日本古生物学會
報告・紀事

Transactions and Proceedings
of the
Palaeontological Society of Japan

New Series No. 96

日本古生物学会

Palaeontological Society of Japan
December 20, 1974

Officers for 1973 – 1974

All communications relating to this journal should be addressed to the
PALAEONTOLOGICAL SOCIETY OF JAPAN
c/o Business Center for Academic Societies, Japan.
Yayoi 2-4-16, Bunkyo-ku, Tokyo 113, Japan
Sole agent: University of Tokyo Press, Hongo, Tokyo

Trans. Proc. Palaeont. Soc. Japan, N.S., No. 96, pp. 411-426, pl. 56, December, 20, 1974

639. CARBONIFEROUS CONODONTS FROM THE ITSUKAICHI DISTRICT, TOKYO, JAPAN*

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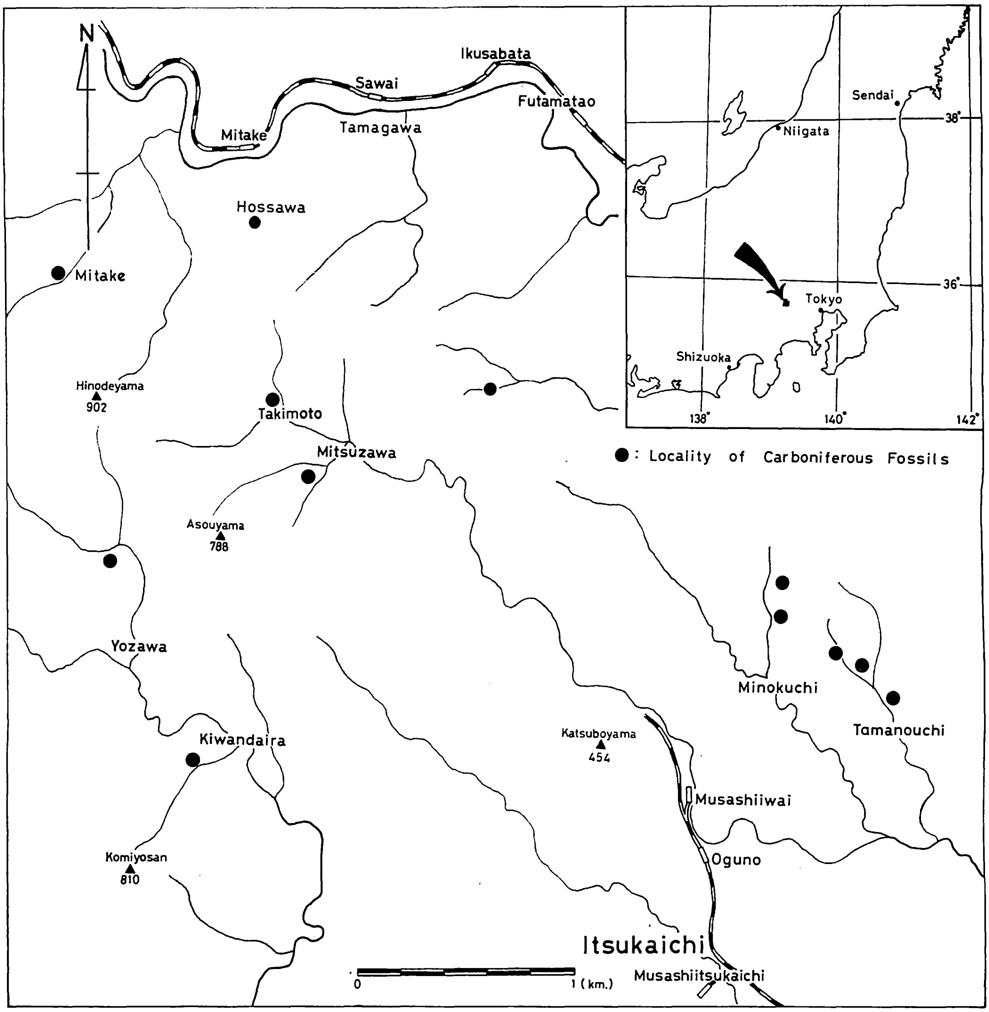
東京都五日市地方の石炭系コノドント：五日市北方には，従来考えられていたより広く三畳系や石炭系が分布していることが判明した。今回は，三沢，滝本，払沢などに分布する石灰岩やチャートに含まれる石炭系のコノドントを記載し，その時代を論じた。コノドント群集は新旧二つあり，旧期のものは北米のチェスター統およびヨーロッパの下部ナムール統のものに対比され，新期のものは北米のペンシルバニア系最下部とヨーロッパの上部ナムール統に比較できる。なお坂上澄夫（1973），柳田寿一（1973）の報じたビゼー世の腹足類や腕足類は筆者らの旧期のコノドント群集を伴なうが，時代論については一致せず，筆者らは同氏らの見解よりやや新しい時代と結論した。 猪郷久義・小林文夫

Introduction

Upper Paleozoic and Mesozoic formations occur as several narrow belts trending northwest and southeast in the Itsukaichi district, southeastern part of the Kanto Massif. FUJIMOTO (1932, 1936), SAKAGAMI (1956, 1958) and others contributed geology and some paleontological aspect of this district, but detailed stratigraphy and paleontology remained unknown. Comprehensive field study of the Itsukaichi district has been made by the junior author during the spring field season of 1971-1972. As a result, he found many new evidence of stratigraphy and geologic structure. He proved more extensive distribution of Triassic and Carboniferous strata than the previously published geologic maps. Many Triassic conodonts were found in the chert members which were treated as the Permian by the previous authors. KOBAYASHI also collected many Carboniferous fusulinaceans and conodonts from limestones outcropped at Yozawa, Mitsuzawa, Tamanouchi, Takimoto, Mitake and Hossawa (Text-fig. 1). These limestones bear primitive fusulinaceans, such as *Millerella*, *Eostaffella*, and *Profusulinella*.

Limestone exposed at Mitsuzawa, approximately 3 km northwest of Itsukaichi is particularly noteworthy because of the occurrence of interesting bryo-

* Received March 2, 1974: read January 16, 1973 at Sendai.



Text-fig. 1. Map showing the localities of Carboniferous fossils in the Itsukaichi district.

zoans, corals, brachiopods, mollusks and conodonts. SAKAGAMI (1972) was the first to recognize them as the Lower Carboniferous. He described *Mourlonia* and concluded that this gastropod is very similar to the specimens from Uzura, Akiyoshi Limestone (SAKAGAMI, 1973). Also, YANAGIDA (1973) described several brachiopods and advocated that the fauna is apparently of Viséan in age.

The purpose of the present paper is to discuss geologic age and descriptions of the conodonts from Mitsuzawa, Takimoto and Hossawa. These conodonts are very important to settle the conodont biostratigraphy near the boundary between the Lower and Middle Carboniferous of Japan. Detailed geologic observations of this district will be presented at a later date.

Acknowledgements: Here the authors record their cordial thanks to Dr. Toshio KOIKE of Tokyo University of Education and Mr. Hisaharu IGO of Tokyo Gakugei University for their discussion in the field and laboratory. The junior author's field survey was carried out under the supervision of Drs. Mosaburo KANUMA and Atsushi ISHII of Tokyo Gakugei University. Dr. Haruyoshi FUJIMOTO, Professor Emeritus of Tokyo University of Education and Dr. Sumio SAKAGAMI, Professor of Ehime University gave us valuable field information. Miss Hiromi KANASUGI, Messrs. T. KUSANO, M. GOKAN and N. MATSUSE of Tokyo Gakugei University helped our field survey and laboratory work. The authors are grateful to these individuals. We are also indebted to the Chichibu Cement, Buko Mining and Mitsubishi Kogyo Cement Companies, Ltd. for generous financial assistance.

Geologic Setting

The Mitsuzawa Limestone outcrops along a small valley in the south of Mitsuzawa. The following succession is measured along the Mitsuzawa Valley in descending order.

Chert; thin-bedded, pale gray, green and partly reddish..more than 20 m thick.

Limestone; well-bedded, intercalating thin layers of chert and dolomitic layers ....9 m thick.

Chert; bedded, pale gray and reddish .... 7 m thick.

Tuff; red, green and variegated, calcareous, intercalating nodular limestones and limestone layers, upper part grades laterally into chert .... 8 m thick.

Tuff; red, partly variegated, intercalating thin layers of limestone in middle part......................15 m thick.

Both the upper and lower limits of this sequence are in contact with Triassic sediments by pronounced faults. These lithologic units trend to N30°W and dip 40° to the northeast. The lower tuff is red, green and partly variegated and becomes calcareous upward. The calcareous part of this tuff comprises fragments of crinoid stems, other calcareous materials and oolites. Nodular shaped limestones are various in shape but mostly subspheroid. Averaged diameter of them is about 30 cm. They contain abundantly crinoid stems, corals, bryozoans, gastropods, brachiopods and rarely goniatites. Fossils described by SAKAGAMI (1973) and YANAGIDA (1973) were collected from this level (158B in Text-fig. 2). Limestones yielding corals and bryozoans have almost the same lithology. The corals are *Lithostrotion* (*Siphonodendron*), *Diphyphyllum* and other Rugosa. These corals are cemented mostly by fine-grained lime mud, subordinate fossil fragments and detrital calcite and partly filled with clear sparry calcite. Brachiopodal and gastropodal limestones are highly bioclastic. These fossils are cemented by fairly large fragments of biogenetic calcite which are mostly originated from crinoid. Interstitial cement of clean calcite is also recognized, and partly interlocking these fragments of biogenetic calcite.

The upper limestone beds are almost barren in megafossils except for small fragments of crinoid and shells, but they contain smaller foraminifers and other microfossils. The lower part of this limestone is thin-bedded, laminated and intercalating thin dolomitic layers. This rock consists of fine-grained lime mud with the admixture of smaller foraminifers and fragments of biogenetic calcite which are mostly echinoderms. Minute shell fragments in varying abundance are also recognized, but what kind of fossil shells they represent is difficult to determine. Small dolomitic rhombs are scattered in the particular laminae as single individuals. These components frequently show graded lamination in a small scale.

The upper remainder of this limestone unit intercalates chert layers of about 10 cm thick. Lithology of this part of limestone is almost similar to the lower part, but dolomitized and laminated parts become obscure. Chert layers intercalated within this limestone are sometimes discontinuous and their upper and lower surfaces show irregular wavy bedding plane.

The uppermost chert is thin-bedded, about 5 to 10 cm thick, intraformationally folded, pale gray, green and partly reddish. This chert unit yields abundant radiolarian remains and conodonts from the particular levels.

The above mentioned sequence of the Mitsuzawa Valley can be traced laterally, but limestone thins abruptly both northwest and southeast and is replaced by chert. At Takimoto, about 800 m north of Mitsuzawa, this chert member is about 40 m thick and intercalates small limestone lenses or lentils in the various levels. Erratics of limestone derived from this member yield conodonts but are barren in megafossils. Conodonts are well-preserved and more numerous than the type section. Limestone at Takimoto may represent the condensed sequence in contrast with the biohermal or reef-like deposition at Mitsuzawa.

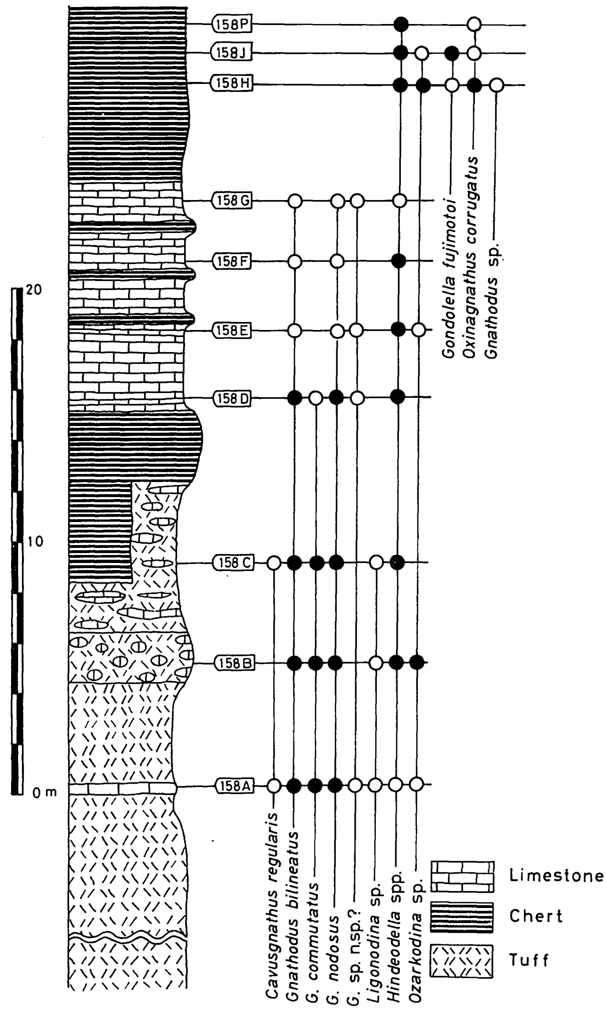
Further northwestern extension of limestone occurs at Hossawa, the south of Mitake Railway Station. Limestone layer interbedded with green chert, about 10-15 cm in thickness yields numerous conodonts. These conodonts are the same with those from the type section of the Mitsuzawa Limestone.

Appraisal of Conodont Fauna

Conodonts were recovered from 1 to 2 kg limestone samples by ordinary acetic acid method. Samples embedded in chert were observed by very thin slices and chips under the transmitted light. Hydrofloric acid was supplementarily used for chert samples. All of the samples shown in Text-fig. 2 are productive. The assemblage of conodont does not show any remarkable difference throughout the calcareous facies of the measured section, but each species varies in individual abundance.

The following species are discriminated from 158A through 158G, namely, *Cavusgnathus regularis* YOUNGQUIST and MILLER, *Gnathodus bilineatus* (ROUNDY), *Gnathodus commutatus* (BRANSON and MEHL), *Gnathodus nodosus* BISCHOFF, *Gnathodus* sp., n. sp. (?), *Ligonodina* sp., *Hindeodella* spp., *Ozarkodina* sp.

Among them, *Gnathodus bilineatus*, *G. commutatus*, and *G. nodosus* are predominant species. *Gnathodus commutatus* ranges throughout the calcareous facies of the measured section, but it is particularly abundant in the lower levels (158A, 158B, 158C). This well-known species has been repeatedly described from the Chesterian of North America (COLLINSON et al., 1971 and others) and the Viséan to Lower Namurian in Germany (MEISCHNER, 1970 and others), Belgium (HIGGINS and BOUCKAERT, 1968), England (RHODES et al., 1969 and others) and elsewhere. It is also present in the



Text-fig. 2. Columnar section measured along the Mitsuzawa Valley, showing the stratigraphic distribution and abundance of conodonts. Solid circle: abundant (more than 10 specimens per kg); open circle: rare (less than 10 specimens per kg).

Nagoe Formation of the Atetsu Limestone (KOIKE, 1967), basal part of the Akiyoshi Limestone Group (Hisaharu IGO, 1973) and the lowest part of the Omi Limestone (WATANABE, personal comm). HAYASHI (1971) reported the occurrence of this species from the Permian Kuzuu Limestone, Tochigi Prefecture and insisted that the species survived into the Permian in Japan. HAYASHI's identification, however, is apparently erroneous and his *Gnathodus commutatus* is a homeromorphic different species of *Gnathodus* (Hisayoshi IGO, 1972). Moreover, according to the authors' numerous unpublished data, this species never coexists with the typical lowermost Pennsylvanian species of conodont in Japan. Therefore, the upper limit of this species almost coincides with the case in Europe and North America.

Gnathodus nodosus is also common in the Mitsuzawa Limestone associated with *Gnathodus commutatus*. This species is abundant in 158A, 158B, 158C and 158D and is rather sporadical in other samples. *Gnathodus nodosus* is widespread in Europe, and it first appears from the Upper Viséan and the middle part of Cu IIIβ and extinguishes in the upper part of the Lower Namurian (E 2c). Typical *Gnathodus nodosus* bears one node on the upper surface of both outer and inner sides of the cup. Numerous specimens recovered from the Mitsuzawa Limestone have some variations in the development of node on the cup. The nodes of the most of our specimens are more than one and rather irregularly disposed compared with the type species described from Germany (BISCHOFF, 1957). Based on the specimens from the Griotte of Northwest Spain, HIGGINS (1962) proposed *Gnathodus commutatus multinodosus* for this type of *G. nodosus*. Therefore, the present ones are referable to *G. multinodosus* rather than *G. nodosus*. This difference, however, seems to be continuous and the authors reserved the validity of *G. multinodosus*.

Gnathodus bilineatus is also one of the most common species in the present fauna, and it is yielded from 158A to 158G, but is particularly abundant in 158A, 158B, 158C and 158D. This species is a well-known species in the Upper Viséan to Lower Namurian of Europe and the Chesterian of North America, and it has been known from the lowermost part of the Akiyoshi Limestone, Omi Limestone and the Nagoe Formation of the Atetsu Limestone in Japan. As will be discussed later, the present specimens show considerable variation in the development of nodes.

Gnathodus sp. (n. sp.?) is rarely yielded from 158A, 158D, 158E and 158G. This species resembles *Gnathodus* cfr. *roundyi* GUNNELL described by KOIKE (1967) from the Lower Pennsylvanian Kodani Formation of the Atetsu Limestone. It is also similar to *Gnathodus roundyi* GUNNELL described from the Morrowan of USA by DUNN (1970). MERRILL (1972) treated the mentioned species as a new species and proposed *Neognathodus medadulitimus* MERRILL. *Gnathodus girtyi intermedius* GLOBENSKY described from the Windsor Group of Canada is slightly related to the present *Gnathodus* sp., n. sp. (?). It differs from GLOBENSKY's (1967) Canadian subspecies in fused carina and other ornamentation of the platform.

Cavusgnathus regularis is frequently fragmental and rare in this section, but it is rather common at Hossawa. This species is known from the entire part of the Chesterian of North America.

The conodont fauna recovered from the Mitsuzawa Limestone is apparently equivalent to the fauna from the Chesterian of the North American Mississippian and also to the Upper Viséan to Lower Namurian of Europe. The faunal aspect near the boundary between the Viséan and Lower Namurian of Europe was discussed by HIGGINS (1961, 1962, 1967), HIGGINS and BOUCKAERT (1968), RHODES et al. (1969), BOUCKAERT and HIGGINS (1970) and others in Europe. According to their studies, the Upper Viséan (V3c) or D3 is characterized by *Gnathodus bilineatus*, *G. girtyi girtyi*, *G. girtyi collinsoni*, *G. commutatus*, *G. nodosus* and others. The fauna of the lowest Namurian (E2a) is poorly known in Belgium but it comprises *Gnathodus bilineatus*, *G. girtyi* and the first occurrence of *Gnathodus noduliferus*. The faunas of E2b—E2c are characterized by *Gnathodus bilineatus*, *G. girtyi*, *G. nodosus* and *G. commutatus*. HIGGINS (1961) reported the Lower Namurian conodonts from North Staffordshire, England. These conodonts are almost the same with the lower part of the type Namurian in Belgium.

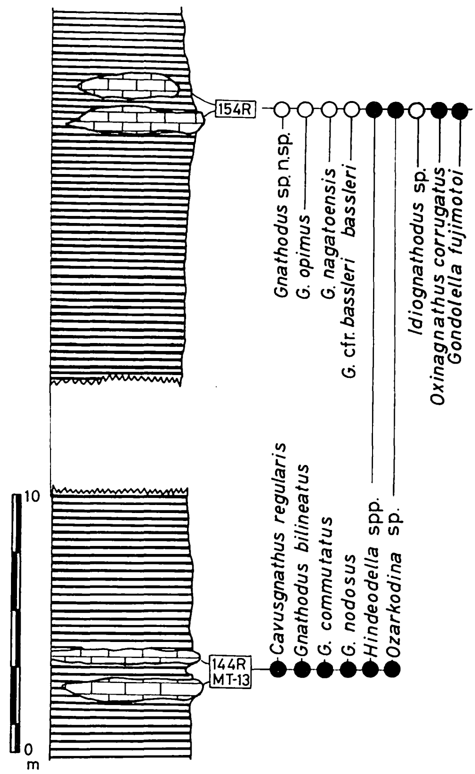
As cited above, there are no remarkable faunal change between the highest Viséan and the basal Namurian except for questionable occurrence of *Gnathodus noduliferus*. Therefore, it is uncertain that the Mitsuzawa conodont fauna indicates Upper Viséan or Lower Namurian. However, the following paleontological and stratigraphical evidence may allow to discuss more detailed correlation of the Mitsuzawa fauna. Our present fauna is entirely lacking *Gnathodus girtyi* and its subspecies which are rather common in European Upper Viséan. *Gnathodus nodosus* collected from the present section is *multinodosus*-type which is probably descendant modification of typical *G. nodosus*. Some of our specimens identified as *Gnathodus bilineatus* are slightly similar to *G. bilineatus bollandensis* HIGGINS and BOUCKAERT rather than the typical *G. bilineatus*. *G. bilineatus bollandensis* was described from E2b2, E2b3, E2c and H1 of the type Namurian.

SAKAGAMI (1973) and YANAGIDA (1973) stated that their brachiopod-gastropod faunas from 158B are equivalent to the Yobara fauna of the Akiyoshi Limestone. Rich brachiopods from Yobara were worked out by YANAGIDA (1962, 1965) who concluded that the geologic age is of Late Viséan. IGO and KOIKE (1965) studied conodonts collected from Yobara and they showed that the fauna is apparently Lower Pennsylvanian or Upper Namurian. As will be discussed later, the Mitsuzawa Limestone characterized by *Gnathodus bilineatus*, *G. nodosus*, and *G. commutatus* is conformably overlain by chert which yielding apparent Lower Pennsylvanian or Upper Namurian conodonts. From the above mentioned evidence, we are inclined to conclude that the geologic age of the Mitsuzawa Limestone is Late Chesterian of North America and Early Namurian rather than Late Viséan of Europe.

The other conodont fauna was found in chert superposed above the Mitsuzawa Limestone in the type section. The following conodonts are discriminated from 158H, 158J and 158P. These include *Gnathodus* sp., n. sp. (?), *Gondolella fujimotoi* IGO and KOBAYASHI, n. sp., *Oxinagnathus corrugatus* (HARRIS and HOLLINGSWORTH), *Gnathodus* sp., *Ozarkodina* sp., and *Hindeodella* spp. This fauna is quite similar to the fauna from the calcareous facies of the upper part of the Takimoto section.

Conodonts obtained from Takimoto consist of two dissimilar faunas which are derived from the different levels. Unfortunately, however, precise stratigraphic relationship between two levels is unknown. The older one was recovered from fine-grained gray limestone intercalated as the lentils in chert. It has completely the same assemblage of conodont elements with the type section of the Mitsuzawa Limestone. The same assemblage of conodonts is also obtained from limestone layers interbedded with chert at Hossawa.

The younger fauna from Takimoto is distinctive and consists of the following species: *Gnathodus nagatoensis* IGO and KOIKE, *Gnathodus opimus* IGO and KOIKE,



Text-fig. 3. Generalized columnar section measured at Takimoto and Hossawa, showing distribution and abundance of conodonts. Legend is the same with Text-fig. 2.

Gnathodus sp., *Gnathodus* cfr. *bassleri bassleri* (HARRIS and HOLLINGSWORTH), *Idiognathodus* sp., *Oxinagnathus corrugatus* (HARRIS and HOLLINGSWORTH), *Gondolella fujimotoi* IGO and KOBAYASHI, n. sp., *Ozarkodina* sp., and *Hindeodella* sp.

Oxinagnathus corrugatus is fairly abundant in this fauna. This species has been reported from the Lower Pennsylvanian Morrowan of North America (DUNN, 1970, etc.) and the Kinderscoutian (Rl) of the type Namurian of Belgium (HIGGINS and BOUCKAERT, 1968; BOUCKAERT and HIGGINS, 1970). *Idiognathodus* sp. is less common in the present fauna and is similar to *Idiognathodus humerosus* DUNN and *I. parvus* (DUNN) which have been described from the upper part of the Morrowan in North America. *Gnathodus opimus* and *Gnathodus nagatoensis* are rare in the present fauna, but they are characteristic species of the Yobara fauna of the Akiyoshi Limestone (IGO and KOIKE, 1965). *Gondolella fujimotoi* is fairly common and is related to *Gondolella* sp. A described from the Kodani Formation of the Atetsu Limestone (KOIKE, 1967). Recently, similar species, *Gondolella gymna*, has been proposed by MERRILL and KING (1971) from the Lower Pennsylvanian of Illinois, USA. Although the specimens are fragmental, the occurrence of *Gnathodus* cfr. *bassleri bassleri* is noteworthy, because this species is an excellent indicator of the Lower Pennsylvanian in North America (LANE et al., 1972). This species is also rather wide-spread in the Japanese Carboniferous associated with *Eostaffella* and other primitive fusulinaceans (Hisayoshi IGO, 1972). The present fauna from Takimoto is unquestionably younger than *Gnathodus commutatus—G. bilineatus—G. nodosus* fauna and is apparently similar to the Morrowan of USA and Upper Namurian of Europe.

In conclusion, the Carboniferous conodont fauna from the Itsukaichi district comprises two distinct assemblages, such as the older *Gnathodus commutatus —G. bilineatus—G. nodosus* fauna and younger *Oxinagnathus corrugatus—Idiognathodus* sp. fauna. The former one represents the majority of the Mitsuzawa Limestone and its equivalent at Takimoto and Hossawa and is correlated to the Lower Namurian and Upper Chesterian. The latter fauna is found in the upper chert beds of the type section of the Mitsuzawa Valley and also in the calcareous facies of the upper sequence at Takimoto. This fauna is considered to represent a part of the Lower Pennsylvanian or Upper Namurian conodont faunas.

Systematic Paleontology

Genus *Cavusgnathus* HARRIS and HOLLINGSWORTH

Cavusgnathus regularis YOUNGQUIST and MILLER

Pl. 56, figs. 4, 5

Cavusgnathus regularis YOUNGQUIST and MILLER, 1949, p. 619, pl. 101, figs. 18-23; REXROAD, 1957, p. 17, pl. 1, fig. 7; REXROAD, 1958, p. 17, pl. 4, figs. 6-11; REXRAOD and BURTON, 1961, p. 1152, pl. 138, figs. 10-12; THOMPSON and GOEBEL, 1963, p. 22, pl. 1, fig. 3, 12; REXROAD and COLLINSON, 1963, p. 9, pl. 1, figs. 26, 27; REXRAOD and FURNISH, 1964, p. 670, pl. 111, fig. 6; REXROAD and NICOLL, 1965, p. 18, pl. 1, figs. 16, 17.

Remarks:—The present material is very similar to the previously described American ones and no remarkable difference is observed.

Occurrence:—Rare at Mitsuzawa and Takimoto, common at Hossawa.

Reg. nos. 22441, 22442, 22443.

Genus *Gnathodus* PANDER, 1856

Gnathodus cfr. *bassleri bassleri* (HARRIS and HOLLINGSWORTH)

Pl. 56, fig. 13.

cfr.

Polygnathus bassleri HARRIS and HOLLINGSWORTH, 1933, p. 198, pl. 1, fig. 13.

Polygnathus wapanuckensis HARLTON, 1933, p. 15, pl. 4, fig. 13.

Gnathodus wapanuckensis, ELLISON and GRAVES, 1941, pl. 2, figs. 13-17; KOIKE, 1967, p. 300, pl. 1, figs. 22-25.

Streptognathodus wapanuckensis, ELIAS, 1956, p. 120, pl. 3, figs. 67-69; WIRTH, 1967, p. 236, pl. 20, figs. 11, 13.

Gnathodus bassleri, LANE, 1967, p. 934, pl. 120, figs. 1-5, 9-15, 17; pl. 121, figs. 6, 9; pl. 123, figs. 1-6; WEBSTER, 1969, p. 29, pl. 5, figs. 9, 14, 15.

Gnathodus cfr. *girtyi*, HIGGINS and BOUCKAERT, 1968, p. 32, pl. 2, fig. 9, pl. 5, figs. 5, 6.

Neognathodus bassleri, DUNN, 1970, p. 336, pl. 64, figs. 1, 12-14, text-fig. 9F.

Neognathodus bassleri, bassleri, MERRILL and KING, 1971, p. 659, pl. 76, figs. 11, 12; MERRILL, 1972, p. 822-823, pl. 71, figs. 16-19.

Remarks:—This species was fully described by MERRILL (1972). The present forms are fragmentary and no complete specimens are obtained. However, their characteristic ornamentation consisting of three longitudinal rows is distinct to identify with *Gnathodus bassleri bassleri*. DUNN (1970) proposed the genus *Neognathodus* with *Polyghathodus bassleri* HARRIS and HOLLINGSWORTH as its type species. He stressed that *Neognathodus bassleri* evolved from *Declinognathodus lateralis* (HIGGINS and BOUCKAERT) and homeromorphic relation of *Ganthodus* and *Neognathodus*. MERRILL and KING (1971) have questioned generic rank of *Declinognathodus* but they treat *Neognathodus* as a distinct genus. ELLISON (1972), however, rejected the validity of *Neognathodus*. We postponed to settle generic problem herein.

Occurrence:—Rare in limestone distributed at Takimoto.

Reg. no. 22444.

Gnathodus bilineatus (ROUNDY)

Pl. 56, figs. 1-3.

Polygnathus bilineatus ROUNDY, 1926, p. 13, pl. 3, figs. 10a-c.
Gnathodus bilineatus, HASS, 1953, p. 79, pl. 14, figs. 25-29; REXROAD and FURNISH, 1964, p. 670; DUNN, 1965, p. 1148, pl. 140, figs. 7-9; WIRTH, 1967, p. 205, pl. 19, figs. 6-9; KOIKE, 1967, p. 296, pl. 1, figs. 9-11; GLOBENSKY, 1967, p. 440, pl. 58, figs. 9, 13; IGO and KOIKE, 1968, p. 29, pl. 3, fig. 6; RHODES, AUSTIN and DRUCE, 1969, p. 94, pl. 18, figs. 14-17; WEBSTER, 1969, p. 30, 31, pl. 5, figs. 11, 12; DUNN, 1970, p. 330, 331, pl. 62, figs. 13, 14; MARKS and WENSINK, 1970, p. 258, pl. 2, figs. 3a, b, 4.
Gnathodus bilineatus bilineatus, HIGGINS and BOUCKAERT, 1968, p. 29, pl. 2, figs. 10, 13; pl. 3, figs. 4-8, 10.
Gnathodus bilineatus modocensis REXROAD and FURNISH, 1964, p. 670, pl. 111, figs. 4, 5.
? *Gnathodus bilineatus schmidti* MEISCHNER, 1970, p. 1176.
Gnathodus modocensis REXROAD, 1957, p. 30, pl. 1, figs. 15-17; REXROAD, 1958, pl. 17, pl. 1, figs. 1, 2.
(Further synonyms: see RHODES, AUSTIN and DRUCE, 1969, p. 94, 95)

Remarks:—Our numerous specimens are quite identical to the previously described ones. There are, however, appreciable variations in the shape of the platform and the disposition of the nodes on the outer lateral platform. In some specimens, the nodes on the outer lateral platform are irregularly disposed, but in the other group these nodes have tendency of longitudinal linear arrangement. The former type somewhat resembles *Gnathodus bilineatus bollandensis* HIGGINS and BOUCKAERT, but they bear more numerous nodes than the Belgian subspecies. However, the mentioned variations are continuous, and there is no obvious difference among the specimens collected from various levels of the present columnar sections.

Occurrence:—Abundant throughout the type section of the Mitsuzawa Limestone and also at Takimoto and Hossawa.

Reg. nos. 22445, 22446, 22447, 22448, 22449, 22450.

Gnathodus commutatus (BRANSON and MEHL)

Pl. 56, figs. 6, 7.

Spathognathodus commutatus BRANSON and MEHL, 1941, p. 98, pl. 19, figs. 1-4.
Gnathodus commutatus, REXROAD and BURTON, 1961, p. 1153, pl. 39, figs. 1-3; HIGGINS and BOUCKAERT, 1968, p. 30, pl. 2, fig. 5; RHODES, AUSTIN and DRUCE, 1969, p. 95, pl. 19, figs. 9-21; WEBSTER, 1969, p. 31, pl. 5, fig. 13.
Gnathodus commutatus commutatus, BISCHOFF, 1957, p. 23, pl. 4, figs. 2-6, 15; KOIKE, 1967, p. 296, pl. 1, figs. 12-16; WIRTH, 1967, p. 206, pl. 19, figs. 10, 11; DUNN, 1970, p. 331, pl. 62, figs. 11, 12; MARKS and WENSINK, 1970, p. 285, pl. 3, figs. 1a, b.
Gnathodus scotiaensis GLOBENSKY, 1967, p. 441, pl. 58, figs. 2-7, 10, 12.
(Further synonyms: see RHODES, AUSTIN and DRUCE, 1969, p. 95).

Remarks:—As already noted by previous many authors, this species shows considerable but continuous variation. The specimens in the present collections also show appreciable variations in the general form of the platform, development of the carina and others. There is remarkable difference between the present and previously described ones in the lateral view of the carina. Most of the specimens described by many authors have high carina even at the posterior end. The carina of the specimens, however, gradually decline posteriorly.

Occurrence:—Very abundant throughout the type section of the Mitsuzawa Limestone, and at Takimoto and Hossawa.

Reg. nos. 22451, 22452, 22453, 22454, 22455, 22456.

Gnathodus nagatoensis IGO and KOIKE

Pl. 56, fig. 14, 15.

Gnathodus commutatus (BRANSON and MEHL) *nagatoensis* IGO and KOIKE, 1965, p. 89, pl. 9, figs. 1-8; KOIKE, 1967, p. 297, pl. 1, figs. 17, 18.

Remarks:—*Gnathodus nagatoensis* was originally proposed by IGO and KOIKE as a subspecies of *Gnathodus commutatus*. Its important distinction is the lateral view of the cup and carina. Two low nodes adjacent to the carina developed on the inner part of the cup in the full growth specimens. Unit is generally thinly constructed compared with typical *Gnathodus commutatus*. The authors are now inclined to believe that the mentioned differences have specific value rather than subspecific.

Occurrence:—Rare in chert superposed above the Mitsuzawa Limestone and also at Takimoto.

Reg. nos. 22457, 22458.

Gnathodus nodosus BISCHOFF

Pl. 56, figs. 8-12.

Gnathodus commutatus nodosus BISCHOFF, 1957, p. 23, 24, pl. 4, figs. 12, 13; HIGGINS, 1961, p. 213, pl. 10, figs. 7, 8; HIGGINS, 1962, pl. 2, fig. 19; KOIKE, 1967, p. 297, pl. 1, fig. 19; WIRTH, 1967, p. 207, 208, pl. 2, figs. 15-18; MARKS and WENSINK, 1970, p. 260, pl. 3, figs. 3, 4.

Gnathodus commutatus multinodosus HIGGINS, 1962, p. 8, 9, pl. 2, figs. 13-18.

Gnathodus nodosus, RHODES, AUSTIN and DRUCE, 1969, p. 104, 105, pl. 19, figs. 16a-20c.

(Further synonyms: see RHODES, AUSTIN and DRUCE, 1969, p. 104, 105)

Remarks:—There is considerable but continuous variation in several biocharacters as in the same tendency reported by many previous authors. Most of the present specimens have more than two nodes on both sides of the platform and similar to "*multinodosus*"-type described by HIGGINS (1962).

Occurrence:—Yielded from the type section of the Mitsuzawa Limestone, limestone lenses exposed at Takimoto and Hossawa.

Reg. nos. 22459, 22460, 22461, 22462, 22463, 22464, 22465.

Gnathodus opimus IGO and KOIKE

Pl. 56, fig. 18.

Gnathodus opimus IGO and KOIKE, 1964, p. 189, pl. 28, figs. 15-18; IGO and KOIKE, 1965 (partim), p. 89, pl. 9, figs. 1-4; KOIKE, 1967, p. 298, pl. 1, figs. 20, 21; WEBSTER, 1969, p. 33, 34, pl. 5, figs. 19-21.

Remarks:—The specimens collected from this area are very similar to the original ones from the Omi Limestone. However, the present collections are mostly small and immature specimens.

Occurrence:—Rare in limestone lenses at Takimoto.

Reg. nos. 22466, 22467.

Gnathodus sp., (n. sp. ?)

Pl. 56, fig. 17.

Axis almost straight or slightly curved inward. Carina composed of fused denticles and ridge-like. Cup asymmetrical and expanded lanceolate in general outline. Inner platform parallel with carina and separated from it by a trough. Trough shallow in posterior half and deepest at anterior part. At posterior end, node of inner platform fused with carina. Rather high but narrow transverse nodes developed on inner platform. Outer side of cup slightly wider and shorter than inner side and subovate in outline. Margin of outer platform with fused nodes which are most prominent near midpoint to anterior end. Blade long, almost equal length with cup and bears serrate denticles. Lower side of cup strongly excavated. Lower side of blade grooved.

Remarks:—This unidentified species seems to be a new species or new subspecies. *Gnathodus* cfr. *roundyi* GUNNEL described by KOIKE (1967, Pl. 1, fig. 27, non fig. 28) is similar to the specimens. It slightly resembles *Gnathodus girtyi intermedius* GLOBENSKY, but the present one differs from his subspecies in isolated nodes of the carina, fused nodes of the outer and inner platform at the posterior end of the cup of the latter. Also the outer cup of the present species is lower than the inner. *Gnathodus bilineatus bollandensis* HIGGINS and BOUCKAERT is also allied one. Not so laterally expanded outer platform, weaker transverse ridge of the inner platform and fused nodes on the posterior part of the cup of *G. bilineatus bollandensis* differ from the present one. This form also resembles *Gnathodus roundyi* described by several American authors and now identified as *Neognathodus bothrops* MERRILL (1972), but the present material bears fused and continuous nodes of the carina and poorly developed ornamentation of the outer platform.

Occurrence:—Rare in various levels of the type section of the Mitsuzawa Limestone and Takimoto.

Reg. nos. 22468, 22469, 22470.

Genus *Gondolella* STAUFFER and PLUMMER, 1932

Gondolella fujimotoi Hisayoshi IGO and KOBAYASHI, n. sp.

Pl. 56, figs. 20-23.

Unit almost symmetrical and slightly arched, elongate lanceolate in outline and tapering anteriorly. Carina composed of 7 or 6 discrete denticles. Denticles node-like and laterally not compressed, erect or slightly directed posteriorly. Upper surface of platform smooth and lacking any ornamentation. Lateral furrow along carina shallow. Cusp and denticles of anterior end larger than other denticles. Pit located at posterior end, broadly flared and comparatively large, surrounded by flange. Basal groove well-developed but shallow. Aboral keel slightly elevated and wide.

Remarks:—This species is similar to *Gondolella* n. sp. A described by MERRILL and KING (1971) from the lowest Pennsylvanian of Illinois, certain specimens of *Gondolella bella* STAUFFER and PLUMMER described by KOIKE (1967) from the Atetsu Limestone, Japan. This new species differs from these species in discreate node-like denticles and slightly elevated aboral keel. *Gondolella gymna* MERRILL and KING and *Gondolella* (?) sp. A (KOIKE, 1967) are also similar species to this new species. *Gondolella fujimotoi* has shorter denticles and lower and wider aboral keel and more expanded platform. The specific name dedicated to Dr. Haruyoshi FUJIMOTO, Professor Emeritus of Tokyo University of Education.

Occurrence:—Rather common in limestone lenses at Takimoto and chert superposed above the Mitsuzawa Limestone.

Reg. nos. 22471 (Holotype), 22472, 22473, 22474, 22475 (Paratypes).

Genus *Idiognathodus* GUNNELL, 1931

Idiognathodus sp.

Pl. 56, fig. 16.

Free blade jointed platform in medial position and continues posteriorly as a low, fused, nodose carina for about half length of platform. Posterior part of platform ornamented with parallel transverse ridges which shallowly grooved along the midline. Anterior part of platform having parapets which consist of fused small nodes on both sides. Lobes consisting of a single or two rows of nodes also developed on both sides of anterior part of platform.

Remarks:—This unidentified species is similar to KOIKE's (1967) *Idiognathodus purvus* (DUNN) illustrated on Pl. 3, figs. 14-17. DUNN's (1970) *Idiognathodus* cfr. *magnificus* STAUFFER and PLUMMER is also allied ones. The present form is also related to young forms of *Idiognathodus delicatus* GUNNELL, but it shows rather primitive feature.

Occurrence:—Commonly yielded from the upper limestone lenses at Takimoto.

Reg. nos. 22476, 22477.

Genus *Oxinagnathus* ELLISON, 1972

Oxinagnathus corrugatus (HARRIS and HOLLINGSWORTH)

Pl. 56, fig. 19.

Idiognathodus corrugata HARRIS and HOLLINGSWORTH, 1933, p. 202, pl. 1, figs. 7, 8a, b.

Idiognathoides corrugatus, LANE, 1967, p. 939, pl. 122, figs. 1, 2, 4-7, 9-11; DUNN, 1970, p. 335, pl. 63, figs. 16-18, 25.

Idiognathoides convexa, HIGGINS and BOUCKAERT, 1968, p. 39, pl. 4, fig. 3.

Polygnathodella ouachitensis HARLTON, 1933, p. 15, pl. 4, fig. 14; ELLISON and GRAVES, 1941, p. 10, pl. 3, figs. 8, 9; WIRTH, 1967, p. 223, pl. 20, figs. 12, 14; KOIKE, 1967, p. 309, pl. 3, figs. 3-5.

Polygnathodella attenuata ELLISON and GRAVES, 1941, p. 8, pl. 3, figs. 11, 13-15.

Polygnathodella fossata BRANSON and MEHL, 1941, p. 103, pl. 19, figs. 27, 28.

Polygnathodella tenuis CLARKE, 1960, p. 28, pl. 5, figs. 12, 13.

Polygnathodella spp. CLARKE, 1960, p. 28, pl. 5, figs. 11, 16.

Remarks:—Well developed transverse ridges on the lanceolate platform, short median groove and lacking of a carina are diagnostic features of this species. The specimens occurred from the present area show slight and graditional variation in the shape of the platform, length of the median groove and others. These differences were also recognized by the previous authors and considered as the intraspecific variation.

Occurrence:—Common in the upper limestone lenses at Takimoto and chert member of Mitsuzawa.

Reg. nos. 22478, 22479, 22480.

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Hossawa	払　沢
Itsukaichi	五日市
Mitake	御　岳
Mitsuzawa	三　沢
Takimoto	滝　本
Tamanouchi	玉ノ内
Yozawa	養　沢

Explanation of Plate 56

All figures enlarged 40 times

Figs. 1-3. *Gnathodus bilineatus* (ROUNDY)
1, 3, upper views; 2, lower view.

Figs. 4, 5. *Cavusgnathus regularis* YOUNGQUIST and MILLER
Lateral views.

Figs. 6, 7. *Gnathodus commutatus* (BRANSON and MEHL)
6, upper view; 7, lower view.

Figs. 8-12. *Gnathodus nodosus* BISCHOFF
8, upper view; 9, lower view of the same specimen; 10, lateral view; 11, 12, upper view of "*multinodosus*-type".

Fig. 13. *Gnathodus* cfr. *bassleri bassleri* (HARRIS and HOLLINGSWORTH)
Upper view of a fragmentary specimen.

Figs. 14, 15. *Gnathodus nagatoensis* IGO and KOIKE
Upper views of two small specimens.

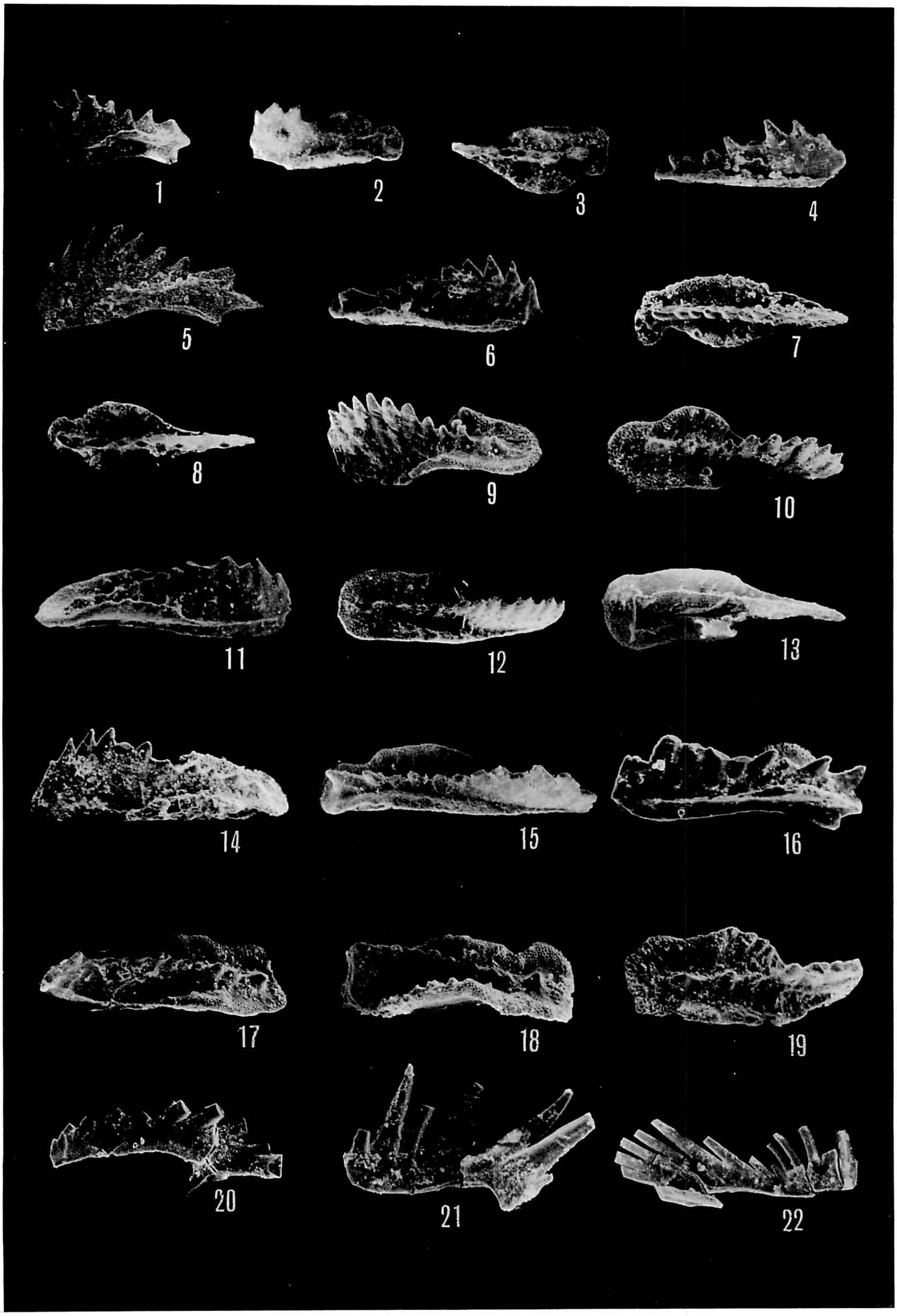
Fig. 16. *Idiognathodus* sp.
Upper view.

Fig. 17. *Gnathodus* sp., n. sp. (?)
Upper view.

Fig. 18. *Gnathodus opimus* IGO and KOIKE
Upper view.

Fig. 19. *Oxinagnathus corrugatus* (HARRIS and HOLLINGSWORTH)
Upper view.

Figs. 20-23. *Gondolella fujimotoi* Hisayoshi IGO and KOBAYASHI, n. sp.
20, lateral view; 22, upper view; 23, lower view of the holotype; 21, upper view of an immature specimen.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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 96, pp. 427-432, December 20, 1974

640. A JURASSIC AMMONITE FROM NEAR INUYAMA, NORTH OF NAGOYA*

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愛知県犬山市付近から産したジュラ紀菊石：犬山市栗栖の北東 500 m にある小谷のシルト岩から産した菊石を記載した。Perisphinctidae に属する *Choffatia* (*Subgrossouvria*) sp. であり，インド・太平洋地域に広く分布する属（亜属）である。産出層準がこの小谷内にあることは確実で，従つてここにジュラ系中部ないし上部があることが確かになつた。この産出によつて，内帯のジュラ紀後期の古地理は大幅に改変されることを議論した。　佐藤　正

The occurrence of a Jurassic ammonite from a small valley near Inuyama, north of Nagoya, is rather well known among those who are interested in the Japanese Jurassic. The first report of this ammonite was that of FUJII and MIYAKAWA in 1953, unfortunately in the form of a mimeograph. In the same year, MATSUMOTO noted its occurrence briefly (1953, p. 358) in published form. The discovery was also briefly mentioned by SATO (1962, p. 8-9) based on an oral communication from Prof. MATSUZAWA, and reported in more detail by MIZUTANI (1964, p. 42).

Recently, Jurassic ammonites have been reported from beds previously believed to have been Paleozoic at two other localities in the Yamaguchi Terrain of Inner** Japan. One locality is near Mashiko, east of Utsunomiya (SUZUKI and SATO, 1972) in finely laminated black silty shale, the age of which has not definitely been determined. The other locality is at Higuchidani in Muikamachi, Shimane Prefecture (IMAMURA, NUREKI and OKIMURA, 1966); here the ammonites are collected from the river float and the beds of origin have not been established.

These two localities and the one near Inuyama are all in the Yamaguchi Terrain (KOBAYASHI, 1941), which had supposedly been folded and partly metamorphosed before Upper Triassic or, locally, Lower Jurassic. Recent stratigraphic work on this terrain is clarifying the wide development of Middle-Upper Traissic strata, dated by conodont faunas found in the chert and limestone beds (e.g., IGO, 1972).

The newly dated Jurassic beds seem to have been folded together with the Paleozoic and Triassic strata, except that there remains some uncertainty about Higuchidani beds; therefore a more precise dating of these beds has been eagerly awaited.

The ammonite specimen discovered at Inuyama was deposited in Nagoya University (Institute of Earth Sciences); in order that it might be described for public reference, Prof. Em. T. KOBAYASHI

* Received March 18, 1974; read June 15, 1974, at Osaka.

** The term Inner Japan is used for a tectonic belt north of the Median Tectonic Line (NAUMANN, 1885).

(University of Tokyo), Prof. Em. I. MATSUZAWA (Nagoya University), and Prof. T. KIMURA (University of Tokyo, formerly of Nagoya University) arranged for study of the specimen. Prof. MIZUTANI (Nagoya University) kindly sent me the specimen along with valuable information about the geology of the area. At my request, Mr. N. KONDO of Nagoya University guided me to the fossil locality and neighboring areas. I am very grateful to all who extended me the courtesies necessary to study the ammonite and its locality.

The specimen is said to have been discovered at a small cliff facing a creek confluent with the valley of the Kiso River, about 500 m NE of Kurusu, Inuyama City (Fig. 1). It was found in 1951 by Mr. O. SENGOKU, then a school boy, who happened to be playing there. Mr. T. SENGOKU, his father, brought it to the Institute of Earth Sciences of Nagoya University where it is now deposited and registered as specimen No. ESN 70001.

Since then, efforts to clarify the geology of the area and especially to establish the fossil bearing horizon have been made repeatedly by many workers, including Prof. KIMURA and Prof. MIZUTANI; yet the fossil bearing horizon has never been firmly established because of the poor exposure.

The small cliff is situated about 100 m from the junction of the creek with the Kiso River. The fossil is an internal

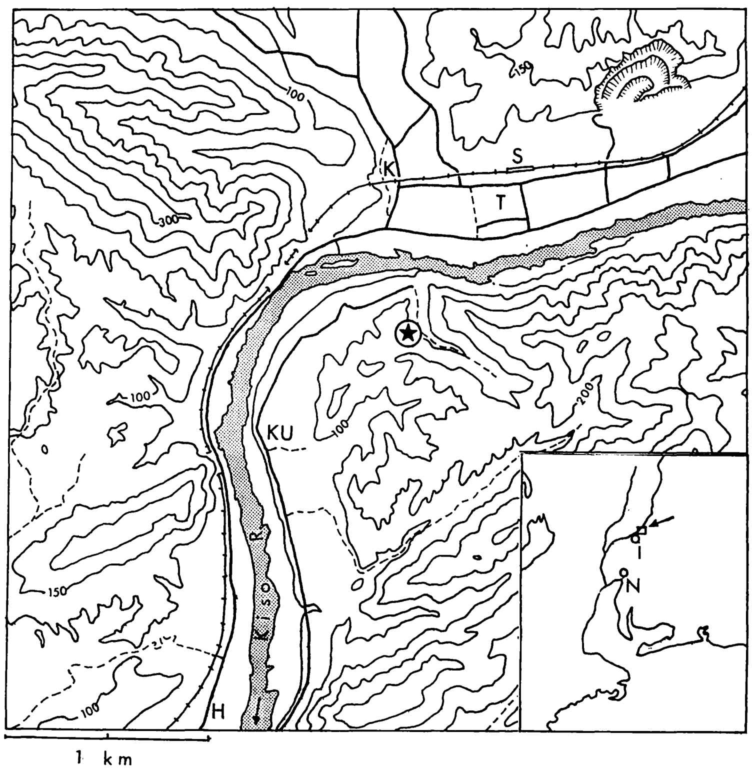

Fig. 1. Inuyama Ammonite locality. H. Hosekiji; I. Inuyama; K. Katsuyama; KU. Kurusu; N. Nagoya; S. Sakahogi Station; T. Torikumi; altitude in meters.

mold of an ammonite of moderate size, impressed on the surface of black finely laminated siltstone. Although the horizon from which the specimen originated could not be positively determined, the debris scattered around the assumed point of discovery is similar lithologically to the specimen. At any rate the specimen in question seems surely to have been derived from the catchment area of the creek.

The Age of the Beds

As will be described the ammonite is a form probably belonging to *Choffatia* (*Subgrossouvria*) of the Pseudoperisphinctinae. The specimen is incomplete and the species could not be accurately determined. The generic and subgeneric assignment ensures that the beds are Upper Bathonian to Lowest Oxfordian. Even if the generic and subgeneric assignments are not accepted, however, a Middle to Upper Jurassic age for the beds would be warranted by the inclusion of the specimen in the Family Perisphinctidae. *Subgrossouvria* is a subgenus widely distributed in the Mediterranean region in addition to East Africa, Iran, Cutch (India), and Mexico; its occurrence in Japan therefore is not surprising.

Paleogeographical considerations deriving from the occurrence of this ammonite

The Inuyama locality is situated in the outer (southern) part of the Yamaguchi Terrain of central Japan. It is very likely that the sea spread over most of the terrain in this epoch, as judged from the occurrence of Upper Jurassic ammonites (though the ages of the ammonites differ slightly), except in the northern part which appears to have undergone uplift indicated by evidence in the Kuruma and Tetori intramontane basins. It remains uncertain, however, if the sea extended farther south onto the Sambagawa metamorphic belt. The "Eo-Nippon Cordillera" (KOBAYASHI, 1941), which if present at all, divided the Upper Jurassic seas into the Japan Sea and Pacific, should be restricted therefore to a much narrower belt than those postulated by KOBAYASHI and others.

Systematic Description of the Specimen

Genus *Choffatia* SIEMIRADZKI, 1898

Subgenus *Subgrossouvria* SPATH, 1924

Choffatia (*Subgrossouvria*) sp. indet.

Text-fig. 2

Material:—An internal mold of two whorls. Inner whorls and the last part of the adult whorl(s) are lost. Deformed laterally into an ellipse, and also probably compressed tectonically.

Repository:—Institute of Earth Sciences, Nagoya University No. ESN 70001.

Measurements:—in mm.

Diameter	Umbilical diameter	Height	Thickness	Number of primary ribs per whorl	Remarks
ca. 75	44 (.72)	ca. 24 (.72)	ca. 16 (.21)	41	
ca. 57	30 (.53)	16 (.28)	?	64	measured parallel to shorter axis
ca. 54	32 (.59)	ca. 14 (.26)	?	60	measured parallel to longer axis

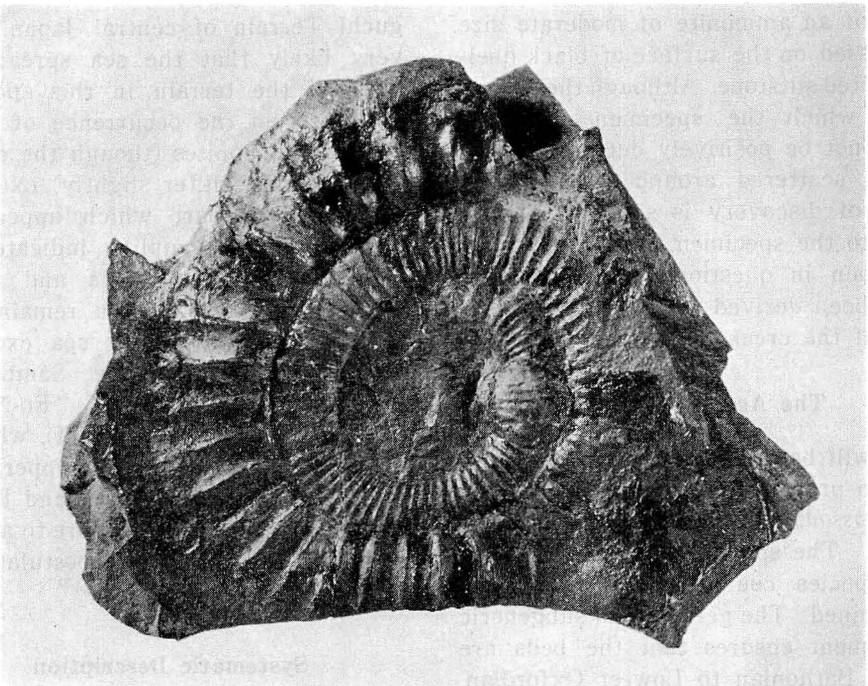

Fig. 2. *Choffatia* (*Subgrossouvria*) sp. Lateral view. ×1.

Description:—Coiling is evolute, overlapping of the inner whorls very slight; section of the whorl is hard to ascertain because of compression, but the flanks are judged to have been gently inflated with the maximum thickness at the lower part; ventral region is not preserved; umbilical is wall very inclined and rounded.

Ribbing on the inner whorls is rectiradiate and dense; probably bifurcating regularly; this ribbing suddenly changes after a shallow but rather oblique constriction into plicate primary ribs which are much less numerous, more distantly spaced, and highest in relief at the umbilical border. The furcation of the secondary ribs from the primaries is rather obscure, but it is likely that bi- or tri-furcations occur at rather indis tinct points of branching.

There are three rather shallow and obscure constrictions per whorl.

The suture-lines are not observable.

Affinities and Comparisons: — The sudden modification of the ribbing while the shell is still small is characteristic of this form. The number of primary ribs suddenly decreases from about 60 to 40 after a wide shallow constriction. Although the larger whorls are not preserved, this modification reveals that the living chamber of the senile stage would not be much larger; therefore the present specimen might represent the microconch.

Sudden modification of ribbing is observable in *Subgrossouvria* as well as in macroconchs of the Perisphinctinae; e.g. *Perisphinctes* s.s., *Liosphinctes*, etc. However, such modification occurs in Perisphinctid macroconchs at much larger diameters, for instance, at a 200–250 mm diameter in *Perisphinctes* s.s., and at a 120–150 mm diameter in *Liosphinctes*. These genera attain a gigantic size, and modified ribs are more or less cuneiform.

As admitted recently by a number of authors, microconch dimorphs of these gigantic forms do not show distinct modifications of ribs. Therefore, the present specimen does not belong to any of the genera cited above.

Subgrossouvria, treated as a subgenus of *Choffatia* by MANGOLD (1970, p. 157), shows also a rather abrupt modification of ribs. Among various species of this subgenus, *C.* (*S.*) *recuperoi* (GEMMELLARO) is superficially very similar to the present form as judged by the figures of GEMMELLARO (reproduced by ARKELL, 1958, p. 221, fig. 80/1a, b). The number of fine, undivided ribs visible within the umbilicus is as high as 56 when the shell is about 50 mm in diameter, and decreases rather abruptly to about 30. However, in the ribs on the outermost preserved whorl of the holotype (probably one more volution overlaps the original specimen, judging by the presence of the scar of the umbilical seam on the last preserved whorl) the branching of secondary ribs occurs lower on the flanks than in the present form.

Because important criteria such as whorl section, ventral aspect and suture lines are unknown, it is reasonable not to give a definite specific name to the present form.

Occurrence:—From a small creek about 500 m NE of Kurusu, Inuyama City. The horizon from which the specimen was derived could be a black laminated siltstone bed.

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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 96, pp. 433-436, pl. 57, December 20, 1974

641. UPPER TRIASSIC CONODONTS FROM OKINAWA-JIMA (PALEONTOLOGICAL STUDY OF THE RYUKYU ISLANDS-IV)

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沖縄島産上部三畳系コノドントについて：沖縄島の今帰仁層上部から，多くのアンモナイトとともにコノドントが採集された。本層のアンモナイトについては，すでに石橋（1970）によって記載されており，コノドントを産する層準は *Juvavites* cf. *kellyi* 帯に含められた。この化石帯は北米のカーニアン上部 *Tropites welleri* 帯に対比された。今回得られたコノドントは *Epigondolella nodosa* (HAYASHI) のほか3種である。*Epigondolella nodosa* の産出から，本層準は北米のカーニアン最上部 *Klamathites macrolobatus* 帯；ハルスタット石灰岩の *Anatropites* 帯に対比される。以上のように，コノドントとアンモナイトによる本層準の時代決定はほぼ同じであるが，現在の知識では，コノドントによるほうが，若干新しい時代を示す。

小池敏夫・石橋　毅

Introduction and Acknowledgements

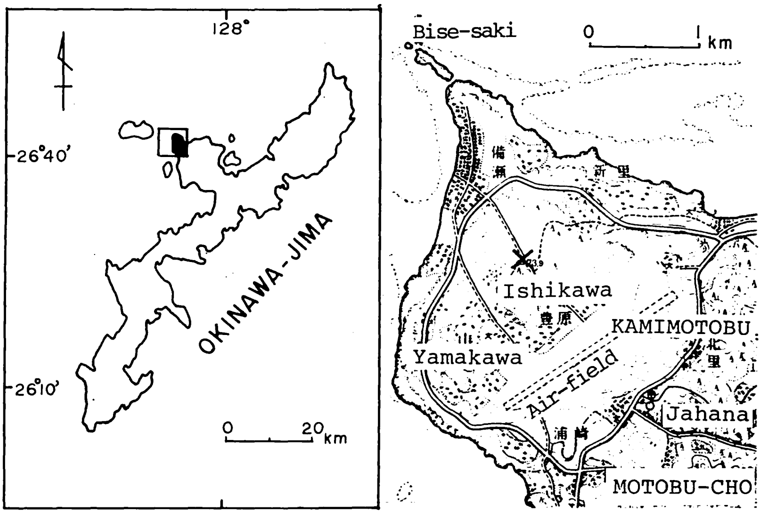
During the study of Upper Triassic ammonoids, ISHIBASHI collected some conodonts from the limestone of the Nakijin Formation (ISHIBASHI, 1969) in Okinawa-Jima. The conodont-bearing limestone was obtained from the *Juvavites* cf. *kellyi* Zone (ISHIBASHI, 1970) which is characterized by the occurrences of arcestids and juvavitids. ISHIBASHI correlated this zone with the upper Carnic *Tropites welleri* Zone (TOZER, 1967) of North America. The conodont fauna also contains important species for age determination and indicates almost equivalent conclusion obtained from the ammonoid assemblage.

Cordinal thanks are due to Professor Emeritus Teiichi KOBAYASHI of Tokyo University, Professor Ryuzo TORIYAMA of Fukuoka University and Professor Wataru Hashimoto of Tokyo University of Education for their kind criticism and encouragement. Acknowledgement is extended to Associate Professor Hisayoshi IGO of University of Tsukuba for his critical reading of this manuscript.

Remarks on the Conodont Assemblage

Conodonts described herein were collected from the muddy black limestone

* Received May 8, 1974: read June 16, 1974 at Osaka.



Text-fig. 1. Index map and location of conodont-bearing limestone collected.

of the horizon 3 (AKa), the upper part of the Nakijin Formation. ISHIBASHI (1973) reported some ammonoids from this horizon such as *Jovites*? sp., *Anatomites* cf. *taulai* (MOJS), *Tardoceras*? sp. and *Arcestes* (*Stenarcestes*) sp. A. From the horizon 1 (Ya) about 20 m above this horizon following ammonoids were also identified by him, *Hannoceras* (*H.*) *henseli* (OPPEL), *Jovites* cf. *dacus* (MOJS), *Juvavites* cf. *kellyi* SMITH, *Discotropites quinquepunctatus* (MOJS), *D.* cf. *plinii* (MOJS). *Hoplotropites* cf. *arionis* (MOJS), *H. georgii* (MOJS), *Arnioceltites* cf. *arietitiformis* (MOJS), *Arietoceltites arietitoides* (DIENER), *Arcestes* sp., *Hypocladiscites subaratus* (MOJS) and others. He referred these two horizons to the *Juvavites* cf. *kellyi* Zone and correlated this zone with the *Tropites welleri* Zone of North America.

The conodont fauna comprises *Epigondolella nodosa* (HAYASHI), *Neohindeodella triassica* (MÜLLER), *Enatiognatus ziegleri* (DIEBEL), and *Cypridodella* cf. *conflexa* MOSHER. *Epigondolella nodosa* is most abundant and comprises about 35 specimens but the others are represented by only one or two specimens in approximately 2 kg rock sample. Among these conodonts *E. nodosa* is a quite important indicator for age. This species was first reported by HAYASHI (1968) from limestone conglomerate of the basal part of the Adoyama Formation in Kuzuu, southern Ashio Mountains. HAYASHI assigned the fauna including this species as Permian in age. According to the study by KOIKE, the conodont fauna is composed of derived fossils. This species is associated not only with *Epigondolella abneptis* (HUCKRIEDE) and *E. postera* (KOZUR and MOSTLER) which indicate late Carnian to middle Norian but also with Middle Permian spathognathodids and gnathodids, and Scythian to Carnian neospathodids and gondolellids. Detailed correlation between conodont assemblages and ammonoid zones of Europe and North America was carried out by MOSHER (1968, 1970), SWEET et al. (1971), KOZUR and

MOSTLER (1971, 1972), KOZUR (1972) and KRYSTYN (1973). In British Columbia this species guides to the uppermost Carnian *Klamathites macrolobatus* Zone and the lowermost Norian *Mojsisovicsites kerri* Zone. In Hallstätter Kalk of Austria this species also occurs from the *Anatropites* Bereich of the uppermost Carnian Tuval Stage and from the *Mojsisovicsites kerri* Zone of the lowermost Norian Lac Stage. On the basis of the study of conodont assemblage, KRYSTYN (1973) correlated the *Anatropites* Bereich of Europe to the *Klamathites macrolobatus* Zone of North America. The conodont assemblage treated herein contains no *Epigondolella abneptis* HUCKRIEDE which appears in upper part of Tuval Stage and later than *Epigondolella nodosa*. Accordingly, this fauna may indicate the lower part of the *Anatropites* Bereich of Europe or the *Klamathites macrolobatus* Zone of North America. The age is almost equivalent with the conclusion by ammonoid assemblage.

Description of Species

Epigondolella nodosa (HAYASHI)

Pl. 57, figs. 1-19.

Gladigondolella abneptis nodosa HAYASHI, 1968, p. 69, pl. 2, fig. 9.
Epigondolella primitia MOSHER, 1970, p. 740, pl. 110, figs. 7-13, 16, 17.
Epigondolella n. sp. A. SWEET et al., 1971, pl. 1, figs. 8, 40.
Tardogondolella nodosa nodosa (HAYASHI)-KOZUR and MOSTLER, 1971, pl. 2, figs. 10, 11, 13.
Epigondolella nodosa (HAYASHI)-KOZUR and MOSTLER, 1972, pl. 3, figs. 9, 10; KRYSTYN, 1973, p. 138, 139, pl. 3, figs. 2-4.
Metapolygnathus nodosa (HAYASHI)-KOZUR, 1972, pl. 3, figs. 10, 11.

Description:—This species is characterized by anteriorly high carina and elongated platform with nodes on anterior lateral margins. On immature specimens platform expanded laterally at central portion and abruptly tapered anteriorly. Posterior end rounded and scooplike. Lateral margins upturned at central portion and crenulated at growth stage. Keel relatively narrow and high. Groove ends in flaring cavity. On mature specimens platform almost equivalent in width at posterior to central portion and gradually tapered anteriorly. Crenulation or nodes on lateral margins developed in anterior two thirds of platform. Keel low and broad, bearing longitudinal striation and ending in small pit. On large specimens keel probably bifurcated.

Remarks:—Immature specimens of this species are closely similar to those of *Paragonodolella polygnathiformis* (BUDUROV and STEFANOV) in gereral aspect. However, the lateral margins of platform of this species are thin and more strongly upturned. Mature specimens of this species are rather similar to *Epigondolella abneptis* (HUCKRIEDE). This species, however, posesses more elongated platform and no nodes on posterior margin.

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Explanation of Plate 57

Figs. 1-19. *Epigondolella nodosa* (HAYASHI).

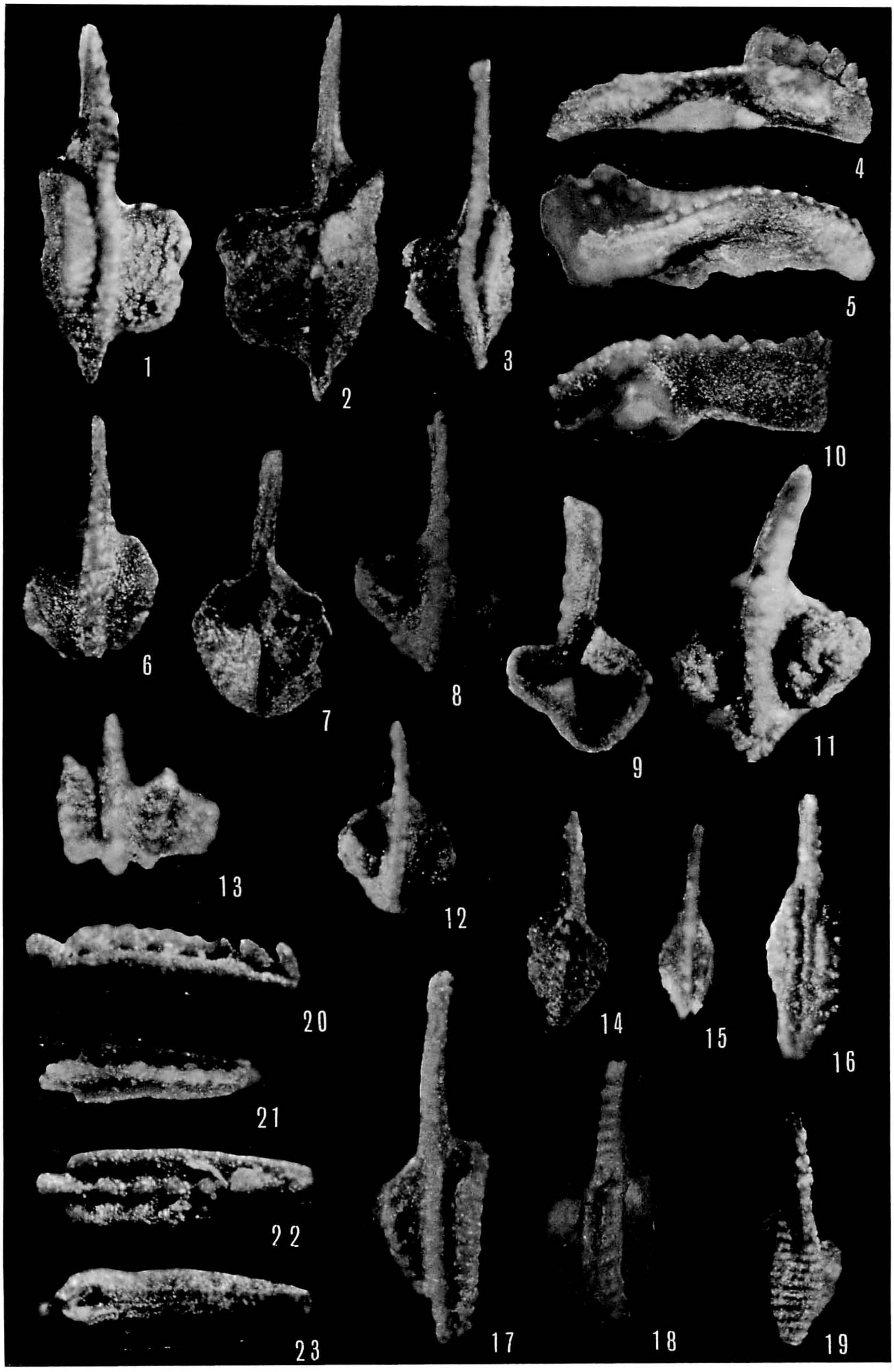
1. Lateral view of an immature specimen. ×130; 2, 3. Lateral and oral views of a immature specimen. ×130; 4. Lateral view of an immature form. ×165; 5. Lateral view of an immature form. ×165; 6. Lateral view of an immature specimen. ×165; 7. Oral view of an immature specimen. ×120; 8. Oral view of an immature specimen. ×120; 9, 10. Lateral and oral views of a mature specimen. ×130; 11-13. Lateral, oral and aboral views of a mature specimen. ×130; 14. Lateral view of a mature specimen. ×165; 15. Lateral view of a mature form. ×130; 16. Lateral view of a mature specimen. ×165; 17. Lateral view of a mature specimen. ×130; 18. Lateral view of a mature specimen. ×100; 19. Oral view of a mature specimen. ×165.

Figs. 20, 21. *Cypridodella* cf. *conflexa* MOSHER.

20. Lateral view. ×130; 21. Lateral view. ×150.

Fig. 22. *Enantiognathus ziegleri* (DIEBEL).

Lateral view. ×145.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Trans. Proc. Palaeont. Soc. Japan, N.S., No. 96, pp. 437-441, December 20, 1974

642. SIZE DIFFERENCES IN THE DIATOM, *ANNELLUS CALIFORNICUS* TEMPERE*

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中新世珪藻 *Annellus californicus* TEMPERE: 本種の2群集の大きさ（長さと幅）を検討したところ，顕著な差異が認められた。群集の一つは東部赤道太平洋のもので，もう一つの群集は本州西岸能登半島のものである。能登群集は赤道太平洋のものよりはるかに大型である。このような群集の大きさの差異は珪藻群集棲息環境の差，とくに水温ならびに水塊の陸地からの距離にもとづくものと考えられる。 L.H. BURCKLE and A. TODD

Introductory Note

The fact that individual Diatom species vary considerably in size has long been established in the literature. Their mode of reproduction allows for size variations in single species ranging from less than 10 μ to over 100 μ. In addition to this, size variations may be a response to changing or differing ecological conditions. WHIMPENNY (1936), for example, found size changes in *Rhizosolenia* spp. as the season progressed. KOLBE (1954) postulated that changes in the rate of upwelling of deep water may be related to changes in the size of *C. nodulifer*. BELAYEVA (1971) added credence to KOLBE's postulate by making actual field observations in the Equatorial Pacific. Subsequently, BELAYEVA (1972) has reported additional species whose size is apparently dictated by upwelling.

The purpose of this note is to add to our knowledge of single species which shows considerable size variation relative to geographic location (in this study *Annellus californicus*) and to offer some speculation concerning the cause of this particular phenomenon. Our samples were obtained from Miocene deep-sea sediments of the eastern Equatorial Pacific and from Miocene sediments on the Noto Peninsula, western Honshu Island, Japan (see Fig. 1 for locations of samples used).

* Received July 15, 1974; read Oct. 19, 1974 at Nagoya. Lamont-Doherty Geological Observatory Contr. No. 2165.

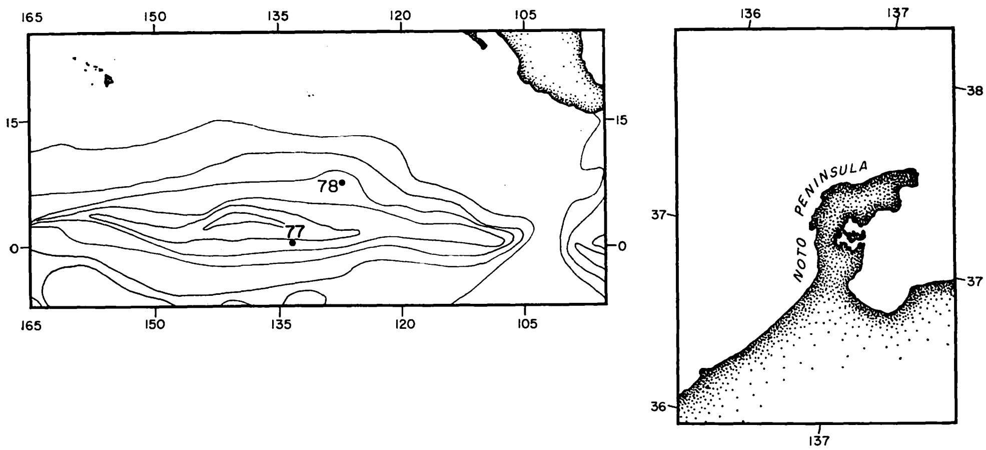

Fig. 1. Generalized location maps for samples used in this study. The samples from the equatorial Pacific came from sites 77 and 78 of DSDP Leg IX. The samples on Noto Peninsula came from the Hojuji and Iida Formations.

The Diatom species *Annellus californicus* TEMPERE has received considerable attention in the literature as a stratigraphic marker (HANNA, 1932; REINHOLD, 1937; WORNARDT, 1967; NAKASEKO et al., 1972; BURCKLE, in press, to mention only a few). OPDYKE et al. (1973) and BURCKLE (in press) have pointed out that this species is a rather reliable marker for the Early/Middle Miocene boundary—its first appearance occurring just before the beginning of the Middle Miocene.

In addition, this species has received considerable attention because of its peculiar morphology. HANNA (1932) was one of the first to point out that the species was like a hollow cylinder, open at both ends. This observation was challenged by RYDE (1962) whose careful work showed the existence of a sieve plate in the central region. Accordingly, RYDE transferred this form to the genus *Craspedodiscus*. With the aid of the Scanning Electron Microscope, WORNARDT (1970) illustrated this central sieve plate but showed that it originated as an invagination of the inner wall. Hence the taxonomic position of this form is still somewhat in doubt and, for this reason, we retain the name *Annellus californicus*.

Methodology

Samples were prepared after the method described by SCHRADER (in press). Approximately 1 gram of sample was placed in a 1 : 1 solution of acetic acid and hydrogen peroxide. The residue was centrifuged seven times and further concentrated by differential settling in beakers of 10 cm height. Disposable pipettes were used to transfer the Diatoms in suspension to a permanent slide.

Each slide was scanned for *Annellus californicus*. Specimens were spotted with mechanical stage coordinates and where possible, two measurements on each specimen were made—length and width (see Fig. 2 for definition of these parameters).

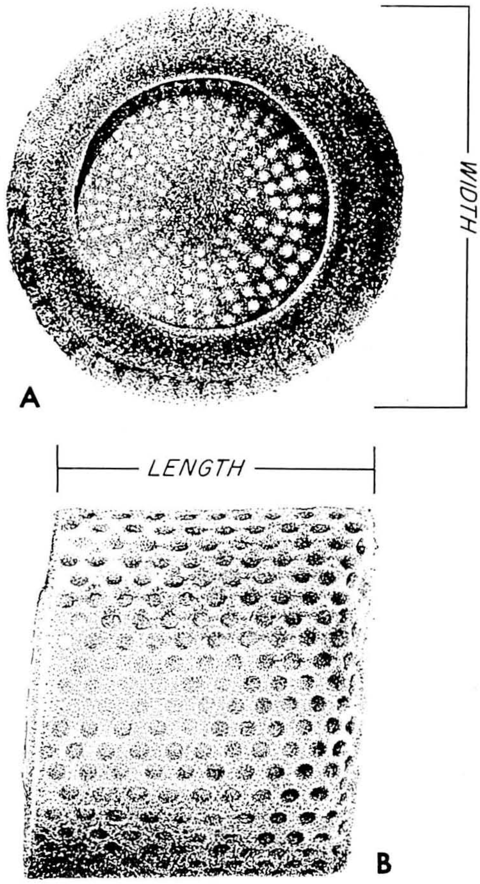

Fig. 2. Illustration of *Annellus californicus* Tempere showing how measurements were made for this study.

The Data

Fifty-five specimens were measured from the Equatorial Pacific and 69 specimens from the Japanese Noto Peninsula section (Hojuji and Iida Formations). Widths for the Equatorial Pacific specimens ranged from 14.2 to 92.9 μ with a mean of 54 μ. Lengths range from 10 to 43.1 μ and averaged 33.4 μ. The standard deviation on width and length measurements were 13.6 and 4.7, respectively. The Japanese specimens had widths ranging from 43.3 to 13.9 μ and averaged 81.8 μ. The standard deviation is 16.5. Lengths ranged from 34.1 to 53.9 μ, with an average of 42.4 μ and a standard deviation of 3.52.

A "t" test was performed to determine the significance of the differences between these sets of data. The "t" test is given by:

$$t=\frac{\bar{X}a-\bar{X}b}{S} \qquad \sqrt{\frac{Na\cdot Nb}{Na+Nb}}$$

where $\bar{X}a$ and $\bar{X}b$ are the means for the two sets of samples and Na and Nb are the numbers of samples for sample sets a and b. S is the average standard deviation for the two sets of samples and is given by:

$$S=\sqrt{\frac{\Sigma(Xa^2)-\frac{(\Sigma Xa)^2}{Na}+\Sigma(Xb)^2-\frac{(\Sigma Xb)^2}{Na}}{Na+Nb-2}}$$

The values we obtained indicate that the differences between the two sample sets are significant at the 99% level. Such values permit us to concluded that the differences are real.

Discussion

It is interesting to speculate on those influences, ecological or otherwise, that may operate to produce such size differences. WHIMPENNY (1936) invoked seasonality as a cause. KOLBE (1954) invoked changes in the rate of upwelling (and, thus, changes in nutrient concentration) as a causative factor.

From a consideration of the geographic distribution of our samples the most obvious cause may be temperature. Many organisms do increase in size from the equator toward the poles. A second suggestion is that the size differences may be due to different habitats. The Equatorial Pacific specimens lived in an open ocean environment, quite distant from land. The Japanese specimens were enclosed in sediments representing a near shore (shelf) environment. Coastal environments normally have much greater concentrations of dissolved nutrients. This factor may contribute to the larger size of the Japanese specimens.

Still, a third possibility is that selective solution has destroyed the larger forms of *A. californicus* in the Equatorial Pacific—leaving only the smaller forms behind as a residue. Of these possibilities, we prefer to speculate on the first two. It seems unreasonable to invoke dissolution as a factor. Such a conclusion implies that the Japanese samples represent a more complete population. If this is so then the lower limit and widths and lengths for the Japanese samples (43.3 and 34.1 μ, respectively) should be close to those for the Equatorial Pacific samples (14.2 and 10 μ, respectively). The fact that they are not suggests that dissolution is not a major factor in the differences between these two populations.

This leads us to conclude that one or both of the first two factors may have operated to cause the size differences. It seems reasonable to conclude further that changes in size with time may cast some light upon temporal changes in the environments of deposition.

Acknowledgements

We thank Tsunemasa SAITO and Peter R. THOMPSON for critically reviewing the manuscript and offering helpful suggestions. Samples from Leg IX of the Deep Sea Drilling Program were generously supplied by the Sample Distribution Committee. Research was supported by National Science Foundation Grants GA 20211 (under the U. S.—Japan Cooperative Program) and GA 35463×.

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Palaeontological Society of Japan Special Papers No. 18 —Silurian Trilobites of Japan in Comparison with Asian, Pacific and Other Faunas

By Teiichi KOBAYASHI and Takashi HAMADA

Issued November 30, 1974; 155 pp., 12 pls.

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The paper contains palaeontological description of Silurian trilobites from Japan based on newly found collections containing 40 species of 7 families, among which 28 species are new to science. Comprehensive discussions are given especially on the systematic classification of the Illaenidae, Scutelluidae, Encrinuridae and Proetidae, in which 2 subfamilies, 3 genera and 1 subgenus are newly established. Synoptic lists of genera and species and also their distribution are shown with respect to several families. Notes are given on the age of the trilobite bearing horizons and on the mode of occurrence and palaeoecology of the described species. In addition a comprehensive review is given on the Silurian trilobite faunas of various areas in East Asia, South Asia, Siberia, Arctic province, Australia, Tasmania and the Americas.

The special papers are on sale at the Society. Orders must be accompanied by remittance, made payable to Dr. Kametoshi KANMERA, Editor of the Special Papers, Palaeontological Society of Japan, Fukuoka Office, c/o Department of Geology, Faculty of Science, Kyushu University, Fukuoka 812, Japan.

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PROCEEDINGS OF THE PALAEONTOLOGICAL SOCIETY OF JAPAN

日本古生物学会第114回例会は1974年10月19日に名古屋大学理学部地球科学教室において開催された（参加者59名)。

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瑞浪層群の植物化石 ....伊奈治行

巡検。10月20日（日）瑞浪層群巡検および瑞浪市立化石博物館見学。 案内者 森下 晶（参加者35名)。

お知らせ

◎**日本古生物学会特別号 No. 18**, "Silurian Trilobites of Japan in comparison with Asian, Pacific and other faunas"（小林貞一・浜田隆士著；155頁，12図版；1974年11月30日発行）が，文部省刊行助成金の援助を得て刊行された。定価は1部3700円（郵送・梱包料350円加算）。注文は，〒813 福岡市東区箱崎，九州大学理学部地質学教室内，日本古生物学会特別号編集員会へ〔振替ロ座，福岡 19014；三和銀行福岡支店上記委員会普通預金口座 12172（注文通知は別に九大へ)〕。郵送によらない直接購入は，上記のほか，東京大学理学部地質学教室内，日本古生物学会本部でも取扱う。

◎**各種学術奨励金の学会推薦について**　本学会以外の各種学術奨励金・助成金は原則として個人またはグループが直接応募申請するのがたてまえであるので，本会としては，昭和49年度からは推薦のご希望の申出があったものについてのみ，賞の委員会で審議のうえ，推薦を決めることにした。しかし自薦だけでは応募申請が減る傾向があるので，昭和49年度後半からは他薦を含めて審議の対象とすることにした。会員各位には，古生物学発展のため下記のような奨励金にふるってご応募・ご推薦されたい。

昭和50年度の下記のような各種奨励金に本会の推薦を希望される場合は，昭和50年1月20日までに，①研究者および協力者氏名所属　②希望される奨励金名称　③課題名と大略の内容を記して，本会賞の委員会の事務局（福岡市区箱崎九州大学理学部教室　首藤次男気付）あて申込まれたい。

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○三菱財団自然科学研究助成金　　1件3000万円以内（300～1000万円程度)，重点対象分野の指定あり，推薦は不要，助成期間は原則として1年間，締切5月末頃。

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なお上記の締切日は昭和49年度のものであるから，50年度には多少更変があるかも知れない。（従来上記のほかに階成学術奨励金，山路自然科学振興財団研究助成金があつたが，前者は昭和49年度から，後者は50年度から廃止される)。

◎本会より推薦中の会員猪郷久義君，小池敏雄君の研究「コノドント生層序による古生代後期から中生代初期の日本列島の地史の再検討」に対して第4回山路自然科学研究助成金が贈呈された。

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日本古生物学會 報告・紀事

Transactions and Proceedings of the Palaeontological Society of Japan

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No. 89～No. 96

1973-1974

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The heading in Japanese commemorates the handwriting of Prof. Matajiro YOKOYAMA, father of Japanese palaeontology, who was a professor of stratigraphy and palaeontology at the Geological Institute, Imperial University of Tokyo.

Fossil on the cover is *Bellerophon jonesianus* DE KONINCK from the Late Permian Aakasaka Series in Gifu Prefecture.

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Biost.	Biostratigraphy
Brach.	Brachiopods
C	Cenozoic
Cephal.	Cephalopods
Conod.	Conodonts
Foram.	Foraminifers
Fusul.	Fusulinids
Gg.	General geology
Gp.	General paleontology
Hg.	Historical geology
M	Mesozoic
Mg.	Marine geology
Mo.	Molluscs
Nannopl.	Nannoplankton
P	Paleozoic
Pg.	Petroleum geology
R	Recent
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Sd.	Sedimentology
Tg.	Tectonic geology

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お知らせ

◎太平洋地域新第三系国際会種（CPNS） 1976年5月に，下記の予定で東京・学術会議において開催される見込み。

日程：5月12日—16日男鹿半島・房総半島巡検，17日—21日　本会議，22日—24日静岡県掛川地方・大阪市周辺巡検。

主要題目：1）太平洋地域新第三系の主要発達地域における年代層序区分，2）同地域の対比基準面，3）同地域内の対比およびヨーロッパ地域との対比，他に微化石ならびに大形化石による化石層位学，古植植物と古気候，古水温，古環境，古地理，古海洋，放射年代，古地磁気層序，太平洋海盆の堆積物の層序，環太平洋地域の新生代火山活動，火山層序，構造発達史，ならびにこれらに関連するエネルギー，鉱物資源問題等。

さらに具体的計画を立てるために英文アンケート（1974年11月30日締切）を配布中。

（連絡先：仙台市青葉山　東北大学理学部地質学古生物学教室　高柳洋吉・CPNS 事務局）。

例会等の通知

	開催地	開催日	講演申込締切
1975年　総会・年会	国立科学博物館	1975年　1月25-26日	1974年11月30日
115回　例会	岩手大学	1975年　6月14日	1975年　4月20日

◎ 1975年総会・年会ではシンポジウム「古生物学と走査型電子顕微鏡」（世話人・岩崎泰穎）が予定されている。

◎ 本会誌の出版費の一部は文部省研究成果刊行費による。

1974年12月15日　印　刷
1974年12月20日　発　行

日本古生物学会報告・紀事

新篇　第96号

1,200円

発行者　日本古生物学会
文京区弥生 2-4-16
日本学会事務センター内
（振替口座東京84780番）

編集者　氏　家　宏

印刷者　東京都練馬区豊玉北2ノ13
学術図書印刷株式会社　富　田　潔

Transactions and Proceedings of the Palaeontological Society of Japan

New Series No. 96 December 20, 1974

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