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JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY,
TOKYO, JAPAN.

VOL. XVIII., ARTICLE 2. (1903)

Cretaceous Cephalopoda from the Hokkaidō.

PART I.

Lytoceras, Gaudryceras and Tetragonites.

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With 7 plates.

Introductory Remarks.

In 1877, BENJAMIN SMITH LYMAN first announced the occurrence of Cretaceous Ammonites in the Hokkaidō, and his collection was examined by EDMUND NAUMANN who published a short account of the fossils without any detailed description.¹⁾ A more detailed account appeared in the work of Prof. MATAJIRŌ

1) E. NAUMANN: Ueber das Vorkommen der Kreideformation auf der Insel Jezo. Mitth. d. deutsch. Gesell. für Natur u. Völkerkunde Ostasiens, Bd. XXI. 1880. p. 28. The following names of Ammonites are mentioned in this work:—

<i>Lytoceras Sacya</i> FORBES.	<i>Stoliczkaia</i> sp.
<i>Phylloceras</i> n. sp. aff <i>indra</i> FORBES.	<i>Anisoceras tenuisulcatum</i> FORBES.
„ cfr. <i>subalpinum</i> d'ORBIGNY.	„ sp.
„ <i>Velledæ</i> MICHELIN.	<i>Anisoceras</i> n. sp.
<i>Amaltheus sugata</i> FORBES.	<i>Ptychoceras gaultinum</i> PICTET.
<i>Haploceras</i> n. sp.	„ n. sp.
„ <i>planulatum</i> SOWERBY.	„ n. sp.
„ <i>Gardeni</i> BAILY.	

In a preliminary note in the same volume, D. BRAUNS mentions an Ammonite from Urakawa as identical with *Stephanoceras coronatum* BRUG.

YOKOYAMA,¹⁾ who described and figured Cretaceous fossils, not only of the Hokkaidō, but also of other parts of Japan. This work was indeed the first which treated systematically of the Cretaceous fauna of the Hokkaidō, but the nature and extent of the Cretaceous formation on that island was not known until the appearance of the publications of Prof. KOTORA JIMBŌ and his assistants who, for several years, were occupied in the geological survey of the whole island. JIMBŌ²⁾

1) M. YOKOYAMA: Versteinerungen aus der Japanischen Kreide. Palaeontographica. Bd. XXXVI. 1890. The following species of Ammonites are described in this work:—

<i>Phylloceras Velledæ</i> MICHELIN.	<i>Anisoceras</i> cfr. <i>rugatum</i> FORBES.
„ <i>ezoënsæ</i> YOKOYAMA.	„ sp.
<i>Lytoceras Sacya</i> FORBES.	<i>Desmoceras sugata</i> FORBES.
„ sp.	„ sp.
„ sp.	„ <i>Gardeni</i> BAILY.
<i>Ptychoceras pseudogaultinum</i> YOKOYAMA.	„ <i>gaudama</i> FORBES.
<i>Anisoceras subquadratum</i> YOKOYAMA.	<i>Pachydiscus ariyalurensis</i> STOLICZKA.
„ <i>Haradanum</i> YOKOYAMA.	„ <i>Sutneri</i> YOKOYAMA.
„ <i>subundulatum</i> YOKOYAMA.	„ <i>Naumanni</i> YOKOYAMA.

2) K. JIMBŌ: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaidō. Palæontologische Abhandlungen. Neue Folge, Bd. II. Heft 3. 1894. In this work, besides *Phylloceras Velledæ* MICH., *P. ezoënsæ* YOK., *Hamites pseudogaultinus* YOK., *H. Haradanus* YOK., *H.* cfr. *rugatus* FORBES, *Baculites* sp., *Scaphites* cfr. *æqualis* SOW., *Pachydiscus ariyalurensis* STOL., *P. Sutneri* YOK. and *P. Naumanni* YOK., which are merely mentioned, the following forms are described:—

<i>Lytoceras Sacya</i> FORB.	<i>Acanthoceras rotomagense</i> DEFR. var.
„ <i>striatum</i> JIMBŌ.	<i>asiatica</i> JIMBŌ.
„ <i>crassicostatum</i> JIMBŌ.	„ <i>pseudodeverianum</i> JIMBŌ.
„ <i>glabrum</i> JIMBŌ.	<i>Olcostephanus</i> sp.
„ <i>sphaeronotum</i> JIMBŌ.	<i>Crioceras spinigerum</i> JIMBŌ.
„ <i>denseplicatum</i> JIMBŌ.	<i>Scaphites Yokoyamai</i> JIMBŌ.
„ <i>crassum</i> JIMBŌ.	„ <i>puerculus</i> JIMBŌ.
<i>Turritiles</i> sp.	<i>Holcodiscus Kotoi</i> JIMBŌ.
<i>Hamites obstrictus</i> JIMBŌ.	<i>Pachydiscus Haradai</i> JIMBŌ.
„ <i>quadrinodosus</i> JIMBŌ.	„ <i>teshionensis</i> JIMBŌ.
„ sp.	„ <i>subtililobatus</i> JIMBŌ.
„ sp.	„ <i>Yokoyamai</i> JIMBŌ.
„ sp.	„ <i>Denisonianus</i> STOL.
„ sp.	<i>Desmoceras Damesi</i> JIMBŌ.
„ sp.	„ <i>planulatiforme</i> JIMBŌ.
„ sp.	„ <i>yubarensæ</i> JIMBŌ.
„ sp.	„ <i>Kawanoi</i> JIMBŌ.
„ sp.	„ <i>Ishikawai</i> JIMBŌ.
<i>Placentoceras subtilistriatum</i> JIMBŌ.	

also wrote on the Cretaceous fauna of the island, giving an account of 47 species, of which 2 had already been described by YOKOYAMA and 6 are considered as identical with those of South India and other foreign localities, while 28 species are treated as quite new.

The Cretaceous formation in the main island of the Hokkaidō occupies a position between the coal-bearing series above and the Palæozoic rocks¹⁾ below, stretching generally north-south along the western side of the main axis of the island. It consists of deposits of a purely marine origin, with a rich fauna mostly made up of numerous Cephalopoda, Gasteropoda and Lamellibranchiata, and sometimes containing some vegetable remains. Among these three groups of the Mollusca, the Cephalopoda are the most abundant, both in species and individuals. Besides the Mollusca, we find some Brachiopoda, Echinodermata, Crustacea and sometimes also fishes;²⁾ vertebræ of Reptilia, apparently of a Plesiosaurus, were also once obtained.

Concerning the age of the Cretaceous deposits of the Hokkaidō, various opinions have been held since the publication of the two works above referred to. YOKOYAMA, who only investigated fossils collected by others, naturally expressed a doubt as to whether all the fossils came from a single horizon, and cautiously said that the *greater part* of the fossils corresponded to those of the Utatur group of South India and consequently that they should be assigned to the Cenoman-Gault of Europe. JIMBŌ on the contrary, considered the Cretaceous fossils of the Hokkaidō as occurring in one and the same horizon of the middle Cretaceous

1) After JIMBŌ and the general usage of Japanese geologists.

2) H. YABE: Notes on some Shark's Teeth from the Mesozoic Formation of Japan. Journ. Geol. Soc. Tōkyō. Vol. IX. No. 110. 1902.

age. European authorities, such as A. DE LAPPARENT,¹⁾ ERNST KOKEN²⁾ and FRANZ KOSSMAT³⁾ believed the existence of different horizons in our Cretaceous upon the palaeontological data, corresponding in age to the different subdivisions of the European upper Cretaceous. On the other hand, J. BÖHM⁴⁾ and R. MICHAEL⁵⁾ noticed the occurrence of fossils characteristic of the Senonian, while RUDOLF ZUBER⁶⁾ expressed the opinion that the Cretaceous of the Hokkaidō and Saghalien contain lower Cretaceous type of Ammonites.

1) A. DE LAPPARENT: *Traité de Géologie*. Quatrième édition. III. 1899. Pp. 1346, 1361 and 1394.

2) ERNST KOKEN: *Die Vorwelt und ihre Entwicklungsgeschichte*. 1893. P. 421.

3) FRANZ KOSSMAT: Ueber die Bedeutung der südindischen Kreideformation für die Beurtheilung der geographischen Verhältnisse während der späteren Kreidezeit. *Jahrb. k. k. geol. Reichsanstalt, Wien*. Bd. XLIV. 1894. Heft. 3, p. 470.

KOSSMAT also criticized the Ammonites of the Hokkaidō in his "Untersuchungen über die südindische Kreideformation." He considers *Phylloceras ezoëse* YOK. as a form very closely allied to *P. Forbesianum* D'ORB., while he considers *Desmoceras Damesi* JIMBŌ as probably identical with *D. sugata* FORBES. He brings *Lytoceras striatum* JIMBŌ, *L. crassicostratum* JIMBŌ and *denseplicatum* JIMBŌ under *Gaudryceras* and *L. glabrum* JIMBŌ under *Tetragonites*. One of the many *Hamites* described as *H. sp.* by JIMBŌ is regarded by him as identical with *H. (Anisoceras) largesulcatus* FORBES, and *Acanthoceras rotomagense* DEFR. var. *asiatica* JIMBŌ as identical with *A. Newboldi* KOSSMAT. *Anisoceras* cfr. *rugatus* of YOKOYAMA, according to KOSSMAT, is distinguished by its finer, obliquely arranged ribs from that of FORBES. *Pachydiscus Denisonianus* STOL. has been divided into the three species of *Holcodiscus sparicostatus*, *P. Jimboi* and *P. Denisonianus*, by KOSSMAT and all of them are quite different from what JIMBŌ described as such. He also doubts whether *Desmoceras Ishikawai* JIMBŌ is not a *Holcodiscus* and takes *D. gaudama* of YOKOYAMA for a coarsely ribbed variety of *D. indopacifica* KOSSMAT.

J. F. WHITEAVES of the Geological Survey of Canada, pointed out the occurrence of *Pachydiscus Haradai* JIMBŌ and *Hamites obstrictus* JIMBŌ in the Cretaceous of Vancouver Island. (J. F. WHITEAVES: On some Fossils from the Nanaimo group of Vancouver Cretaceous. *Trans. Royal Soc. Canada*. Section IV. 1895. Pp. 130 and 132). In one of his letters to JIMBŌ in 1895, he expressed the opinion that *Desmoceras Ishikawai* might possibly be identical with *Haploceras* (afterward considered as an *Holcodiscus*) *cumshewaense* WHITEAVES from the Queen Charlotte Islands.

4) JOH. BÖHM: Ueber *Ammonites pedernolis* v. BUCH. *Zeitschrift d. deutsch. geol. Gesellschaft*. Bd. L. Heft. 1. 1895. P. 200.

5) R. MICHAEL: Ueber Kreidefossilien von der Insel Sachalin. *Jahrb. d. k. preuss. geol. Landesanstalt für 1898. 1899*. P. 164.

6) RUDOLF ZUBER: *Geologie der Erdöl-Ablagerungen in den galizischen Karpathen*. I. Allgemeiner Theil. Heft 1. 1899. P. 48.

The present writer went to the Hokkaidō mainly for the purpose of settling the question of the relation of the Cretaceous Ammonite-bearing deposits and the coal-bearing series, and was there during four summer vacations from 1899 to 1902 inclusive, thus having ample opportunities to make a valuable collection of the Cretaceous fossils and also careful researches in the stratigraphical order of the rocks.

He proposes the following subdivisions of the Cretaceous deposits of the Hokkaidō, although the thickness of each division has not yet been ascertained. Beginning from below, we have :

- I. The lower Ammonite-beds with *Orbitolina*-limestone.
- II. The *Trigonia*-sandstone.
 - a. Lower *Acanthoceras*-zone or *Trigonia longiloba*-zone.
 - b. *Thetis*-zone.
 - c. *Pectunculus*-zone.
- III. The upper Ammonite-beds.
 - a. Upper *Acanthoceras*-zone.
 - b. *Scaphits*-beds.
 - c. *Pachydiscus*-beds.

The upper part of the Cretaceous passes gradually into the coal-bearing series.

The layers of the Cretaceous complex are everywhere perfectly conformable to one another and evidently represent a continuous sedimentation. At the base of this formation, there is a thick complex of shales and sandstones ; in it the former predominates over the latter and contains in some places lenticular masses of limestone with *Orbitolina concava* LAM.¹⁾ This complex is what the present writer calls the lower Ammonite-beds. Above

1) H. YABE: *Orbitolina*-Limestone in the Hokkaidō (in Japanese). Journ. Geol. Soc. Tōkyō. Vol. VIII. No. 91. 1901.

this complex is another which is also thick and consists chiefly of sandstones with subordinate layers of shale and conglomerate. This formation, being a more littoral deposit than the above, is very poor in Cephalopoda while Gasteropoda and Lamelli-branchiata, especially the remains of *Trigonia*, are common. The writer gives to this series the name of *Trigonia*-sandstone. The upper Ammonite-beds, which directly cover the *Trigonia*-sandstone, are again argillaceous, being mainly composed of shales with a few layers of sandstone. Most of the fossils described by Professors YOKOYAMA and JIMBŌ and above alluded to, as well as the greater part of my collection, were derived from these beds.

The fossils described in the following pages are partly those already treated by JIMBŌ in his work and partly those collected by the writer during his field work in the provinces of Ishikari, Teshio, Iburi and Kitami, while some are those belonging to the museum of the Science College. Not a few have been presented to the writer by gentlemen, who have kindly interested themselves in his work.

The writer begins the present memoir with the description of those groups of Ammonites which have been hitherto included in the genus *Lytoceras*, but which are now separated into *Lytoceras*, *Gaudryceras* and *Tetragonites*. A general discussion on the nature of the fauna will be given at the end of the memoir.

In the present paper, the geographical names of the Hokkaidō have been spelled according to BATCHELOR's¹⁾ system of writing Ainu names, and those of the other parts of Japan according to the system adopted by the Society for romanizing Japanese Writing. These two systems are essentially the same in principle,

1) Ainu-English-Japanese Dictionary and Grammar by the Reverend JOHN BATCHELOR. 1889.

all the vowels being pronounced as in Italian and all the consonants as in English.¹⁾ The only difference lies in the sharp consonantal endings of many Ainu words and the existence of the sounds *hu* and *tu* in them.

The writer takes this opportunity to express his best thanks to Prof. BUNJIRŌ KOTŌ and Mr. DENKICHI YAMASHITA for the great encouragement given to him during his geological researches in the Hokkaidō. Thanks are also due to Professors M. YOKOYAMA and K. JIMBŌ for valuable suggestions in the execution of the present work. Moreover, the writer is under special obligation to the Hokkaidō Colliery Railway Company for allowing him to make thorough examinations of the strata of the coal field now being worked, and also to its chief engineers, Messrs. ROKURŌ ŌSHIMA and KIYOTSUGU YONEKURA, who were always ready to make his stay in that region as comfortable as possible. In conclusion the writer wishes particularly to thank Mr. JUNGO ISHIZAKI who has drawn all the figures except the suture lines.

LYTOCERAS, GAUDRYCERAS AND TETRAGONITES, IN GENERAL.

Lytoceras ranges from the Lias to the end of the Mesozoic, being very rich in species, from which many retrogressive genera of normal and abnormal forms have been derived. Where the upper Cretaceous deposits are developed, there we always find abnormal

1) For the pronounciation of Japanese words see Professor BASIL HALL CHAMBERLAIN'S Handbook of Colloquial Japanese.

forms such as *Turrilites*, *Hamites* and *Baculites*. Associated with these forms, there is still a larger group of Ammonites of the same stock, which are especially numerous in the Indo-Pacific Cretaceous deposits. These Ammonites, which possess closely coiled and more or less deeply involute volutions, early attracted the attention of VICTOR UHLIG,¹⁾ who was the first to call them the "Group of *Lytoceras Sacya*" and who thought that all of the upper Cretaceous *Lytoceras* might belong to this group. In 1894, A. DE GROSSOUVRE²⁾ proposed the new generic name *Gaudryceras* for these Ammonites. KOSSMAT³⁾ who had an opportunity of examining better materials of these Ammonites, separated from *Gaudryceras* two other types under the names of *Tetragonites* and *Pseudophyllites*, and considered these three as subgenera of *Lytoceras*. More lately, ALPHEUS HYATT⁴⁾ placed them in his second family Tetragonitidæ in the suborder Leptocampyli.

Besides these three geologically young types, remnants of another type of *Lytoceras*, of the Jurassic and lower Cretaceous formations, have also been found in the South Indian Cretaceous fauna, and in that of nearly the same age on the Pacific coast of North America. They are the Ammonites of the group of *Lytoceras fimbriatum*, or of *Lytoceras* in the most restricted sense.

Among these several types of the upper Cretaceous *Lytoceras*, there is a monotypic genus called *Pseudophyllites*, which at present has only one species, *P. indra*. This species has a very wide dis-

1) V. UHLIG: Bemerkungen z. Gliederung karpatischer Bildungen. Jahrb. d. k. k. geol. Reichsanstalt. Bd. XLIV. Heft 2. 1894. P. 217.

2) A. DE GROSSOUVRE: Recherches sur la Craie supérieure. II partie. Les Ammonites de la Craie supérieure. Mémoires pour servir à l'explication de la carte géologique détaillée de la France. 1893. P. 225.

3) FR. KOSSMAT: Untersuchungen über die südindische Kreideformation I. Beiträge z. Palaeontologie u. Geologie Österreich-Ungarns u. d. Orients. Bd. IX. 1895. P. 17 (113).

4) ALPHEUS HYATT: Cephalopoda in Zittel's Text Book of Palaeontology. 1900.

tribution, being recorded from the Vancouver Island,¹⁾ South India²⁾ and Madagascar;³⁾ to which list France should also be added, as *Gaudryceras Colloti* GROSSOUVRE of that country has been proved to be identical with the above species.⁴⁾ According to YOKOYAMA⁵⁾ the specimen from the Hokkaidō, which had been considered by E. NAUMANN as a new species allied to *P. indra*, is too fragmentary for exact determination. Similar specimens are not contained in the writer's collection so that, much to his regret, he finds himself unable to decide whether NAUMANN's determination is correct or not.

LYTOCERAS SUESS.

Ammonoceratites

LYTOCERAS EZOËNSE M.

Pl. I. Fig. 1 ; Pl. V. Fig. 1.

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5-1

The writer examined two specimens of this species; the one which is here figured, is nearly perfect, with a partly preserved shell and showing only a single suture line.

1) J. F. WHITEAVES: Mesozoic Fossils. Vol. I. pt. 2. 1879. p. 105.

2) F. STOLICZKA: The Fossil Cephalopoda of the Cretaceous Rocks of Southern India. Pal. Indica. Vol. I. p. 112.—FR. KOSSMAT: l. c. p. 41 (137).

3) M. M. BOULE: Note sur de nouveaux fossiles secondaires de Madagascar. Bull. du Mus. d'hist. nat. 1899.

4) A. de Grossouvre: Sur la genre *Neptychites*. Bull. Soc. géol. France. Ser. III. Tome 24.

5) M. Yokoyama: l. c. p. 175.

Dimensions :—

		Ratio.
Diameter.	20.0 cm.	100.
Height of the last whorl.	8.0 „	40.
Breadth of the last whorl.	7.5 „	37.
Height of the whorl last but one.	2.8 „	14.
Breadth of the whorl last but one.	3.2 „	16.
Width of umbilicus.	7.0 „	35.

Shell discoidal, composed of many round whorls, increasing rather rapidly in height and breadth. Whorls nearly round, somewhat laterally compressed on the last volution, but elsewhere rather inflated, being broader than high. Umbilicus very wide, surrounded by a perpendicular wall which gradually passes to the lateral side of the whorls; the outer volutions embrace the inner ones only to a small extent. Surface covered with very numerous, transverse, fimbriate striæ, close to one another, at intervals of about two m.m. on the last volution, without any trace of periodic arrest of growth. Ribs flat, scarcely elevated, the cast of the interior being quite smooth.

Suture line shows three saddles and corresponding lobes on each side of the siphonal line, regularly diminishing in size toward the umbilical suture. Siphonal saddle elongate lanceolate and serrated along the margin. External lobe considerably shallower than the first lateral which is the broadest. External saddle unequally bifid inclining somewhat inward; first lateral saddle also asymmetrically bipartite and larger than the external one. Second lateral saddle very deeply bipartite, apparently forming two separate saddles on the umbilical wall. All branches of the saddles and lobes are repeatedly bifid and finely incised. The branchlets along both sides of the siphonal saddle are asymmetrically arranged, as shown in the accompanying figure.

The present species is distinguished from *Lytoceras Mahadeva* STOLICZKA found in the lower division of the Utatur group of Marattur, South India,¹⁾ and from *L. Batesii* MEEK of the Shasta group of California and Richardson's C horizon of the Cretaceous of Queen Charlotte Islands,²⁾ by its whorls more rapidly increasing in height and breadth.

Localities :—The Pombets and Ponporonai, tributaries of the Ikushumbets, Prov. Ishikari.

Horizon :—Lower Ammonite-beds.

LYTOCERAS IMPERIALE M.

Pl. II. fig. 1; pl. IV. fig. 1.

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4-1

Among numerous specimens of Ammonites from the Cretaceous of the Hokkaidō which are yet undescribed, the present is the most striking on account of its peculiar sculpture. The following are the dimensions of the shell as actually measured in our only specimen³⁾ :—

Diameter.	22.0 cm.	Ratio. 100.
Height of the last whorl.	10.0 „	45.
Breadth of the last whorl.	5.0 „	22.
Width of umbilicus.	7.0 „	31.

1) STOLICZKA: l. c. p. 165, Pl. LXXX. Kossmat: l. c. p. 16 (112).

2) W. M. GABB: Palæontology of California: Creta. Foss., p. 67. Pl. XIII, fig. 16 a, b.—J. F. WHITEAVES: Mesozoic Fossils. Vol. I. Pt. 1, p. 45, Pl. IX. fig. 2. Vol. I. Pt. 3, p. 202, Pl. XXVII. fig. 1.—T. W. STANTON and DILLER: The Shasta-Chico Series. Bull. Geol. Soc. America. Vol. V. 1894. P. 446.—T. W. STANTON: Contribution to the Cretaceous Palæontology of the Pacific Coast: The Fauna of the Knoxville Beds. Bull. U. S. Geol. Surv. No. 133. 1895. P. 75. Pl. XIII. figs 9—11.

3) The flattening of the body-whorl, which is at first nearly round, does not seem to be wholly due to mechanical action. It is, therefore, to be considered as one of the distinguishing characters of the species.

The inner volutions, which gradually broaden anteriorly, are nearly round in section, showing only a slight lateral compression. The body-chamber is longer than one half of the last volution; it is high and narrow. Umbilicus moderate in size; relatively narrower on the last volution than on the inner.

The surface of the septate portion is apparently smooth while the-body chamber shows radial furrows which are 15 in number; the furrows are shallow and not well defined, becoming gradually obsolete toward the umbilicus. The interspaces are flat, slightly elevated, broadest along the ventral side, measuring 1.5—2.5 cm. in breadth. These flat interspaces and furrows extend also over the ventral surface.

The suture line which is partly preserved, shows a lanceolate siphonal saddle with serrated margin. The external saddle is inclined inward and asymmetrically bifid, while the first lateral lobe is broad and deep.

The suture line and the appearance of the septate portion of this species remind us of an Ammonite of the group of *Lytoceras fimbriatum* Sow. sp., while the suddenly enlarged and laterally compressed body-whorl, together with its peculiar sculpture, distinguishes it from all the known allies.

Locality :—A cliff somewhat above the lowest gorge of the Ikushumbets, Prov. Ishikari, where the species occurs together with *Puzosia subcorbarica* m.

Horizon :—Lower Ammonite-beds.

GAUDRYCERAS GROSSOUVRE *emend.* KOSSMAT.

We have one addition to make to the remarks of KOSSMAT on the genus *Gaudryceras*, and that is respecting its suture line. Putting aside the question whether *Gaudryceras* is a well defined genus or not, it has been divided into two well marked sections, to the first of which belong *G. Agassizianum* PICTET¹⁾ from the upper Gault of Switzerland and *G. Marut* STOLICZKA²⁾ from the Utatur group of South India. The former shows the antisiphonal lobe prolonged and reflected on the preceding septum as illustrated in detail by QUENSTEDT.³⁾ but the suture line of the latter has been only partly figured. The second group, or the group of *G. Sacya*, contains more than thirty species, of which there are only two,—*G. vertebratum* KOSSMAT⁴⁾ and *G. varagurense* KOSSMAT⁵⁾—whose lobes have been examined; but as to the septal lobe in these two species, there exists neither a drawing nor a description. However, after careful examination of several Japanese species of *Gaudryceras*, the writer was able to find three species showing the septal lobe just as in *G. Agassizianum* Pictet. These three are *G. tenuiliratum*, m., *G. striatum* JIMBŌ sp. var. *pictum* m. (Pl. IV. fig. 6 c) and *G. limatum* m., each representing a particular type in the group of *G. sacya*. The presence of the septal lobe in the above three and in *G. Agassizianum* leads us to presume that it is a character common to all species of *Gaudryceras* although

1) J. F. PICTET et W. ROUX: Mollusques fossiles des Grès Verts des environs de Genève. 1847-53. P. 47, Pl. IV. figs. 3, 4.

2) STOLICZKA: l. c. p. 162, Pl. LXXIX., fig. 1.—KOSSMAT: l. c. p. 34 (130).

3) F. A. QUENSTEDT: Handbuch d. Petrefaktenkunde. III. Auflage. 1885. P. 579, Pl. XLV. fig. 11.

4) KOSSMAT: l. c. p. 26, Pl. IV., fig. 2.

5) KOSSMAT: l. c. p. 30, Pl. I., figs. 4, 5.

it is not usually visible unless the specimen is in a very favorable state of preservation.

All the species of *Gaudryceras* seem to be very imperfectly known. This is partly due to the fact that although they are very common especially in the upper Cretaceous deposits of the Indo-Pacific region, the specimens usually belong to immature animals, and consequently closely resemble one another so that the determination is not only very difficult, but often quite impossible. Moreover, the aspect of the shell of this genus is so different in its younger and older stages, that without a large series of specimens for comparison, the larger and smaller forms are often liable to be separated into distinct species. There are already several instances of confusion among the species of this genus. The full specific character, as it seems to the writer, appears always in the mature stage or at least after the shell has attained the middle stage of its life. The differences existing among the young individuals of different species are very slight and often apparently less marked than those between individuals in one and the same species, while the shell of the full grown forms of each species is well characterized and easily distinguishable from its allies. However, owing to the rapid enlargement of whorls in adult specimens and the extreme thinness of the shell, it is not always easy to get specimens with a well preserved shell.

The largest Japanese species is *Gaudryceras tenuiliratum*, one of the specimens measuring over 30 cm. in diameter and being entirely septate, but still showing the sharp ribs as usual. The following is what FR. SCHMIDT¹⁾ wrote about an Ammonite from the Cretaceous of Saghalien which he identified with *G. Sacya*.

1) FR. SCHMIDT: Die Petrefakten der Kreideformation von der Insel Sachalin. 1873. P. 16.

“Bei meinem grössten Stück, das über einen Fuss im Durchmesser hielt, und von dem ich nur ein Bruchstück mitgebracht habe, ist der Steinkern der äussersten Windung ganz glatt, nur über and über mit ineinander gewirrter Lobenzeichnung bedeckt; die erwähnten dichteren Rippen sieht man an nächst der inneren Windung des nämlichen Stücks.”

The smoot state of the outer volutions of the older individuals, as above referred to, is very common also in the Japanese species of *Pachydiscus*, but has never yet been observed in the *Gaudryceras*, occurring very abundantly in the Hokkaidō and sometimes also in Amakusa.

The writer is now acquainted with nine species and five varieties of *Gaudryceras* from the Hokkaidō, all of which belong to the category known as ‘the group of *Gaudryceras Sacya*.’ This group is again divisible into six subgroups, chiefly according to the character of the full grown shells.

I. Subgroup of *Gaudryceras tenuiliratum* YABE.

This subgroup is characterized by the full-grown whorl having numerous ribs of two kinds, a number of narrower ribs being inserted between each pair of broader ribs. The latter on a closer examination are found to be made up of two or three finer ribs placed close together. The whorls grow exceedingly rapidly in height and breadth.

The type is *G. tenuiliratum*¹⁾ from the upper Ammonite beds of the Hokkaidō and is very variable in form. *G. varagureense* KOSSMAT²⁾ sp. probably belongs to this subgroup, and *G. mite*

1) Vide p. 19.

2) KOSSMAT: l. c. p. 26 (122), Pl. IV (XVIII), fig. 2 a, b, c; Pl. III (XVII), fig. 9.

HAUER¹⁾ sp. from the Senonian of Gossau and France is also referable to this subgroup.

II. Subgroup of *Gaudryceras crasscostatum* JIMBŌ SP.

Whorls compressed on the sides, with broad ribs and finer interstitial ones. Suture line in young specimens more complicated than in those of the first subgroup. The type is *G. crasscostatum* JIMBŌ²⁾ sp. The two other species from the Hokkaidō—*G. denseplicatum* JIMBŌ³⁾ sp. and *G. striatum* JIMBŌ⁴⁾ sp.—show a sculpture somewhat deviating from this type species. *Ammonites glanegensis* REDTENBACHER⁵⁾ from the Gossau formation of the north-eastern Alps, being intermediate between *G. tenuiliratum* and *G. denseplicatum*, forms a connecting link between this subgroup and the preceding. *G. subtililineatum* KOSSMAT sp. is also probably referable to this subgroup.

III. Subgroup of *Gaudryceras limatum* YABE.

The striæ on the whorls in young specimens are so extremely fine that the surface appears to be almost smooth. The adult shells present ribs which are broad and elevated, and crowded together without any interstitial striæ as in the foregoing subgroup. Suture line very complicated, characterized by the bipartite second

1) FR. v. HAUER: Neue Cephalopoden der Gosaugebilde. Sitzungsab. Akad. Wiss. Wien. 1866. Bd. LIII. p. 7 (305), Pl. II., figs. 3-4. A. DE GROSSOUVRE: l. c. p. 227, Pl. XXVI., fig. 4; Pl. XXXIX.

2) Vide p. 29.

3) Vide p. 30.

4) Vide p. 31.

5) ANTON REDTENBACHER: Die Cephalopodenfauna d. Gosauschichten in d. nordöst. Alpen. Abh. d. k. k. geol. Reichsanstalt. Bd. V. Heft 5. P. 119, Pl. XXVII., fig. 3.

lateral lobe. Type:—*G. limatum* m.¹⁾ *G. politissimum* KOSSMAT²⁾ from the upper Trichinopoly group of South India is a species closely resembling this Japanese form. *Lytoceras* sp. of SCHLÜTER³⁾ from the Senonian of Germany may also be cited as an ally of the latter.

IV. Subgroup of *Gaudryceras denmanense* WHITEAVES.

This embraces these Ammonites whose surface bears numerous simple, equal, sharp ribs in the full grown state. It is closely related to the first subgroup, but is distinguished from it by the absence of periodic ribs. Type:—*G. denmanense* WHITEAVES sp.,⁴⁾ once treated as *L. Jukesii*? SHARPE⁵⁾, and considered by KOSSMAT⁶⁾ as identical with *G. Kayei* FORBES sp. *G. Jukesii* is a species from the Senonian of England which was founded on a single fragment.

V. Subgroup of *Gaudryceras Sacya* FORBES sp.

A full grown shell shows many, very shallow and narrow, transverse grooves separated by wide interspaces. The suture line resembles that of the subgroup of *G. tenuiliratum*. Type:—*G. Sacya* FORBES⁷⁾ sp., the adult specimens of which were called by

1) Vide p. 34.

2) KOSSMAT: l. c. p. 32 (128), Pl. L' (XV). figs. 7 a, b, c.

3) SCHLÜTER: Cephalopoden d. oberen deutschen Kreide. P. 16, Pl. XLII. figs. 6, 7.

4) WHITEAVES: On some Fossils from the Nanaimo group of the Vancouver Cretaceous. 1895. P. 129, Pl. II. figs. 1-2. Note on a Supposed New Species of *Lytoceras* from the Cretaceous Rocks at Denman Island. Ottawa Naturalist. 1901. Vol. XV. No. 2, p. 31.

5) WHITEAVES: Mesozoic Fossils. Vol. I. Pt. 2, p. 119, Pl. XIII. figs. 3, 3 a, b.

6) KOSSMAT: l. c. p. 125.

7) STOLICZKA: l. c. p. 154, Pl. LXXV. figs. 5-7; Pl. LXXVI. figs. 1-3.—WHITEAVES: l. c. Vol. I. Pt. 1, p. 43, Pl. II. figs. 2 a, b, c, 3. Pt. 3, p. 203, Pl. XXV.—KOSSMAT: l. c. p. 23 (119).

FORBES *Ammonites Budha*. The single fragment of an Ammonite from the Hokkaidō shows the character of the subgroup.

VI. Subgroup of *Gaudryceras varuna* FORBES sp.

This subgroup holds a somewhat isolated position as compared with the above five, including *G. varuna* FORBES sp.,¹⁾ *G. odiense* KOSSMAT sp.,²⁾ *G. anaspatum* REDTENBACHER sp.³⁾ and *G. Kawanoi* JIMBŌ sp.⁴⁾ The whorls of these species are considerably compressed on the side, the involution being very deep and the umbilicus narrow from the beginning of the shell, while the surface is nearly smooth. To these differences is still to be added another concerning the course of the suture line. There are numerous auxiliary lobes slowly diminishing in size toward the umbilicus.

Although it appears somewhat artificial to make such subdivisions of *Gaudryceras* as above enumerated, yet in this way, not only geologically younger forms are easily separated from the older, but also the extreme confusion which has hitherto prevailed among the Ammonites of the whole group may also be avoided.

1) KOSSMAT: l. c. p. 34 (130); p. 65 (161), Pl. II (XVI), figs. 4 a, b; Pl. III (XVII), fig. 8.

2) KOSSMAT: l. c. p. 33 (129), Pl. IV (XVIII), fig. 1 a, b, c; Pl. V (XIX), fig. 3.

3) REDTENBACHER: l. c. p. 113, Pl. XXVI. fig. 1.

4) Vide p. 41.

SUBGROUP OF GAUDRYCERAS TENUILIRATUM.

GAUDRYCERAS TENUILIRATUM M.

MM 7473-3-3

Pl. III., figs. 3 and 4. (R) MM 7474-3-4

1890. *Lytoceras Sacya* YOKOYAMA: Versteinerungen aus der japanischen Kreide. P. 178, Pl XVIII. figs. 12 a, b, 13 a, b.

1894. *Lytoceras Sacya* JIMBŌ: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaidō. P. 13 (159)—18 (164).

This species is the most common form in our Cretaceous, playing the rôle of the leading fossil of the upper Ammonite-beds. It has long been known under the name of '*Lytoceras Sacga*' and the occurrence of the middle Cretaceous in Hokkaidō has been based by several authorities on this determination. The writer took special care in studying this species, as it has been often much confounded with allied forms.

Dimensions:—

	(1)		(2)		(3)		(4)		(5)	
Diameter.	30.0 cm.	100.	23.0 cm.	100.	4.2 cm.	100.	3.95 cm.	100.	3.50 cm.	100.
Height of the last whorl.	16.0 "	53.	13.0 "	56.	— "	—	1.45 "	36.	1.2) "	34.
Breadth of the last whorl.	16.5 "	53.	12.0 "	52.	1.6 "	38.	1.45 "	36.	1.35 "	38.
Width of umbilicus.	5.5 "	18.	4.8 "	20.	1.8 "	42.	1.60 "	40.	1.50 "	42.

1) The largest specimen ever found; from a cliff opposite the mouth of the Panke-moyūbari, a branch of the Yūbarigawa.

2) A specimen from Urakawa.

3) A specimen from Urakawa (after YOKOYAMA).

4) A specimen from the Kikumezawa, a tributary of the Ikushumbets.

5) A specimen from the Kikumezawa, a tributary of the Ikushumbets.

The description of this species by YOKOYAMA is very accurate, but it is based on young specimens and not on adult ones. The full-grown individual of *G. tenuiliratum* must have attained a considerable size, for a specimen from a cliff opposite the mouth of the Panke-moyūbari measures 30 cm. in diameter and is entirely septate. By removing the outer volutions, we can trace each stage of development back to the embryonal chamber. However, when specimens are very small, it is not always easy to determine whether they represent a young stage of the present species or of other allied forms. That the young and adult specimens belong to one and the same species is shown by the abundant occurrence of many transitional forms. For the sake of convenience the writer describes this species in three different stages of development, although in fact there is no sharp boundary between any two of them.

The **young** stage¹⁾:—Shell discoidal, composed of many slightly involute whorls. A specimen, 3.5 cm. in diameter, is composed of six volutions. Whorls transversely reniform, broader than high and broadest near the umbilical edge. Umbilicus very wide, with a moderately steep wall.

Surface with very numerous fine striæ and few periodic ribs; striæ unequal in length, more or less S-shaped and acute, much narrower than their interspaces. The longest striæ embrace the entire surface of the whorl, while the shortest ones are only on its ventral side; others are on the ventral as well as on the

1) YOKOYAMA: l. c. Pl. XVIII. fig. 13.

lateral sides. All of these striæ are very fine, but their size varies much in each individual. The periodic ribs are round and parallel to the striæ, five of them being on each volution, and correspond to faint grooves on the cast of the interior. These ribs are also covered with fine striæ.

The suture line has one external, two lateral and three auxiliary saddles, diminishing gradually in size toward the umbilical suture.

The above description and that of YOKOYAMA clearly indicate that this Ammonite is closely related to *G. multiplexum* Koss.¹⁾ (= *G. Sacya* FORBES var. *multiplexum* STOLICZKA), with which YOKOYAMA indeed identified it, while KOSSMAT considered it to be *G. Sacya*. The former species is distinguished from this by the different forms of the auxiliary saddles. The latter, when compared with this, possesses less numerous volutions, although it is often impossible to find this distinction, when we have not full grown forms before us. *G. denmanense* WHITEAVES²⁾ sp. from the Vancouver Cretaceous which is identified with *G. Kayei* FORBES by KOSSMAT, is also hardly distinguishable from the young forms of the present species.

WHITEAVES, after a direct comparison of the specimens of his *G. denmanense* with those of *G. tenuiliratum* which had been sent to him for examination, informed the writer that he saw at present, no reason why the latter should be distinguished from the former. *G. alamedense* J. P. SMITH³⁾ is also certainly related to *G. tenuiliratum*, but according to the above author to whom

1) KOSSMAT: l. c. p. 25 (121), Pl. I (XV), figs. 6 a, b, c.

2) WHITEAVES: On Some Fossils from the Nanaimo group of the Vancouver Cretaceous 1895. P. 129, Pl. II. figs. 1-2.

3) SMITH: The Development of *Lyloceras* and *Phylloceras*. Proc. Calif. Acad. Sci. Series. III. Vol. I. No. 4. 1898. P. 136.

some specimens of the Japanese species were also sent for comparison, the Californian form is said never to attain such a large size, and to be less involute. This is the more remarkable, as the specimens sent to him were all of a young stage. Now, as shown by the descriptions of the varieties of this species, the involution of whorls is also not always constant, therefore it seems to the writer that the distinction based on this character is not of much value. *G. varagurense* KOSSMAT¹⁾ from the Trichinopoly group of South India is also one of the nearest allies, but it possesses a more compressed shell and higher whorls.

The **middle** stage²⁾:—Whorls rather rapidly growing in height and breadth; the height and breadth being at first nearly equal, while later the height becomes greater than the breadth. Umbilical wall very steeply inclined.

Surface with striæ and ribs, the shortest striæ disappearing imperceptibly as the shell grows, while the remaining ones, on the contrary, become thicker and more elevated and separated by wider intervals than on the whorls of the young stage. Ribs very numerous, with seven or eight striæ between, somewhat elevated, round, composed of two or three striæ which are very close together and run into one on the lateral side. Involution also somewhat deeper, about one half of the preceding volution being covered.

Suture line as in the preceding stage with some slight complications.

G. mite HAUER³⁾ and *G. varagurense* KOSSMAT in form closely resemble this stage. The first species which is from the

1) KOSSMAT: l. c. p. 26 (122), Pl. IV (XVIII), figs. 2 a, b, c; Pl. III (XVII), fig. 9.

2) YOKOYAMA: l. c. Pl. XVIII. figs. 12 a, b.

3) HAUER: l. c. p. 7 (305), Pl. II. figs. 3-4. A. DE GROSŒUVRE: l. c. p. 227, Pl. XXVI. fig. 4; Pl. XXXIX.

Gossau bed of the Alps, on comparison, has less involute whorls (about $\frac{1}{3}$) and the ribs are less conspicuous. *G. varagurens* which is allied to *G. tenuiliratum* in the young stage of its shell, is a species based on fragments from the upper Trichinopoly group of Varagur, South India. It shows only one periodic rib in a space corresponding to the last quarter of the last volution.

The **mature** stage:—Whorls enlarging very rapidly; rounded and at the same time broadest at the umbilical edge, the breadth from this point gradually diminishing toward the ventral side. Involution more than $\frac{1}{2}$. Umbilicus narrow, very deep, surrounded by a perpendicular wall.

Surface with very narrow, sharp, prominent, simple, transverse ribs whose greater part entirely surrounds the whorls. Between the ribs, sometimes, shorter ones of the same character are inserted. Interspaces between the ribs flat, measuring 2 mm. on the ventral side. Periodic ribs composed of a partial union of two ordinary ribs, with a regular interspace of about 2–3 cm. along the ventral side, 22 of which are on the last volution of the largest well preserved specimen.

The suture line is of the same type as in the preceding stage, only it is very much complicated, the accompanying figure having been taken from a large fragment found on the Bannosawa which is, no doubt, considerably larger than that which the writer has already referred to at the beginning.

The full specific character is shown after the Ammonite has attained its adult stage. The full grown shell is quite different from others in form, while that of the young or middle stage is very liable to be confounded with allied species. This may be partly due to the fact that the adult shells of the allied forms are mostly imperfectly known.

G. denmanense WHITEAVES¹⁾ shows phases of growth similar to those of *G. tenuiliratum*. Its adult stage is provided with a single kind of ribs which are somewhat thicker and separated by wider intervals than in Japanese species.

G. glanegense REDTENBACHER²⁾ from the Gossau formation of the Alps also more or less closely resembles the Japanese species, showing surface marking intermediate between it and *G. denseplicatum* JIMBŌ sp.

Localities:—Abundant wherever the *Pachydiscus*- and the *Scaphites*-beds occur, but especially frequent in the *Pachydiscus* beds. Found in Sorachigōri and Yūbarigōri in the Province of Ishikari; Yūfutsugun in the Province of Iburi; along the Opiraushibets, and the Abeshinai, a tributary of the Teshiogawa, in the Province Teshio; Urakawa, in the Province of Hidaka; Sōyagori, in the Province of Kitami. Outside of the Hokkaidō, this species has been also found in the Cretaceous of Amakusa.³⁾

I. Variety with a Wider Umbilicus.

VAR. ORNATA M.

MM 7472

Pl. III., figs. 2 a, b.

Compare:—

1865. *Ammonites Kayei* STOLICZKA: l. c. p. 15, Pl. LXXVII.
fig. 1.

1871. *Ammonites Kayei* GRIESBACH: Geology of Natal.
Quart. Journ. Geol. Soc. London. Vol. XXVII. p. 63.

1) WHITEAVES: On Some Fossils from the Nanaimo Group of the Vancouver Cretaceous. p. 129, Pl. II. figs. 1-2.

2) REDTENBACHER: l. c. p. 119, Pl. XXVII. figs. 3 a, b.

3) H. YABE: Note on Three Upper Cretaceous Ammonites from Japan. P. 10.

1895. *Lytoceras Kayei* STEINMANN: Die Cephalopoden d. Quiriquina Schichten. Neues Jahrb. f. Mineral., Geol. und Palaeont., Beilageband X. p. 86, Pl. V. fig. 5 a, b.

1895. *Lytoceras (Gaudryceras) Kayei* KOSSMAT: l. c. p. 162, Pl. II (XVI), fig. 5 a, b; Pl. III (XVII), fig. 2 a, b.

Dimensions:—

	(1) Ratio.	(2) Ratio.	(3) Ratio.	(4) Ratio.	(5) Ratio.	(6) Ratio.
Diameter.	5.85 cm. 100	4.00 cm. 100.	2.25 cm. 100.	2.10 cm. 100.	2.30 cm. 100.	1.26 cm. 100.
Height of the last whorl.	1.85 „ 32	1.20 „ 30.	0.65 „ 28.	0.60 „ 28.	— „ —	0.30 „ 24.
Breadth of the last whorl.	1.80 „ 31	1.35 „ 34.	0.75 „ 33.	0.70 „ 33.	0.70 „ 30.	0.50 „ 40.
Width of umbilicus.	2.75 „ 47	1.80 „ 45.	1.20 „ 53.	1.10 „ 52.	1.20 „ 52.	0.70 „ 56.

1). A specimen of *G. Kayei* from the Valudayur beds of Pondicherry (after KOSSMAT).

2). A specimen of var. *ornata* from the *Pachydiscus*-beds of the Kikumezawa (Pl. III. fig. 2 a, b).

3). A specimen of *G. Kayei* from South India (after FORBES).

4). A specimen of *G. Kayei* from the Quiriquina bed of Chili (after STEINMANN).

5). A specimen of var. *ornata* from the upper Ammonite beds of the Ikushumbets.

6). A specimen of *G. Kayei* from the Valudayur beds of Pondicherry (after KOSSMAT).

The specimen, No. 5, consists of seven volutions. The umbilicus is very wide, being broader than one half of the whole diameter of the shell, slightly covering the ventral portion of the preceding volutions. Aperture subquadrate, broader than high; in older stages, becoming higher and laterally compressed. Surface

with exceedingly fine striæ and five periodic elevations. The suture is similar to that of the normal form, the head of the first auxiliary saddle touching the umbilical suture which is followed by two or three small denticulations.

This variety is distinguished by a very slow growth of whorls and an umbilicus wider than the normal form. The writer thought at first that this form was a distinct species, and probably identical with *G. Kayei* FORBES sp. from the Senonian deposits of S. India,¹⁾ Natal,²⁾ Chili³⁾ and Tunis,⁴⁾ whose European ally is *G. planorbiforme* BÖHM sp.;⁵⁾ but the presence of many transitional forms between this and the normal specimen of *G. tenuiliratum* convinced him that it is impossible to treat them as different species.

The above mentioned characters being common to this variety and *G. Kayei*, it is doubtful whether the greater part of the forms described as *G. Kayei* are not a mere variety of *G. tenuiliratum*.

It is quite impossible to decide whether an Ammonite described under the name of *G. planorbiforme* resembles Senonian or Cenomanian forms when we have only young specimens. The writer is also in doubt whether the large individuals figured in Pl. XXXIV. fig. 4, 5. and Pl. XXXV. fig. 7, by A. de Grossouvre really belong to the adult stage of *G. planorbiforme*.

An Ammonite from the Vancouver Cretaceous first described

1) STOLICZKA: l. c. KOSSMAT: l. c.

2) GRIESBACH: l. c.

3) STEINMANN: l. c.

4) L. PERVINQUIÈRE: Sur un facies particulier de Sénoïen de Tunisie. 1898. (by referat).

5) J. BÖHM: Palæontographica. Bd. XXXVIII. p. 49, Pl. I. fig. 12.—V. UHLIG: Bemerkungen z. Gliederung karp. Bildungen. Jahrb. d. k. k. geol. Reichsanstalt. Wien. 1894. P. 216, fig. 1.—GROSSOUVRE: l. c. p. 231, Pl. XXVII. fig. 2.

as *L. Jukesi* SHARPE? and afterward under the name of *L. denmanense* sp. nov. and considered to be identical with *G. Kayei* by KOSSMAT, is believed by the writer to be a distinct species, he in this respect agreeing with the latest view of WHITEAVES.

Localities:—The Kikumezawa, a tributary of the Ikushumbets, and the upper course of the latter; one from each locality.

Horizon:—*Pachydiscus*-beds.

II. Varieties with a Narrower Umbilicus and Coarser Ribs.

VAR. INTERMEDIA. M.

Pl. III., figs. 1 a, b.

 MM7471

1895. *Lytoceras Sacya* JIMBŌ: l. c. p. 34 (180), Pl.

VI. fig. 1.

1895. *Lytoceras denseplicatum* var. JIMBŌ: l. c. p. 36 (182).

Dimensions:—

	(1)	Ratio.	(2)	Ratio.	(3)	Ratio.	(4)	Ratio.
Diameter.	3.1 cm.	100.	3.40 cm.	100.	4.1 cm.	100.	11.7 cm.	100.
Height of the last whorl.	1.3 „	41.	1.45 „	42.	1.8 „	43.	5.7 „	48.
Breadth of the last whorl.	1.3 „	41.	1.50 „	44.	1.5 „	36.	5.3 „	45.
Width of umbilicus.	1.05 „	33.	1.10 „	32.	1.3 „	30.	3.0 „	25.

- 1) A specimen from the Yūbarigawa, Prov. Ishikari.
- 2) The original of JIMBŌ's Pl. VI. fig. 1; loc. Yūbarigawa.
- 3) A specimen from the Penke-moyūbari.
- 4) A specimen from the Sanushibe, Prov. Iburi.

This variety is distinguished from the normal form by the following characters:—

When young, the whorls grow more rapidly in height; the umbilicus is narrower and somewhat deeper, a little more than

one third of the inner volution being visible; the aperture is nearly round; the striæ on the surface are coarser.

The suture line is the same in both.

This variety differs from *G. madraspatanum*¹⁾ BLANFORD sp. from the lower Utatur group of South India in its coarser striæ; but in form they are remarkably alike.

Lytoceras sp. (YOKOYAMA: l. c. p. 80, Pl. XIX. fig. 3 a, b.) may probably be referred to this variety, as it agrees quite well in form and sculpture; periodic ribs are very indistinct in this and the next variety, being almost invisible in some specimens, although more distinct in exceptionally well preserved ones.

A specimen from the Hokkaidō in the Imperial Museum of Natural History in Berlin was considered by JIMBŌ, to be a variety of *G. denseplicatum*. But the examination of a plaster-cast kindly sent to the writer by O. JÆCKEL, the director, shows that it really belongs to this variety of *G. tenuiliratum*.

Localities:—The Yūbarigawa, above the mouth of the Panke-moyūbari; the Ikushumbets; the Sanushibe, a tributary of the Popets. Five specimens were examined.

Horizon:—Upper Ammonite-beds. Exclusively in the *Pachydiscus*-beds?

✓
K

VAR. INFREQUENS M.

MM7470

Pl. IV., fig. 3 a, b.

1894. *Lytoceras Sacya* JIMBŌ (par.): l. c. p. 34 (180).

Dimensions:—

Diameter.	4.30 cm.	Ratio. 100.
Height of the last whorl.	1.75 „	40.

1) STOLICZKA: l. c. p. 151, Pl. LXXV. fig. 2.—KOSSMAT: l. c. p. 32 (128).

Breadth of the last whorl.	1.90 cm.	44.
Width of umbilicus.	1.40 „	32.

Shell broader than in other varieties; whorls broaden slowly toward the mouth, broader than high. Umbilicus wide, surrounded by a vertical wall. Surface with striæ of the same type as in the preceding variety but considerably coarser and more prominent.

Localities:—On the Opiraushibets, about 35 miles from its mouth, Prov. Teshio; Makka-ushipe, a branch of the Sanushibe, Prov. Iburi; the Kikumezawa, a tributary of the Ikushumbets Prov. Ishikari. Only one specimen from each locality was examined.

Horizon:—Upper Ammonite-beds.

SUBGROUP OF GAUDRYCERAS CRASSICOSTATUM.

GAUDRYCERAS CRASSICOSTATUM JIMBŌ sp.

Pl. IV., fig. 4. ✓

MM 7469

1894. *Lyloceras crassicostatum* JIMBŌ: l. c. p. 36, Pl. VI.
figs. 7, 7 a.

This species is exceedingly rare. It was first founded on a somewhat water-worn but yet full grown specimen from Cape Soya in the Province of Kitami. The writer has drawn up the following diagnosis from an examination of a specimen which belongs to a young stage.

Dimensions :—

		Ratio.
Diameter.	4.5 cm.	100.
Height of the last whorl.	1.5 „	33.
Breadth of the last whorl.	1.2 „	26.
Width of umbilicus.	2.1 „	46.

Shell discoidal, compressed; composed of about 7 volutions. Umbilicus very wide, about twice as broad as the height of the whorl, becoming gradually narrower as the shell grows. The inner volutions slightly inflated, merely touching one another, but the last volution is higher than broad, embracing one half of the preceding one. The surface sculpture is similar to that of *G. tenuiliratum*, but the striæ become gradually finer toward the mouth where the shell appears almost smooth. The whorls of the later stages possess many thick periodic ribs as shown in fig. 7, Pl. VI. in the work quoted above.

This species, being characterized by the peculiar sculpture of the adult specimen, and the very loosely coiled volutions of the young individual, is easily distinguished from others.

Locality : Cape Sōya, Prov. Kitami.

Horizon : Upper Ammonite-beds.

GAUDRYCERAS DENSEPLICATUM JIMBŌ sp.

1894. *Lytoceras denseplicatum* JIMBŌ : l. c. p. 36 (182), Pl. III. fig. 1.

This beautiful but rare form is represented by a single specimen in the writer's collection, this and the type figured by Jimbō being the only ones found up to the present time. The writer's specimen is less complete than JIMBŌ's, having only a part of

the last volution which is marked by the characteristic sculpture of the adult stage. When judged from the sculpture, the Japanese form comes near to *Gaudryceras glanegense* REDTENBACHER¹⁾ from the Gossau formation of the Alps which, with a somewhat similar form and sculpture, shows a position intermediate between this species and *G. tenuiliratum*.

It is not yet possible to ascertain the exact relation between the present form and *G. striatum* JIMBŌ sp. described below, because the imperfect state of preservation of the former does not allow the examination of its inner volutions which alone would settle its relation to the latter.

Localities :—The type specimen of JIMBŌ is from the Ekimoanoro, a tributary of the Yūbarigawa, while the other is from a cliff of the Yūbarigawa, close to its junction with the Penkemo-yūbari.

Horizon :—*Pachydiscus*-beds.

GAUDRYCERAS STRIATUM JIMBŌ sp.

Pl. IV., fig. 5. ✓

MM 7468

1894. *Lytoceras striatum* JIMBŌ : l. c. p. (181), Pl. VI.
fig. 6 a, b.

The type specimen, which has been described and figured in the above paper, is a young individual of 4.7 cm. in diameter from the Abeshinai-rubeshibe, a tributary of the Teshiogawa. Another less imperfect but somewhat larger specimen from the same place has been lately found in the collection of JIMBŌ which necessitates the revision of the diagnosis given by him.

1) REDTENBACHER : l. c. p. 119, Pl. XXVII. fig. 3.

Dimensions :—

		Ratio.
Diameter.	7.2 cm.	100.
Height of the last whorl.	3.0 „	41.
Breadth of the last whorl.	2.8 „	38.
Height of the whorl last but one.	1.2 „	16.
Breadth of the whorl last but one.	1.4 „	19.
Width of umbilicus.	2.4 „	33.

Inner volutions broader than high; when 4.0 cm. in diameter, they are as high as broad, after which they rapidly increase in height, so that a cross-section near the mouth of the larger individual shows a subquadrate form, higher than broad, being broadest near the umbilical edge, but narrowing toward the rounded ventral side. A change also takes place in the surface sculpture, just as in *G. tenuiliratum* and *G. crassicostatum*. The surface is at first covered with numerous very fine striæ and about five periodic ribs, corresponding to the feeble furrows on the cast. The striæ and the ribs are slightly S-shaped as is usual in shells of this genus. These periodic ribs appear more frequently when the shell has attained a diameter of about 5 cm. The figured specimen shows 7 of them on the last quarter of the last whorl. The suture line of our specimen when compared with that shown in fig. 6 b, Pl. VI. of JIMŌ's work, is far more finely toothed.

The relation of this species to *G. denseplicatum* JIMBŌ sp. has been already alluded to. It does not appear, at first sight, to be different from the subgroup of *G. tenuiliratum*, and it is commonly not easy to distinguish the former from the finely sculptured variety of the latter. The main points in which they differ lie in the fact that the suture line in *G. striatum* is more finely divided than in *G. tenuiliratum*, and the thicker ribs and

their interspaces on the former are uniformly covered with very fine striæ which do not become gradually coarser and less in number in the older volutions, as we have seen in *G. tenuiliratum*.

On account of the above characters I have provisionally referred *G. striatum* to the subgroup of *G. crassicostatum*, although its affinity to this subgroup is not very close, as is also the case with *G. denseplicatum*.

Locality:—The Abeshinai-rubeshibe, a tributary of the Teshiogawa, Prov. Teshio. We possess only two specimens—one of which is the original of JIMBŌ's illustration and the other is represented in figure 5 in Pl. IV.

Horizon:—*Pachydiscus*-beds.

VAR. **PICTA** M.

Pl. IV., fig. 6 a, b, c.

MM 7467

The third specimen of *G. striatum* is a somewhat modified form; the following table exhibits the dimensions measured on the external as well as on the internal volutions of the same specimen.

Dimensions:—

		Ratio.			Ratio.	
Diameter.	5.6 cm.	100.		1.50 cm.	100.	
Height of the last whorl.	3.3 „	41.		0.45 „	30.	
Breadth of the last whorl.	2.3 „	41.		0.60 „	40.	
Width of umbilicus.	2.0 „	35.		0.75 „	50.	

From the above table it is evident that the form of this variety varies greatly in various stages of its growth. It is distinguished from the normal type by its broader whorls whose cross-section is quadrate.

The specimen is in a good state of preservation. The shell

is composed of six volutions, the inner ones showing a wide umbilicus and very inflated whorls which are broader than high, and strikingly resembling *G. tenuiliratum* of the same size. All the whorls become gradually higher as they grow, so that their height and breadth become almost equal, showing a nearly square cross-section when the shell measures 5 cm. in diameter. The ventral side is round and broad.

In other respects, that is, in its shape, surface markings and the suture line, it does not show any appreciable difference from the normal type of the species. The septal lobe is beautifully preserved, as shown in fig. 6 c, Pl. IV.

Locality and Horizon:—*Pachydiscus*-beds of the Uipets-rubeshibe, a tributary of the Uipets, Prov. Teshio.

MM 7466 - 4-2
5-2
MM 7465 - 6-3

GROUP OF GAUDRYCERAS LIMATUM.

Ana—

GAUDRYCERAS LIMATUM M. ✓

Pl. IV., fig. 2; Pl. V., fig. 2; Pl. VI., figs. 3 a, b. ✓

Of the many specimens of Ammonites referable to the present species and its varieties, one half are provided with whorls of the adult stage, although in a more or less deformed state.

Dimensions:—

	(1)	Ratio.	(2)	Ratio.
Diameter.	8.2 cm.	100.	7.7 cm.	100.
Height of the last whorl.	3.5 "	42.	3.0 "	38.
Breadth of the last whorl.	3.2 "	39.	— "	—.
Width of umbilicus.	2.7 "	32.	2.6 "	33.

VI

1) A specimen from the Ikushumbets. (Pl. ~~IX~~^{VI}, figs. 3 a, b).

2) A specimen from the Yūbarigawa. (Pl. ~~IX~~^{VI}, fig. 2).

Shell discoidal, somewhat compressed, composed of numerous whorls; whorls oblong, becoming gradually higher as the shell grows, the broadest part lying near the umbilical edge. Umbilicus wide, shallow, exposing nearly three-fifths of the inner volutions; Umbilical wall perpendicular, surrounded by a rounded edge. The suture of the shell except on the last volution is smooth, being provided only with very fine striae of growth. The striae begin at the umbilical suture, bend forward at its edge and extend into the lateral side of the whorl with a slight flexure, passing straight over the ventral side. When the shell becomes larger than about 8-9 cm. in diameter, the thick transverse ribs gradually begin to appear, encircling the whorl parallel to the striae and rapidly becoming broader and more elevated toward the periphery. These ribs are broad, measuring 0.6 cm. in average breadth with interspaces of about 0.4-0.8 cm. in breadth on the siphonal line. However they become broader and more closely set together toward the mouth. Suture line very complicated; the external saddles as well as two lateral ones and the first auxiliary are bipartite, while the remaining three auxiliaries are simple. The lobes are narrow, the two lateral ones being bipartite. The auxiliary saddles and lobes hang obliquely on the umbilical wall. The septal lobe has been seen in a well preserved specimen.

There is only one ally of the present form, and that is *Gaudryceras politissimum* KOSSMAT sp.¹⁾ from the upper Trichinopoly group of Varagur, South India. This Indian species resembles in many respects the Japanese. It is known only by a specimen at the middle stage of growth, which is distinguished

1) KOSSMAT: l. c. p. 32 (128), Pl. I. (XV), figs. 7 a, b, c.

by a wider umbilicus and relatively low, much compressed whorls. Still there is no doubt that there exists an intimate relation between these two forms.

The Japanese species is very variable in its form; some (Pl. V., fig. 2) show a wider umbilicus and lower whorls, strongly reminding us of the form of *G. politissimum*, while others are characterized by a narrower umbilicus, higher whorls and the earlier appearance of broad ribs. The latter is now considered merely as a variety (var. *obscura*). Fig. 3 a, b. in Pl. VI. is a form intermediate between this and the normal type.

Localities and Horizon :—The upper course of the Ikushumbets, above the mouth of the right branch, the Yoshiashizawa, and along the latter itself; found in the upper Ammonite-beds. Along the Opiraushibets, Prov. Teshio, in the *Scaphites*-beds.

Ana-

GAUDRYCERAS YOKOYAMAI M.

MM 7464-6-1
MM 7463-6-2, 7-6 Pl. VI., figs. 1 a, b, 2 a, b; Pl. VII., fig. 6'.

There are only a few specimens belonging to this species, one of which is a cast of an interior of a moderate size, showing the suture line; the others are smaller, but mostly provided with the shell.

Dimension :—

	(1)	Ratio.	(2)	Ratio.
Diameter.	4.5 cm.	100.	8.6 cm.	100.
Height of the last whorl.	2.0 „	44.	4.2 „	48.
Breadth of the last whorl.	1.8 „	40.	4.0 „	46.
Width of umbilicus.	1.35 „	30.	2.1 „	24.

- 1) A young individual from the Yūbarigawa.
- 2) The largest specimen from the Ikushumbets.

Shell discoidal, thick; whorls round in the early stage; subquadrate in the adult, higher than broad, and broadest near the umbilical edge. Ventral side uniformly rounded. Umbilicus moderate in size, showing about three fifths of the circumference of each volution and surrounded by a perpendicular wall. Surface ornamented with very fine striæ, and also very feeble and narrow furrows. The striæ are so fine that we can hardly detect them without the aid of a magnifier; they rise at the umbilical suture, bend abruptly forward at the umbilical edge and then traverse the sides without any further flexion. The faint furrows on the body chamber of the largest specimen are narrow, parallel to the striæ, and arranged at intervals of about half a centimeter from one another. The suture line is very complicated, but shows on the whole the character of the group of *G. Sacya* FORBES. There are six or seven saddles on each side; the external, the two lateral and the first auxiliary saddles are symmetrically bifid; the first lateral lobe is the deepest, slightly surpassing the external lobe in depth and also symmetrically bipartite. Auxiliary saddles and lobes hang obliquely toward the umbilical suture.

The fine striæ of growth and numerous feeble furrows of the present form make it seem at first sight to be allied to *Pseudophyllites indra* STOLICZKA¹⁾ sp., to which its general aspect also closely conforms. The most characteristic feature of *Pseudophyllites*, however, lies in the suture line of the young shell, which shows tripartite saddles with ptylloid termination, while in individuals of an advanced stage both branches of the external saddle become unequal in size. The Indian form is, therefore, not only different from the Japanese, but also from all other

1) STOLICZKA: l. c. p. 112, Pl. LVIII, fig. 2.—KOSSMAT: l. c. p. 41 (137), Pl. II. (XVI.), figs. 6 a, b, 9 a, b; Pl. III. (XVII.), figs. 6, 7 a, b; Pl. IV. (XVIII.), fig. 3.

species of *Gaudryceras*. On this account, it was placed by NAUMANN and WHITEAVES in the genus *Phylloceras*,¹⁾ while KOSSMAT treated it as *Pseudophyllites*,²⁾ a new subgenus of *Lyto-ceras*; but the writer is at present not in a position to advance any opinion on the matter.

In common with the preceding species and *G. Rouvillei* GROSSOUVRE,³⁾ *Gaudryceras Yokoyamai* has fine striæ traversing the ventral side, bending neither forward nor backward, but running always straight. The small specimens of *G. Yokoyamai* and *G. limatum* are liable to be confounded with one another, but those of the former possess higher whorls and a narrower umbilicus than those of the latter. *G. Rouvillei* from the Santonien of Southern France is too small for a closer comparison, but it seems to be distinguished from the young of the Japanese species by its deeper involution.

Localities and Horizon:—In pebbles from the Yūbarigawa and the Ikushumbets. Found also in the *Pachydiscus*-beds along the Kikumezawa, a left tributary of the Ikushumbets.

Ana-

GAUDRYCERAS YAMASHITAI M.

✓ Pl. IV., fig. 7.

MM7462

Only two immature specimens of this species were found, the larger of which measures:—

Diameter.	8.8 cm.	Ratio. 100.
Height of the last whorl.	4.4 „	50.

1) WHITEAVES: On some Foss. Nanaimo group Vancouver Cret. p. 129.

2) KOSSMAT: l. c. p. 41 (137).

3) GROSSOUVRE: l. c. p. 228, Pl. XXXVII. figs. 7 and 10.

Breadth of the last whorl	3.3 cm.	37.
Width of umbilicus	2.2 „	25.

Shell discoidal, compressed; when young, whorls nearly round, with wide umbilicus; when about 5 cm. in diameter, the whorl enlarges rapidly in height, and is flattened on the sides. Involution about one half or slightly less. The surface of the shell is covered with very fine thread-like striæ which are somewhat flexuous. The whorl has neither periodic ribs nor furrows. There are three bipartite saddles and lobes, all of which are finely toothed. The three auxiliary saddles hang obliquely on the umbilical wall.

This Ammonite shows a great resemblance to *G. Yokoyamai*, from which it is distinguished by its compressed, comparatively higher whorls and wider umbilicus. It also approaches *G. limatum*, and appears to have a character intermediate between this species and *G. Yokoyamai*.

Localities:—The Ikushumbets, Prov. Ishikari; the Makka-ushipe, a tributary of the Popet, Prov. Iburi; one from each locality. The figure is that of the smaller specimen from the Makka-ushipe.

Horizon:—Upper Ammonite-beds.

The two species—*G. Yokoyamai* and *G. Yamashitai*, have been described from young individuals, as in the case of *G. politissimum* from South India. Although their full grown specimens are not yet known to the writer, still when judged from their general shape, surface ornamentation and suture line, which are all very peculiar, it is quite certain that they form a special subgroup with *G. limatum* as the type.

SUBGROUP OF GAUDRYCERAS SACYA.

GAUDRYCERAS sp.

The writer has seen only a single fragment of an Ammonite which is referable to the subgroup of *G. Sacya*. This fragment being a part of the body chamber of an adult specimen, nothing can be said about its general shape and suture line. But the surface with narrow flexuous furrows is quite similar to that of *G. Sacya* figured by STOLICZKA¹⁾ and WHITEAVES.²⁾ The space between two successive furrows measures above 1.2 cm., while the furrows themselves measure about 0.3 cm. in breadth on an average on the ventral side; besides there are numerous fine striæ covering the entire surface of the shell.

The specimen is too imperfect for exact determination, but its resemblance to *G. Sacya* is so great that there is hardly any doubt of its representing a form closely related to, if not actually identical with that species.

Locality;—A specimen, found in the collection of JIMBŌ, is in a marly nodule from Ishuikarushihara, on the Penkeohoshikep, a branch of the Teshiogawa.

Horizon:—Unknown.

1) STOLICZKA: l. c. p. 154, Pl. LXXV., fig. 7.

2) WHITEAVES: Mesozoic Fossils. Vol. I. Pt. 3, P. 203, Pl. XXV.

SUBGROUP OF GAUDRYCERAS VARUNA.

*Zelandites***GAUDRYCERAS KAWANOI** JIMBŌ sp.

1894. *Desmoceras Kawanoi* JIMBŌ: l. c. p. 28, Pl. I. (XVII.),
figs. 7 a, b.

This species is represented by two specimens, one of which belongs to the type described by JIMBŌ. The other slightly deviates from this type, but is considered by the writer as belonging to the same species.

Dimensions :—

	(1)	Ratio.	(2)	Ratio.
Diameter.	2.5 cm.	100.	2.2 cm.	100.
Height of the last whorl.	1.0 „	40.	0.9 „	40.
Breadth of the last whorl.	0.8 „	32.	0.75 „	34.
Width of umbilicus.	0.8 „	32.	0.75 „	34.

1) The type specimen of *Desmoceras Kawanoi* JIMBŌ from Ikandai near Urakawa, Prov. Hidaka.

2) The second specimen from the Bannosawa, a tributary of the Ikushumbets near the Poronai coal-mines, Prov. Ishikari.

The diagnosis of this species given by JIMBŌ is as follows:—

“Schale flach-scheibenförmig. Umgänge schnell an Höhe zunehmend, die grösste Dicke des Umganges in der Mitte. Die Zahl der Umgänge ist ca. 7. Nabel weit. Die Oberfläche ist von äusserst feinen Streifen bedeckt und zeigt 3 schwache Einschnürungen auf der letzten Windung. Die Streifen und Einschnürungen bilden auf der Aussenseite leichte, vorwärts gerichtete Buchten.”

In this diagnosis, the last part needs some alteration. The periodic furrows and numerous fine striæ extend obliquely forward from the umbilical suture to the ventral side, without the slightest

trace of a forward prolongation. The cross-section of the whorl is oblong, being broadest in the middle of the lateral side. The umbilicus is of a moderate size, about $\frac{2}{3}$ of the inner volution being exposed; the umbilical wall gently slopes toward the umbilical suture and to the lateral side.

The suture line shows many lobes on each side, which are finely and deeply incised and diminish in size toward the umbilicus. The external lobe is as deep as the first lateral. The external and the lateral saddles as well as the first lateral lobe are bipartite. Judging from the general aspect of the shell, and especially from the suture line, the present species seems to belong to a particular subgroup of *Gaudryceras*, which contains only three species from foreign Cretaceous, viz., *G. odiense* Koss. of the lower Utatur group of South India, *G. varuna* FORBES of the Valudayur bed of the same region and *G. anaspatum* REDTENBACHER sp. of the Gossau bed of north-east Alps. Our form is distinguished from *G. odiense* by its broader umbilicus and its lower whorls, from *G. varuna* and *G. anaspatum* by the different form of the whorls. *G. varuna* is a species also found in the Quiriquina bed of Chili.⁴

Localities :—Chashikots in Ikandai near Urakawa, Prov. Hidaka, and the Bannosawa near the Poronai coal-mines, Prov. Ishikari.

Horizon :—*Pachydiscus*-beds.

1) KOSSMAT: l. c. p. 33 (129), Pl. IV. (XVIII.), fig. 1 a, b, c; Pl. III. (XVII.), fig. 8.

2) KOSSMAT: l. c. p. 34 (130); p. 65 (161), Pl. II. (XVI), fig. 4 a, b; Pl. III (XVII), fig. 8.

3) REDTENBACHER: l. c. p. 113, Pl. XXVI., fig. 1.

4) STEINMANN: l. c. p. 48, Pl. V., figs. 2 a, b.

TETRAGONITES KOSSMAT.

Of the species of *Tetragonites* described in the following lines, three have been already described by JIMBŌ. One of these—*Lytoceras glabrum* JIMBŌ—is considered by KOSSMAT¹⁾ to belong to his newly established subgenus *Tetragonites*. He states that nothing definite can be said about the other two—viz., *L. crassum*. JIMBŌ and *L. sphaeronotum* JIMBŌ. However, after a careful examination of the types and other specimens the writer has come to the conclusion, that these two should also be brought under the same genus.

TETRAGONITES GLABRUS JIMBŌ sp.

Pl. VII., figs. 2 and 5.

MM 7461-7-2, 7-5

1894. *Lytoceras glabrum* JIMBŌ: l. c. p. 34 (180), Pl. VI. (XXII.), figs. 2, 2 a.

1895. *Lytoceras (Tetragonites) glabrum* KOSSMAT: l. c. p. 133.

Dimensions :—

	(1)	Ratio.	(2)	Ratio.
Diameter.	3.5 cm.	100.	6.5 cm.	100.
Height of the last whorl.	1.7 „	48.	3.2 „	49.
Breadth of the last whorl.	1.9 „	54.	3.6 „	55.
Width of umbilicus	0.8 „	22.	1.4 „	21.

1) A specimen from the Sanushibe, Prov. Iburi. (Pl. V., fig. 2).

2) A specimen from the Opiraushibets, Prov. Teshio.

This and the next species possess very inflated whorls in the later stages of growth, and comparatively a very thin test. There-

¹⁾ KOSSMAT: l. c. p. 37 (133).

fore, the outer volution in adult specimens is generally not well preserved, which makes exact measurement very difficult. These two species are closely allied to each other, and if we compare their dimensions, it is quite evident that there is no material difference between them. The coincidence is not only in dimensions, but also in nearly all other characters if we except the periodic ribs. There is a group of Ammonites in which the shell is smooth until it has attained about 7 cm. in diameter, after which a periodic arrest of growth begins to appear, while another group shows periodic ribs from the very beginning; still it not rarely happens that we can not determine which of these two characters is shown by a specimen not in a good state of preservation. However, in spite of the imperfect nature of the type specimens, we can easily see that JIMBŌ's *L. sphaeronotum* is of the first category, while his *L. glabrum* is of the second. It is to be added that the writer is, at present, not quite sure whether the absence of periodic ribs on the inner volutions is sufficient for specific distinction. *Tetragonites epigonus* KOSSMAT,¹⁾ a closely related species, is stated to be rather variable in the appearance of the ribs, some young individuals showing them typically, while the larger ones are smooth. Although this statement leads us to assume that the ribs are not of much importance in the distinction of species, yet the present case must be considered as somewhat different from the above one. As above stated, in *T. sphaeronotus* the periodic ribs appear after the shell has attained a certain size, while in *T. glabrus* they are already present when the shell is young. Forms intermediate between these two have not yet been found. Therefore the writer

1) KOSSMAT: l. c. p. 39 (135), Pl. III. (XVII), fig. 4,5.

is for the time being compelled to treat the two as specifically distinct, as has already been done by JIMBŌ.

It is necessary to make a few remarks on the internal suture line of *T. glabrus* which was not figured by JIMBŌ. It shows two saddles and the corresponding lobes. The antisiphonal and the lateral lobes are narrow and deep; the two saddles are also slender and of equal height, the inner ending bifid and the outer simple.

The above characters of the internal lobes and saddles, together with those of the external part of the suture line, are exactly what we find in the type of *Tetragonites* and especially in *T. epigonus* which also shows two internal saddles.

Localities:—The upper course of the Ikushumbets, and the Yūbarigawa, both in the Province of Ishikari; the Saushi-sanushibe, a tributary of the Popets in the Prov. Iburi; the Opiraushibets and the branches of its upper course, in the Prov. Teshio. Many specimens from all the localities mentioned.

Horizon:—Upper Ammonite-beds.

TETRAGONITES SPHAERONOTUS JIMBŌ sp.

Pl. VII., figs. I a, b.

MM7540

1894. *Lytoceras sphaeronotum* JIMBŌ: l. c. p. 35 (181), Pl.

VI. (XXII.), figs. 3, 3a.

Dimensions:—

	(1)	Ratio.	(2)	Ratio.
Diameter.	14.5 cm.	100.	6.9 cm.	100.
Height of the last whorl.	7.0 „	48.	3.3 „	47.
Breadth of the last whorl.	7.2 „	49.	3.8 „	54.
Width of umbilicus.	3.0 „	20.	1.4 „	20.

- 1) A specimen from the Opiraushibets, Prov. Teshio.
- 2) A specimen from the Yūbarigawa, Prov. Ishikari.

Shell thick, discoidal, composed of many whorls; whorls somewhat trapezoidal being laterally flattened, ventrally inflated and slightly broader than high. Umbilicus narrow, deep, with a perpendicular wall and bluntly angular edge. Involution about $\frac{2}{3}$. Surface with very fine but distinct striæ of growth, without any trace of periodic ribs. The older specimens show whorls more rapidly increasing in height and breadth, and provided with periodic ribs. These ribs are slightly elevated and rounded, corresponding to shallow furrows on the cast of the interior. They are widely separated, there being only two or three in one volution. The fine striæ as well as the periodic ribs which are also covered with striæ, rise at the umbilical suture, bend obliquely forward on the lateral sides and then backward on the ventral side. Besides there are a few longitudinal lines on the external half of the lateral sides which are visible only on the last half of a volution of the largest specimen in the writer's collection. The periodic ribs begin to appear when the shell attains 7 cm. in diameter.

The length of the body chamber of *Tetragonites* is not yet known. The largest specimen, mentioned above, shows two thirds of the last volution not septate, but as the anterior end of the whorl is broken off, the length of the body chamber must be more than $\frac{2}{3}$ of a volution.

Suture line as in the preceding species.

There are many well preserved individuals of this species in the writer's collection, one of which is shown in fig. 1, Pl. VII. The above diagnosis was written after a study of them and the two specimens in Jimbō's description essentially agree with them.

Besides these specimens, there are also a somewhat modified form distinguished by a slightly wider umbilicus and compressed whorls. For the present, this is considered only as a variety.

Localities:—The Yūbarigawa; the Ikushumbets and its branches, the Yoshiashizawa and the Kikumezawa; between the Motomari and the Chietomanai, Sōyagōri, Prov. Kitami; Shirutsuruhara, on the left bank of the Teshiogawa; the Opiraushibets and its tributaries, the Penke-kenebets and the Panke-kenebets, in the Province of Teshio. The figured specimen was found in a pebble from the Yūbarigawa.

Horizon:—Upper Ammonite-beds; abundant in the *Scaphites*-beds.

TETRAGONITES CRASSUS JIMBŌ sp.

1895. *Lytoceras crassum* JIMBŌ: l. c. p. 35 (181), Pl. VI. (XXII.), fig. 5 a, b.

Whorls nearly round, slightly flattened on the sides and inflated ventrally, broader than high. Umbilicus moderate in size, deep, surrounded by a perpendicular wall. Involution about $\frac{2}{3}$. Surface unknown, the only specimen being a cast of an interior. The suture line is shown in JIMBŌ's work. The siphonal saddle, however, is high and trigonal, and not so low or flat at the apex as is shown in his figure. The external as well as the first lateral lobe is asymmetrically bipartite; besides, there are four auxiliary saddles and corresponding lobes; the first auxiliary saddle is just at the umbilical edge whence the others incline obliquely downward to the umbilical suture.

JIMBŌ took the shape of the whorl to be the character distinguishing the present species from the preceding. He de-

scribes *T. crassus* as “Windung seitlich nicht abgeplattet” and *T. sphaeronotus* as having “Seitenflächen etwas abgeplattet.”¹⁾

The present species being based on a single young specimen represented by an internal cast, the writer is not in a position to draw a distinct line of demarcation between it and *T. sphaeronotus* or *T. glabrus*. However a slight difference in the form of the whorls and the somewhat wider umbilicus of the present species, as compared with the above two, seem to indicate that it belongs to a distinct species.

Locality:—In a pebble from the Pombets, Prov. Ishikari.

Horizon:—Unknown.



TETRAGONITES POPETENSIS M.

MM7460-7-4

MM7541-7-6

Pl. VII., figs. 4. a, b, and 6. ✓



Dimensions:—

	(1)	Ratio.	(2)	Ratio.
Diameter.	3.4 cm.	100.	2.05 cm.	100.
Height of the last whorl.	1.45 „	42.	0.90 „	43.
Breadth of the last whorl.	1.50 „	44.	0.90 „	43.
Width of umbilicus.	1.05 „	30.	0.55 „	26.

- 1) A specimen from the Shi-sanushibe. (Pl. VII. figs., 4 a, b).
- 2) A specimen from the Penke-opushikep, a tributary of the Teshiogawa. (Pl. VII., fig. 6.)

Shell discoidal, compressed, the smaller specimens measured above, being composed of five volutions. Umbilicus moderate in size; involution about $\frac{2}{3}$. Whorls subquadrate in section, inflated ventrally, and the umbilical wall perpendicular. Surface smooth, with exceedingly fine lines of growth. Periodic arrest of growth

1) JIMBŌ: l. c.

marked only by feeble furrows on the cast; about six of them were counted in the smaller specimens. These striæ or lines and furrows are of exactly the same nature as those of the above three species, but project more strongly forward. The suture line shows four saddles on the external side, a saddle and one or two denticles following them on the umbilical wall, and two saddles on the internal side.

In the suture line and the general aspect of the shell, the only species which approaches this is *T. epigonus* KOSSMAT. The suture lines of both species can hardly be distinguished from each other. However, the Japanese form is rather widely umbilicated and its whorls are lower.

Localities:—The Makka-ushipe, a tributary of the Sanushibe, Prov. Iburi; the Penke-opushikep, a tributary of the Teshiogawa, Prov. Teshio. One specimen from each locality. From the Shisanushibe, also a tributary of the Sanushibe, we have three specimens, one of which is figured.

Horizon:—*Pachydiscus*-beds; the horizon at the last mentioned locality has not yet been ascertained.

TETRAGONITES cfr. **EPIGONUS** KOSSMAT.

Pl. VII., fig. 3. ✓

MM 7459

Compare:—

1895. *Lytoceras epigonum* KOSSMAT: l. c. p. 39 (135), Pl. III. (XVII.), figs. 4, a, b, c, and 5, a, b.

1865. *Ammonites Timotheanus* p. p. STOLICZKA: l. c. p. 146, Pl. LXXIII., fig. 5.

Dimensions :—

		Ratio.
Diameter.	3.2 cm.	100.
Height of the last whorl.	1.4 „	43.
Breadth of the last whorl.	1.55 „	48.
Width of umbilicus.	0.90 „	28.

General shape as in *T. sphaeronotus*. Umbilicus moderate in size, surrounded by a perpendicular wall. Involution about $\frac{2}{3}$. Whorls rather slowly growing, subquadrate in cross-section, somewhat broader than high and broadest near the umbilical margin. Surface smooth, but with periodic arrest of growth, indicated by inconspicuous round ribs of which four have been counted on the last half of the outer volution. The character of the ribs is the same as in *T. glabrus* and *T. sphaeronotus* being distinguished only by a somewhat more oblique course.

Suture as in the preceding species.

The Japanese specimens agree quite well with those described by KOSSMAT under the name of *T. epigonus* from the upper Trichinopoly group of Andur and Varagur, S. India. The body whorl of the larger Indian specimen figured by KOSSMAT measures 2.6 cm. high and 2.7 cm. broad, and its umbilicus 1.5 cm. in width, the diameter of the shell itself being 5.9 cm. Among the Japanese specimens there is none which attains such a large size. But they are comparable to, and agree in every particular, with the smaller ones of *T. epigonus* also figured by KOSSMAT. The periodic arrest of growth is sometimes entirely absent and sometimes present on the young shells of *T. epigonus*, so that this seems to be of no special importance in the distinction of the species. In the specimens in the writer's collection, the periodic ribs are shown with moderate distinctness and their number agrees with those of the larger specimen figured by KOSSMAT.

The reason why the writer hesitates to identify the Japanese form with *T. epigonus* lies in the fact that his specimens are all in a young stage, and that there is none which clearly shows the suture line.

Distinguished from *T. popetensis* by the higher and broader whorls and the narrower umbilicus; from *T. sphaeronotus* and *T. glabrus* by the lower whorl and the wider umbilicus. *T. crassus*, on the other hand, is distinguished by its broader whorls.

Localities :—The Penke-kenebets and the Kenekawen-opirau-shibets, both branches of the Opiraushibets, and the Abeshinai, a tributary of the Teshiogawa. Five specimens have been examined.

Horizon :—*Scaphites*-beds.

Foreign Localities of *T. epigonus* :—Upper Trichinopoly group of S. India and Senonian of Tunis.¹⁾

1) L. PERVINQUIERE: Sur un facies particulier du Sénonien du Tunisie. 1898.

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H. YABE.

CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE I.

Lytoceras.

Plate I.

Lytoceras ezoëense m. Pp. 9-11.

7467

Fig. 1. Side view of the type, preserved in the Sci. Coll. Mus. From lower Ammonite-beds of the Pompets, Prov. Ishikari. Reduced to $\frac{3}{4}$ nat. size.

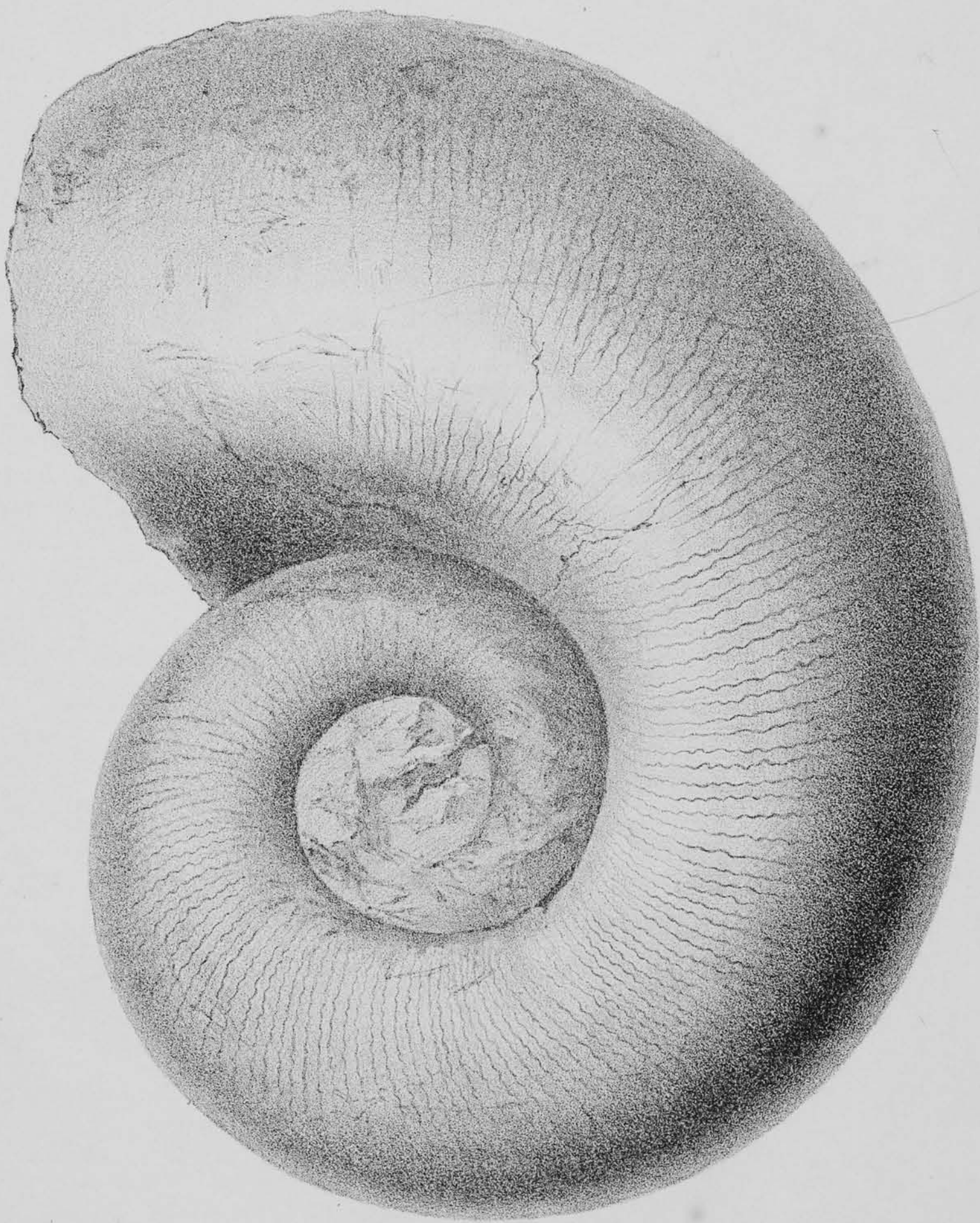


Fig. 1.

MM7476

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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE II.

Lytoceras.

Plate II.

Lytoceras imperiale m. Pp. 11-12.

17475

Fig. 1. Side view of the type, preserved in the Sci. Coll. Mus. From lower Ammonoite-beds of the Ikushumbets, Prov. Ishikari. Reduced to $\frac{3}{4}$ nat. size.



✓ Fig. 1. ✓

MM 7475

i-173

H. YABE.

CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE III.

Gaudryceras.

Plate III.

Gaudryceras tenuiliratum m. Pp. 19-29.

(All the specimens in the Sci. Coll. Mus.).

7471 R

7472 R

7473

7474 R

Fig. 1. var. *intermedia*. a, side view; b, front view of a specimen from upper Ammonite-beds of the Sanushibe, Prov. Iburi. Nat. size.

Fig. 2. var. *ornata*. a, side view; b, front view of a specimen from *Pachydiscus*-beds of the Kikumezawa, Prov. Ishikari. Nat. size.

Fig. 3. A part of the suture line of a large specimen of normal type. From *Pachydiscus*-beds of the Bannosawa, Prov. Ishikari. Nat. size.—s., siphonal line.

Fig. 4. Suture line of a specimen, 3.5 cm. in diam., of normal type. From *Pachydiscus*-beds of the Sanushibe, Prov. Iburi.—s., siphonal line; um., umbilical margin; us., umbilical suture. $2\frac{1}{2} \times$.



Fig. 3.



Fig. 4.

MM7474

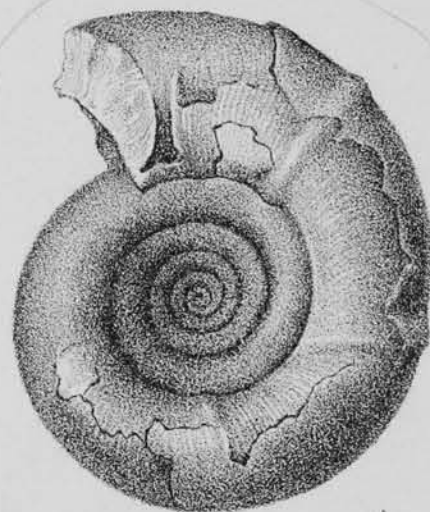


Fig. 2.a.

MM7472

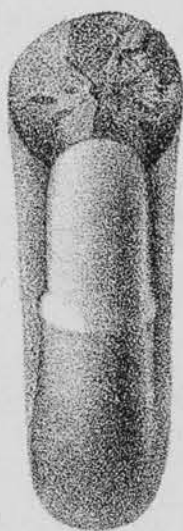


Fig. 2.b.

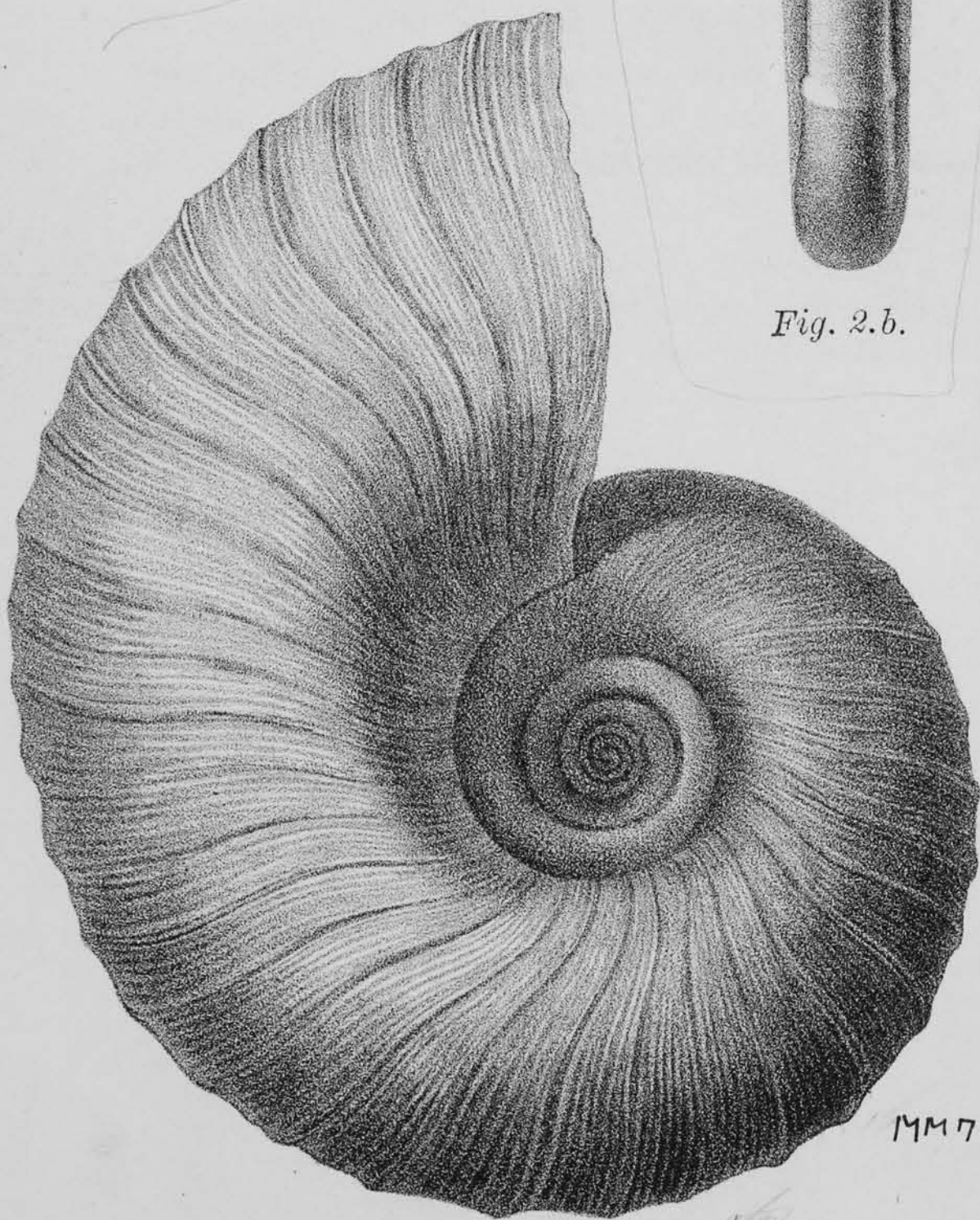


Fig. 1.a.

MM7471

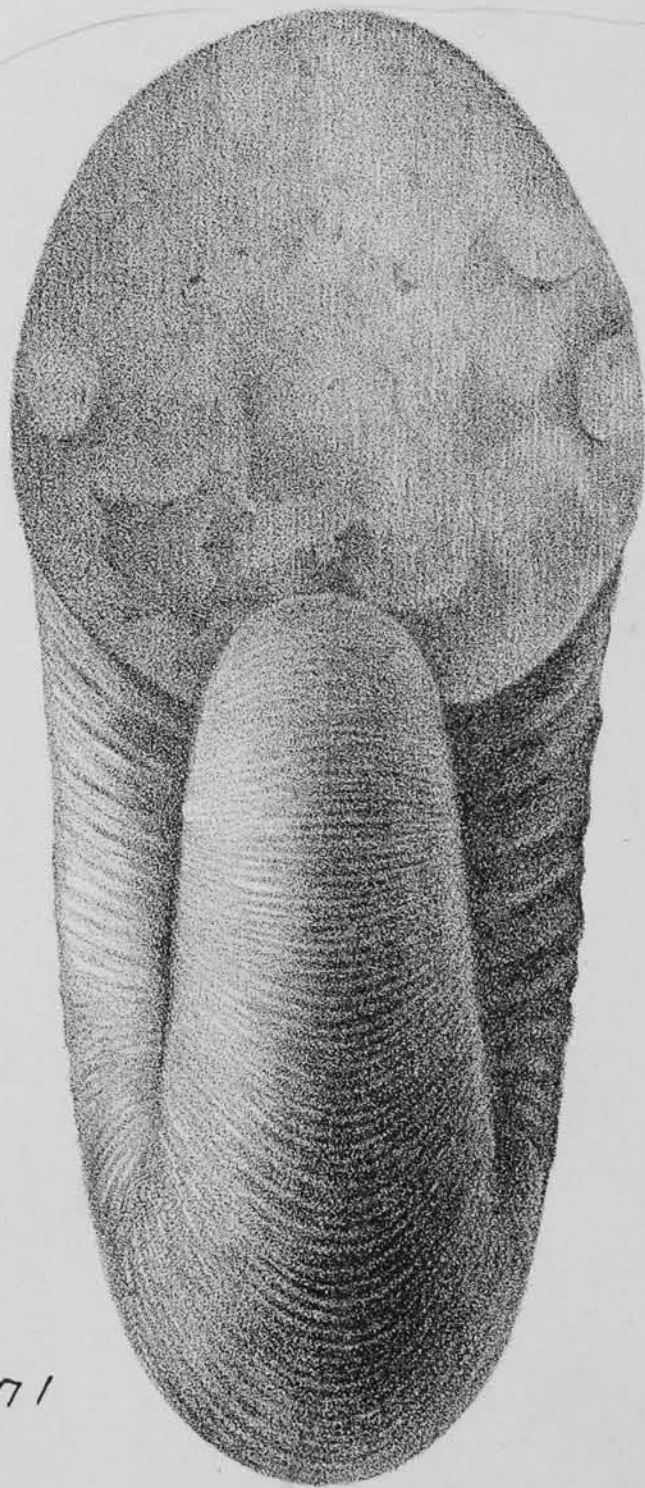


Fig 1b.

H. YABE.

CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE IV.

Lytoceras and Gaudryceras.

Plate IV.

Lyloceras imperiale m. P. 12.

7475

Fig. 1. Suture line, drawn from the specimen figured in Pl. II. Nat. size.—
s., siphonal line; um., umbilical margin; us., umbilical suture.

Gaudryceras limatum m. P. 35.

7466

Fig. 2. Suture line, drawn from the specimen figured in fig. 2, Pl. V.
Nat. size. Lettering as in fig. 1.

Gaudryceras tenuiliratum m. Pp. 28-29.

7470



Fig. 3. var. *infrequens*. a, side view; b, front view of a specimen preserved
in the Sci. Coll. Mus. From *Scaphites*-beds of the Opiraushibets,
Prov. Iburi. Nat. size.

Gaudryceras crassicostatum JIMBŌ sp. Pp. 29-30.

7469

Fig. 4. Side view of a specimen in the Sci. Coll. Mus. From upper
Ammonite-beds of Cape Sōya, Prov. Kitami. Nat. size.

Gaudryceras striatum JIMBŌ sp. Pp. 31-34.

7468

Fig. 5. Side view of a specimen in the Sci. Coll. Mus. From *Pachydiscus*-
beds of the Abeshinai-rubeshibe, Prov. Teshio. Nat. size.

7467

Fig. 6. var. *picta*. a, side view; b, outline of a transverse section; c,
surface of a septum, showing the septal lobe, of a specimen in the
Sci. Coll. Mus. From *Pachydiscus*-beds of the Uipets-rubeshibe,
Prov. Teshio. Nat. size.

Gaudryceras Yamashitai m. Pp. 38-39.

7462

Fig. 7. Side view of the type in the Sci. Coll. Mus. From upper Ammonite-
beds of the Sanushibe, Prov. Iburi. Nat. size.

mm

J. I.

MM7470

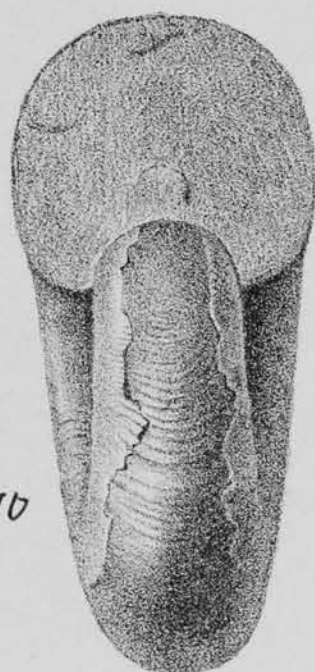


Fig. 3.b.

MM7475



Fig. 1.

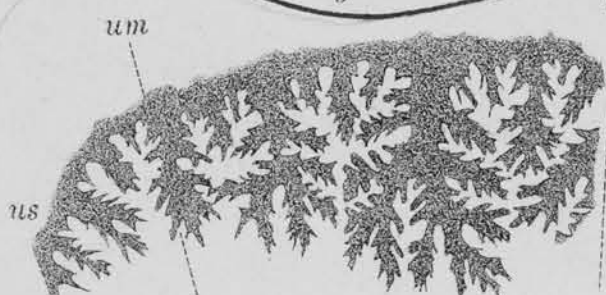


Fig. 2.
MM7466

MM7470

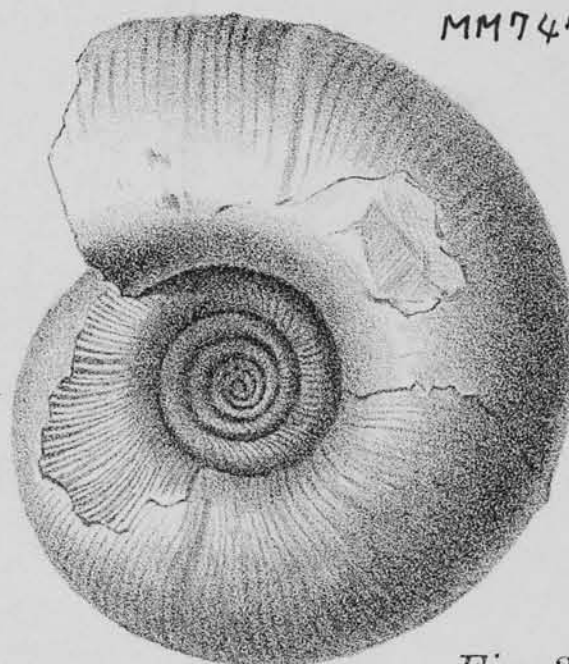


Fig. 3.a.

MM7467



Fig. 6.a.

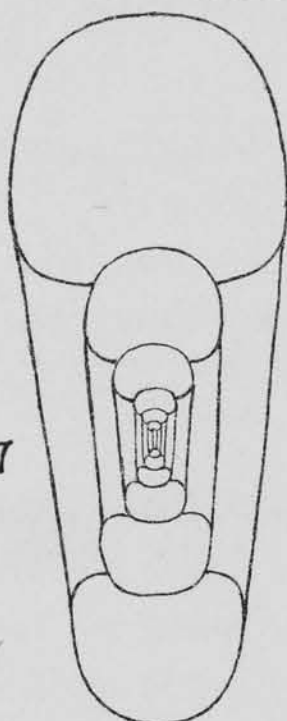


Fig. 6.b.

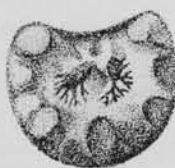
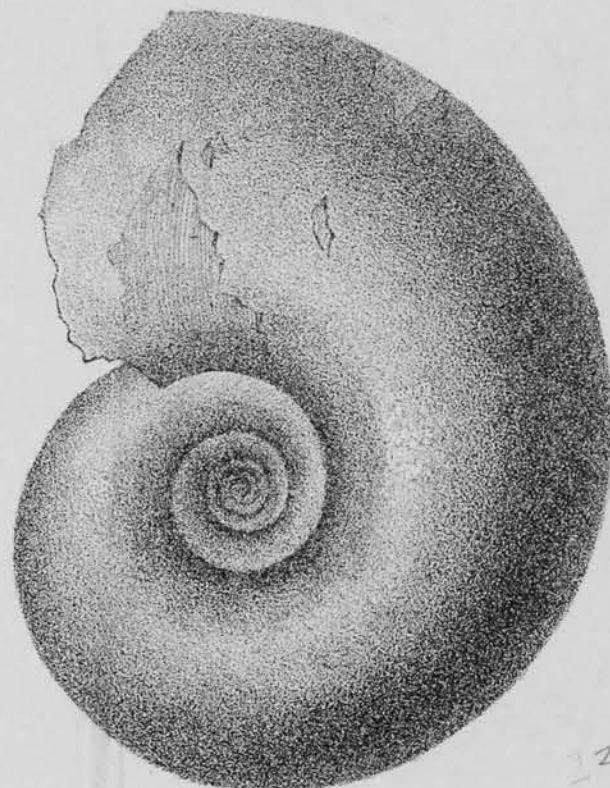


Fig. 6.c.

Fig. 7.
MM7462



MM4769

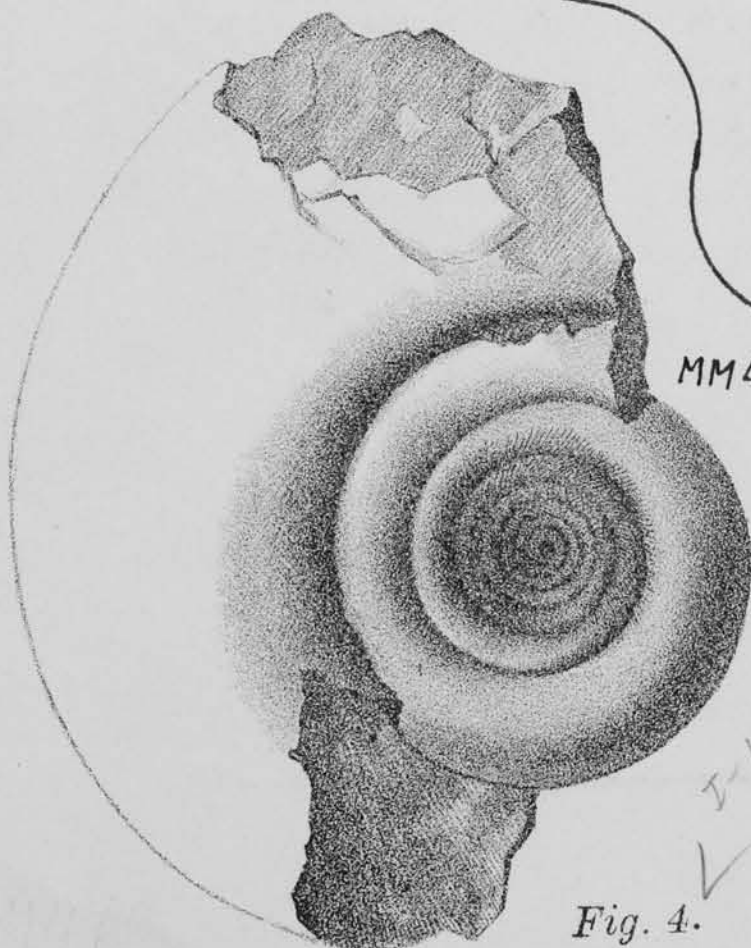


Fig. 4.

MM7468

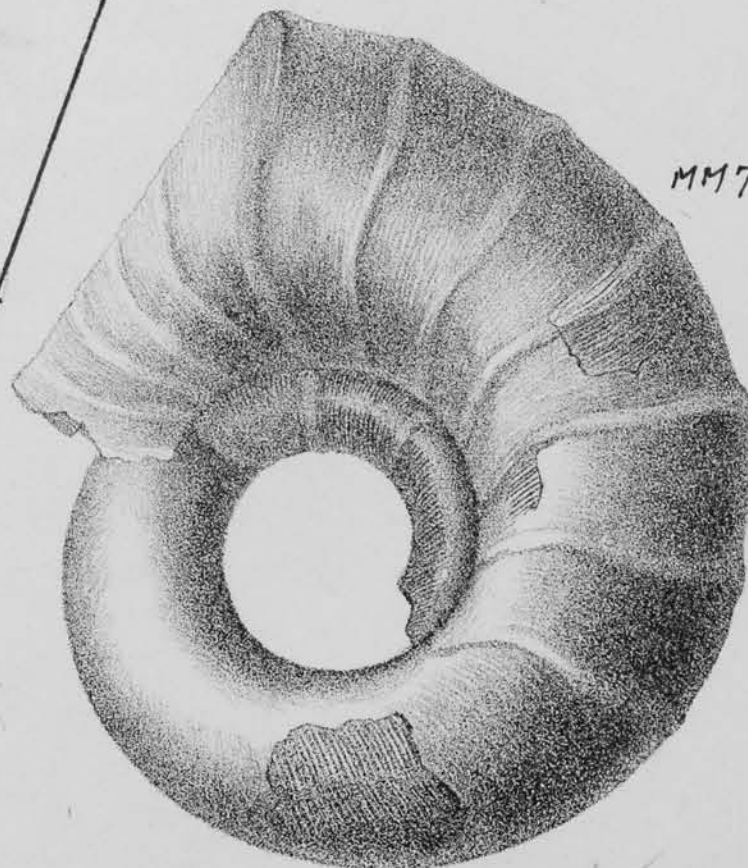


Fig. 5.

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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDO.

PLATE V.

Lytoceras and Gaudryceras.

Plate V.

Lytoceras ezoëense m. P. 10.

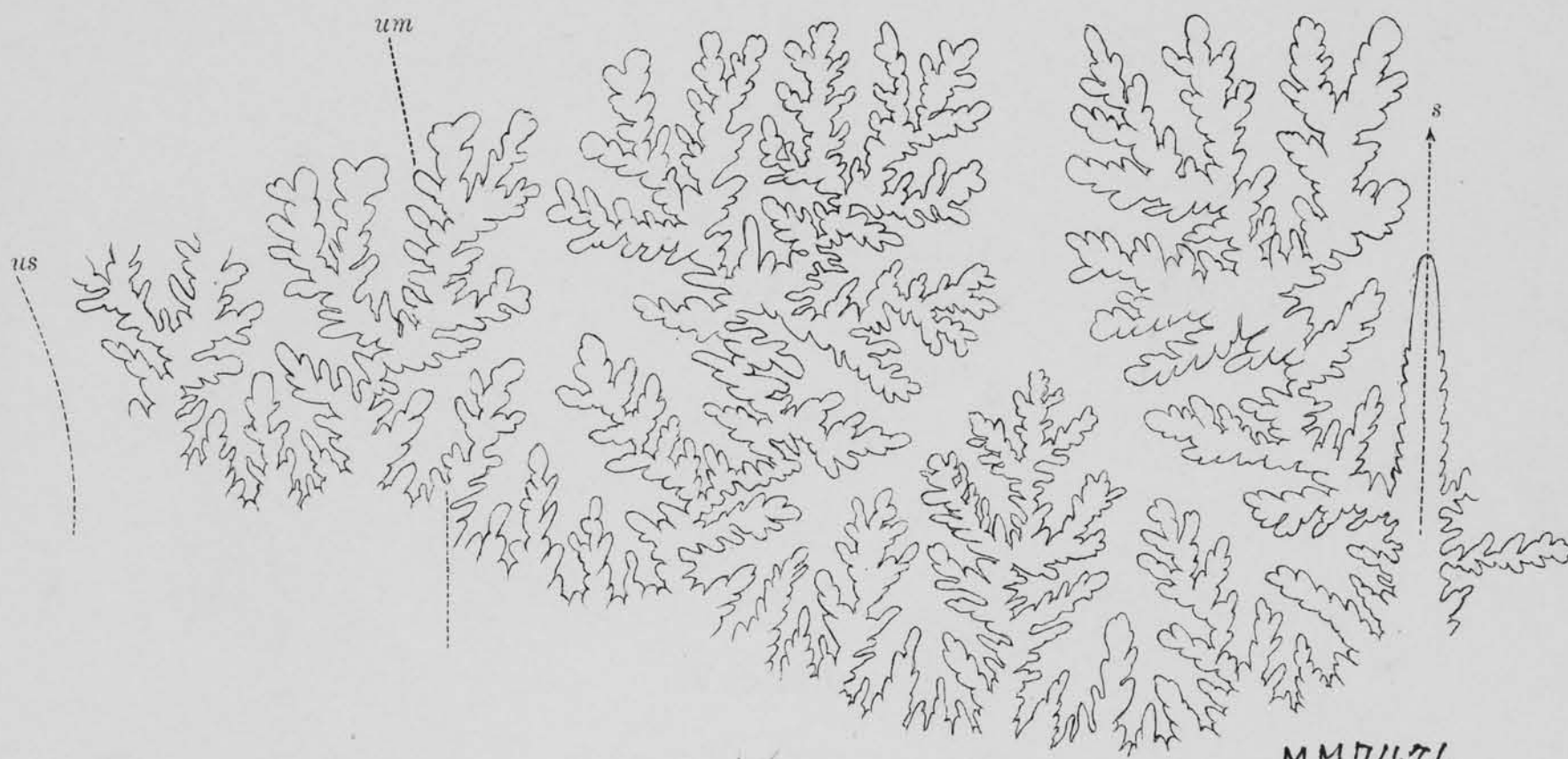
7476

Fig. 1. Suture line, drawn from the specimen figured in Pl. I. Nat. size

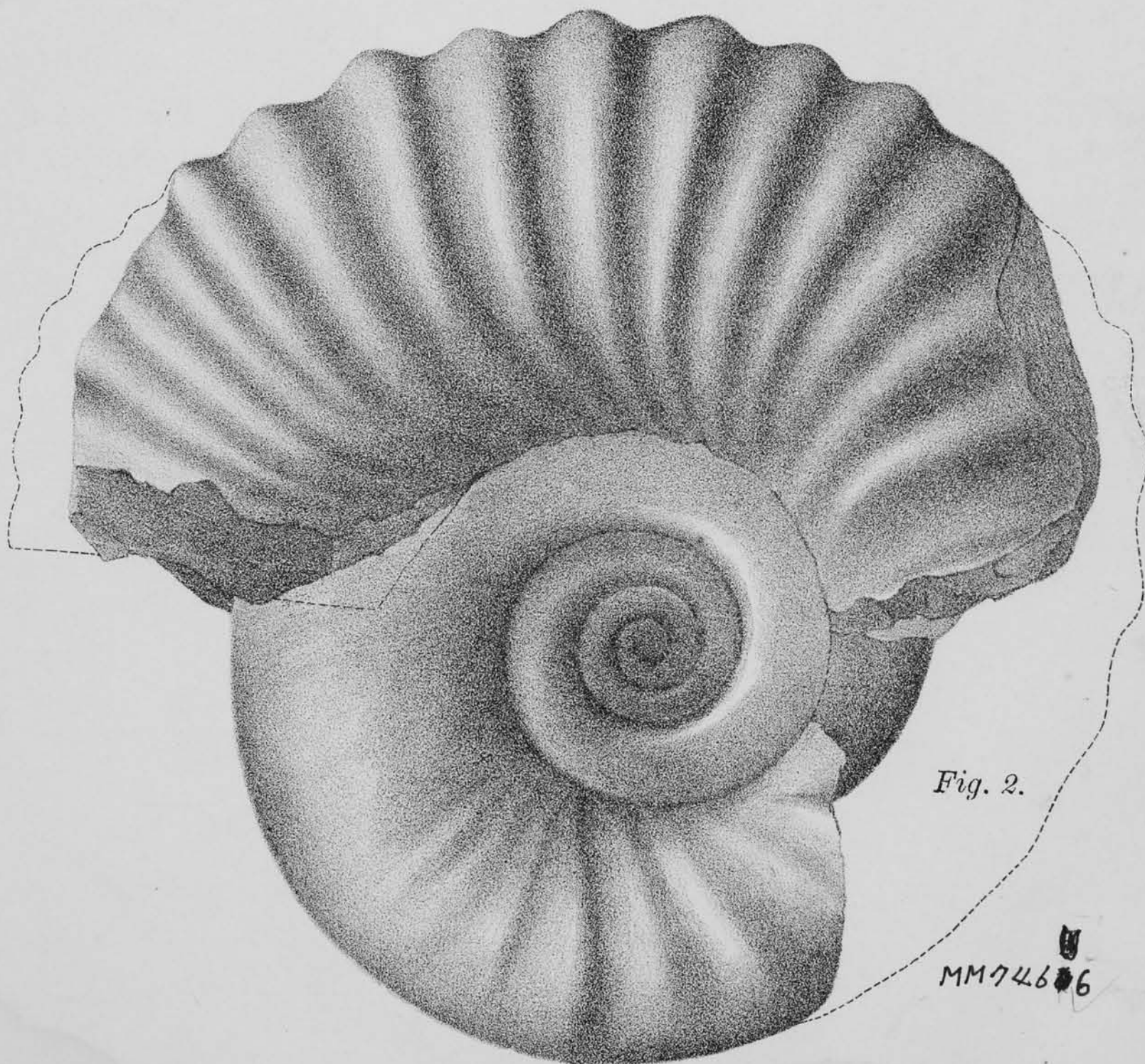
Gaudryceras limatum m. P. 36.

7466

Fig. 2. Side view of a specimen, preserved in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.



✓ Fig. 1.



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CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE VI.

Gaudryceras.

Plate VI.

Gaudryceras Yokoyamai m. Pp. 36-38.

7464

Fig. 1. a and b, side and front views of the type in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

7463

(7)

Fig. 2. a, side view ; b, front view, of a younger specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

Gaudryceras limatum m. Pp. 34-36.

7465

(14)

Fig. 3. a, side view, somewhat restored ; b, front view, of the type in the Sci. Coll. Mus. From upper Ammonite-beds of the Yoshiashizawa, a tributary of the Ikushumbets, Prov. Ishikari. Nat. size.



I-197 ✓
Fig. 1a.
MM 7464

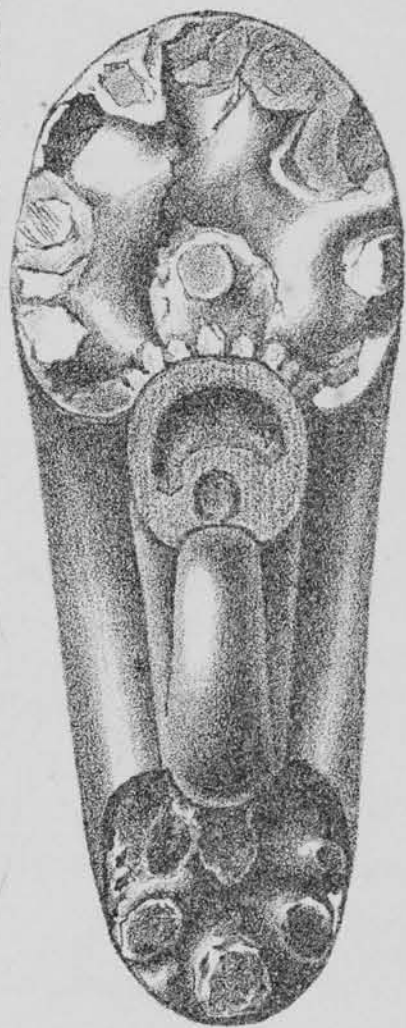


Fig. 3.b. ✓
MM 7465

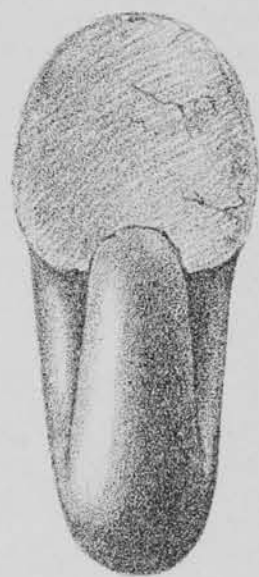


Fig. 2.b.
MM 7463 ✓



Fig. 2.a.

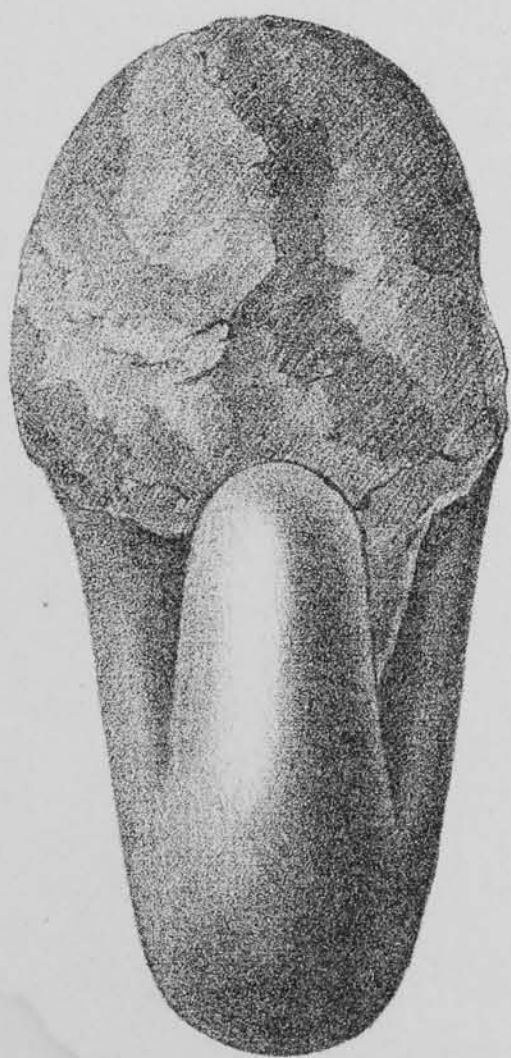


Fig 1b. ✓



Fig. 3.a. ✓

H. YABE.

CRETACEOUS CEPHALOPODA FROM THE HOKKAIDŌ.

PLATE VII.

Gaudryceras and Tetragonites.

Plate VII.

Tetragonites sphaeronotus JIMBŌ sp. Pp. 45-47.

17540 Fig. 1. a, and b, side and ventral views of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Yūbarigawa, Prov. Ishikari. Nat. size.

Tetragonites glabrus JIMBŌ sp. Pp. 43-45.

MM 17461 (Fig. 2. Side view of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Sanushibe, Prov. Iburi. Nat. size.
Fig. 5. A part of the suture line of the same specimen. Enlarged.

Tetragonites cfr. *epigonus* KOSSMAT. Pp. 49-51.

MM 17459 Fig. 3. Side view of a specimen in the Sci. Coll. Mus. From upper Ammonite-beds of the Kenekawen-opiraushibets, Prov. Teshio. Nat. size.

Tetragonites popetensis m. Pp. 48-49.

(R) 17460 Fig. 4. a, side view; b, front view, of the type in the Sci. Coll. Mus. From *Pachydiscus*-beds of the Sanushibe, Prov. Iburi. Nat. size.

7541 Fig. 6. Suture line of another specimen in the Sci. Coll. Mus. From *Pachydiscus*-beds of the Penke-opushikep, Prov. Teshio. Enlarged.

Gaudryceras yokoyamai m. P. 37.

(R) 17463 Fig. 6'. Suture line drawn from the specimen figured in Pl. VI., fig. 2. Enlarged.—s., siphonal line; um., umbilical margin; us., umbilical suture; as., antisiphonal line.

Fig 1.b.



MM7463



(R)

1-208

Fig. 6'

MM7461



Fig. 2.

I-207

MM7459



Fig. 3.

I-209

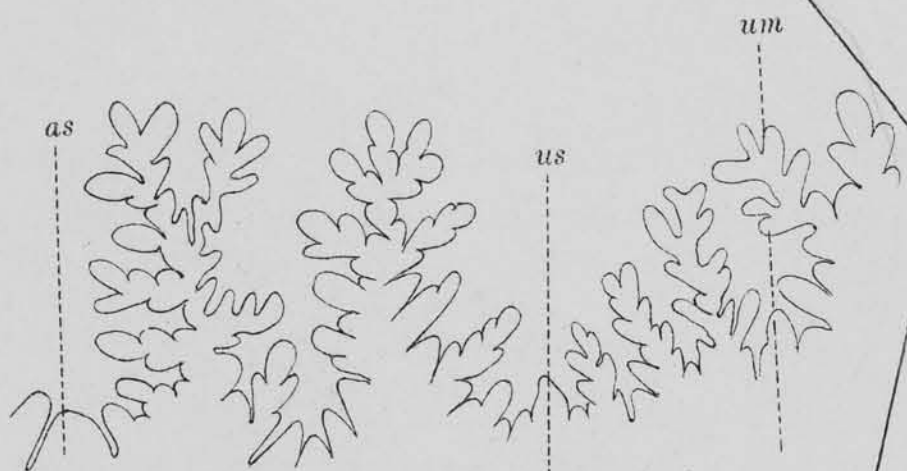


Fig. 5.
MM7461

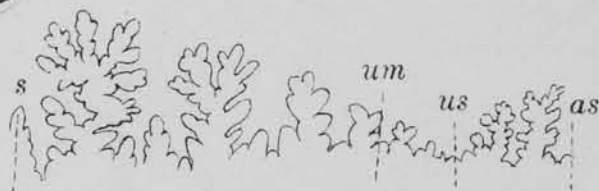
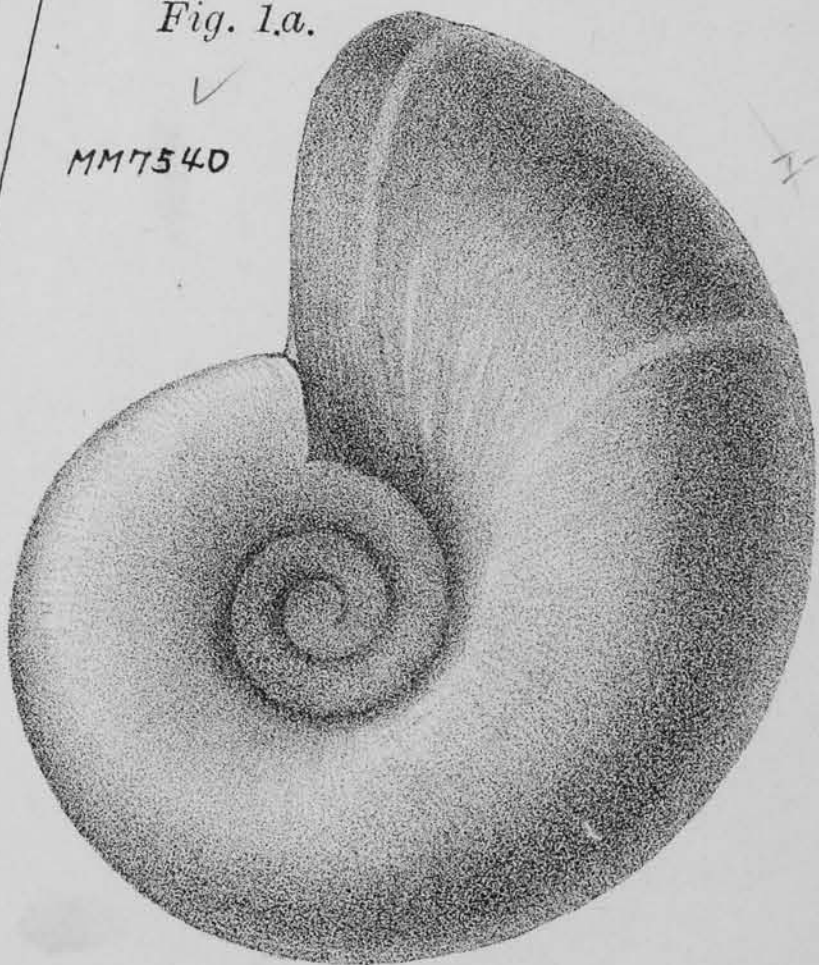


Fig. 6.
MM7541

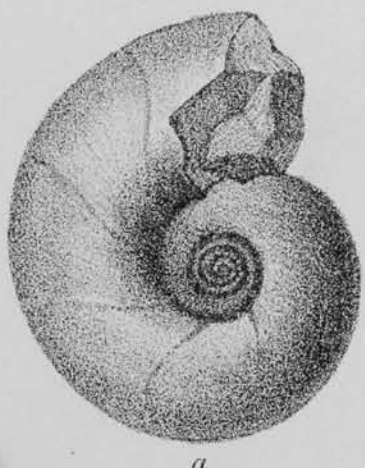
Fig. 1.a.

MM7540

I-206



MM7460



a.



b.

Fig. 4.

(Z)

Vol. XVIII, Art. 2, published June 8th, 1903.

Price in Tōkyō, Yen 1.00.

This Journal is on sale at

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TŌRI SANCHŌME, NIHONBASHI, TŌKYŌ.

R. FRIEDLÄNDER & SOHN,

CARLSTRASSE 11, BERLIN N. W.

明治三十六年六月三日印刷
明治三十六年六月八日發行

編纂兼發行者 東京帝國大學

印刷者

東京市京橋區築地三丁目十五番地

野村 宗十郎

印刷所

東京市京橋區築地二丁目十七番地

株式會社 東京築地活版製造所

賣捌所

東京市日本橋區通三丁目十四番地

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