M. SCHMIDT: Anaptychen von *Lytoceras cornu copiae* YOUNG a. BIRD. Ibid., Beilagebd. LXI, Abt. B, 1929, pp. 399-432.

Neocomian and referred by W. EDER[8] to this species or allied *L. subfimbriatum* D'ORB. is[9] considered as *Lamellaptychus* of *Haploceras*, *Oppelia*, or some allied genus, introduced accidentally into the chamber of that specimen of *Lytoceras*. The anaptychus of *L. cornu copiae* is the first example of the operculum of this family, though it was not found in the chamber of the ammonite. Thus the discovery of a similar operculum in *Gaudryceras* of the Upper Cretaceous does not deserve less attention on this point.

Aptychus

Two-valved opercula of Ammonoidea is common in the Mesozoic in foreign countries and it is not rarely met in its original position, that is in the outer chamber of the ammonite. However, we have no record of such an organ from Japan, as far as the author is aware, except a detached specimen reported by Prof. H. YABE[10] thirty years ago from the Upper Ammonites Beds of Hokkaidô. The present author has two specimens of this sort contained each in the body of an ammonite. Both of them belong, as described below, to *Striaptychus* (s. lat.)[11] recently defined by TRAUTH. *Striaptychus* in this sense is derived from the deposits ranging from Dogger to Upper Cretaceous and comprises, according to that author, the three subtypes of 1) *Praestriaptychus* TRAUTH ad *Cosmoceras*, *Parkinsonia*, etc., 2) *Granulaptychus* TRAUTH ad *Perisphinctes*, ? *Stephanoceras*, etc., 3) and *Striaptychus* (s. str.) ad *Scaphites*. One of our specimens agrees well with *Striaptychus* (s. str.), and the other represents a new subtype for which the author wishes to propose *Substriptychus*.

***Striaptychus* (s. lat.) TRAUTH**

***Striaptychus* (s. str.) TRAUTH**

***Striaptychus* (s. str.) sp. indet.**

Pl. XV, Figs. 9, 9a.

Ad *Scaphites* (? *Yozoites*) sp.

Two-valved; valve thin, small, being 3.8 mm. long and 2.3 mm. broad, and slightly convex; somewhat elliptic-quadrate in outline, with its apical angle of about 90°; internal margin straight, the lateral one

(8) W. EDER: Das Heuberg-Gebiet u. sein Vorland. News Jahrb. f. Min., etc., LII, Beilageb., Abt. B, p. 36.
(9) F. TRAUTH: Op. cit., 1927, p. 235, foot note 2 and p. 239, foot note 1.
(10) H. YABE: New Discovery of Aptychus in Japan (in Japanese). Jour. Geol. Soc. Tôkyô, Vol. VIII, 1901, p. 161.
(11) F. TRAUTH: Aptychenstudien. III-V. Ann. Naturh. Mus. Wien, 1930, p. 379.

slightly convex, passing gradually into the external; terminal angle roundly subpointed and the harmonic line straight in its greater part; umbonal angle obtusely rounded. Adsymphisal area not observed, but most probably present.

Concentric sculpture of the outer surface consisting of numerous narrow and symmetrically sloped ribs which are slightly elevated, being separated by often narrow interspaces and parallel to the lateral and external margins; lines of growth fine and very crowded, covering all over the surface on the ribs and the interspaces between them; there exist also some traces of radial striae, almost invisible to the naked eye.

Locality and geological horizon: The *Scaphites* Bed of the Upper Ammonites Bed; Ôyûbari, Yûbari-gun, Province of Ishikari. R. SAITO coll.

The present specimen is contained in the last chamber of a small ammonite whose adequate position in either *Scaphites* or *Yezoites*[12] is not certain, as the internal lobes are not visible in it. Moreover, it is not specifically determinable on account of the absence of the greater part of the last chamber. This ammonite is tightly coiled with a rather great involution and a relatively deep and large umbilicus which occupies about one third of the height of the shell. The lateral surface is slightly, and the dorsal moderately, convex. The flanks are ornamented with broad and somewhat wavy transverse ribs alternated with concave interspaces nearly as broad as the ribs themselves; these ribs gradually disappear toward the ventral surface which is covered by numerous crowded and fine transverse striae.

The present operculum belongs to *Striaptychus* (s. str.) TRAUTH as all known *Scaphites* aptychi do. It is similar to *S. roemeri* TRAUTH[13] ad *Scaphites* (*Acanthoscaphites*) *roemeri* SCHLÜT. from the Upper Senonian of Hanover, Germany, in outline of the valve, but has not a distinct radial sculpture and a short groove which is plainly observable in the German form in the apical region. It is also related to *S. cretaceus* (MÜNST.)[14] from the Upper Turonian and Coniacean of Europe, differing from it in being much smaller and in having a different form of the valve. Moreover, the concentric ribs are narrower and more crowded in ours than in the latter.

(12) H. YABE: Die Scaphiten der Oberkreide von Hokkaidô. Beitr. z. Palaeont. u. Geol. Oesterr.-Ung.-u. Orients, Vol. XXIII, 1910.

(13) C. SCHLÜTER: Cephabopoden der oberen deutschen Kreide, Pt II. Palaeontographica, Vol. XXIV, 1876, p. 163. Pl. XLII, figs. 4, 5.
F. TRAUTH: Op. cit., 1928, p. 156, Pl. IV, fig. 14.

(14) For the synonyms of this form see F. TRAUTH: Op. cit., 1928, pp. 140, 141.

Substriaptychus NAGAO

Type: *Striaptychus* (*Substriaptychus*) *yabei* NAGAO

Striaptychus (*Substriaptychus*) *yabei* NAGAO

Pl. XV, Figs. 8, 8a, 8b, 8c.

Ad *Hamites* (*Polyptychoceras*) *yabei* NAGAO and SASA.

Two-valved; valve thin, moderate in size, being 14 mm. long and 11.5 mm. broad, and weakly convev, with the apex pointed and curved inward. Subtrigonal in outline; apical angle approximately 70°; dorsal margin almost straight and the ventral semicircular together with the external one. Harmonic line nearly straight with a rather well developed adsymphisal area.

Outer surface ornamented with numerous, somewhat flattened and narrow concentric bands or ribs alternating with very narrow furrows; there exist numerous linear and distant radial grooves, separated by by broad and flat interspaces; these radial grooves well developed near the ventral margin and the concentric ribs somewhat wavy on crossing them.

Locality and geological horizon: The *Parapachydiscus* Bed of the Upper Ammonites Beds exposed along the Panke-Oshokenai near Hetonai, Yûfutsu-gun, Province of Iburi. K. ÔTATSUME coll.

The present operculum is contained in the last chamber of a specimen of *Hamites* (*Polyptychoceras*) which is somewhat akin to, but distinct from, *H.* (*P.*) *pseudogaultinus* YOK.[15] and *H.* (*P.*) *yubarensis* YABE.[16] Mr. SASA and the present author wish to propose the name *H.* (*P.*) *yabei* for this species, the full description of which will be published in the near future.

We have no record of aptychus which was found within the body of *Hamites* or even any operculum ascribed to this genus. It is very remarkable that the present specimen is so closely similar to *Scaphites* aptychus (*Striaptychus* in a strict sense), that it might be taken as an operculum of this latter genus if it were not found in the former ammonite. Our specimen seems to have been displaced from its original position to face its apex backwards, but the author believes that there is no reasonable doubt about its belonging to this ammonite.

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(15) M. YOKOYAMA: Versteinerungen aus der japanischen Kreide. Palaeontographica, Vol. XXXVI, 1890, p. 181, Pl. XX, figs. 1—3.

(16) H. YABE: Cretaceous Cephalopoda from Hokkaidô (MS.), 1901.

(17) H. YABE: Die Scaphiten der Oberkreide von Hokkaidô, op. cit, 1910.

Moreover, no species of *Yezoites* or *Scaphites* known from Japan[17] attain such a large dimension as to fit the present operculum in question. Although our specimen is slightly different from most of *Striaptychus* (s. str.) in its form and surface sculpture, we are persuaded to expect an intimate relation existing between *Hamites* and *Scaphites*, as far as the opercula are concerned.

Hamites is currently included in Lytoceratidae together with *Baculites*, but the operculum of the latter, *Rugataptychus* TRAUTH,[18] is more distantly related to *Substriaptychus* than *Scaphites* aptychus. Furthermore, as stated on another occasion, it is urgently needed to make clear the mutual relations between these gerontic forms with a real aptychus, on one side, and *Lytoceras* and *Gaudryceras* with an anaptychus, on the other.

It is not worthless to give a few lines to that detached operculum reported by Prof. YABE thirty years ago. According to him, the fossil is large, being 53 mm. long and 74 mm. broad, and composed of two thin, semioval, weakly convex valves with the surface ornamented with numerous small rectangular tubercles which are regularly arranged in many radial and concentric rows. It is certainly different from ours, and thus we can expect to find from the Upper Cretaceous of Hokkaidô some group of Ammonites bearing this kind of opercula.

At the end the author wishes to express his hearty thanks to Prof. H. YABE of the Institute of Geology and Palaeontology in Sendai for his encouragement bestowed during the preparation of the present paper and the kind permission for the free use of his private library.

(18) F. TRAUTH: Op. cit., 1928, p. 122.

Plate XV

PLATE XV.

(All figures are of natural size unless otherwise stated.)

Figs. 1, 1a. *Gaudryceras tenuiliratum* YABE with *Neoanaptychus tenuiliratus* NAGAO (O). Loc.: The Ikushumbets, Province of Ishikari, at a cliff just above the junction of this river with its tributary Kikumenzawa; the *Parapachydiscus* Bed of the Upper Ammonites Beds.

Figs. 2, 2a. *Neoanaptychus* f. 1, Loc.: The Yûbari-gawa, Province of Ishikari; the *Scaphites* bed (?) of the Upper Ammonites Beds.

Figs. 3, 3a. *Neoanaptychus* f. 4. Loc.: The Kikumenzawa, a tributary of the Ikushumbets; the *Parapachydiscus* Bed. 3a, a thin section showing the chitinous layer covered by a calcareous one at the apical region. ×8.

Fig. 4. *Neoanaptychus* f. 5. Loc.: Ibid.

Figs. 5, 5a. *Neoanaptychus* f. 3. Loc.: The Ikushumbets; the Upper Ammonites Beds. 5a, a thin section showing the recurved portion; the greater part of the chitinous layer is missing. ×16. D. the chitinous layer; C, the calcareous layer.

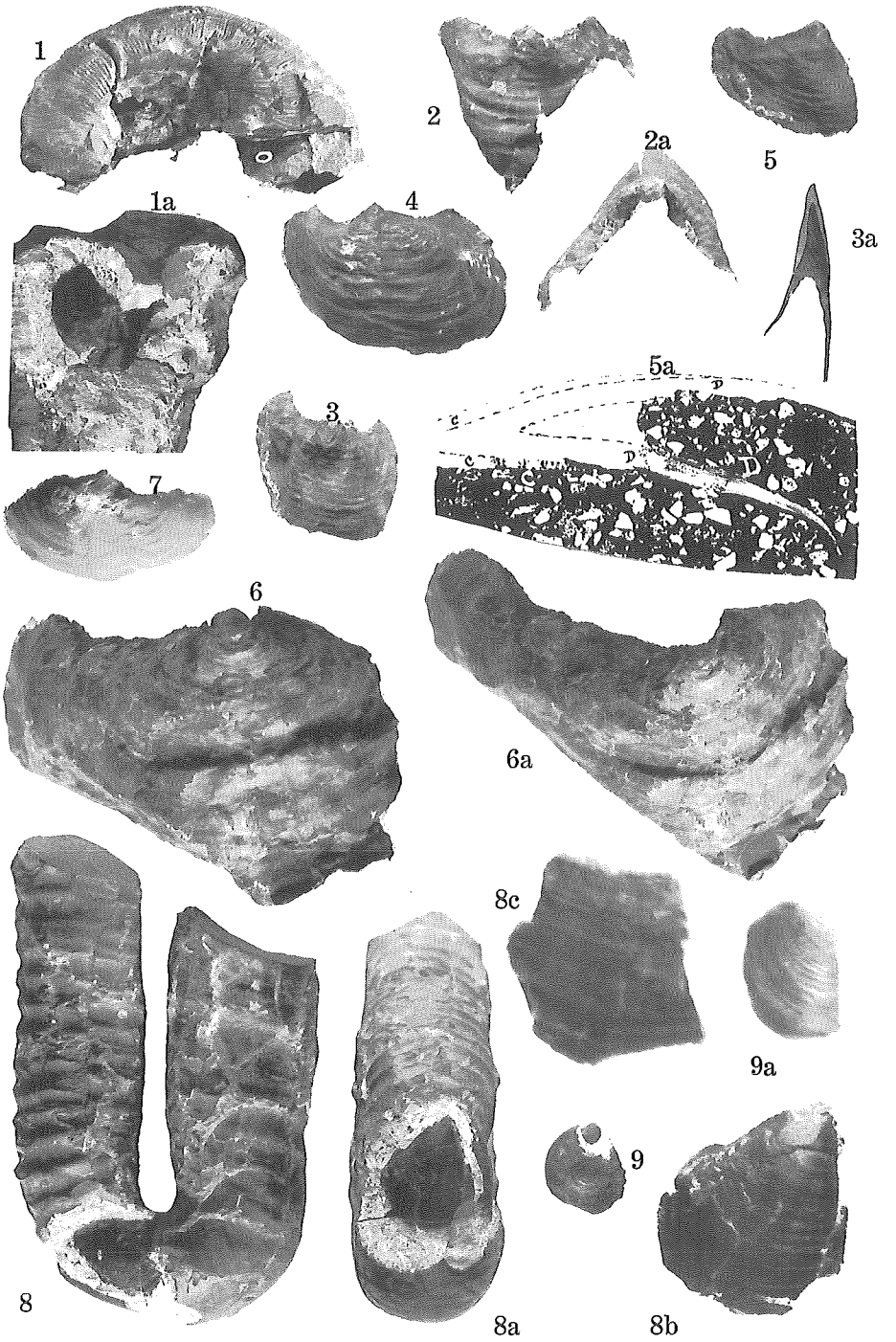
Figs. 6, 6a. *Neoanaptychus* f. 7. Loc.: The Kikumenzawa, a tributary of the Ikushumbets; the *Parapachydiscus* Bed.

Fig. 7. *Neoanaptychus* f. 2. Loc.: The Ikushumbets; the Upper Ammonites Beds.

Figs. 8, 8a. *Hamites yabei* NAGAO and SASA with *Striaptychus* (*Substriaptychus*) *yabei* NAGAO. Loc.: The Panke-Oshokenai near Hetonai, Province of Iburi; the *Parapachydiscus* Bed of the Upper Ammonites Beds.

Figs. 8b, 8c. *Striaptychus* (*Substriaptychus*) *yabei* NAGAO. 8b, the left valve of the operculum. ×2. 8c, a small part of the outer surface showing the sculpture. ×5.

Figs. 9, 9a. *Scaphites* (*? Yezoites*) sp. with *Striaptychus* (s. str.) sp. Loc.: Ôyûbari along the Yûbari-gawa, Province of Ishikari; the *Scaphites* Beds of the Upper Ammonites Beds. 9a, the left valve of the operculum. ×5.



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