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Fossil on the cover is the six leaves in a whorl of *Trizygia oblongifolia* (GERM. & KAULF.) ASAMA from the Maiya formation (*Parafusulina* zone), Maiya, N. E. Japan.

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AMMONITOLOGY IN JAPAN—A HISTORICAL REVIEW

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日本におけるアンモナイトの研究史：わが国におけるアンモナイトの研究史は，世界全般の古生物学の発達と，幾代かにわたっての日本の学者の研究活動に負う所が大きい。およそ100年の学史を大別すると，次の4段階に分けることができる。

第1期（1873-1915）開拓時代（古典的モノグラフ）；第2期（1920-1950）L.F. SPATH 博士らの強い影響下，前半（1920-1935）少数専門家（清水博士その他）の活動，後半（1936-1950）ポスト清水（短篇のみ）；第3期（1951以降）研究活動旺盛（おもに分類と化石層序区分・対比）（*Treatise* 出版前後の国際的交流）；第4期（第3期と重複しつつ将来へ）パレオバイオロジカルな面も活発化

先達の開拓・建設の努力に感謝し，国際的の広い視野と地球生物学的の感覚をもって，今後いっそうの発展をはかりたい。

松本達郎

The history of researches on ammonites in our country may be divided in four major stages, depending much on the world development of palaeontology and also on the activities by Japanese palaeontologists for generations.

The first stage, until 1915, is characterized by monographic works. The ammonites obtained by pioneers' geological reconnaissance in various parts of Japan were described by MOJSISOVICS (1889), YOKOYAMA (1890, 1904a, b), JIMBO (1894), YABE (1901-2, 1903-4, 1909, 10, 14, 15) and DIENER (1915). The results were useful for the age determination of Mesozoic formations. Two interesting heteromorph genera, *Pravitoceras* and *Nipponites*, were discovered by YABE (1901, 4) in this stage. For some reasons (probably affected by World War I), there is a blank of activity for 1916-1920, but an issue of a revised textbook of palaeontology (in Japanese) by YOKOYAMA in 1920.

The second stage, from 1920 to 1950 is under a strong influence of L. F. SPATH's works. It is subdivisible into two substages. The earlier half, for 1920-1935, is characterized by SHIMIZU's activity ('26a-b, 27a-b, 30a-d, 31a-c, 32, 34, 35a-b), besides works by YABE and SHIMIZU ('21, 24, 25a-b, 26a-b, 27), YEHARA ('25, 26, 28), SHIMIZU and JIMBO ('33), TOKUNAGA and SHIMIZU ('26), KAWADA ('29) NAGAO ('31a-b, 32a-b) and KOBAYASHI ('35) for the descriptions of Mesozoic ammonites. These were within the framework of the systematics proposed by SPATH, who seemed to have classified the Ammonoidea on his philosophical basis of iterative evolution, and other authorities in Europe and America.

The biostratigraphic results in this stage were summarized by YABE and SHIMIZU ('33) for the Triassic, MABUTI ('33) for the Jurassic and YABE ('27) and SHIMIZU ('31, 35) for the Cretaceous. Only a species of Permian ammonite was reported in this substage (MABUTI, '35).

The later half, 1935-1950, is represented by a number of shorter papers, for instance HAYASAKA ('40) on two Permian species, YABE ('49) on an uncoiled (?) Triassic ammonite, KOBAYASHI ('47), KOBAYASHI and FUKADA ('47a-c) and FUKADA ('50) for some Jurassic ones, and MATSUMOTO's (1936, 38a-c, 42a-d, 47) preliminary results of studies on Cretaceous ammonites. The apparently less active situation was complementary with very active works by KOBAYASHI on Lower Palaeozoic nautiloid cephalopods from China and Korea and on non-marine fossils from the Mesozoic of East Asia. The field works, as exemplified by MATSUMOTO ('42-43) and MATSUMOTO and ONO ('47), however, constructed foundations for further advances in the next stage.

The research works in the third stage, since 1951, have been much stimulated by international exchange of knowledge, aided by publications of such comprehensive works as the *Treatise*, the *Osnovy* etc., and by airway transportation. A great number of papers have been published for the up-to-date descriptions of ammonites from Japan:—HAYASAKA ('54, 63), IGO ('64), YANAGISAWA ('67), NISHIDA ('71) and BANDO ('75) on some Carboniferous and Permian ones, which are still awaiting further descriptions; NAKAZAWA and SHIMIZU ('55), NAKAZAWA ('57, 58a-b, 64, 71) (S.W. Japan), SAKAGAMI ('55), KUMMEL and SAKAGAMI ('60) (Iwai), ONUKI and BANDO ('59a-b), BANDO ('64a-c, 66, 67a-b, 68a-b, 70, 71, 73), BANDO et al. ('70, 74) (Kitakami etc.), and ISHIBASHI ('70, 72, 73, 75) (Okinawa and Tanoura) on the Triassic ammonites; SATO ('54a-b, 55, 56, 57, 58, 59, 61c-d, 62a-c, 72, 74), SATO and KANIE ('63), SUZUKI and SATO ('72), MATSUMOTO ('56), MATSUMOTO and HIRATA ('70), TAKAHASHI ('69, 73) and HIRANO ('71, 73a-b) on the Jurassic ones; OBATA ('67a-b, 69, 73, 75), OBATA et al. ('75), MATSUMOTO et al. ('52, 66, 68, 69), NAKAI and HADA ('66), NAKAI and MATSUMOTO ('68), NODA ('72), SATO ('61) and TAKAHASHI ('73) on the Lower Cretaceous ones, HAYASAKA and FUKADA ('51), WRIGHT and MATSUMOTO ('54), MATSUMOTO ('53, 54a-b, 55b-c, 56, 57, 59, 60, 63, 65a-b, 67, 69, 70a-b, 71, 73b, 75) MATSUMOTO et al. ('53, 54, 55, 56, 57, 63a-b, 64, 66, 67a-b, 69, 72, 75) OBATA ('65), SAITO ('58-59, 61-62), HASHIMOTO ('73), HIRANO ('75) and TANABE ('75) on the Upper Cretaceous ones. Some of these works have contributed to improve considerably the taxonomic framework of certain families, e.g. Desmoceratidae, Pachydiscidae, Kossmaticeratidae, Acanthoceratidae, Collignoniceratidae, Nostoceratidae and Otoceratidae.

The biostratigraphic results are also significant in establishing a reference scale for the circum-Pacific areas and also in attempting zonal correlation with other standard or reference scales of the world, although there are further problems to be settled.

In the third stage the activities of Japanese palaeontologists are extended overseas to the ammonite faunas and type-specimens from certain areas as seen in the results of NAKAZAWA and BANDO ('68), KAPOOR and BANDO ('74), BANDO ('75), ISHIBASHI ('75), SATO ('61a-b, 63, 72, 75), KOMALARJUN and SATO ('64), MATSUMOTO ('55, 59b, 59-60a-c, 60, 66a-b, 73a), MATSUMOTO et al. ('58, 65, 66, 67, 69), and OBATA et al. ('75). They have contributed to the knowledge of international correlation and world palaeobiogeography.

The fourth stage has started already, overlapping the third, and will continue further on. By this I would *mean the* gradually increased importance laid on palaeobiological studies. SCHINDEWOLF's (1968) comments on ammonitology may mark a stimulating milestone for this trend.

To understand the lively ammonoids it is important to study the shell structure, its ontogenetic development, its functional morphology, its relation to the soft part, as well as the soft body itself. The analysis from population to population on the stratigraphically well sorted material, combined with palaeoecology and palaeobiogeography, would be essential to know the true state of evolution in the Ammonoidea. The results would give foundations for more natural classification and more precise zonation or correlation, as well.

Along these lines the works done in our country are still in the infancy, although there were some. SHIMIZU (29, 34) once examined through microsection the siphuncle and other shell characters in early ontogeny on some well preserved ammonites from Hokkaido and Sakhalin. This was an adventurous attempt but has been little developed further, until HIRANO's ('75) recent recommencement on similar material by means of up-todate methods. OBATA ('59, 60) has illustrated through longitudinal section the formula of spiral growth in some ammonites which show more than one phases in ontogenetic changes. On several occasions I endeavoured to make clear the ontogenetic development of sutures in certain genera and the results have been used by SCHINDEWOLF for his comprehensive and systematic treatment.

Dimorphism in ammonite species has recently received special attention. Although positive evidence has not been given for the interpretation of sexual dimorphism with the material from Japan, examples of lappet-bearing smaller forms as compared with commonly known larger shells of the Puzosiinae have been recently reported by MATSUMOTO et al. ('72). JORDAN and I notice examples of injured ammonites from Japan. This kind of study (not yet published) would give information on whereabouts of anatomically important portion of the soft body and also on the mode of life. A palaeobiochemical study, attempted by FUJIWARA ('61) on an ammonite, awaits advances in proper way.

On the basis of the favourable material of fossil population in a zone of the Ikushumbetsu sequence OBATA ('65) studied the ontogeny and allometry of *Reesidites minimus* and its relation to *Subprionocyclus normalis* from the underlying zone (Turonian). This is going to be improved by REYMENT ('75) by more precise mathematical treatment. TANABE ('75) attempts to clarify the chronological change of shell characters and its functional meaning in Turonian species of *Otoscaphites* and *Scaphites* from Hokkaido. This would serve as a step for further improvement of the concept of the life zone of ammonite species, as suggested by HAYAMI ('73).

The above works may foreshadow a fraction of the activity in the fourth stage and I would hope further development in palaeobiological aspects of ammonitology, keeping pace with the advances in taxonomic and biostratigraphic aspects.

References

References are omitted for brevity. See the chronological table (appendix) and also the bibliography in the *Palaeont. Soc. Japan Special Papers* Nos. 1, 9 and the forthcoming issue.

Appendix

Data for a historical review of ammonitology in Japan
—Chronological table of works (shortened titles)—

Abbreviation: Amm.=Ammonites, ammonoid, Cr.=Cretaceous, Jr.=Jurassic, Tr.=Triassic, L.=Lower, M.=Middle, Up.=Upper, F=formation, J=in Japanese, *=Palaeobiological work

1876. [LYMAN: Geol. sketch map Yesso.]
1889. MOJSISOVICS: Japan. Trias-Fossilien
1890. NEUMAYR: Jura *in* NAUMANN & NEUMAYR: Geol. Pal. Japan; YOKOYAMA: Verstein. japan. Kreide
1894. JIMBO: Kreide Hokkaido; YOKOYAMA: Text-book [J] [ZITTEL, 1876–93: Handbuch]
1900. [HYATT Cephalopoda *in* ZITTEL-EASTMAN's Text-book]
1901–2. YABE: 3 Up. Cr. Amm. (=*Pravitoceras*)
1903–4. YABE: Cr. Ceph. Hokkaido, I–II (=*Nipponites*)
1904. YOKOYAMA: Jr. fossils Rikuzen; Jr. Amm. Echizen & Nagato
1907. YAKOYAMA: Text-book [J]
1909. YABE: Strati. & Pal. Ob. Kreide Hokkaido & Sakhalin
1910. YABE: Scaphiten Hokkaido
1914. YABE: Amm. Tosa (Shikoku)
1915. DIENER: Triasfaunen; YABE: Cr. fossils Awaji & Toyajo

[1914–18 World War I]

1920. YOKOYAMA: Revised Text-book of palaeontology [J]
1921. YABE & SHIMIZU: Cr. Amm. Japan & Calif.
1924. YABE & SHIMIZU: *Brahamites* Sakhalin
1925. YEHARA: L. Tr. Amm. Nomura (Shikoku); YABE & SHIMIZU: *Crioceras* from Oshima; Prionotropidae, I
1926. YEHARA: Tr. Fauna Sakawa (Shikoku); YABE & SHIMIZU: *Parapachydiscus*; SHIMIZU *in* YABE et al.: Cr. Moll. Sanchu Graben; SHIMIZU: 3 interesting Cr. Amm.; Choshi Cr. [J]; TOKUNAGA & SHIMIZU: Cr. Futaba [Pan-Pacific Sci. Congr. Tokyo]
1927. YABE & SHIMIZU: Tr. fauna Rifu; SHIMIZU: Remarks on 2 Amm. Sakawa; *Perisphinctes* from Soma; YABE: Cr. Stratigr. Japan. Isl.
1928. YEHARA: L. Tr. Ceph. Shikoku
1929. KAWADA: 2 Amm. from Naibuchi; *SHIMIZU: Siphuncle [J]
1930. SHIMIZU: Tr. Amm. Sakawa; Anisic Amm. Kitakami; Ladinic Amm. Rifu; SHIMIZU: 2 Tithon. sp. *Perisphinctes* from Koike (Soma)
1931. SHIMIZU: Carnic *Proarcestes* Shikoku; Tithon. *Streblites*, Koike (Soma); SHIMIZU: L. Cr. Amm. Japan; NAGAO: Cr. *Anaptychus* like bodies; *Anaptychus* & *Aptychus*
1932. NAGAO: Jr. *Cornaptychus*; *Desmoceras*-operculum; SHIMIZU: Senon. Amm. *Pseudobarroisiceras*
1933. YABE & SHIMIZU: Tr. deposits Japan; SHIMIZU & JIMBO: L. Tr. Amm. Tao [J]; MABUTI: Jr. strati. S. Kitakami
1934. *SHIMIZU *in* SHIMIZU & OBATA, T.: Cephalopoda [J] [Iwanami series]; *NAGAO & SAITO: Septal features
1935. MABUTI: *Stacheoceras* from Kitakami (Perm.); KOBAYASHI: Jr. Torinosu; SHIMIZU: So-called *Hamites*; Up. Cr. Ceph. Japan, I

[Pal. Soc. Japan established]

1936. MATSUMOTO: So-called *Pachydiscus egertoni*
1938. MATSUMOTO: Goshora fauna (=*Pseudouhligella*); MATSUMOTO: *Zelandites*; Naibuchi biostrati.
1940. HAYASAKA: 2 Amm. Kitakami (Perm.); NAGAO: *Praestriaptychus* (Jr.)
1941. *MATSUMOTO: Interspecific relationships [J]
1942. MATSUMOTO: Notes on Desmoceratinae; Gaudryceratidae; Tetragonitidae; Phylloceratidae
42–43. MATSUMOTO: Fundamentals in Cr. Strati.

[1939–45 World War II]

1947. KOBAYASHI & FUKADA: *Ataxioceras*; *Katroliceras*; *Discosphinctes*; MATSUMOTO & ONO: Biostrati. Jr. Toyora [J]; KOBAYASHI: *Seymourites* & Jr. palaeogeography; MATSUMOTO: L. Cr. Amm. Yuasa [J]

1949. YABE: *Rikuzenites* from Tr. Kitakami; FUKADA: Atlas Jr. Amm. [J]

1950. FUKADA: *Perisphinctes ozikensis*

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1951. [Pal. Soc. Japan, Trans. Proc. N.S. No. 1; Special Pap. No. 1]
HAYASAKA & FUKADA: Ontogeny of *Barroisiceras minimum*; MATSUMOTO & MAEDA, Y.: *Pachydiscus* from Awaji [J]

1952. MATSUMOTO et al.: Cr. Amm. undivided Meso.

1953. MATSUMOTO & HASHIMOTO: *Pseudaspidoceras*; MATSUMOTO: Ontogeny of *Metaplacenticeras*

1954. HAYASAKA: Young. Palaeoz. Ceph. Kitakami; SATO: *Tmetoceras*; *Hammatoceras* Kitakami; MATSUMOTO (ed.): Cr. System Japan. Isl.; Selected Cr. leading Amm.; MATSUMOTO & SAITO, R.: Smooth Pachyd.; WRIGHT & MATSUMOTO: Doubtful Cr. Amm. genera; MATSUMOTO: Puzosiidae; KOBAYASHI et al.: Palaeont. I [J] - Asakura

1955. NAKAZAWA & SHIMIZU: *Glyptophiceras* from Hyogo; SAKAGAMI: L. Tr. Amm. Iwai; SATO: Amm. Kuruma (L. Jr.); MATSUMOTO: Evolution of Peroniceratidae; MATSUMOTO: Kossmaticeratidae; Bituberculate Pachyd.; MATSUMOTO & OBATA, I.: Up. Cr. Desmoceratidae

1956. SATO: Karakuwa (M. Jr.); Correlation L. Jr. [J]; MATSUMOTO: *Yebisites* (L. Jr.); MATSUMOTO: Kossmaticeratidae, further notes; MATSUMOTO & SAITO, R.: Cenomanian *Damesites*

1957. NAKAZAWA: *Monophyllites* [J]; SATO: Shizukawa (L. Jr.); MATSUMOTO: Turonian *Damesites;* MATSUMOTO, SAITO & FUKADA: Some Acanthoceratids

1958. NAKAZAWA: *Monophyllites arakurensis*; Tr. system Maizuru; SATO: Shizukawa, supplement; MATSUMOTO & MILLER: Cr. Amm. Kansas

58-59. SAITO, T.: Cr. fossils Nakaminato, I-II

1959. NAKAZAWA: 2 ceph. Nariwa; ONUKI & BANDO: M. Tr. Amm. Rifu; Tr. Amm. Isatomae; SATO: Berriasian in Kitakami; *OBATA: Croissance relative sur Desmoc.; MATSUMOTO: Zonation of Up. Cr. Japan; Cr. Amm. Alaska

59-60. MATSUMOTO: Up. Cr. Amm. California, I-III

1960. KUMMEL & SAKAGAMI: Mid-Scyth. Amm. Iwai; SATO: Courants océaniques froids Jr. Japonais; MATSUMOTO: *Graysonites* from Kyushu; Type Amm. Cr. Gulf Coast [J]; *OBATA: Spirale de Amm.

1961. [Pal. Soc. Japan: Catalogue of Type specimens]
SATO: Aalen. Amm. Mae Sot, Thail.; Oxf. Amm. Mindoro, Phil.; SATO: Jr.-Cr.; Berr. & Tith. fauna; *FUJIWARA: Amino-acid Cr. Amm. [J]

61-62. SAITO, Toshio: Up. Cr. Ibaraki & Fukushima, I-II;

1962. SATO: Biostr. Amm. Jr. Japon; Jr. Jap.-Amm. Zones; Zones d'Amm. Jr. [J]; MATSUMOTO & UEDA *in* UEDA: Type Himenoura

1963. [Pal. Soc. Japan: Revision of Classical Monographs]
HAYASAKA: Perm. Amm. Kitakami; SATO: Amm. Tr. Malaisie; SATO & KANIE: *Lillaetia*; MATSUMOTO & OBATA: Baculitidae;* Baculites-facies [J]; MATSUMOTO & OBATA: *Bevahites* from Shikoku; *MATSUMOTO: Ontogeny & evolution [J]

1964. IGO: *Goniatites* Hida; MURATA: Kanokura (list of Perm. Ceph.); NAKAZAWA: Anisian fauna Shikoku; BANDO: L. Tr. and Tr.-Perm. [J]; Tr. Strati. & Amm. fauna Japan; Mid. Tr. ceph. Jap.; KOMALARJUN & SATO: Aalen. (Jr.) Amm. Mae Sot, Thail.; MATSUMOTO et al.: *Yabeiceras*; MATSUMOTO: Cr. Ceph. faunal changes [J]

1965. MATSUMOTO et al.: Buried Cr. W. Taiwan; MATSUMOTO: Collignoniceratidae, I–II; *OBATA: Allometry of *Reesidites minimus*

1966. BANDO: Note on Tr. Amm.; NAKAI & HADA: Apt. Amm. Shimanto; MATSUMOTO et al.: Mesoz. Amm. Amami-Oshima; MATSUMOTO & OBATA: *Acanthoc.* Sakhalin; MATSUMOTO: Amm. Curaçao; MATSUMOTO, SASTRY & SARKAR: Notes on Cr. Amm. S. India, I; MATSUMOTO: *Amm. flaccidicosta*, Texas; MATSUMOTO & NODA: *Amm. bravaisianus*

1967. YANAGISAWA: Geol. Pal. Takakurayama (Perm.); BANDO: Tr. Amm. Inai; M. Tr. Amm. & strati. [J]; OBATA: *Valdedorsella* Miyako; Silesitids (*Miyakoceras*); MATSUMOTO: Nostoceratidae; MATSUMOTO & KANIE: *Ainoceras*; MATSUMOTO & MURAMOTO: 2 heteromorph Amm.; SUYARI et al.: Shimanto [J]; MATSUMOTO & SASTRY: Notes on Cr. Amm. S. India, II

1968. BANDO: U. Perm. & L. Tr. ceph. faunas [J]; BANDO: L. Tr. Amm. Kitakami & Maizuru [J]; NAKAZAWA & BANDO: L. & M. Tr. Amm. Timor; ANDAL et al.: Jr. Mansalay F., Philippines; HANAI et al.: Cr. Miyako Group [J]; NAKAI & MATSUMOTO: Amm. Cr. Fujikawa (Shikoku); MATSUMOTO *in* MATSUMOTO et al.: 2 Cr. Amm. Tomochi (Kyushu)

1969. TAKAHASHI: Jr. str. & Amm. fauna, Kitakami; OBATA: Douvilleiceratids Miyako; MATSUMOTO & HIRATA: Amm. Shimanto; MATSUMOTO et al.: Selected Acanthoceratids; MATSUMOTO & OTSUKA: Amm. Y. OGAWA Collection [J]; MATSUMOTO: Collignoniceratidae, III

1970. BANDO: L. Tr. Amm. Kitakami; BANDO & ARAKI: *Glyptophiceras* from Hiraiso (Kitakami) [J]; ISHIBASHI: Up. Tr. Amm. Okinawa, I; *SHIKAMA & HIRANO: Mode of occurrence (Toyora Amm.); MATSUMOTO & HIRATA: Jr. Amm. Kuraoka (Kyushu) [J]; MATSUMOTO: Collignoniceratidae, IV; Uncommon keeled Amm.

1971. NISHIDA: Carb. Amm. Akiyoshi; BANDO: Otoceratidae [J]; NAKAZAWA: L. Tr. Kurotaki fauna (Shikoku); HIRANO: Biostrati. Jr. Toyora, I; MATSUMOTO: Collignoniceratidae, V

1972. ISHIBASHI: Up. Tr. Ceph. Tanoura (Kyushu); SATO: Bajoc. Amm. Kitakami; SUZUKI & SATO: Jr. Amm. Toriashi [J]; SATO: Amm. Toarcien Saigon; NODA: Amm. (*Berriasella*) Yamabu (Kyushu); SHIKAMA & SUZUKI: Choshi Cr. [J]; MATSUMOTO et al.: Cenomanian gaudryc. Amm.; *MATSUMOTO et al.: 2 small desmoc. Amm.

1973. BANDO: Otoceratidae & Ophiceratidae; ISHIBASHI: Up. Tr. Amm. Okinawa, II; HIRANO: Biostr. Jr. Toyora, II–III; TAKAHASHI: Up. Jr.-L. Cr. Amm. Isokusa (Kitakami); OBATA: *Pseudoleymeriella* from Miyako; HASHIMOTO: *Hourcquia* from Abeshinai (Hokkaido); *MATSUMOTO: Late Cr. Amm. (Palaeobiogeogr.); Vascoceratid; MATSUMOTO et al.: Shimanto Cr. fossils Kagoshima (Kyushu) [J]; *HAYAMI: Evolutionary interpret. biostrati. zones [J]

1974. BANDO & SHIMOYAMA: Late Scyth. Amm. Kitakami; KAPOOR & BANDO: L. Tr. Kashimir; SATO: Jr. Amm. Inuyama (central Japan); MATSUMOTO *in* TAMURA et al.: Amm. (*Eucalycoc.*) Mifune; MATSUMOTO (ed.): Palaeontology, II [J]–Asakura

1975. BANDO: Perm. Medlicottiidae; *Subcolumbites*; L. Tr. Amm. Kashimir; ISHIBASHI: Up. Tr. Amm. Okinawa, III; Tr. Amm. Indonesia & Malaysia; SATO: Marine Jr. S.E. Asia (with list of Jr. Amm.); OBATA et al.: Cr. Choshi [J]; Alb. Amm. cent. Andes [J]; OBATA: *Diadochoceras*, Miyako; *REYMENT: *Reesidites*; MATSUMOTO: Additional Acanthoceratids; *HIRANO: Ontogeny of *Gaudryceras tenuiliratum*; *TANABE: Allometr. ontogeny & funct. morph. of *Otoscaphites puerculus*; MATSUMOTO & KAWANO: *Pseudocalycoceras*

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643. A FIND OF *PSEUDOCALYCOCERSA* FROM HOKKAIDO (STUDIES OF CRETACEOUS AMMONITES FROM HOKKAIDO AND SAGHALIEN—PART XXVII)

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北海道からシュードキャライコセラスの発見： *Pseudocalycoceras* はアカントセラス科の1属で，THOMEL (1969) が提唱した。模式種の *Ammonites harpax* STOLICZKA は，インド・マダガスカル・モロッコ・フランス南東部などに知られる。THOMEL (1972) は最近フランス南東部産の種をいくつか記載し，またチュニジア・中東などにも若干種が産することを指摘した。他方北アメリカでは，COBBAN & SCOTT (1972) が本属の実例を記載した。同じ年に北海道の幾春別から珍しいアンモナイトを河野が採集し，松本が研究した結果，これは *Pseudocalycoceras* の好例であり，しかも北アメリカ産の *P. dentonense* にきわめて近いものであることが分かった。本属の日本におけるはじめての認定である。松本は *Am. harpax* の模式標本を観察したことがあるので，これを基礎に，この際同属に入れるべき種を整理し直し，*Pseudocalycoceras* を再定義する。本属はフランスではセノマニアン最上部に産するとされているが，北海道産の種は *Kanabiceras septemseriatum*, *Sumitomoceras faustum* に伴い，*Inoceramus labiatus* らしきものをも伴うので，チューロニアン最下部の可能性はなお否定できない。最近国際的に問題となっているセノマニアン・チューロニアン境界の定義と対比に関連して，きわめて興味深い材料であるので，論議を試みる。 松本達郎・河野正志

Introduction

In July 1972 one of us (T. K.) collected an interesting ammonite from loc. Ik 1038, Ikushumbets, Hokkaido. This was so unfamiliar to Hokkaido that it was sent in 1973 to the other of us (T. M.) for further study. As a result it is clear that the specimen is an example of *Pseudocalycoceras* THOMEL, 1969.

Although only one specimen is available, the discovery is so important for the evaluation of this recently established genus and also for international correlation of Cretaceous sequences that we give a palaeontologic description of the ammonite in this paper. Notes are also given by one of us (T. M.) on the genus *Pseudocalycoceras*. We then discuss age correlation of the relevant strata.

Before going further we thank Messrs Masanobu KIKUCHI and Tatsuo MURAMOTO who gave us valuable information. Dr. Hiromichi HIRANO and Miss Mutsuko HAYASHIDA assisted us in preparing the plate and typescript. Finally we are much indebted to Mr. C. W. WRIGHT for critical reading of the first draft and

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* Received June 28, 1974: read June 15, 1974 at Osaka.

giving unpublished information on a British example.

Notes on *Pseudocalycoceras*

(by Tatsuro MATSUMOTO)

The generic diagnosis originally given by THOMEL (1969) and subsequently followed by others (e. g. KENNEDY, 1971, p. 81) is revised here in the light of a redefinition of the type-species and a revised list of species to be included in the genus.

Genus *Pseudocalycoceras* THOMEL, 1969

Type-species:—*Ammonites harpax* STOLICZKA, 1865.

Generic diagnosis:—Medium-sized, moderately involute to rather evolute, not markedly compressed or depressed, with flexuous to rursiradiate ribs, consisting of longer primaries and inserted or branched secondaries, distinct umbilical, inner [i. e. lower] ventrolateral, outer [i. e. upper] ventrolateral and siphonal tubercles. The outer ventrolateral and siphonal tubercles are more or less clavate and fairly closely spaced across a moderately rounded venter.

For most of the outer whorl the ribs are rursiradiate and comparatively coarse and the umbilical tubercles are stronger and may be twisted to S. Some of the ribs may be accentuated, without forming a tubercle, at the bending point on the flank.

On the last part of the adult body-chamber the ribs tend to be narrower and less distant, the outer tubercles weaken and are finally absorbed by an elevated rib and the umbilical tubercles become bullate and weaker.

The suture is of *Acanthoceras* type and probably varies to a considerable extent between species.

Restudy of Pseudocalycoceras harpax:—STOLICZKA (1865, p. 72) established *Ammonites harpax* on more than one specimen. Of the two illustrated syntypes, the one figured in pl. 39, fig. 1 (GSI. 169), which was regarded by STOLICZKA himself as representing a "regular or typical" form, is here designated as the **lectotype**. It came from a calcareous sandstone, west of Odium, near Moraviatoor, southern India.

On the basis of my observation of this specimen at Calcutta, notes are given below, with a sketch (Text-fig. 1).

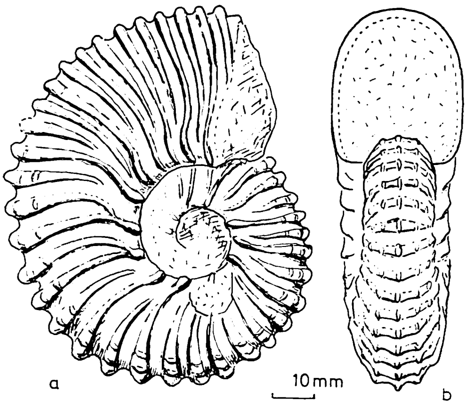
(1) The measurements of the lectotype are as follows:

	Diameter	Umbilicus	Height	Breadth	B./H.
Near the end	91.5(1)	27.5(.30)	38.0(.41)	33.5(.36)	0.88
−90°	74.5(1)	20.5(.27)	32.5(.43)	29.7(.39)	0.91
−270°	—	—	23.5	22.5	0.95

(2) The shell is moderately involute, with the outer whorl embracing the inner a little further than the row of inner ventrolateral tubercles. The umbilicus is accordingly of moderate size, not exceeding 30 percent of the entire shell diameter.

(3) The whorl is somewhat higher than broad in the adult stage, although it may be only slightly so in immature stages. It has nearly parallel and flattened flanks, a moderately round arched venter, subrounded umbilical shoulders and nearly vertical, partly overhanging, umbilical walls.

(4) There are numerous ribs, 38 on the last entire whorl; long and short ones as a rule alternate, though occasionally



Text-fig. 1. *Pseudocalycoceras harpax* (STOLICZKA).

Diagrammatic sketch of the lectotype, GSI. 169. Lateral (a) and frontal (b) views. (T.M. *delin.*)

two shorter ribs are inserted. On the last part (about 60°) of the body-chamber ribs are more crowded than on other parts, numbering 16 on the last quarter whorl. On the preceding half whorl, i.e. the posterior part of the body chamber and the last part of the septate whorl, which is here called the adolescent stage for convenience' sake, ribs are coarser than on other parts, numbering 16 per half whorl at this stage. Contrary to THOMEL's description (1969, p. 650), ribs never number 25 per whorl at any stage of this lectotype or in KOSSMAT's illustrated specimen.

(5) Ribs are somewhat prorsiradiate on the inner part of the flank, then curve backward, being more or less rursiradiate on the main outer part of the flank, and cross the venter with a considerable elevation. At the adolescent stage the convex curvature is strong, resulting in remarkable rursiradiate ribbing. In the last part the curvature becomes gentle. On the flank of the earlier stages the ribs look somewhat flexuous.

(6) In the adolescent part umbilical tubercles are prominent and apparently twisted. In the preceding part they are of moderate intensity. In the last part, i.e. on the anterior half of the body-whorl, they are bullate and tend to be weakened.

(7) In that last part the outer tubercles are much weakened and finally disappear, although the ribs are distinctly elevated. Otherwise the five rows of outer tubercles are prominent and clavate. They are nearly equidistant; the distance between the siphonal tubercle and the outer ventrolateral is slightly shorter than that between the outer ventrolateral and the inner ventrolateral, with a proportion of about 10 : 11 (i.e. 5.0 : 5.5 mm. at whorl-height=27 mm.).

(8) The suture illustrated by STOLICZKA (1865, pl. 39, fig. 1b) is essentially correct.

I do not know precisely the extent of variation in *P. harpax*. The other specimen illustrated by STOLICZKA (1865, pl. 18, fig. 2), which he regarded as a compressed variety of the same species, was transferred by KOSSMAT (1897, p. 14) to *Eucalycoceras pentagonum* (JUKES-BROWNE, 1896). This has recently been accepted by KENNEDY (1971, p. 81) but I think this assignment doubtful. I examined STOLICZKA's original specimen, GSI. 168, and observed that it is not referable to *E. pentagonum*, because it has somewhat rursiradiate ribs and distinctly clavate outer tubercles in five rows, of which first the inner ventrolateral and then the siphonal tubercles disappear before the outer ventrolateral, and because ribs are not effaced at mid-flank. This specimen might be a species of *Eucalycoceras*, allied to such species as *E. collignoni* (FABRE) (see THOMEL, 1972, p. 85, pl. 27, fig. 7), from the top of the Cenomanian in the Maritime Alps, showing intermediate features between *Eucaly-*

coceras and *Pseudocalycoceras.*

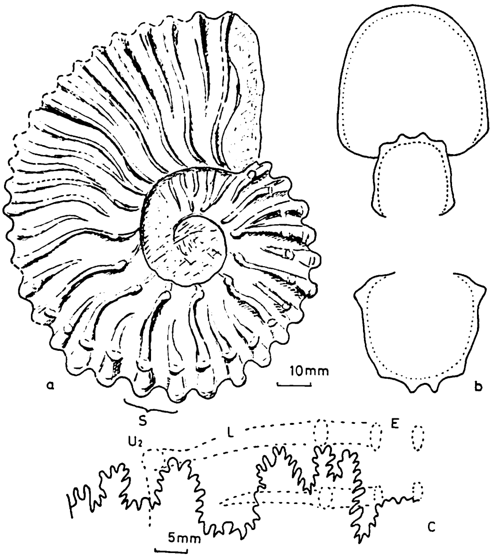
KOSSMAT (1897) dealt with five specimens of *P. harpax* but did not mention variation within the species. His illustrated specimen (KOSSMAT, 1897, p. 13, pl. 4, fig. 2) seems to represent what I call the adolescent stage. Its outer whorl has somewhat coarser and more distant ribs than the corresponding stage of the lectotype. Such a difference can well be considered to be within the extent of variation of the same species. Considerable variability is seen in a number of illustrated specimens of *P. harpax* from other areas (e.g. COLLIGNON, 1937, p. 33, pl. 1, figs. 1-4; COLLIGNON, 1964, p. 145, pl. 373, figs. 1620-1622, from Madagascar; COLLIGNON, 1966, p. 30, pl. 13, from Tarfaya, Morocco; THOMEL in PORTHAUL et al., 1966, p. 428, pl. 9, figs. 1-3; pl. 10, figs. 1-2; THOMEL, 1972, p. 88, pl. 29, fig. 3; pl. 30, figs. 10-11, pl. 31, figs. 1-5, pl. 32, figs. 1-2, from southeast France). Several subspecies were reported to occur in the same zone of France. If the fossil populations were examined more carefully, some of the subspecific names would prove to be unnecessary.

Species to be referred to Pseudocalycoceras:—THOMEL (1972, p. 88) listed seventeen species under the genus *Pseudocalycoceras.* It may indeed be difficult to comment on all of them without seeing the original specimens, but some species are better excluded from this genus. Certain other species should be added to the list. The following is a list of species which are to be referred to *Pseudocalycoceras.*

(1) *Ammonites harpax* STOLICZKA, 1865, type-species (see above).

(2) *Ammonites morpheus* STOLICZKA, 1865 (p. 80, pl. 38, fig. 1), from southern India. This was establised on two syntypes, but the unillustrated one is missing. Therefore, the illustrated one (GSI. 167), which I examined at Calcutta (Text-fig. 2), is designated here as the lectotype. In lateral view it does show the diagnostic features of *Pseudocalycoceras*, but it is very peculiar in that it has only two, instead of three, approximated rows of ventral clavi in addition to the tubercles at the ventrolateral shoulders. Moreover, in a limited part (−260° to −300°) of its outer whorl (i.e. the earlier half of the adolescent stage), a longer rib on the left side joins a shorter one on the right. These features suggest that it is a malformed shell.

C. W. WRIGHT reports (*in litt.*) that he has a specimen (19820) from Bed C of the Cenomanian of the Devon, England, consisting of one third of a whorl corresponding to the last quarter of the penultimate whorl and beginning of the last whorl of the lectotype. It closely



Text-fig. 2. *Pseudocalycoceras morpheus* (STOLICZKA).

Diagrammatic sketch of the lectotype, GSI. 167. Lateral view (a), whorl-section (b) and external suture (c) at S. (T. M. *delin.*)

resembles the lectotype except that the outer ventrolateral tubercles are much further apart and between them there is a row of siphonal clavi; at the earliest part of the fragment the siphonal tubercle is as strong as the outer ventrolateral, but by the end it has almost disappeared.

Pseudocalycoceras morpheus is allied to *P. harpax*, but is distinguished by its broader whorl (B./H.=1.05 at diameter of 113 mm), wider umbilicus (32 percent of diameter), stronger and coarser ribs (numbering 14 per half whorl at the adolescent stage) and broader, subquadrate lateral lobe (L). The accentuated elevation of the longer ribs at the bending point is considerable in the lectotype of *P. morpheus*.

This species was reported to occur in the Cenomanian (zone 5) of the Subalpines, southeast France, by THOMEL (1972, p. 91, pl. 32, figs. 3-4). His specimen is also characterized by four rows of outer tubercles, with disappearance of the siphonal tubercle at an early stage.

(3) *Acanthoceras barcousi* JONES (1938, p. 117, pl. 6, figs. 2, 3, 8, 9) from the basal part of the Eagle Ford Formation, Texas, and the Indidura Formation of Coahuila, Mexico. This is fairly similar to *P. morpheus*, but its siphonal tubercles are distinct and its ventrolateral tubercles are less clavate and its ribs less flattened than in the latter.

(4) *Eucalycoceras dentonense* MOREMAN (1942, p. 205, pl. 33, figs. 4, 5; text-fig. 2k), from the Britton Member of the Eagle Ford Formation of Texas, and the basal part of the Bridge Creek Limestone Member of the Greenhorn Limestone, Colorado (see COBBAN and SCOTT, 1972).

(4′) *Pseudocalycoceras* sp. aff. *P. dentonense* (MOREMAN), from Hokkaido, described below in this paper.

(5) *Calycoceras alaouitense* BASSE (1940, p. 449, pl. 8, figs. 1, 4), from the Cenomanian of Syria. This is fairly similar to *Pseudocalycoceras dentonense*, but owing to the secondary deformation of the specimens exact comparison is difficult. Another question is whether *Calycoceras paralaouitense* BASSE (1940, p. 449, pl. 7, fig. 4, pl. 8, figs. 2, 3; pl. 9, fig. 3) and *C. alaouitense* from the same locality are really different species or merely polymorphic variation of one and the same species. It is furthermore a puzzle that this species of *Pseudocalycoceras* is recorded as occurring with *Mantelliceras couloni* and two species of *Acompsoceras*, which suggest Lower Cenomanian.

(6) *Pseudocalycoceras eguituriense* THOMEL (1972, p. 92, pl. 29, figs. 6, 7, pl. 30, fig. 7; pl. 31, fig. 6), from the Upper Cenomanian of southeast France.

(7) *Acanthoceras haugi* PERVINQUIÈRE (1907, p. 270, pl. 14, fig. 1), from the Upper Cenomanian of Tunisia. This is closely allied to *P. barcusi* (JONES), although the rursiradiate ribbing is not so marked as in the latter. It has been reported to occur also in the Upper Cenomanian of the Middle East, Madagascar and southeast France (at the boundary of zones 5 and 6). THOMEL (1972, p. 96) proposed subgenus *Haugiceras* for this species.

The specimens which were described under the name of *P.* (*H.*) *robustum* THOMEL (1972, p. 98, pl. 47, figs. 6-7) could be within the variation of *P. haugi* in view of their resemblance and the occurrence at the same horizon (boundary of zones 5 and 6) in southeast France.

THOMEL's interpretation of *Pseudocalycoceras* seems to me too comprehensive. COBBAN and SCOTT (1972, p. 63) have pointed out that *Barroisiceras trinodosum* MOREMAN (1942, p. 212, pl. 33, figs. 1-2; text-fig. 2a) and *B. brittonense* MOREMAN (1942, p. 212, pl. 33, fig. 3; text-fig. 2b), assigned to *Pseudocalycoceras* by THOMEL, are abnormally formed specimens of *Metoicoceras whitei* HYATT. I consider it possible that *Pseudocalycoceras planum* THOMEL (1972, p. 93, pl. 30, figs. 1-6) could be grouped with "*Jeanrogericeras? sornayi* THOMEL (*in* PORTHAULT et al., 1966, p. 431, pl. 11, figs. 1-3) in *Thomelites* WRIGHT and KENNEDY, 1973, of the Metoicoceratinae.

Protacanthoceras collignoni FABRE (1940, p. 225, pl. 7, fig. 7, 8) could be referable to *Pseudocalycoceras* as KENNEDY (1971, p. 97) considered. I would provisionally assign it to *Eucalycoceras*, as THOMEL (1972, p. 85) did, although it is atypical, having mixed characters of the two genera.

I hesitate to ascribe *Protacanthoceras angolaense* SPATH (1931, p. 316), *P. batnense* COLLIGNON (1937, p. 36, pl. 2, fig. 3), *P. jullieni* COLLIGNON (1937, p. 36, pl. 2, fig. 1; pl. 8, fig. 3), and *P. judaicum* (TAUBENHAUS) (1920, p. 13, pl. 3, fig. 1; AVNIMELECH and SHORESH, 1965, p. 531, pl. 15, fig. 1) to *Pseudocalycoceras*, although they differ from typical species of *Protacanthoceras*.

I have no comments on *Protacanthoceras flandrini* THOMEL (1966, in PORTHAULT et al., p. 430, pl. 10, figs. 3-5), *Pseudocalycoceras pseudo-orbignyi* THOMEL (1972, p. 95, pl. 29, figs. 1-2) and *Pseudocalycoceras dromense* THOMEL (1972, p. 94, pl. 30, figs. 8-9). If they are to be referred to *Pseudocalycoceras*, they are all atypical.

Comparison and affinity: — Immature shells of *Pseudocalycoceras* are somewhat similar to *Protacanthoceras* SPATH, 1923. The latter genus is represented by *Ammonites bunburianus* SHARPE, 1853, type-species, and other allied species, mostly based on small specimens. COLLIGNON suggested (see THOMEL, 1972, p. 99) that the two nominal genera might represent a sexual dimorphism, microform *Protacanthoceras* and macroform *Pseudocalycoceras*. The available evidence is yet insufficient. COBBAN and SCOTT (1972) have shown specimens of various size in *Pseudocalycoceras dentonense*, which do not seem to support the above interpretation. In the specimen from Hokkaido described in this paper as *P.* sp. aff. *P. dentonense* the immature whorl has rather flattened flanks and somewhat, but not much, closely spaced three rows of ventral tubercles, but the ventral tubercles are not so distinctly clavate as in *Protacanthoceras*.

In the visible earlier part of the lectotype of *Pseudocalycoceras harpax* the ventral tubercles are somewhat clavate but not so closely spaced and the venter is not so high and narrow as in typical species of *Protacanthoceras*. KENNEDY (1971, p. 96) has recently given a revised diagnosis of *Protacanthoceras*. While the difference is not great in immature shells of *Pseudocalycoceras*, distinction in the adult shells is unmistakable.

WRIGHT and KENNEDY (1973, p. 26) suggest that *Protacanthoceras* may be micromorphs of *Thomelites*.

Pseudocalycoceras resembles *Eucalycoceras* SPATH, 1923 (see redefinition by KENNEDY, 1971, p. 80), in the fairly closely spaced ventral rows of tubercles which may disappear on the last part of the body-whorl, but is distinguished by its less involution, wider umbilicus, less compressed or broader whorl, less numerous and more distant ribs, which are characteristically rursiradiate on the outer whorl. In the typical species of *Eucalycoceras* ribs are rectiradiate and even somewhat projected forward on the ventral part. Exceptional examples in this respect are *Eucalycoceras collignoni* (FABRE, 1940) (see THOMEL, 1972, p. 85, pl. 27, fig. 7), from the Upper Cenomanian of France, and its allied species from

India [=*Ammonites harpax* STOLICZKA, 1865, p. 72 (pars.), pl. 38, fig. 2], in which the ribs are somewhat curved backward on the flank. In other respects, however these species are closer to the typical species of *Eucalycoceras* than to those of *Pseudocalycoceras*.

Pseudocalycoceras is apparently similar to *Paracalycoceras* SPATH, 1925 (see recent redefinition by KENNEDY, 1971, p. 79) in the strong, rursiradiate ribbing on the adult whorl. Only an incipient siphonal tubercle is discernible in the immature shell of *Paracalycoceras*, which shows "*Submantelliceras*" like aspect. *Paracalycoceras* has been known in the Lower Cenomanian and there are no connecting forms between the two genera. Probably the resemblance of the two genera is heterochronous homoeomorphy within the same family.

In THOMEL's (1972, p. 199) study of the French material *Pseudocalycoceras* has been endowed with an important position in the phylogeny of the Acanthoceratidae, a starting point were Metoicoceratinae and Mammitinae are going to branch apart from the Mantelliceratinae. This is considerably different from the previous view (e. g. REYMENT, 1955; WRIGHT, 1957) in which the origins of Metoicoceratinae and Mammitinae were ascribed to Acanthoceratinae. THOMEL (1972) furthermore interpreted *Pseudocalycoceras*, *Protacanthoceras* and *Eucalycoceras* as being derived in common from the group of *Calycoceras gentoni* (subgenus *Gentoniceras* THOMEL, 1972), regarding all of them as later members of the Mantelliceratinae. KENNEDY (1971), however, keeps *Protacanthoceras* in Acanthoceratinae. As I have now no good evidence to discuss the phylogeny, I merely draw attention to the problem.

Description of a species from Hokkaido

(by Tatsuro MATSUMOTO and Masashi KAWANO)

Family Acanthoceratidae DE GROSSOUVRE, 1894

Genus *Pseudocalycoceras* THOMEL, 1969

Pseudocalycoceras sp. aff. *P. dentonense* (MOREMAN)

Pl. 1, Fig. 1; Text-fig. 3

Compare:—

1927. *Acanthoceras* sp. A, MOREMAN, *Jour. Paleont.*, vol. 1, p. 95, pl. 15, fig. 2.
1942. *Eucalycoceras dentonense* MOREMAN, *Jour. Paleont.*, vol. 16, p. 205, pl. 33, figs. 4, 5; text-fig. 2k.
1942. *Eucalycoceras indianense* MOREMAN, *Jour. Paleont.*, vol. 16, p. 206, pl. 33, figs. 9, 10; text-fig. 2l.
1942. *Eucalycoceras lewisvillense* MOREMAN, *Jour. Paleont.*, vol. 16, p. 206, pl. 33, figs. 6, 7; text-figs. 2n, u.
1973. *Pseudocalycoceras dentonense*, COBBAN and SCOTT, 1972, *U.S. Geol. Surv. Prof. Paper* 645, p. 63, pl. 13, figs. 11-29; pl. 15, figs. 1-7, 10-13 (with a complete list of synonymy).

Material:—A specimen of T. KAWANO's collection from loc. Ik 1038, Ikushumbets, represented by a fairly well preserved internal mould.

Description:—The ventral portion of the adoral part of the body chamber is missing. If it was preserved, the shell would be about 90 mm in diameter. From various aspects the specimen is judged as representing an adult shell.

The shell is considerably evolute, with the umbilical seam of the outer whorl running along the row of inner ventrolateral tubercles of the next inner whorl. The whorls grow at a moderate rate, encircling an umbilicus of moderate size, 31 to 32 percent of the entire shell diameter.

The septate whorl is a little higher than broad and has rather flattened, roughly parallel flanks; the body chamber is nearly as high as broad or only very slightly higher than broad, having gently inflated flanks. The venter is arched and moderately rounded; the umbilical wall is steep and nearly vertical, the umbilical shoulder is subangular on the main part and subrounded on the last part of the body chamber.

The ornament of the "adolescent stage", which occupies about a half whorl, consisting of the last part of the phragmocone and the posterior part of the body chamber, with diameters from 45 to 65 mm, is most diagnostic. At this stage the ribs are strong and more or less rursiradiate; some of them are somewhat prorsiradiate on the inner part of the flank and then abruptly bent backward, being accentuated at the bending point, if not forming a tubercle. Bifurcated ribs and a simple one as a rule alternate. The bifurcation occurs at or near the very prominent, apparently backward twisted umbilical tubercle, whereas some of the simple ribs have a weaker umbilical tubercle. In this half whorl there are 12 ribs, separated by somewhat broader interspaces. The outer tubercles are moderately prominent; the siphonal and the outer ventrolateral ones clavate, equally strong and considerably approximated, forming three rows on the venter. The inner ventrolateral tubercle is nodate and more distant from the outer ventrolateral tubercle than the siphonal one.

On the earlier whorl the ribs are weaker, nearly rectiradiate or slightly prorsiradiate, and somewhat flexuous on the flank. The umbilical tubercles are rather bullate; the outer tubercles are distinct, the ventral three fairly approximated but not so distinctly clavate as in later stages. Shorter, inserted ribs have no umbilical tubercles. Ribs number 12 or 13 per half whorl.

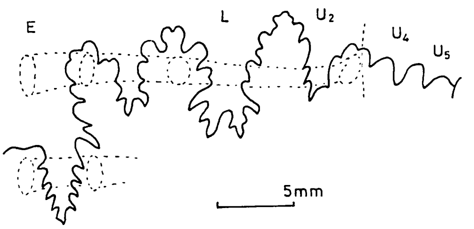
The body chamber occupies at least about half a whorl. On its earlier part (for about 60° or 1/6 whorl), the ornament of the "adolescent type" continues, but the outer tubercles in five rows tend to be gradually weakened. On the rest of the body chamber the ribs are mostly simple, equally long, fairly elevated but gradually becoming narrower than the ribs of the preceding stage. They are rather gently rursiradiate on the flank and cross the venter, where tubercles are obsolete. The umbilical tubercles are also weakened but remain as bullae at the shoulder. A weak extension of the rib on the inclined umbilical wall runs obliquely forward from the umbilical bulla to the umbilical seam. The intervals between the ribs are broader than the ribs themselves, but tend to decrease their breadth slightly towards the aperture. A shorter rib may occasionally be intercalated; this feature is uncertain because the last part of the specimen is incompletely preserved. There are 13 (+1?) ribs on the body chamber. Some of the ribs are slightly accentuated on the middle of the flank.

Sutures are of general acanthoceratid type. The features which may be characteristic of this species are (1) deepness of E, being twice as deep as L, (2) broadness of the first lateral saddle, which is asymmetrically bipartite, (3) L being somewhat narrowed at the middle of its stem, with lower lateral branches expanding on both sides, and (4) the second lateral saddle (between L and U2) being higher but much narrower than (about a half as narrow as) the first.

Measurements :—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
(1) Hokkaido	ca 90(?)	27.6(.30)	—	28 (.31)	—
″(−70°)	70.0	22.8(.32)	28.2(.40)	27.4(.39)	0.97
″(−160°)	60.5	19.0(.31)	26.0(.42)	24.0(.39)	0.92
(2) BEG. 19804	—	—	33.0	31.5	0.95
(3) BEG. 19805	—	—	25.0	23.0	0.92

(1) this specimen, (2) holotype of *E. dentonense*, (3) holotype of *E. indianense.*



Text-fig. 3. *Pseudocalycoceras* sp. aff. *P. dentonense* (MOREMAN)
External suture at whorl-height = 21 mm. The same specimen of KAWANO's Collection as illustrated in Pl. 1, Fig. 1a-e.

Comparison :—The described specimen from Hokkaido is very close to the holotype and other specimens of *Pseudocalycoceras dentonense* (MOREMAN), redescribed by COBBAN and SCOTT (1972), from the Britton Clay of the Eagle Ford Shale of Texas and the Bridge Creek Limestone Member of the Greenhorn Limestone of Colorado. We would agree with COBBAN and SCOTT in admitting a certain extent of variation in shell-form and ornamentation of *P. dentonense* and in regarding the types of MOREMAN's *Eucalycoceras indianense* and *E. lewisvillense* as specifically identical with *P. dentonense.* In fact the later half of the last whorl of our specimen is very close to the holotype (BEG. 19804) of *Eucalycoceras dentonense* MOREMAN and the earlier half to that (BEG. 19805) of *E. indianense.*

COBBAN and SCOTT report that ribs number 15-21 per half whorl. If this was the real extent of variation in rib density, our specimen would be outside it, because ribs number 12 or 13 per half whorl in ours. The difference is, however, small and we do not know the extent of variation in our population. Among the specimens illustrated by COBBAN and SCOTT, that of pl. 15, figs. 4-6 (USNM 163923) is the closest to our specimen. It seems to have 26 ribs in the last full whorl, showing almost the same rib density as ours. In spite of a considerable number of specimens from the United States no clear illustration of suture is available. The suture of the holotype is imperfectly preserved, although MOREMAN described it at some length. COBBAN and SCOTT reported that only parts of the suture were visible. Our specimen does show diagnostic features in suture. Whether the same features are maintained in American examples of *P. dentonense* or not is a point to be worked out.

In the above circumstances, we have to call our specimen for the time being *Pseudocalycoceras* sp. aff. *P. dentonense* (MOREMAN); the present specimen may represent a geographical subspecies of *P. dentonense.*

Our specimen is somewhat similar to the lectotype of *Ammonites harpax* STOLICZKA (1865), defined above, but has a broader and more inflated body-whorl, more distant ribs and nodate, instead of clavate, inner ventrolateral tubercles which are more distant from the outer ones. Even if we admit a certain extent of variability, *P. dentonense* is distinguishable from *P. harpax* in that in the former the shell is more evolute and more widely umbilicate, the three rows of ventral, clavate tubercles are more approximated and the inner ventrolateral tubercles are nodate, instead of clavate, and more distant from the inner ventral ones than in the latter. Probably the former has on the average less numerous ribs than the latter, although the range of rib density may overlap between the two species. Incidentally the sutural pattern of *P. harpax*, as illustrated by STOLICZKA (1865, pl. 39, fig. 1b) and COLLIGNON (1937, pl. 1, figs. 2, 4; pl. 8, figs. 1, 2), is essentially similar to that of our specimen, especially with respect to the character of the first lateral lobe.

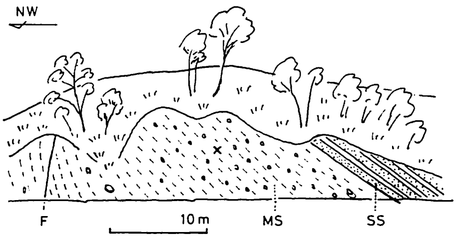
Occurrence:—Loc. Ik 1038, a cliff on the right side of the main stream of the Ikushumbets (see map in MATSUMOTO, 1965, fig. 2), where uppermost part of the middle siltstone member (unit IIc) of Mikasa Formation is exposed (see columnar section in MATSUMOTO, 1965, fig. 4). The described ammonite was contained in a calcareous nodule which was found at a horizon about 8 m stratigraphically below the green sandstone at the base of the Upper member (unit IId), as shown in a sketch of Fig. 4. It was collected and developed by T. KAWANO. The associated ammonites in the same nodule are a fragment of *Eucalycoceras* (?) sp. aff. *E. collignoni* (FABRE), *Allocrioceras* sp., *Sciponoceras* sp. and *Scaphites* sp.

Remarks:—In addition to the above described specimen there are three other incompletely preserved ones from the Ikushumbets area which may be of identical species. One is GK. H5692, collected by T. MURAMOTO from loc. Ik 1434p, Kami-ichino-sawa, a tributary of the Ikushumbets, which is somewhat deformed but shows essentially the same characteristic features as the above. Two others in the collection of Hokkaido University, No. 12434 and 12435, were tentatively described under *Eucalycoceras* sp. by MATSUMOTO, SAITO and FUKADA (1957, p. 38, pl. 11, fig. 2; text-fig. 14) but now seem to be better transferred to the present species, although they are too poorly preserved for a definite conclusion.

Correlation problem

The siltstone of about 15 meters which occupies the uppermost part of unit IIc, immediately below the green sandstone at the base of unit IId, is expoed at loc. Ik 1038 and Ik 987, across the main course of the Ikushumbets River. In this part of the Ikushumbets sequence *Kanabiceras septemseriatum* and *Sumitomoceras faustum* occur exclusively and are associated with *Sciponoceras kossmati*, *Allocrioceras* sp. and other species of ammonites. It represents the Zone of *Kanabiceras septemseriatum* which can be traced laterally in the Ikushumbets area.

In some previous papers (e.g. MATSUMOTO, 1959a, p. 65; MATSUMOTO et al.



Text-fig. 4. Sketch of the exposure at loc. Ik 1038.

SS. Green sandstone at the base of Member IId; MS. mudstone, containing calcareous nodules, upper part of Member IIc; ×A nodle from which the described specimen of *Pseudocalycoceras* sp. aff. *P. dentonense* was found; F. Fault. (T.M. *delin.*)

1969, p. 289) this zone was correlated with Lower Turonian, since *Kanabiceras septemseriatum* occurs characteristically in the zone of *Sciponoceras gracile* of the Gulf Coast and the Western Interior of the United States, which, in turn, had been assigned to Lower Turonian (MOREMAN, 1942; COBBAN and REESIDE, 1952). In the recent paper of COBBAN and SCOTT, 1972, the Cenomanian-Turonian boundary is put, though with a query, between the zone of *Sciponoceras gracile* and that of *Watinoceras coloradoense*. One of the reasons of this assignment by these authors is the frequent occurrence of *Pseudocalycoceras dentonense* in the zone of *Sciponoceras gracile*. In fact many species of *Pseudocalycoceras* have been reported to occur in the Upper Cenomanian of southeast France, mostly in the highest zone 6 and some in the subjacent zone 5 (THOMEL, 1972), but no example of *P. dentonense* has been found there. In the type Cenomanian of Sarthe, northern France, no species of *Pseudocalycoceras* was indicated in HANCOCK'S (1960) and WRIGHT and KENNEDY'S (*in* JUIGNET et al., 1973) reliable lists of Upper Cenomanian, although there seems to be a certain thickness of strata without ammonites near the Cenomanian-Turonian boundary.

KENNEDY (1971) has recently shown a fine scheme of ammonite sequence in the Cenomanian Lower Chalk of southern England. In spite of plentiful illustration of acanthoceratid species, no example of *Pseudocalycoceras* was shown in this British sequence. However, as recorded above (p. 10), C. W. WRIGHT reports *Pseudocalycoceras* cf. *morpheus* from Devon Bed C. It is noted that KENNEDY (1971, p. 125) is inclined to draw the base of the Turonian stage at the base of the *Mammites nodosoides-Mytiloides labiatus* Zone. In other words, the *Sciponoceras gracile-Metoicoceras whitei* Zone, the *plenus* Marls and those parts of the Middle Chalk below the appearance of *Mammites* and *Mytiloides labiatus*, yielding *Sciponoceras gracile*, *Kanabiceras* and *Neocardioceras* should be, according to him, considered Upper Cenomanian. It is, however, difficult to understand, for us who are unfamiliar with the details of the British field evidence, that the same author listed (KENNEDY, 1971, p. 103) as an ammonite assemblage of the Middle Chalk (lower part) *Mammites nodosoides*, *M.* spp., *Metasigaloceras rusticum* and *Fagesia pachydiscoides*, together with *Sciponoceras gracile*, *Kanabiceras* sp. *Watinoceras* sp. and *Neocardioceras* sp. This "assemblage" must be a mixed list of ammonite species from at least two zones; otherwise KENNEDY'S conclusion (in p. 125) would be inconsistent with his explanation of the faunal sequence (in p. 103).

Regarding the Cenomanian-Turonian boundary in the type sequence of the Mans (Sarthe) area, France, JUIGNET, KENNEDY and WRIGHT (1973) have recently presented a result of their valuable work with the following conclusion: (a) D'ORBIGNY'S base of Turonian must be above the *Metoicoceras* Zones and at the base of *Mammites nodosoides-Inoceramus labiatus* Zone; (b) it is not yet clear in which zone—or which stage—the *Neocardioceras juddi* and *Watinoceras* faunas should be placed.

So far as the available information from North America is concerned, species of *Watinoceras* are characteristic of Lower Turonian. *Sumitomoceras faustum*, which occurs in the Zone of *Kanabiceras septemseriatum* of the Ikushumbets sequence, is closely allied to *Sumitomoceras* [*Watinoceras* ?] *amudariense*, from the Lower Turonian of Turkestan (ARKHANGUELSKY, 1916). As has already been pointed out (see MATSUMOTO et al., 1969, p. 281), *Sumitomoceras* and *Watinoceras* are so to speak in a sisterhood relationship. In the sequence of England, as described by KENNEDY, *Sumitomoceras* spp. are listed, together with *Kanabiceras* sp. and others in his Zone of *Metoicoceras gourdoni* and *Watinoceras* sp., *Kanabiceras* sp., *Neocardioceras* sp., etc. in his list of Middle Chalk (lower part). Thus, in the British sequence, *Watinoceras* and *Sumitomoceras* begin to appear in Upper Cenomanian, if we follow KENNEDY's conclusion of correlation. Anyhow, we are anxious to know what kinds of *Sumitomoceras* and *Watinoceras* are found in which zones in England.

C. W. WRIGHT's (*in litt.*, 20 April, 1974) provisional view at present is that the *Neocardioceras-Watinoceras-Sumitomoceras* horizons should be treated as basal Turonian. *Watinoceras* is very closely related, with many transitional forms, to *Mammites*. *Sumitomoceras*, however, may also really occur with *Metoicoceras* in England.

In the sequence of Colorado studied by COBBAN and SCOTT (1972) *Kanabiceras puebloense* occurs in the Zone of *Mammites nodosoides*, unmistakable Lower Turonian, which is well distinguishable from *K. septemseriatum* of the underlying zone. Thus *Kanabiceras* passes across the Cenomanian-Turonian boundary in North America. We are again anxious to know what kinds of *Kanabiceras* are found in the British sequence.

Although the specimen is fragmentary, an ammonite referable to *Eucalycoceras* (?) sp. aff. *E. collignoni* (FABRE) was found in the same nodule as *Pseudocalycoceras* sp. aff. *P. dentonense* at loc. Ik 1038. This could be reckoned as evidence favouring the correlation with Upper Cenomanian, but the identification is not convincing. On the other hand, the occurrence of *Puzosia* sp. aff. *P. intermedia orientale* MATSUMOTO (Pl. 1, Fig. 2), *Gaudryceras* sp. aff. *G. varagurense* (KOSSMAT) (Pl. 1, Fig. 3) and *Zelandites kawanoi* (JIMBO) (all collected by T. KAWANO) from the same locality (Ik 1038) may be rather suggestive of a Turonian age, although these species may be long-ranging.

Sciponoceras kossmati (NOWAK) occurs fairly commonly in the same Zone of *Kanabiceras septemseriatum* and also immediately subjacent parts on the exposures along the Ikushumbets River (MATSUMOTO and OBATA, 1963). In Hokkaido fossils of the same species were obtained at loc. R 117 of the Kotanbetsu area in a musdtone unit from which *Inoceramus* (*Mytiloides*) *labiatus* was found (at loc. R 114) (see MATSUMOTO and OKADA, 1973, p. 285, figs. 7, 8) and also at loc. Y552a of the Shuyubari area in unit IIh above which (i. e. in unit IIj) *Calycoceras orientale* was found. Thus, the available evidence in Hokkaido shows that *S. kossmati* ranges from Middle Cenomanian to Lower Turonian. The holotype of *S. kossmati* came from the lower Trichinopoly Group (probably Lower Turonian) of India. Examples of the same species were recorded from California (MATSUMOTO, 1959b, p. 106). At one of the localities in California (i. e. CAS. 33719) *S. kossmati* is associated with *Kanabiceras septemseriatum* and *Inoceramus* (*Mytiloides*) cf. *labiatus* (MATSUMOTO, 1959c, p. 102).

Allocrioceras sp. and *Desmoceras* (?) sp. are associated with *Kanabiceras septemseriatum* and *Pseudocalycoceras* aff. *dentonense* in the Ikushumbets area. The former is represented by incomplete, fragmentary specimens and the latter by somewhat deformed specimens. We have to search for more and better specimens for the exact identification.

The associated *Inoceramus* resembles and could be identified with *I.* (*Mytiloides*) *labiatus*, but a careful work is needed for this sort of highly variable bivalve. In this connexion we are again anxious to know what kind of *Inoceramus pictus* s. l. occurs in the Zone of *Sciponoceras gracile* of North America.

A large sized species of *Inoceramus* which can be comparable with *I. pennatulus* PERGAMENT occur commonly in the main part of the siltstone of unit IIc immediately below the Zone of *K. septemseriatum* in the Ikushumbets sequence. In this part of IIc an example of *Calycoceras* cf. *naviculare* was obtained by OMORI (*in* IKEGAMI and OMORI, 1957, pl. 7, fig. 1a, b) from his loc. B11, about 73 m in distance (along a water supply channel) westward from the exposure of the green sandstone at the base of IId. This indicates unmistakably Upper Cenomanian. In the lower part of unit IId, which is composed of sandstone and sandy siltstone with some conglomerate, ammonites are very few and bivalves belonging to *Aphrodina*, *Glycymeris* and trigonians occur at several horizons. *Inoceramus hobetsensis* begins to appear in the middle part of IId, which indicates, together with *Collignoniceras woolgari*, Middle Turonian.

To sum up the present circumstances, it has become possible that the Zone of *Kanabiceras septemseriatum* in the sequence of Hokkaido might be assigned to the uppermost Cenomanian in terms of the international scale, although the previous assignment of the Lower Turonian could still remain as another alternative. It is emphasized that internationally cooperative work is keenly required for the final solution of the correlation problem.

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Porthault, B., Thomel, G. and Villout-

Explanation of Plate 1

Fig. 1. *Pseudocalycoceras* sp. aff. *P. dentonense* (Moreman) ....Page 13
Kawano Collection, from loc, Ik 1038, uppermost part of Member IIc of the Mikasa Formation, Ikushumbets area. Lateral (a) and ventral (b) views, slightly enlarged (×1.1) ; diagrammatic costal whorl-section at each 90° (c-e), ×1.

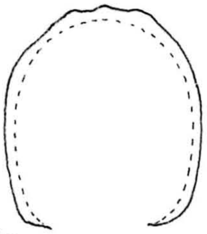
Fig. 2. *Puzosia* sp. aff. *P. intermedia orientale* Matsumoto ....Page 18
Kawano Collection, from loc. Ik 1038, lateral view, ×1.

Fig. 3. *Gaudryceras* sp. aff. *G. varagurense* (Kossmat) ....Page 18
Kawano Collection, from loc. Ik 1038, lateral view, ×1.

Photos by H. Hirano, without whitening. Figs. 1c-e T. M. *delin.*

1b

1a



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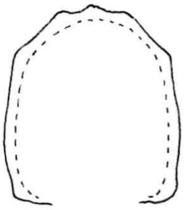

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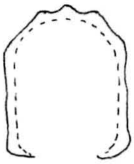

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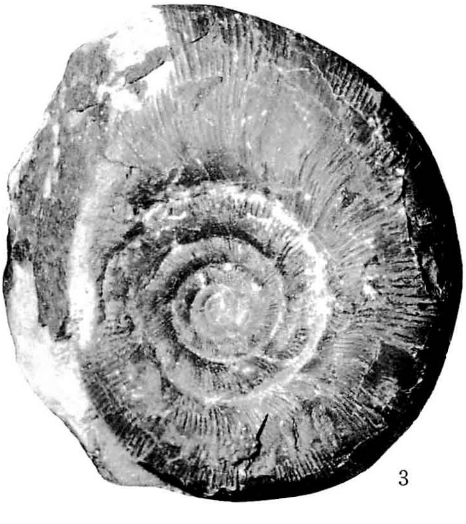
2



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P. S. This work has been done within the framework of the IGCP project entitled "Mid-Cretaceous Erents".

Ikushumbets [=Ikushunbetsu]	幾春別
Kami-ichino-sawa	上一の沢
Kotanbetsu	古丹別
Mikasa	三笠
Shuyubari	主夕張

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 97, pp. 22-31, April, 30, 1975

644. DISCOVERY OF LATE PERMIAN *ARAXOCERAS* FROM THE TOYOMA FORMATION IN THE KITAKAMI MASSIF, NORTHEAST JAPAN*

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北上山地登米層よりペルム紀後期 *Araxoceras* の発見：宮城県本吉郡本吉町平磯海岸に分布する登米層より，アンモナイト *Araxoceras* sp. が発見された。産出標本は1個体で，小型のうえ保存状態は良好とはいえないが，外形の特徴はよく保存され，中国江西省の呉家坪層の楽平含炭層より記載された *Araxoceras kiangsiense* CHAO と酷似する。産出地点は最下部トリアス系平磯層の模式地より連続する露頭で，平磯層基底の不整合面より15m下位にある。登米層の最近の化石層位学的研究結果に従うと，共存する化石から *Araxoceras* 産出層準は登米層中部の *Palaeoneilo ogachiensis-Phestia kon'noi* (MS) 帯にあたる。*Araxoceras* はトリアス紀初期の *Otoceras* に系統進化するもので，中国のほかソ連のアルメニアおよびイランのズルファ，イラン中部のザクロス山脈から報告され，テーティス海域のペルム紀後期 Dzhulfian Stage を待徴づける。登米層中部より *Araxoceras* が産出し，その層準が決定したことは，大きな意義をもつ。

村田正文・坂東祐司

Introduction and Acknowledgments

The Toyoma Formation, representing the upper part of the Permian System in the southern part of the Kitakami Massif, consists mainly of black slate of about 1,700 meters in thickness. In spite of the stratigraphical and paleontological studies by many authors for many yeras, no fossils useful for dating the formation have been found. HANZAWA and MURATA (1963) and MURATA (1964, 1969) assigned the Toyoma Formation to the Late Permian age, on the basis of its stratigraphical position and the geological age of the underlying formations, because of the lack of fossils.

In the present article the writers describe a Dzhulfian ammonoid, *Araxoceras*, collected from the Toyoma Formation and stress its stratigraphical significance.

The writers offer their cordial thanks here to Dr. Kotora HATAI, Professor Emeritus of Tohoku University, and to Dr. Yoshio ONUKI, Hase Geological Survey Office, Sendai, for their kind guidance

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and advice to this study. The writers also express their sincere thanks to Professor Keiji NAKAZAWA, Kyoto University, and to Associate Professor Ken-ichi ISHII, Osaka City University, for their advice and encouragement. The present authors are indebted to the member of the Permo-Triassic Working Group who are concentrating on the Lower Himalayan Belt in a comparative study with the Permian ammonoids from Kashmir of India and from Iran. The writers' sincere thanks are extended to Dr. Hushang TARAZ and Mr. Farrock GOLSHANI of the Geological Survey of Iran, for their kind help during the field work in Iran, in 1969 and 1972.

Stratigraphical Note of the Toyoma Formation at the Ammonoid Locality

The Toyoma Formation was proposed by MABUTI (1932, MS) for a thick clay slate formation, which is superposed with conformity upon the Yamazaki Conglomerate, exposed in the vicinity of Kitazawa, Toyoma-cho, Tome-gun, Miyagi Prefecture. In the Kitakami Massif, the Toyoma Formation is developed in six separate areas, and shows rather uniform lithological facies, consisting of thick black slate intercalated with medium- to fine-grained sandstone layers and small lenses of pebbly conglomerate in the lower part. The Toyoma Formation is covered with distinct unconformity by the Scythian Hiraiso Formation. Consequently, the thickness of the Toyoma Formaton varies in different areas due to the pre-Triassic erosion. In the type area, this formation is 750 meters thick, and the maximum thickness attains 1,700 meters in the Utatsu Area.

The Toyoma Formation in the southern part of the Kitakami Massif is almost barren of fossils. However, in the past nearly fifty years some fossils were found sporadically from the formation, and were listed by MABUTI and NODA (1934), INAI and TAKAHASHI (1940), SHIIDA (1940), CHISAKA (1935), ONUKI *et al.* (1960), UEDA (1963) and SATO (1969). Some of the fossils were described by HAYASAKA (1924, 1967), SUGIYAMA (1942), KOBAYASHI (1945), MURATA (1967, 1969) and NAKAZAWA and NEWELL (1968).

Recently, the senior writer was successful in working out a biostratigraphical subdivision of the Toyoma Formation as follows :*

> *Kitakamispira hanzawai* (MS)—*Nuculopsis mabutii* (MS) zone, *Palaeoneilo ogachiensis*—*Phestia kon'noi* (MS) zone, and *Euphemitopsis kitakamiensis*—*Astartella toyomensis* zone.

The lower fossil zone is defined by the stratigraphic range of *Euphemitopsis kitakamiensis* MURATA and *Astartella toyomensis* NAKAZAWA and NEWELL. This zone can be confirmed in almost all of the six areas. It corresponds to the lower of the Toyoma Formation, from the base up to about 500 meters. In the Kitakami Massif, *Lepidolina multiseptata* (DEPRAT) and *L. kumaensis* KANMERA range up to just below the *Euphemitopsis kitakamiensis—Astartella toyomensis* zone as shown in Fig. 3. The middle fossil zone is defined by the range of *Palaeoneilo ogachiensis* HAYASAKA and *Phestia kon'noi* MURATA (MS). It is about 500 to 600 meters thick uniformly, and is widely distributed except for the Karakuwa Area. This fossil zone corresponds to the middle part of the Toyoma Formation, however, the upper part of the formation was

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* Details of the biostratigraphical and paleontological studies on the Toyoma Formation will be treated in the next paper.

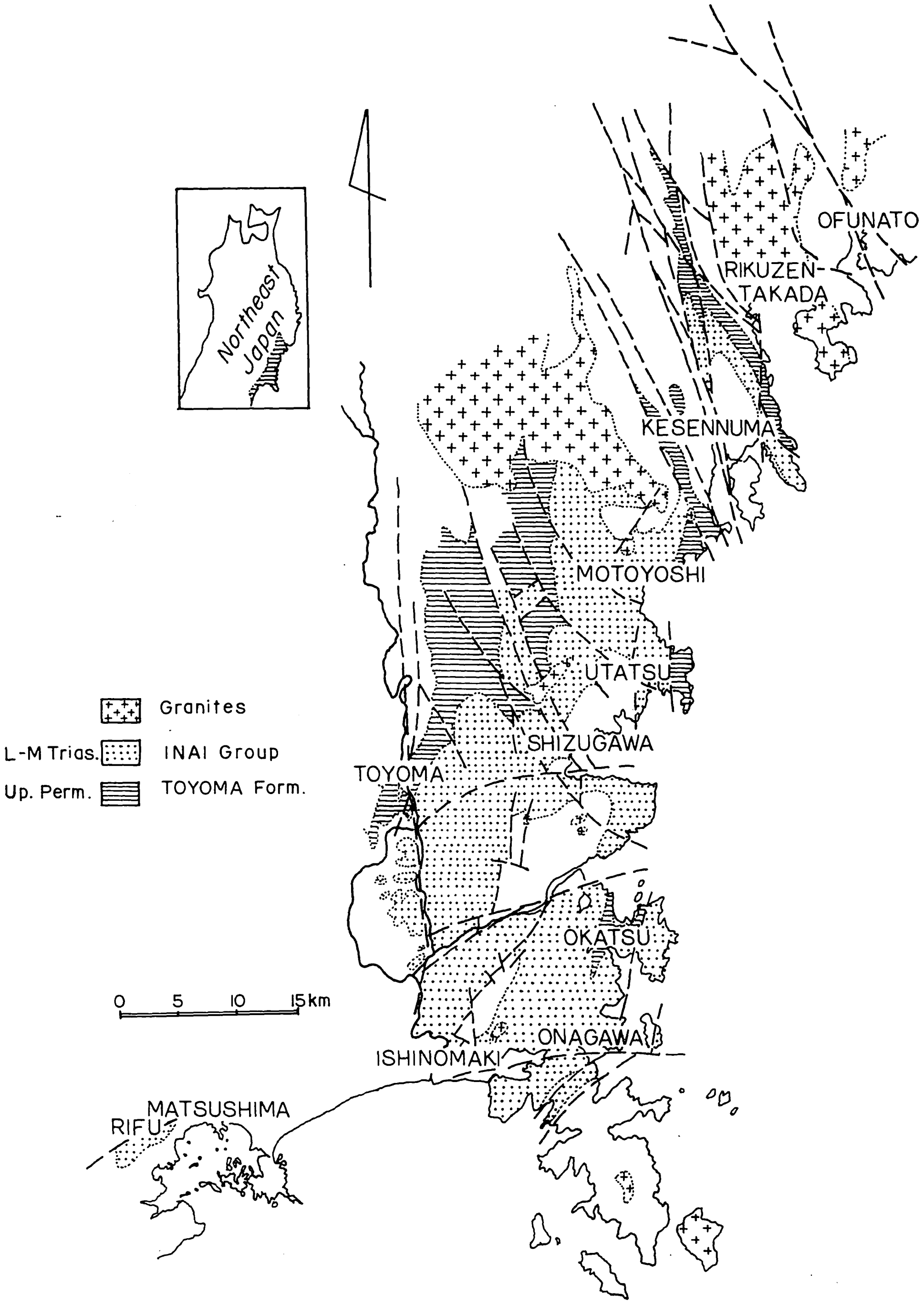

Fig. 1. Distribution of the Toyoma Formation in the southern part of the Kitakami Massif.

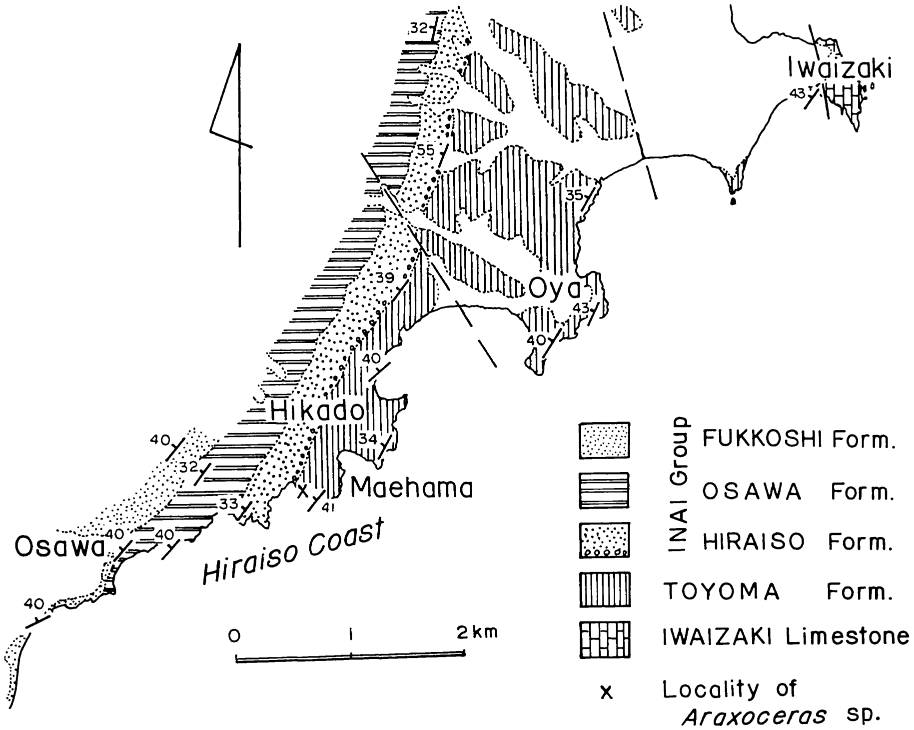

Fig. 2. Geological map of the Toyoma Formation in the Motoyoshi Area.

eroded away throughout before the beginning of the Triassic. The upper fossil zone is only confirmed in the Utatsu Area, where the Toyoma Formation attains its maximum thickness.

The sea coast of Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, where the present *Araxoceras* sp. was found, is the type locality of the Early Triassic (Scythian) Hiraiso Formation. Here the black slate of the Toyoma Formation is covered by the Hiraiso Formation with distinct unconformity. The Toyoma Formation is exposed sporadically along the sea coast from Hiraiso to Iwaizaki, Kesennuma City, Miyagi Prefecture, and rests conformably on the Middle Permian Iwaizaki Limestone. Although the Toyoma Formation is cut by many faults, its thickness is estimated about 900 meters at Hirasio.

From the uppermost part of the Iwaizaki Limestone, *Lepidolina multiseptata—L. kumaensis* fauna was described by MORIKAWA (1960) and CHOI (1970, 1973). The fauna of the *Euphemitopsis kitakamiensis—Astartella toyomensis* zone could not yet be found from the lower part of the Toyoma Formation in the Hiraiso Area, except for a trace fossil of *Notaculites toyomensis* KOBAYASHI. From a horizon 10 to 20 meters below the base of the Lower Triassic Hiraiso Formation at Hiraiso, however, the Toyoma Formation yielded many molluscan fossils. *Bellerophon* sp., *Leda* sp., *Yoldia* sp., *Anthraconeilo* sp. and *Nuculana* sp. were listed from this horizon by MABUTI and NODA (1934). Recently, the senior writer distinguished *Palaeoneilo*

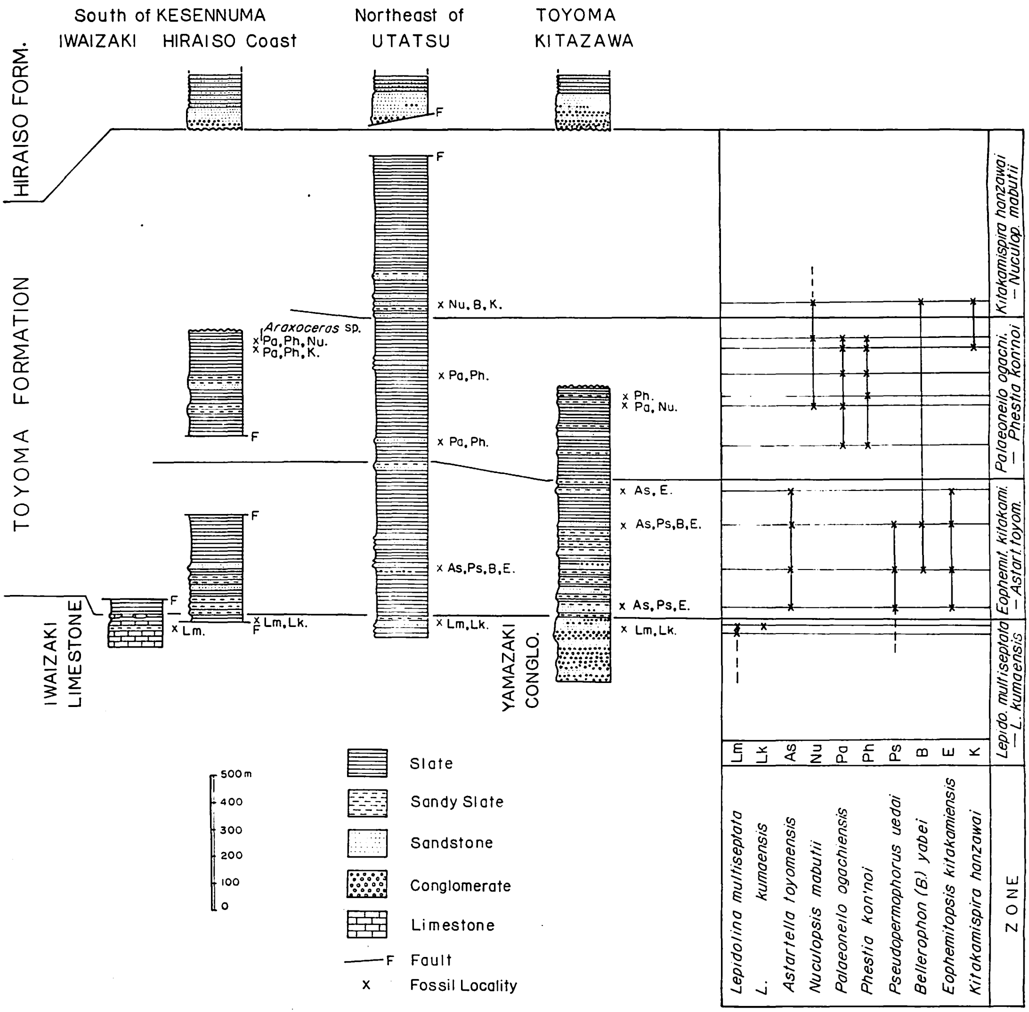

Fig. 3. Columnar sections and faunal distributions of the Toyoma Formation in the Toyoma, Motoyoshi and Utatsu areas.

ogachiensis HAYASAKA, *Nuculopsis mabutii* MURATA (MS), *Paleyoldia* ? sp., *Phestia kon'noi* MURATA (MS), *Mourlonia* (*M.*) *toyomensis* MURATA and *Kitakamispira hanzawai* MURATA (MS) from the same horizon by MABUTI and NODA (1934). This molluscan fauna belongs to the *Palaeoneilo ogachiensis—Phestia kon'noi* (MS) zone of the middle part of the Toyoma Formation.

The present specimen of *Araxoceras* sp. (cf. *A. kiangsiense* CHAO) was collected by the senior writer at 15 meters below the base of the Hiraiso Formation on the Hiraiso coast, along with many specimens of *Phestia kon'noi* (MS).

On the *Araxoceras* Fauna

The genus *Araxoceras* was first established by RUZHENCEV (1959) based upon the Araxes fauna from the Dzhulfian of Armenian Dzhulfa. RUZHENCEV (1959) described some species of *Araxoceras*, i. e. *A. latissimum* RUZHENCEV (type species), *A. trochoides* (ABICH) and *A.* sp. nov., and subsequently he (1962, 1963) described *A. latum* RUZHENCEV, *A. varicatum* RUZH., *A. glenisteri* RUZH., *A. rotoides* RUZH. and *A. tectum* RUZH. from the same Dzhulfian bed.

Another species, *Araxoceras kiangsiense* CHAO, was repoted by CHAO (1965) from the Loping Coal Series of the Wuchiaping Formation, lower part of the Loping Series, in Kiangsi. According to CHAO (1965), the *Araxoceras* fauna from the Wuchiaping Formation in Kiangsi contains *Andersonoceras*, *Prototoceras*, *Araxoceras*, *Vescotoceras* and *Pseudogastrioceras*. This Kiangsi fauna is almost comparable with the Dzhulfian fauna.

In Iran, the Dzhulfian fauna was reported by STEPANOV, GOLSHANI and STÖCKLIN (1969) and TEICHERT, KUMMEL and SWEET (1973) from the Permo-Triassic section at Kuh-e-Ali Bashi in Iranian Julfa along the Araxes River, Northwest Iran, and it was identified with the fauna repoted by RUZHENCEV (1959, 1962, 1963) and RUZHENCEV and SARYCEVA (1965). In the Zagros Range, TARAZ (1969, 1971) repoted the occurrence of the *Araxoceras* fauna from the Dzhulfian bed of the Abadeh section, exposed at Kuh-e-Hambast, near Abadeh.

In the western hemisphere, *Eoaraxoceras ruzhencevi* SPINOSA, FURNISH and GLENISTER was described by SPINOSA, FURNISH and GLENISTER (1970) from the uppermost Guadalupian (Amarassian) La Colorada beds of the Valle de Las Delicias in Coahuila, Mexico. They regarded this species as a representative form of the phyletic link between the Guadalupian Paraceltitinae and the Dzhulfian Araxoceratidae. The genus *Eoaraxoceras* may be ancestral to the Ophiceratidae rather than to the Araxoceratidae as already pointed out by BANDO (1973), judging from the characters of septa and whorls.

The genus *Araxoceras* may be also ancestral to *Otoceras* s. str. which is well known from the Himalayas (Spiti, Niti and Kashmir), Greenland, South China, Siberia, North America and Timor ?, but *Araxoceras* has not been recorded to date in association with *Otoceras* s. str. Concerning the relation between the Dzhulfian *Araxoceras* and the Early Triassic *Otoceras* various problems have been presented by many authors. Recently, KUMMEL (1972) concluded that *Araxoceras* is belonged to the Otoceratidae, and BANDO (1971, 1973) commented on the evolutional trends and morphological changes from *Araxoceras* to *Otoceras*.

The Japanese *Araxoceras* from the Toyoma Formation is similar to *Araxoceras kiangsiense* CHAO in the morphological characters, but the material is too small to be identified with the Chinese species. According to the observation on the Iranian *Aroxoceras*, the ontogenetic variation of shell form is considerably prominent in each stage.

Description of Species

by Yuji BANDO

Superfamily Otocerataceae HYATT, 1900

Family Araxoceratidae RUZHENCEV, 1959

Genus *Araxoceras* RUZHENCEV, 1959

Type Species: *Araxoceras latissimum* RUZHENCEV, 1959, p. 58, figs. 1a, 2a.

Remarks: The type species illustrated by RUZHENCEV (1959, p. 59, fig. 1a) has a wide umbilicus with ear-like projected umbilical margin and widely tabulated venter with sharply edged shoulders.

Araxoceras has no keel on the venter, but some species have a median ridge on the venter.

The genus *Araxoceras* may be a form intermediate from the groups of *Vedioceras, Prototoceras* and *Avushoceras* to the group of *Otoceras* in the evolutional trend judging from the morphological transformations (BANDO, 1973).

Occurrence and geological horizon:— Lower Dzhulfian bed at Dzhulfa in Armenia and Iran, Loping coal series of the Wuchiaping Formation in Kiangsi, South China, and middle part of the Toyoma Formation, Northeast Japan. Late Permian Dzhulfian stage.

Araxoceras sp. (cf. *A. kiangsiense* CHAO)

Figs. 4–6

Compare:
Araxoceras kiangsiense CHAO, 1965, p. 1820, text-fig. 3a, pl. 2, figs. 10, 11.
Kiangsiceras rotule CHAO, 1965, p. 1820, text-fig. 3c, pl. 2, figs. 4–6.

Description: — Shell rather involute, whorls depressed, with broadly tabulated venter and sharply projected umbilical shoulders. Sides concave and ventral shoulders sharply edged. Umbilical diameter about 1/3 of shell diameter, and umbilical wall steep, funnel-shaped. Breadth of whorl widest at umbilical margin. Height of whorl about 1/2 of width, and width of venter about 1/3 of width of whorl. No ribs or striations on shell surface. Venter ornamented with a median ridge. Suture unknown.

Measurements (in mm.):—

D	H	W	U	H/D	W/H	U/D
16.6(13.1)	6.0	10.5	6.5(5.2)	0.36	1.75	0.39

IGPS*, coll. cat. no. 93346

Remarks:—The material at hand comprises only a single specimen, and half of the whorl is an internal mould. The specimen is small and represents a younger stage of *Araxoceras*, but the preservation of the shell is considerably well for study. The specimen at hand resembles that of *Araxoceras kiangsiense* CHAO which was reported by CHAO (1965) from th Loping Coal Series of the Wuchiaping Formation in Kiangsi, South China, but in detail it is difficult to identify the Japanese species with the Chinese one, because the specimens from Japan and China represent younger stage of *Araxoceras*.

The illustrated specimen of *Kiangsiceras rotule* CHAO (1965, p. 1820, pl. 2, figs. 4–6) from the Loashan Shale of the Loping Group in Kiangsi Province of South China is similar to the present specimen in the ventral features and whorl shape, and the present writer thinks that the species *Kiangsiceras rotule* may be the same as *Araxoceras kiangsiense* judging from the photographs by CHAO (1965). The illustrated suture of *Kiangsiceras rotule* by CHAO (1965, text-fig. 3c) is

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* Abbreviation for the Institute of Geology and Paleontology, Tohoku University, Sendai, Japan.

Figs. 4-6. *Araxoceras* sp. (cf. *Araxoceras kiangsiense* CHAO).
4: Lateral view, 5: Ventral view, and 6: Whorl section of the outer whorl, IGPS, coll. cat. no. 93346, ×2.
The specimen illustrated here was collected from the black shale of the middle part of the Toyoma Formation at Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, southern part of the Kitakami Massif. Early Dzhulfian ? (Late Permian). Coll. M. MURATA, 1972.

similar to that of *Araxoceras kiangsiense* except for slight difference of first lateral lobe. Moreover, the form of venter is completely similar to that of *Araxoceras kiangsiense*. The present writer considers that *Kiangsiceras rotule* should be identified as *A. kiangsiense* judging from their whorl section, ventral feature, ear-like umbilical margin and suture.

The present specimen partly resembles that of *Araxoceras varicatum* RUZHENCEV (RUZHENCEV, 1962, p. 91, pl. 4, fig. 2) in the form of the venter, but the former has more convex and wider venter than the latter.

Occurrence and geological horizon:— Black slate of the middle part of the Toyoma Formation at Hiraiso, Motoyoshi-cho, Motoyoshi-gun, Miyagi Prefecture, southern part of the Kitakami Massif, Northeast Japan. Early Dzhulfian ? of the Late Permian. Reg. No. IGPS, coll. cat. no. 93346, coll. M. MURATA, 1972.

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Hiraiso	平　磯
Iwaizaki	岩井崎
Karakuwa	唐　桑
Kiangsi	江　西
Kitazawa	北　沢
Toyoma	登　米
Utatsu	歌　津

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 97, pp. 32-47, pl. 2-4, April, 30, 1975

645. ONTOGENIES OF TWO SPECIES OF SILICIFIED TRILOBITES FROM MIDDLE ORDOVICIAN, VIRGINIA*

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バージニア州中部オルドビス系産珪化三葉虫2種の個体発生： *Remopleurides caelatus* および *Isotelus* sp. の個体は かつて WHITTINGTON (1959) および EVITT (1961) によって記載されたが，なお幾多の疑問点が残されていた。筆者は上記産珪化標本を新たに研究し，EVITT による *Isotelus* sp. の原楯体は *R. caelatus* に，また WHITTINGTON による *Tretaspis sagenosus* の原楯体ならびに *R. caphyrides* の幼楯体は *Isotelus* sp. にそれぞれ属することを明らかにした。 胡 忠 恒

Introduction

The ontogenetic development of two species of Middle Ordovician trilobites is described. They are *Remopleurides caelatus* WHITTINGTON and *Isotelus* sp. The first species can be segregated into two groups by minor morphologic differences within the same species population. These bimodal traits are seen either in the characters of the cranidium or pygidium, or both, and are probably represent the secondary sexual features of the two sexes of the respective species. The sex of *R. caelatus* is determined by its sexual ratio or the number of the individual specimens within the two morphologic groups (HU, 1968, 1971).

The specimens of *R. caelatus* were collected by Dr. F. RASETTI, Universita Degli Studi, Roma, from the Edinburg Formation, Middle Ordovician, 1.5 mile southeast of Strasburg Junction, Virginia, and those of *Isotelus* sp. are collections of the Geology Museum, University of Cincinnati, Ohio. The *Isotelus* sp. material came from the Chambersburg Limestone, Middle Ordovician, at Willow Groove, 3 miles southwest of Woodstock, Virginia. All of the materials are fine grained black limestone, containing very abundant trilobite fragments, bryozoans, ostracodes, a few brachiopods, and conodonts. The fragments are well silicified, and all were etched from the limestone in the 5～10% diluted glacial acetic acid as employed by WHITTINGTON and EVITT (1953). About seventeen species of trilobites with very well preserved growth sequence are recovered from the original acidified residues. The present report is a small part of these research, and the most undescribed materials will subsequently be published in near future.

The writer wishes to give his thanks to Dr. K. E. CASTER, University of Cincinnati, Ohio, for his supervision and kindly reading over the present manuscript. Thanks are also given to Dr. F. RASETTI, Universita Degli Studi, Roma, and the Geology Museum, University of Cincinnati, for permission to study their collections. The figured specimens are

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* Received Sept. 30, 1974; read June 14, 1975.

all stored in the Geology Museum, University, Ohio (U. C. G. M.).

Systematic Paleontology

Family Remopleurididae
HAWLE & CORDA, 1847

Genus *Remopleurides* PORTLOCK, 1843

Remopleurides caelatus WHITTINGTON

Pls. 2, 3, and text-figs. 1, 2

Remopleurides caelatus WHITTINGTON, 1959, pl. 4, figs. 1–25, text-fig. 5 only (not fig. 4), p. 401.

Asaphidae (*Isotelus* sp.), EVITT, 1961, pl. 117, figs. 1–19, pl. 118, figs. 1–34, 37–39, and text-figs. 1–4 only, p. 986–995.

Discussion: — The characteristics of this species conform to WHITTINGTON's (1959) description represented by material from the Lower Edingburg Formation, located at 2–4, 6, and 7, Virginia. The specimens are extremely abundant within the faunal assemblage. Several hundred of both immature and mature skeletal fragments were acid-etched from a few pieces of dark limestone. Four species are available under the genus *Remopleurides*, these are *R. caelatus* WHITINGTON, *R. eximium* WHITTINGTON, *R. asperulus* WHITTINGTON, and *R. caphyroides* WHITTINGTON; the last two are very rare, and also their growth sequences are incompletely known.

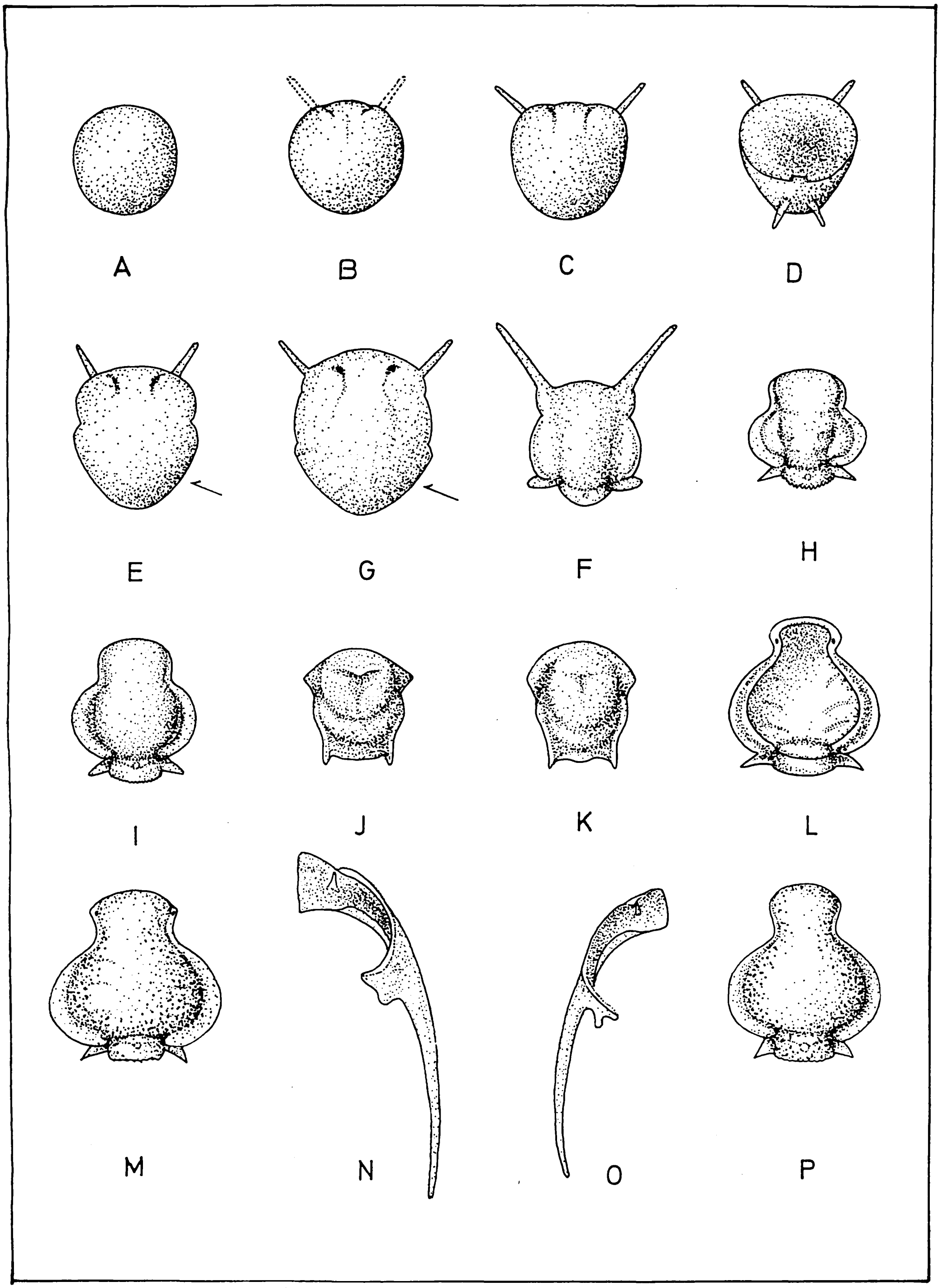
The present species can be morphologically differentiated into two different groups by their minor features. These differences seem best to be attributed to sexual dimorphism. In comparing two cranidia and pygidia of the same size, the " male " glabella is greatly expanded laterally, the anterior glabella is nicked or tongue-shaped, the posterior librigena is narrow and minutely bifurcated, the hypostoma is strongly impressed with the concentric wrinkles and a medium-sized triangular median boss is present; the " male " pygidium possesses a median ridge behind the bilobed terminal portion. The cranidium of the " female " has a narrower glabella, longer anterior glabellar nock or tongue, the posterior librigena is wider and has be bifurcation, the hypostoma is smooth without a median boss, and the pygidium possesses no median ridge behind the bilobed terminal portion.

The ontogenetic development of the present species shows a very complete growth sequence from the early protaspis to the fully developed adult form. The early protaspis shows no special exoskeletal characteristics dorsally, no median tubercle or paired anterior glabellar granules; two pairs of short spines are located at both anterior and posterior lateral margins. The meraspid skeletons are well differentiated into cranidium, librigena, hypostoma and pygidium. The early immature pygidium possesses five axial rings and elongate terminal portion. In the later growth stage the five axial rings are possibly developed into five thoracic segments and an elongate terminal portion which correlates with a specific thoracic segmental spine of the still later growth stages. The holaspid pygidium is developed laterally behind the median spinous thoracic segment. In the larger specimens the cephalic spines of the cranidium to be reduced and the glabella increases in width laterally. The fixigena becomes narrow and then disappear. The hypostoma increases in length and its marginal spines are reduced.

The present material suggests that the supposed early protaspides of *Isotelus* sp. reported by EVITT (1961) possibly belong to the early protaspides of *Remopleurides* *caelatus* WHITTINGTON. The supposed protaspides of *Tretaspis sagenosus* WHITTINGTON reported by WHITTINGTON (1959) now appear to belong to *Isotelus* sp. The earliest ontogenetic sequence of *R. caphyroides* and *R. caelatus* were unknown to WHITTINGTON, and the meraspides of *Isotelus* sp. were reported by EVITT as "missing" in the record possibly because of incomplete molting of the youthful exoskeleton, or due to differences in referred habitats at different stages in the life cycle. The present assumption is based on the gradual appearance or absence of certain skeletal ornamentation, e. g., the median tuberble and paired granules on the glabella, number of marginal spines, and median spinous thoracic segment. These morphologic metamorphoses are traceable uninterruptedly from stage to stage. For example, the cranidium possesses an median tubercle and no paired granules on the anterior glabella, the pygidium has a large elongate terminal portion which correlates with the spinous thoracic segment later, and the librigena or librigeno-hypostoma shows a small tubercle internally and a depression externally (EVITT, 1961, pl. 118, figs. 13, 17), and the early skeleton has two pairs of marginal spines only. These features evidently belong to the *R. caelatus.* On the other hand, those larval glabellae which bear a median tubercle and a pair of rather minute anterior granules, and in which the pygidium possesses no large elongate terminal portion, and the early immature skeleton has three pairs of marginal spines, belong to *Isotelus* sp.

The early development of the present species is compositely similar for the most part to that attributed by WHITTINGTON (1959) and EVITT (1961) to *Menoparia genalunata* ROSS (ROSS, 1951) and *Isotelus* sp. All immature skeletons are extremely convex, broadly rounded and faintly marked with dorsal furrows without any indication of segmentation; the palpebral lobe is large, with two or three pairs of spines extending along the shield margin. Thus, among these genera, WHITTINGTON (1959) considered that *Menoparia* and *Remopleurides* represent two subfamilies of Remopleuridae, and EVITT (1961) considered the Asaphidae and Remopleuridae to be the families whose phylogenies were closely related. It is obviously that these interpretations are derived from the different numbers of marginal shield spines, e. g., both of the early immature skeletons of *Menoparia* and *Remopleurides* possess three pairs of marginal spines, whereas *Isotelus* sp. possesses two pairs only. In fact, if the present assignment of the early protaspides and meraspides of each genus as indicated in the preceding paragraph are acceptable, then the skeletal spines, either two or three pairs, may not have very much phylogenetic or taxonomic significance, since, within the same genus, certain species may have two or three pairs of marginal spines. For instance, *R. caelatus* has two pairs, and *R. caphyroides* and *R. eximius* have three pairs.

Text-fig. 1. A growth sequence of *Remopleurides caelatus* WHITTINGTON. A, a problematic anaprotaspis, ×24; B, dorsal view of a metaprotaspis, ×24; C–E, G,dorsal and ventral views of a few paraprotaspides, ×24, ×20, ×20; F, an early meraspid cranidium, ×18; H, I, dorsal views of two late meraspid cranidia, ×20; J, a "male" hypostoma, ×20; K, a "female" hypostoma, ×20; L, M, ventral and dorsal views of a "male" cranidium, ×8; N, a "female" librigena, ×5; O, a "male" librigena, ×5; P, a "female" cranidium, ×8. (All drawings were made from photographs.)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Here, the writer considers that the genera *Isotelus*, *Remopleurides*, and *Menoparia* all possess no rostrum but the paired librigena only, and are connected by median suture. These all belong to the group birostraloid as proposed previously by the author (1971).

Figured specimens:—

"Male" form, Cranidia, U.C.G.M. 40416q, w-z, a′, b′, Librigenae, U.C.G.M. 40416z′, aa, Hypostomara, U.C.G.M. 40416u, v, Pygidia, U.C.G.M. 40416j′-1′, p′.

"Female" form, Cranidia, U.C.G.M. 40416cc-ff, Librigenae, U.C.G.M. 40416y′, bb, Hypostomara, U.C.G.M. 40416s′, t′, Pygidia, U.C.G.M. 40416q′.

Remopleurides caelatus WHITTINGTON, ontogeny

The ontogenetic development of the present species is separated into three divisions: protaspid, meraspid, and holaspid periods. The main developmental features of the protaspid period may be briefly described as follows:

*Protaspia period:—*The shield is spherical to subspherical in outline, convex, with the axis somewhat longer than wide, and generally shows a medusoid-form with the large shield above and the spiny librigeno-hypostoma hanging below; about 0.7-1.4 mm in length (sag.). The surface is smmoth or faintly granulated, with a pair of pits and faint axial furrows present on the anterior margin of the shield. The ventral aspect of the shield commonly has well-developed librigena and hypostoma fused as a single structure. The facial suture is well developed in the earliest stage, but is invisible from the dorsal view. The palpebral lobe is well recognized in the later growth stage, which is indicated by the course of the facial suture. It is located at the anterior half of the shield. The protopygidium is possibly developed immediately behind the posterior end of the facial suture and has four or five faint segments. The late protopygidium is round and consists of five uniform annular, a large terminal portion, and five pleural bands. The internal surface of the protopygidium has four pairs of marginal spines along the narrow posterior doublure. The present period is subdivided into the anaprotaspid, metaprotaspid, and paraprotaspid stages by the presence or absence of the axial lobe, facial suture, and protopygidium.

Anaprotaspid stage (Pl. 2, fig. 1, and text-fig. 1A)*:—*The shield is about 0.7 mm in length (sag.), spherical to oval, somewhat longer than transverse, convex, domed, without any distinct marking on the dorsal surface, except for fine granules.

Only a single specimen has been recovered; the ventral view of the specimen shows a rounded cavity; no librigena or hypostoma are in place. The shield margin is incomplete and irregularly wedge-shaped, which may be the result of breakage.

Metaprotaspid stage (Pl. 2, fig. 2, and text-fig. 1B)*:—*The shield is round to subround in outline, dome-shaped, somewhat longitudinally convex, and about 0.7-1.0 mm in length (sag.). Possibly a pair of spines at the anterior lateral margin projects obliquely downward from the frontal border; another pair projects postero-laterally immediately from behind of the posterior border. The dorsal surface of the shield is marked by a pair of distinct anterior pits. The axial and the pleural lobes are incompletely differentiated. The surface of the shield is covered by faint granules and a longitudinal furrow occurs along the median axis. The under view of the specimen shows a round hollow with the narrow, crescentic, evanescent librigena located at the right side of the shield margin. This stage is equivalent to the earliest protaspis of EVITT (1961).

Paraprotaspid stage (Pl. 2, figs. 3-7, 12, 13; pl. 3, figs. 1-4, 21, 22; and text-fig. 1E, G, and 2A, B.):—The shield lengths vary from 1.0-1.2 mm (sag.); subspherical in outline, with the anterior half slightly broader than the posterior end: convex along the axial lobe, but moderately flattened at the anterior and strongly convex behind. A pair of elongate anterior pits is distinctly impressed along the incompletely developed axial furrow. No glabellar furrows or segments are visible. The facial suture appears behind the antero-lateral cephalic spines and in front of the mid-length of the shield; it curves strongly laterally along the rounded palpebral lobe. The posterior facial suture rounds downward, under and inward almost to the posterior midline, then makes a short-cut at an acute angle to the free margin. The posterior cephalic margin is not known, but is possibly immediately behind the equatorial line, between the posterior end of the facial suture lines. In some early shield the protopygidium is indicated by a few faint segments.

Librigena and hypostoma are fused into a single structure. The librigena is a narrow crescentic band, and its lateral side has a facial suture extending upward along the vertical ocular platform. The hypostoma is subcircular in outline, convex, and its central body is V-shaped; its anterior is connected with the librigena, and tapers back to form a sharp projection. The lateral margin is crescentic and is projected oblique-laterally into four pairs of long slender spines. The lateral hypostomal borders are nearly vertical, thickened slightly at the free margin, and without distinct doublure. The anterior end of the librigena is sometimes flat or slightly depressed externally, and possibly bears a small tubercle internally (EVITT, 1961, pl. 118, figs. 10, 13, 17).

The associated late paraprotaspid pygidium is not articulated with the cranidium. It is convex, round to subround in outline, about 0.5-0.7 mm in length (sag.) with well defined axial and pleural lobes. The axis is convex, elevated above the pleural lobes, gently tapering at the posterior, and divided into five nearly uniform axial rings and an elongate terminal portion. The pleural lobe is twice as wide as the axis, slopes gently to the lateral margin except postero-laterally at the axal region, which is bent down nearly vertically. The ventral side of the specimen shows four pairs of tiny spines situated along the posterior pygidial margin. The doublure is widest at the posterior, diminished anteriorly, and disappears at the anterior lateral corners.

The present stage is correlated with the latest protaspides of EVITT (1961, p. 988), and with the meraspid degree 0 of WHITTINGTON (1959, p. 406).

Meraspid period: — The cranidium of pygidium are generally disarticulated. Therefore, any association of these parts is synthetic. In the present species the cranidium is an isolated part, not associated with the librigena and the pygidium. It is small and subquadrate in outline, convex, and retains a pair of long anterior cephalic spines. It has no distinct glabellar furrow. The palpebral lobes are large and located between the cephalic spines and the narrow posterior fixigena. The large specimen lacks the anterior cephalic spines, but has well developed dorsal furrows and sickle-shaped palpebral lobes. The largest cranidium shows that the fixigena is reduced by lateral expansion of the glabella between the eye lobes; it is crescentic, narrow and disappears during the later growth stage.

The librigeno-hypostoma is differentiated into isolated parts, i. e., librigena and hypostoma. The librigena is narrow, crescentic, bears a short genal spine. The hypostoma is elongate, and the four pairs of marginal spines and a posterior spine are still retained.

The early meraspid pygidium is triangular, convex, and consists of three pairs of marginal spines and a long median axial one which is curved and directed upward at the posterior. The late meraspid pygidium is quadrate to subquadrate in outline, convex and has two to three pairs of short broad pleural spines. The broad axial lobe is divided into two rings and a broad semicircular terminal portion. The axial ring is without spine.

Although the median spinous thoracic segment of the present stage is possibly correlated with the terminal portion—the sixth axial ring—of the protopygidium, and the latest meraspid pygidium, or true pygidium, which is added to the spinous segment, is newly developed; this pygidium does not possess an axial spine, convexity, or an elongate terminal portion. If the present interpretation is acceptable, then it is possibly that the present species has five thoracic segments in front of the median axial spine, since only in the earliest stage its recognizable, or paraprotaspid pygidium has five axial rings in front of the elongate terminal portion.

Early meraspid stage (Pl. 2 figs. 8-11; pl. 3, figs. 5-7; text-figs. 1F, and 2C, D)*:*—The cranidium is about 1.0-1.4 mm in length (sag.), trapezoidal in outline, moderately convex, and possesses a pair of cephalic spines. The glabella is expanded from the occipital furrow forwardly to the anterior margin and no glabellar furrow is visible. The anterior margin arches gently forward; no preglabellar field is present. The occipital ring is moderately convex, bearing a minute node close to the anterior margin. The occipital furrow is narrow and distinctly impressed with an anterior edge—the glabellar base—which is higher than the occipital ring. The fixigena is crescentic, faintly delimited by dorsal and palpebral furrows, and its greatest width is situated on the mid-line of the glabella (tr.). The posterior fixigena is rather narrow (sag.), low, and sharply pointed laterally from the side of the occipital ring.

The hypostoma is elongate, convex, having a wedge-shaped median body. The median body is faintly delimited by lateral furrows and continuously runs into a median spine directed toward the posterior end. The four pairs of lateral marginal spines are shorter and stouter than in the early growth stage; they are equi-spaced and radiated from the margin.

The pygidium is about 0.5-1.0 mm length, convex, triangular in outline, bearing a long stout upwardly curving median axial spine. The axial lobe is rather broad, divided into 2-3 segments by indistinct axial furrows, and convex above the pleural lobes. Three pairs of thorn-like pleural spines, in essence extensions of the pleural bands are directed postero-laterally. The ventral view of the specimen shows a narrow curved doublure along the margin with a median posterior notch. The median segmental spine is possibly located at the third axial ring—two complete axial rings and a half ring—, and behind this spinous segment it may be assumed that there is one more rudimentary segment.

The present stage differs from the

paraprotaspis in having a well defined glabella and palpebral lobes; the pygidium is without ventral marginal spines, and the librigeno-hypostoma is well differentiated into isolated parts — the librigena and the hypostoma.

Late meraspid stage (Pl. 2, figs. 14-17; pl. 3, figs. 7-11, 23-24; text-figs. 1H, I, and 2F.):—The cranidium is about 1-4-2.0 mm in length (sag.), and moderately convex; the glabella has expanded between the pleural lobes so that the fixigena is gradually eliminated, and the dorsal furrow coincides with the palpebral furrow. This furrow is broadest at its mid-point between the palpebral lobes (tr.), and narrows at both anterior and posterior ends. The anterior margin of the glabella is broader than the occipital ring (tr.). The occipital ring is lenticular, convex, well marked by an occipital furrow, and bears a small node near the anterior edge of the occipital ring and is decorated by a serration of marginal spines. No anterior fixigena is observed except for a pair of narrow ridges continuously running from the anterior palpebral lobe to the anterior lateral corners of the glabella. The palpebral lobe is large and broad, sickle-shaped, and encircles the narrow fixigena from the side of the occipital furrow to the posterior lateral corners of the glabella. The posterior lateral fixigenae are rather narrow, and show only a pair of broad-based spines extended laterally from the both sides of the occipital ring.

The librigena (pl. 3, figs. 23, 24) is essentially like that of an adult form, with a narrow ocular platform outside of the very large eye lobes. The rear librigenal border is narrow and strongly divaricated at the posterior from the lateral border. Neither lateral nor posterior furrows are recognizable. The genal spine runs continuously from the lateral border; it is medium-sized and sharply pointed at the posterior. The doudlure is broad, running parallel to the lateral border except at its anterior end, near the median suture, where it is narrow, arched, and marked with a small pit underneath and with tubercles internally.

The pygidium is generally hexagonal in outline, convex, and the axial rings are faintly impressed. The first ring is distinctly separated into a half and a main ring by a furrow; the second and third rings may be outlined by shallow ring furrows; the anterior furrow being the deepest, and the following being progressively shallower and the rings shorter. The pleural lobes are rather narrow, bearing three to four pairs of spines which extend backward from the axial ring. The first pair of spines is the longest, its facet angle is thick and shoulder-trap like. In the under view of the pygidium it has a broad doublure which is under-curled with a posterior median notch.

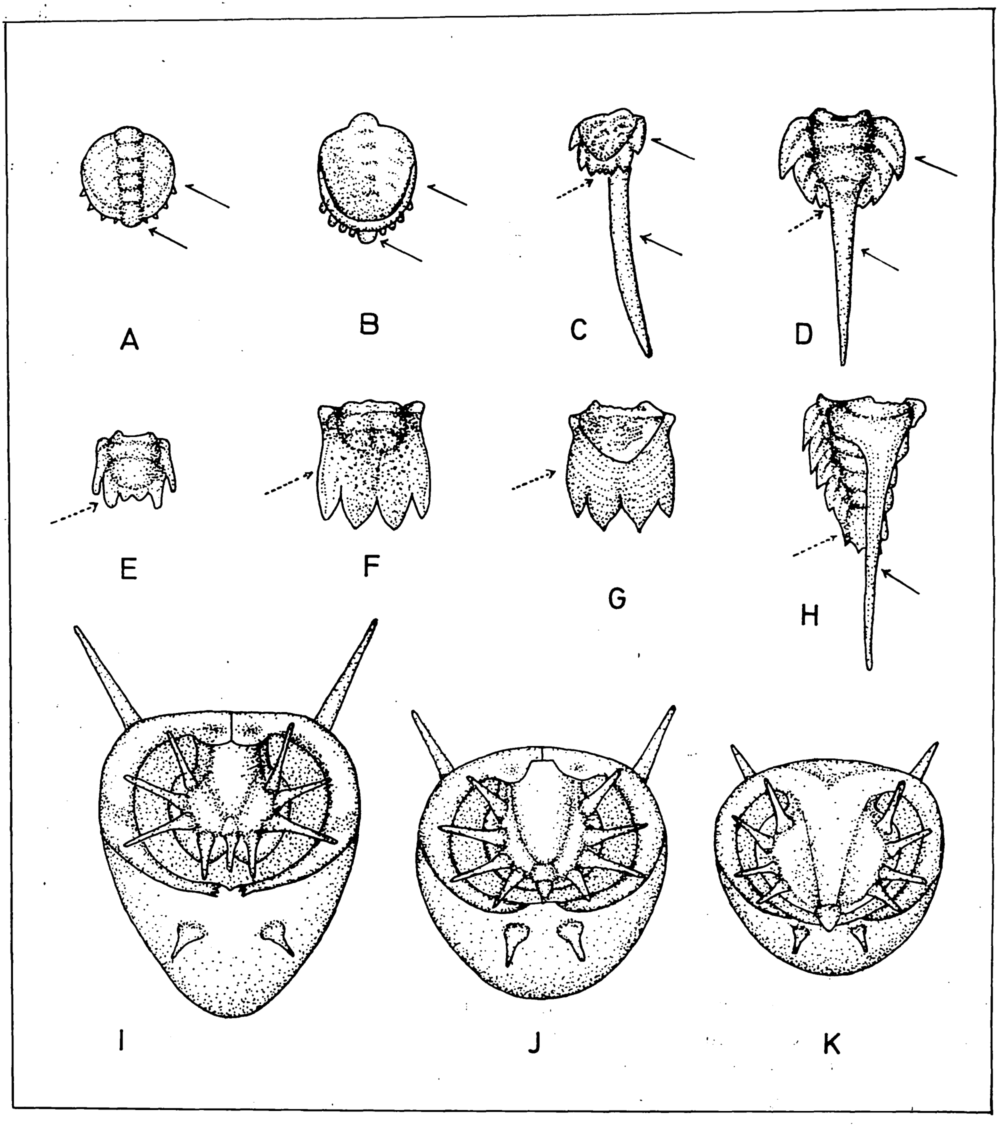
The pygidium of the present stage is presumably developed behind the median spinous segment, since there is no any more spinous segment is observed. Behind this spinous segment three more thoracic segments and a true pygidium will be added laterally, and the holaspid form is achieved.

Figured specimens:—Anaprotaspis, U.C.G.M. 40416,(Metaprotaspis, U.C.G.M. 40416a, Paraprotaspides, U.C.G.M. 40416b-f, k, l, c′, d′, f′, g′, Early meraspides, U.C.G.M. 40416g-j, h, i′, Late meraspides, U.C.G.M. 40416m-p, j′-l′, Protaspid hypostoma, U.C.G.M. 40416r-t.

Family Asaphidae BURMEISTER, 1843

Genus *Isotelus* DEKAY, 1842

Isotelus sp.



Text-fig. 2. A growth sequence of *Remopleurides caelatus* WHITTINGTON. A, B, dorsal and ventral views of a protopygidium, ×25; C, D, ventral, lateral; and dorsal views of two early meraspid pygidia, ×20; E, F, dorsal view of two late meraspid pygidia, ×20; G, ventral view of a pygidium, ×15; H, dorsal view of a pygidium associated with a few of thoracic segments, ×6; L-K, ventral views of threep rotaspides, showing the librigeno-hypostoma. (Arrows indicate the correlated parts of the skeleton; half arrow indicates thoracic segment, solid arrow indicates the spinous segment, dotted arrow indicated pygidium. L-K, redrawn from EVITT, 1961, with slight modification.) (All drawings were made from photographs.)

Pl. 4, figs. 1-33, and text-fig. 3

Isotelus sp., EVITT, 1961, pl. 117, figs. 20-23, pl. 118, figs. 35, 36, only (not pl. 117, figs. 1-19, and 118, figs. 1-34, 37-39), p. 985-995.

Remopleurides, EVITT, 1961, text-figs. 5, 6, p. 785-995.

Tretaspis sagenosus WHITTINGTON, 1959, pl. 26, figs. 1-13 only, p. 55.

Remopleurides caelatus WHITTINGTON, 1959, pl. 3, figs. 1-6, text-fig. 4, p. 401.

R. caphyroides WHITTINGTON, 1959, pl. 10, figs. 8-13, 15, 16, 18, 20; pl. 11, figs. 1-4, p. 391-412.

R. caphyroides ? WHITTINGTON, 1959, pl. 11, figs. 9-11, p. 414-420.

Discussion:—The present species is represented by more than a hundred immature and mature specimens. Following EVITT (1961), they are recognized as *Isotelus* sp., without any attempt as evaluation of the species. The early immature forms were placed in *Tretaspis sagenosus* WHITTINGTON and *Remopleurides caphyroides* WHITTINGTON by WHITTINGTON (1959), and in *Remopleurides* by EVITT (1961). The material, which I have studied, suggested that the early immature forms associated which *Isotelus* sp. by EVITT (1961) may belong to *Remopleurides caelatus* and the meraspides of *Remopleurides caphyroides* WHITTINGTON (1959) belong to *Isotelus* sp. The reason for the present assignment is based on the unbroken grown sequence; the morphologic development from the early larval stage to the adult form is continuous. For example, the skeletal spines situated on the cranidial and pygidial margins are continuously present throughout of the meraspid period. The meraspid pygidium do not possess an elongate terminal portion as does *Remopleurides*. The median glabellar tubercle remains throughout of the growth of the animal. The paired anterior glabellar granules are reduced only during the late meraspid stage. Furthermore, the present material from the Chambersburg Limestone contains very abundant mature and immature specimens, whereas the forms from the Edinburg Formation are only a few large-sized fragments and no complete grown series can be traced.

Figured specimens:—Cranidia, U.C.G.M. 40417a, b, Librigenae, U. C. G. M. 40417v. w, Hypostomata, U. C. G. M. 40417r-u, Pygidia, U. C. G. M. 40417z, b′, c′.

Isotelus sp., ontogeny

The ontogenetic development of the present species is represented by four growth stages only; metaprotaspid, paraprotaspid, early meraspid, and late meraspid stages. The early protaspid or anaprotaspid skeleton in unknown. It seems that the protaspides may show similar features throughout the protaspid period, but morphologic changes, such as the cephalization, pygidial segmentation etc., are possibly progressively differentiated underneath the exoskeleton, and in this respect are quite unlike the ptychopariids: *Parabolinoides contractus* FREDERICKSON, *Aphelaspis subditus* PALMER, and *Welleraspis lochmanae* HU (HU, 1969), etc. where parts of segments are added one by one to the cranidium and are distinctly seen on the dorsal surface. The delay of the exoskeletal segmentation between the cephalon and the pygidium may indicate that the animal had increased the period of pelagic larval life.

Metaprotaspid stage (Pl. 4 figs. 1-3 and text-fig. 3A, B.):—The shield is oval, convex, about 0.6-0.75 mm in length (sag.), having well defined axial and pleural lobes. The axial lobe extends the full length of the shield, expanding slightly forward and marked with a median tubercle at one-third of the length (tr.). The fixigena is well defined by a dorsal furrow, gently convex, uniformly and abruptly sloping along the anterior margin, and about the same width as the mid-line of the glabella (tr.). Three pairs of slim spines arise from the margin, one anterior lateral, one at the greatest width, directed outward and backward, and a posterior pair situated close together and backwardly directed. In the under view of the skeleton there is a narrow doublure extending around the posterior half of the shield, and reaching

Text-fig. 3. A growth series of *Isoteus* sp. A, B, dorsal and ventral views of a possible metaprotaspid shield, ×23; C–F, side, frontal, oblique, and dorsal views of a few paraprotaspides, ×20; G, dorsal view of an early meraspid cranidium, ×17; H, dorsal view of a late meraspid cranidium, ×10; I, J, ventral and dorsal views of a protopygidium showing the association of the occipital segment, ×24; K, L, dorsal and ventral views of a protopygidium, ×24; M, a meraspid hypostoma, ×10; N, hypostoma, ×7; O, a possible early meraspid pygidium, ×20; P, a librigena, ×5; Q, dorsal view of a pygidium, ×4; R, dorsal view of a possible late meraspid pygidium, ×9; S, dorsal view of cranidium, ×5. (Arrows indicate the correlated parts of the animal skeleton; solid arrow indicates median tubercle; dotted one indicates fixigenal spine; half arrow indicates paired glabellar granules.). (All drawings were made from photographs.)

Explanation of Plate 2

Figs. 1–30. *Remopleurides caelatus* Whittington.

1. A possible anaprotaspid shield, showing no anterior pits, axial differentiation, and and pleural lobes. ×24, U. C. G. M. 40416.
2. A possible metaprotaspid shield, showing the appearence of the anterior pits. ×24, U. C. G. M. 40416a.

3–7, 12, 13. Six paraprotaspid shields, showing the naterior and posterior marginal spines, and the differentiation of the axis and the pleural lobes. 3, ×24, U. C. G. M. 40416b; 4, ×20, U. C. G. M. 40416c; 5, ×24, U. C. G. M. 40416d; 6, ×24, U. C. G. M. 40416e; &, ×20, U. C. G. M. 40416f; 12, ×18, U. C. G. M. 40416k; 13, ×20, U. C. G. M. 40416l.

8, 9, 10, 11. Four early meraspid cranidia, showing the anterior spines and the indistinct axial furrows. 8, ×18, U. C. G. M. 40416g; 9, ×18, U. C. G. M. 40416h; 10, ×20, U. C. G. M. 40416i; 11, ×20, U. C. G. M. 40416j.

14, 15. Dorsal views of two late meraspid cranidia, showing the distinct glabellar furrows. 14, ×20, U. C. G. M. 40416m; 15, ×18, U. C. G. M. 40416n.

16, 17. Two late meraspid cranidia, showing the lateral furrows. 16, ×16, U. C. G. M. 40416o; 17, ×20, U. C. G. M. 40416p.

19. A meraspid hypostoma, showing the increasing of the median body and the reduction of the marginal spines.

20–22. Three protaspid hypostomata; notice the marginal spines, and the differentiation of the rostrum, and the librigenae. 20, ×20, U. C. G. M. 40416r; 21, ×20, U. C. G. M. 40416s; 22, ×21, U. C. G. M. 40416t.

23, 24. Two possible male forms of hypostomata; notice the anterior median nodes. 23, ×20, U. C. G. M. 40416u; 24, ×20, U. C. G. M. 40416v.

18, 25–30. Six well preserved male cranidia. 18, ×14, U. C. G. M. 40416q; 25, ×10, U. C. G. M. 40416w; 26, ×11, U. C. G. M. 40416x; 27, ×7, U. C. G. M. 40416y; 28, ×8, U. C. G. M. 40416z; 29, ×9, U. C. G. M. 40416a′; 30, ×8, U. C. G. M. 40416b′.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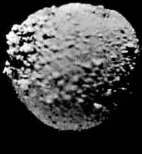
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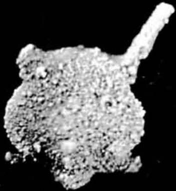
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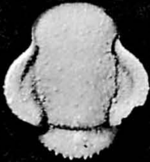
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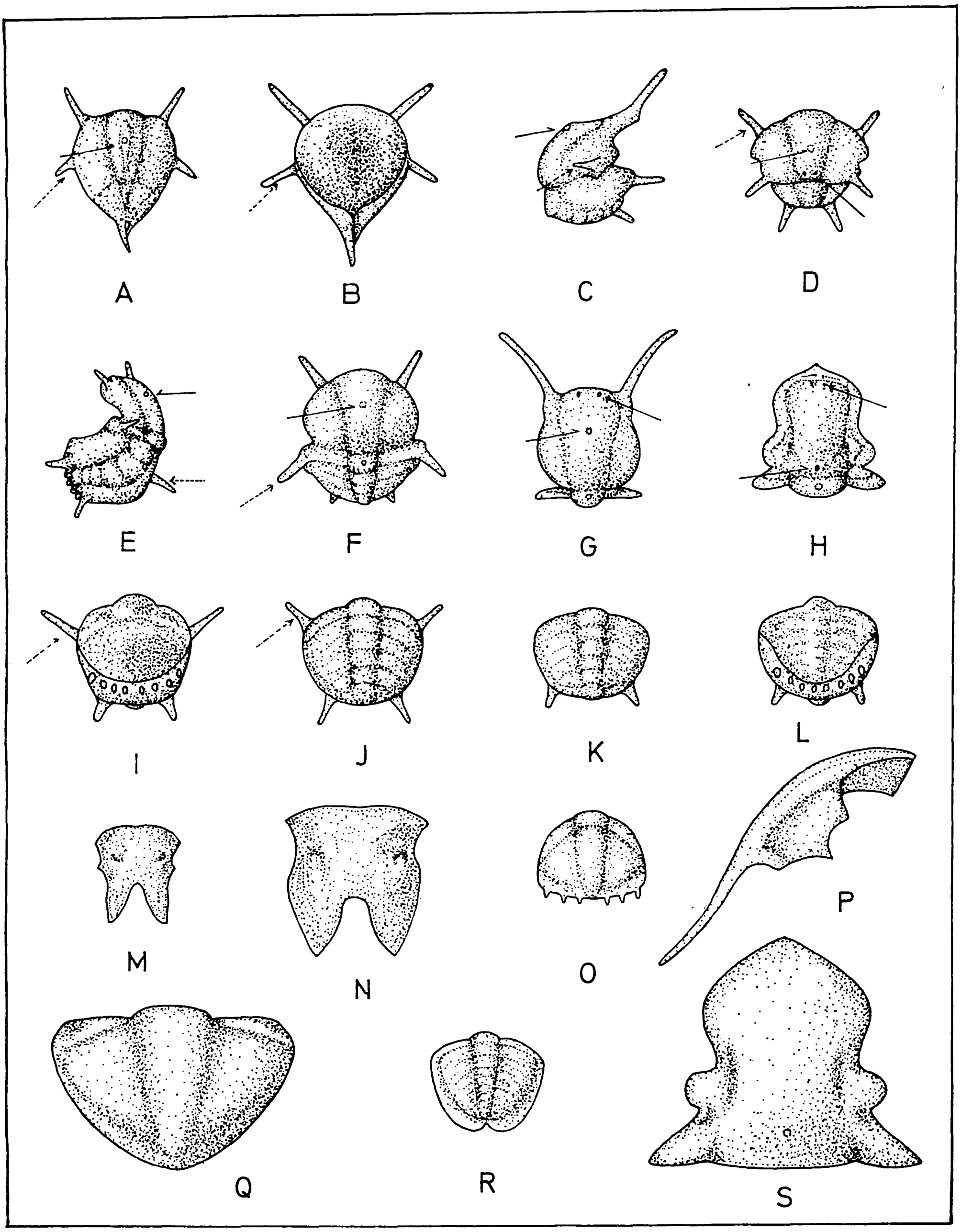
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forward to a point beneath the base of the lateral spines. The external surface is covered by very faint granules, and there is a very faint transverse depressed line at the posterior one-thirds of the length of the glabella and the fixigenae (tr.); this suggests a possible segmental line lying between the cephalon and the pygidial shield.

Paraprotaspid stage (Pl. 4, figs. 4-6, 11, 16-19 and text-fig. 3C-F, I-L.):—The skeleton is strongly convex, about 0.8-1.2 mm in length (sag.), and in certain small specimens the anterior and the posterior margins may curve to oppose each other. The cranidium is quadrate to subquadrate in outline, convex, with well differentiated dorsal furrows, and no glabellar furrows. The anterior lateral margin has a pair of long slim cephalic spines extending anterior laterally from the cranidial corners. The palpebral lobe is large, located between the cephalic spine and the narrow posterior fixigena. No distinct palpebral furrow or fixigenal separation is present. The anterior glabella is marked by a pair of minute anterior tubercles and a medium sized median node. Some small specimens have a pair of spines directed posterolaterally from the extreme lateral end of the posterior fixigena.

The pygidium is trapezoidal in outline, convex, with the narrow axial lobe above the pleural region. The axial lobe is narrower than the pleural region, divided into six uniform axial rings by several indistinct furrows. The pleural region is divided into six pleural bands, which are of the same width and uniformly curved at the posterior. The ventral side of the pygidium is decorated by four pairs of minute spines along the narrow, rear doublure, and a pair of long lateral spines is situated at the posterior lateral pygidial margin.

The present stage differs from the previous in having the pygidium differ-

Explanation of Plate 3

Figs. 1-32. *Remopleurides caelatus* WHITTINGTON.

1-4. Four paraprotaspid pygidia. 1, x25, U.C.G.M. 40416c′; 2, x25, U.C.G.M. 40416d′; 3, 4, x25, U.C.G.M. 40416f′, g′.

5, 6. Oblique and dorsal views of two early meraspid pygidia, showing the median axial spine. 5, x20, U.C.G.M. 40416h′; 6, x20, U.C.G.M. 40416i′.

7-10. Four late meraspid pygidia. 7, x25, U.C.G.M. 40416j′; 8, x20, U.C.G.M. 40416k′; 9, specimen missing; 10, x20, U.C.G.M. 40416l′.

11-14. Dorsal and ventral views of four pygidia. 11, specimen missing; 12, x15, U.C.G.M. 40416m′; 13, x18, U.C.G.M. 40416n′; 14, x15, U.C.G.M. 40416o′.

15, 16. Dorsal and ventral views of a male and female forms of pygidia; notice the presence (male) and abesence (female) of the posterior median ridge. 15, x15, U.C.G.M. 40416p′; 16, x15, U.C.G.M. 40416q′.

17, 18. Dorsal and oblique views of a pygidium, associated with one to four thoracic segments. x6, U.C.G.M. 40416r′.

19, 20. Two hypostomata, possibly belong to female form, showing no antherior median node. 19, x20, U.C.G.M. 40416s′; 20, x20, U.C.G.M. 40416t′.

21, 22. Two isolated protaspid librigenae. 21, x16, U.C.G.M. 40416u′; 22, x16, U.C.G.M. 40416v′.

23, 24. Two meraspid librigenae. 23, x12, U.C.G.M. 40416w′; 24, x20, U.C.G.M. 40416x′.

26, 27. Two male librigenae. 26, x8, U.C.G.M. 40416z′; 27, x5, U.C.G.M. 40416aa.

28. A female librigena. x5, U.C.G.M. 40416bb.

29-32. Oblique, dorsal, and ventral views of four complete cranidia; notice the longer glabellar neck and the smaller ocular lobe compared with that of male form. x10, x9, x8, x8, U.C.G.M. 40416cc-ff.


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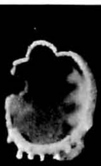
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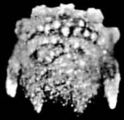
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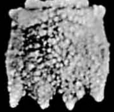
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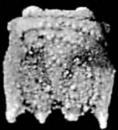
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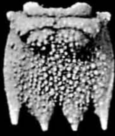
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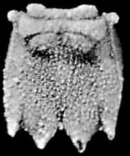
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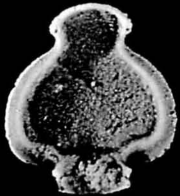
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entiated from the cranidium, the facial suture has migrated upward onto the dorsal surface, and the posterior paired pygidial spines are more widely separated.

Early meraspid stage (Pl. 4, figs. 7-27, 27, and text-fig. 3G, O.)*:*—The cranidium is subspherical in outline, convex, 0.9-1.2 mm in length (sag.). The glabella is faintly delimited by dorsal furrows, cylindrical, slightly expanded forwardly from the occipital ring, and without glabellar furrows. The anterior glabella bears a pair of granules and a median tubercle. The occipital ring is well delimited by a narrow, distinct occipital furrow which is crescentic, strongly curving backward, and having a minute median node. No preglabellar field or anterior border is seen except for a pair of long, slim cephalic spines extending antero-laterally from the lateral corners of the anterior cranidium. The fixigena curves laterally, crescentic, with a well delimited free margin, convex, gently sloping downward from the dorsal furrow. The palpebral lobe is rather narrow and faintly separated by the palpebral furrow. The anterior branch of the facial suture is short and divergently convex, and the posterior one runs mostly parallel to the posterior lateral border.

The pygidium is moderately convex, oval-transverse, without any distinct segmental furrow. The axial lobe tapers at the posterior end, convex, above the pleural lobe. The pleural lobe is faintly separated by dorsal furrow, wider than the axis (tr.), and decorated by three pairs of short marginal spines along the posterior margin. The broad marginal border is convex, shallowly delimited by and inner marginal furrow. The anterior end of the axis is associated with an incomplete thoracic segment. The skeletal surface is faintly granulated.

Late meraspid stage (Pl. 4, figs. 12, 13, 23, 24, 28 and text-fig. 3H, M, R.)*:*—The cranidium is subquadrate in outline, longer than wide, moderately convex, about 1.3-2.0 mm in length (sag.). The glabella is expanded forwardly from the narrow occipital ring (tr.); a pair of well defined glabellar furrows exist behind the mid-line of the glabella, directed posteriorly from the shallow dorsal furrow to the occipital furrow. No preglabellar field is present. The anterior border is narrow, gently convex, with median point at the anterior end. The crescentic occipital ring is convex, and well delimited by a narrow distinct occipital furrow. The medium sized palpebral lobe is located behind the mid-length of the glabella (tr.); it is gently convex, without a distinct palpebral furrow. The fixigena is rather narrow, moderately convex, directed upward from the dorsal furrow. The narrow posterior fixigene is triangular-transverse, narrower than the occipital ring (tr.), and the border furrow is well defined. The surface is covered by faint granules; a pair of superciloid granules occur along the anterior furrow. A median tubercle is located near the occipital furrow, and a pair of minute granule seems to be present of the anterior glabella near the edge of the frontal furrow.

The pygidium is ovate-elongate in outline, convex, with the posterior margin notched. The convex axial lobe is rather narrower than the pleural lobe, tapering slightly at the posterior end, and marked by several axial rings. The pleural lobe is convex above the flat broad marginal border, and divided into four or five pleural bands by well defined furrows.

Figured specimens: — Metaprotaspides, U.C.G.M. 40417, 40417a, b, Paraprotaspides, U.C.G.M. 40417d, c, i, Early meraspides, U.C.G.M. 40417e-h, n-q, Late meraspides, U.C.G.M. 40417j, k, x, y.

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Explanation of Plate 4

Figs. 1-33. *Isotelus* sp.

1-3. Three metasprotaspid shields, notice the three pairs of marginal spines and the median tubercles. 1, ×23, U. C. G. M. 40417; 2, ×23, U. C. G. M. 40417a; 3, ×23, U. C. G. M. 40417b.

4-6. Side, ventral, and obliquely views of two paraprotaspid shields. 4, 5, ×20, U. C. G. M. 40417d; 6, ×20, U. C. G. M. 40417c.

11. Dorsal view of a paraprotaspid shield; notice the paired fixigenal spines. 11, ×20, U. C. G. M. 40417i.

7-10. Four early meraspid cranidia, showing a pair of anterior glabellar nodes and the absence of fixigenal spine. 7, ×17, U. C. G. M. 40417e; 8, ×20, U. C. G. M. 40417f; 9, ×17, U. C. G. M. 40417g; 10, ×17, U. C. G. M. 40417h.

12, 13. Dorsal views of two late meraspid cranidia; notice the deepening of the dorsal furrow and the position of the median tubercle. 12, ×10, U. C. G. M. 40417j; 13, ×10, U. C. G. M. 40417k.

14, 15, 31. Dorsal views of three cranidia. 14, ×10, U. C. G. M. 40417l; 15, ×7, U. C. G. M. 40417m; 31, ×5, U. C. G. M. 40417a′.

16, 17. Dorsal and ventral views of two early meraspid pygidia. ×24, U. C. G. M. 40417o, n.

18, 19. Dorsal and ventral views of an early meraspid pygidium, showing the occipital segment and a pair of fixigenal spines in place. ×24, U. C. G. M. 40417q, p.

20-23. Dorsal and ventral views of four different sized hypostomata; notice the lateral expanding of the marginal border. 20, ×10, U. C. G. M. 40417r; 21, ×7, U. C. G. M. 40417s; 22, ×9, U. C. G. M. 40417t; 23, ×5, U. C. G. M. 40417u.

24-26. Three different sized librigenae; notice the widening of the ocular platform and the broad doublure. 24, specimen missing; 25, ×5, U. C. G. M. 40417v; 26, ×5, U. C. G. M. 40417w.

27. An earliest late meraspid pygidium articulating in series with a thoracic segment, and showing three or four pairs of posterior marginal spines. ×20, U. C. G. M. 40417x.

28. Dorsal view of a late meraspid pygidium, showing the deep dorsal furrows, and posterior marginal notch. ×9, U. C. G. M. 40417y.

29, 30, 32, 33. Dorsal and ventral views of four complete pygidia; notice the disappearence of the dorsal furrows and the broad doublures. 29, ×6, U. C. G. M. 40417z; 30, 32, ×4, U. C. G. M. 40417b′; 33, ×6, U. C. G. M. 40417c′.


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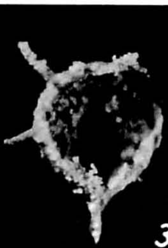
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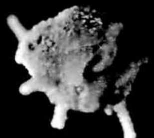
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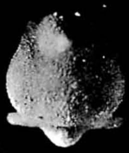
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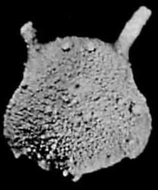
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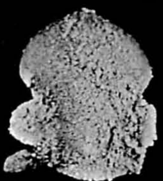
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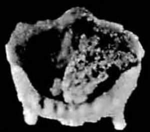
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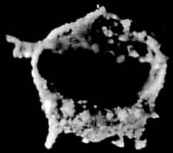
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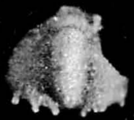
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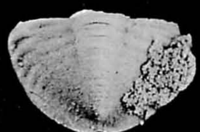
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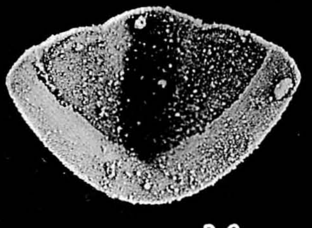
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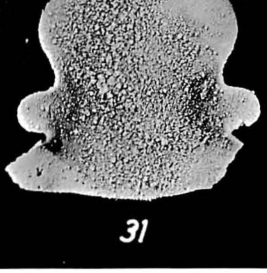
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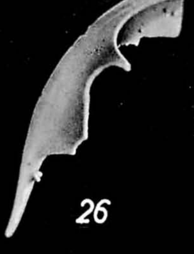
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Paleont., vol. 25, p. 578-586, pls. 81-84.

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学会記事

◎ 1974年11月に行われた1975・1976年度評議員選挙の結果，次の諸君が当選した（以下敬称略，ＡＢＣ順）浅間一男，浅野　清，鎮西清高，浜田隆士，花井哲郎，速水　格，亀井節夫，勘米良亀齢，小高民夫，松本達郎，鹿間時夫，首藤次男，高柳洋吉，棚井敏雅，氏家　宏。

◎ 1975年1月24日の評議員会において，1975・1976年度の会長は松本達郎，常務委員は浅間一男（会員），鎮西清高（庶務），浜田隆士（「報告・紀事」編集），花井哲郎（庶務），速水　格（庶務），勘米良亀齢（特別号），小高民夫（行事），高柳洋吉（「化石」），氏家　宏（会計）と決った。

◎ 同上評議員会において，賞の委員会委員半数改選を行った結果，小高民夫，浅間一男の2名と決った。従って1975年度の同委員は，会長，花井哲郎，氏家　宏，浅間一男，小高民夫の5名である。

◎ 1975年1月24日の評議員会において次の入・退会等が認められた（以下敬称略，ＡＢＣ順）。

1975年度よりの入会者は，普通会員10名，在外会員1名，計11名（以下敬称略，ＡＢＣ順）。原田憲一，John Davis HILL，伊奈治行，礒田喜義，松田哲夫，西村明子，西村　昭，岡崎美彦，奥村好次，大野照文，杉田福松。

事務手続きの誤りのため退会扱い（1973年6月）となっていた次の3君の復活を確認した。浅見清秀，柴田豊吉，滝沢　茂。

1975年度より次の諸君が特別会員となった（7名）。藤山家徳，小泉　格，村井貞允，中村耕二，大塚裕之，高安泰助，田代正之。

1974年度中の退会は，特別会員1名，普通会員6名，賛助会員1社である。土井清磨，服部陸男，福留高明，上西敏郎，湊　正雄，三宅　茂，中居　功，中東石油ＫＫ。

◎ 本会特別号第19号として，田代正之君の“Bivalve Faunas of the Cretaceous Himenoura Group in Kyushu”の出版が1975年1月24日の評議員会で承認された。

◎ 1975年度より次の通りに会費が値上げされ，会則の当該部分も変更された。普通会員4,000円，特別会員5,600円，在外会員ＵＳ＄20。

◎ 本会会誌「日本古生物学会報告・紀事」の定価が No. 97 より1,600円に改訂された。

◎ 1975年度学会誌論文賞は，棚部一成君の“Evolution and mode of life of *Inoceramus* (*Sphenoceramus*) *naumanni* YOKOYAMA emend., an Upper Cretaceous bivalve”（報告・紀事 No. 92 掲載）に授与された。

◎ 1975年度学術奨励金は，柳田寿一君（上部古生代腕足類の研究），および糸魚川淳二君（中新世瀬戸内地域の軟体動物の古生態学的研究）に授与された。

◎ 既報の通り，本会「報告・紀事」100号記念事業を行なう小委員会（松本達郎・委員長，浜田隆士，高柳洋吉，氏家　宏各委員）が発足したが，その事業として「日本の古生物学小史」を英文で出版することになった。

1974年度最優秀論文賞推薦文

棚部一成君，1973年12月20日発行日本古生物学会報告紀事92号163～184頁収載論文「Evolution and mode of life of *Inoceramus* (*Sphenoceramus*) *naumanni* YOKOYAMA emend., an Upper Cretaceous bivalve」

本研究は，北海道中軸部および南樺太の上部白亜系サントニアンないしカンパニアン産二枚貝 *Inoceramus* (*Sphenoceramus*) *naumanni* の集団標本について，その産状・形態変化を生物統計学的に解析し，その結果を生態学的に，かつ系統発生的に解釈を試みた意欲的論文である。両統の諸層準より得た合計38サンプル（浦河地域12，達布地域19，内淵地域7サンプル）の産出地点と層準を，まず明示し，1250以上の個体の産状を岩相との対応・articulation の状態・殻高などについて検討した。特に顕著な成果は，貝殻の相対成長に伴なう変化と生活様式の変化との相関，および貝殻の形態変化と産出層準との相関（つまり系統発生的相対成長の証拠の提出）を明らかにした点である。同心円状彫刻のみを有する個体が圧倒的なサントニアンの population や，カンパニアン標本の幼期 population においては，殻厚が殻高に対して劣成長にあり，また殻壁，特に稜柱層の厚さも殻高に対して劣成長であって，足糸で流木や海藻に付着した擬浮遊性生活様式が示唆される。一方，カンパニアン標本の成体に特徴的な分岐肋が出現するや，殻厚および稜柱層層厚は殻高に対して優成長に転じ，生活様式は底生型に変ったものと推定された。この生活様式

Paleont., vol. 25, p. 578–586, pls. 81–84.

MOORE, R. *et al.* ed. (1951): Treatise on Invertebrate Paleontology, Part O, Arthropoda, 541 p., 415 text-figs. *Geol. Soc. America & Univ. Kansas.*

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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会1975年総会・年会は，1975年1月25日（土）・26日（日）に国立科学博物館本館（東京都台東区上野公園）において開催された（参加者110名）。

海外学会出席報告

Marine plankton and sediments に関するシンポジウム及び第3回 Planktonic Conference 報告 ....西田史朗

第5回オストラコーダシンポジウム報告 ....石崎国熙

会長講演

Ammonitology in Japan—a historical review ....T. Matsumoto

特別講演

グロマー・チャレンジャー号航海記 ....氏家　宏

総会

シンポジウム「古生物学と走査型電子顕微鏡」

世話人：岩崎泰頴

超微化石研究と走査電顕 ....西田史朗

走査型電子顕微鏡による放散虫化石の観察 ....八尾　昭

貝形虫の殻の構造と表面装飾について ....岡田　豊・池谷仙之・花井哲郎・西田憲正

貝殻構造観察と走査電顕 ....岩崎泰頴

有孔虫の殻構造—Elphidiidae の例を中心として ....氏家　宏

堆積岩のエッチング表面の観察について ....斉藤靖二

微化石試料の調整とその問題点 ....酒井豊三郎・高山俊昭・高柳洋吉

個人講演

Late Cenozoic micropaleontologic events in the equatorial Pacific sediments ....Y. Takayanagi, T. Takayama, T. Sakai, M. Oda and M. Kato

静岡県相良層群模式セクションのプランクトン性有孔虫層序............氏家　宏・針生真也

房総半島養老川流域における石灰質ナノプランクトン化石群集の時代的変遷..高山俊昭・池野紀男

中部日本，上部新生界浮遊性有孔虫化石層序区分..............................尾田太良

常磐地域上部新生界浮遊性有孔虫化石層序区分 ....加藤道雄

フィリッピン，パナイ島上部新生界の微化石層序学的検討....高柳洋吉・高山俊昭・尾田太良

Biostratigraphical significance of some productoid brachiopods from the Kashiwadaira Formation of the Abukuma Mountains, Japan.. ....K. Nakamura and H. Koizumi

一関付近の下黒沢層産浮遊性有孔虫の新種について....................高柳洋吉・尾田太良

Eocene Larger Foraminifera collected by dredge haul at the Amami Plateau, northern margin of the Philippine Sea ....I. Konda, K. Matsuoka, A. Nishimura and T. Ōno

Permian Bryozoa from Khao Hin Kling, near Phetchabun, North-Central Thailand ....S. Sakagami

Giant fusulinid discovered from Iran ....K. Ishii and M. Murata

Studies on the genus *Triticites* from the Madre de Dios Island, in the southern part of Chile ....T. Chisaka

硬鱗魚の上皮表面のSEMによる観察 ..福田芳生

神奈川県産長鼻類化石について ....長谷川善和・松島義章・鹿間時夫

日本貝形類属，いわゆる *Hermanites* について ....石崎国熙

日本の“*Balanus amphitrite*” group について..............................山口寿之

Pamirina 属の分類上の位置について ..小林文夫

Toward a systematic catalogue of Mesozoic Bivalvia from Japan ....I. Hayami

Some evolutionary lineage of the Cenozoic Radiolaria ....T. Sakai

上部成田層産の rock-boring shell について.. ....福田芳生

Ligament を伴なった *Clinocardium* (*Fuscocardium*) *braunsi* について ....福田芳生

Some considerations on the phylogeny of

学会記事

◎ 1974年11月に行われた1975・1976年度評議員選挙の結果，次の諸君が当選した（以下敬称略，ＡＢＣ順）浅間一男，浅野　清，鎮西清高，浜田隆士，花井哲郎，速水　格，亀井節夫，勘米良亀齢，小高民夫，松本達郎，鹿間時夫，首藤次男，高柳洋吉，棚井敏雅，氏家　宏。

◎ 1975年1月24日の評議員会において，1975・1976年度の会長は松本達郎，常務委員は浅間一男（会員），鎮西清高（庶務），浜田隆士（「報告・紀事」編集），花井哲郎（庶務），速水　格（庶務），勘米良亀齢（特別号），小高民夫（行事），高柳洋吉（「化石」），氏家　宏（会計）と決った。

◎ 同上評議員会において，賞の委員会委員半数改選を行った結果，小高民夫，浅間一男の2名と決った。従って1975年度の同委員は，会長，花井哲郎，氏家　宏，浅間一男，小高民夫の5名である。

◎ 1975年1月24日の評議員会において次の入・退会等が認められた（以下敬称略，ＡＢＣ順）。

1975年度よりの入会者は，普通会員10名，在外会員1名，計11名（以下敬称略，ＡＢＣ順）。原田憲一，John Davis HILL，伊奈治行，礒田喜義，松田哲夫，西村明子，西村　昭，岡崎美彦，奥村好次，大野照文，杉田福松。

事務手続きの誤りのため退会扱い（1973年6月）となっていた次の3君の復活を確認した。浅見清秀，柴田豊吉，滝沢　茂。

1975年度より次の諸君が特別会員となった（7名）。藤山家徳，小泉　格，村井貞允，中村耕二，大塚裕之，高安泰助，田代正之。

1974年度中の退会は，特別会員1名，普通会員6名，賛助会員1社である。土井清磨，服部陸男，福留高明，上西敏郎，湊　正雄，三宅　茂，中居　功，中東石油ＫＫ。

◎ 本会特別号第19号として，田代正之君の " Bivalve Faunas of the Cretaceous Himenoura Group in Kyushu " の出版が1975年1月24日の評議員会で承認された。

◎ 1975年度より次の通りに会費が値上げされ，会則の当該部分も変更された。普通会員4,000円，特別会員5,600円，在外会員ＵＳ＄20。

◎ 本会会誌「日本古生物学会報告・紀事」の定価が No. 97 より1,600円に改訂された。

◎ 1975年度学会誌論文賞は，棚部一成君の " Evolution and mode of life of *Inoceramus* (*Sphenoceramus*) *naumanni* YOKOYAMA emend., an Upper Cretaceous bivalve "（報告・紀事 No. 92 掲載）に授与された。

◎ 1975年度学術奨励金は，柳田寿一君（上部古生代腕足類の研究），および糸魚川淳二君（中新世瀬戸内地域の軟体動物の古生態学的研究）に授与された。

◎ 既報の通り，本会「報告・紀事」100号記念事業を行なう小委員会（松本達郎・委員長，浜田隆士，高柳洋吉，氏家　宏各委員）が発足したが，その事業として「日本の古生物学小史」を英文で出版することになった。

1974年度最優秀論文賞推薦文

棚部一成君，1973年12月20日発行日本古生物学会報告紀事92号163～184頁収載論文「Evolution and mode of life of *Inoceramus* (*Sphenoceramus*) *naumanni* YOKOYAMA emend., an Upper Cretaceous bivalve」

本研究は，北海道中軸部および南樺太の上部白亜系サントニアンないしカンパニアン産二枚貝 *Inoceramus* (*Sphenoceramus*) *naumanni* の集団標本について，その産状・形態変化を生物統計学的に解析し，その結果を生態学的に，かつ系統発生的に解釈を試みた意欲的論文である。両統の諸層準より得た合計38サンプル（浦河地域12，達布地域19，内淵地域7サンプル）の産出地点と層準を，まず明示し，1250以上の個体の産状を岩相との対応・articulation の状態・殻高などについて検討した。特に顕著な成果は，貝殻の相対成長に伴なう変化と生活様式の変化との相関，および貝殻の形態変化と産出層準との相関（つまり系統発生的相対成長の証拠の提出）を明らかにした点である。同心円状彫刻のみを有する個体が圧倒的なサントニアンの population や，カンパニアン標本の幼期 population においては，殻厚が殻高に対して劣成長にあり，また殻壁，特に稜柱層の厚さも殻高に対して劣成長であって，足糸で流木や海藻に付着した擬浮遊性生活様式が示唆される。一方，カンパニアン標本の成体に特徴的な分岐肋が出現するや，殻厚および稜柱層層厚は殻高に対して優成長に転じ，生活様式は底生型に変ったものと推定された。この生活様式

の変化に伴う適応的形態変化はサントニアンからカンパニアンにかけて生じているので 1 chronospecies としての本種はサントニアンの *I.* (*S.*) *naumanni naumanni* と，カンパニアンの *I.* (*S.*) *naumanni schmidti* の2亜種にわけられる。

古生物統計学が盛んになりつつある昨今においても，なおかつ統計学的遊びに終る論文が少なくない現状にあって，本研究は統計学的手法を用いてこそ，はじめてこのように具体的な古生態や化石層序的推定が可能なのであることを示した秀作と評価される。よって日本古生物学会は，本研究に対して論文賞を贈り，同君の今後の著しい発展を期待するものである。

1974年度学術奨励金推薦文

柳田寿一君：上部古生代腕足類の研究

日本の石炭系には多くの腕足類化石を産するが，これまでの研究はむしろ散点的であり，一産地あるいは一化石帯について徹底的に記載検討した例は少ない。とくに，炭酸塩岩相中のものは従来ほとんど手をつけられないままにおかれていたきらいがある。柳田君は，秋吉石灰岩のウズラ帯を中心に，精力的な採集を重ね，石灰岩中より大量の標本をとり出すことに成功し，これまでまったく無知に等しかった当石灰岩の腕足類群集の内容を詳細に記載し，その意義を論じた。すなわち，ウズラ帯は upper Viséan に相当するが，productid がきわめて貧弱であることなどの特徴から，北上山地の鬼丸統に代表される，いわゆる Kueichouphyllum 動物相とは，明瞭に区別できることを指摘した。秋吉型は，日本では内帯を中心に，ユーラシア大陸では中国北西部からベルギーにまで類縁をたどることができる。一方，鬼丸型は，外帯から中国の中南部を経てトルコにまで連続しており，この二つの明瞭な動物相の分布は日本のみならず，テチス海域全般にわたって，それを南北二帯に分ける重要な対立であることを明らかにした。この対立はサンゴ化石や岩相の特徴によっても裏付けられている。

柳田君の上部古生界腕足類研究は，これら秋吉 up. Viséan の資料にとどまることなく，同地の lower Viséan の大型腕足類，九州水越層，四国中久保や山姥，関東山地三沢などの二畳・石炭紀腕足類にも及んでいる。また外国のものについては，数次にわたる海外調査を通じて，主としてタイ，マレーシアの二畳・石炭紀化石を多数記載報告し，この地域ににについてのまったく新しい知識を提供している。このような広い視野と豊富な経験とにもとずいて，動物相の構成，近縁関係等にも詳しくふれ，とくに石炭紀前期の腕足類動物相にみられるアジア・オーストラリア間の類似性を指摘し，従来からのサンゴ類についての考察と併せて大きな貢献をしている。よって日本古生物学会はここに学術奨励金を贈り，今後のいっそうの発展を期待する。

会費値上げと会則改訂について

1975年1月の総会において，次のように会費値上げが承認され，それに伴う会則改訂が行なわれた。( ) 内が旧条文。

第12条　会費の金額は総会に計って定める。会費は普通会員 年 **4,000** 円 (3,000円)，特別会員 年 **5,600** 円 (4,200円)，賛助会員 年1口 10,000円以上とする。名誉会員は会費納入の義務がない。在外の会費は年U. S. **$ 20** (16) とする。

日本古生物学会報告紀事100号記念

1975年1月の総会において，上記記念事業として「日本の古生物学小史」(A Concise History of Palaeontology in Japan) の刊行が承認された。報告・紀事は本年12月号をもって新編100号に達する。記念号は No. 100s として通常号1冊分程度の規模とし，会員全員に配布される。本事業のために，常務委員会内に計画実行小委が設置され，委員長に松本達郎君，委員に氏家宏，高柳洋吉，浜田隆士の三君が選ばれた。No. 100s の刊行は 1976年2月頃の予定。この事業に対して会員から協賛の寄付を求めることになり，内容目次等とともに要綱が近日中に公表される。

日本古生物学会特別号の原稿募集

PALAEONTOLOGICAL SOCIETY OF JAPAN, SPECIAL PAPERS, NUMBER 20 を 1976 年度に刊行したく，その原稿を公募します。適当な原稿をお持ちの方は，次の事項に合わせて申込書を作成し，〒812 福岡市東区箱崎町 九州大学理学部地質学教室気付，日本古生物学会特別号編集委員会（代表者勘米良亀齢）宛に申し込んで下さい。

(1) 古生物学に関する論文で，欧文の特別出版にふさわしい内容のもの。同一の大題目の下に数篇の論文を集めたもの（例えばシンポジュウムの欧文論文集）でもよい。分量は従来発行の特別号に経費上ほぼ匹敵すること。学会から支出できる経費は 50 万円程度です。学会以外からも経費が支出される見込のある場合には，その金額に応じて上記よりも分量が多くてよい。

(2) 内容・文章ともに十分検討済の完成した原稿（または完成間近い原稿）で，印刷所に依頼して正確な見積りを算出できる状態にあること。なるべく原稿の写しを申込書とともに提出して下さい。（用済の上は返却致します）。

(3) 申込用紙は自由ですが，次の事項を明記し，〔　〕内の注意を守って下さい。

(a) 申込者氏名；所属機関または連絡住所・電話番号。〔本会会員であること〕。

(b) 著者名；論文題目。〔和訳を付記すること〕。

(c) 研究内容の要旨。〔800～1, 200 字程度，和文で可〕。

(d) 内容ならびに欧文が十分検討済であることの証明。〔校閲者の手紙の写しでもよい〕。

(e) 本文の頁数（刷上り見込頁数または原稿で欧文タイプ25行詰の場合の枚数 — ただし，パイカーかエリート字体かを添記すること）；また本文中小活字（8ポ組み）に指定すべき部分があるときは，そのおよその内訳（総頁に対するパーセント）；挿図・表の各々の数と刷上り所要頁数；写真図版の枚数。

(f) 他からの経費支出の見込の有無，その予算額，支出源。〔その見込の証明となる書類またはその写しを添えて下さい〕。〔1976 年度の文部省の刊行助成金を申請希望の場合も，その旨を上記の準じて添記して下さい〕。

(g) その他参考事項。原稿が未完成の場合には，申込時における進行状況ならびに完成確約年月日を必ず記して下さい。

(4) 申込締切 1975 年 10 月 15 日（消印有効）。採否は 1976 年 1 月の評議員会で審議決定の上申込者に回答の予定です。ただしその前または後に，申込者との細部の交渉を，編集委員から求めることがあるかもしれません。

(5) 印刷予定論文が完全な場合には，決定後できるだけ早く印刷にとりかかる予定です。文部省の刊行助成金（「研究成果刊行費補助金」）を申請希望の場合には，学会から申請（例年は 11 月中旬中に申請締切）し，その採否・金額など決定後印刷にとりかかります。その場合は文部省との約束により，その年の秋（前例では 10 月 20 日）までに初校が全部出なければ，補助金の交付が中止されることになっています。

(6) 特別号の投稿規定はとくにありません。会誌に準じ，前例を参考とし，不明の点は編集委員会に問い合わせて下さい。経費がかかるので，特別な場合を除き，別刷は作成せず，本刷 25 部を著者に無料進呈します。それ以上は購入（但し著者には割引）ということになります。いくつかの論文を集めて 1 冊にするときには，世話人の方から指示して，体裁上の不統一のないようにして下さい。印刷上の指示事項が記入できるよう，原稿の左右両側・上下に十分空白をとって，タイプで浄書して下さい。

CONSTITUTION
of the
PALAEONTOLOGICAL SOCIETY OF JAPAN

(Jan. 25, 1975)

Article 1. The Society shall be known as the Palaeontological Society of Japan.

Article 2. The object of the Society is to promote the study and popularization of palaeontology and related sciences.

Article 3. The Society, to execute Article 2, shall undertake the following business:

  1. Issue the Society journal and other publications.
  2. Hold or sponsor scientific lectures and meetings.
  3. Popularize the science by field trips, scientific lectures and other projects.
  4. Aid and encourage research work; award outstanding contributions to the Society; carry out the objectives stated in Article 2.

Article 4. To attain the object of the Society, the Society may, by decision of the General Meeting, establish within it research committees.

Article 5. The Society shall be composed of members who are active or interested in palaeontology or related sciences.

Article 6. The members shall be known as Regular Members, Fellows, Patron and Honorary Members.

Article 7. Persons desiring membership in the Society are requested to fill out the necessary application forms and receive the approval of the Council.

Article 8. Fellows are persons who have held Regular Membership in the Society for more than ten years, have contributed to the science of palaeontology, have been nominated by five Fellows and approved by the Council.

Article 9. Patrons are organizations supporting Article 2 and recommended by the Council.

Article 10. Honorary Members are persons of distinguished achievement in palaeontology. They shall be recommended by the Council and approved by the General Meeting.

Article 11. The members of the Society shall be obliged to pay the annual dues stated in Article 12. Members shall enjoy the privilege of receiving the Society journal and participating in the activities stated under Article 3.

Article 12. The rates for annual dues shall be decided by the General Meeting. Rates for annual dues are: Regular Members, Yen 4,000; Fellows, Yen 5,600; and Foreign Members, U.S.$20.00; Patrons are organizations donating more than a share (Yen 10,000) annually; Honorary Members are free from obligations.

Article 13. The budget of the Society shall be from membership dues, donations and bestowals.

Article 14. The Society, by decision of the Council, may expel from membership persons who have failed to pay the annual dues or those who have disgraced the Society.

Article 15. The officers of the Society shall be composed of one President and fifteen Councillors, among whom several shall be Executive Councillors. The term of office is two years and they may be eligible for re-election without limitation. The President may appoint several persons who shall be Secretaries and Assistant Secretaries. An Executive Council shall be nominated and approved by the Council. Councillors shall be elected from Fellows by vote of returned mail unsigned ballot.

Article 16. The President shall be a Fellow nominated and approved by the Council. The President shall represent the Society and supervise the business affairs. The President may appoint a Vice-President when he is unable to perform his duties.

Article 17. The Society may have the Honorary President. The Honorary President shall be recommended by the Council and approved by the General Meeting. The Honorary President may participate in the Council.

Article 18. The Society shall hold regularly one General Meeting a year. The President shall be Chairman and preside over the administrative affairs. The program for the General Meeting shall be decided by the Council. The President may call a Special Meeting when he deems it necessary. The General Meeting requires the attendance of more than one-tenth of the members. The President shall call a Special Meeting at the written request of more than one-third of the members. The request shall be granted only if the written statement fully explains the reasons for assembly and items for discussion.

Article 19. Members unable to attend the General Meeting may give as attending member a written statement signed by himself trusting the bearer with the decision of business matters. Only one attending member may represent one absentee.

Article 20. The decision of the General Meeting shall be by majority vote. When the number of votes is equal, the President shall cast the deciding vote.

Article 21. The President and Councillors shall compose the Council. The dicision of the General Meeting concerning administration shall be considered and implemented by the Council.

Article 22. The Executive Council shall carry out the decisions of the Council.

Article 23. An auditor shall be elected by the Council from Fellows excluding Councillors and Secretaries. The term of office is two years and he may be eligible for re-election.

Article 24. The fiscal year of the Society shall begin on the first of January each year and end on the thirty-first of December of the same year.

Article 25. The amendments to the Constitution of the Society shall be decided at the General Meeting and must be approved by more than two-thirds of those members who are in attendance.

Addendum 1) Voting in the Council shall be by unsigned ballot.


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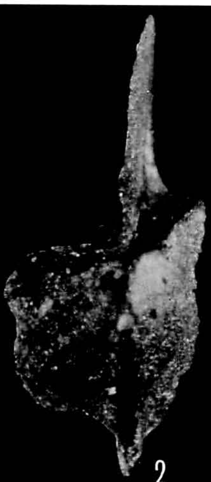
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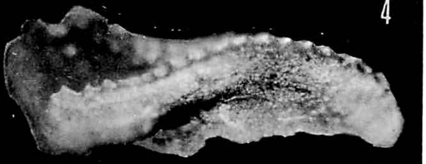
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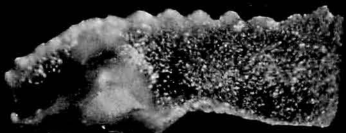
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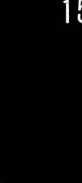
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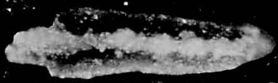
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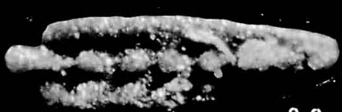
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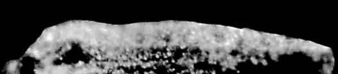
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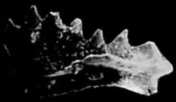
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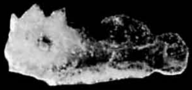
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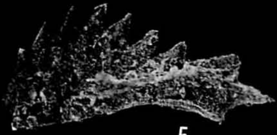
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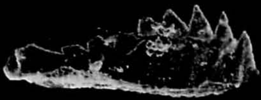
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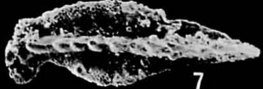
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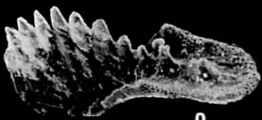
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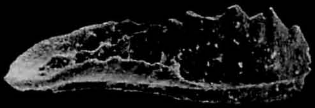
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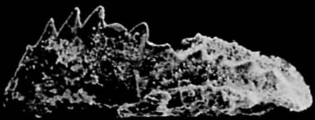
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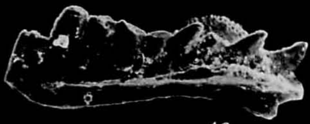
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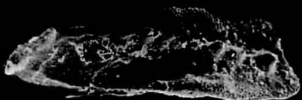
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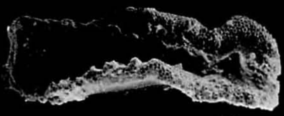
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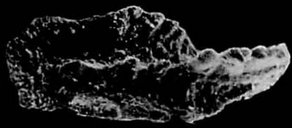
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例会等の通知

	開催地	開催日	講演申込締切日
115回例会	岩手大学	1975年6月14日	1975年4月20日
116回例会	金沢大学	1975年9月23,24日	1975年7月20日
1976年総会・年会	鳴子川渡 共同セミナーハウス	1976年1月30,31日	1975年11月20日

◎ 116回例会ではコロキウム「硬組織の生長」（世話人・小西健二）が予定されている。

お知らせ

◎ **琵琶湖深層掘削（第二次）の研究参加について** 琵琶湖深層掘削第二次計画を文部省の特別事業計画で実施する計画を，学術会議地球物理学研究連絡委員会付置琵琶湖深層掘削事業計画小委員会の審議結果に基いて，連絡します。

上記の審議の結果，要約された研究テーマは，

(1) 古地磁気，(2) 古環境の変遷（地球化学・地球物理学），(3) 地質学及び地殻構造，(4) 古生態学，(5) 古水理学，(6) 総合解析，(7) 掘削作業実施

本学会の会員の方で，研究分担者として参加を希望される方は，6月30日までに，藤　則雄（〒921 金沢市窪四丁目206番）あて，**簡易書留ハガキ**にてお知らせ下さい。

地球物理学研究連絡委員会付置
琵琶湖深層掘削事業計画小委員会
藤　則雄

◎ 前号（96号）444頁の「お知らせ」で各種学術奨励金中 山路自然科学振興財団研究助成金は昭和50年度より廃止とお知らせいたしましたが実際は昭和51年度より廃止され今年は推薦を受付けますので訂正させていただきます。助成金の内容は次の通りです。

山路自然科学振興財団研究助成金（1件100〜200万円年令45才未満，学会の推薦による。締切8月頃）

尚各種学術奨励金の自薦・他薦の締切を4月末まで延期いたしますのでふるってご応募・ご推薦下さい。但し朝日学術奨励金の推薦は3月に締切られましたので念のため申し添えます。

Erratum:
Plates 56 and 57 in No. 96 should change places with each other, leaving their running titles intact. For amendment, extra prints of the Plates are enclosed.

◎ 本会誌の出版費の一部は文部省研究成果刊行費による。

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CONTENTS