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YOUNGER PALEOZOIC CEPHALOPODS FROM THE KITAKAMI MOUNTAINS, JAPAN.

By

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(With 2 Plates and 1 Table)

Contribution from the Department of Geology and Mineralogy
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I. Introductory

In contrast to the rather abundant occurrence of foraminifers, corals and brachiopods in the Carboniferous and Permian formations of Japan, molluscan remains, especially of cephalopods, hitherto known, are quite limted in kind and number. As far as the writer is aware, H. YABE is the first to have referred to the occurrence of the younger Paleozoic cephalopods in our country. In a Japanese note entitled "Ammonites from the Paleozoic of Japan"(1), 1904, he reported the discovery of some doubtful species of *Gastrioceras* from the southern prat of the Kitakami mountains, and from the limestone gorge of the Ômi-gawa, Ômi-mura, Niigata Prefecture. From the former region a few specimens of poorly preserved cephalopods were collected by Yônosuke OTSUKI in a limestone exposed at Kobama, Jûgohama-mura, Monôgun, Miyagi Prefecture. At least one of them is possibly a *Gastrioceras*, as was judged from the form of the shell and sculpture. Let it be called *Gastrioceras* sp. *a* in this note. The locality is just where some brachiopods(2), a sponge(3) and an indeterminable species of *Stacheoceras*(4), together with some other fossils, were collected many yers later by the writer. Another species mentioned by YABE is a *Gastrioceras*, decided by tracing a suture-line. It was found in the collection of an amateur collector, and was entrusted to him for examination. It originated at a certain horizon, not exactly known, of the very thick limestone formation ranging from the Carboniferous to the Permian in age which is traversed by the stream of the Ômi-gawa. This *Gastrioceras* was briefly described by YABE who gave a sketch of the suture-line also. According to him the fossil is characterized by having a large umbilicus, and the whorls

strongly depressed and deeply involute with a lunar profile: diameter is 23 mm. The ventral qart of the suture-line appears to be quite singular: it suggests the possibility of the species being some unfamiliar sub-genus or genus. This is *Gastrioceras* sp. β in this note.

These occurrences were referred to again by YABE in his famous and epoch-making paper on the Japanese FUSULINIDAE[6]. Here he emphasizes that the Japanese Anthracolithic limestones almost always lack cephalopods because these limestones are of littoral origin. This is the only occurrence hitherto known of the Younghr Paleozoic cephalopds in Japan outside the Kitakami mountains*.

From the Kitakami mountains a small number of nautiloids and ammonoids have been reported to occur from time to time since about thirty years. In 1924 *Protocycloceras* cf. *cyclophorum* WAAGEN to time was described by the present writer from the uppermost Permian Ogachi Slate formation: it occurred in associaton with a few other fossils[7]. After a long interval of time, further records of the Permian cephalopods followed it; namely, those of S. MABUCHI (1935)[8], YABE and MABUCHI (1935)[9] and HAYASAKA (1940), *op. cit.*

All these taken together the list of the Japanese Carboniferous and Permian cephalopods is as follows.

Nautiloidea.

1. *Protocycloceras* cf. *cyclophornm* WAAGEN. This is, according to S. SHIMIZU and T. OBATA, *Cycloceras* sp. nov.?[10]
   LOCALIT:— Ogachi, Jûgohamamura, Monô-gun, Miyagi Prefecture: the Toyoma sub-stage, the upper Kitakami Permian.**
2. *Metacoceras* sp., YABE and MABUTI- *op. cit.*, 1935.
   LOCALITY:—Iwaizaki, Monô-gun, Miyagi Prefecture: the Iwaizaki limestone of the Kanôkura sub-stage, the middle Kitakami Permian.

Ammonoidea.

3. *Stacheoceras iwaizakiense* MABUTI, *op. cit.*, 1935.
   LOCALITY:—Iwaizaki. Iwaizaki limestone.

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* Very recently an incomplete specimen of a nautiloid found in the *Fusulina*-limestone of Kinshôzan, Gifu Prefecture, was sent to the writer for study by Mr. MASUTOMI of Kyôto. The writer could see another, small nautiloid obtained by Prof. OZAKI of the Kanazawa University from the Permian limestone exposed in the upstream region of the Kuzuryû, in Fukui Prefecture. These will be described in a future note. Decemoer 20, 1953

** Geographical and stratigraphical names are given in a list after references.

4. *Stacheoceras* sp. indet., HAYASAKA, *op. cit*, 1940.
   LODALITY:—Kobama, Jôgohama-mura, Monô-gun, Miyagi Prefecture: the Kanôkura sub-stage, possibly.
5. *Paraceltites* cf. elegans GIRTY, HAYASAKA, *op, cit.*, 1940.
   LOCALITY:—Imô, Yahagi-mura, Kesen-gun, Iwate Prefecture: the Kanôkura sub-stage; in association with *Lyttonia* and others.

Beside these, there was, in the writer's possession, a fragment of an outer mold of a small discoidal ammonoid which faintly preserved, rather thick, radially arranged short ribs recognized as elongate nodes across the ventro-lateral border. It is possidly a *Propinacoceras*: it is in the Department of Geology, National Taiwan University, Taipei, Formosa.

So far had been our knowledge until a short time ago when some additional material was obtained in the Kitakami region by the members of the Department of Geology and Mineralogy, Hokkaidô University in a few past years.

The Kitakami mountains are at present the only region in Japan where an almost complete sequence of formations ranging from the Gotlandian up to the Permian has been recognized by the evidence of fossils. The area most intensely explored in recent years lies in the southern part of Iwate Prefecture, and the north of the localities of the above mentioned fossils. Our present knowledgr on the geology and stratigraphy of this area is due, in a great measure, to the laborious works carried out chiefly by M. MINATO assisted by younger members and some students of the Department of Geology and Mineralogy, Hokkaidô University. Incerted is the generalized table of succession of the Kitakami Paleozoic adopted from an unpublished table compiled by MNIATO. (Table I)

During the past ten years abundant fossils were collected from different horizons at different localities. Among them a few incomplete and deformed specimens of cephalopods are recognized in the Carboniferous and Permin materials. In no way are they in a better state of preservation than those hitherto known. In reality, most of them are almost worthless as paleontological material. However, it may be of some use to put them on record in order to direct attention of geologists to the existence of nautiloids and ammonoids in the Kitakami mountains.

In the present paper the following forms are described, in part

provisionally.

Nautiloidea :

Coelonautilus sp.

Ammonidea :

Gastrioceras sp. *γ*
? *Prolecanites* sp. *α*
? *P.* sp. *β*
? *Medlicottia* sp.
Haniloceras intermedium (WANNER)

II. Description of Species

NAUTILOIDEA

Coelonautilus FOORD

The writer follows Hermann SCHMIDT[11] in placing in this genus the forms called *Triloboceras, Vestinautilus* and *Trigonoceras.*

Coelonautivs sp. indet

Pl. 22, Figs. 1 a—1 b.

This is represented by a fragmentary specimen consisting of a part of an external mold and an internal one filling it, or the counterpart. The specimen measures about 135 mm long along the venter, and about 60 mm wide where it is widest. The specimen being more or less strongly compressed obliquely, these measurements only give the idea of its size. However, the following descripive characters are observed.

Whorl is depressed, flatly six-sided in cross section, with a pair of faint spiral ribs about 8～10 mm apart on an average, and the umbilical declivity below is a flat zone about 12～13 mm wide. Umbilicus is quite wide and deep. Three suture-lines have been polished out of the inner mold. They are almost straight on the ventral and ventrolateral areas, but tend to slightly curve forward on the lateral areas. If they are consecutive suture-lines, they may be said sigularly remote, because they are, as seen in the figure, about 25～20 mm aqart on the venter.

The species here described may probably belong to the type of *Vestinautilus* which is represented by many forms in the Carboniferous

formations of Britain and other European countries.

LOCALITY :—Ôsugi-zawa, Kashiwari, Setamai-mache, Kesen-gun, Iwate Prefecture.

HORIZON :—Arisu series (Hinotsuchi stage).

AMMONOIDEA

Gastrioceratidae WEDEKIND

Gastrioceras HYATT

Gastrioceras sp. indet. *γ*.

Pl. 22, Fig. 2.

An incomplete inner mold quite strongly compressed in the direction of the plane of volution: only half of an individual is preserved in a hard, fine-grained sandstone or sandy shale. It is so far observed of the specimen, however, that whorls are depressed, low and broad, only slightly involute; venter wide and slightly convex; umbilicus broad and deep, umbilical shoulders being narrowly rounded. Only a fragment of a suture-line is observed on the ventral surface: ventral part is not preserved; what seems to be the firts lateral saddle is represented by an elliptical or oval curve which, at its external end, tends to curve away laterally as if to from an obtusely pointed lateral lobe farther down.

That this fossil belongs to GASTRIOCERATIDAE, there is hardly any doubt. In regard to the shape of the shell as is assumed to be from detailed observations, the fossil can not be a species of such genera as *Paragastrioceras*, *Strigogoniatites* or *Paseudogastrioceras*[12]. It may either be an *Eoasianites* or a *Metalegoceras*, although decision is by no means easy. Hitherto the former has been known from the Pennsylvanian and Permian, while the latter is believed to be lower Permian[13]. As the Japanese specimen at hand came from the Arisu series (possidly younger Tournaisian) of the Kitakami mountains, it may possibly be a *Gastrioceras*. This genus is known to include different types of shells.

LOCALITY :—Karima-zawa, Kashiwari, Setamai-machi, Kesen-gun Iwate Prefecture. In the immediate neighborhood a ? *Prolecanites*, and a *Coelonautilus* were found in the same bed.

HORIZON :— Arisu series.

Prolecanitidae HYATT

? *Prolecanites* sp. indet. *α*.

Pl. 23, Figs. 1 a, 1 b,

There are at hand several deformed specimens of discoidal ammonoids preserved in a dark bluish, fine-grained sandstone mostly as outer molds. These specimens are characterized by the following features. The whorls are only slightly involute, and very slowly increasing in size, more than five volutions being counted in a specimen about 6 cm in longer diameter of the oval outline. The whorl is higher than broad, and widened dorsally. Umbilicus is wide and shallow.

No suture-line is preserved perhaps because the grains of the matrix sandstone are not fine enough to preserve the delicate structure intact.

It is almost impossible to decide the genus of such fossils. But the writer ventures to tentatively call them a *Prolecanites*, with a question mark attached, until future discoveries of well-preserved material would decide. However, the resemblance between the present species and a number of the known European and American species of that genus may perhaps appear quite close to those who would compare the pictures of these fossils. They are, for instance, *P. compressus* SOW. of Ireland[14] (Upper Avonian D_1 zone),[15] *P. greenii* MILLER, *P. gurleyi* SMITH, *P. houghtoni* WINCHELL, *P. lyoni* MEEK & WORTHEN (all from toe Kinderhookian) and the like of North America[16].

LOCALITIES:—(1) Shiritaka-zawa (entrance of the valley), Hinotsuchi, (2) Haneishi-zawa, Shimo-Arisu-mura, and (3) Yokoiwa-zawa, Setamai-machi, all in Kesen-gun, Iwate Prefecture.

HORIZON:—Localities 1 and 2—the Jûmoni stage, Arisu series, and locality 3—Lower Hikoroichi series.

? *Prolecanites* sp. indet. *β*.

Pl 23, Figs. 2 a, 2 b.

In the material at the writer's disposal there is another species which appears to belong to the same group of ammonoid as the preceding one. It is smaller than the latter, one of the specimens measuring 15 mm along the longer diameter of its deformed oval outline.

The measured specimen is an outer mold split into two longitudinal halves, that is, along the axial plane of volution. No suture-line is preserved, consequently. Plaster casts have been made to restore the form of the shell. It has been found that the specimen yielded to pressure, and not only flattend as a whole but also the inner volutions was pushed out to one side, so that it looks aomewhat laike an *Euomphalus* at a first glance. Umbilucus is moderatly deep. There are more than five volutions recognized, and the whorls appear to be ornamented with fine, radial striae that are straight.

Locality :—Kashiwari, Setamai-machi, Kesen-gun, Iwate Prefecture. In this neighborhood *Gastrioceras* sp. and *Coelonautilus* sp. described in this note were found in the same horizon.

Horizon :—The Jûmonji atage of the Arisu series.

Medlicottiidae Karpinssky

? *Medlicottia* sp.

Pl. 23, Figs. 3 a, 3 b.

This is a fragmentary specimen, almost a qurdrant of a rather small, discoidal ammonoid, preserved as an inner mold in a fine-grained tuffaceous sandstone. It was found by Takashi Yoshida of the Japanese Geological Survey some time ago at a place north of Kesen-gun, Iwate Prafecture in the Kitakami mountainland. The specimen was found together with a *Spiriferina* and a *Martinia* (possibly *Spiriferina* cf. *ornata* Waagen and *Martinia* cf. *elongata* Waagen, respectively, first recorded from the *Productus*-Limestone of Salt Range). The ammonoid is in a very poor state of preservation : its umbilical part is not retained and its ventral portion is disturbed to the effect that the ventral lobe and the first lateral saddle with adventitious lobes are obliterated. However, a few of the suture-lines are seen on the flanks. They are characterized by rounded saddles and deeply bifurcated lobes. The pattern is that of the genera of the family Medlicottidae, though the number of saddles and lobes sppear to be rather too few for the size of the conch, perhaps being in conformity with their comparatively large size. Besides, inaccessibility to the details of the ventral portion of sutures is an objection to the generic discrimination within the family.

However, it is recognized in the present specimen that the space outside the second lateral saddle is very narrow, and consequently the first lateral saddle can not be wide. This fact leads the present writer

to place the fossil in the genus *Medlicottia* rather than in the other ones. If this allocation is admissible the fossil may possibly represent a species which has not been known up to present, being characterized by comparatively large and round saddles and deeply bifurcate lobes, as well as by the small number of saddles and lobes.

Measuring dimensions of such a specimen is not of much sense: the pictures on the plate are given in natural (Fig. 3 a) and double (Fig. 3 b) sizes.

Locality and Horizon:—A little north of the mountain pass called Haritsuke-tôge, which is in Tassobe-mura, Shimo-Heii-gun, Iwate Prefecture. The details of the geology of the area are not known at present. The geological age of the tufaceous sandstone in which the ammonoid specimen was preserved is judged to be younger Permian from the kinds of the brachiopods found in association referred to above. The ammonoid, if it is a *Medlicottia*, conforms with them in point of the geological age.

Cyclolobitidae Zittel

Hanieloceras Miller

Hanieloceras intermedium (Wanner)

Pl. 23, Figs. 4, 4 a, 4 b.

1932. *Waagenoceras intermedium* Wanner: Zur Kenntnis der permischen Ammonideenfauna von Timor. N. Jahrb. f. Min., *etc.*, Beil. Bd. 67, Abt. B., pp. 272–8, 2 textfigs., pl. 9, fig. 1; pl. 10, fig. 1.

1933. *Hanieloceras intermedium* Miller: Age of the Permian Limestones of Sicily. Amer. Jour. Sci., 5 ser., vol. 26, p. 413.

Waagenoceras intermedium was established by Wanner in 1932 on a single specimen which was found by H. Ehrat at Kiumoko in Bassleo region, western Timor. It is described to have been filled with a hard, reddish brown marl of the upper Permian age. Wanner seems to have faced with a difficulty in deciding its genus: it has features characterizing *Cyclclobus*, on the one hand, and *Waagenoceras*, on the other; hence perhaps the specific name *intermedium*.

Considering, however, that it differs from either *Waagenoceras* or *Cyclolobus* as are represented by the characteristic species of these genera, Miller proposed, in 1933, to sparate it from them and call it with a new generic name *Hanieloceras*. "*Hanieloceras* differs from *Waagenoceras* s. s., from which it doubtless developed, in that there are eight or nine

rather than six or seven lobes···, and all of those lobes are very much more strongly subdivided ; *etc*".

Subsequently, in 1940, MILLER and FURNISH remarked that the inner volutions of the conch of an American species closely related to *Waagenoceras intremedium* strikingly resembles the small specimens named *Timorites* by HANIEL. Considering that the amount of involution of conchus varies a great deal in cyclolobids and related species of *Waagenoceras* they were strongly inclined to call almost all Timorese cyclolobids *Timorites*. On the assumption, however, that the genus *Timorites* was based by *Haniel* on adult specimens, instead of younger ones, the present writer prefers to reinstate MILLER's genus of 1933, and to name the specimen from the Kitakami mountains a *Hanieloceras*. If MILLER and FURNISH's step is to be followed, however, there is no difference in the fact that a Timorese species, or a species very close to it, occurs in the Permian of the Kitkami mountains of Japan.

Be that as it may, WANNER's description of this species is very exhaustive and detailed. In essence it is as follows.

Conch is quite large for a *Waagenoceras*, measuring 175 mm and 64 mm, in diameter and width, respectively, the latter being 0.37 of the former in ratio. Venter is narrowly rounded ; umbilicus deep and narrow just like in *W. mojsovicsi* GEMMELLARO, the type of the genus. Whorls are deeply involute, the last one almost entirely embracing the preceding : sides are flattened, and grade round gradually into venter, but umbilical slope is almost perpendicular. Faint radial swellings, about 10–11, are recognized along the umbilical edge.

Shell is thin (not quite 1 mm), with weakly sigmoidal, thin, simple transverse striae ; without constrictions. Because of lateral shifting of sutural elements on sides the suture as a whole is dissymmetric. Suture is only slightly convex anteriorly, convexity of the line connecting distal ends of saddles culminating at third or fourth lateral saddle. Between external lobe and umbilical edge there are 9 lobes and 8, or possibly 9, saddles : siphonal lobe is the largest, widest and deepest, but narrowed anteriorly ; divided into two parts by a median saddle, each part being quadrifid, with the longest branch or digit on ventral side. The first lateral lobe is trifid, also with the longest digit on the ventral side : following two lobes are bifid, while further ones are like the first lateral in being trifid. External saddles are convex toward umbilicus, and distal expanded ends on both sides of venter approach to each other : axes of all other saddles are practically straight. The distal

foliole of the external saddle as well as those of the six following ones are considerably larger than the leaflets of stems or axes, and characteristically mushroom-shaped, and are almost symmetrical, sitting as it were, on slender stalks: in the last two saddles the symmetry is lost, their distal folioles being expanded toward siphonal side. Saddles become smaller toward umbilicus, the one nearest to it being about 1/3 of the external saddle in length. The distal, mushroom-shaped flioles of all the saddles except two or three from the umbilical edge have, as it were, two laps hanging down from both sides of head or pileus.

Now, there is, in an extensive collection of the Permian fossils of H. SUETOMI, made while a student of the Hokkaido University, in the southern part of the Kitakami mountains, a fragmentary and strongly deformed specimen of an ammonoid preserved as an internal mold in a black, fine-grained sandy shale. It is not quite one half of a whorl, without keeping earlier ones attached: it shows a deep and narrow dorsal surface. The material being like this, many of the characteristic features observed by WANNER on his *W. intermedium* are not to be seen in this specimen. Fortunately, however, several suture-lines are comparatively weell shown on one side of the specimen, though they are not complete because of the damages on both ventral and umbilical margins. Besides, the form of lobes is not very distinct due to deformation of the specimen. But some of the saddles are marvellously well preserved. It seems there are 8 or 9 saddles of which 5 were painted white to show the characteristic form: they are believed to be 2 nd ~ 6 th lateral saddles. These represent the rather unique form of the corresponding saddles of the specimen from Timor: even the two hanging laps of the distal, mushroom-shaped folioles are distinctly recognized.

Lobes are not pointed as in *Perrinintes*, but digitate, although details are obliterated. The form of conch is discoidal, and shows no sign of constrictions. The suture as a whole seems to follow an anteriorly convex curve on the flank. The size of the conch is shown by the pictures given on the annexed plate (Pl. 23, Fig. 4). There is no reason to regard the specimen to be a part of the living chamber: when complete the conch might have been much lorger.

Although the material is by no means satisfactory, there is a striking coincidence between the Kitakami specimen and *Hanieloceras intermedium* with respect to those features that are preserved in the formr,

as described above. Thus, the writer is very strongly disposed to regard the two fossils specifically identical, or, at least very closely allied to each other.

LOCALITY and HORIZON:—The specimen was found together with several brachiopods at the height of about 460 m above sea level in the small valley of the Budô-zawa, a tributary of the Katchizawa, Setamai-machi, Kesen-gun, Iwate Prefecture. The fossiliferous rock is a fine-grained sandy shale occupying the upper part of the Kanôkura series of the Permian, which ranges from the *Parafusulina*-zone up to the *Yabeina*-zone according to the foraminifer zoning.

III. Conclusive Remarks.

The material dealt with in this note is such a fragmentary and obscure one as is seen in the descriptions given above. Especially the Carboniferous forms are far from being useful for the stratigraphical and paleogeographical consideration. However, It can be said that cephalopods are not so very scarce in the upper Paleozoic formations of our country as has been believed to be, although it has been, and is, very difficult to get access to excellent specimens as we often do with other kinds of fossils. It does not mean that there is no hope of discovering well-fossilized specimns in the future.

The Permian species hitherto known in Japan may be of some value as data for the stuby of paleo-zoogeography. *Hanieloceras*, first of all, is a genus which is regarded to occupy a taxonomic position intermediate between *Waagenoceras* and *Cyclolobus*, as stated above. The genus *Waagenoceras* is represented in the Sosio or the Word stage, and ranges up to the Basleo or the Capitan stage, while *Cyclolobus* is an upper Permian genus being found in the Basleo and Chideru stages. Therefore *Hanieloceras* is not older than the Sosio or the Word stage, though it can be younger than the Basleo. The specimen of *Hanieloceras* from the Kitakami mountains is labelled to have occurred in the rock corresponding to the upper part of the Kanôkura series which ranges from the *Parafusulina* zone up to the *Yabeins* zone according to the foraminferal zoning. The occurrence of this ammonoid therefore stratigraphically conforms with that in Timor.

Medlicottia is represented in the Middle and the Upper Permian,

that is, from the Artinskian up to the Chideru, reaching farther up to the Triassic. The species from Kitakami, if it is really a *Medlicottia*, is of the Upper Permian age, as is judged from the associated brachiopods, as already referred to.

Paraceltiees elegans GIRTY was found in the Leonardo formation (lower Middle Permian), and the genus is known to range up into the Capitan formation in North America. *P.* cf. *elegans* is regarded to be within this range. As a matter of fact it was found together with many species of brachiopods including *Lyttonia* : the fauna as a whole is regarded as of the early Middle Permian.

The last genus to be considered is *Stacheoceras* which is represented by two different specien in the Permian of the Kitakami mountainland. The genus persists throughout the Permian, though it seems to be common in the Middle Permian.

It is obvious, therefore, that the Permian ammonoids of Japan, though small in number, have the same stratigraphical meaning as they do in the other regions of the world.

In this place, the writer likes to refer to a small faunule of the Permian cephalopods from a locality in the maritime region of the Chinese Province Chêchiang, of which he published a paper sometime ago[17]. It was buried in a black, bituminous or coaly shale, occasionally calcareous, exposed at East Tungkuan, Chientêhsien, Prov. Chêchiang. The fauna contained, beside four nautiloids, the following ammonoids: *Stacheoceras quadridens* HAYASAKA, *Waagenoceras* cf. *dieneri* BÖSE, *Pesudogastrioceras roadense* BÖSE, and *beedei* PLUMMER et SCOTT, and *Paracibolites costatns* HAYASAKA. Of the four nautiloids two are indeterminable species of *Coloceras* and the others are two new genera, *Hexagonites* and *Tungkuanoceras*. This fauna is significant in that it consists of species identical with or very closely allied to those well known forms in the Tethys fauna. *Paracibolites* is a small flat ammonoid which differs from *Cibolites* in having the top of the second lateral saddle, instead of the third lateral lobe, falling on the umbilical shoulder. As *Cibolites* is a genus occurring in the upper Permian, *Paracibolites* also may indicate a horizon of the similar age. *Pseudogastrioceras* has a wide range through the whole Permian, but the species described from Chêchioang represent the later half of the Permian in their original localaities.

There are several fragmentary records of occurrences of cephalopods in the upper Paleozoic formations of China. There may be many more than the writer has been aware of. As far, however, as his

knowledge is concerned, the upper Paleozoic cephalopod faunas found sporadically in southern China are of composition different from those of the Kitakami mountains of Japan and the East Tungkuan of China referred to above. If this proves to be true by further data we may perhaps assume a paleo-zoogeographical cause of some kind for this. To this problem the writer will come back some time in the future.

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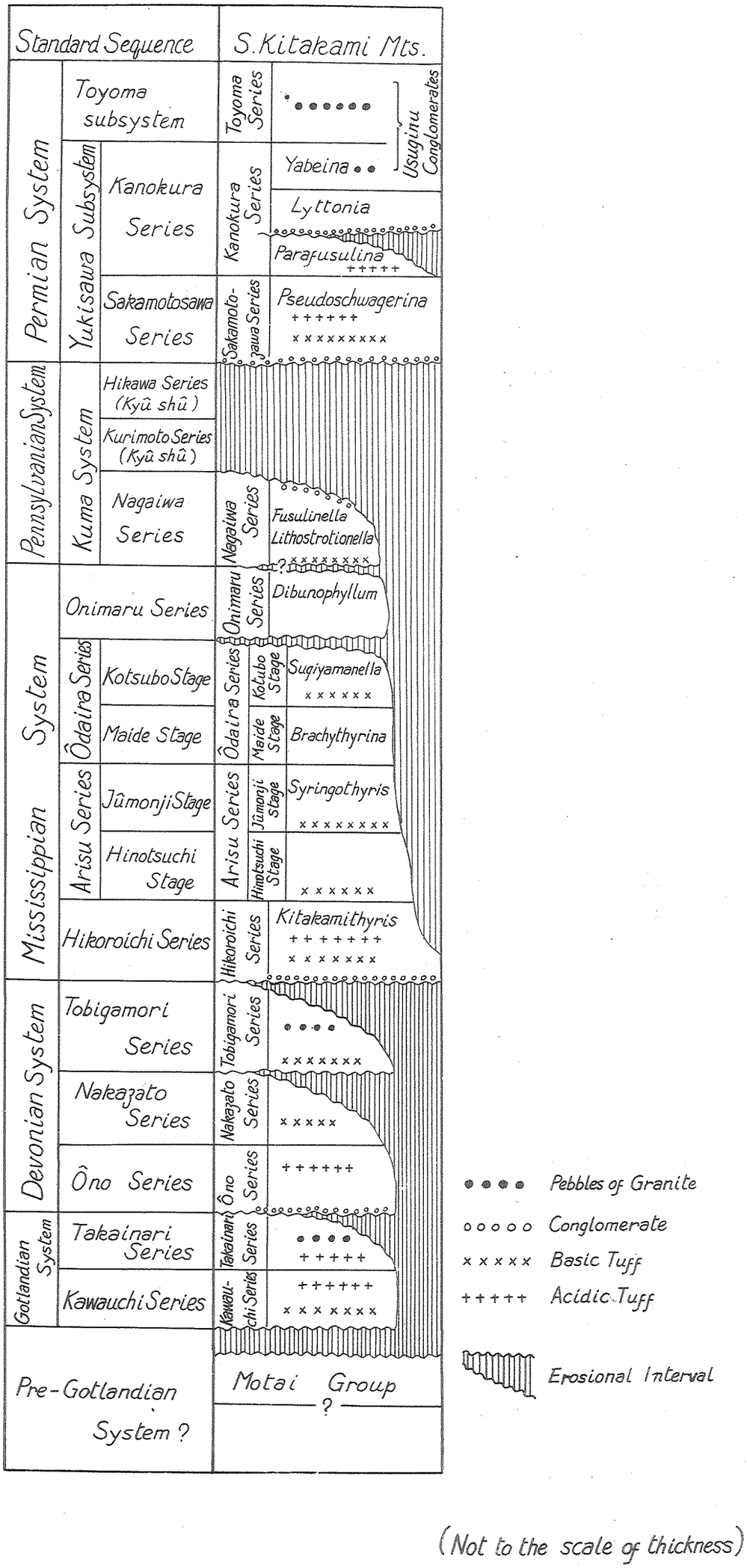
Geographical and Stratigraphical Names in the Origina Characters.

Arisu	有住	Katchi-zawa	合地澤	Ôno	大野
Budô-zawa	ブドウ澤	Kawauchi	川内	Ôsugi-mura	大杉村
Chêchiang	浙江省	Kesun-gun	氣仙郡	Sakamoto-zawa	坂本澤
Chientêhsien	建德縣	Kobama	小濱	Setamai-machi	世田米町
Haneishi-zawa	羽根石澤	Kotsubo	小坪	Shimo-Arisu-mura	下有住村
Haritsuke-tôge	磔峠	Kuma	球磨	Shimo-Heii-gun	下閉伊郡
Hikawa	氷川	Kuriki	栗木	Shiritaka-zawa	尻高澤
Hikoroichi	日頃市	Maide	舞出	Takainari	高稻荷
Hinotsuchi	日ノ土	Monô-gun	桃生郡	Tassobe-mura	達曾部村
Iwaizaki	岩井崎	Motai	母體	Tobigamori	鳶ケ森
Jûgohama-mura	十五濱村	Nagaiwa	長岩	Toyoma	登米
Jûmonji	十文字	Nakazato	中里	Tungkuan	銅官
Kanôkura	叶倉	Ôdaira	大平	Yahagi-mura	矢作村
Karima-zawa	假間澤	Ogachi	雄勝	Yokoiwa-zawa	横岩澤
Kashiwari	柏里	Onimaru	鬼丸	Yuki-sawa	雪澤

Paleozoic Succession of the Southern Part of the Kitakami Mountainland and the Standard Section of the Japanese Paleozoic

Adopted from the Table compiled by M. MINATO for the Committee on the Japanese Paleozoic in the National Research Council for 1953.



(Not to the scale of thickness)

Explanation

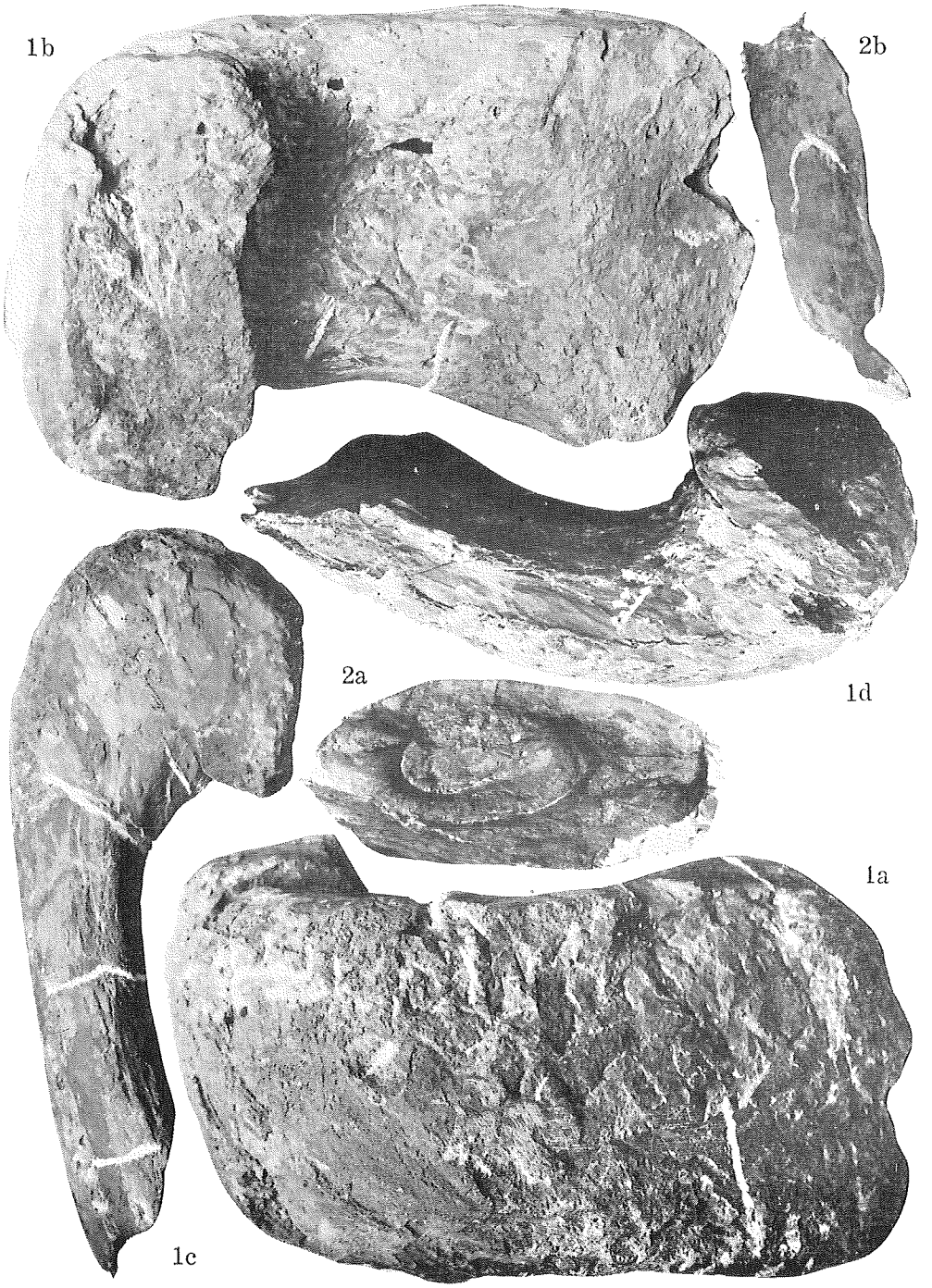
of

Plate 22

Plate 22

Figs. 1a–1d. *Coelonautilus* sp. indet. Natural size. Ventral, dorsal and two lateral views: suture-lines are partly seen.

Figs. 2a–2b. *Gastrioceras* sp. indet. *r*. Natural size. 2a, Lateral view of the specimen which is an external mold, showing a deep umbilicus. 2b, ventral view of the specimen retaining one half of the conch; lateral area on the right of the figure; a fraction of a suture-line is traced with white tint.



HAYASAKA: Younger Paleozoic Cephalopods KUMANO photo

Explanation

of

Plate 23

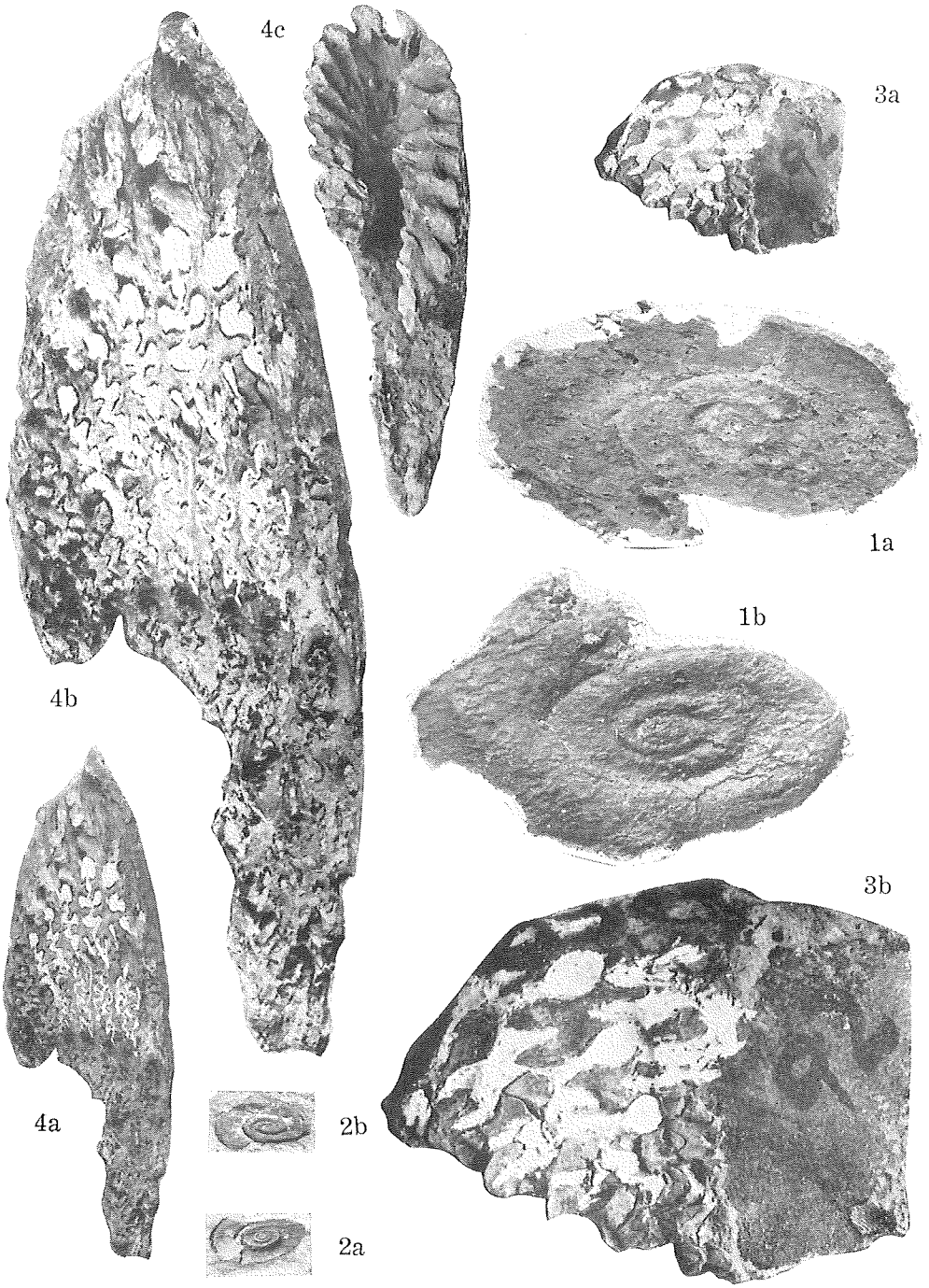
Plate 23

Figs. 1a–1b. ? *Prolecanites* sp. indet. *α*. Natural size. 1a, one of the specimens as is preserved in the rock, the matrix being painted white to show the outline. 1b, a gutta-percha negative of the former to restore the relief of the species.

Figs. 2a–2b. ? *Prolecanites* sp. indet. *β*. Natural size. Two parts of a specimen split apart along the axial plane. 2a, concave half. 2b, convex half.

Figs. 3a–3b. ? *Medlicottia* sp. 3a, natual size. 3b, twice natural size to show suture-lines somewhat more clearly.

Figs. 4a–4c. *Hanieloceras intermedium* (WANNER). 4a and 4b, lateral views of the specimen in natural and double sizes: characteristic suture-lines are shown. 4c, an oblique view of the specimen to show the dorsal side of the whorl.



HAYASAKA : Younger Paleozoic Cephalopods KUMANO photo