

Notes on Some Cretaceous Fossils from Anaga on the Island of Awaji and Toyajo in the Province of Kii

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Notes on Some Cretaceous Fossils from Anaga on the Island of Awaji and Toyajo in the Province of Kii.

BY

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With 4 Plates.

In the preceding article on the geotectonics of southwestern Japan, much stress was put on the fossil fauna in the Cretaceous rocks well developed on the island of Awaji and in the province of Kii. It was maintained that we have good palaeontological evidence against the supposition that the Cretaceous rocks of the Izumi-sandstone-belt have been deposited in an inland sea more or less well secluded from direct communication with the outer open ocean, while there is no doubt that the sedimentation of the contemporaneous rocks, now distributed in the outer side of the Kuma-Kii land, took place in the ocean.

The stratigraphy of the Cretaceous rocks in these two districts being already given in the preceding article, my present task is chiefly concerned with the description at some length of the fossils obtained from the Cretaceous rocks.

The two fossil localities, Anaga-mura on the island of Awaji and Toyajo near Yuasa in the Province of Kii, were visited in the summer of 1914 by MR. SH. YEHARA, who succeeded in getting a number of fossils in these places; they are by no means very numerous, but geologically are of great interest. Of these fossils, only those with important bearing on the correlation of the geological age of the strata, in which the fossils are contained, and on the consideration of the faunal character, are to be described in the present paper. Hence all the Cephalopods and two important forms of the genus *Inoceramus* in his collection are taken into consideration in this place, while other 3 species of *Inoceramus*, which are not yet specifically identified, and a few other lamellibranchiats of less significance are now discarded.

The Cretaceous fauna of Toyajo was, a few years ago, studied by *J. Takahashi*; his collection as well as his paper (Ms) on the geology of the district is accessible in the Geological Institute of the Imp. University of Tokyo. His collection contains number of fossils not represented in that of Yehara, though only two deserve special attention at least for my present purpose. Not to be forgotten, however, in the progress of our geological knowledge, is his merit in having made known this important fossil locality in Kii, having subdivided the marine upper Cretaceous deposits developed in the area into three distinct series—Yoshihara, Suhara and Toyajo series, and finally in having rightly correlated the Toyajo series to Senonian. As will be explained later on, his view regarding the geological age is confirmed by my present study.

The material now at my disposal consists of the following forms:

I. Toyajo.

a) Suhara Series.

Acanthoceras sp. of the group of *A. (Calycoceras) naviculari* MANTELL.

b) Toyajo Series.

- Gaudryceras denseplicatum* JIMBO?
Tetragonites cfr. *cala* FORBES.
Turrilites (*Bostrychoceras*) *Otsukai* YABE.
T. (B.) *japonicus* YABE.
T. (*Hyphantoceras*) *Oshimai* YABE var.
Pravitoceras sigmoidale YABE.
Baculites sp.
Pachydiscus rotalinoides YABE.
Kossmaticeras sp. indet.
Inoceramus cfr. *regularis* D'ORB. = *I. cripsi* auct.
I. *Schmidti* MICHAEL.

II. Anaga.

- Pravitoceras sigmoidale* YABE.
Turrilites (*Bostrychoceras*) *Otsukai* YABE.
Turrilites (*Hyphantoceras*) *Oshimai* YABE var.

Now comparing the Cretaceous fauna of Toyajo with that of Anaga, nobody will deny either their geological contemporaneity, or their total identity from the ecological point of view. Certainly they belong to one and the same fauna essentially composed of molluscs which are vagile benthos in life. Such forms like *Turrilites* and *Pravitoceras* could surely not be free-swimming organisms, just as most Gastropods with similar shells are not.

Next, let us see the geographical distribution of the above mentioned fossils or their nearest allies. The first fact to attract our attention is their wide extension; thus we have:

Anaga and Toyajo ; <i>Turrilites Otsukai.</i>	Hokkaido ; <i>T. Otsukai.</i>	Europe, Africa, Persia ; <i>T. polyplocus.</i>
Anaga ; <i>T. japonicus.</i>	Hokkaido ; <i>T. japonicus.</i>	—
Anaga and Toyajo ; <i>T. Oshimai</i> var.	Hokkaido ; <i>T. Oshimai.</i>	Europe ; <i>T. Reussianus.</i>
Anaga and Toyajo ; <i>Pravitoceras sigmoidale.</i>	—	—
Toyajo ; <i>Baculites</i> sp.	Hokkaido ; <i>B.</i> cfr. <i>teres.</i>	India ; <i>B. teres</i>
Toyajo ; <i>Gaudryceras denseplicatum?</i>	Hokkaido ; <i>G. denseplicatum.</i>	—
Toyajo ; <i>Tetragonites</i> cfr. <i>cala.</i>	—	S. India and Pondoland ; <i>T. cala.</i>
Toyajo ; <i>Pachydiscus rotalinoides.</i>	Hokkaido ; <i>P. rotalinoides.</i>	S. India, Madagascar, Snow hill island ; <i>P. rotalinus.</i>
Toyajo ; <i>Inoceramus</i> cfr. <i>regularis.</i>	—	Europe ; <i>I.</i> cfr. <i>regularis.</i>
Toyajo ; <i>I. Schmidti.</i>	Hokkaido, Saghalien, Amakusa ; <i>I. Schmidti.</i>	—

The wide geographical distribution of all the organisms composing the present fauna, except *Pravitoceras*, indicates that the fauna is one of open sea. From this, it does not, however, immediately follow that the Cretaceous rocks of Anaga and Minato with *Pravitoceras* and *Turrilites*, must be an open sea

deposit, for the possibility is nevertheless not quite excluded that these molluscan remains are mere drifts from the outer sea into the inland sea. But it must be always borne in mind that there are two circumstances unfavourable to the last supposition, namely: 1) the ammonite-bearing rocks of Anaga and Toyajo are lithologically quite identical, and 2) so far as known at present, the fossiliferous deposits of Anaga contain only those forms, which are known from Toyajo, and nothing else. Hence it seems most probable, if not absolutely sure, that the deposition of the Cretaceous rocks of Awaji took place likewise in an open sea and not in a more or less land locked inland sea.

Secondly, regarding the geological age of the fauna of the Toyajo series, we find no difficulty in assigning it to Senonian, for almost all forms and their nearest foreign allies are the characteristic Senonian species. The only exception to this is *Turrilites Oshimai*, hitherto known only from the *Scaphites* beds of Hokkaido, which apparently corresponds to Turonian, and is the Japanese representative of European *T. Reussianus* D'ORB., a typical Turonian species; but now we have from Toyajo a varietal form of *T. Oshimai* and not the typical form itself. Without other fossils indicating Turonian age in the present fauna, I find it more proper to assume either that the Toyajo form is a geologically younger mutational form (in Waagen's sense), or more simply that the species, including both the typical and varietal forms, has a geological range from Turonian to Senonian, than to ascribe it any value as an index of Turonian age.

Whether the Toyajo series may represent Upper Senonian or Lower Senonian, or both together, is the next question, which, however, I can not settle at present. J. TAKAHASHI distinguished several fossiliferous horizons in the series exposed at Toyajo, but YEHARA found these fossil horizons not quite so distinct as the former thought them to be. To settle this question we need more thorough stratigraphical and palaeontological study. In this connection, it is probably important to take notice of the fact that *Parapachydiscus* is not represented in the Toyajo series by any species, although very rich in the number of its species and individuals in the upper division of the *Pachydiscus* beds of Hokkaido, contemporaneous with Upper Senonian.

After all, only it remains to be pointed out, that we find in *Pravitoceras sigmoidale* a very peculiar form characteristic of the Toyajo series and confined to it so far as we know at present.

Description of Species.

Cephalopoda.

Gaudryceras.

Gaudryceras denseplicatum JIMBO?

1894. *Lytoceras denseplicatum* JIMBO: Beiträge zur Kenntnis der Fauna der Kreideformation von Hokkaido. P. 36, Pl. III, Fig. 1.

1903. *Gaudryceras denseplicatum* YABE: Cretaceous Cephalopoda from the Hokkaido. Pt. I. P. 30.

There is a small fragment of an Ammonite belonging to the group of *Gaudryceras crassicostatum* JIMBO in the fossil collection of Mr. TAKAHASHI; judging from the thickness of the striae covering the whole surface of the shell, it seems in most probability identical with *G. denseplicatum*, a species first described from the *Pachydiscus* beds of the Ekimomoanoro, a tributary of the Yubarigawa and subsequently found at a cliff of the latter, close to its junction with the Penkemoyubari.

I once suspected the specific identity of *G. denseplicatum* and *G. striatum* JIMBO, but based on a well preserved specimen belonging to the former species from Saghalien which is preserved in the Natural

History Museum of the University of Berlin, these two forms are now regarded to be specifically distinct, as already mentioned elsewhere (YABE: Zur Stratigraphie und Palaeontologie der oberen Kreide von Hokkaido und Sachalin. Zeitschrift d. deutsch. geol. Gesell. Vol. LXI, 1909. P. 403).

Loc.:—Toyajo.

Hor.:—Toyajo series.

Tetragonites.

Tetragonites *cf.* **cala** FORBES.

Pl. I, Fig. 7; Pl. III, Fig. 2.

The two specimens here figured represent a species of the genus *Tetragonites*, and perhaps closely allied to, if not identical with, *T. cala* FORBES from South India. The shell is rather discoidal, composed of relatively low, flat-sided whorls, which are as broad as high, and showing a wide umbilicus which is surrounded by a vertical wall. There are probably 4 or 5, very oblique and feeble periodic ribs on a volution, because two such grooves are preserved on an internal cast which represents half a volution. The suture-line shows 5 saddles gradually diminishing in size toward the umbilical suture where they are followed by another extremely small one.

Loc.:—Toyajo.

Hor.:—Toyajo series.

The species was first described by FORBES and then by KOSSMAT¹⁾ from the Valudayur group of Pondicherry, South India; the identical or closely allied form was also found from the upper Cretaceous beds of Pondoland.²⁾ I accept with some doubt, on the other hand, the occurrence of this species in the Cretaceous of Tunisie.³⁾

Turrilites (*Bostrychoceras*, *Hyphantoceras*).

Turrilites (*Bostrychoceras*) **Otsukai** YABE.

Pl. I, Figs. 2, 3.

1909. *Heteroceras* (?) *Otsukai* YABE: Cretaceous Cephalopoda from Hokkaido, II. P. 14, Pl. IV, figs. 1-2; Pl. VI, fig. 7.

In the paper cited above, a group of the genus *Turrilites* including such forms as *T. Otsukai* and *T. japonicus* YABE was, with some doubt, referred to the genus *Heteroceras*, this error took place from my unfortunate misunderstanding of the suture-line shown by *T. Otsukai* and its variety *multicostata* YABE. The more careful study of the present material revealed that what I took in the former occasion as representing the antisiphonal saddle, is nothing but the median leaf dividing the second lateral lobe almost symmetrically. In reality, therefore, the suture line of the species shows two lateral lobes of immense size and distinctly shallower siphonal and antisiphonal lobes. The external and the internal saddles are set quite obliquely. Thus, the suture line does not essentially differ from that of *Turrilites* or more especially from that of *Bostrychoceras polyplocum* ROEMER.⁴⁾

1) KOSSMAT: Südindische Kreideformation. P. 136, pl. XVII, fig. 12.

2) H. WOODS: The Cretaceous Fauna of Pondoland. 1906. P. 335, pl. XLI, fig. 7.

3) PERVINQUIÈRE: Études des paléontologie Tunisiennne. 1907. P. 79, pl. III, fig. 3.

4) O. GRIBENKERL: Die Versteinerungen der Senonen Kreide von Koenigslutter im Herzogthum Braunschweig. Pal. Abh. Bd. IV, Ht. 5. 1889. Pl. XII. Fig. 1.

Being deceived by the apparent difference shown by the suture-line, I thought *T. Otsukai* quite different genetically from *T. polyplocus*,¹⁾ in spite of the great resemblance shown by them referring to the general outline of the shell and its surface sculpture. But it now becomes quite evident that these two species are very closely related, as already pointed out by SAYN,²⁾ PERVINQUIÈRE,³⁾ BOULE etc.⁴⁾; *T. Otsukai* is thus reasonably to be taken as the Japanese representative of *T. polyplocus*.

All that I have written about the specimens of *T. Otsukai* from Hokkaido holds also quite well for those now at my disposal, except a slight difference in the angle sustained by the coil at its apex—a character which is also very variable in any species of the same genus.

Broadly speaking, the Japanese species is distinguished from *T. polyplocus* by having much more slender whorls which form a somewhat broader coil; further the ribs are more numerous and hence more crowded in our species than in the other.

Loc.:—Toyajo and Anaga; the specimen figured early by M. YOKOYAMA under the name *Helicoceras* sp. from Oumi, Ouchi-gori, Prov. Sanuki, also probably represents a much distorted fragment of this species.⁵⁾

Hor.:—Toyajo series.

The type specimens of *T. Otsukai* are from the *Pachydiscus* beds of Hokkaido. The nearest ally, *T. polyplocus*, is known from the Upper Turonian and Senonian of Northern Germany and other localities in Europe; also found from the Senonian of Tunisia, Madagascar, and the upper Senonian of Persia. If BOULE⁶⁾ and PERVINQUIÈRE⁷⁾ are justified in regarding *T. indicus* STOLICZKA⁸⁾ synonymous to *T. polyplocus*, then the latter extends its distribution to the lower Senonian (Trichinopoli group) of South India.

Turrilites (Bostrychoceras) japonicus YABE.

Pl. I, Figs. 4–6.

1904. *Heteroceras*(?) *japonicum* YABE: l.c. P. 17, pl. III, fig. 8.

The second species of the same genus which is likewise represented very often in the Toyajo series of Kii, is a much smaller form than the preceding one. The shell is turreted, rather widely umbilicated, loosely coiled except the younger volutions which are contiguous. Whorls very slender, increasing very slowly in breadth with age, and crossed by numerous transverse ribs; ribs slightly flexuous, always simple, smooth, sharp and prominent, being separated by an interspace thrice as broad as themselves.

Thus, the specimens from Toyajo are hardly distinguishable from *T. japonicus* YABE from Hokkaido. The type specimen of the named species is a little larger than the present examples and is provided with a broader and more prominent ridge than the usual ones. On the former occasion, I thought that the species was provided with periodic ridges beside the usual ribs; but as only one is found on two volutions preserved of the type specimen, especially near its anterior end, and as no such thickening is found on the younger specimens now at my disposal which are otherwise quite indistinguishable from the former, it seems more reasonable that the single prominent ridge is simply a sign of senility of the shell, hence

1) C. SCHLÜTER: Cephalopoden der oberen deutschen Kreide. Palaeontographica Bd. XXI. 1872. P. 112, pl. XXXII, fig. 3–8; pl. XXXIV, fig. 1–5. Bd. XXIV. 1876. P. 135, pl. XXXV, fig. 1–10. GEINITZ: Das Elbtalgebirge. Palaeontographica. Bd. XX, 2. 1874. P. 195, pl. XXXVI, figs. 1–3. M. BOULE, P. LEMOINE et A. THÉVENIN: Céphalopodes crétacés des Environs de Diégo-Suarez. 1906 7. P. 61, pl. XIV, figs. 1, 2.

2) SAYN in Revue critique de la Paléozoologie.

3) L. PERVINQUIÈRE: Études de paléontologie Tunisienne. I. 1907. P. 103.

4) BOULE etc: l.c. P. 63.

5) M. YOKOYAMA: On Some Cretaceous Fossils from Shikoku. Journ. Coll. Sci. Tokyo. Vol. IV. P. 366, pl. XI, figs. 10, 10 a.

6) BOULE: l.c.

7) PERVINQUIÈRE: l.c.

8) STOLICZKA: Cretaceous Cephalopoda of South India. Pal. Indica. 1865. P. 184, pl. LXXXVI, figs. 1, 2. KOSSMAT: Südindische Kreideformation. Pal. u. Geol. Oesterreich-Ungarns u. Orients. Bd. IX. 1895. P. 143, pl. XX, figs. 5, 6.

probably not recognisable as a specific character of the shell in its younger and mature stages of growth.

Loc.:—Toyajo.

Hor.:—Toyajo series.

The type specimen of the species is from the Upper Ammonites-beds of Hokkaido.

Turrilites (Hyphantoceras) Oshimai YABE var.

Pl. I, Figs. 1 a, b.

1904. *Heteroceras* (?) *Oshimai* YABE: l.c. P. 12, pl. III, figs. 5, 6.

The third species of the genus *Turrilites* represents a form belonging also to a species already known from the Cretaceous of Hokkaido and described under the name of *H. Oshimai*. The specimen from Anaga, here figured, shows a part of its coil, consisting of two contiguous volutions, which sustains a somewhat larger angle at its apex, than the type specimen from Hokkaido. More important differences between them, however, are shown by their ribs, which are more numerous, narrower and, less flexuous on the present specimen than on that from Hokkaido. On both the specimens, each rib in alternation of two or three is tuberculated; but there are only two spiral rows of them, instead of four, on the present specimen, along the upper-outer margin and the median lateral line, those on the upper-inner line and the lower outer border disappearing almost completely from it.

The specimens from Toyajo in the collection of TAKAHASHI show also the same divergence from the type specimen of Hokkaido; hence I think it better to take the specimens from Toyajo and Anaga as a variety of *T. Oshimai*.

T. Oshimai and the present variety remind us strikingly of *T. Reussianus* D'ORB. from the European Turonian. Further, it is very worthy of note that we can find the forms of *Turrilites* very closely allied to *T. Oshimai*, *T. japonicus* and *T. Otsukai* in the Nanaimo group of the Vancouver island; thus *T. hornybyence* WHITEAVES does not much differ from *T. Oshimai* and *T. clongatum* WHITEAVES (= *T. Cowardi* WHITEAVES) from *T. japonicus* and *T. Otsukai*.

Loc.:—Anaga and Toyajo.

Hor.:—Toyajo series.

Pravitoceras.

1902. *Pravitoceras* YABE: Note on Three Upper Cretaceous Ammonites from Japan, outside of Hokkaido. Journ. Geol. Soc. Tokyo. Vol. VIII, p. 4.

Shell flat discoidal, scarcely involute, composed of numerous round, slowly growing whorls. When it attains maturity, the whorl begins to detach itself from the inner coil and gradually makes a curve in an opposite direction. There are numerous narrow, nearly straight ribs, embracing the whorl, besides stronger ones appearing at some intervals.

“The suture-line consists of (1) a short siphonal lobe divided into two halves by a long linguiform siphonal saddle, (2) a deep and widely spread first lateral lobe, bipartite with bifid divisions, (3) a second lateral lobe of the same character, (4) a very short and narrow antisiphonal lobe, (5) an unsymmetrically bipartite external saddle with bipartite branches, (6) wide but somewhat lower lateral saddle with bipartite branches and (7) an anti-siphonal saddle similar to the external one, but smaller. All the branches of the saddles and lobes are finely incised just like in *Lytoceras*.

Pravitoceras is a genus founded on a single species *P. sigmoidale* most characteristic of which is its body whorl, when the shell is fully grown, detached from the inner coil and curved in an opposite direction. Its generic diagnosis mentioned above is a mere copy of that given in another paper, cited above, with but slight modification.

On the former occasion, I brought this genus into comparison with *Lytoceras*, s.s., *Costidiscus*, *Cicatriles* and *Macroscaphites*. The last genus, derived from *Costidiscus*, has an especially close resemblance to ours through its detached anterior portion of the shell which however, curves again in the same direction; but this and *Costidiscus* are distinguished from *Pravitoceras* by their suture-line, for that of *Costidiscus* is characterised as follows by V. UHLIG¹⁾:

“Der Siphonallobus ist auch bei grossen Exemplaren so lang als der erste Seitenlobus oder noch länger und wird niemals durch den äusseren Ast des ersten Laterals eingeengt und zurückgedrängt. Der erste Lateral ist schön symmetrisch gebaut, mit sehr langem und schmalen Körper, die paarigen Aeste sind fast gleich stark entwickelt. Der zweite Lateral steht an der Naht; bei *L. (C.) recticostatum* und *Grebenianum* greift ein Seitenast des zweiten Lateral auf die Innenseite über und breiten sich daselbst mächtig aus. Bei *L. (C.) striatissulcatum* dagegen folgt auf den zweiten Seitenlobus ein kleiner Secundärlobus und ein innerer Seitenlobus, welche zusammen fast dieselben Elemente darstellen, wie bei den ersteren Formen, nur hatten sie hier Raum zu selbständiger Entwicklung. Der Antisiphonallobus zu dessen Seiten sich reich gezackte Internsättel befinden, ist lang, schmal, subsymmetrisch und endigt in einen langen, einspitzigen unpaaren Endast, ohne Scheidewandloben.”

and that of *Macroscaphites* is known as not essentially different from it.

The suture line of *Pravitoceras* differs from that of *Lytoceras* s.s., *Gabbiceras* (the group of *L. Batesi* GABB) and *Cicatriles* (whose type is *C. Abichi* ANTHULA) only by the form of the antisiphonal lobe and the internal saddle, the antisiphonal lobe being considerably shorter than the lateral lobe and the internal saddle consequently much inclined in *Pravitoceras*. These features indicate certainly that *Pravitoceras* is the phylogerontic group derived from *Lytoceras* s.s. or its allied group, as *Macroscaphites* is that derived from *Costidiscus*.

***Pravitoceras sigmoidale* YABE.**

Pl. II, Figs. 1-4; Pl. III, Fig. 1.

1902. *Pravitoceras sigmoidale* YABE: Note on three Upper Cretaceous Ammonites from Japan, outside of Hokkaido. P. 6, pl. I, figs. 2-4.

Whorls slowly growing in height and breadth; those of the coiled portion nearly round in cross section and that of the detached portion somewhat laterally compressed. Coiled portion, 19-18 cm. in diameter, flat discoidal; umbilicus very wide, the outer whorl only just touching the inner ones. Detached portion forming an S-like curve, with the aperture, in a full grown specimen, constricted by a shallow groove of moderate breadth.

Ribs distinct, rather narrow, obtuse, almost straight, and everywhere radially arranged, with intervals of about the same or slightly greater breadth than the ribs themselves; very numerous, numbering some 50 of them on the last volution of a shell, 4.5 cm. in diameter; often tuberculated on certain but not all specimens, the tuberculated ribs appearing in alternation with one to six smooth ribs. Tubercles, if present, moderately sharp, and lengthened along the ribs; those of the detached portion of the shell better developed, but appearing less frequently. Besides, three periodic ridges crossing obliquely each volution; they are bordered in front by a somewhat broad, shallow depression.

1) V. UHLIG: Die Cephalopoden der Wernsdorfer Schichten. Denksch. d. K. Akad. d. Wiss. Mat.-Nat. Classe. Bd. XLVI. 1883. P. 186.

Suture-line composed of a very shallow siphonal lobe, with the tall and narrow siphonal saddle, two lateral lobes of huge size and symmetrically divided, one large lateral saddle which is likewise symmetrically divided, a shallow antisiphonal lobe with an almost perpendicular lateral branch on each side, and an internal saddle of smaller size than the external saddle but of quite similar shape with it; these two saddles are asymmetrically divided, the outer branch being very much better developed than the inner one, and set very obliquely to the siphonal or antisiphonal line, owing to the deep extent of the inner resp. outer branch of the two lateral lobes.

When I first described this species, I had many specimens at my disposal, two being collected by T. SUZUKI and preserved in the museum of the Geological Institute of the University of Tokyo, many others collected by E. SAGAWA and S. MATSUSHIMA and preserved in the Imperial Geological Survey and the First Higher Middle School. The figures 2-4 on the accompanying plate are the exact copies of those given in my first paper, written in reference to this interesting ammonite. All these specimens are known to be collected near the town Minato along the western coast of the island of Awaji.

Pl. II, fig. 1 and pl. III, fig. 1 represent two new specimens lately collected by YEHARA from Anaga on the same island and Toyajo, Prov. Kii. Examined in detail, there is no essential difference between them and the former specimens, save the smoothness of the ribs of those newly found. As the tubercles are known to be rather inconstant on the ribs of some species of the genus *Turrilites*, I consider this also to be the case in the present species.

The ammonite is preserved in nodules of a fine friable, calcareous sandstone, usually much deformed and moreover easily broken into small pieces by an attempt to isolate the fossil from the rock. A specimen with well preserved suture-line is rarely found.

In the Explanatory Text of the Geological Sheet of Tokushima, T. SUZUKI, the first discoverer of this ammonite, has mentioned *Belemnites* sp., *Macrosphites* sp., *Lytoceras* sp. and *Anisoceras* sp. from the locality near Minato-mura. His *Macrosphites* is no doubt identical with *Pravitoceras*, and it is highly probable that his *Lytoceras* is nothing but a coiled portion of the same.

Loc.:—Anaga-mura and Minato-mura on the island of Awaji; Toyajo in the Province of Kii.

Hor.:—Toyajo series.

Baculites.

Baculites sp. indet.

There are numerous fragments of a species of *Baculites* in the collections of Takahashi and Yehara from Toyajo; all the specimens which I have examined, show a smooth shell with no sign of the costulation characteristic to the most species of the genus. By this characteristic as well as by the elongate oblong section of the shell, the specimens appear hardly distinguishable from *B. aff. teres* FORBES from the Upper Ammonites-beds of Hokkaido, and *B. teres* FORBES¹⁾ from the Valudayur group of South India. But owing to poor preservation, the specimens from Toyajo at my disposal can not with any confidence be identified with either of them.

Loc.:—Toyajo.

Hor.:—Toyajo series.

1) STOLICZKA: Fossil Cephalopoda of the Cretaceous Rocks of Southern India. 1865. Pl. NC, fig. 12, and fig. 13. KOSSMAT Südind. Kreidef. 1895. p. 155.

Pachydiscus.

Pachydiscus rotalinoides sp. nov.

Pl. I, Fig. 9; Pl. II, Figs. 5 a, b, 6 a, b.

One of the Ammonites from Toyajo, in the collection of TAKAHASHI, is identical with a form which was described under the name of *Pachydiscus rotalinoides* sp. nov. in my "Cretaceous Cephalopoda of Hokkaido," (Ms.) but not yet published. The type specimens from Hokkaido are considerably better preserved than that now found from Toyajo; hence I introduce in this place the original diagnosis of the species and the figures of its type specimens, accompanying the photograph of the Toyajo specimen.

Dimensions:

	A.	B.
Diameter	2.35 cm.	5.9 cm.
Height of the last whorl	0.99 "	2.4 "
Breadth of the last whorl	1.30 "	2.7 "
Width of the umbilicus	0.75 "	1.7 "

A. Specimen from Kikumezawa.

B. " " Urakawa.

Shell thick discoidal, composed of numerous rounded whorls; umbilicus moderately wide and rather deep; involution $1/3$. Whorls transversely oblong in cross-section, crossed radially by a few very broad ribs (numbering 16 of them on the last volution of a shell whose diameter is 6 cm.). Ribs simple, straight, and provided with two pairs of spines, of which one pair lies on the ventral border and the other on the umbilical border; the majority of the ribs become distinctly feebler on the ventral side between two rows of spines. Spines long, if well preserved, sometimes attaining a length of more than 0.9 cm.; at least partly hollow, thus being preserved on the stone nucleus of the shell as large rounded tubercles.

Suture-line composed of an external, two lateral and three auxilliary saddles and the corresponding number of lobes. All the saddles and lobes showing narrow bodies, deeply incised. Saddles being regularly bipartite and lobes tripartite; the first lateral lobe very slightly deeper than the dorsal lobe; auxilliary lobes and saddles arranged obliquely downward to the umbilical suture, gradually diminishing in size.

The single known species to which the present form shows undeceivable affinity, is *Ammonites rotalinus* STOLICZKA¹⁾ from the Utatur group of South India, which according to KOSSMAT²⁾ is more probably derived from the rock of the Trichinopoli group of Anapady. The latter KOSSMAT considered to belong to the genus *Pachydiscus* and KILLIAN and REBOUL to *Kossmaticeras* (*Jakobites*).³⁾ This and our species agree in showing an external aspect somewhat reminding one of that of an *Acanthoceras*, so much that NEUMAYR⁴⁾ once counted the Indian form into the genus; but their suture line is not decidedly of an *Acanthoceras* as already explained by KOSSMAT. Judging from the general surface sculpture of the shell, these species appear to me more probabiy to find their position in the genus *Pachydiscus* than in *Kossmaticeras*.

The Japanese form is easily distinguished from its Indian ally by wanting the median ventral row of spines.

On the accompanying plate, three specimens of *P. rotalinoides* are figured, two, figs. 5-6, being from Hokkaido and one, fig. 9, from Toyajo. The comparison of the smaller specimen from Hokkaido with that from Toyajo renders their specific identity free from any doubt.

1) STOLICZKA: l.c. P. 56, pl. XXXIV, fig. 2.

2) KOSSMAT: l.c. P. 91, pl. XIV, figs. 3 a, b.

3) W. KILLIAN et P. REBOUL: Les Céphalopodes Néocératés des îles Seymour et Snow Hill. 1909. P. 37.

4) NEUMAYR: Ammoniten d. Kreide. Zeitsch. d. deutsch. Geol. Gesell. P. 931.

Loc.:—The largest specimen figured is from Urakawa, a well known Upper Cretaceous fossil locality in Hokkaido, the smaller one from Kikomezawa, in a drainage area of the Ikushumbets in the Prov. of Ishikari. Further, the species is found in a locality along the Sanushibe which is a tributary of the Rurumoppe in the province of Teshio.

Loc.:—Toyajo.

Hor.:—Upper Ammonites beds (Hokkaido), in all probability from the *Pachydiscus* beds and not from the *Scaphites* beds; Toyajo series (Toyajo).

P. rotalinus STOLICZKA is recorded from South India (Utatur or Trichinopoli group), Madagascar (Senonian),¹⁾ and Grahamland (Senonian).

Kossmaticeras.

Kossmaticeras sp. indet.

Pl. I, Fig. 8.

This is too fragmental for the specific determination; only to be mentioned is its very inflated shell, with the whorl lunular in cross section. The periodic grooves are impressed very strongly, and provided with small but prominent spines on the umbilical border; they cut obliquely one or two ribs behind them. The ribs are subequal in length, obtuse and separated by interspaces as broad as themselves.

Loc.:—Toyajo.

Hor.:—Toyajo series.

Acanthoceras.

Acanthoceras sp. indet.

The single specimen of this species now at hand is too fragmental and much squeezed, but its belonging to the group of *A. naviculare* MANTELL (*Calycoceras* HYATT) is beyond doubt, for the ribs, which are prominent, rounded and of equal length, cross the ventral side uninterruptedly, there making a gentle forward curve and attaining their greatest breadth; all of them bear three small, but rather prominent tubercles on the lateral surface of the whorl. The umbilicus is wide and the involution is a little less than $\frac{1}{3}$.

Hor.:—Suhara series! Cenomanian.

Loc.:—Toyajo.

Lamellibranchiata.

Inoceramus.

Inoceramus cfr. *regularis* D'ORB.

Pl. III, Fig. 3.

There are many specimens belonging to the genus *Inoceramus* in the collection of fossils from Toyajo; the most conspicuous of them are two forms to be mentioned here, one under the name of *I.* cfr. *regularis*

1) M. BOULE, P. LEMOINE et A. THÉVENIN: Céphalopodes crétaçés des environs de Diégo-Suarez. 1906. P. 25, pl. VI, figs. 5, 5 a, 5 b; pl. VII, figs. 1, 1 a.

D'ORB. and the other of *I. Schmidtii* MICHAEL. The former, as represented by the figures, fig. 3, belongs no doubt to the type of *Inoceramus* which was long known by the name of *I. cripsi* MANT., but in reality distinct from the type of *I. cripsi* MANT., as lately pointed out by W. PETRASCHKE,¹⁾ J. BOEHM²⁾ and H. WOODS.³⁾ The latter is from the zone of *Schloenbachia varians* (Cenomanian) while the former is from Senonian. For instance, the very variable form from Gosau, well illustrated by ZITTEL⁴⁾ under the name of *I. cripsi*, is, according to PETRASCHKE, not identical with the English *I. cripsi* and better to be treated provisionally as *I. cfr. regularis*; this indeed, is the very species to which the Japanese form, here figured, agrees very well in every respect.

M. YOKOYAMA⁵⁾ has already described an *Inoceramus* from the upper Cretaceous of Hokkaido, which but little differs from the Senonian "*I. cripsi*"; he found between them a slight difference in convexity of their shells and proposed the name of *I. ezoensis* for the Hokkaido form. I have also one specimen from the Upper Ammonite-beds of the Abeshinai district in Hokkaido (Pl. IV, Fig. 1), which agrees quite well with his description. This specimen, like his, is characterised by being somewhat convex near the apical portion, but from there rapidly and uniformly sloping down all around except toward the apex, and thus being surrounded by a gently sloping or rather much flattened area along the anterior and posterior ends and the lower border. Further, both the specimens of *I. ezoensis* agree with one another in sustaining an angle of nearly 90° between the anterior and the posterior side.

The specimens from Toyajo, likewise those from Gosau are very variable in their form and surface-sculpture; in spite of the great variation, however, there are certain features very characteristic and common to all the specimens from both the localities, by which they are easily distinguished from *I. ezoensis*, referred to above. The specimens from Toyajo and Gosau have, thus, the anterior end considerably bulged forwards, and the anterior side making usually a very wide angle with the posterior border, often even approaching 180°, and further the convexity of their shell almost everywhere uniform, at most somewhat conspicuously flattened towards the posterior side and end. The specimens from Toyajo and Gosau are equally provided with many broad rounded concentric ribs, separated by more or less broader concave interspaces; both the ribs and the interspaces are covered uniformly by numerous distinct concentric striae.

After all, the specimens from Toyajo seem clearly different from *I. ezoensis* YOKOYAMA on one side and indistinguishable from *I. cfr. regularis* D'ORB. = *I. cripsi* auct. of Gosau on the other.

Loc.:—Toyajo.

Hor.:—Toyajo series.

A similar form is already recorded from the Cretaceous of Kunimi in Southern Tosa, by M. YAGI; it is hence highly probable that the Senonian Toyajo series also extends to the above named district.

***Inoceramus Schmidtii* MICHAEL.**

Pl. I, Figs. 10, 11.

1899. *I. Schmidtii* MICHAEL: Ueber Kreidefossilien von der Insel Sachalin. Jahrb. d. K. preuss. geol. Landesanstalt. P. 153.

1) PETRASCHKE: Ueber Inoceramen aus der Gosau und dem Flysch der Nordalpen. Jahrb. K.K. geol. R.-A. Wien. Bd.-LVI. 1906.

2) J. BOEHM: *Inoceramus cripsi* MANT. Z. d. deutsch. geol. Gesell. Vol. LIX, 1907, p. 113. HENRY SCHROEDER und J. BOEHM: Geologie u. Palaeontologie der Subhercynen Kreidemulde. 1909. P. 47.

3) H. WOODS: Cretaceous Lamellibranchiata of England. Pal. Soc. Mon. 1912, p. . The Evolution of *Inoceramus* in the Cretaceous Period. Q. Jour. geol. Soc. London. Vol. LXVIII, 1912, p. 13.

4) ZITTEL: Die Bivalven der Gosaugebilde. Denksch. d. K. Akad. d. Wiss. Mat.-Nat. Kl. Bd. XXV. 1866. P. 95, pl. XIV. figs. 1-5; pl. XV, figs. 1-5.

5) M. YOKOYAMA: Versteinerungen aus der japanischen Kreide. Palaeontographica. Bd. XXXVI, 1890. P. 175, pl. XVIII, fig. 6, 7.

1873. *I. digitatus* FR. SCHMIDT: Ueber die Petrefakten der Kreideformation. P. 25, pl. V, figs. 8, 9; pl. VI; pl. VII; pl. VIII, figs. 9-15.
1894. *I. digitatus* JIMBO: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaido. P. 43, pl. VIII, figs. 8-10.

This is a form of *Inoceramus* very widely distributed in a certain horizon of the Cretaceous of Hokkaido and Saghalien, probably corresponding to the Lower Senonian=Emscher Mergel of Germany in which the true *I. digitatus* Sow. is found. FR. SCHMIDT identified this northwestern Pacific form with *I. digitatus*, but R. MICHAEL pointed out the specific distinction between them and named the former *I. Schmidtii*. So far as I can understand his paper, he liked to limit the application of this specific name strictly to such forms as his type specimens figured, excluding all other very allied forms found in Hokkaido and Saghalien in the close association of the former. It seems to me, however, more likely that all of these forms, including his type of *I. Schmidtii*, represent mere varieties or forma of one and the same species which is very variable.¹⁾ Some of them are provided with exceedingly prominent radial ridges, but without any conspicuous concentric ribs; the others, on the contrary, show only a slight trace of radial ridges in addition to the very distinct concentric ribs. At present, I am inclined to include all these forms into one species, to which the name given by MICHAEL is applied.

It is of a great geological interest that some of the varietal forms of *I. Schmidtii*, so extended as mentioned above, are found outside of Hokkaido and Saghalien; first, F. OTSUKI found a form, with very strong radial ridges or folds and almost free from the concentric ribs, from the Cretaceous of Amakusa, in association with *Gaudryceras tenuiliratum* YABE and *Pachydiscus* cfr. *Haradai* JIMBO, and secondly YE HAR A collected a form nearly identical with the type illustrated by MICHAEL from Toyajo. The latter which is here figured is thus hardly distinguishable, for instance, from Fig. 1 on Pl. VI accompanying the said paper by MICHAEL.

The second specimen in YE HAR A'S collection belongs to a form with very feeble trace of the radial folds along the anterior border; this variety also occurs not rarely in the Cretaceous of Hokkaido and resembles strikingly *I. Naumanni* YOKOYAMA, which is also a species described from the same region. This similarity was first pointed out by K. JIMBO²⁾ who maintains that *I. Naumanni* represents nothing but the young specimens of *I. Schmidtii*. But it seems more likely that *I. Naumanni* is an extreme form of variation belonging to *I. Schmidtii* or to the group of *I. Schmidtii*.

Loc.:—Toyajo.

Hor.:—Toyajo series.

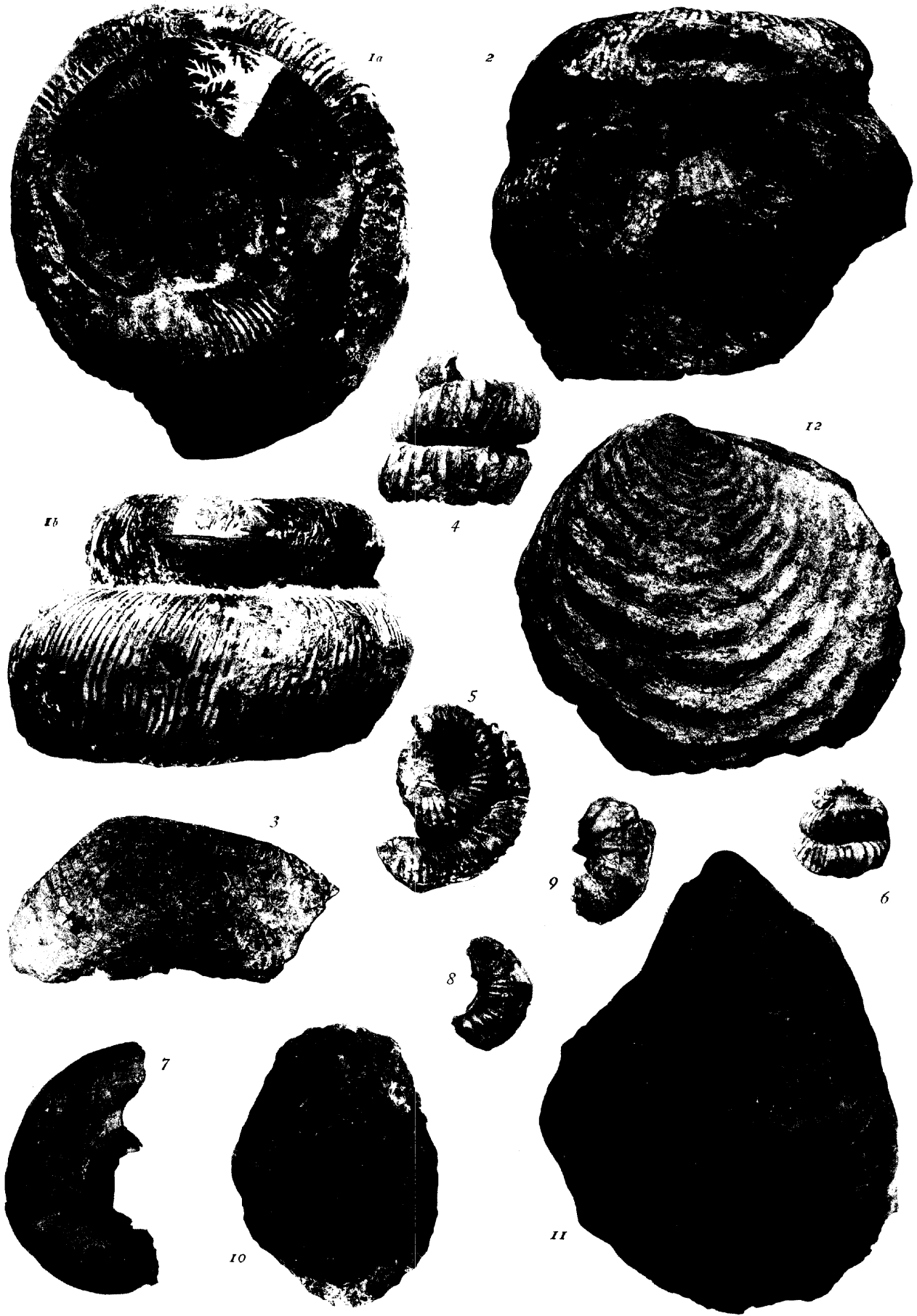
1) When I visited the Geological Department of the University in Petrograd, early in 1912, a detailed study of *Inoceramus* of this group was undertaken by a gentleman in the University; his work will finally settle the question regarding the specific distinction of these forms.

2) JIMBO: l.c. P. 44.

Pl. I.

All figures are in natural size.

- Fig. 1. *Turrilites (Hyphantoceras) Oshimai* YABE var. Anaga on the island of Awaji; Toyajo series.
- Fig. 2. *Turrilites (Bostrychoceras) Otsukai* YABE. Toyajo, Prov. Kii; Toyajo series.
- Fig. 3. *Turrilites (Bostrychoceras) Otsukai* YABE, showing the suture-line; Toyajo, Prov. Kii; Toyajo series.
- Figs. 4, 5 and 6. *Turrilites (Bostrychoceras) japonicus* YABE. Toyajo, Prov. Kii; Toyajo series.
- Fig. 7. *Tetragonites* cf. *cala* FORBES. Toyajo, Prov. Kii; Toyajo series.
- Fig. 8. *Kossmaticeras* sp. Toyajo, Prov. Kii; Toyajo series.
- Fig. 9. *Pachydiscus rotalinoides* YABE. Toyajo, Prov. Kii; Toyajo series.
- Fig. 10. *Inoceramus Schmidt* MICHAEL. Toyajo, Prov. Kii; Toyajo series.
- Fig. 11. *Inoceramus Schmidt* MICHAEL var. Toyajo, Prov. Kii; Toyajo series.
- Fig. 12. *Inoceramus* cf. *regularis* D'ORB. Toyajo, Prov. Kii; Toyajo series.



Pl. II.

- Fig. 1. *Pravitoceras sigmoidale* YABE. Anaga on the island of Awaji; Toyajo series. Nat. size.
- Fig. 2, 3 and 4. *Pravitoceras sigmoidale* YABE. Copy of the figures of two type specimens and a suture line of another specimen, once given in the Journ. Geol. Soc. Tokyo, Vol. VIII. Figs. 2, 3 in $\frac{3}{4}$ of the natural size; fig. 4 in natural size.
- Fig. 5. *Pachydiscus rotalinoides* YABE. Urakawa, Prov. Hidaka; *Pachydiscus* beds. Nat. size.
- Fig. 6. *Pachydiscus rotalinoides* YABE. Kikomezawa, a left tributary of the Ikushumbets, Prov. Ishikari, Nat. size.

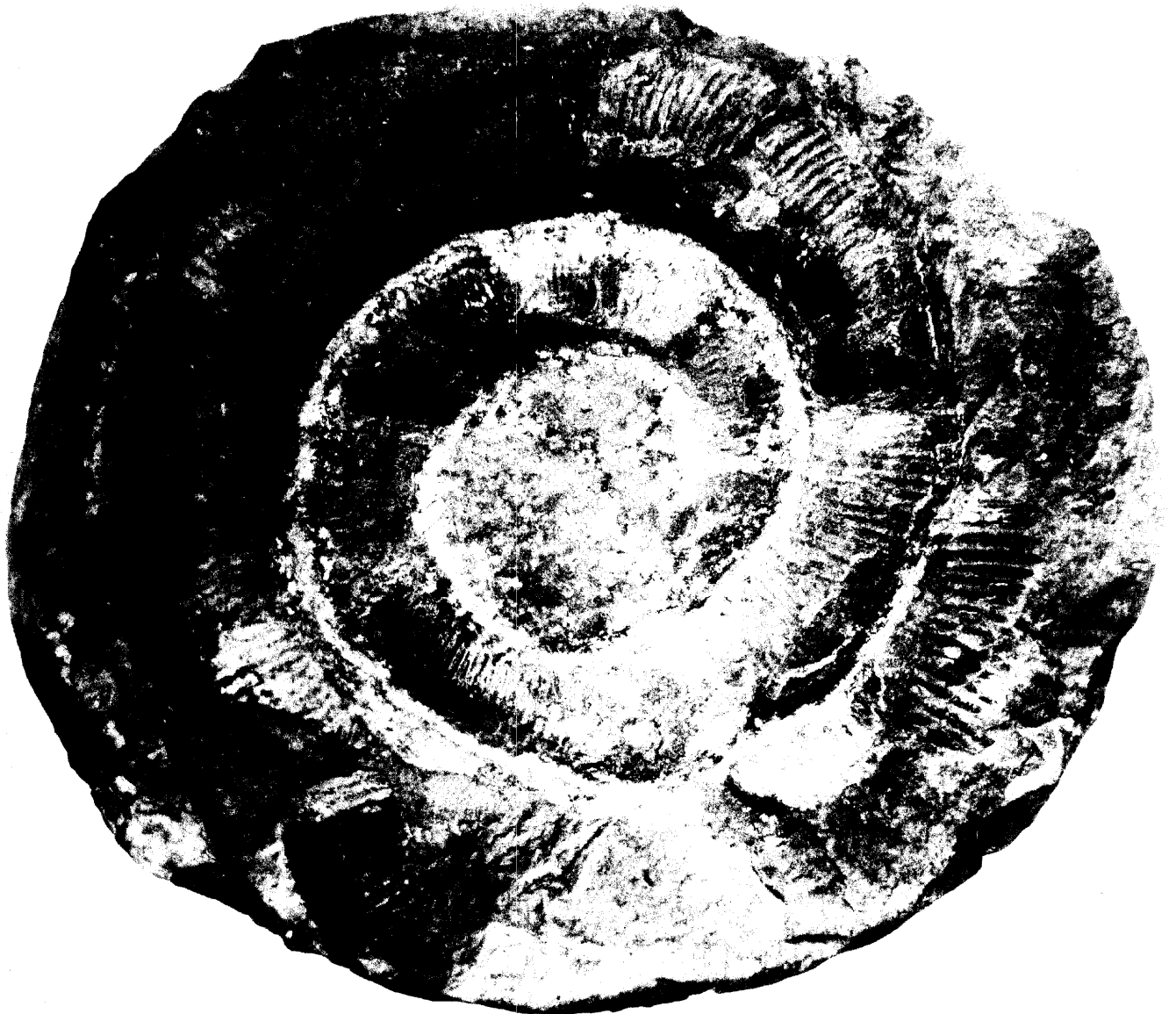


1, Tamura Photo.; 2-6, Ishizaki Del.

Pl. III.

All figures are in natural size.

- Fig. 1. *Pravitoceras sigmoidale* YABE. Toyajo, Prov. Kii; Toyajo series.
Fig. 2. *Tetragonites* cfr. *cala* FORBES. Toyajo, Prov. Kii; Toyajo series.
Fig. 3. *Inoceramus* cfr. *regularis* D'ORB. Toyajo, Prov. Kii; Toyajo series.



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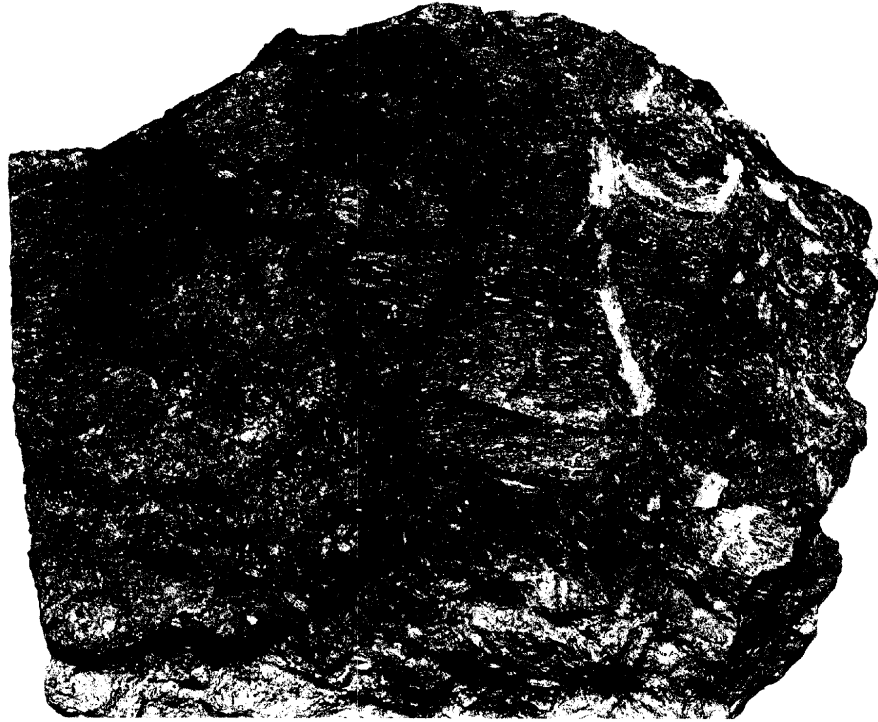


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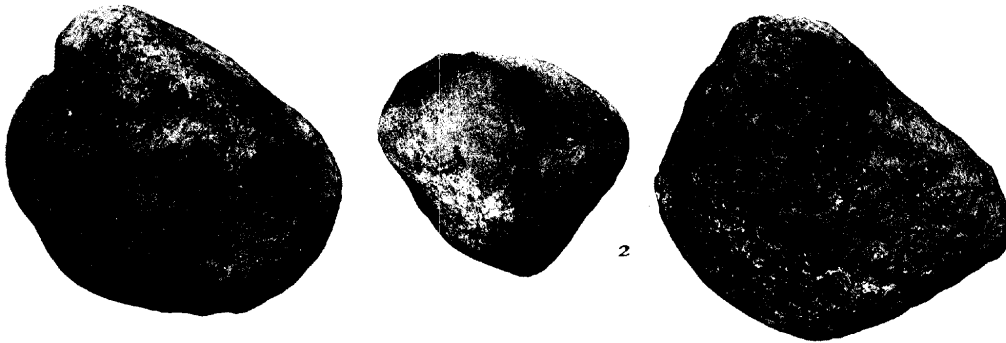
Pl. IV.

All figures are in natural size.

- Fig. 1. *Inoceramus ezoensis* YOKOYAMA. Upper Ammonites beds; the Osoushinai, a tributary of the Abeshinai, Prov. Teshio.
- Fig. 2. Three quite water-worn pebbles of Izumi-sandstone found in conglomerate. Ichinokawa, Prov. Iyo.
- Fig. 3. Friction-breccia of graphite schist. Ichinokawa, Prov. Iyo.



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