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# Family Puzosiidae from Hokkaido and Saghalien: Studies on the Cretaceous Ammonoidea from Hokkaido and Saghalien-V

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## Family Puzosiidae from Hokkaido and Saghalien

## (Studies on the Cretaceous Ammonoidea from Hokkaido and Saghalien-V)

By

#### Tatsuro MATSUMOTO

#### Introduction

There are a number of forms referable to the Desmocerataceae in the Cretaceous deposits of Hokkaido and Saghalien. They are grouped in four families, Desmoceratidae, Puzosiidae, Kossmaticeratidae and Pachydiscidae. Some of the important members of the first and last groups have been described in my recent paper (Appendix *in* T.M. (Editor) 1954). I treat here the second group.

Although it would be desirable to give a definition of the "Family Puzosiidae", there are certain unsettled questions relating to the extent and status of that group, so that I shall not discuss the matter at length here. However we have a series of forms which constitute a fairly easily recognizable natural group. The main purpose of this paper is to describe them systematically. In connexion with the description of our material some necessary remarks on foreign specimens will be included. In a concluding chapter I shall give my preliminary view on the "family".

The material which I have studied is mainly my own collection which was obtained in connexion with my stratigraphical work. The specimens are preserved partly in the Geological Institute, University of Tokyo (GT.) and partly in the Department of Geology, Kyushu University (GK.). As to the localities, horizons and stratigraphical problems readers are requested to refer to the previous papers (T.M. 1942-43 and also T.M. (Editor) 1954). I have fortunately been able to examine fully the original material of Jimbo (1894), Yabe (1909) and Kawada (1929) in the University of Tokyo. Some of the collections in the Department of Geology & Mineralogy, Hokkaido University and in Hokkaido Mineral Resources Survey ('Chikashigen-Chosajo'), Sapporo have also been examined. After I had prepared a draft of this paper and photographs of our specimens I visited London (1953-54) and had an opportunity to observe specimens which are preserved in the British Museum (Natural History), Geological Survey & Museum of Great Britain and Mr. Wright's collection.

#### **Systematic Description**

Order Ammonoidea
Superfamily Desmocerataceae
Family Puzosiidae Spath, 1922
Genus Puzosia Bayle, 1878

Type species: Ammonites subplanulatus Schlüter, 1871 (=Ammonites planulatus Bayle, 1878, non Sowerby, 1827).

Generic Diagnosis: Discoidal and rather evolute shell, consisting of many whorls which are compressed and elliptical in cross section and have an arched venter. Umbilicus of moderate size (30-40% of diameter) surrounded by a perpendicular wall with a subangular umbilical shoulder. Periodic, more or less flexiradiate, constrictions showing a forward projection on crossing venter. The ventral part of the whorls is ornamented with subcostae or fine costae which run nearly parallel to constrictions. The inner part of the flanks is almost smooth. Suture-lines in early stage of growth are similar to those of immature Melchiorites and in later stage of growth have a large and asymmetrically trifid L, unusually small U1, oblique or recurved U2 and remarkably descending elements of subdivided U3 (=S).

Remarks: The generic name was proposed by Bayle (1878, explanation of pls. x1v and x1vi) without description of diagnosis. Of the three species figured by Bayle as Puzosia, planulata was selected by H. Douvillé (1879, p. 91) as type. Bayle's figure of "planulata" shows that he interpreted that species too widely and in fact his figure represents a species previously described by Schlüter (1871, p. 4, pl. ii, figs. 5-7) as Ammonites subplanulatus. There is therefore a case for regarding planulatus Sowerby as debarred from selection as type species on the grounds that it was not one of Bayle's syntypes, but the question requires a decision by the International Commission on Zoological Nomenclature\*. For the time being I follow Dr. Spath's interpretation (1923, p. 42).

The genus varies to some extent in compression and involution of whorls and also in curvature and strength of the constrictions; the features vary with growth and are modified by condition of preservation. Therefore careful comparison at each growth-stage is necessary for the precise specific identification, while in too many cases only small, presumably immature specimens have been treated. However in the present state of our knowledge the genus seems to be divided into two subgroups, which are defined here as subgenera.

Subgenus Puzosia (s.s.)

*Diagnosis*: The outer whorl of the full-grown stage is essentially similar to the inner whorls but with obsolescent ornamentation.

<sup>\*</sup> Mr. C. W. WRIGHT proposes to refer the question to the Commission (personal communication, May, 1953).

#### Subgenus Anapuzosia, nov.

(ex Матsuмото, 1938, MS. nom. nud.)

Type species: Puzosia buenaventura Anderson, 1938.

*Diagnosis*: The adult body chamber is ornamented with periodic, flared or tuberculated, strong ribs of little or no flexuosity.

About a half century ago Professor Jacob, who examined carefully the change of characters at different growth-stages, described some interesting specimens with a peculiar ornamentation on the large adult body chamber under the specific name Puzosia mayoriana (JACOB, 1908, p. 38, pl. vi, figs. 1-4) and remarked that Puzosia planulata from Basses-Alpes, which is as large as his mayoriana, never shows such a strong ornamentation. Puzosia subplanulata (Schlüter), the type species of Puzosia, is represented also by fairly large specimens, one of which exceeds over 300mm, in diameter (Schlüter, 1871, p. 5). Puzosia odiensis Kossmat, which is closely allied to P. subplanulata, reaches again to a very large size, being 285 mm. in one example. However neither author observed in these large specimens of Puzosia the particular ornament of Jacob's mayoriana. Fortunately I have been able to study a large specimen of Puzosia from the Cenomanian of England, about 20cm, indiameter (in GRIMSDALE Coll. Brit. Mus. (Nat. Hist.), without reg. no. but with GRIMSDALE'S no. 1551). Although it is water worn and still septate near its preserved last part, it shows normal ribbing of subplanulata-type on the venter and there is no trace of periodic, flared ribs. Our four species of Puzosia, described below, includes fairly large specimens of 200mm. or over in diameters but they never show strong periodic ribs, while some of our Puzosiids of later date, described in later pages under Jimboiceras, do have that peculiar ornament on the adult body chmber. Unfortunately I have failed to discover unmistakable examples of Anapuzosia from Hokkaido and Saghalien. However in the Albian (Upper Horsetown group) of California there is another interesting example of Anapuzosia, P. buenaventura Anderson (1938, p. 185, pl. 41, figs. 1, 2;? pl. 40, fig. 3), whose large outer whorl, about 160 mm. in diameter, has strong periodic ribs, although without the pripheral tubercles of Jacob's mayoriana. I designate here P. buenaventura Anderson as the type species of Anapuzosia, since the specimens of Jacob's mayoriana are nomenclatorially doubtful.\*

<sup>\*</sup> Recent authors in France (FABRE, 1940; BREISTROFFER 1936, 1947) seem to have made it clear that d'Orbigny's type of mayoriana came from the Cenomanian and the species could range down to the Albian, while Jacob's precise stratigraphic work (1907, 1908) tells us that his P. mayoriana is rather common in the Lower to Middle Albian and is replaced by P. planulata-subplanulata in the Upper Albian and Cenomanian. Jacob recorded the occurrence of his large mayoriana in the dentatus-zone. Breistroffer (1936, in Besaire) regarded the small specimen of Jacob's mayoriana (1908, pl. vi, fig. 1) as a variety (bonarellii) of Puzosia quenstedti Parona & Bonarellii. Thus the question remains whether Jacob's large mayoriana is identical with Ammonites mayoriana d'Orbigny, Puzosia quenstedti Parona & Bonarelli or otherwise.

Thus the distinctness of *Anapuzosia* from *Puzosia* (s. s.) is justified as far as the well preserved specimens are concerned. However the inner whorls of the two groups are essentially similar and the special ornament of *Anapuzosia* did not affect the immature shell.

There my be some distinction even in the immature shells, but I have failed to find good criteria. Prof. Jacob and other authors remarked that *P. mayoriana* is less flattened than *P. planulata*(-subplanulata) and in the former the lateral lobe (L) is regularly trifid and somewhat deeper than E while in the latter it is distinctly asymmetric and much deeper than E. *P. buenaventura* Anderson is also round whorled and has the suture of 'hoffmani-type'.

The whorl shape however changes with growth and in different species. For instance I fortunately had an opportunity to observe a number of English specimens belonging to P. sharpei Spath, which is said by many authors fairly similar to P. mayoriana (d'Orbigny). In this species the whorl is as high as broad and rounded in section at diameters over 50mm, but is sometimes higher than broad and rather flattened at diameters below 40mm or so. (Jacob's immature specimen 'mayoriana' (1908, pl. vi, fig. la, b) belongs rather to the latter category.) Indeed P. sharpei might belong to Anapuzosia, but the largest specimen hitherto known is the one figured by Spath (1923, pl. i, fig. 12a, b) with a diameter of 83 mm., so that we cannot decide whether it belongs to Puzosia (s.s.) or Anapuzosia. Meanwhile P. odiensis Kossmat, which is an example of Puzosia (s.s.) defined above, has somewhat inflated flanks as compared with P. subplanulata and P. planulata. The suture seems more reliable than whorl shape but in the smaller immature specimens there is no essential difference between the two subgroups. The depth, width and curvature of the constriction may be useful for specific distinction but not always so in subgeneric separation.

Thus most smaller or immature specimens are in practice hardly separable into the two subgroups. However the peculiar character in the outer whorl is, as explained above, more than specific. Therefore the subgeneric sparation is, in my opinion, appropriate at least for the time being. Anyhow it is necessary to search for better specimens so that the character at each growth-stage may be clarified in every species.

Distribution: There are four new syecies of Puzosia (s.s.) in the Cretaceous of Hokkaido and Saghalien. One of them occurs also in India and other provinces. These species indicate that the stratigraphic range of the genus is very long both in the Japanese province and in India, that is Neomiyakoan, Paleogyliakian and Neogyliakian, namely Albian, Cenomanian and Turonian. The geographical distribution of Puzosia is also world wide. In Europe the genus has been known in Albian (mainly Middle and Upper Albian) and Cenomanian, but in my opinion there are a few Turonian species which are referable to this genus, as will be discussed below.

No example of *Anapuzosia* has been discovered in Hokkaido and Saghalien. In Europe and California it begins to appear from the Lower Albian. The upper limit of its range is still uncertain.

Subgenus *Puzosia* (s. s.)

Puzosia subcorbarica, sp. nov.
(ex Yabe, 1927 MS. nom. nud.)
Pl. 9, fig. 1 a, b; Pl. 12, fig. 1.

Material: Holotype, GT. I-370 (H. Yabe's Coll.) from Ikushumbets gorge, Lower Ammonite Beds of Yabe (main part of the Middle Yezo Group in Matsumoto's revision) somewhat below the Mikasa Sandstone. Paratypes 1-3, GT. I-671 and GT. I-672 from the same locality (Ik-6-2) as the holotype (T. M. Coll.) and GT. I-2632 from locality N327b, zone Kz-Mh in the Naibuchi Valley, South Saghalien (T. M. Coll.).

Other comparable specimens of rather poor preservation are GT. I-2631 from loc. I-69-2, zone Kv (a large fragment); GT. I-2628, loc. I-205p derived from Kv; GT. I-2629, 2630, loc. I-69-1, Kv in the Aikawa Valley, South Saghalien (T.M. Coll.) and GK. H 1222 from loc. Y181p, bed IIb2 (or IIb1) in the Shiyubari Valley, Ishikari Province, Hokkaido (T.M. Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT. I-370	173.5			59.0 (34%)
" "	150.5	63.1	43.5 (0.69)	48.8 (31.4%)
GT. I-2632	183.0	81.2	2410 (051)	58.7 (32%)

Specific diagnosis: Species of Puzosia characterized by highly compressed outer whorls which have flattened, nearly parallel flanks and rapid growth in height. External half of whorls ornamented with numerous, narrow and sharp subcostae, while the internal part of the flanks is nearly smooth, except for faint flexiradiate striae extended from some of the external subcostae. Periodic constrictions gently sigmoidal and with a considerable forward projection on the ventral area.

Remarks: The frequency of the constriction varies with age and individuals. In some there are only 4 or 5, in others 6 in one volution.

A small specimen with a diameter of 44.0 mm, which came from the same bed as the holotype, certainly represents an immature stage of the species. This has sharp subcostae on the ventral half of the whorl. In this stage the typical *Puzosia*-type pattern is not manifested in the suture-line and it is similar to that illustrated suture-line of *Anapuzosia mayoriana* (d'Orbigny) (Jacob, 1908, p. 25 text fig. 13; Sarasin, 1898, p. 797, text fig. 20), which also belongs to an immature stage and resembles that of *Melchiorites*. The adult shell of the present species has a characteristic suture-line with a large and asymmetrically trifid L, curved U2 and remarkably descending elements of subdivided U3.

The present species is closely allied to *Puzosia takei* Popovici-Hatzeg (1899, p. 12, pl. ii, fig. 2) from the Lower Cenomanian of Rumania, but seems to be distinguished by less frequent constrictions, a little wider umbilicus and somewhat broader whorl. However exact comparisen is difficult as the Rumanian specimen is secondarily deformed.

Puzosia compressa Kossmat (1898, p. 119, pl. xviii, fig. 4) (=Ammonites durga Stoliczka, 1865, p. 143, pl. lxxi, figs. 6, 7 only) from the Lower Utatur group of India is somewhat similar to the present species in the compressed whorl and slight subcostation but is distinguished by its more compressed form, wider umbilicus, slower growth of whorls and more strongly projected subcostae.

Although the specific name, *P. subcorbarica* which was given by Yabe (1927, p. 41(15), listed only), seems to suggest some alliance with *Parapuzosia corbarica* (Grossouvre, 1894), of a higher horizon, there is no close relation between the two species. Shimizu (1935, p. 176) probably wished to reject such a confusing name and intended to give another name, *P. tenuis* Shimizu, but that is also invalid because the mere mention of its resemblance to *P. takei* Popovici-Hatzeg is no valid description.\* As I have examined Yabe's original specimen and not had access to Shimizu's collection, I adopt Yabe's MS. name which has become already familiar to Japanese geologists. *Occurrence*: The holotype and paratypes are from the upper part of the Neomiyakoan and Infragyliakian of Hokkaido and Saghalien, approximately equivalent to the Upper Albian. Comparable specimens are from other parts of the Neomiyakoan.

*Material*: Holotype, a large shell whose outer and inner whorls have been detached: GK. H 1225 from locality Y420c, bed IIn (lower part of the Saku formation) in the Shiyubari Valley, Ishikari Province, Hokkaido. Paratype, GK. H 1224 from IIp, lower part of the Saku formation in the Shiyubari Valley. (T. M. Coll.)

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GK. H 1225 (at mid. age)	126.3	50.0	38.7 (0.775)	43.3 (34%)
Kossmat, 1898, pl. xxii, fig. 2	80.0	32.0	23.0 (0.72)	26.0 (32%)
Сноffat, 1898, pl. xvii,	125.0	57.0	40(?)(0.70)	34.0 (27%)
fig. 2. xviii. fig. 1				

Specific diagnosis: A species of *Puzosia* characterized by relatively compressed whorls, narrowly arched venter, numerous, regular, fine and narrow costae on the external half and the prorsiradiate course on sides and conspicuous forward bend on the periphery of the costae and the constrictions.

<sup>\*</sup> The specific name *Puzosia tenuis* is now used for a different species from the Albian of Angola (Haas, 1942).

Remarks: The specimens at my disposal were once listed as a variety of Puzosia gaudama (Forbes) (T.M. 1942-43, p. 233 and elsewhere). Indeed they are so closely allied to those described under that specific name by Kossmat (1898, p. 118, pl. xvi, figs. 2a, b, 3) that their specific identity is undoubted. Minor differences between ours and Kossmat's are found in the proportion between height and breadth of whorls and in the width of umbilicus in proportion to diameter. The Japanese form is slightly broader and also slightly more widely umbilicate than the Indian one. The two geographically separated forms should be distinguished subspecifically since these minor but constant differences are found in the characteristic features of the species. The Japanese holotype is far larger than the illustrated specimen of Kossmat and is nearly smooth in the outermost part. The fact can be regarded as a difference in growth-stage. Kossmat himself mentioned the presence of a large shell in India.

The question remains whether or not Kossmat's illustrated specimen is specifically identical with Forbes' original one. Although I have not yet observed the former, I fortunately had quite recently an opportunity of examining the latter, owing to the kindness of the authorities of the British Museum (Natural History). The specimen (BM. 10487) is unfortunately poorly preserved and its outer whorl is so deformed that the curvature of its ribs and constrictions are apparently quite different between the side illustrated and the opposite one. (The ribs and constrictions on the unillustrated side have only gentle forward curvature.) As its ribs are not so narrow nor so dense as those of the clearly illustrated specimen of Kossmar, the two must be specifically separated. It is rather similar to "Puzosia" indopacifica Kossmat, as Dr. Spath (1921, p. 47) has already pointed out, but its deformed condition, as well as somewhat worn surface, prevents us from precise identification. At any rate Kossmat's specimens should be transferred from P. gaudama to P. orientale and are here called Puzosia orientale kossmati, subsp. nov., on the grounds of the above mentioned difference of subspecific value. The holotype of the subspecies is, of course, the illustrated one: Kossmat, 1898, p. 118 (183), pl. xvi (xxii), figs. 2a, b.

Similarly *Puzosia* cf. *gaudama* (Forbes) from the Turonian of Portugal (Choffat, 1898, p. 82, pl. xvii, figs. 2, 2; pl. xviii, fig. 1) may be another example of *P. orientale kossmati*. On the other hand "*Puzosia gaudama* (Forbes)" from Madagascar (Boule, Lemoine & Thévenin, 1906-7, pp. 20, 21, pl. iv, figs. 4, 4a, 5, 6) seems to me composite and needs further study. *Desmoceras gaudama* Yokoyama, 1890 (p. 184, pl. xviii, fig. 14; pl. xix, fig. 5a, b) belongs to a quite different species, as will be described below. (See *Neopuzosia japonica* (Spath).)

Puzosia orientale is allied to Puzosia subcorbarica in its compressed whorl and fine subcostation, but is distinguished by the more prominent forward bend of the costae and constrictions. Probably the former is a descendant of the latter.

Puzosia miilleri de Grossouvre, 1894 (=Ammonites hernensis Schlüter, 1872, non 1867) from the Upper Turonian of Europe, which was regarded as identical with Kossmat's 'P. gaudama' by several authors, including Kossmat himself, is indeed closely allied to the inner whorls of the present species but is still more compressed (b/h being 0.52, 0.58 or 0.64 as compared with 0.77 in typical orientale and 0.70 or 0.72 in orientale kossmati) and has elliptical, instead of rather convergent, whorls, so that I regard it a distinct species, though allied to the present one. Contary to the views of the above authors Spath (1922, p. 128) not only admit the specific distinctness but furthermore placed it in his Tragodesmoceras. I cannot agree with this generic reference because of a considerable morphological difference from the type species of that genus, whereas a close affinity to P. orientale and P. subcorbarica strongly suggests us the reference to Puzosia. Mr. C. W. Wright kindly showed me a specimen in his collection from the Chalk Rock (Upper Turonian) of England which is also closely allied to Puzasia orientale and P. mülleri. Thus Puzosia seems to have survived up to Turonian and is a persistent genus.

Occurrence: Lower part of the Neogyliakian in Hokkaido, Japan, approximately Lower Turonian. *P. orientale kossmati* is reported from the Trichinopoly group of India, without exact statement of its upper or lower part. Choffat's comparable specimen from Portugal came from Lower Turonian.

## Puzosia orientale intermedia Kossmat Pl. 12, figs. 2 and 3.

1898. Puzosia gaudama var. intermedia Kossmat, p. 116 (181), pl. xvii (xxiii), figs. 3a-c.

*Material*: GK. H 1223 from locality Y137, bed IIn, Shiyubari Valley, Ishikari Province (T.M. Coll.).

Subspecific diagnosis: Closely allied to the typical form of the species but dissimilar in the frequent development of flexuous long ribs, besides numerous short external ones, after the middle growth-stage.

Remarks: The Japanese specimen is very similar to the Indian form described by Kossmat, but is somewhat larger and has less flexuous long ribs. The feature can be ignored as a minor change with growth-ages and individuals.

The development of longer ribs might suggest Austiniceras, but the large shell from Japan does not show the difference in strength of major and minor ribs, On the other hand this form is rather akin to Mesopuzosia yubarense (Jimbo) emended below, in which longer ribs are more frequently developed but are as narrow as the shorter ribs. Probably the present from represents a passage stage from Puzosia orientale (s. s.) to Mesopuzosia yubarense. From this assumption the subspecific distinctness can be justified.

Occurrence: Kossmat's original specimen was reported from the Lower Trichinopoly group of South India. Our single specimen came from the lower part of the Neo-

gyliakian in Hokkaido, just corresponding in age to the Indian one.

Puzosia nipponica, sp. nov.Pl. 10, fig. 1; Pl. 11, fig. la, b, c.

Material: Holotype, GT. I-3191 from locality T547p, bed IIb in the Abeshinai-Saku area, Teshio Province, Hokkaido (T. Matsumoto Coll.). Other examples from the same area are GT. I-3188 from locality T549r, bed IIb; GT. I-3198, loc. T861e, IIb (lower part); GT. I-3199, loc. T25, IIb; GT. I-3200, loc. T230p, IIb; GT. I-3229, loc. T652a, IIb. GK. H 1221 from locality Y141, bed IIk in the Shiyubari Valley, Ishikari Province, Hokkaido (T. M. Coll.). GT. I-2638, loc. N38, zone Mho-Mh<sub>1</sub>; GT. I-2637, loc. N69-70p, zone Mho(?); GT. I-2636, loc. N69-70p, Mho(?); GT. I-2635, loc. I34 (Aikawa), zone Mho; GT. I-3766, loc. N308g, horizon Kz-Mh; GT. I-3767, loc. IIIc, zone Mho, all at or near the basal part of the Miho group in the Naibuchi Valley and adjacent area in South Saghalien (T. M. Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT. I-3191	<b>24</b> 3.0	100.0	63.0 (?) (0.63)	75.0 (30.8%)
GT. I-3189		82.5	54.0 (0.65)	
GK. H 1221		83.1	51.7  (0.62)	

Specific diagnosis: Species of Puzosia characterized by fairly large size, rapid growth of whorl height, gentle flexuosity of constrictions, ribbing of moderate strength and the occasional development of somewhat longer ribs in mature stage. Costae and constrictions show a distinct forward bend on the venter.

Description: Shell discoidal, large when full grown; whorls rapid in growth, much compressed, with a fairly narrowly arched venter and with only slightly inflated flanks. The width of umbilicus slightly exceeds 30% of a diameter. Overlapping of whorls nearly a half.

The immature shell is ornamented with numerous fine subcostae on its external half. In the adult stage the ornamentation becomes somewhat stronger, the costae being narrow and sharp of equal breadth on the ventral area but of unequal length. The longer ribs reach more or less nearly to the umbilical margin. Constrictions fairly frequent, shallow and broad. Constrictions and ribs gently flexiradiate, showing a distinct forward projection on the venter.

The large outermost whorl is nearly smooth, the ribs being obsolete.

Suture-lines are of typical Puzosia-type.

Remarks: The present species is fairly similar to Puzosia subplanulata (Schlüter) from the Cenomanian of Europe. It is however somewhat more compressed, more rapid in growth of whorls and characterized by the development of longer ribs in later stages. In this respect it is somewhat nearer to a typical from of a new genus (Mesopuzosia pacifica described below) of somewhat later date.

The longer ribs remind us the major ribs of *Austiniceras* but they are not so broad (strong) nor so frequent as in that genus, while in the large outermost whorl the smoothing of ornament takes place as in typical *Puzosia*.

Thus the species is interesting in that it foreshadows *Austiniceras* on one hand and another allied new genus (*Mesopuzosia* described below) on the other. As its new character is not so much stabilized as in either of the two genera, it should be better included in *Puzosia*.

Puzosia odiensis Kossmat\* (1898, p. 112, pl. xvi figs. 5a, b, 4, pl. xviii, fig. 1a, b), even the larger illustrated specimen of which is said to be the inner whorls of a very large form, is closely akin to the present form, but is somewhat broader and more inflated. Moreover we do not find in Kossmat's description mention of such long ribs as are observed in the later whorls of Puzosia nipponica.

Occurrence: Zone Mho of the Naibuchi Valley and adjacent area in South Saghalien, common; Bed IIb (from its base to middle) of the Abeshinai Valley and adjacent area in Teshio Province, Hokkaido; Bed IIk of the Shiyubari Valley in Ishikari Province, Hokkaido. Summarizing the above, the species is common in the Paleogyliakian (approximately Cenomanian) of Hokkaido and South Saghalien.

A single specimen, which is similar but not precisely identical to the present species, was found at locality N308g, zone Kz-Mh of the Naibuchi Valley.

*Material*: Holotype, GT. I-2639 from locality N309d, zone Mho, Naibuchi Valley, South Saghalien. Its outer whorl is partly broken away and the figures are of the same individual. GT. I-2640, loc. N74b, zone Mho; Several other specimens from the Abeshinai Valley, Teshio Province are also before me: GT. I-3189, loc. T7b, top of bed IIb; GT. I-3190, loc. T28p, bed IIb-c ( $\beta$ ); GT. I-3197, loc. T27-28p, IIb-c ( $\beta$ ), etc. (T. M. Coll.)

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT. I-2639	Ca 200	80	52 (0.65)	65 (32.5%)

Description: Similar to Puzosia nipponica but the longer ribs are more frequent, more flexuous and appears in earlier growth-stage than in that species.

Remarks: This species might be referred to Mesopuzosia described below, but from its quite intimate relation to Puzosia nipponica and its longer ribs being still infrequent and indistinct near the umbilical margin as compared with those of typical Mesopuzosia, it is here provisionally included in Puzosia. Anyhow it is an interesting intermediate form between typical Puzosia and Mesopuzosia.

<sup>\*</sup> In agreement with Dr. Spath I think it better to regard Kossmat's form as an independent species from the European one. Anyhow it has more affinity to *P. subplanulata* (Schlüter) than to *P. planulata* (Sowerby).

Occurrence: Zone Mho in the Naibuchi Valley, South Saghalien and the uppermost part of bed IIb, IIb-c  $(\beta)$  and IIc  $(\alpha)$  of the Abeshinai-Saku area, Teshio Province, Hokkaido. Thus the occurrence of this intermediate species is in the upper half of the Paleogyliakian.

#### Genus Mesopuzosia, nov.

(ex Matsumoto, 1938, MS. nom. nud.)

Type species: Mesopuzosia pacifica, sp. nov.

Generic diagnosis: Similar to Puzosia in shell form and suture-line but with much better developed costae. In the middle and adult stages of growth many of the costae (including both longer and some shorter ones) extend below the middle of the flanks and are of equal strength on the outer half of whorls. Although there are longer and shorter ribs, the differentiation to broader (or stronger) and narrower ones is not found as in Parapuzosia (s. s.) or in Austiniceras and the costation is relatively regular. The shell often attains a huge size and in the last whorl the ornamentation disappears.

Remarks: Besides the type species Moesopuzosia indopacifica (Kossmat) and M. yubarense (Jimbo) emended below are the examples of this genus. There is also another new species (M. densicostata). These species are similar to certain species of Puzosia in their immature stage and there are somewhat intermediate forms. Thus Puzosia orientale Matsumoto, with subsp. intermedia Kossmat, is apparently a passage form between Puzosia subcorbarica (Yabe MS.) Matsumoto and Mesopuzosia yubarense (Jimbo) and Puzosia nipponica Matsumoto and its ally, P. ambigua Matsumoto, shows intermediate characters between Puzosia subplanulata (Schlüter) or P. odiensis Kossmat and Mesopuzosia indopacifica (Kossmat) or M. pacifica (described below).

Mesopuzosia occurs abundantly in the Neogyliakian or Turonian and less commonly in the Urakawan or Coniacirn plus Santonian of Indo-Pacific realm, while Puzosia ranges from Albian to Turonian. Mesopuzosia can thus be regarded as a direct descendant of true Puzosia.

To make the distinction of this genus from *Parapuzosia* and *Austiniceras* clearer I include here a definition and remarks of those two genera, although there are no examples of them in our collection.

#### Genus Parapuzosia Nowak, 1913

Type species: Sonneratia daubreei de Grossouvre, 1894.

Generic disgnosis: Similar to Puzosia in general character and distinguished by the unmistakable separation, at least after the middle growth-stage, of the costae into two different types; they consist of numerous, external, short ones and less numerous, lateral, long and broad ones which reach, or nearly reach, the

umbilical margin. Often the latter branch into two or three of the former on the ventral area. The ribs are nearly rectiradiate on the side and rather suddenly, but sometimes rather gradually, curved forward at the ventrolateral edge, forming ventral projection. On the huge last whorl the major lateral ribs persist as broad, coarse, widely separated ones but the external ribs are obsolete.

#### Genus Austiniceras, Spath, 1922

Type species: Ammonites austeni Sharpe, 1855.

Generic diagnosis: Similar to Puzosia in general character but has on the large outer whorl frequent major ribs which are sigmoidal or arcuate and stronger on the sides than the numerous external minor ones.

Ambigious points in Nowak's proposal of *Parapuzosia* (1913, p. 363) were pointed out by Spath (1922, p. 120), who gave no clear generic diagnosis but listed the species to be included and designated a Santonian form as type species.

Of the species hitherto assigned to *Parapuzosia* by Spath and subsequent authors there are more than two groups of forms ranging through a number of stages of Neocretaceous. Taking into consideration the rich material from the Upper Cretaceous of Hokkaido and Saghalien as well as the hitherto known foreign species, I am obliged to take notice of the diversities in the ornamentation of Puzosiids. "*Parapuzosia* (s.1)" seems to have been distinguished from *Puzosia* chiefly by the relatively well developed costation. However there is more than one mode of development in the ornamentation and here *Mesopuzosia* and *Neopuzosia* (defined below) are separated from *Parapuzosia* and its allies.

The examples of *Parapuzosia* in my definition are, besides the type species, *P. corbarica* (Grossouvre), *P. tannenbergensis* (Fritsch & Schloenbach) and *P. leptophylla* (Sharpe). Probably several species from America (Miller & Youngquist, 1946; Scott & Moore, 1928) and possibly "*Pachydiscus*" seppenradensis Landois\* may be the gigantic examples of this genus.

Development of the major ribs in addition to the external costae is found also on the outer whorl of Austiniceras and that genus may be intimately related to Parapuzosia. One criterion for distinguishing the type species of the two genera is that Austiniceras austeni (Sharpe) has a convergent whorl section while Parapuzosia daubreei (de Grossouvre) has a semioval or rather elliptical one. However there can be a certain range of variability in the breadth of venter and shape of whorl-section within the genus, as in the case of Puzosia and Mesopuzosia. Spath (1922, p. 127) proposed the genus Austiniceras "for one of the true puzosids still persisting

<sup>\*</sup> Its suture is of the Puzosia-type (LANDOIS, 1895, pls. i, ii).

in the Turonian, specializing in size," selecting *Amm. austeni* Sharpe as type species. The statement is not definitive but seems to suggest that *Austiniceras* is nearer to *Puzosia* than *Parapuzosia*.

Indeed one of the characteristic features of A. austeni is the unmistakable sigmoidal curvature of the costae especially on the lateral sides of the outer whorl, apart from the forward projection of ventral ribs. However certain species of "Austiniceras," such as A. dibleyi Spath and A. mobergi (de Grossouvre), have gently arcuate rather than sigmoidal ribs on the lateral sides, while in "Parapuzosia" there is also some variability in the course of ribs. Thus the two genera approach each other in some species and specimens in which the outer whorls are missing are hardly distinguishable.

In these circumstonces it seems me difficult to decide now whether the distinction of Austiniceras and Parapuzosia is generic or subgeneric. Someone who is more acquainted with the European material may settle the status. Here I treat them quite provisionally as separate genera, following the current opinion in recent publications. At any rate Parapuzosia and Austiniceras are closely allied to each other and the former is probably a direct descendant from the latter.

Our *Mesopuzosia* is allied to *Austiniceras* but does not show much difference in strength between longer and shorter ribs and tends to be smooth on the last whorl. Probably the two genera developed in parallel from *Puzosia*.

In some inner whorls and also in some weathered outer whorls *Mesopuzosia* is often hardly distinguishable from *Austiniceras*. Furthermore there are forms, like *Austiniceras mobergi* (de Grossouvre) (=*Amm. austeni* in Schlüter, 1872, p. 38, pl. xi, fig. 11), in which differention into major and minor ribs is less distinct than in the type species and thus *Austiniceras* actually approaches *Mesopuzosia*.

Among the Japanese ammonites hitherto obtained, I have not yet identified any specimens referable to *Parapuzosia* or to *Austiniceras* here defined. Those which have been preliminarily identified with *Parapuzosia* are to be transferred to *Mesopuzosia* or *Neopuzosia*. Although Shimizu (1935) listed a species of *Austiniceras*, *A. minimum* Shimizu MS. (nom. nud.), from the Cretaceous of the Naibuchi Valley, South Saghalien, the full description was not published. (It is doubtful if such a small specimen as is suggested by his specific name could be precisely identified.)

From the character of the differentiation of ribs and the rectiradiate, coarse, lateral ornament *Parapuzosia* has been often misidentified or even regarded as genetically related to *Pachydiscus* (s.s.) (i.e. the *gollevillensis-neubergicus* group). As I have stated (1947, 1951), *Pachydiscus* has nothing with the Puzosiidae, the two being an example of small scale homoeomorphy within the Desmocerataceae. One of the evidences, which are basel upon continuous series of forms obtained by a good deal of field works, is the character of suture-lines. Even in the compressed forms of *Pachydiscus* (s.s.) the suture is essentially similar to that in depressed

Pachydiscids, as for instance Anapachydiscus. Similarly the strongly constricted Pachydiscids, Canadoceras and closely allied Patagiosites, can be distinguished from Parapuzosia by the suture as well as the umbilical tubercles (which however disappear in the outer whorl of those genera). Examining the original specimens I have noticed that "Parapuzosia" griffithi (Sharpe) is a Patagiosites and "Parapuzosia" icenica (Sharpe) is an inner whorl of Pachydiscus or P. (Neodesmoceras). Similarly "Parapuzosia" stobaei (Nilsson) (Moberg, 1885), which was regarded as a transitional form from Parapuzosia to Pachydiscus, is nothing but a Patagiosites, a smoothed out derivative from Canadoceras.

Parapuzosia thus revised occurs in Santonian and just above and below but never ranges up to Upper Campanian or Maestrichtian, whereas Austiniceras comes from Cenomanian and Turonian.

Mesopuzosia pacifica, sp. nov.

Pl. 14, fig. 1a, b; Pl. 15, figs. 1a, b, 2a, b; Pl. 16, figs. 1a, b, 2a, b, 3a, b; Text fig. 2.

*Material*: Holotype, GK. H 1257 from locality Y 216 p<sub>1</sub> in the Shiyubari Valley, Ishikari Province, Hokkaido (T. Matsumoto Coll.). Besides the holotype there are a number of specimens. Examples from the same valley (locality number with prefix Y) (T.M. Coll.) and adjacent Oyubari area (loc. no. with Oy) (S. NAGAO & A. Osanai Coll.) are: GK. H. 1256a, b from loc. Y206 p<sub>1</sub>; GK. H 1265, loc. Y216 p<sub>1</sub>; GK. H1571, loc. Oy104; GK. H1244, loc. Y115 p<sub>1</sub>; GH. H1245, loc. Y216 p<sub>1</sub>; GK. H1246, loc. Y216 p<sub>1</sub>; GK. H1231, loc. Y130 d; GK. H1232, loc. Y137; GK. H1572, loc. Oy107A; GK. H1573, loc. Oy158; GK. H1574, loc. Oy167 b; GK. H1249, loc. Y225. All these came from the Saku formation and its equivalent in the western part of the Yubari Mountain Range, Ishikari Province, Hokkaido. From the same area was obtained GT. I-364 (MM7635), pebble of the Yubari (H. YABE Coll., labeled as Puzosia indopacifica), another example of the present species. Furthermore in the collection from the Shimo-Kanayama area on the eastern side of the Yubari Mountain Range, the Ikushumbets and Ashibets Vallies in Ishikari Province and the Abeshinai and Obirashibets Vallies in Teshio Province, Hokkaido and the Naibuchi Valley in South Saghalien there are a number of specimens which are referable to the same species. Their list is omitted here, except the two whose dimensions are recorded below: GT. I-3216 from locality T345 p<sub>3</sub>, bed IId (Saku formation) and GT. I-3217 from locality T42p, IId in the Abeshinai Valley (T.M. Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GK. H 1257	101.8	40.4	33.6 (0.83)	33.2 (32.6%)
		32.3	25.9 (0.80)	
		21.5	18.3 (0.81)	

GK. H 1571 (outer whorl excluded)	112.5	45.2	37.8 (0.83)	38.5 (34.2%)
GK. H 1573	45.3	17.0 12.5	14.8 (0.87) 11.0 (0.88)	16.0 (35.3%)
GK. H 1244	17.9	7.8	Ca 6.0 (0.89)	6.25 (34%)
GK. H 1245	69.25	27.4	22.0 (0.80)	23.1 (33%)
GK. H 1246		31.25 21.2	24.1 (0.77) 16.9 (0.79)	
GT. I-364	Ca 120	<b>44</b> .8 41.8 35.8	34.7 (0.77) 32.5 (0.78) 28.1 (0.785)	45.5 (38%?)
GT. I-3216	79.2	31.0 20.0	25.2 (0.81) 16.5 (0.825)	28.4 (36%)
GT. I-3217	72.7	28.8	23.0 (0.8)	

*Diagnosis*: Shell large in the full-grown stage, similar to *Puzosia* in general aspect of shell form, increasing rather slowly in size with growth, and periodically constricted, generally with 6 constrictions in one volution. Whorls fairly compressed with gently inflated flanks, moderately arched venter, subrounded umbilical shoulder and perpendicular umbilical wall.

The whorls in early middle age are provided with alternately long and short flexuous ribs. The ribs in later middle age are of moderate strength and coarseness, separated by interspaces nearly as wide as the ribs themselves, gently flexuous on the lateral sides, regular in size and distance, showing a moderately forward projection on the external half. The long ribs begin at the umbilical margin. The shorter ribs, less numerous than the longer ones, mostly begin a little below the middle of the flanks. Constrictions are only slightly flexuous on the lateral sides and gradually pass to the moderate projection on the venter. In the large adult stage the ribs are fairly strong but narrow, separated by a little wider interspaces. They show a gentle flexuosity on the lateral sides and a considerable forward projection on the ventral area. The very large outermost part is nearly smooth.

Suture-lines are of typical *Puzosia*-type, characterized after early middle-age by a large, asymmetricaly trifid, lateral lobe and strongly descending auxiliaries, and deeply and finely incised in later stages.

Remarks: There are a number of specimens of this species in the Cretaceous of Hokkaido and Saghalien. As they resemble Mesopuzosia indopacifica (Kossmat), I once referred them to that species in my previous stratigraphical papers (1938, 1942-43). However most of them have gently inflated flanks, while the Indian form is said by Kossmat to have flattened, parallel flanks. The proportion between breadth and height of the whorl is variable to some extent with age and individual. It ranges from 0.77 to 0.84 in the middle or adult stage of M. pacifica and, thus, on the average most of the Japanese specimens have always somewhat broader whorl than the type specimen of M. indopacifica (Kossmat) from India, although there is

apparently a form intermediate in this character. There is furthermore a difference in the curvature of ribs. The illustration and description of the Indian original specimen show ribs which are straight and somewhat oblique on the inner half of the flanks and bent rather abruptly forward at the ventrolateral part, while the typical example of the Japanese form shows rather gently flexuous curvature with a moderate ventral projection. Only a few specimens have somewhat stronger forward bend than the normal ones, but the character is not so remarkable as in the Indian form.

Thus in spite of the resemblance to *M. indopacifica* the distinction is still fairly clear and the Japanese specimens in question constitute a solid group, so that I have decided to treat them as a separate species for which the specific name *pacifica* is here introduced. This conclusion should be confirmed by further examination of the variation in the Indian species.

There is some variation in the frequency or coarseness or ribs. However a complete gradation is found and sometimes the rib density varies from one to another and in the same individual. There is rarely an abnormal form (GK. H1256b, Pl. 16, fig. 3a, b) in which a long rib on one side is continued as a short one on the other and the short one on the former is divided at the periphery into long and short ones on the latter.

The present species has intimate relation to *Puzosia odiensis* Kossmat and may be a derivative from that species, as has been remarked on above.

Occurrence: Typically in the Saku formation and its equivalent (the so-called Scaphites Bed) in the Shiyubari-Oyubari area and Shimokanayama area on both sides of the Yubari Mountain Range, Ishikari Province, Hokkaido. Specimens have also been found in and near the zonule of Reesidites minimum (Hayasaka & Fukada) in the Ikushumbets Valley, Ishikari Province, Hokkaido; "Scaphites Beds" of the Obirashibets area, Teshio Province; Commonly in Bed IId (Saku formation) and less frequently IIc  $(\alpha, \beta)$  of the Abeshinai-Saku area, Teshio Province, Hokkaido and zone Mh3 (and doubtfully zones Mh2 and Mh4) of the Naibuchi Valley, South Saghalien.

Summarizing the above the species occurs most commonly in the Neogyliakian (Turonian) and occaionally in the Paleourakawan (approximately Coniacian) of Hokkaido and Saghalien.

#### Mesopuzosia indopacifica (Kossmat)

1898. Puzosia indopacifica Kossmat, p. 117, pl. xvii, fig. 2a, b; pl. xviii, fig. 3.

1932. Puzosia (Parapuzosia) indopacifica Kossmat, Collignon, p. 18, pl. vi, figs. 1, 1a, 1b.

Material: (Examples in our material) GK. H1248a, b (adults) from locality Y207p<sub>2</sub>; GK. H1247 (immature) from loc. Y207p<sub>1</sub>; GK. H1250 (middle-aged) from loc. Y133; GK. H 1251 (middle-aged) from Y466, all these came from the Saku formation in the

Shiyubari Valley, Ishikari Province, Hokkaido (T.M. Coll.). GK. H 1572 from locality Oy158, equivalent of Saku formation in the Oyubari area, just adjacent to the Shiyubari area (S. Nagao & A. Osanai Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Kossmat's type (After Kossmat)	115	44.5 21	33 (0.74) 17 (0.81)	41 (36%)
GK. 1248a	Ca 100	36.5	26.5 (0.73)	32.5 (+) (32.5%)
	48.2	22.4	17.0 (0.76)	15.2 (31.5%
GK.H 1250	64.0	26.1	21.1 (0.81)	21.5 (?) (33-34%)
		20.0	16.0 (0.80)	
GK.H 1247	33.8	15.2	11.2 (0.73)	10.8 (32%)
GK.H 1572	82.5	34.0	24.0 (0.71)	26.4 (32%)
		12.5	11.0 (0.71)	
Collignon, 1932	184.0	80.0	60.0 (0.75)	50.0 (27%)

Diagnosis: Shell-form Puzosia-like, with a moderate growth of whorl-height, umbilicus of moderate width and about 1/2 involution. Whorls compressed with flattened and nearly parallel flanks, rather narrowly arched venter, subangular umbilical shoulder and low but perpendicular umbilical wall.

Whorls in the middle growth-age provided with numerous gently flexuous ribs, consisting generally of alternately longer and shorter ones. The long ribs start at or very near the umbilical margin, while the short ribs begin at the middle of the flanks or a little below. They are of equal strength and are arranged very regularly, separated by interspaces as wide as themselves. In the adult whorl ribs become coarser and run subradially (i.e. straight but slightly oblique to the strict radial direction) on the inner half of flanks and show a conspicuous forward projection on the external half of the whorl. Constrictions fairly frequent, 6 in one volution, running rather obliquely forward on flanks and show a distinct forward projection on the ventral area.

Remarks: Specimens which are certainly identical with the Kossmat's original Indian species have also been furnished from the Japanese Cretaceous, though not so abundantly as those referable to *Mesopuzosia pacifica* Matsumoto. The available material suggests, however, that the Japanese form is a little more narrowly umbilicate than the Indian type specimen.

"Puzosia (Parapuzosia) indopacifica Kossmat" from the Upper Cretaceous of Madagascar (Collignon, 1932, p. 18, pl. vi, fig. 1, 1a, 1b) is probably another example of this species, although its ribs look somewhat weaker than the ordinary one, being perhaps affected by a condition of presservation. It is rather narrowly umbilicate, but the size of umbilicus in proportion to a diameter generally decreases with growth in this species.

Kossmat (1898) regarded "Desmoceras gaudama (Forbes)" in Yokoyama (1890,

p. 184, pl. xviii, fig. 4; pl. xix, fig. 5) from Urakawa, Hokkaido as synonymous with his species. However this is not tenable and the specimens in question represent a quite different species, *Neopuzosia japanica* (Spath) described below, and its stratigraphic horizon is higher than that of *Mesopuzosia indopacifica* (Kossmat) in Japan. *Occurrence*: Saku formation of Hokkaido, i.e. Neogyliakian (approximately Turonian) of the Japanese Cretaceous; Upper Trichinopoly group (probably Coniacian) of India; 'Upper Cretaceous' of Madagascar.

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Mesopuzosia yubarense (JIMBO)
Pl. 13, figs. 3a, b, 4; Pl. 14, figs. 2, 3a, b.
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1894. Desmoceras yubarense JIMBO, p. 28, pl. i(xvii), fig. 6, 6a, 6b. 1909. Puzosia yezoense YABE, MS. nom. nud., p. 443, listed only.

Material: Holotype, Jimbo's single original specimen (GT. I-97), a small immature shell, came from a pebble of the Yubai River in Ishikari Province, Hokkaido. One of Yabe's specimens (GT. I-385) is labeled similarly. Two others in Yabe's collection (GT. I-365, I-366) are from the upper course of the Ikushumbets, Ishikari Province, Hokkaido. They are of moderate size. Subsequent collections (T.M.) contain several additional specimens, including larger ones, from the Neogyliakian of the Yubari Valley and Shimo-Kanayama area on both sides of the Yubari Mountain Range and the Paleourakawan and Neoyliakian of the Ikushumbets and Ashibets Vallies in Ishikari Province, Hokkaido. In the collection of Hokkaido University I saw two other specimens referable to the present species. They came from pebbles in the Obirashibets and the Nio-zawa, a tributary of the Abeshinai, Teshio Province, Hokkaido.

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT.I-97	42.1	18.8	12.9 (0.68)	11.0 (26 %)
GT.1-365	{82.0	34.0	22.0 (0.65)	27.0 (33 %)
	(	24.0	15.5 (0.66)	
GT.I-385	95.0	37.3	22.5 (0.60)	34.0 (35 %)

Diagnosis: Attains a large size, although the holotype is a small, immature shell. Whorls increasing rather rapidly, considerably compressed, with rather flattened and convergent flanks and a relatively narrowly arched venter. The maximum breadth is somewhat or a little below the middle of the whorl. Umbilcus of moderate size in the middle age but fairly narrow in younger stages, with gently rounded umbilical shoulder in early stages and more angular one in later stages of growth and provided with low, perpendicular, umbilical wall.

Below a diameter of 30mm, the ornamentation is very weak, especially so in the inner half of the flanks. Shell in the middle and adult ages is ornamenten with numerous ribs, close-set and separated by interspaces as narrow as or somewhat narrower than the ribs. There are longer and shorter ribs, the former predominant over the latter. The long ribs begin at the umbilical margin and the short ones somewhat below the middle of the flanks. Ribs show an abrupt and strong forward bend in the ventrolateral portion with a remarkable projection on the ventral area, while their sinuosity on the inner half of the flanks is very slight.

Constrictions and associated elevations are shallow and low, running nearly paralled to the ribs and are frequent only in the later middle age.

Shell in the later stage, of large size, is still provided with ribs of equal size but the last whorl is nearly smooth.

Remarks: This species was established by Jimbo (1894) on the basis of a single specimen. The specimen is an immature shell, the later part poorly preserved, and was collected in a pebble from the Yubari River in Hokkaido. There are two specimens (GT. I-365 and I-366) which were labeled and listed by H. Yabe as Puzosia yezoense Yabe MS. but unfortunately have not yet been described. These three specimens agree well with one another in essential characteristics and should be assigned to one and the same species, for which Jimbo's name must be adopted. Some difference between Jimbo's specimen and Yabe's ones is due to difference in growth-stage. Another specimen (GT. I-385) which was labeld by Yabe as Puzosia indopacifica Kossmat is also an example of the present species.

In the shell-form and ribbing the present species is akin to *Puzosia orientale* Matsumoto but is somewhat more compressed and provided with numerous longer ribs which are less flexuous and bent more obliquely forward. It is at the same time somewhat similar to *Mesopuzosia indopacifica* (Kossmat) but has distinctly finer and more numerous ribs. There seems to be some variation in the coarseness of ribs within *Mesopuzosia indopacifica* (Kossmat). As the material of *M. yubarense* (Jimbo) is relatively scanty and is derived from the area where *M. inpacifica* (Kossmat) is found in Japan, there is a possibility that the former is an extreme variety of the latter. However, so far as the specimens at hand are concerned the former has such a compressed whorl and narrowly arched venter that specific distinction is warrantable.

Occurrence: Although the exact horizon of the original material is not recorded, subsequent collections indicate that the occurrence of the present species is the same as that of *M. indopacifica* (Kossmat) and *M. pacifica* Matsumoto, mainly in Neogyliakian and partly in Paleourakawan. However it must be decided more precisely in future.

Mesopuzosia densicostata, sp. nov.

Pl. 22, figs. la, b, 2.

1929. Puzosia ishikawai (JIMBO), KAWADA, p. 3, listed only.

Material: Holotype, GT. I-544 (=MM7694) from locality 'Santan-gawa', zone Mh6 of the Miho group, Naibuchi Valley, South Saghalien (M. KAWADA Coll.). Paratype, GT. I-3438 from locality T 311p (the Wakkawembets), bed IIId (upper), the Abeshinai Valley, Teshio Province, Hokkaido (T. M. Coll.). Other comparable specimens, GT. I-2689 from locality N331b, zone Mh6  $\alpha$  (lower); GT. I-2690 from locality N331a, zone Mh6  $\alpha$ , Naibuchi Valley, South Saghalien (T. M. Coll.), etc.

#### Measurements:

	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Inner whorl	110.0	44.5	01 5 (0.50)	40 5 (05 0 4/)
of GT.I-544	113.0	44.7	31.5 (0.70)	40.5 (35.8 %)

Specific Diagnosis: Moderately involute  $(\frac{1}{2})$  and moderately umbilicate, large, discoidal shell. Whorls much compressed and flattened with parallel flanks and narrowly arched venter. Numerous, gently flexuous, long ribs with some intercalated shorter ribs, very regular and rather close-set on the external half of the whorl, showing a moderate ventral projection. Constrictions rather shallow and similar in curvature to the long ribs. Nearly smooth last whorl.

Remarks: In its fine and close-set costae, compressed whorls and narrow venter this species is rather similar to Mesopuzosia yubarense (JIMBO) but its costae are not so projected as in that species and flanks are flat and parallel, instead of convergent. In the curvature of ribs it is fairly similar to Mesopuzosia pacifica Matsumoto but the costae are distinctly finer and more close-set than in that species.

From *Mesopuzosia indopacifica* (Kossmat) it is easily distinguished by the difference in the curvature and density of ribs. '*Puzosia*' gaudemarisi Roman & Mazeran (1920, p. 69, pl. ii, figs. 1, 1a, 2, 2a) from the Turonian of France is very similar to the present species and is probably an example of *Mesopuzosia* in Europe. Our species seems somewhat more compressed and evolute than that species.

Immature specimens of this species might be misidentified with "Desmoceras" ishikawai Jimbo, but that species is now proved to belong to a different genus. When the shells with diameters of 100-150 mm. are compared the difference is very distinct, as will be understood by the description of that species (see below). Even in the smaller specimens careful observation can separate the two species by the curvature and strength of constrictions and some difference in whorl section.

It should be noted that this species occurs in the Neourakawan which corresponds in age to the Santonian (plus earliest Campanian), when in Europe and America Parapuzosia is common, but it does not show the strong (or broad) and straight, major, lateral ribs of Parapuzosia-type. It represents a species of Mesopuzosia which presists up to Santonian.

Occurrence: Neourakawan (mainly Santonian and possibly inclusive of lowest Campanian). Definitely identified specimens are few, but I have observed occasionally large puzosiid shells in the Neourakawan. They seem to belong to the present species.

#### Genus Neopuzosia, nov.

(ex Matsumoto, 1954, MS. nom. nud.)

Type species: Kitchinites japonicus Spath, 1922.

Generic diagnosis: Similar to Puzosia in shell form and in suture-lines and resembling Mesopuzosia and Parapuzosia in the characters of inner whorls. The adult living chamber is abruptly ornamented with strong and coarse ribs which start from or near the umbilical margin, are almost rectiradiate or slightly arcuate on the flanks and are curved forward on the ventrolateral part and cross the venter with increasing breadth. Shell typically of moderate size and usually not so large as in Mesopuzosia or Parapuzosia.

Remarks: The genus includes Neopuzosia japonica (Spath), the type species, N. ishikawai (Jimbo) and doubtfully certain foreign forms.

Neopuzosia closely resembles Mesopuzosia before the adult body chamber and the generic identification of immature specimens is often difficult. Examined in detail, however, the ribs are seen to cover more distinctly the whole surface of the whorl than in Mesopuzosia and Puzosia, the smooth young whorl being succeeded soon by wholly costate whorl; the ventrally subcostate and internally smooth intervening stage being very short, if not absent.

The tendency to decrease the flexuosity of ribs on the umbilical half of flanks is one of the characteristic features of this genus, although a similar tendency is also found in later whorls of some species of *Mesopuzosia* (e.g. *M. indopacifica* (Kossmat).

From both the morphological characters and stratigraphical occurrence, *Neopuzosia* can be regarded as a direct derivative of *Mesopuzosia*.

On the other hand Neopuzosia resembles Kitchinites Spath, 1922. In fact Spath (1922) included Neopuzosia japonica (Spath) within Kitchinites, but the latter should be confined to the group of the type species, Kitchinites pondicherryanus (Kossmat) (1897, p. 40(147), pl. vi (xvii), fig. 6a-c). It is characterized by a rectiradiate or somewhat prorsiradiate costation even in the immature stage and very distinctly so in the body chamber. In Neopuzosia the ribs are often still gently flexuous or arcuate on the flanks even in later whorls and show mostly a prominent forward projection on the periphery, although the degree of flexuosity and projection varies in some ribs. In respect of the curvature or straightness of ribbing Kitchinites brevicostatus (Marshall) (1926, p. 183, pl. 24, fig. 3, pl. 43, fig. 2, pl. 45, fig. 6) is somewhat intermediate between typical Kitchinites and Neopuzosia.

The suture-line of *Neopuzosia* in its later stages of growth is of typical *Puzosia*-pattern, being characterized by a large and asymmetrically trifid L and obliquely arranged descending auxiliaries. As the type species of *Kitchinites* is based on a small shell (BM. C. 47548), the asymmetry of its L is not so distinctly exemplified as in the larger Puzosiids, but its suture is rather that of Puzosiidae than that of

typical Kossmaticeras in its large development of L and strongly descending auxiliaries. Kitchinites brevicostatus (Marshall) is fairly similar to Neopuzosia in suture, especially in that exhibited by a specimen, probably adult shell of that species, in Mr. Wright's collection, which he kindly showed me.\*

Neopuzosia is fairly similar to Kitchinites also in shell-from, but the type species and other possible members of the latter, such as one from West Australia (Spath, 1940, p. 45, pl. ii, fig. 2) and K. brevicostatus (Marshall), have a remarkable flattening of whorls, while Neopuzosia retains an elliptical or oval whorl section.

Another feature which should be noted is the intersection of the ribs by the more or less oblique constrictions. This feature, which may be called a kossmaticeroid character, is occasionally found in the immature shell but scarcely discernible on the outer whorl of *Neopuzosia*, while it is more constant and noticeable in *Kitchinites*. In this respect *K. brevicostatus* (Marshall) and *K.* (?) *darwini* (Philippi) (Steinmann, 1895 p. 73, pl. v, fig. 3a, b) are also good examples of *Kitchinites*. Wright's specimen mentioned above clearly shows the character in the body chamber.

Summarizing the above, I regard *Neopuzosia* as a distinct genus, which is characterized by the coarse and ventrally broadened ribs, particular to its adult shell, but is closely allied to *Mesopuzosia* in many respects, still keeping normal Puzosiid characters and, at the same time, somewhat allied to *Kitchinites* in the appearance of new characters in common. The assignment of the age of *Kitchinites* to the Campanian and Maestrichtian (Spath, 1922, 1940, 1953) is probably correct. If it is so, *Neopuzosia*, of Santonian and lowest Campanian, can well lead to *Kitchinites*.

Neopuzosia is somewhat allied to Parapuzosia especially in the immature shell. Parapuzosia has rectiradiate major ribs on the lateral sides of the outer whorl which form a strong contrast to the numerous, fine, ventral ribs. Some of the minor ribs diverge from the major ribs. Such a differentiation of ornament does not take place in Neopuzosia. Another difference may be in the size of shell. We know a good many huge examples in Parapuzosia, Austiniceras and Mesopuzosia. Probably the large size is one of the characteristic features of these genera. In my experience Neopuzosia does not reach such a large size. Its body chamber, which is presumed to be adult from its relatively strong ornamentation, is always reached at a moderate size. Probably a reduction in size is another tendency acquired by Neopuzosia and probably also by Kitchinites. In short Neopuzosia and nearly contemporary Parapuzosia are parallel and not in direct relationship.

<sup>\*</sup> Owing to the kindness of Mr. WRIGHT and Dr. C. V. FLEMING of the Geological Survey of New Zealand, I fortunately had an opportunity to study also the holotype of that species.

#### Neopuzosia japonica (Spath)

Pl. 17, figs. 1a, b, 2a, b; Pl. 18, figs. 1, 2a, b, 3a, b, 4; Pl. 23, figs. 1a, b, c, 3; Text fig. 4.

- 1890. Desmoceras gaudama YOKOYAMA (non FORBES), p. 184, pl. xix, fig. 5a, b; pl. xviii, fig. 14.
- 1909. Puzosia japonica YABE, MS. nom. nud., p. 433, listed only.
- 1927. Puzosia japonica YABE MS. nom. nud., p. 45, pl. vi, fig. 3a, b.
- 1922. Kitchinites japonicus Spath, p. 127.
- 1935. Kitchinites spathi SHIMIZU, p. 179.

Material: Lectotype, here designated, is the larger of the specimens illustrated by Yokoyama (1890, pl. xix, fig. 5a, b) from Urakawa, Hidaka Province, Hokkaido, probably collected by Benjamin Smith Lyman. Its precise horizon was not recorded, but the subsequent survey of the same area suggests its probable occurrence in beds Ur1β or Ur2, Neourakawan (Santonian). This specimen is not preserved in Japan and is not at my disposal. The Institution in which Yokoyama's (1890) specimens have been preserved was not clearly described in his paper but is presumed to be in Berlin or in München, so that the lectotype may have been lost during World War II.

In the subsequent collections there are a large number of specimens which are specifically identical with Yokoyama's type. The following is a list of selected examples: GT. I-368 (=MM7637) from the right branch of the Saushisanushibe, Popets (Hobetsu), Iburi Province, "Pachydiscus" (=Anapachydiscus) Bed (YABE Coll.). GT. I-2703 (loc. N371, zone Mh6), GT. I-2709 (N189a, Mh6), GT. I-2710 (N184p<sub>2</sub>, Mh6), GT. I-2711 (N189b, Mh6  $\beta$ ), GT. I-2712 (N400m1, Mh6  $\beta$ ) (T. M. Coll.) and GT. I-2714, GT. I-2671 (Miho) (M. KAWADA Coll.) from the Naibuchi Valley, South Saghalien; GK. H 5143 (purchased, S. NAGAOKA'S Coll. from South Saghalien); GT. I-3421 (loc. T277c, bed IIId), GT. I-3424 (T277, IIId), GT. I-3426 (T277a, IIId), GT. I-3428 (T277, IIId), GT. I-3429 (T739r, IIId), GT. I-3431 (T308, IIId), GT. I-3433 (T705p, IIId), GT. I-3434 (T472p<sub>2</sub>, IIId (top?)) and GT. I-3435 (T947p, IIId) in the Abeshinai Valley, Teshio Province, Hokkaido (T.M. Coll.); GK. H 3360 (loc. U141 $p_5$ , bed Ur1  $\beta$ ) and GK. H 3350 (U600b, Ur2  $\beta'$ ) from the Urakawa area, Hidaka Province, Hokkaido (T.M. Coll.); BM. C. 47735 presumably from zone Mh6, Naibuchi Valley, South Saghalien (T. M. Coll., presented to the British Museum (Natural History)) and? BM. C. 22418, "Hokkaido", probably Neourakawan from the associated fossils (Inoceramus naumanni Yokoyama and Polyptychoceras sp.) (purchased, Dr. Krantz's Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Lectotype (From Yokoyama's figure)	94.5	39.5	? 24.5 (0.62)	31.0 (32.8%)
GK.H 5143	${125.0 \atop 79.0}$	51.8 31.5	? 29.7 21.1 (0.67)	37.5 (30 %) 37.2 (34 %)

GK.H 3350	52.5	20.5	16.9 (0.82)	17.7 (33.7%)
BM.C. 47735	Ca 93	40 28 5	25 (0.63) 19.2 (0.68)	28.3 (30.4%)

Description: Shell of moderate size, attaining a little more than 12 cm. in diameter in the adult, puzosiid in general aspect of shell-form, fairly narrowly umbilicate for the family and frequently constricted in the phragmocone and less so in the body chamber. After middle age the whorls are compressed, broadest in the lower part, with slightly inflated flanks, narrowly arched venter, subangular umbilical shoulder and low but perpendicular umbilical wall.

The immature shell, except for the very early smooth whorls, is ornamented with numerous small ribs, of which some are gently flexuous and others are subradial on the main part of the flanks. Shorter ribs, which begin somewhat below the midst of flanks, are intercalated with or branch from long ones starting at the umbilical margin. All the ribs show a more or less strong forward projection on the ventral area. The ribs become rather suddenly strong and coarse in the adult shell, especially on the venter; they run subradially on flanks, with or without slight flexuosity, and show a forward inclination on the ventrolateral part. Spiral striae are discernible on the inner layer of test in the adult shell.

The aperture with a pair of short inner lateral lappets and shallow outer lateral sinus and moderately projected rostrum; marginal part only weakly ornamented and strongly constricted behind.

Suture-line of *Puzosia*-type, with a large and asymmetrically trifid L, recurved U2 and strongly descending auxiliaries (subdivided elements of U3 (=S)) at least in the later stages of growth.

Remarks: Yokoyama (1890) assigned the illustrated specimens from Urakawa to Desmoceras gaudama (Forbes), but he certainly misidentified them. When Spath (1922, p. 127) proposed Kitchinites for the group of "Holcodiscus" pondicherryanus Kossmat, he gave the new specific name\* Kitchinites japonicus Spath to Yokoyama's specimens.

Meanwhile Yabe (1909, 1927) listed a number of undescribed MS names, including *Puzosia japonica* Yabe MS. Under that name a specimen was illustrated (Yabe, 1927, pl. vi, fig. 3a, b), but Yabe did not remark on its relation to Yoko-yama's described specimens and to Spath's nomenclature. Shimizu (1935, p. 179) remarked that *Kitchinites japonicus* Spath must be renamed *K. spathi* Shimizu as "*Puzosia*" *japonica* Yabe may be another species of *Kitchinites*. However, following the Rule of Nomenclature, Shimizu's proposal is invalid, because "*Puzosia*" *japonica* Yabe MS was never described. Much of Yabe's collection (i.e. the material of Yabe, 1909) was fortunately deposited in the Geological Institute, University of Tokyo. There are two specimens labeled as *Puzosia japonica* Yabe. One of them,

<sup>\*</sup> The specific name is valid since 1921, for it was proposed in his 1921 paper (p. 45).

GT. I-368, illustrated in this paper (Pl. 18, fig. 3a, b), is an adult shell which is specifically identical with Yokoyama's specimen. Accordingly "Puzosia japonica YABE MS" is, quite accidentally, conspecific with "Kitchinites japonicus Spath."

The immature shell of this species resembles quite well that of *Mesopuzosia pacifica* Matsumoto, both being provided with gently flexiradiate ribs. The obliteration of flexuosity of ribs in the adult shell is found also in *Mesopuzosia indopacifica* (Kossmat). Moreover the suture-lines in the later growth stages of the present species are of unmistakable puzosiid pattern and somewhat different from the illustrated suture of *Kitchinites pondicherryanus* (Kossmat), although the immature ones are fairly similar. The rectiradiate costation is found even in the immature shell of *K. pondicherryanus*, while the present species is provided with gently flexuous subcostae in its immature stage, as was illustrated by Yokoyama (1890, pl. xviii, fig. 14), Yabe (1927, pl. vi, fig. 3a, b) and also in this paper (Pl. 17, fig. 2a, b; Pl. 18, fig. 2a, b). Kossmat noticed that the ribs of *K. pondicherryanus* are weakened on the siphonal line. A similar tendency can be detected in the early immature stage of the present species but is never found in the later stages, where, on the contrary, the ribs are strengthened on the ventral area.

From the above I am led to the conclusion that it is better to remove the present species from *Kitchinites*. As there was no proper position in the hitherto established classification, the new genus *Neopuzosia* has been established above.

Apart from *Kitchinites pondicherryanus* (Kossmat) there are a few forms provisionally or doubtfully referred to *Kitchinites*, such as *K.* sp. (Spath, 1940) from Western Australia and *K. brevicostatus* (Marshall, 1926), but they are not identical with the present species, because of their too much flattened whorls and different ornament.

As has already been remarked the present species is fairly similar to Mesopuzosia pacifica Matsumoto or M. indopacifica (Kossmat) especially in the immature stage. The strengthening of ribs in the adult of N. japonica is very remarkable and abrupt while in *M. indopacifica* of corresponding size it is very gradual, inconspicuous and, furthermore, obscured by the tendency to smoothness on the large outer whorl. The forward projection of ribs on the ventral part of M. indopacifica of corresponding size is more noticeable than in N. japonica, although the extent of difference varies in some individuals. The stratigraphical occurrence of the three species is successive, and partly overlapping. Thus the derivation of N. japonica from M. pacifica is highly possible if not convincing and M. indopacifica may be a short lateral offshoot in the intervening stage. I have never seen specimens of N. japonica as large as full grown M. pacifica and M. indopacifica, while the strongly ribbed body chamber of constant size (with a diameter of about 12 cm.) suggests the adult stage. Therefore the reduction in size may be one of the tendencies in the evolution from Mesopuzosia to Neopuzosia.

Occurrence: Zone Mh6 in the Naibuchi Valley and adjacent areas in South Saghalien; bed IIId in the Abeshinai Valley, Teshio Province; Beds Ur1 $\beta$  and Ur2 in the Urakawa area, Hidaka Province; the corresponding horizons in other places of Hokkaido. Neourakawan (mainly Santonian).

Neopuzosia ishikawai (Jimbo)
Pl. 19, figs. 1a, b, 2a, b, 3a, b, 4;
Pl. 23, fig. 2a-d; Text fig. 3.

- 1894. Desmoceras ishikawai JIMBO, p. 28, pl. i(xvii), fig. 5, 5a, 5b.
- 1909. Kossmaticeras ishikawai (JIMBO) YABE, p. 44(18).
- 1922. Kitchinites ishikawai (JIMBO) SPATH, p. 127.
- 1935. Kitchinites ishikawai (JIMBO) SHIMIZU, p. 174, etc., listed.
- 1942-3. Parapuzosia (Mesopuzosia) ishikawai (JIMBO) MATSUMOTO, p. 161 (1942) and elsewhere, listed.
- 1942-3. Parapuzoias (Mesopuzosia) comacana MATSUMOTO MS. nom. nud., p. 161 (1942) and elesewhere, listed.

Material: Lectotype, GT. I–95a (Jimbo's illustrated specimen) and another Jimbo's syntype, GT. I–95b, both from the Obirashibets River, about 52 km. from the mouth, Teshio Province, Hokkaido (K. Jimbo Coll.). Among a number of specimens in subsequent collections the following is a list of selected examples: GT. I–2706 from locality N202b2, zone Mh6 $\alpha$ · $\beta$ , GT. I–2705 (N167p, Mh6 $\beta$ ), GT. I–2687 (N400m3, Mh6 $\beta$ ), GT. I–2688 (N204b, Mh6 $\alpha$ · $\beta$ ), GT. I–2713 (N400m4, Mh6 $\beta$ ) and GK. H 2458 (N22z, Mh6 $\beta$ ) from the Naibuchi Valley, South Saghalien (T. M. Coll.). From the same valley (probably from zone Mh6) GT. I–547 ("the Miho"), GT. I–548 ("the Santan"), GT. I–550 ("Naibuchi Valley") (M. KAWADA Coll.) and BM. C. 47736 (T. M. Coll., presented to the British Museum (Natural History)); GT. I–3432 from locality T212p, bed IIId, Abeshinai Valley, Teshio Province (T. M. Coll.); GK. H 3366 from locality U512r4. bed Ur2 $\beta$ , Urakawa area, Hidaka Province, Hokkaido (T. M. Coll.).

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT.I-95a (JIMBO's desc	:.) 38	17	14	14 (36.8%)
" (Reexamine	d) 38.5	16.5	13.8 (0.83)	12.0 (31 %)
GT.I-2706 maximum	Ca 140			
	Ca 126.0	50.4		? 47
GK.H 3366	49.5	19.0	14.5 (0.76)	16.5 (33.3%)
BM. C. 47736	63.4	25.4	19.8 (0.78)	20.9 (32.9%)

Specific diagnosis: A species of Neopuzosia characterized by fine and rather dense costae in the phragmocone; the costae and constrictions show a slight flexuosity on the flanks and a remarkable forward projection on the periphery. Adult body chamber ornamented with ribs which are distinctly coarser and stronger than those in the immature stages, gently arcuate on the flanks and show a prominent ventral projection. Whorls compressed with the maximum breadth nearly between the middle of flanks.

Remarks: This species differs from the closely allied and almost contemporary N. japonica (Spath) mainly in the finer and denser costae. There may be slight difference in shell-form, which however varies to some extent in both species. There is also some variation in the frequency of ribs.

Generally speaking *Neopuzosia ishikawai* (Jimbo) might be interpreted as a descendant of *Mesopuzosia yubarence* (Jimbo) just as *N. japonica* (Spath) can be assumed to be related to *M. pacifica* Matsumoto or to *M. indopacifica* (Kossmat).

As Jimbo's specimens were immature, there is some obscurity in the definition of the species. There are among subsequent collections a number of specimens which are quite similar to, but often somewhat larger than, the type. In my stratigraphical paper (1942-43) I listed *Parapuzosia* (*Mesopuzosia*) comacana MS. nom. nud., which is so far we know at present nothing but the later whorls of Neopuzosia ishikawai (Jimbo). Thus a revised diagnosis has been given above.

"Puzosia gaudama (Forbes)" of Simionescu (1899, p. 19, pl. i, fig. 4) from the Upper Cretaceous of Rumania seems to me very similar to the immature (deformed shell) of the present species.

In the present species the constrictions occasionally cut a few of the ribs behind them. That character appears more frequently in the inner whorls, so that some authors referred the species to *Kossmaticeras* or *Kitchinites*. In the outer whorls, however, the character generally disappears and typical features of *Neopuzosia* are shown.

"Puzosia" darwini Philippi (Steinmann, 1895, p. 73, pl. v, fig. 3a, b) from the Quiriquina group of Chile is somewhat similar to the present species, but it has frequent constrictions which cut constantly ventral ribs even in the large outer whorl. It may be a special member of *Kitchinites* on which smoothing of costae takes place on the umbilical half of the lateral side.

Occurrence: Neourakawan of Hokkaido and South Saghalien, approximately Santonian.

#### Genus Jimboîceras Shimizu, 1935

Type species: Desmoceras planulatiforme Jimbo, 1894.

Generic diagnosis: Similar to Puzosia in lateral view but with whorls more rounded or elliptical in cross-section, somewhat inflated flanks and rounded umbilical shoulder as compared with typical Puzosia and its direct derivatives. The whole surface of the whorls after middle age is ornamented with costae, some of which in the middle age are bifurcating. The constrictions are very broad and deep and associated with a high elevation. The periodic ribs in the adult shell are very strong and nearly rectiradiate. The shell usually attains a moderate or fairly large size. Suture-lines in later growth stages are puzosiid with long and asymmetrically trifid L, recurved U2 and strongly descending elements of subdivided U3 (=S).

Remarks: Shimizu (1935, p. 180) introduced the new generic name designating as type species the well defined Desmoceras planulatiforme Jimbo, 1894, and remarked very briefly that "the holotype of this genus resembles Parapuzosia, but has a different type of ornamentation." The definition is so brief and incomplete that the validity of his proposal is questionable under the Rule of Nomenclature. The generic name is adopted here and a clearer diagnosis given.

In its shell-form and in the development of well marked constrictions and associated high elevations, which are replaced by strong ribs in the adult, the genus is allied to Puzosia (Anapuzosia) defined above, but has better developed costation even on the inner whorls. From Mesopuzosia and Neopuzosia it is distinguished by the roundness of whorl (i.e. relatively inflated flanks and more rounded umbilical shoulder) as well as by the periodic, rectiradiate, strong ribs in the outer whorl. Similarly Jimboiceras is parallel to and not directly connected with Parapuzosia. On the outer whorl of Parapuzosia nearly straight, strong ribs do exist, but are confined to the sides with splitting into minor ventral ribs, which show forward projection and then obsoletion, while in those of Jimboiceras the ventral projection of costae decreases with growth and the periodic, strong ribs cross the venter nearly radially.

Thus Jimboiceras may have evolved from Puzosia (Anapuzosia), just as Neopuzosia is possibly derived through Mesopuzosia from Puzosia (s. s.) Although the stratigraphic occurrence does not contradict this assumption, linking species between Albian and (?) Lower Cenomanian species of P. (Anapuzosia) and the Turonian species of Jimboiceras have still to be found.

A possible relation between *Jimboiceras* and *Kossmaticeras* will be mentioned in my paper of the Kossmaticeratidae (now in preparation).

Lastly the homoeomorphy between the Cretaceous Puzosiidae and the Jurassic Perisphinctidae should be pointed out here. In the mode of coiling and shell-form the two are somewhat analogous. Even in the suture-line there is some analogy in the descending auxiliaries and long lateral lobe. *Jimboiceras* has diverging ribs at a certain stage and very coarse ribs in the adult. This feature appears in certain Periphinctids (e. g. *Perisphinctes* (s. s.) or *P.* (*Arisphinctes*)), although the Perisphinctids include forms which are characterized by multipartite ribs and less projection of ribs on the venter.

Distribution: From the two species described below the genus ranges from the Neogyliakian (Turonian) to Lower Neourakawan (Lower Santonian).

#### Jimboiceras planulatiforme (JIMBO) Pl. 20, figs. 1, 2, 3a, b, c, 4.

1894. Desmoceras planulatiforme JIMBO, p. 27, pl. i, fig. 4, 4a.

1927. Puzosia planulatiforme (JIMBO), YABE, p. 45(19), ? pl. ix(vii), fig. 2 a, b.

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1935. Jimboiceras planulatiforme (JIMBO), SHIMIZU, p. 180.
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Material: Holotype, GT. I-94 from a nodule of shale on the Obirashibets, Teshio Province (K. Jimbo Coll.) (=Jimbo, 1894, pl. i, fig. 4. 4a). The examples in subsequent collections are: GT. I-2651 from locality I-236p. zone Mh 2 or Mh 3, Aikawa Valley, South Saghalien (T.M. Coll.); GT. I-2648 from loc. N126b, zone Mh3 and GT. I-2654 from loc. N124b, Mh2-3, Naibuchi Valley, South Saghalien (T.M. Coll.); GT. I-3219 (loc. T7bp, bed IIc), GT. I-3230 (T7bp, IIc), GT. I-3231 (T42, IId), GT. I-3224 (T344p<sub>3</sub>, IId), GT. I-3226 (T735p, IId), etc from the Abeshinai Valley, Teshio Province, Hokkaido (T.M. Coll.). GK. H1257 (loc. Y216p<sub>1</sub>), GK. H1258 (Y216p<sub>1</sub>), GK. H1259 (Y129p<sub>2</sub>), GK. H.1260 (Y115p), GK. H1261 (Y464p<sub>2</sub>). GK. H1262 (Y467p) and GK. H1266 (Y214a) from the Saku formation, Shiyubari Valley, Ishikari Province, Hokkaido (T.M. Coll.); GT. I-2719, Obirashibets, Teshio Province (H. Yabe Coll.). Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT.I-94 (J1MBO's desc.)	118	45	33*	45 (38%)
(Reexamined)	116	41	39 (0.95)	44.7 (38%)
GT.I-3221	133.2	53.5	48.8 (0.91)	47.1 (35%)

Diagnosis: Whorls in immature ages rounded in cross section with moderately inflated flanks, rounded umbilical border and moderately arched venter; and ornamented with distinct costae which run subradially or with slight flexuosity on the inner half of the flank and show a forward projection on the external part; in the middle age rather elliptical in section, with somewhat narrowly arched venter in the later substage and ornamented with well-marked, broad, periodic constrictions, which are bordered and then replaced by thick ribs, becoming more frequent in the late substage, and numerous, rather closely-set, distinct costae consisting of longer and shorter ones. The longer ribs start from the umbilical margin while the shorter ribs are inserted or branch near the middle of the flanks. The costae are mostly rectiradiate and sometimes gently flexuous on the inner half of the flank and show a strong forward bend at the ventrolateral edge with a projection on crossing the venter. The ventral projection gradually decreases with growth. The constrictions follow a similar course but are laterally more straight than most of the intervening ribs.

In the fairly large adult shell the ornament consists of strong and broadly rounded ribs separated by flat interspaces as wide as or somewhat wider than the ribs. The ribs cross the venter without or with a slight ventral bend.

Suture-lines after the early middle age are of typical Puzosia-pattern, with

<sup>1938.</sup> Anapuzosia (Jimboiceras) planulatiforme (JIMBO), MATSUMOTO, p. 193.

<sup>\*</sup> This may be a misprint for 38.

extremely asymmetrically trifid (and thus apparently bifid) L and strongly descending auxiliaries.

Remarks: As the character changes fairly remarkably in the course of growth, specimens of this species must be carefully identified. Jimbo's original specimen and YABE's illustrated specimen are still middle-aged shells. The adult shell is represented by several specimens in subsequent collections and the original description is here revised.

Occurrence: The species is characteristic to the Neogyliakian (approximately Turonian) of Hokkaido and Saghalien, although the exact horizon of the holotype was not recorded.

Jimboiceras mihoense, sp. nov. Pl. 21, figs. 1, 2a, b, 3.

1938. Anapuzosia (Jimboiceras) mihoensis MATSUMOTO, MS. nom. nud. p. 193, listed only.

Material: Holotype, GT. I-2641 from locality  $N131m_1$ , zone Mh5, Naibuchi Valley, South Saghalien (T. Matsumoto Coll.). Paratypes, GT. I-2642 from loc. N163a3, top of zone Mh5; GT. I-2650 from loc. N136, top of zone Mh5; GT. I-2647 from loc. N133h, the lowest part of zone Mh6 α; GT. I-2643 from loc. N136, Mh5; GK. H 2455 from loc. N136a4, top of zone Mh5; GK. H 2457 and H 2460 from loc. N311b, Mh5 or Mh6 and four other comparable specimens from zone Mh5 in the Miho area, Naibuchi Valley, South Saghalien (T. M. Coll.). Comparable specimens have also been obtained from the corresponding zone in the Ashibets Valley, Ishikari Province, Hokkaido (N. Kanbe & T. Matsumoto Coll. in the Geological Survey of Japan).

Diagnosis: Whorls relatively compressed and with subrounded umbilical shoulder. The shell in most of immature stages is ornamented with relatively coarse costae which are nearly rectiradiate on the main part of the flank but show a gentle forward projection on the periphery; strong constrictions follow a similar curvature. In the adult shell there appear abruptly strong ribs which are widely separated and rectiradiate. Most of them are much elevated and long but some are weak and somewhat shorter. The latter are inserted between or sometimes branch from the former more or less near the umbilical margin. Suture-lines after middle age are of *Puzosia*-pattern.

Remarks: This species and Jimboiceras planulatiforme (JIMBO) have a noticeable common tendency in shell-from and ornamentation as well as suture-lines. The specific distinction is in that J. mihoense has a more compressed whorl, low umbilical wall and a wider umbilicus than J. planulatiforme and that its ribs and constrictions are not so strongly projected as in J. planulatiforme. In the former coarse ribs appear earlier than in the latter and the branching of the ribs takes place at a different position.

At the same time the present species apparently resembles Neopuzosia japonica

(Spath) in general aspects, but *N. japonica* has a more compressed whorl with less inflated flanks and more angular umbilical shoulder. In the immature shell *J. mihoense* is ornamented with coarse costation than *N. japonica* and in the adult shell the ribs are distinctly different. Thus the resemblance of the two species is a parallelism between two different genera within the same family.

On the other hand the shell of J. mihoense before the strongly ribbed living chamber has some points in common with Kossmaticeras (theobaldianum-group), which has oblique constrictions, slight elevation at the umbilical edge of the long ribs and a different type of suture.

Occurrence: Common in zone Mh5 and the lower part of Mh6 $\alpha$  in South Saghalien and sometimes found in the corresponding horizon in Hokkaido. Lower half of the Neourakawan, approximately Lower Santonian. The possibility of its occurrence in the Paleourakawan should be examined in future.

#### Genus Pachydesmoceras Spath, 1922.

Type species: Ammonites denisonianus Stoliczka, 1865.

Generic diagnosis: Fairly similar to Puzosia especially in the immature shell, but characterized in later whorls by more or less rounded section with somewhat inflated flanks and rounded umbilical border and by gently arcuate, rather than sigmoidal, ribs which become very coarse in the adult. Suture-lines of typical Puzosia-type with large and somewhat asymmetrically trifid L, recurved U2 and strongly descending auxiliaries. Shell reaches to a large size and is sometimes smooth in the last part.

Remarks: Superficially the adult shell of this genus is analogous to some inflated Pachydiscids and unlike Puzosia. However its ontogenetic development, as was well illustrated by Kossmat (1898), clearly indicates its intimate relation to the Puzosiids. It is distinguishable from Lewesiceras or Anapachydiscus by its suture-line, absence of umbilical tubercles at any growth stage and the compressed inner whorls. The genus is one of the specialized Puzosiids.

The coarse ribbing in the adult is somewhat similar to that of certain later Puzosiids. *Jimboiceras* however, which has coarser ribs in the outer whorl and is more round-whorled than *Puzosia*, does not show a pachydiscoid inflation of whorl in the adult and the ornamentation is different from *Pachydesmoceras*. *Parapuzosia* has also coarse ribs in its large outer whorl, but is generally compressed as in typical *Puzosia* and has minor external ribs some of which diverge from the major ones.

In connection with *Pachydesmoceras* reference should be made to *Lytodiscoides* Spath, 1922 and *Achilleoceras* van Hoepen, 1951 from the Upper Albian of Africa. They are probably specialized Puzosiids rather than early Pachydiscids, because

before the peculiarly ornamented adult body chamber their whorls are very similar to those of *Pachydesmoceras* and, accordingly, in some respects to *Puzosia*. Unfortunately their suture was not clearly described, but that shown by Choffat suggests Puzosidae in the strongly descending auxiliaries.

Distribution: Two species referable to Pachydesmoceras are known from the Japanese province: Pachydesmoceras denisonianum (Stoliczka), with a comparable form, and a new species described below. The first species and its allies are distributed fairly widely in the Indo-Pacific, Tethys and Malgash regions in the Upper Albian and Cenomanian. The second species occurs in the Neogyliakian, that is approximately Turonian. Possible Turonian forms are also known in Europe (e.g. "Puzosia denisoni (Stoliczka)" Zimmermann, 1912, p. 542, pl. 26) and Africa (Desmoceras kamerunense v. Koenen, 1898, p. 55, pl. vii, figs. 1, 2, 3; Puzosia denisoniana (Stoliczka) Solger, 1904, p. 103, pl. iii, fig. 1a, b and text figs. 5, 6). Therefore the genus has a vertical range from Upper Albian through Cenomanian up to Turonian.

#### Pachydesmoceras cf. denisonianum (Stoliczka)

Cf. 1865. Ammonites denisonianus STOLICZKA, p. 133, pl. lxvia; pl. lxvi, fig. 2.

1898. Puzosia denisoniana (STOLICZKA) KOSSMAT, p. 121(186), pl. xiv (xx), figs. 5a, b, 6; pl. xv (xxi), fig. 5a, b.

1914. Puzosia denisoniana (STOLICZKA) YABE, p. 72(2), pl. xii(i).

Description: The following five specimens before me are comparable to the designated species: GT. I-3195 and GT. I-3194 from the upper part of bed IIb and GT. I-3196 from the lowest part of bed IIb of the Abeshinai Valley, Teshio Province, Hokkaido; GT. I-3765 from locality N305d, horizon Ky of Naibuchi Valley, South Saghalien; GK. H1226 from locality Y610, middle part of bed IIf in the Shiyubari Valley, Ishikari Province, Hokkaido (all T.M. Coll.). Besides them I have seen a huge specimen collected from the zone of Desmoceras japonicum (Cenomanian) at Ashibets (Ashibets Park) by Mr. Tanaka and Mr. Y. Maeda. It is now preserved in the Geological Survey of Japan.

The first specimen is a large shell in which two outer whorls are visible and other inner whorls are not preserved. The outer whorl has only distant coarse ribs and resembles the outer whorl of Stoliczka's specimen (1865, pl. lxvia).

The inner whorl has longer and larger ribs and shorter and smaller ones, both of which are coarsely arranged as in the outer whorl of Kossmar's large specimen (1898, pl. xv, fig. 5a, b).

The second specimen is larger than the first one and still has very coarse and distant ribs in its outer whorl and its inner whorls are similar to the first one. The third one is smaller and resembles the middle aged whorl of the Indian species. The fourth one is not in a favourable state of preservation.

Occurrence: The specimens from Hokkaido indicate the vertical range from Infragyliakian to the whole Paleogyliakian, i.e. the approximate equivalent of the Uppermost Albian and Cenomaian.\*

Outside Hokkaido within Japan the species was reported by Yabe (1914) from a block of fine grained sandstone from Oidaira in the Monobegewa Valley, Kochi Prefecture, Shikoku. In spite of the uncertainty of the exact horizon, "Puzosia-shale" (=Pachydesmoceras bearing shale) was introduced in subsquent literature, and I have failed to ascertain the evidence about this change of recording. The fossiliferous fine-grained sandstone occurs at two or three horizons in the Cretaceous succession of Kochi Prefecture, one at the top of the Monobegawa group as is represented by Miyanohara sandstone, another in the lower part of the upper subgroup and another in the middle part of the lower subgroup of the same group. The first or the second horizon or the intervening part may be the possible source of the fossil. At any rate Yabe's dating of this fossil in Upper Albian and Cenomanian seems to be confirmed by the material from Hokkaido.

Pachydesmoceras denisonianum (STOLICZKA) is known from the Utatur group of India, Upper Albian of Persia and Madagascar and a closely allied (possibly identical) species Pachydesmoceras alimanestianui (Popovici-Hatzeg) (1899, p. 14, pl. i, fig. 1) from the Cenomanian of Rumania and also (?) from the Uppermost Albian of Southeast France (Breistroffer, 1936, p. 65). These facts are quite in harmony with the occurrence in Japan.

#### Pachydesmoceras pachydiscoides, sp. nov.

Pl. 9, fig. 2a, b.

Material: Holotype, GT. I–2805 from the "Miho group", Naibuchi Valley, South Saghalien (M. KAWADA Coll.). Paratypes, GT. I–2716 from locality N123c, zone Mh3 and GT. I–2717 and GT. I–2718 from locality N320b, zone Mh2, Naibuchi Valley, South Saghalien (T. Matsumoto Coll.); GT. I–2721 and GT. I–2720 from a left tributary of the Obirashibets, about 1 km above the mouth of the Sankeshomap (H. Yabe Coll.). Comparable specimens are GT. I–3207 from locality T72a, Saku formation (IId), Abeshinai Valley (T.M. Coll.) and a large specimen from the zone of Inoceramus hobetsensis Nagao & Matsumoto (large form) in the Ikushumbets Valley, Hokkaido and another from the same zone in the Odasam Valley, South Saghalien.

<sup>\*</sup> Pachydiscus denisonianus (STOLICZKA) in JIMBO (1894, p. 29, pl. ii, fig. l. la. lb) is not referable to the designated species nor to Nowakites (?) jimboi (KOSSMAT) but is an immature shell of Canadoceras kossmati (YABE MS) MATSUMOTO, which was discribed in my recent paper (T. M. in T. M. (Editor) 1954.)

#### Measurements:

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT.I-2805	215	98	84 (0.86)	65 (30 %)

Specific diagnosis: A species of *Pachydesmoceras* characterized by the development of stronger costae from much earlier stage of growth and somewhat more rapid growth of whorls than in *Pachydesmoceras denisonianum* (Stoliczka). Last whorl is almost smooth and attains a huge size.

Remarks: The species is very similar to Pachydesmoceras denisonianum (Stoliczka) in suture-lines and general shell-form and ornamentation. In P. pachydiscoides however the increase of whorls is somewhat more rapid and, when the whorls of the same stage of growth are compared, the section is much higher than broad with its maximum inflation a little below the mid-height.

Below 30cm. diameter the immature shell is constricted and almost smooth apart from fine subcostae on the ventral part of its latest stage. This stage is just comparable to the somewhat later inner whorl (40-55mm. in diameter) of *P. denisonianum*, as illustrated by Kossmat (1898, pl. xiv, fig. 5a, b). When the shell of *P. pachydiscoides* attains a similar size, there appear distinct ribs which are still small, round, numerous and fairly close-set, being separated by interspaces nearly as wide as ribs, and gently arcuate or slightly flexuous as in certain *Austiniceras*. They consist of longer and shorter ones, alternating somewhat irregularly. Some of the shorter ribs reach below the middle of the flanks, being usully intercalated between the longer ones and rarely branching from a long one. Constrictions and the associated elevations are 5 or 6 in one volution in this stage. This *Puzosia*-like ornamentation prevails throughout the middle age, although in the later middle stage ribs are more widely separated and curve obliquely forward with a ventral projection and without curvature on the inner half of the flanks.

In the adult stage when diameters ranges from 16cm, to about 30cm, the ribs become rather abruptly strong and coarsely distributed and the shell is inflated, resulting in the pachydiscoid aspect. There are, however, no umbilical nodes, but constrictions and the associated thick elevations continue to appear though less frequently than before. Increase of whorl in this stage is very rapid.

In the final or gerontic (?) stage the ornamentation becomes obsolete, with low and distant ventral ribs in the earlier half and without notable ornament in the inner half. This smooth stage is represented by at least a half volution.

The present species is also allied to *Pachydesmoceras* (?) *kamerunense* (von Koenen) from the Lower Turonian of Kamerun\* (1898, p. 55, pl. vii, figs. 1, 2, 3)

<sup>\*</sup> I take this offortunity to express my thanks to Mr. R.A. REYMENT of the Geological Survey of Nigeria who has given me the recent information about the stratigraphical occurrence of the Nigerian species.

(=? Puzosia denisoniana (Stoliczka) (Solger), 1904) but has higher whorl and more arcuate, ventrally more projected and somewhat more widely spaced ribs.

Occurrence: The species is characteristic to the Neogyliakian of Hokkaido and South Saghalien, approximately equivalent to Turonian.

#### Concluding Remarks

'Puzosinae' was proposed by Dr. Spath (1922, p. 120) as one of the subfamilies of Desmoceratidae, Zittel. Under that name he put, besides *Puzosia*, a number of Upper Cretaceous genera, mostly created by himself, such as *Austiniceras*, *Parapuzosia*, *Tragodesmoceras*, *Pachydesmoceras* and *Kitchinites*, and furthermore *Schlüteria* (now *Desmophyllites*) and *Hauericeras*. Some of them were regarded as 'true Puzosiids' connected with ancestral *Puzosia* but in the same paper (p. 120) he assumed that the Puzosiinae was "a convenient but polyphyletic assemblage of successive waves of modified Phylloceratids". He ranked the group as a family in his recent paper (1940, 1953) without mentioning a reason, but his idea of it seems fundamentally unchanged.

In the same 1922 paper Pachydiscinae and Kossmaticeratinae were established as other subfamilies of the Upper Cretaceous Desmoceratidae. While the two are now generally ranked as families, C. W. WRIGHT (1952) in his comprehensive scheme of classification of the Cretaceous Ammonites still kept Puzosiinae and Desmoceratinae as subfamilies of Desmoceratidae, the main stock of Desmocerataceae.

It is often very difficult to prove precisely a true lineage or phylogenetic series. The evolution of many ammonoids may have proceeded in various lines, sometimes diverging, sometimes running nearly parallel and sometimes apparently entangled. If some of these lines have been derived from a common stock and have a similar general tendency of morphological change, they can be grouped together in one family, in spite of some diversities in the details of phylogenetic series of species. It seems preferable to try to find a natural group of such a kind and approach step by step nearer to a natural classification. This applies particularly in the case of the Desmocerataceae, because it is one of the relatively less specialized and probably fundamental groups of the Cretaceous Ammonidea.

Now there are a number of forms referable to the Desmocerataceae in the Cretaceous province of Japan and adjacent areas. The main purpose of a series of my papers is to describe what sort of forms are found in this province. Fortunately we have a nearly perfect and continuous succession of ammonite-bearing strata from Albian to Maestrichtian in Hokkaido and Saghalien and we can recognize fairly well relatively natural groups from carefully collected specimens.

Without similarly continuous material of the Lower Cretaceous forms I cannot discuss fully the whole system of Desmocerataceae. Therefore the ranking of Puzosi-

ids as family or subfamily is quite provisional in this paper. What I want to do in this concluding chapter is to summarize characteristic features and history of the Puzosiids (Puzosiidae or Puzosiinae) in the present state of our knowledge.

In the family Puzosiidae the following genera are to be included:

Puzosia Bayle (Type species, P. subplanulata (Schlüter))

Subgenus Puzosia (s.s.)

Subgenus Anapuzosia (Type species, P. (A.) buenaventura Anderson)

Mesopuzosia, gen. nov. (Type species, M. pacifica, sp. nov.)

Neopuzosia, gen. nov. (Type species N. japonica (Spath))

Kitchinites Spath (Type species, K. pondicherryanus (Kossmat))

Austiniceras Spath (Type species, A. austeni (Sharpe))

Parapuzosia Nowak (Type species, P. daubreei (GROSSOUVRE))

Jimboiceras, Shimizu (Type species, J. planulatiforme (Jimbo))

Pachydesmoceras Spath (Type species, P. denisonianum (Stoliczka))

Lytodiscoides Spath (Type species, L. conduciensis (Choffat))

Achilleoceras van Hoepen (Type species, A. erasmusi v. Hoepen)

These have been mostly defined in the main chapter. They are intimately connected with one another in morphological characters and stratigraphic occurrences, forming a relatively natural and solid group. The diagnostic features of the family common to all of the above genera may be described as follows.

Discoidal shell consisting of many whorls (i.e. polygyral), more or less evolute, in general moderately umbilicate and mostly very large when full grown. Whorls usually compressed with an arched venter and flattened flanks, but in some case somewhat inflated, although never depressed as in certain Pachydiscids.

Shell periodically constricted and ornamented with numerous subcostae or ribs, which are essentially flexiradiate at least on the inner whorls, more distinct on the external half of whorls but sometimes modified, especially on the outer whorls. The ribs and constrictions show a forward curvature on the ventral area in most growth stages, except in the adult body chamber of certain genera.

Suture-lines of [E L U2 U3 (=S) U1 I] type; L well developed and the largest of all, being much larger than E, asymmetrically trifid in later growth-stages; U2 recurved or oblique; U1 reduced in size; subdivided elements of U3, together with U2 (externally) or U1 (internally), strongly descend towards the umbilical suture; saddles mostly bifid and all the elements are finely and deeply incised in later growth stages as in usually the case in Desmocerataceae.

As a general tendency in this family the diagnostic characters of each genus are exhibited more distinctly in late than in early stages of growth. Consequently most of the genera listed above are fairly similar, especially between the closely related ones, in their immature shell but differ considerably in the adult. In

too many cases only immature shells of Puzosiids have been described and it is often hard to understand the actual feature of the genera from such material. It goes without saying that the exclusive dependence for description on adult shells is also undesirable. I have paid attention to the characters in every stage of growth. The continuous material from the successive strata is also helpful for sound interpretation. The conclusion through this study is that the Puzosiidae is a fairly compact group, consisting of a series of forms which have evolved from a single stem, that is to say a monophyletic rather than polyphyletic family.

So far as the Albian and Upper Cretaceous forms are concerned, the Puzosiidae is generally quite distinct from the Desmoceratidae. The typical representatives of the latter are Desmoceras (s. s.), D. (Pseudouhligella), D. (Lunatodorsella), Tragodesmoceroides, Desmophyllites and Damesites. In the very young stage the two groups are, of course, very similar but at fairly early in immature stage the distinction begins to appear. In most of the growth stages the shell of Puzosiidae is more evolute and more widely umbilicate than that of Desmoceratidae. The proportion of umbilicus to diameter is generally 30-40% in the former as compared with about 20% or less in the latter. We should admit a few exceptions for these figures, since the outer whorl of some Puzosiids is more involute than the inner whorls. The difference in the suture is quite distinct. All the above listed genera of Desmoceratidae are essentially constant in their sutures, which I have called the Desmoceras-type. It consists of numerous, regularly arranged, finely and deeply incised elements, in which saddles are bifid and lateral lobes are trifid. L is not so large nor so asymmetric as in Puzosiids and all the numerous elements are arranged in a nearly straight row or quite gradually descending towards the umbilicus.

The test of Desmoceratidae is generally thin and is nearly smooth or weakly ribbed (keeled in *Damesites*). *Puzosia* in Puzosidae is rather weak in ornamentation, but broadly speaking, other genera in the same family have stronger ornament than most Desmoceratidae.

Desmoceratids are generally small or moderate in size, while Puzosiids mostly reach a very large size when full grown, although in a few genera of the latter, such as *Neopuzosia* and *Kitchinites*, a very large shell has not yet been known.

More or less sigmoidal, periodic constrictions appears in both groups and their curvature varies with species. Similarly the perpendicular umbilical wall with angular shoulders is not necessary rare in Desmoceratidae, though more frequently found in Puzosiidae.

Shortly, so far as the above listed forms are concerned, Puzosiidae is well distinguishable from Desmoceratidae. Generally speaking the former is somewhat more specialized than the latter in the ornamentation, sutures and in size. They may be a single, but flexible, stock with two branches of unequal specialization.

To clarify the natural systematic position of Puzosiidae we must study the Lower Cretaceous "Desmoceratids" (s.l.). However I am obliged to suspend the final decision of the problem since we have not enough material of them in our province.

From a preliminary study on some foreign specimens as well as literature followings are my preliminary views. Puzosiidae has its origin perhaps in Aptian *Melchiorites*. Although the type species, *M. melchioris* (Tietze), has a rather convergent whorl section, the genus includes species, such as *M. emerici* (Raspail), of rounded or elliptical whorl section. It has frequent constrictions and weak subcostae both of which show a prominent ventral projection, foreshadowing well the characters of *Anapuzosia* and *Puzosia* (s. s.). The suture of *Melchiorites* (Text fig. 1) has a subsymmetric L, which is not so large as in the outer whorls of *Puzosia* (s. s.) but nearly as large as in the immature shell of *Puzosia* and *P. (Anapuzosia*), and its descending of the auxiliaries, if present, is not so remarkable as in *Puzosia* (s. l.).

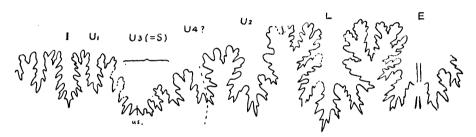


Fig. 1. A septal suture of *Melchiorites emerici* (RASPAIL) (immature) at a diameter of 33.5mm., BM. 437426 from Barrême (Basses Alpes), France. (T.M. del., by kind permission of Keeper of Geology, British Museum (Natural History)).

Between *Melchiorites* and "evolute Phylloceratids" (e. g. Fallot, 1920b) no one has discovered an intermediate from in the strict sense of the word, while *Melchiorites* is closely related, through some intermediate form (like '*Desmoceras*' ponticum Karakasch, 1907\*), to a nearly smooth and straightly constricted Desmoceratid group, perhaps a new genus, represented by '*Desmoceras*' crassidorsatum Karakasch\*, 1907 and '*Desmoceras*' loryi Paquier, 1900 (Barremian-Hauterivian) and their allies. That group may have its ultimate origin in *Eodesmoceras*. These Neocomian genera should not be included in the Puzosiidae (s. s.) since they have not acquired the diagnostic characters of the "family" defined above.

On the other hand there are a few Aptian species, like *Desmoceras voyi* Anderson, 1902 and *Ammonites athos* Coquand, 1865, which are referable or at least closely allied to *Desmoceras* (s.s.) (i.e. the *latidorsatum*-group of Albian-Cenomanian).

<sup>\*</sup> Mr. R. A. REYMENT has kindly helped me in translating the Russian description of KARAKASCH.

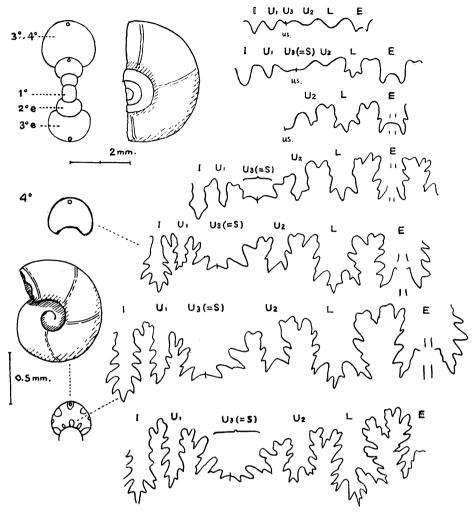


Fig. 2. Very early growth-stages of *Mesopuzosia pacifica*, sp. nov., showing whorl sections, lateral views and suture-lines. 1°l, 2°e,......late substage of the first whorl, early substage of the second whorl, etc. The suture at the bottom is at a whorl-height of 6mm. Specimen GK. H. 1246 from locality Y 216p1, Saku formation, Shiyubari Valley, Ishikari Province, Hokkaido. (T.M. Coll. & Del.)

Apart from the quite doubtful and indefinite genus *Phyllodesmoceras*, this kind of Aptian *Desmoceras* can be connected with the above mentioned "crassidorsatum-group" through such intermediate forms as *Ammonites inca* Forbes, 1845\* and *Valdedorsella*(?) getuline (Coquand), 1880.

Thus the branching of Desmoceratidae (s.s.) and Puzosiidae (s.s.) may have

<sup>\*</sup> I fortunately had an opportunity to study the holotype of Am. inca Forbes (BM. 13096) from Bogota, which has a good Desmoceras-type suture, gently sigmoidal constrictions and the fairly narrow umbilicus.

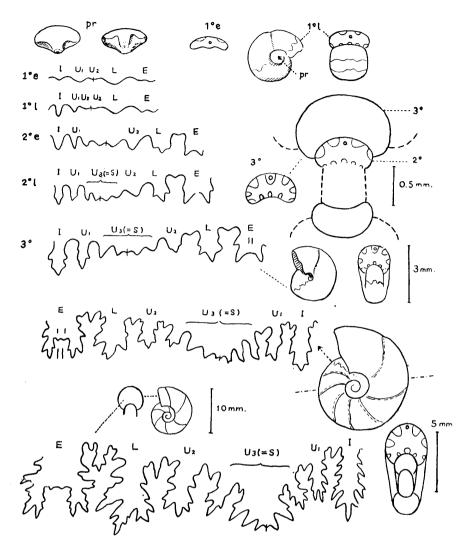


Fig. 3. Very young growth-stages of *Neopuzosia ishikawai* (JIMBO), showing enlarged protoconch, suture-lines, lateral views and sections of whorls up to a diameter of 10mm. pr.: protoconch,  $1^{\circ}e$ : early substage of the first whorl,  $2^{\circ}l$ : late substage of the second whorl. Specimen, GK. H2435 from locality N182f, zone Mh6 $\beta$ , Naibuchi Valley, South Saghalien. (T.M. Coll. & Del.)

taken place in late Neocomian. At that date the distinction of the branches was not clear enough for separation of families, but conventionally most of the Neocomian forms concerned could be grouped together in one 'family' or 'subfamily' with Eodesmoceras as its representative. Pseudohaploceras is one of the member of this Neocomian group, but does not seem to me the direct ancestor of Puzosia or Anapuzosia, because of too much development of costae and considerable difference in the curvature of costae and constrictions.

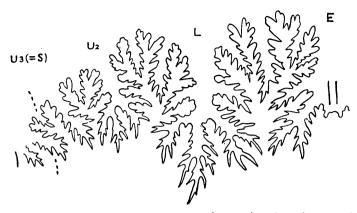


Fig. 4. External suture of *Neopuzosia japonica* (SPATH), enlarged, at a whorl-height of about 23mm., BM. C. 47735 from zone Mh6, Naibuchi Valley, South Saghalien. (T.M. Coll. & Del.)

In short I am inclined to group together *Puzosia*, *Anapuzosia* and the later members listed above in Puzosiidae (s.s.). It may have derived from the flexible Neocomian 'Desmoceratids', which, on the other hand, may also have given rise Desmoceratidae (s.s.) above defined. Probably each of the four families of the Upper Cretaceous Desmocerataceae is well stabilized to form a distinct group respectively, while the main stock of the Lower Cretaceous Desmocerataceae is still very flexible and not stabilized enough to form such distinct groups, apart from the lateral offshoots such as Holcodiscidae, Silesitidae and other derivatives.

Now I will turn to a short summary of the history of Puzosiidae within itself. The evolutional change of characters in Puzosiidae is rather slow and unremarkable, as is also the case in Desmoceratidae (s.s.). However there are a large number of forms so that the classification into the ten genera listed above is, I think, necessary and quite useful, although morphological criteria between the allied genera may not always be so remarkable as in many examples of the well ornamented Ammonitina. The geological range of each genus or species is generally rather long.

In the early epoch in the history of Puzosiidae, mainly in Albian, several genera have differentiated. They are, besides the simply ornamented and persistent *Puzosia* (s.s.), the more or less strongly ornamented *P.* (*Anapuzosia*), *Lytodiscoides* and *Achilleoceras* and the rather inflated and coarsely ribbed *Pachydesmoceras*. Their particular characters are, however, manifested mainly in the adult body chamber or later whorls and do not affect the immature shell, so that the specialization is by no means advanced. While *Anapuzosia* is known from Lower-Middle Albian, the other three genera appear near the top of Albian.

In the Upper Cretaceous, from Cenomanian to Maestrichtian, a very slow evolutional change proceeded in three parallel lines. The first is from *Puzosia* through

K 2	К3 <i>х</i>	Кзβ	Кзү	K 4 &	K 4 B	K 5 &	K 5 β	K 5 %	KSd	K 6	C
ARITAN	PALEO-	NEO-	INFRA-	PALEO-	NEO-	PALEO-	NEO-	INFRA-	PALEO-	NEO	
	MIYAKOAN	MIYAKOAN	GYLIAK.	GYLIAKIAN	GYLIAKIAN	URAKAWAN	PARAPUZOSIA	HETONAL.	HETONAIAN	HETON	)
				AUS	TINICERAS						
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Table I. Evolution of Puzosiidae and Desmoceratidae

Those in [ ] are to be excluded from Puzosiidae (s.s.) and Desmoceratidae (s.s.).

Mesopuzosia (mainly Turonian-Coniacian, rarely Santonian) to Neopuzosia (Santonian plus? earliest Campanian), in which gradual development of long ribs and strengthening of ribs took place, retaining quite well the fundamental characters of Puzosia. The second is from Puzosia through Austiniceras (Cenomanian-Turonian) to Parapuzosia (Coniacian-Santonian-earliest Campanian), in which differentiation of ribs into major (broad and long) and minor (narrow and short or branched out) ones and also some strengthening of ribs took place. The third one, still somewhat obscure in tracing precisely its history, is Puzosia (Anapuzosia) (Albian and? Cenomanian)-Jimboiceras (Turonian-early Santonian) series, in which extremely strong, sometimes flared, periodic ribs were specially developed on the outer whorl, besides some roundness of whorls, broadness of constrictions and increase of other ribs on the inner whorls.

Broadly speaking in all these series the straightening of ribs on the lateral sides is revealed as time goes on and that character affects even the inner whorls in *Kitchinites*, which is probably a descendant of *Neopuzosia*, acquiring at the same time some kossmaticeroid character (see remarks in *Neopuzosia*). *Pachydesmoceras* ranges up to Turonian with very slow change and does not seem to produce later derivatives.

There are a few forms, probably lateral offshoots, which are rather difficult to place in either of Puzosiidae or Desmoceratidae, for example Hauericeras, Oiophyllites and Tragodesmoceras. As we have a number of specimens of Hauericeras ranging from Santonian to Maestrichtian, I shall not discuss that genus until I describe them,\* although it might be included in Puzosiidae. Tragodesmoceras has been included in Puzosiidae and I myself regarded its resemblance to Tragodesmoceroides (of Desmoceratidae) as superficial (T.M. in T.M. (Editor), 1954). However, examining some specimens of that genus as well as literature, I am now inclined to change my previous view. I would like to restrict the genus to Ammonites clypealoides LEONHARDT, the type species, Ammonites clypealis Schlüter and their allies (e.g. two species reported from Turonian of North America (Morrow, 1935; Moreman, 1942)) and remove "Tragodesmoceras" mülleri (GROSSOUVRE) and "T." hernensis (Schlüter, 1868, non 1872) to Puzosia of orientale group and Nowakites (?) respectively. The genus thus revised is fairly narrowly umbilicate, involute and has a sutures of Desmoceras-type. It is closely allied to Tragodesmoceroides especially in the inner whorls but has a fastigate venter in the outer whorls where ribs form angular chevrons and the sharp mid-venter has a crenulation by the intersection of the ribs. Thus the genus is better removed from Puzosiidae to Desmoceratidae and is probably derived directly from Tragodesmoceroides or from Desmoceras (Pseudouhligella) in parallel with Tragodesmoceroides. At any rate its character is fairly

<sup>\*</sup> Oiophyllites will be mentioned when I treat with Hauericeras.

peculiar and the suture tends to be reduced, with minute fringing and broadening of elements, so that the genus can be regarded as a lateral offshoot, which, in turn, perhaps gives rise a particular form called *Muniericeras*.

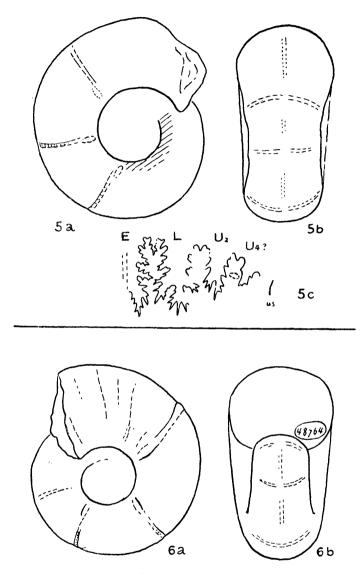


Fig. 5. Pseudopuzosia marlowense (Noble), holotype, Geol. Surv. & Museum, Great Britain, 25456, reussianum-subzone, Upper Turonian, Blounts Farm, Buckinghamshire, England. Lateral (a) and ventral (b) views, natural size, and suture-line (c), ×2. A posterior quater of the outer whorl is too much artificially treated, so that the umbilical nodes are not preserved. (T.M. del., by kind permission of the Director G.S.M.)

Fig. 6. Pseudopuzosia marlowense (Noble), another comparable specimen, BM. 48764, Holaster planus zone, Middle Chalk, Upper Turonian, locality unrecorded, Toulmin SMITH Collection (1869). Lateral (a) and frontal (b) views, natural size. (T.M. del., by kind permission of the Keeper of Geology, British Museum (Natural History)).

Another doubtful genus which has been assigned to Puzosiidae is *Pseudopuzosia* Spath, 1926. Examining the type species, *Desmoceras marlowense* Noble, 1911 (holotype, Geol Survey & Museum of Great Britain, 25456 and another referable specimen Brit. Museum (Nat. Hist.) 48764) (Text figs. 5, 6), I have recognized that the genus is a Pachydiscid provided with weak umbilical bullae at the edge of shallow constrictions of a slight curvature and sometimes with faint ribs on the lateral sides, never showing *Puzosia*-like ventral projection of the ornament. The subrounded and rather broad whorl and the pattern of suture, which are similar to those of *Anapachydiscus*, Yabe & Shimizu, also support the assignement to Pachydiscidae. And indeed this Turonian genus may be a possible ancestor of Senonian *Anapachydiscus* and *Nowakites*.

Lastly here is another doubtful group of species that have heen assigned to *Puzosia* but distinct enough to require a new generic name.

#### Genus Bhimaites, nov.

Type species: Ammonites bhima Stoliczka, 1865.

Generic diagnosis: Shell involute, fairly narrowly umbilicate and compressed at least in relatively late growth stages; umbilical wall steep; umbilical shoulder subangular to subrounded; flanks rather flattened; venter narrowly arched in typical forms. Constrictions frequent, rather prorsiradiate and only slightly flexuous on the flanks and projected forward on the venter. Surface nearly smooth, only with striae and sometimes with faint peripheral subcostae or weak lateral costae in the outer whorl. Suture-lines are deeply and finely incised, with large and asymmetrically trifid L as in *Puzosia* but consist of numerous elements as in *Desmoceras*, the auxiliaries being gradually or moderately descending towards the umbilical suture and U1 erect and distinct. Sometimes shell attains a large size.

Remarks: The new genus is typically represented by Ammonites bhima Stoliczkai and Puzosia stoliczkai Kossmat (=Ammonites beudanti Stoliczka) from the lower part of the Utatur group of India and probably Puzosia pinguis Crick, 1907 (=? P. bhima), P. subtillis Crick, 1907 and P. spathi Venzo, 1936 from the Cenomanian of Zululand (Africa). The last species occurs also in the Albian of Angola (Haas, 1942). Ammonites aliena Stoliczka, another Utatur species, and Puzosia furnitana Pervinquiere, 1907 from the Upper Albian of Tunis may be immature of this genus. The second species (stoliczkai) was reported also from the Cenomanian of Zululand (Crick, 1907, Spath, 1921). Fortunately I have been able to study the original specimens of Crick's pinguis (BM. C. 18243, C. 18244), stoliczkai (BM. C. 18241) and subtilis (BM. C. 18242). Although I have not had access to the Indian specimens, their description and illustration are so clear that the distinctness of the new genus is fully justified.

The genus is interesting in that almost all its characters indicate an apparently intermediate state between *Desmoceras* and *Puzosia*. In shell-from it is rather nearer to *Desmoceras* and very similar to the subgenus *Pseudouhligella*. *Bhimaites* has however somewhat wider umbilicus than *Desmoceras*, especially in the inner whorls. In this respect and in the character of its adult suture it is allied to but not identical with *Puzosia*. Although it is more involute than typical *Puzosia*, some of the Puzosiids do show relatively stronger involution and narrower umbilicus in their outer whorl. For instance, *Puzosia insculpta* Kossmat, a rare species from the Utatur group, and *Puzosia androiavensis* Breistroffer (in Besaire, 1936) from the Middle Albian of Madagascar seems to approach to *Bhimaites* in their relatively narrow umbilicus, considerable involution, frequent and rather prorsiradiate constrictions and very fine subcostation.

Between these two intimately related families we can expect an apparently intermediate form, which, however, is not necessarily a passage form in the phylogenetic sense. In such a case its assignement to either of the two families may be arbitrary, although it could be decided on the basis of phylogeny. Whether *Bhimaites* is a puzosioid derivative from *Desmoceras* (*Pseudouhligella*) or desmoceroid offshoot from *Puzosia* or otherwise is rather difficult to tell at present. Although I am rather inclined to the latter view, I suspend a final conclusion until I obtain the sufficient material to discuss the problem.

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Family Puzosiidae from Hokkaido and Saghalien

# **Explanation of Plates**

Eig 1	Burgaria autombanias (VARR MC) and	.~. 72
rig. 1.	Puzosia subcorbarica (YABE MS.) sp. nov	e the
	Ishikari Province, Hokkaido (H. YABE Coll.).	1921),
Fig. 2.	Pachydesmoceras pachydiscoides, sp. nov. Pag Lateral (a) and frontal (b) views, $\times \frac{1}{2}$ . Holotype, GT. I-2805, Miho group of Naibuchi Valley, South Saghalien (M. KAWADA Coll.).	
	Photos by C. UEKI.	

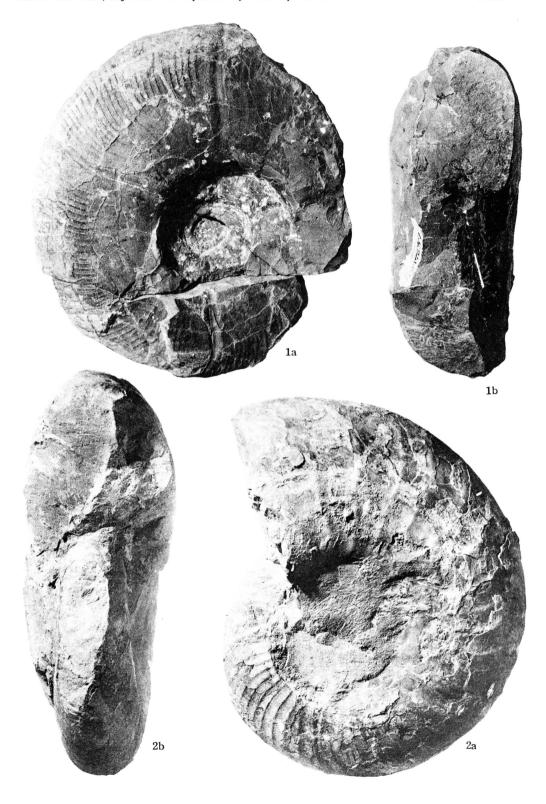


Fig. 1.	Puzosia nipponica, sp. nov	
Figs. 2,	Page Lateral view of inner whorls (2) and lateral view (3a) and cross-section (3b) of incomplete outer whorl, ×1/2. Holotype, GT. I-2639, locality N309d, zone M Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.).	the
	Photos by C. UEKI.	



Photos by T. MATSUMOTO.

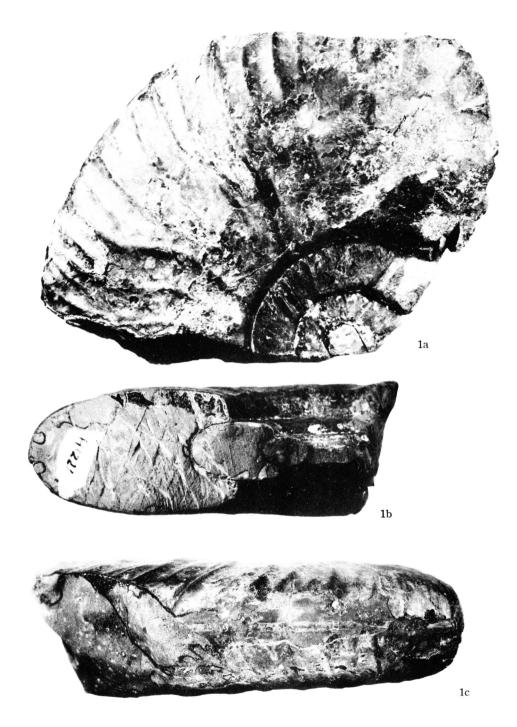
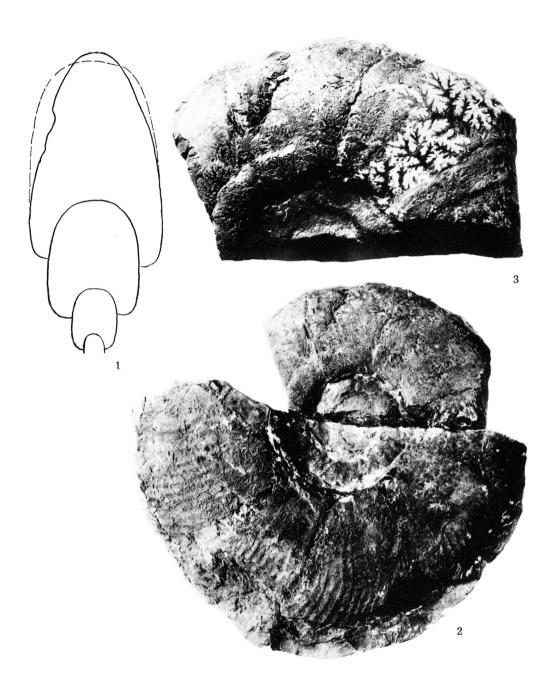


Fig. 1.	Puzosia subcorbarica (YABE MS.) sp. nov	
Figs. 2, 3	3. Puzosia orientale intermedia KOSSMAT.  Lateral view (2), ×2/3; A part of the same specimen showing suture-line (3 example from Japan, GK. H 1223, locality Y137, Shiyubari Valley, Ishikari Pi MATSUMOTO Coll.).	), ×1. An
	Del. & photos by T. MATSUMOTO.	



Figs. 1, 2.	Puzosia orientale sp. nov. Page 74 Lateral view of a part of the outer whorl (1), ×2/3; Lateral view (2a) and whorl- section (2b) of the inner whorls of the same individual, ×2/3. Holotype, GK. H 1225, locality Y420c, bed IIn, Shiyubari Valley, Ishikari Province, Hokkaido (T. MATSUMOTO Coll.),
	Photos by T. MATSUMOTO.
Figs. 3, 4	Mesopuzosia yubarense (JIMBO)
	Photos by C. UEKI.

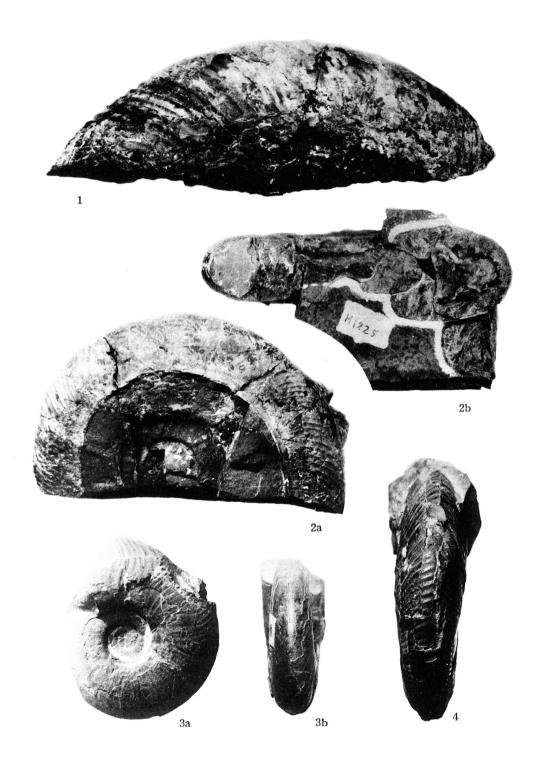
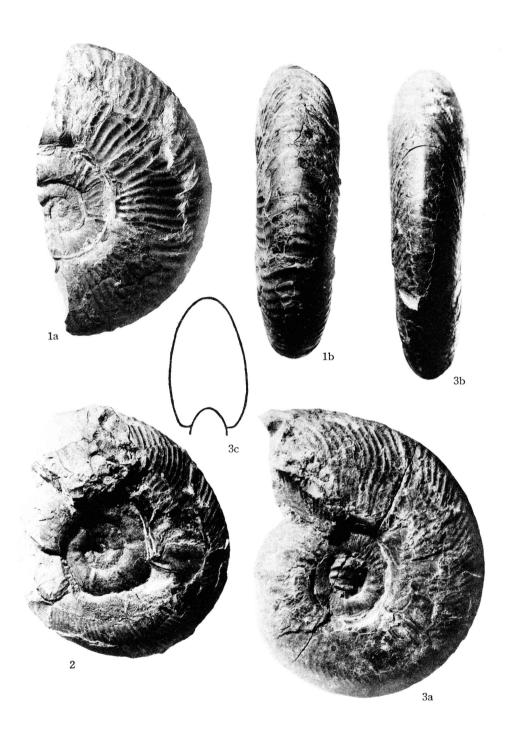
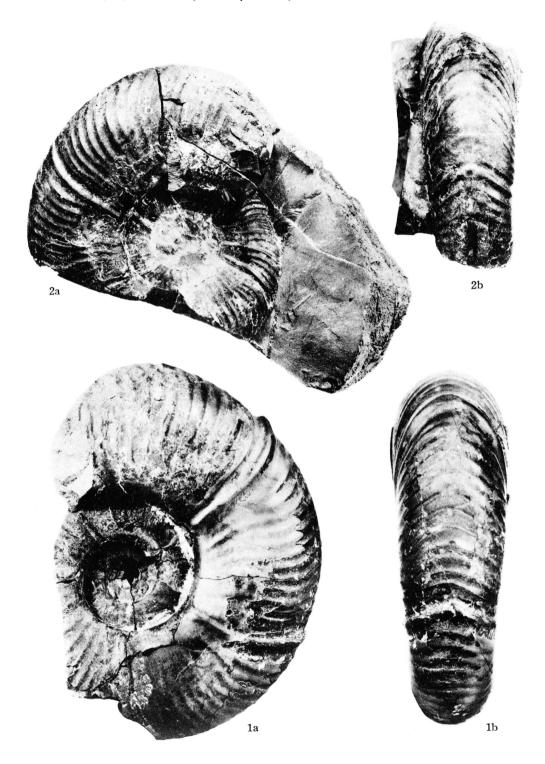


Fig. 1.	Mesopuzosia pacifica, sp. nov	
Figs. 2,	3. Mesopuzosia yubarense (JIMBO)	ri le-
	Photos by C. UEKI.	



Figs. 1,	2, Mesopuzosia pacifica, sp. nov	Page 82
	1. Lateral (a) and ventral (b) views, ×1. I	Holotype, middle-aged, GH. H 1257, locality
	Y216p, Saku formation, Shiyubari Valley, Ishil	kari Province, Hokkaido (T. MATSUMOTO
	Coll.).	
	2. Lateral (a) and ventral views, ×2/3. Page 2.	aratype, middle-aged, GH. H 1571, locality
	104, Oyubari area, Ishikari Province, Hokkaido	o (S. NAGAO & A. OSANAI Coll.).

Photos by T. MATSUMOTO.



Figs. 1-3.	Λ	<i>Aesop</i>	uzosia	pacif	ica, s	p. nov			. <b></b>							Page	e 82
	1.	Late	ernal	(a)	and	ventr	al (	b)	views,	× 1.	A	form	which	is	approa	ching	M.
	ine	dopac	fica i	n som	e res	pects.	GK.	Н	1245,	locality	, 1	7216p,	Saku	forn	nation,	Shiyu	bari
	Va	alley,	Ishik	arí Pi	rovino	ce, Ho	kkaid	do (	T. MA	TSUMO	то	Coll.)					

- 2. Lateral (a) and ventral (b) views, ×1. A relatively compressed form, middle-aged, GK. H 1244, locality Y115p, Saku formation, Shiyubari Valley, Ishikari Province, Hokkaido (T. MATSUMOTO Coll.).
- 3. Lateral (a) and ventral (b) views, ×1. A form with the abnormal ribbing, GK. H 1256b, locality Y216p, Saku formation, Shiyubari Valley, Ishikari Province, Hokkaido (T. MATSUMOTO Coll.).

Photos by K. KANMERA & K. FUJII.



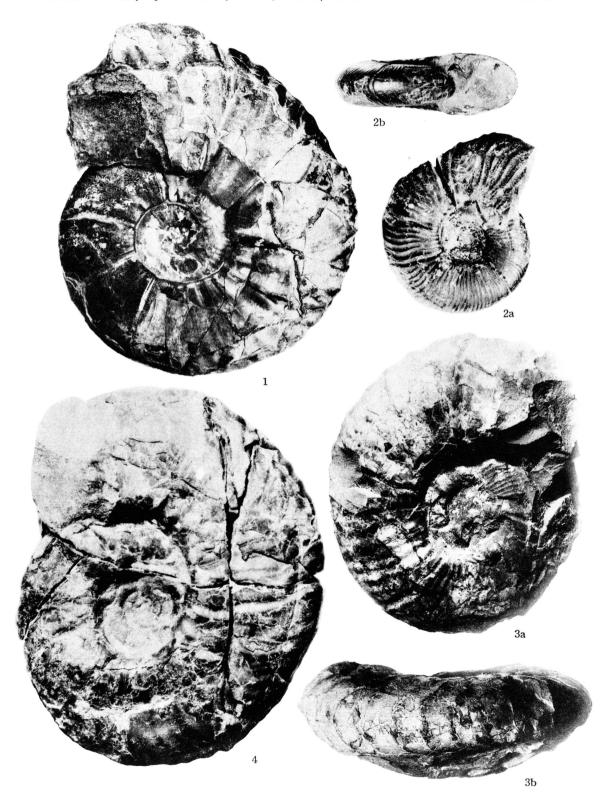
Figs. 1, 2. Neopuzosia japonica (SPATH)	Page 91
1. Lateral (a) and vetral (b) views, ×4/5. An example of	
5143, locality unrecorded in South Saghalin, purchased, S. NA	GAOKA Coll.
2. Two lateral views (a, b), ×1. Middle-aged shell of the s	ame individual.
Photos by T. MATSUMOTO.	



Figs.	1-4. Neopuzosia japonica (SPATH).	Page 91
_	1. Lateral view, ×4/5. An example of the adult shell, GK. H 5143, localit	y unrecorded
	in South Saghalien, purchased, S. NAGAOKA Coll. (The same specimen as	illustrated in
	Pl. 17 figs. 1, 2)	

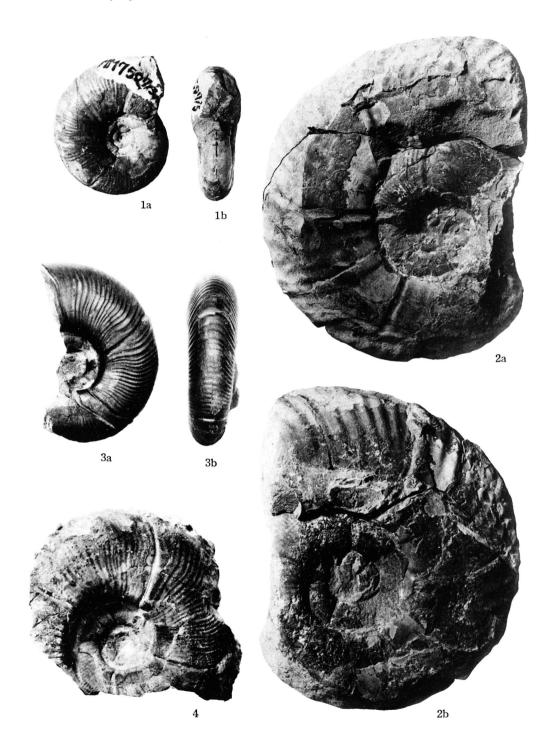
- 2. Lateral (a) and frontal (b) views, ×1. Immature shell, GK. H 3350, locality U600b, bed Ur2B', Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
- 3. Lateral (a) and ventral (b) views, ×2/3. Adult shell, GT. I-363, the right branch of the Sanushibe, Popets (Hobetsu), Iburi Province, Hokkaido (H. YABE Coll.).
- 4. Lateral view, ×1. GK. H 3360, locality U141p5, bed Ur1β, Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).

Photos by C. UEKI (fig. 3) and T. MATSUMOTO (figs. 1, 2 and 4).



Figs. 1-4.	Neopuzosia ishikawai (JIMBO)
	1. Lateral (a) and frontal (b) views, ×1. Lectotype, immature, reillustration of
	JIMBO's original specimen (=JIMBO, 1894, pl. i, fig. 5), GT. I-95, the Obirashibets,
	about 52 km. from its mouth, Teshio Province, Hokkaido (K. Jimbo Coll.).
	2. Two lateral views (a, b), $\times 2/3$ . An example of the adult shell, GT. I-2706, locality
	N202b2, zone Mh6α-β, Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.).
	3. Lateral (a) and ventral (b) views, ×1. Immature, GK. H 3366, locality U512r4,
	bed Ur2β, Urakawa area, Hidaka Province, Hokkaido (T. MATSUMOTO Coll.).
	4. Lateral view, ×1. A middle-aged example, GK. H 2458, locality N22z, zone Mh6,
	Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.).

Photos (1, 2) by C. UEKI and (3, 4) T. MATSUMOTO.



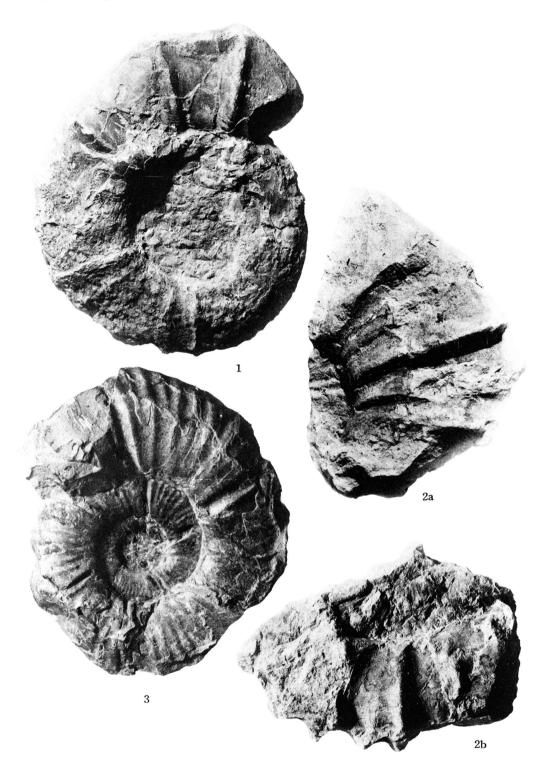
Figs. 1-4.	Jimboiceras planulatiforme (JIMBO)	<b>P</b> age 96
	1. Lateral view, ×2/3. Holotype, reillustration of JIMBO's original specimen (	
	1894, pl. i, fig. 4), middle-aged, GT. I-94, from a nodule of the Obirashibet	
	Province Hokkaido	

- 2. Latral view, ×1. An immature example, GT. I-354a, pebble of the Ikushumbets, Ishikari Province, Hokkaido (H. YABE Coll.).
- 3. Lateral view (a) and whorl-sections (b, c),  $\times 2/3$ . An example of the adult, with its body chamber mostly destroyed away. GT, I-3221, locality T42. Saku formation, Abeshinal-Saku area, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).
- 4. A fragment of the body chamber,  $\times 2/3$ . GT. I-2951, locality I-236p, zone Mh2 or Mh3, the Aikawa Valley, South Saghalien (T. MATSUMOTO Coll.).

Photos by C. UEKI.



Figs. 1-3.	Jimboiceras mihoense, sp. nov.	Page 98
	1. Lateral view, ×2/3. Holotype, adult, GT. I-2641, locality N131m, zone Mh5,	Naibuchi
	Valley, South Saghalien (T. MATSUMOTO Coll.).	
	2. Lateral view of fragmentary whorls (a, b), ×2/3. Paratype, adult, GT.	I-2642,
	locality N136a3, zone Mh5, Naibuchi Valley, South Saghalien (T. MATSUMOTO	Coll.).
	3. Lateral view, ×1. Paratype, middle-aged, GT. I-2650, locality N136, zon	ne Mh5,
	Naibuchi Valley, South Saghalien (T. MATSUMOTO Coll.).	
	Photos by C. UEKI.	



Figs. 1, 2. Mesopuzosia densicostata, sp. nov.	Page 87
1. Lateral (a) and frontal (b) views, Ca ×2/3. Holotype, GT. I-544, the San	
a tributary of the Naibuchi, upper part of the Miho group (zone Mh6), South	Saghalien
(M. KAWADA Coll.).	

2. Lateral view, Ca  $\times 2/3$ , Paratype, GT. I-3438, locality T311p, Wakkawembets, bed IIId or IIIe, Abeshinai area, Teshio Province, Hokkaido (T. MATSUMOTO Coll.).

Photos by C. UEKI.



Fig. 1.	Neopuzosia japonica (SPATH).  Two lateral (a, b) and frontal (c) views, ×1. An example of the adult shell, BM.C 47735, a pebble probably derived from zone Mh6, Naibuchi Valley, South Saghalien (TMATSUMOTO Coll.).
Fig, 2.	Neopuzosia ishikawai (JIMBO)
Fig. 3.	Neopuzosia aff. japonica (SPATH)
	Photos by I V BROWNS

