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Biostratigraphy of the Upper Cretaceous Santonian Stage in Northwestern Hokkaido

Seiichi TOSHIMITSU

Abstract

This paper describes the biostratigraphy of the upper part of the Upper Yezo Group (Upper Cretaceous) exposed in the Haboro and adjacent areas of northwestern Hokkaido to define the Santonian Stage in Japan by establishing a revised scheme of zonation.

The Upper Yezo Group in the Haboro area is made up mainly of sandstone, siltstone and claystone, and is divided on the basis of predominant lithology into the Lower, Middle and Upper Haborogawa Formations. This lithostratigraphic division can be also applicable to the northerly adjacent Chikubetsu and southerly neighbouring Kotanbetsu and Obira areas. Some of relatively thick sandstone interbeds in the mudstone succession are laterally traceable as marker beds from the Chikubetsu area to the Obira area.

Of these three formations, the Middle and Upper Haborogawa Formations which encompasses the so-called Santonian Stage are almost continuously exposed and yield abundant fossils. As a result of a biostratigraphic study of these two formations, the following four inoceramid zones were recognized; in ascending order, the *Inoceramus uwajimensis*—*I. mihoensis* Zone, the *I. amakusensis* Zone, the *Platyceramus japonicus* Zone, the *Sphenoceramus orientalis* Zone and the *S. schmidtii* Zone. A subzone characterized by the association of *S. sanrikuensis*, *S. cristatus* sp. nov. and *Inoceramus* (*Cordiceramus*) *kanmerai* is discriminated in the upper main part of the *P. japonicus* Zone. On the other hand, the successions studied can be divided into two ammonite zones based on the *Texanitinae*, i.e. the *Texanites collignoni*—*T. quinquenodosus* Zone below and the *Plesiotexanites kawasakii*—*P. pacificus* Zone above. It is also suggested that the latter zone is subdivided into the subzones of *T. amakusensis* (lower), *Protexanites* (*Anatexanites*) *fukazawai*—*P. (P.) bontanti shimizui* and/or *Submortonicerases* cf. *condamii* (upper). The *T. collignoni*—*T. quinquenodosus* Zone occupies the basal part of the *I. amakusensis* Zone, and is correlated with the Lower Santonian. The occurrences of *Submortonicerases* cf. *condamii*, *Menabites mazenoti* and *Globotruncana arca* from the *Platyceramus japonicus* Zone indicate that this zone should be regarded as the Lowest Campanian. Consequently the zone of *I. amakusensis* corresponds precisely to the Santonian.

I. Introduction

The Santonian Stage of Japan has hitherto been divided into two inoceramid zones, the *Inoceramus amakusensis* Zone below and the *Platyceramus japonicus* Zone above. The zonal index species are, however, endemic, and short-ranged and widespread ammonites are rather few in the Santonian of Japan. On account

of these facts not only the inter-regional correlation of the Santonian Stage but also the setting of the stage boundary between the Santonian and the Campanian have remained unsettled. MATSUMOTO and TASHIRO (1982) integrated the macro-biostratigraphy (MATSUMOTO, 1982; MATSUMOTO *et al.*, 1982; TASHIRO and KOZAI, 1982) and micro-biostratigraphy (OKAMURA *et al.*, 1982; TAKAYANAGI *et al.*, 1982) of the Cretaceous sequence of the Monobe area, Shikoku, and suggested that the Santonian-Campanian boundary in terms of the micro-biostratigraphy may be placed within the zone of *Platyceramus japonicus*, which had been regarded as the Upper Santonian. MATSUMOTO and TAKAHASHI (1986) reported the occurrence of *Menabites mazenoti* COLLIGNON, a Middle Campanian species in Madagascar, from the zone of *Platyceramus japonicus* in the Migino-sawa, a branch of the Haboro River (TOSHIMITSU, 1985). Therefore the idea that at least part of the *Platyceramus japonicus* Zone belongs to the Campanian is supported not only by micro-fossils but also by an ammonite.

Recently, KENNEDY (1983 and 1984a) restudied the ammonite faunas of the Coniacian, Santonian and Campanian stratotypes in the Aquitaine Basin, France, and clarified that the previous ammonite records from the Aquitaine Basin should be treated with great caution because of insufficient taxonomic revision, and that the zonation based on the ammonites faunas from the Upper Coniacian to the Lower Campanian in that area is practically difficult because of their poor occurrences. Under these circumstances, the Subcommission on Cretaceous Stratigraphy of IUGS held a Symposium at Copenhagen in 1983 and proposed the tentative stratotypes of those stages and their boundaries. Of course, these proposals should be examined thoroughly by later studies.

The Upper Cretaceous succession exposed in northwestern Hokkaido provides good material for a study of this type, in particular to get evidence suitable for the definition and zonation of the Santonian Stage.

For these five years I have carried out field work along numerous routes in the Chikubetsu, Haboro, Kotanbetsu and Obira areas (Fig. 1) to examine in detail the stratigraphic successions of the upper part of the Middle Yezo Group and the Upper Yezo Group and at the same time to obtain samples of both micro- and mega-fossils, with special reference to the sequence which encompasses the zone of *Platyceramus japonicus*.

II. Lithostratigraphic summary

The Cretaceous deposits in the Haboro to the Obira areas consist of the Middle and Upper Yezo Groups and the disconformably overlying Hakobuchi Group in the Chikubetsu area. The strata of the Middle and Upper Yezo Groups in the study area trend north-northwest to south-southwest, as shown in Fig. 1. The Middle Yezo Group crops out on the northeastern side and the Upper Yezo Group is progressively younger towards the west, although there are some repetition of beds due to folding and faulting. The two groups are well exposed, from north to south, along the Sankebetsu-gawa, a tributary in the upper reaches of the Chikubetsu River, the Detofutamata-gawa, Nakanofutamata-gawa, Sakasagawa, Otodo-zawa and, Chimei-zawa of the Haboro River, and the upper reaches

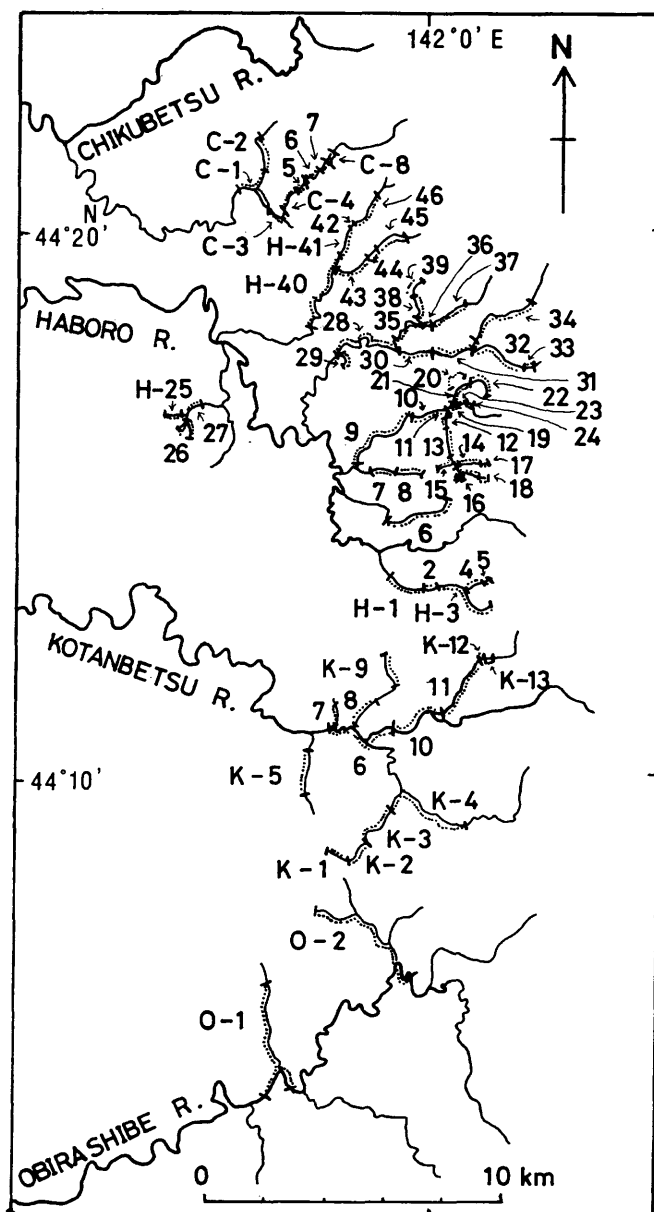


Fig. 2. Index map of the Chikubetsu, Haboro, Kotanbetsu and Obira areas indicating the routes C-1 to O-2 along which the Cretaceous sequences were measured and illustrated in Fig. 3.

of the Kotanbetsu River and the Akano-sawa and the Jugosen-zawa, western branches of the Obirashibe River (Figs. 1, 2, 3). The Upper Yezo Group crops out again as dome shaped inlier surrounded by the Neogene Tertiary in the Migino-sawa, a tributary of the Haboro River to the west.

The geology of the Upper Cretaceous areas in northwestern Hokkaido, such as the Chikubetsu, Haboro, Kotanbetsu and Obira areas, was mapped and described

by several workers. TANAKA's (1963) lithostratigraphic subdivision in the Obira area has often been referred by the subsequent workers, but it is difficult to apply it to the northerly adjacent Kotanbetsu and Haboro areas. Meanwhile, I divided the Cretaceous deposits of the Haboro area into four formations, paying attention to the sedimentary cycle and associated sandstone members intercalated in the mudstone (TOSHIMITSU, 1985). As my investigation proceeded, it has become clear that this division is available also to the upper part of the Middle Yezo Group and the Upper Yezo Group exposed in the southerly adjacent Kotanbetsu and Obira areas (Fig. 3).

The stratigraphy of the Yezo and Hakobuchi Groups exposed in the study area is described briefly below. The full descriptions of the stratotype areas are given by TOSHIMITSU (1985) and MATSUNO and KINO (1960), respectively.

A. Middle Yezo Group

(1) *Shirochi Formation* (corresponding to the Saku Formation of MATSUMOTO, 1942a): mudstone with many interbeds of turbidite sandstone; about 830 m in thickness. This formation can be divided into the *Inoceramus hobetsensis* Zone and the *I. teshioensis* Zone in the ascending order.

B. Upper Yezo Group

(2) *Lower Haborogawa Formation*: clayey mudstone predominant, with frequent intercalations of acidic tuff and some thin interbeds of sandstone; about 950 m thick in the Haboro area and 350 m in the Obira area. This formation can be referred to as the uppermost part of the *Inoceramus teshioensis* Zone and the superjacent *I. uwajimensis*—*I. mihoensis* Zone.

(3) *Middle Haborogawa Formation*: largely silty mudstone with several sandstone interbeds, each several meters thick; about 800 m thick in the Haboro area and approximately 1000 m in the Obira area. This formation belongs to the upper part of the *Inoceramus uwajimensis*—*I. mihoensis* Zone and the *Inoceramus amakusensis* Zone.

(4) *Upper Haborogawa Formation*: Consisting of at least three, 100 to 250 m thick, coarsening-upward sequences (called "Haboro cycle" by OKADA and MATSUMOTO, 1969) which begin with mudstone, passing through bioturbated siltstone to end with a 5 to 20 m thick bed of cross-laminated glauconitic sandstone. Some sandstones are tuffaceous; at least 850 m thick. I recognized the fourth cycle, which grades upward from clayey mudstone into a several-meter thick tuffaceous sandstone in the uppermost part of this formation exposed along the Detofutamata-gawa, Nakanofutamata-gawa, Chimei-zawa and Kotanbetsu River. This formation ranges biostratigraphically from the upper part of the *Inoceramus amakusensis*, *Platyceramus japonicus*, *Sphenoceramus orientalis* and *S. schmidtii* Zones.

C. Hakobuchi Group

(5) *Pankezawa Formation*: consisting of large-scale cross-stratified coarse-grained sandstone, tuffaceous claystone and acidic tabular-bedded tuff; about 130 m thick. This formation yielded *Baculites* cf. *occidentalis* MEEK, *Canadoceras*

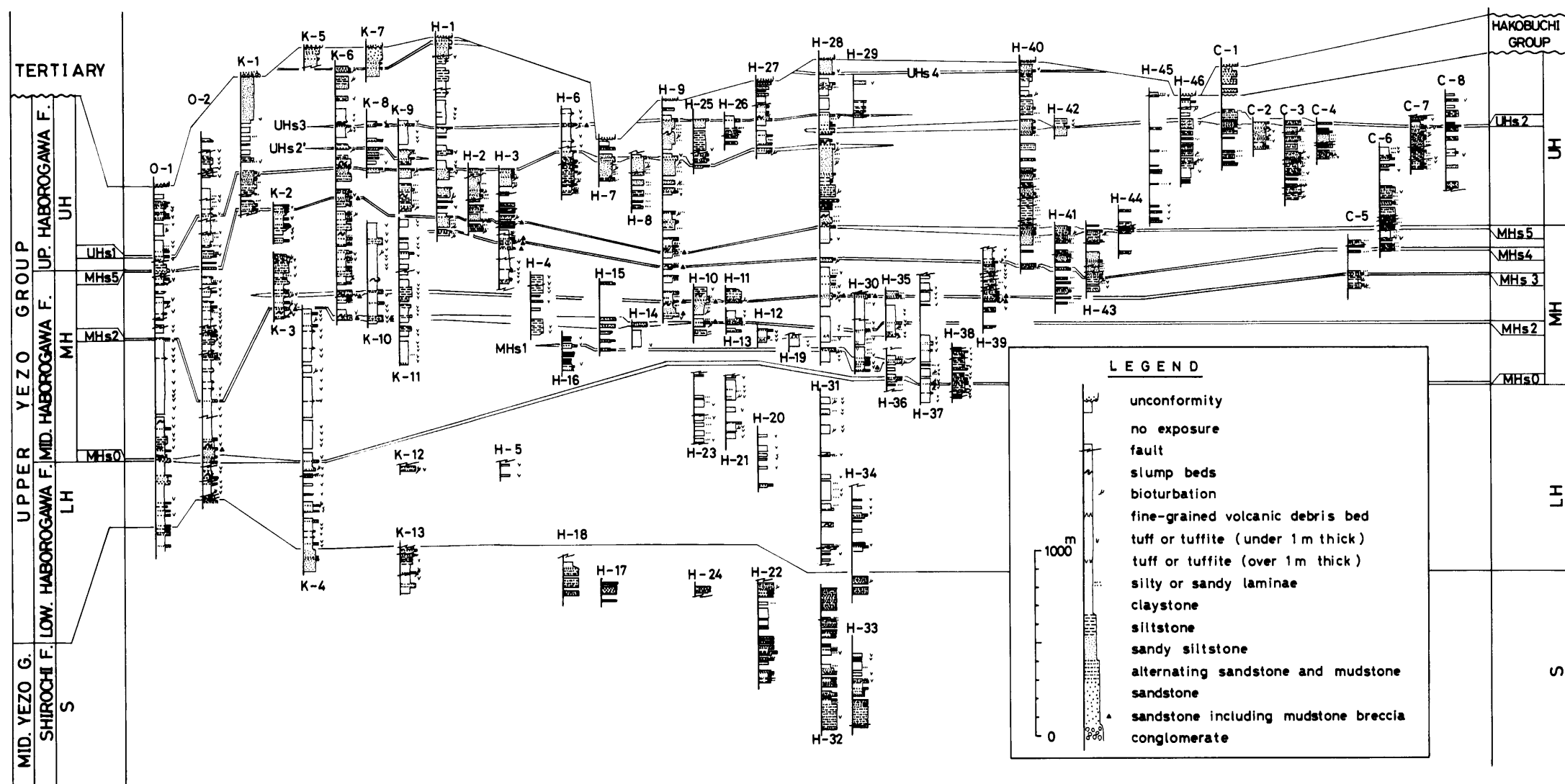


Fig. 3. Stratigraphic columnar sections of the uppermost part of the Middle Yezo Group, the Upper Yezo Group and the Hakobuchi Group in the Chikubetsu, Haboro, Kotanbetsu and Obira areas, northwest Hokkaido.

multicostatum MATSUMOTO, *Ryugasella* cf. *ryugasensis* WRIGHT and MATSUMOTO, cf. *Pachydiscus ootacodensis* (STOLICZKA) and *Inoceramus* cf. *balticus toyajoanus* NAGAO and MATSUMOTO (HATTORI, 1965). This assemblage suggests the upper part of the Campanian.

Among these formations, the Middle and Upper Haborogawa Formations are distributed in a continuous belt from the Chikubetsu area to the Obira area, and several to 20 m-thick sandstone interbeds can be traced throughout these areas as key beds. Therefore, these sandstone beds are named MHs0 to MHs5 in the Middle Haborogawa Formation and UHs1 to UHs3 in the Upper Haborogawa Formation (TOSHIMITSU, 1985). Furthermore the newly named UHs2' and UHs4 sandstone beds are also useful as a marker bed. The former is situated at the top of the second cycle in the Upper Haborogawa Formation of the Kotanbetsu area, and is stratigraphically equivalent to the UHs2 of the Haboro area. The latter lies at the upper part of the fourth cycle in the Upper Haborogawa Formation of the Haboro and Kotanbetsu areas.

III. Biostratigraphy of the so-called Santonian Stage in the Haboro and adjacent areas

The Cretaceous deposits in the study area yield abundant fossils of various kinds such as mollusca, simple corals, echinoids, crustaceans, fish scales and teeth, and plant remains. I examined in detail the biostratigraphic sequence of the so-called Santonian Stage including the zones of *Inoceramus amakusensis* and *Platyceramus japonicus* by means of inoceramid bivalves and ammonoids. The identified species and their locations of occurrence are shown in Tables 1 to 8, and their stratigraphic horizons are plotted on the measured columnar sections shown in Figs. 7 to 15, with locality maps (Figs. 16 to 26). In this paper the columnar sections are numbered as follows (see Figs. 2, 3): H-40 to H-46: Detofutamata-gawa, H-28 to H-39: Nakanofutamata-gawa, H-25 to H-27: Migino-sawa, H-7 to H-10: Sakasa-gawa, H-6: Otodo-zawa, H-1 to H-5: Chimei-zawa, K-1 to K-13: Kotanbetsu River, O-1 and O-2: Obirashibe River.

In these columnar sections, the line drawn from the first occurrence to the last occurrence of a given species is tentatively regarded as a local range of that species. After these local ranges of the identified species in all of the measured sections were acquired by this operation, they were unified into a generalized columnar section (Figs. 3, 27a-f) compiled on the basis of the correlation by means of the aforementioned sandstone marker beds such as MHs and UHs, which can be regarded as approximately isochronous planes. Therefore, the total range of individual species was deduced by linking the lowest and highest levels of their occurrences in the generalized columnar section. Furthermore, the biostratigraphic ranges of inocerami and selected ammonites yielded from the two routes in the Saku area, about 50 km north of the Haboro area are also taken as supplementary data (Figs. 4a, b).

As the results of the detailed examination of the assemblages and stratigraphic ranges of the contained species, the Upper Cretaceous of the study

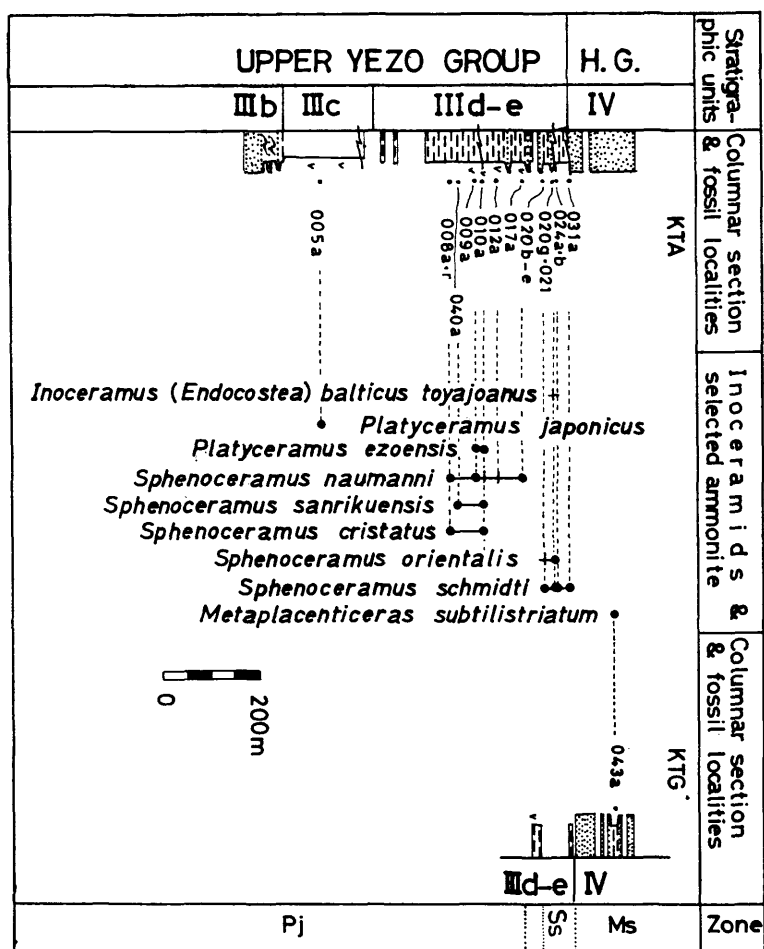


Fig. 4a. Biostratigraphic successions of the Upper Yezo Group and the Hako-buchi Group along the Tanno-sawa (left column) and Gakkono-sawa (right column) in the Saku area, Hokkaido. Legend is shown in Fig. 7. Stratigraphic units are after MATSUMOTO (1942b).

Pj: *Platyceramus japonicus* Zone, Ss: *Sphenoceramus schmidtii* Zone, Ms: *Metaplacenticerias subtilistriatum* Zone.

area can be divided on the basis of inoceramid into the zones of *Inoceramus uwajimensis*—*I. mihoensis*, *I. amakusensis*, *Platyceramus japonicus*, *Sphenoceramus orientalis*, and *S. schmidtii*. According to the inoceramid zonation previously presented by MATSUMOTO (1977) and TAKAYANAGI and MATSUMOTO (1981), these zones are correlated with the Coniacian, Lower Santonian, Upper Santonian and Lower Campanian, respectively. To be newly added is that the main part of the *P. japonicus* Zone is characterized by the assemblage of *Sphenoceramus sanrikuensis* MATSUMOTO and SUGIYAMA, *S. cristatus* sp. nov. and *Inoceramus* (*Cordiceramus*) *kanmerai* TOSHIMITSU, and can be recognized as a distinct subzone. Representative species of these zones are shown in Plates 1 to 7.

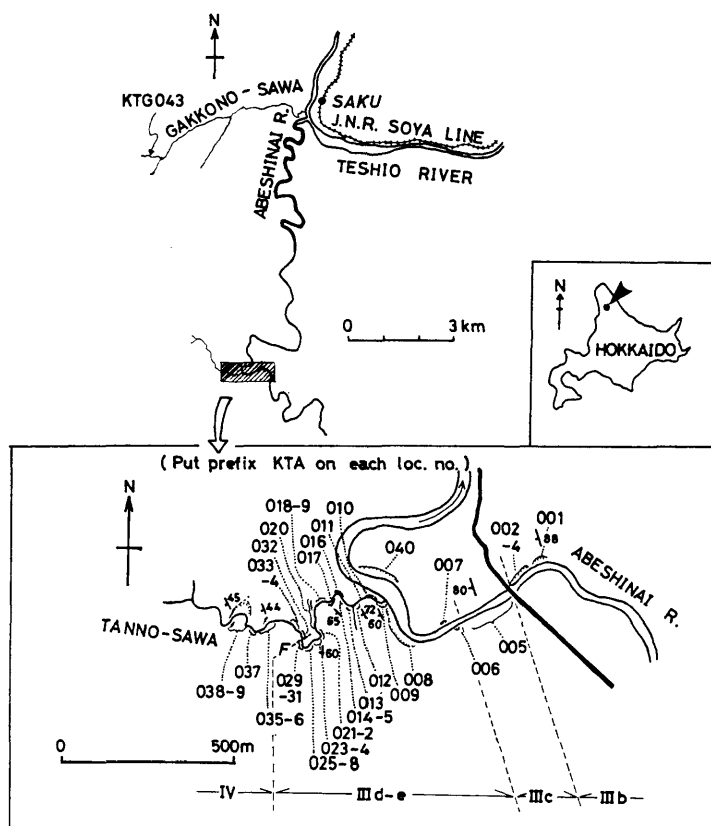


Fig. 4b. Route map in the Saku area.

(1) *Inoceramus uwajimensis*—*I. mihoensis* Zone

This zone ranges from the Lower Haborogawa Formation to the lowermost part of the Middle Haborogawa Formation. The inoceramid species obtained from the upper part of this zone are, in addition to the index species, as follows: *Inoceramus* aff. *mihoensis* MATSUMOTO, *I. sp. A*, *I. sp. C*, *I. sp. D*, *Inoceramus* (*Cordiceramus*) cf. *cordiformis* SOWERBY, *I. (C.) kawashitai* NODA, *P. yubariensis* (NAGAO and MATSUMOTO), *Sphenoceramus naumanni* (YOKOYAMA), *Mytiloides* aff. *incertus* (JIMBO).

The ammonoid species obtained from the same part are follows: *Neophylloceras* cf. *ramosum* (MEEK), *Damesites* cf. *damesi* (JIMBO), *Mesopuzosia* cf. *pacifica* MATSUMOTO, *M. cf. yubarensis* (JIMBO), *Jimboiceras* cf. *mihoense* MATSUMOTO, *Tetragonites glabrus* (JIMBO), *T. popetensis* YABE, *Gaudryceras tenuiliratum* YABE, *G. denseplicatum* (JIMBO), *Anagaudryceras* cf. *limatum* (YABE), *Scaphites* cf. *pseudoequalis* YABE, *Otoscapites* sp., *Clioscapites* sp., *Scalarites* sp., *Nipponites* (?) sp., *Yezoceras* sp., *Baculites* cf. *princeps* MATSUMOTO and OBATA.

(2) *Inoceramus amakusensis* Zone

This zone ranges from the lower part of the Middle Haborogawa For-

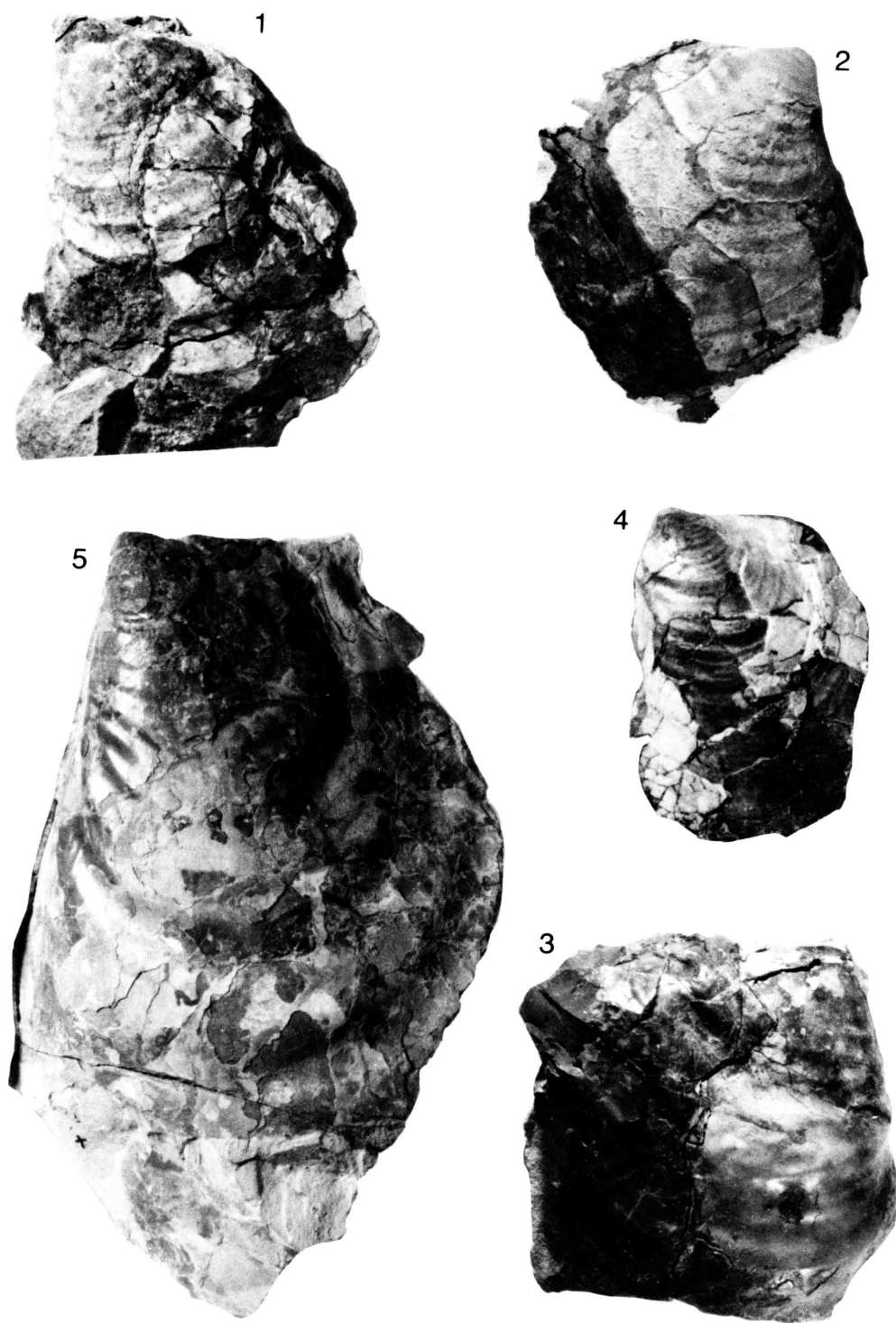
mation to the lower part of the Upper Haborogawa Formation. The base of this zone is defined by the first occurrence of the *Inoceramus amakusensis* NAGAO and MATSUMOTO. *Inoceramus* sp. A and *I. (C.)* cf. *kawashitai* occur, though rarely, in the basal part of this zone. In addition to *I. amakusensis*, the following inoceramids and ammonoids, occur in this zone:

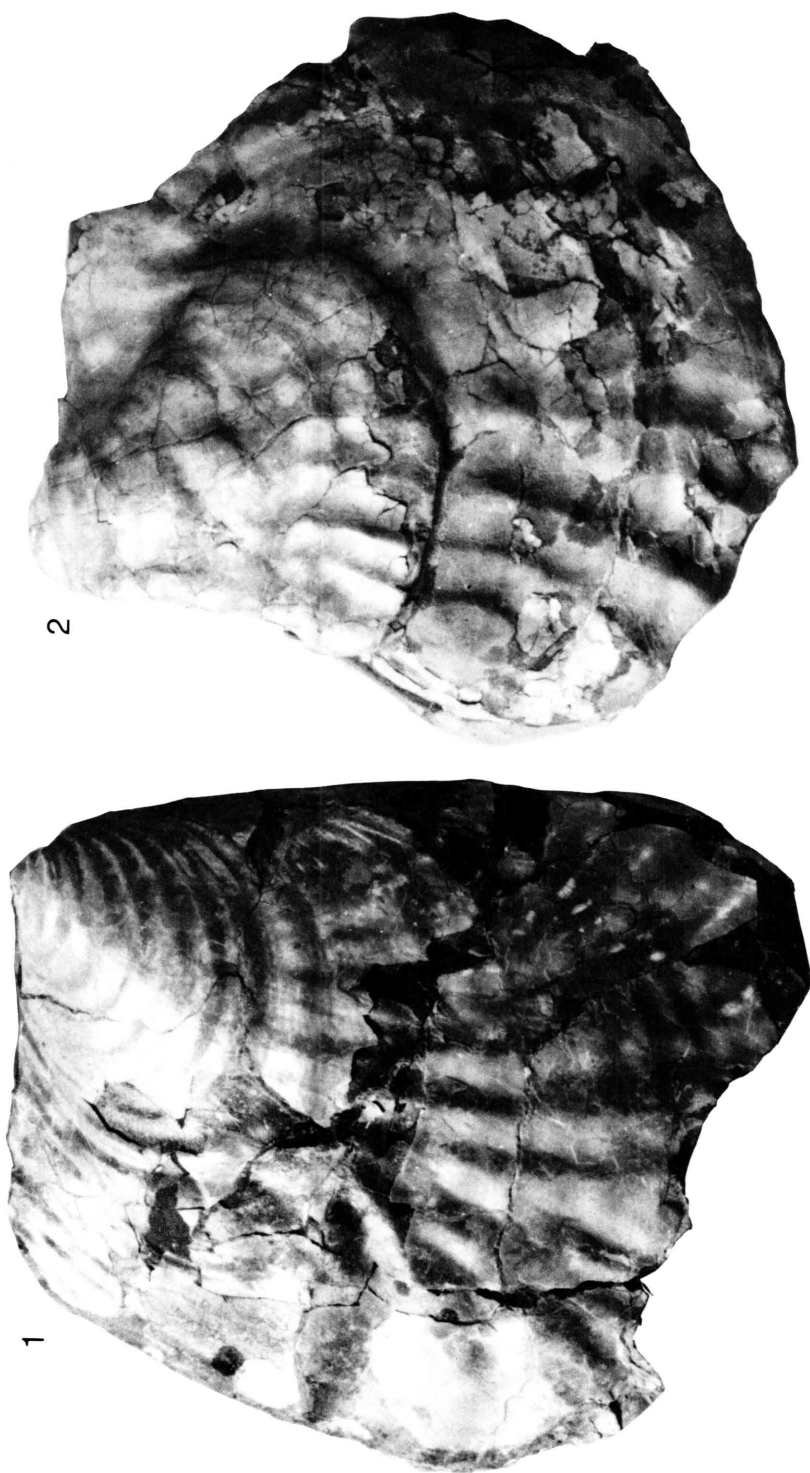
Inoceramids: *Inoceramus (Cordiceramus)* cf. *cordiformis*, *I. (C.) mukawaensis* NAGAO and MATSUMOTO, *Platyceramus yubariensis* (NAGAO and MATSUMOTO), *Sphenoceramus* cf. *yokoyamai* (NAGAO and MATSUMOTO), *S. naumanni*, *S. nagaoi* (MATSUMOTO and UEDA), *S. africanus* (HEINZ), *S. aff. cristatus*, *Mytiloides* aff. *striatoconcentricus* (GÜMBEL), *Inoceramus (Cordiceramus)* *gilberti* WHITE,

Ammonoids: *Neophylloceras subramosum* SPATH, *N. ramosum*, *Phyllopachyceras ezoense* (YOKOYAMA), *Yokoyamaoceras kotoi* (JIMBO), *Y. jimboi* MATSUMOTO, *Damesites damesi*, *D. semicostatus* MATSUMOTO, *D. sugata* (FORBES), *Hauericeras (Gardeniceras)* *angustum* (YABE), *Kitchinites (Neopuzosia)* *ishikawai* (JIMBO), *K. (N.) haboroensis* MATSUMOTO and INOMA, *K. (N.)* cf. *japonicus* SPATH, *Eupachydiscus haradai* (JIMBO), *Anapachydiscus deccanensis yezoensis* MATSUMOTO, *A. sutneri* (YOKOYAMA), *Menuites pusillus* MATSUMOTO, *M. japonicus* MATSUMOTO, *Tetragonites glabrus*, *T. popetensis*, *T. cf. epigonus* (KOSSMAT), *Zelandites kawanoi* (JIMBO), *Gaudryceras tenuiliratum*, *G. denseplicatum*, *G. intermedium*, *Anagaudryceras yokoyamai* (YABE), *Polyptychoceras obstrictum* (JIMBO), *P. haradanum* (YOKOYAMA), *P. subquadratum* (YOKOYAMA), *P. pseudogaultinum* (YOKOYAMA), *P. subundulatum* (YOKOYAMA), *P. yubarens*, *Neocrioceras spingerum* (JIMBO), *Eubostriyoceras densicostatus* MATSUMOTO, *Hyphantoceras* cf. *oshimai* (YABE), *H. orientale* (YABE), *Baculites bailyi* WOODS, *B. uedae* MATSUMOTO and OBATA, *B. boulei* COLLIGNON, *B. capensis* WOODS, *B. princeps*, *Pseudoxybeloceras quadrinodosum* (JIMBO), *Glyptoxoceras* (?) sp., *Sornayceras omorii* MATSUMOTO, *S. proteus* MATSUMOTO, *Protexanites (Anatexanites)* *fukazawai* (YABE and SHIMIZU), *P. (A.)* aff. *fukazawai*, *P. (Miotexanites)* *minimus* MATSUMOTO, *Paratexanites compressus* MATSUMOTO, *P. aff. orientalis* (YABE), *Texanites* cf. *collignoni* KLINGER and KENNEDY, *T. cf. quinquenodosus* (REDTENBACHER), *Plesiotexanites kawasakii* (KAWADA), *P. pacificus* (MATSUMOTO), cf. *P. shiloensis* YOUNG, *P. (Eutexanites)* sp., *Haboroceras haboroense* gen. et sp. nov., *H. aff. haboroense*.

Explanation of Plate 23

- Fig. 1. *Inoceramus uwajimensis* (YEHARA)
GK. H8230 from loc. RH2435b1, in the Machiyoi-zawa. Left valve. $\times 1$.
- Fig. 2. *Inoceramus (Cordiceramus)* *kawashitai* NODA
GK. H8231 from loc. RH2439, in the Machiyoi-zawa. Right valve. $\times 1$.
- Fig. 3. *Inoceramus mihoensis* MATSUMOTO
GK. H8234 from loc. RH2134a4, in the Nakanofutamata-gawa. Left valve. $\times 1$.
- Fig. 4. *Platyceramus yubariensis* NAGAO and MATSUMOTO
GK. H8233 from loc. RH2153a2, in the Nakanofutamata-gawa. Left valve. $\times 1$.
- Fig. 5. *Inoceramus amakusensis* NAGAO and MATSUMOTO
GK. H8232 from loc. RH2506a, in the Nakanofutamata-gawa, collected by K. MURAMOTO, S. UCHIDA, S. YAMAGUCHI and S. T. Left valve. $\times 0.4$.





(3) *Platyceramus japonicus* Zone

This zone comprises the strata above the base of the middle part of the Upper Haborogawa Formation. This zone is subdivided into the following two parts.

(A) *Lowermost part*; The lowermost part is represented by mudstone of several ten meters in thickness above the UHs1 sandstone. The base of this subzone is drawn at the level of the first occurrence of *Platyceramus japonicus* (NAGAO and MATSUMOTO). In addition to the zonal index species, this subzone contains the following inoceramid and ammonoid species:

Inoceramids: *I. (Endocostea) balticus balticus* BÖHM, *I. (Endocostea) balticus toyajoanus* NAGAO and MATSUMOTO, *Platyceramus ezoensis* (YOKOYAMA), *P. cf. cycloides* (WEGNER), *Sphenoceramus cf. yokoyamai*, *S. naumanni*, *S. nagaoi*,
Ammonoids: *Neophylloceras subramosum*, *Damesites damesi*, *Hauericeras cf. angustum*, *Eupachydiscus haradai*, cf. *Anapachydiscus deccanensis yezoensis*, *A. (Neopachydiscus) cf. naumanni* (YOKOYAMA), *Menuites pusillus*, *M. cf. japonicus*, *Gaudryceras tenuiliratum*, *G. denseplicatum*, *G. intermedium*, *Polyptychoceras haradanum*, *P. cf. yubarense*, *Baculites capensis*, *Neocrioceras spingerum*, *Submortonicerases cf. condamyi* (COLLIGNON).

(B) *Main part*; The upper main part of the Upper Haborogawa Formation is designated as the subzone of *Sphenoceramus sanrikuensis*—*S. cristatus*—*Inoceramus (Cordiceramus) kanmerai*. This subzone is recognized by the occurrence of at least one of the three index species. It contains, besides the index species, the following species:

Inoceramids: *Inoceramus (Cordiceramus) cf. cordiformis*, *Inoceramus (Endocostea) balticus balticus*, *I. (E.) balticus toyajoanus*, *Platyceramus japonicus*, *P. ezoensis*, *Sphenoceramus naumanni*, *S. haboroensis* sp. nov., *S. cf. kiritachensis* sp. nov.,

Ammonoids: *Neophylloceras subramosum*, *N. ramosum*, *Phyllopachyceras ezoense*, *Damesites damesi*, *D. sugata*, *Hauericeras angustum*, *Kitchinites (Neopuzosia) ishikawai*, *K. (N.) haboroensis*, *K. (N.) japonicus*, *Anapachydiscus aff. fascicostatus* (YABE), *Eupachydiscus haradai*, *E. teshioensis* (JIMBO), *Menuites pusillus*, *M. japonicus*, *Tetragonites glabrus*, *T. popetensis*, *T. epigonus*, *Gaudryceras tenuiliratum*, *G. denseplicatum*, *G. intermedium*, *G. striatum* (JIMBO), *Polyptychoceras haradanum*, *P. cf. subquadratum*, *P. cf. pseudogaultinum*, *P. subundulatum*, *P. yubarense*, *Neocrioceras (?) sanushibensis* WRIGHT and MATSUMOTO, *Hyphantoceras orientale*, *Baculites bailyi*, *B. capensis*, *B. princeps*, *Protexanites (P.) bontanti shimizui* MATSUMOTO, *P. (Anatexanites) cf. fukazawai*, *Plesiotexanites kawasakii*, *P. pacificus*, *P. (Eutexanites (?)) sp.*, *Haboroceras haboroense*, *Submortonicerases cf. condamyi*.

Explanation of Plate 24

Fig. 1. *Platyceramus japonicus* (NAGAO and MATSUMOTO)

GK. H8235 from loc. RH2530a, in the Nakanofutamata-gawa. Right valve. ×1.

Fig. 2. *Inoceramus (Cordiceramus) kanmerai* TOSHIMITSU

GK. H8111, holotype, from loc. RH4023c1, in the Otodo-zawa. Left valve. ×1.

In addition, *Menabites mazenoti* COLLIGNON reported by MATSUMOTO and TAKAHASHI (1986) is probably assigned to this zone. OKADA and MATSUMOTO (1969, p. 316) listed *Inoceramus* (*Cordiceramus*) n. sp. aff. *I. mukawaensis* from loc. R421 (= RH1211) in the middle part of the Upper Haborogawa Formation along the Sakasa-gawa. It is identified with *I. (C.) kanmerai*.

(4) *Sphenoceras orientalis* Zone

This zone is represented by the uppermost part of the Upper Haborogawa Formation. It is differentiated by the occurrence of *S. orientalis* (SOKOLOV) from the subjacent zone. It contains, besides the zonal index species, *Sphenoceras naumanni*, *S. cf. nagaii*, *S. cristatus*, rarely *S. cf. sanrikuensis*, *Hauericeras angustum* and *Polyptychoceras* sp.

(5) *Sphenoceras schmidtii* Zone

This is a superjacent zone represented by the occurrence of *S. schmidtii*, *S. naumanni*, *S. cf. nagaii*, *S. kiritachiensis*, *Polyptychoceras haradanum* and *Kitchinites* (*Neopuzosia*) sp.

The above explained zones abound in long ranging ammonoid species. Some species of the Texanitinae, however, have a short range (Fig. 27f). On the basis of these species, the Middle and Upper Haborogawa Formations can be divided into two zones: *Texanites collignoni*—*T. quinuenodosus* Zone below and *Plesiotexanites kawasakii*—*P. pacificus* Zone above. The boundary of these two zones is defined by the first occurrence of the latter species, and is placed at the Middle part of the Middle Haborogawa Formation. Moreover, the succession from the lowest part of the Upper Haborogawa Formation to the middle part of this formation can be designated as the total range zone of *Protexanites fukazawai*—*Protexanites bontanti shimizui*. These species are reported by MATSUMOTO (1970, p. 146, pl. 23, fig. 4) from loc. 82206 (near loc. RH4074) in the Otodō-zawa and by MATSUMOTO and HIRANO (1976, p. 335, pl. 35, fig. 2) from near loc. CK80 of UEDA *et al.* (1963) (= RH7021–7022) in the Detofutamata-gawa. Their stratigraphic positions are, together with others, shown in Fig. 27f. *Texanites cf. amakusensis*, *Submortonoceras cf. condamyi* and *Menabites mazenoti* reported by MATSUMOTO and TAKAHASHI (1986) are important for correlation, although they were rarely found. *Texanites cf. amakusensis* and *Menabites mazenoti* are based on the specimens from two different floated calcareous

Explanation of Plate 25

Fig. 1. *Texanites* sp. cf. *T. collignoni* KLINGER and KENNEDY

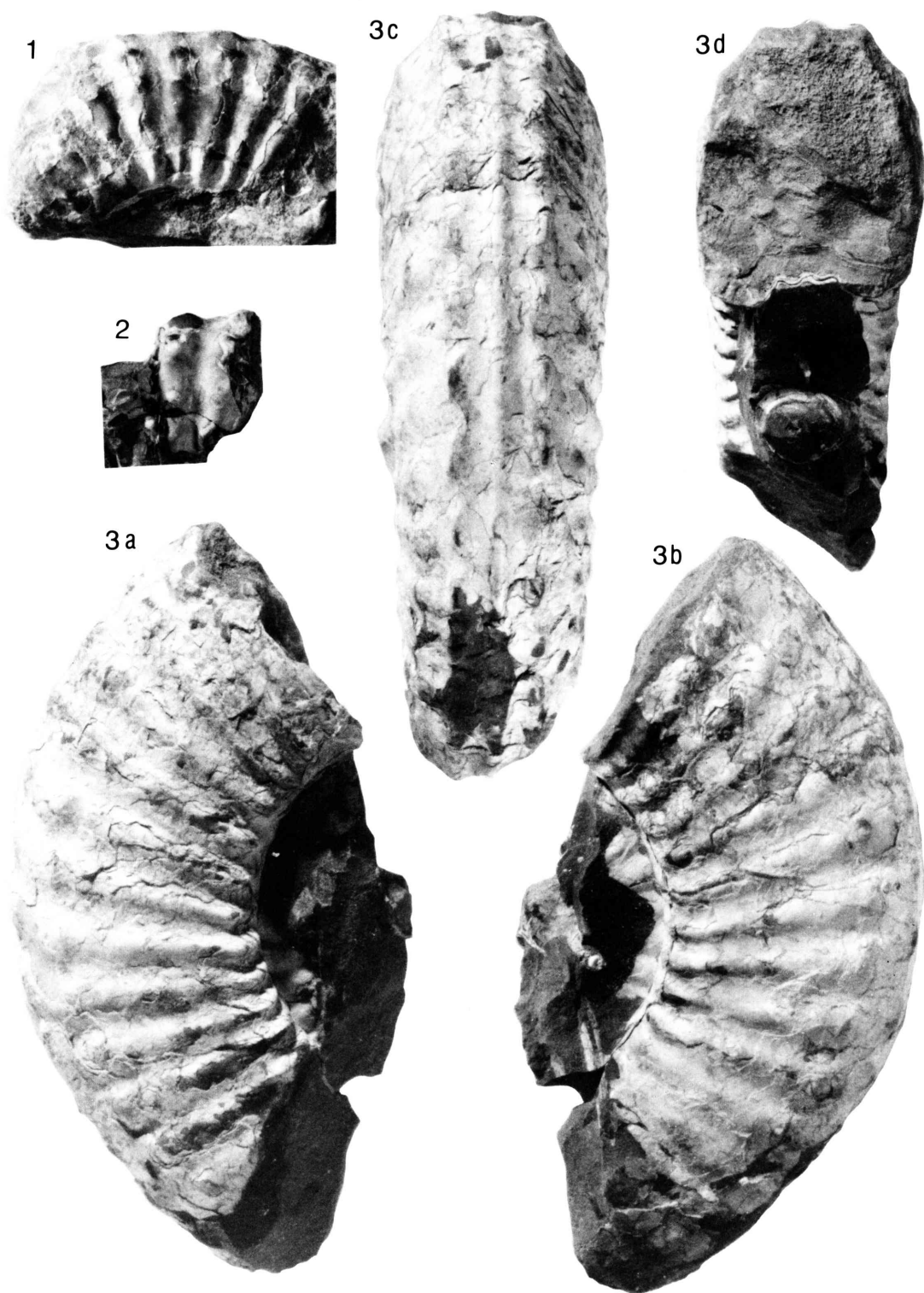
GK. H8240 from loc. RH1271b in the Sakasa-gawa. $\times 1$.

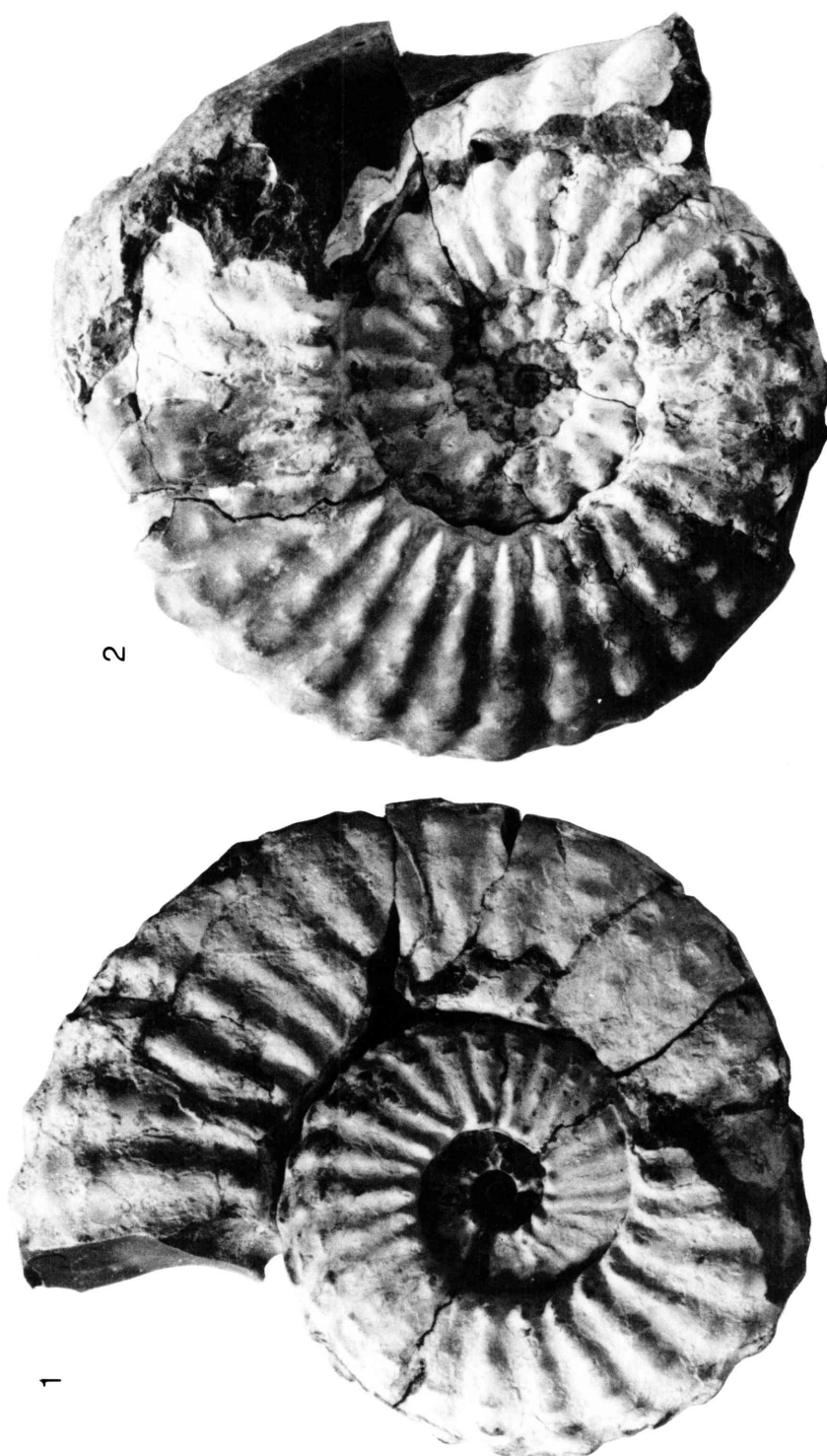
Fig. 2. *Texanites* sp. cf. *T. quinuenodosus* (REDTENBACHER)

GK. H8241 from loc. RH1267a in the Sakasa-gawa. $\times 1$.

Fig. 3. *Texanites* sp. cf. *T. amakusensis* (YABE)

GK. H8244 from loc. RH2802p1 in the Shimizu-zawa, collected by T. MATSUMOTO, M. NODA and S. T. Lateral views (a, b); ventral (c); cross-section (d). $\times 1$.





nodules, but the stratigraphic position of the former is inferred to be restricted to the upper part of the Middle Haborogawa Formation and that of the latter to the upper part of the Upper Haborogawa Formation from the surrounding geological conditions.

The stratigraphic distribution of inoceramids and selected ammonoids in the area southerly adjacent to Haboro, such as the Kotanbetsu and Obira areas, and the northerly neighbouring Saku area are shown in Figs. 14a, b, 15a, b and 4a. Their stratigraphic positions in these areas are quite similar to those of the Haboro area. The ranges of *Sphenoceras sanrikuensis*, *S. cristatus*, *S. haboroensis*, *S. kiritachiensis* and *S. aff. lingua* GOLDFUSS are clearly retained within the *S. orientalis* Zone. In the Saku area, *Metaplacenticeras subtilistriatum* (JIMBO) occurs from a sandy siltstone bed at loc. KTG043a (near loc. T1194 of MATSUMOTO and OKADA, 1973, fig. 3) of the middle part of the Hakobuchi Group. Its stratigraphic position is above the *Sphenoceras schmidtii* Zone. The same relationships has been confirmed by MATSUMOTO and MIYAUCHI (1984, p. 35) in the Upper Cretaceous of the Soya area, northern Hokkaido.

IV. Interregional Correlation

Only a few species of ammonoids which are useful for the interregional correlation are known from the *Inoceramus uwajimensis*—*I. mihoensis* Zone in the studied sections. They are *Barroisiceras onilahyense* BASSE obtained from the Obira area (TANABE *et al.*, 1977; MATSUMOTO *et al.*, 1981) and *Forresteria aff. itwebae* VAN HOEPEN from the Haboro area (TOSHIMITSU, 1985). The stratigraphic positions of these species are assigned to the middle Coniacian. TOSHIMITSU and MAIYA (1986) obtained two species of planktonic Foraminifera, *Whiteinella archaeocretacea* PESSAGNO and *Dicarinella imbricata* (MORNOD), from the basal part of the Middle Haborogawa Formation (H-30, loc. RH2146) in the Haboro area. ROBASZYNSKI *et al.* (1984) and CARON (1985) have allocated the last occurrences of these two species at the latest Coniacian, which conforms with the age indicated by inoceramid species, although they are not associated with each other. Therefore the *Inoceramus uwajimensis*—*I. mihoensis* Zone is certainly correlated with the Coniacian.

The base of the *Inoceramus amakusensis* Zone is defined by the first appearance of the zonal index, but this species is endemic. Fortunately, however, in the lower part of this zone occur *Texanites cf. collignoni* and *T. cf. quinquenodosus* which are common and worldwide in the Lower Santonian. The latter

Explanation of Plate 26

Fig. 1. *Plesiotexanites pacificus* (MATSUMOTO)

GK. H8242 from loc. RH5144a in the Chimei-zawa. $\times 1$.

Fig. 2. *Plesiotexanites kawasakii* (KAWADA)

GK. H8243 from loc. RH1214b in the Sakasa-gawa, collected by S. UCHIDA and S. T. $\times 1$.

species is exceptionally recorded also from the upper part of the Santonian in Madagascar (COLLIGNON, 1966). It is uncertain whether the first appearances of *I. amakusensis* and *T. collignoni* or *T. quinquenodosus* are coincident in north-western Hokkaido, because of the sporadic occurrence of the texanite ammonites. The co-occurrence of *I. amakusensis* and *T. collignoni*, which had been identified as *T. oliveti* (BLANCKENHORN), is recorded from the Himenoura Group in the western part of Hinoshima, Amakusa area, Southwest Japan (MATSUMOTO and UEDA, 1962). Anyway, the levels of the first occurrence of these two species are very close. *Paratexanites* aff. *orientalis*, *Sornayceras omorii* and *S. proteus* obtained from the lower part of the Middle Haborogawa Formation belong to this zone. *S. omorii* and *S. proteus* which are common in the *I. mihoensis* Zone (Upper Coniacian) of the Ikushumbetsu area of central Hokkaido (MATSUMOTO, 1970) range up to the lower part of the Santonian.

The *Plesiotelexanites kawasakii*—*P. pacificus* Zone follows the above mentioned *Texanites collignoni*—*T. quinquenodosus* Zone. *P. kawasakii* and *P. pacificus* are relatively common in the middle part of the *Inoceramus amakusensis* Zone to *Platyceramus japonicus* Zone in the Japanese province, but are unknown from other provinces of the world, except for *P. cf. kawasakii* reported from California (MATSUMOTO, 1959, p. 124). Only a single specimen of *Texanites* cf. *amakusensis* was found from the probably lower part of the *P. kawasakii*—*P. pacificus* Zone. Three specimens of *Protexanites* (*Anatexanites*) *fukazawai* were obtained from the middle and upper parts of the *P. kawasakii*—*P. pacificus* Zone in the Haboro and Kotanbetsu areas, forming a subzone. Although the stratigraphic position of *Texanites amakusensis* has not been precisely known in Amakusa, Kyushu, the type locality of this species (YABE, 1902), KASE *et al.* (1984) obtained this species from somewhat below the horizon of *Protexanites* (*Anatexanites*) *fukazawai* in the Kuji area of Northeast Japan. It is noted that this stratigraphic relationship is the same as that of the Haboro area. It is thus suggested that *T. amakusensis* may form the subzone in the lowest part of the *P. kawasakii*—*P. pacificus* Zone, slightly below the *P. fukazawai* Subzone. Three specimens of *Protexanites* (*Protexanites*) *bontanti shimizui* are obtained and other two specimens of the same species are reported by MATSUMOTO (1970) and MATSUMOTO and HIRANO (1976). Their stratigraphic positions are situated in the middle part of the *P. kawasakii*—*P. pacificus* Zone. The subzone of this species largely overlaps the *P. fukazawai* Subzone, but the former is generally younger than the latter. Therefore both subzones are better to be united and regarded as a total range zone of *P. fukazawai* and *P. bontanti shimizui*, as mentioned above. Another subzone suggested at present by only two small specimens of *Submortonicerias condamyi* can be placed in the upper part of the *P. kawasakii*—*P. pacificus* Zone, beginning somewhat later than the *P. (P.) bontanti shimizui* Subzone.

The *Platyceramus japonicus* Zone probably starts at the same level as the *Submortonicerias* cf. *condamyi* Subzone, although they have not been found at one and the same locality. Recently, MATSUMOTO and TASHIRO (1982) and MATSUMOTO *et al.* (in press) pointed out that *Platyceramus japonicus* zone, which has been correlated with the Upper Santonian, contains the Campanian

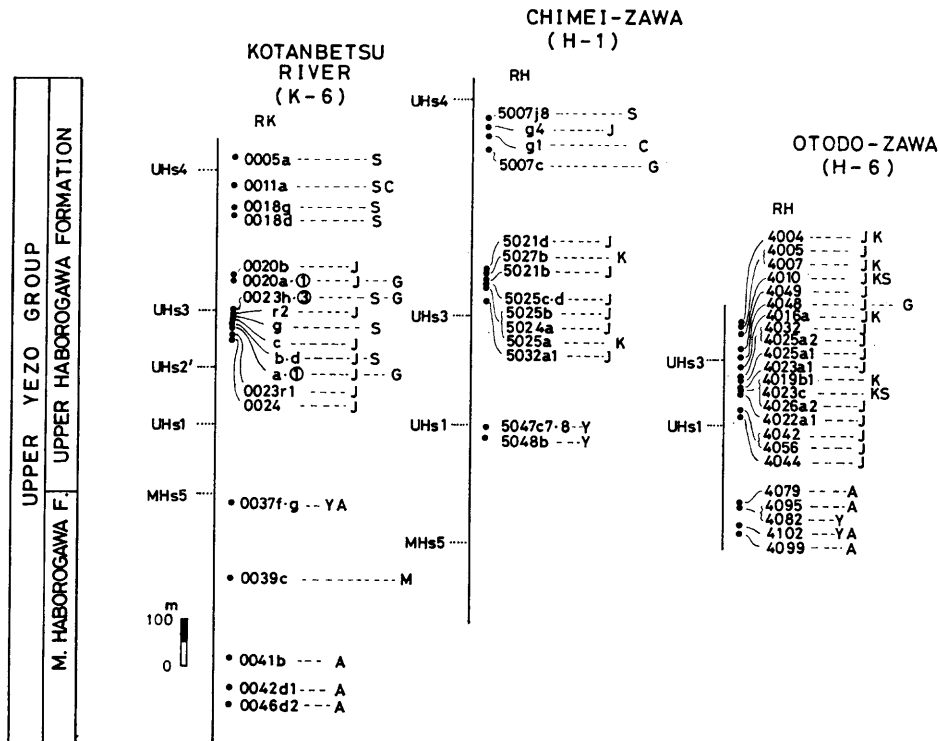


Fig. 5. Stratigraphic relationships between the selected mega- and micro-fossils, along the Ototo-zawa, Chimei-zawa and Kotanbetsu River.

Y: *Platyceramus yubariensis*, A: *Inoceramus amakusensis*, J: *Platyceramus japonicus*, K: *Inoceramus (Cordiceramus) kanmerai*, S: *Sphenoceramus sanrikuensis*, C: *Sphenoceramus cristatus*, G: *Globotruncana arca*, M: *Marginotruncana pseudolinneiana*.

microfossils in the Monobe area, Southwest Japan and Ikushunbetsu area, central Hokkaido, respectively. The investigation of Foraminifera is being carried on in northwestern Hokkaido, and Dr. S. MAIYA has kindly helped me in the identification of foraminiferal species on the samples which I collected. According to him (letter of December 23th, 1986), *Globotruncana arca* (CUSHMAN) occurs from loc. RH4048 in the Ototo-zawa, RH5007c in the Chimei-zawa, RK0020 ①, 0023 ① and 0023 ③ in the Kotanbetsu River (Fig. 5). All of these localities belong to the *Platyceramus japonicus* Zone. The first appearance of *Globotruncana arca* corresponds with the base of the Campanian in Japan (MAIYA and TAKAYANAGI, 1977; MAIYA, 1985) and California (DOUGLAS, 1969), West Carpathians (SALAJ and GAŠPARIKOVÁ, 1983), Poland (POZARYSKA and PERYT, 1979) and Tunisia (SALAJ, 1984). On the other hand, *Marginotruncana pseudolinneiana* PESSAGNO occurs at loc. RK0039c in the Kotanbetsu River. It ranges from the middle part of the Turonian to the latest Santonian (CARON, 1985). Therefore the boundary between the Santonian and Campanian in the sense of the foraminiferal biostratigraphy is drawn between the horizons of RK0023 ① and RK0039c.

KLINGER and KENNEDY (1980) regard the range of *S. condamyi* as the Upper Santonian to the Lower Campanian in Zululand and Pondoland, South Africa, but the clear evidence indicating the Upper Santonian has not been found, as far as the stratigraphical descriptions by KENNEDY and KLINGER (1975) and KLINGER and KENNEDY (1980, 1981) are concerned. BIRKELUND *et al.* (1984) have proposed a possibility that the evolution of *Submortonicer* from *Texanites* is a good marker of the base of the Campanian. If this proposal is accepted, the occurrence of *Submortonicer* cf. *condamyi* certainly indicates the Campanian.

As I mentioned above, the first appearances of *Platyceramus japonicus*, *Submortonicer* cf. *condamyi* and *Globotruncana arca* are nearly contemporaneous. Therefore, the occurrence of *P. japonicus* really indicates the Lowest Campanian, although generally it has been thought as the zonal index of the Upper Santonian. The horizon of *Menabites mazenoti* reported by MATSUMOTO and TAKAHASHI (1986) is probably assigned to the upper part of the *P. japonicus* Zone. They have inferred that *M. mazenoti* as well as *M. menabensis* COLLIGNON ranges from the Lower to the Middle Campanian.

The *Sphenoceramus sanrikuensis*—*S. cristatus*—*I. (C.) kanmerai* Subzone occupies the main part of the *P. japonicus* Zone, and persists to the *S. orientalis* Zone. The three species are the indices of the Lowest Campanian. The species diversity of *Sphenoceramus* in this subzone is high. A similar feature is known in the Upper Santonian to the Lower Campanian of Europe (SEITZ, 1965) and also in the Upper Santonian of USSR Far East (PERGAMENT, 1974, 1978). In other words, the diversity of *Sphenoceramus* occurred in parallel in Europe and Japan or the northwestern Pacific province.

The specimens of *S. sanrikuensis* described by MATSUMOTO and SUGIYAMA (1985) have been obtained from the upper part of the Okonai Member of the Taneichi Formation in northern Honshu. That member is probably correlated with the Kunitan Formation of the Kuji Group in the northern Honshu. From the Kunitan Formation the lectotype and other specimens of *Platyceramus japonicus* were obtained long ago (SASA, 1932) and some species of *Texanites* and *Plesiotexanites* have been recently found (KAWAKAMI *et al.*, 1983). Unfortunately the precise stratigraphic relationships among these species are uncertain in the Kuji area.

Sphenoceramus orientalis is the index of the Lowest Campanian and is stratigraphically distributed below the first occurrence of *S. schmidt* in Japan and British Columbia (WARD, 1978). The former species, however, persists into the "Lower Campanian" (= *S. schmidt* Zone) in the Tomiuchi and Saku areas of central and northern Hokkaido (MATSUMOTO, 1943), and then the co-occurrence of both species was confirmed in the Saku area in this study (loc. KTA020g; Pl. 5, Figs. 1, 2, 3). The *Sphenoceramus orientalis* Zone and *S. schmidt* Zone has been regarded as the Lower Campanian in Japan and California (MATSUMOTO, 1960) and British Columbia (WARD, 1978). However, it was confirmed to be the upper Lower Campanian because of the existence of the underlying Lowest Campanian *Platyceramus japonicus* Zone.

On the basis of the above mentioned correlation, the ranges of the selected

STAGE		INOCERAMIDS		AMMONITES	
Campanian	Upper	<i>Mytiloides shimanukii</i>		<i>Metaplacenticeras subtilistriatum</i>	
	Lower	<i>Sphenoceras schmidti</i>		<i>Menabites mazenoti</i>	
		<i>S. orientalis</i>			
	Lowest	<i>P. japonicus</i>	<i>I. (Cordiceras) kammeri</i> <i>S. sanrikuensis</i> — <i>S. cristatus</i>	<i>Plesiotexanites pacificus</i> — <i>Pl. kawasakii</i> <i>Protexanites fukazawai</i> — <i>Pr. bontanti shimizui</i> <i>Submontoniceras</i> cf. <i>condamyi</i>	<i>Pl. shiloensis</i>
Santonian		<i>Inoceramus amakusensis</i>		<i>T. amakusensis</i>	
		<i>Platyceras yubariensis</i>		<i>Texanites collignoni</i> — <i>T. quinquenodosus</i>	
Coniacian		<i>I. uwajimensis</i> — <i>I. mihoensis</i>	<i>I. (C.) kawashitai</i>		

Fig. 6. Revised zonal scheme for the Santonian and Lower Campanian of Japan.

species in northwestern Hokkaido are shown in a summarized chart of Fig. 6.

V. Discussion

KENNEDY (1983, 1984a) restudied the ammonites faunas of the stratotype of the Upper Cretaceous in the Aquitaine basin, France, and clarified that DE GROSSOURE's (1901) zonation, i.e. *Texanites texanus* (ROEMER) below and *Placenticeras syrtale* (MORTON) above, are not realized there, because the two index ammonite species do not occur in the type area. Then he thought that the base of the Santonian Stage can be taken at the appearance of *Placenticeras polyopsis* (DUJARDIN) and *Texanites* (*Texanites*) species, and that the stage may correspond to the Total Range Zone of *P. polyopsis*, although the occurrence of ammonites is too rare to allow the erection of a usable zonation. The basal Campanian yields *Placenticeras bidorsatum* (ROEMER), but its occurrence is also very rare.

The Santonian of the other regions of Europe and Russian Platform show

similar stratigraphic succession. In the former the base of the Santonian Stage is defined by the appearance of *Platyceramus undulaticus* (ROEMER) and '*Texanites texanus*' (ERNST *et al.*, 1979; SCHULZ *et al.*, 1984). In the European Boreal realm, the Santonian Stage is divided into tripartite zones by means of macrofossils, i.e. Lower, Middle and Upper, and each of them is subdivided into bipartite zones. However belemnites are predominant in this realm, and only the *Platyceramus undulaticus* Zone of the Lowest Santonian or two zones including *P. undulaticus* Zone and the *Inoceramus* (*Cordiceras*) *cordiformis* Zone of the lower Middle Santonian are recognized. Therefore the Santonian and Campanian Stages are characterized by belemnites except for the Lower Santonian *Platyceramus undulaticus* and *Inoceramus* (*Cordiceras*) *cordiformis* Zones (NAIDIN, 1979; ERNST *et al.*, 1979; SCHULTZ *et al.*, 1985; SEITZ, 1961, 1965, 1967; TRÖGER, 1966). No successive ammonite zones are established for the Santonian Stage of Europe and only the zone of "*Texanites texanus*" of the lowest part of the Santonian is presented (ERNST *et al.*, 1979).

In the Mediterranean area, for example, Tunisia, the basal Santonian is represented by *Platyceramus sicilis* (PERVINQUIÈRE) and '*Texanites oliveti*' (SALAJ, 1984), but the Upper Santonian zonation has not been well established on macrofossils.

According to COLLIGNON (1948a, b) and BASAIRE and COLLIGNON (1972), the Santonian Stage of Madagascar is divided into the following three zones by means of mainly texanite ammonites (see MATSUMOTO and HARAGUCHI, 1978).

(1) Lower Santonian: zone of *Texanites oliveti* (BLANCKENHORN) (= *T. collignoni*) with *T. texanus gallicus* COLLIGNON, *T. texanus hispanicus* COLLIGNON and *T. cf. roemeri* (LASSWITZ).

(2) Middle Santonian: zone of *Texanites hourcqui* COLLIGNON with *T. hourcqui* var. *soumarayensis* COLLIGNON, *T. oliveti* var. *spinosa* COLLIGNON, *T. texanus gallicus*, *T. rarecostatus* COLLIGNON, *T. quadrangulatus* COLLIGNON, *T. soutoni* (BAILY), *T. aff. quinquenodosus* (REDTENBACHER), *T. venustus* COLLIGNON, *T. [= Plesiotexanites] stangeri* (BAILEY) including var. *densicostus* (SPATH) and var. *sparsicostus* (SPATH).

(3) Upper Santonian: zone of *Pseudoschloenbachia umbulazi* (BAILY) with *T. dichotomus* COLLIGNON, *T. mikobokensis* COLLIGNON, *T. raliatonai* COLLIGNON, *T. quadrangulatus*, *T. texanus gallicus*, *T. texanus hispanicus*, *T. hourcqui* var. *soumarayensis*, *T. pseudotexanus*, *T. quinquenodosus* and *T. [= Plesiotexanites] stangeri* var. *densicostus*.

(4) Lower Campanian: zone of *Anapachydiscus wittekindi* SCHLUTER and *Eulophoceras jacobii* HOURCQ.

In the Western Interior province, U.S.A., COBBAN (in OBRADOVICH and COBBAN, 1975) established six zones for the Santonian Stage by means of the following zonal indices: in ascending order, (1) *Scaphites depressus* REESIDE and *Inoceramus undulaticus*, (2) *Clioscapites saxitonus* (MCLEARN), (3) *Clioscapites vermiformis* (MEEK and HAYDEN), (4) *Clioscapites choteauensis* COBBAN, (5) *Desmoscapites erdmanni* COBBAN and (6) *Desmoscapites bassleri* REESIDE. In the southern Interior Plains of Canada, a similar zonation is established by CALDWELL and NORTH (1984). In Texas, YOUNG (1963) shows

a schem of zonation for the Santonian of Texas and also a range chart of selected species, as follows:

Lower Santonian

- (1) zone of *Texanites stangeri densicostus*
(associated with *Inoceramus undulatopticatus*)
- (2) zone of *Texanites texanus texanus*
(associated with *Inoceramus undulatopticatus*)
- (3) zone of *Texanites texanus gallicus*

Upper Santonian

- (4) zone of *Texanites shiloensis*

Lower Campanian

- (5) zone of *Submortonicerias tequesquitensis* YOUNG.

In Siberia, the Lower Santonian is indicated by *Inoceramus cardissoides* GOLDFUSS, and the Upper Santonian by *I. patootensis* DE LORIOLE and the Lower Campanian by *Scaphites hippocrepsis* (DEKAY) (PERGAMENT, 1978). In the USSR Far East, i.e. Sakhalin and Kamchatka-Koryak regions, the *Inoceramus undulatopticatus* Zone for the lower Santonian, the *Inoceramus transipacificus* Zone for the middle Santonian and the *Inoceramus patootensis* Zone for the upper Santonian to the lower Campanian are recognized (PERGAMENT, 1978).

In Japan, MATSUMOTO (1977) and TAKAYANAGI and MATSUMOTO (1981) have shown two zones for the Santonian by means of inoceramids, that is, the *Inoceramus amakusensis* Zone below and the *Platyceramus japonicus* Zone above, and two zones for the Lower Campanian, the *Sphenoceramus orientalis* Zone below and *S. schmidtii* Zone above. Furthermore, MATSUMOTO (in MATSUMOTO and HARAGUCHI, 1978) has shown three zones for the Santonian by the texanite ammonites, i.e. *Texanites olivetti* (lower), *Plesiotexanites kawasakii*, *P. pacificus* and *Protexanites fukazawai* (middle), and *Plesiotexanites shiloensis* (upper). However, this zonation was modified in this study as mentioned above. As shown in Fig. 6, the base of the Japanese Santonian is defined by the appearance of *Inoceramus amakusensis* and *Texanites collignoni* or *T. quinquenodosus*, and the base of the Campanian is shown by the appearance of the *Platyceramus japonicus* together with *Submortonicerias cf. condamyi* and *Globotruncana arca*.

Therefore the Santonian Stage in Japan consists of only one inoceramid zone, the *Inoceramus amakusensis* Zone, and two ammonoid zones, i.e. the *Texanites collignoni*—*T. quinquenodosus* Zone and the *Plesiotexanites kawasakii*—*P. pacificus* Zone which extends to the Lower Campanian. Moreover the zone of *P. kawasakii*—*P. pacificus* may be subdivided into two subzones: the subzone of *Texanites amakusensis* (below) and the subzone of *Protexanites* (*P.*) *bontanti shimizui*—*P. (A.) fukazawai* (above). Although the stratigraphic positions of *P. bontanti shimizui* from the Haboro area described by MATSUMOTO (1970, p. 237, pl. 31, figs. 1, 2) were unknown, the horizon of the specimen (GK. H5631) of the species came from the Chikubetsu coal mine is inferred to be in the middle part of the Upper Haborogawa Formation, which agrees with the stratigraphic distribution established in this paper. The exact horizon of the holotype of *P. bontanti shimizui* in Sakhalin cannot be reexamined, but it belongs to the zone of *Plesiotexanites kawasakii* (MATSUMOTO, 1970, p. 239). This is in accord

with the above-mentioned zonal scheme in which the range of *P. bontanti shimizui* is known to be from the uppermost Santonian to the lowermost Campanian. KENNEDY (1984b, p. 112–114) referred the incorrectly inferred horizon of *P. bontanti shimizui* (Lower Santonian; MATSUMOTO, 1970; MATSUMOTO and HARAGUCHI, 1978), and he suggested the species as a synonym of *P. bontanti* (DE GROSSOUVRE), an Upper Coniacian species.

As *Placenticerias* species are unknown in Japan, the Santonian Stage in Japan cannot be directly correlated with the stratotype in France. But the base of the Santonian in Japan would be correlated with the currently known base of the stage if *Texanites* (*Texanites*) is usable as a marker. Similarly, the direct correlation of the lower Campanian in Japan with the stratotype is very difficult in the present state of our knowledge.

VI. Palaeontological notes of the selected species

Family Inoceramidae ZITTEL, 1881

Genus *Inoceramus* SOWERBY, 1814

Subgenus *Cordiceramus* SEITZ, 1961

Inoceramus (*Cordiceramus*) *kanmerai* TOSHIMITSU, 1986

1986. *Inoceramus* (*Cordiceramus*) *kanmerai* TOSHIMITSU, *Proc. Japan Acad.*, vol. 62(B), p. 227, fig. 1.

Pl. 24, Fig. 2

Remarks.—This species was recently established by TOSHIMITSU (1986) with a full description based on the holotype and paratype specimens, so no further notes are needed. In that paper was noted that the species has a range from the uppermost Santonian to the Lowest Campanian, but now it is revised to be restricted to the Lowest Campanian.

Genus *Sphenoceramus* BÖHM, 1915

Sphenoceramus africanus (HEINZ, 1930)

1930. *Inoceramus africanus* HEINZ (*nom. nud.*), in BESAIKIE, *Rech. geol. Madagascar*, p. 128.

1933. *Mytiloides africanus* HEINZ, *Z. Deutsch. Geol. Gesellsch.*, vol. 85, p. 249, pl. 21, figs. 3–4.

1964. *Inoceramus* (*Sphenoceramus*?) *africanus*; SORNAY, *Ann. Paléont., Invertébré*, vol. 50, p. 12, pl. 11, fig. 4.

Pl. 27, Figs. 9a, b

Material.—Specimen GK.H8135 from loc. RH2511k1 and GK.H8136 from loc. RK3010p3 (left valves) and GK.H8137 from RK0005a5 (articulate valve).

Descriptive remarks.—Shell small, relatively convex owing to somewhat secondary depression which makes an apparent anterior shoulder between the steeply inclined anterior side and the main part of disk. Obliquity moderate ($\delta=59^\circ$). Posterior wing fairly broad, unclearly demarcated from the main disk with a slight difference in level in a specimen from RH2511k1, but definitely in other two specimens. Hinge-line about a half of shell-length, with an acute

anterior angle ($\alpha=72^\circ$) and obtuse posterior one ($\gamma=135^\circ$). Umbonal inflation acute ($\beta=47^\circ$). A faint shallow posterior radial sulcus is discernible. Ventral margin asymmetrically rounded, passing into gently arcuate anterior margin and nearly straight posterior one. Shell ornamented with numerous, regular concentric rings on the regular concentric undulations or ribs, which continue onto the posterior wing.

These specimens resemble the holotype of *S. africanus* of HEINZ (1933, pl. 21, fig. 3) in the outline and ornamentation, although they have a smaller shell and a slightly smaller apical angle.

Measurements (in mm).—

specimens	h	l	l/h	H	L	L/H	b	b/h	s	s/l	α	β	γ	δ
GK. H8135	32.5	28.0	.86	37.0	(20.5)	(.55)	(11.0)	(.34)	(14.0)	(.50)	(72°)	(47°)	135°	59°

For letters see MATSUMOTO and NODA (1985). The parentheses show an approximate value.

Occurrence.—The specimen from RH2511k1 of the Nakanofutamata-gawa, occurs in sandy siltstone of the lower part of the Upper Haborogawa Formation. Those from RK0005a5 of the Kotanbetsu River and RK3010p3 of the Onkono-sawa occur in sandy siltstone of the upper part of the Upper Haborogawa Formation.

Sphenoceramus sanrikuensis MATSUMOTO and SUGIYAMA, 1985

1985. *Sphenoceramus sanrikuensis* MATSUMOTO and SUGIYAMA, *Proc. Japan Acad.*, vol. 61(B), p. 106, fig. 2.

1986. *Sphenoceramus sanrikuensis* MATSUMOTO and SUGIYAMA, *Bull. Iwate Pref. Mus.* (4), p. 21, pl. 3, figs. 1–12.

Pl. 27, Figs. 4, 5

Remarks.—This species was recently established by MATSUMOTO and SUGIYAMA (1985) and described in more detail in Japanese (MATSUMOTO and SUGIYAMA, 1986). Although there are some variations in the ornamentation and the extent of posterior wing, the specimens examined in this paper are so similar to the type specimens that they can be identified with this species.

Occurrence.—Most of the specimens examined occur in claystone and siltstone of the middle and upper parts of the Upper Haborogawa Formation in the Haboro, Kotanbetsu and Obira areas, and some are from siltstone of IIId member in the Saku area (MATSUMOTO, 1942b, p. 200).

Sphenoceramus sp. nov.(?) aff. *S. lingua* GOLDFUSS, 1835

Pl. 27, Figs. 10a, b, 11a, b

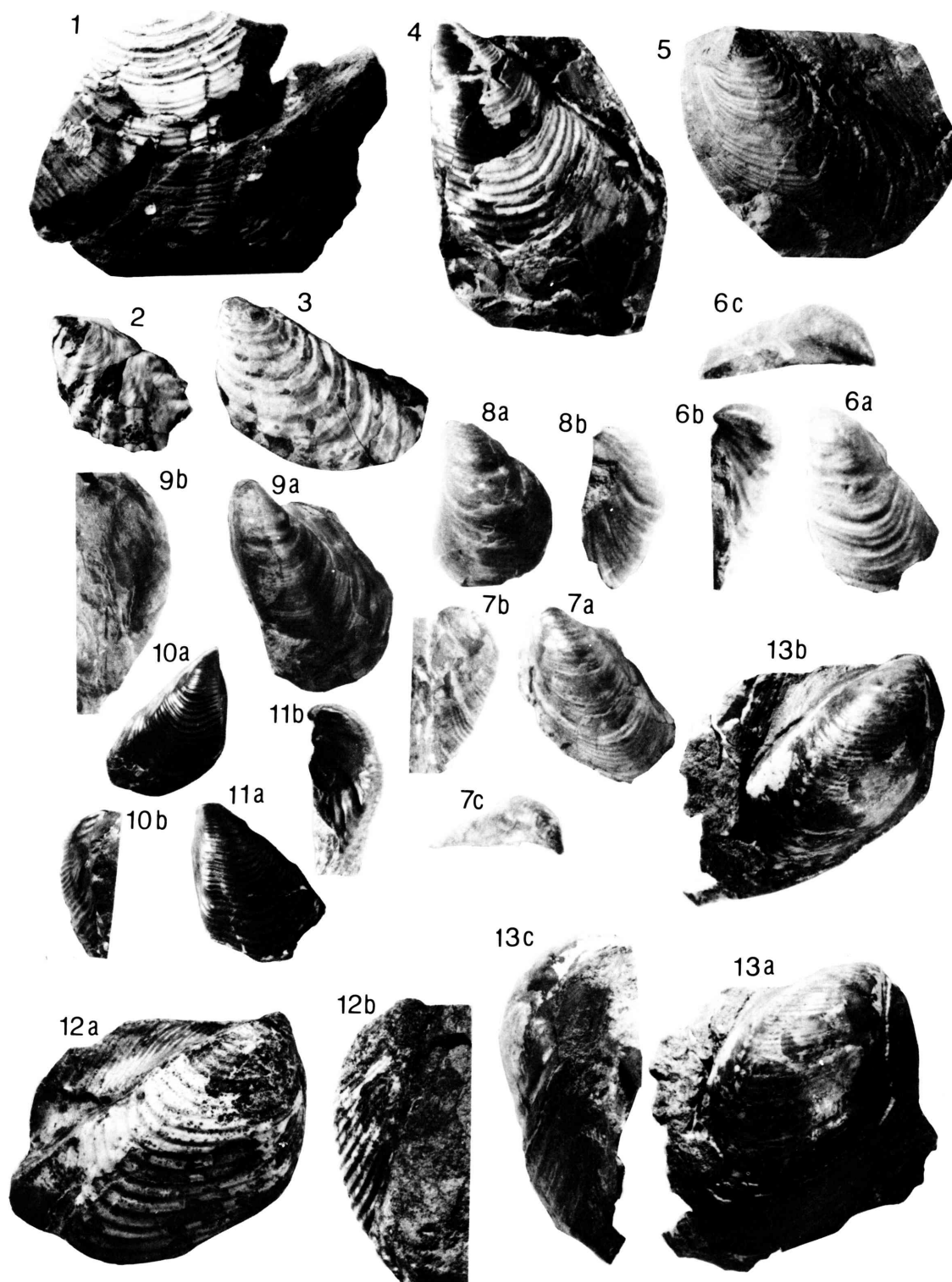
Material.—Specimen USR101 and 102, a pair of inarticulate right and left valves collected from a floated nodule by S. UCHIDA at loc. Rh-12p in a small branch of Nakanofutamata-gawa (H-29). Left valve (GK. H8138) from a floated nodule at loc. RK3003p1 and two left valves (GK. H8139 and 8140) from loc. RK3012a along the Onkono-sawa.

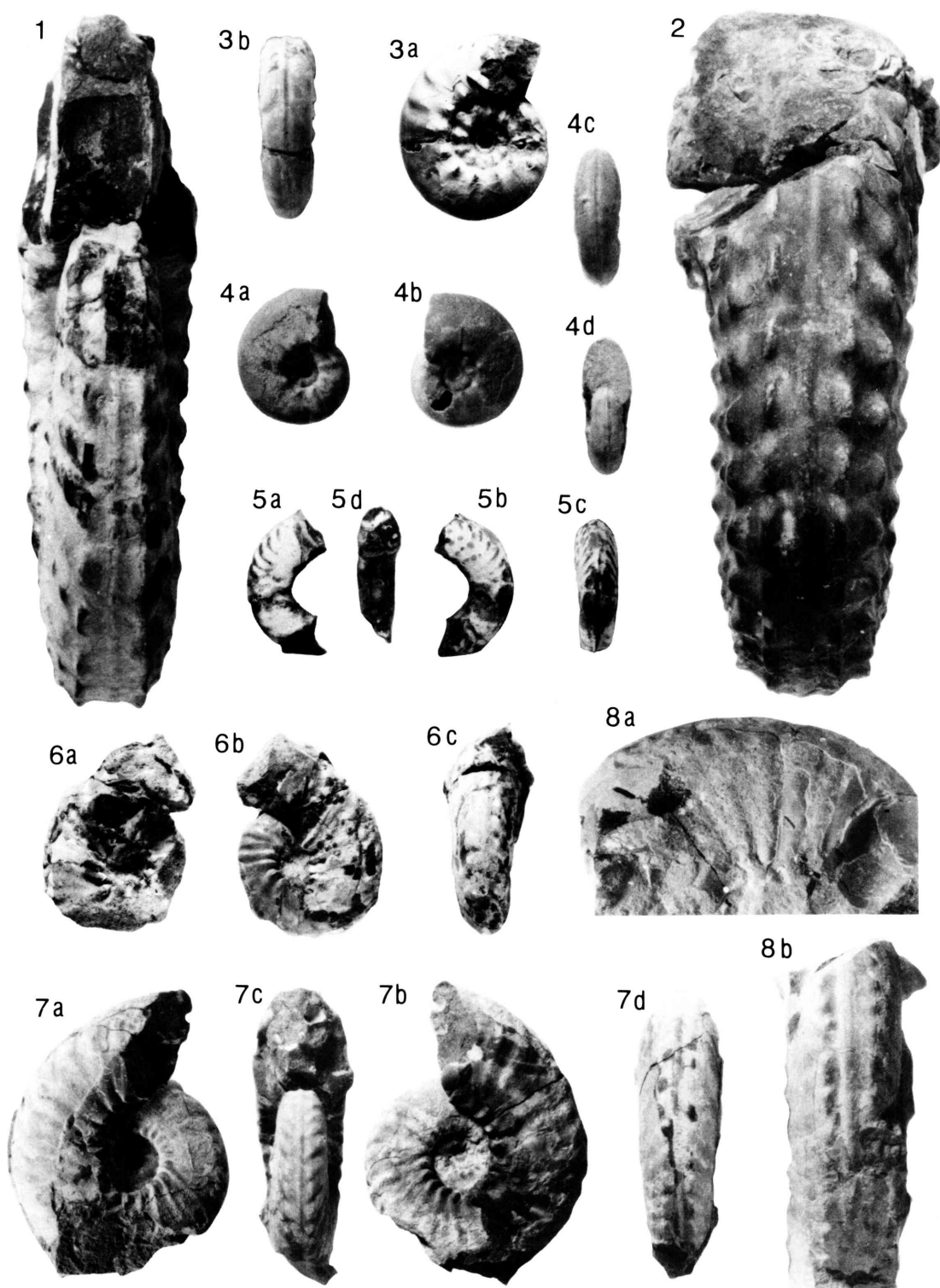
Description.—Shell small, moderately convex and equivalve, extending relatively obliquely to the posteroventral margin with a straight growth axis. The

features of the posterior wing uncertain because of its poor preservation. Anterior margin very gently arcuate, ventral margin asymmetrically and fairly narrowly rounded, and posterior margin long and straight. Three radial ridges developed along the anterior margin, growth axis and boundary between the main disk and posterior wing. Sulcuses discernible between the anterior and central ridges and between the central and posterior ones. Anterior sulcus clearer than posterior one. Main part of disk ornamented with numerous, regular concentric rings, but typical double rings not observed.

Explanation of Plate 27

- Fig. 1. *Sphenoceramus schmidtii* (MICHAEL)
GK. H8236 from loc. RH5007j1 in the Chimei-zawa. Right valve. $\times 1$.
- Fig. 2. *Sphenoceramus schmidtii* (MICHAEL)
GK. H8237 from loc. KTA020g in the Tanno-sawa of the Saku area. Left valve. $\times 1$.
- Fig. 3. *Sphenoceramus orientalis* (SOKOLOV)
GK. H8257 from loc. KTA020g in the Tanno-sawa. Left valve. $\times 1$.
- Fig. 4. *Sphenoceramus sanrikuensis* MATSUMOTO and SUGIYAMA
GK. H8238 from loc. RH7176a1 in the Detofutamata-gawa, collected by S. UCHIDA and S. T. Left valve. $\times 1$.
- Fig. 5. *Sphenoceramus sanrikuensis* MATSUMOTO and SUGIYAMA
GK. H8239 from loc. R346p6 in the Migino-sawa. Left valve. $\times 1$.
- Fig. 6. *Sphenoceramus cristatus* sp. nov.
GK. H8177 from loc. RK3002p2 in the Onkono-sawa, collected by S. UCHIDA and S. T. Lateral view of the left valve (a); anterior view (b); dorsal view (c). $\times 1.5$.
- Fig. 7. *Sphenoceramus cristatus* sp. nov.
GK. H8166, holotype from loc. RK3020i in the Onkono-sawa, collected by S. UCHIDA and S. T. Lateral view of the left valve (a); anterior view (b); dorsal view (c). $\times 1$.
- Fig. 8. *Sphenoceramus* sp. aff. *S. cristatus* sp. nov.
GK. H8195 from loc. RK1007b3 along the Kamino-sawa. Lateral view of the left valve (a); anterior view (b). $\times 2$.
- Fig. 9. *Sphenoceramus africanus* (HEINZ)
GK. H8135 from loc. RH2511k1 in the Nakanofutamata-gawa. Lateral view of the left valve (a) and anterior view (b). $\times 1$.
- Fig. 10. *Sphenoceramus* sp. aff. *S. lingua* GOLDFUSS
USR101 from loc. Rh12p in the small branch of the Nakanofutamata-gawa, collected by S. UCHIDA. Lateral view of the right valve (a) and anterior view (b). $\times 1$.
- Fig. 11. *Sphenoceramus* sp. aff. *S. lingua* GOLDFUSS
USR102 from loc. Rh12p in the small branch of the Nakanofutamata-gawa, collected by S. UCHIDA. Lateral view of the left valve (a) and anterior view (b). $\times 1$.
- Fig. 12. *Sphenoceramus haboroensis* sp. nov.
GK. H8198, holotype from loc. RH7176c1 in the Detofutamata-gawa, collected by S. UCHIDA and S. T. Lateral view of the right valve (a) and anterior view (b). $\times 1$.
- Fig. 13. *Sphenoceramus kiritachiensis* sp. nov.
GK. H8201, holotype from loc. RK0011a9 in the Kotanbetsu River. Lateral view of the right valve (a); oblique view (b); anterior view (c). $\times 1$.





Measurements (in mm).—

specimens	h	l	H	L	L/H	b	s	α	β	γ	δ
USR102	—	—	25.0	18.5	.72	9.0	—	—	59°	—	—
USR101	—	—	22.5	15.0	.66	7.5	—	—	52°	—	—

Remarks.—These specimens resemble *S. lingua* (see SEITZ, 1965, pl. 16, fig. 4) and *S. juv. cf. lingua* (SEITZ, 1965, pl. 18, fig. 3, 5), but the latter two have neither anterior ridge nor anterior sulcus. They are also similar to *S. cardissoides* (GOLDFUSS), *S. pinniformis* (WILLET) and *S. patootensiformis* (SEITZ, 1965), but the latter species have much coarser ornamentation and well-developed radial pits.

Occurrence.—The specimens USR101 and 102 were collected from a floated silty calcareous nodule at loc. Rh-12p of S. UCHIDA along the route H-29. GK. H8139 to 8141 were obtained from sandy siltstone along the Onkono-sawa. The localities of these four specimens belong to the upper part of the Upper Haborogawa Formation.

Sphenoceramus cristatus sp. nov.

Pl. 27, Figs. 6a–c, 7a–c

Material.—The holotype (GK. H8166; Pl. 27, Figs. 7a–c) is a left valve collected by S. UCHIDA and S. TOSHIMITSU from loc. RK3020i along the Onkono-sawa. Other specimens came from the following localities. Specimens marked with * are from floated nodules:

Explanation of Plate 28

- Fig. 1. *Plesiotexanites pacificus* (MATSUMOTO)
Frontal view of GK. H8242. $\times 1$.
- Fig. 2. *Plesiotexanites kawasakii* (KAWADA)
Ventral view of GK. H8243. $\times 1$.
- Fig. 3. *Protexanites* (*Miotexanites*) *minimus* MATSUMOTO
GK. H8207, ornate form, from loc. RH3126 in the Kotodo-zawa. Lateral view (a); ventral view (b). $\times 2$.
- Fig. 4. *Protexanites* (*Miotexanites*) *minimus* MATSUMOTO
GK. H8214, smooth form, from loc. RK1007b3 in the Kamino-sawa. Lateral view (a, b); ventral view (c); frontal view (d). $\times 2$.
- Fig. 5. *Haboroceras* sp. aff. *H. haboroense* sp. nov.
GK. H8226 from loc. RH2873b5 in the Shimizu-zawa. Lateral views (a, b); ventral view (c); cross-section (d). $\times 2$.
- Fig. 6. *Protexanites* (*Protexanites*) *bontanti shimizui* MATSUMOTO
GK. H8246 from loc. RH1200g, a road-cut on the Sakasagawa Forest Road, collected by T. MATSUMOTO, M. NODA, S. UCHIDA and S. T. Lateral views (a, b); ventral view (c). $\times 1$.
- Fig. 7. *Protexanites* (*Anatexanites*) *fukazawai* (YABE and SHIMIZU)
GK. H8245 from loc. RH7239a in the Pisshiri-zawa, collected by S. UCHIDA and S. T. Lateral views (a, b); frontal view (c); ventral view (d). $\times 1$.
- Fig. 8. cf. *Plesiotexanites shiloensis* (YOUNG)
GK. H8247 from loc. RH5047c6 in the Chimei-zawa. Lateral view (a); ventral view (b). $\times 1$.

Right valve—RH346p6* (GK. H8141, 8143), RH2532i (GK. H8144), RH7176b7 (GK. H8145), RH7176c4 (GK. H8150), RH7311b1 (GK. H8151) in the Haboro area, RK0011a13 (GK. H8153), RK3014p1* (GK. H8154, 8155, 8156), RK3015d (GK. H8159), RK3105p2* (GK. H8161, 8162), RK3018a (GK. H8163), RK3020n (GK. H8165), RK3218a3 (G.K. H8167, 8168) in the Kotanbetsu area, KTA008r1 (GK. H8176), KTA008r2 (GK. H8171) in the Saku area.

Left valve—R346p6* (GK. H8142), RH7176b7 (GK. H8146 to 8149), RH7176cr1 (GK. H8172) in the Haboro area, RK0011a8 (GK. H8173), RK0011a9 (GK. H8174), RK0011a11 (GK. H8175), RK0011a13 (GK. H8152), RK0017a1 (GK. H8176), RK3002p2* (GK. H8177), RK3009p1* (GK. H8178), RK3011a (GK. H8179, 8180), RK3011r1 (GK. H8181, 8189), RK3015d (GK. H8157, 8158, 8160), RK3015g (GK. H8182), RK3018a (GK. H8164), RK3019a (GK. H8183), RK3020e (GK. H8184, 8185), RK3206a (GK. H8186, 8187), RK3218a3 (GK. H8188) in the Kotanbetsu area.

Description.—Shell small, equivalve, inequilateral and convex, extending obliquely from beak to posteroventral extremity, with a nearly straight growth axis which forms an angle (δ) of 47° to 62° with the hinge-line. Umbo terminal, slightly prominent and incurved. Valve much inflated in the umbonal part and gently in the ventral part, with convexity changing rapidly with 2 steps in the early and middle growth stages. Posterior wing moderately broad with some variation, definitely demarcated from the main part of disk. Length of hinge-line uncertainly, with an anterior angle (α) of 70° – 80° and a probably obtuse posterior angle (not precisely measured), while an angle (β) of umbonal inflation acute (44° – 60°). Anterior margin nearly straight or somewhat convex; ventral margin asymmetrically and fairly narrowly rounded; posterior margin long and nearly straight.

Test thin, but for somewhat thick hinge plate. Three radial ridges of unequal and variable strength. Shallow radial sulcuses developed in some case between the anterior and central ridges and between the central and posterior ones. Main part of disk ornamented with small and irregular concentric undulations and numerous, regular concentric rings, some of which may be united near the margin but do not form typical double rings. These ornaments weaken or disappear on the posterior wing.

Measurements (in mm).—

specimens	h	l	l/h	H	L	L/H	b	b/h	s	α	β	γ	δ
Left valve													
Holotype	25.0	25.0	1.00	31.0	(20.0)	(.65)	10.5	.42	—	84°	60°	—	47°
GK. H8175	10.5	12.5	1.19	14.5	10.0	.69	4.5	.43	—	59°	46°	—	49°
GK. H8178	18.0	15.0	.83	20.5	13.0	.63	5.5	.31	—	83°	—	—	60°
GK. H8179	18.5	18.0	1.00	22.5	12.5	.56	12.0	.65	—	73°	44°	—	59°
GK. H8180	8.0	9.0	1.13	11.0	7.0	.64	3.5	.44	—	78°	50°	—	46°
GK. H8181	15.5	16.5	1.06	19.0	14.5	.76	7.0	.45	—	80°	59°	—	62°
GK. H8160	10.5	10.5	1.00	13.0	8.5	.65	6.5	.62	—	77°	54°	—	56°
GK. H8184	12.0	13.5	1.13	15.0	10.0	.67	7.0	.58	—	67°	47°	—	58°
GK. H8167	10.0	8.5	.85	11.5	7.0	.61	3.0	.30	—	74°	48°	—	47°
Right valve													
GK. H8150	7.5	10.0	1.33	11.0	6.9	.59	3.0	.40	—	59°	53°	—	35°

GK. H8151	11.5	10.5	.91	13.0	9.0	.96	3.0	.26	—	80°	58°	—	59°
GK. H8159	7.5	8.5	1.13	9.5	7.0	.74	3.5	.47	—	68°	60°	—	38°

Remarks.—This species resembles *S. sanrikuensis*, *S. naumanni* and *S. yokoyamai*, but it is distinguished by its radial ridges and much inflated valves. It is also similar to *S. lingua*, *S. cf. lingua* and *S. juv. cf. lingua* (see SEITZ, 1965), but it has three radial ridges, a much smaller shell and denser ornamentations than the latter species.

Occurrence.—The specimens from the Haboro and Kotanbetsu areas occurred in sandy mudstone of the upper part of the Upper Haborogawa Formation. Those from the Saku area also occurred in sandy mudstone.

Shenocerasmus sp. aff. *S. cristatus* sp. nov.

Pl. 27, Figs. 8a–b

Material.—Right valve (GK. H8192) from loc. RH7239a in the Detofutamata-gawa.

Left valves from loc. RH5049c4 (GK. H8193) in the Chimei-zawa, locs. RH7239a (GK. H8190, 8191) and RH7013a (GK. H8194) in the Detofutamata-gawa, and loc. RH1007b3 (GK. H8195 to 8197) in the Kamino-sawa.

Description.—Shell small, very convex in the early growth stage, but moderately convex later with two changing points of shell growth in the early and middle stages, extending obliquely to the posteroventral margin, with a straight growth axis which forms an angle (δ) a little less than 50° with the hinge-line. Posterior wing weakly developed. The angle (α) between hinge-line and anterior margin acute but somewhat variable. The angle (β) of umbonal inflation acute (ca. 50°). Anterior margin nearly straight or very gently arcuate; ventral margin asymmetrically and fairly narrowly rounded; posterior margin nearly straight. Three very faint radial ridges observed in the earlier growth stage, but undiscernible in the later stage. Main part of disk ornamented with numerous, regular concentric rings and occasionally with irregular and faint, concentric major undulations.

Measurements (in mm).—

specimens	h	l	l/h	H	L	L/H	b	b/h	s	α	β	γ	δ
GK. H8193	15.0	15.5	1.03	19.5	11.0	.56	6.0	.40	—	28°	47°	(131°)	48°
GK. H8190	9.0	13.0	1.44	13.5	8.5	.63	5.5	.61	—	65°	50°	—	47°

Remarks.—*S. aff. cristatus* shows variation in development of three radial ridges and in feature of concentric ornamentation, but the angle β and δ are relatively stable.

This species resembles *S. cristatus*, but it is distinguished by its weak radial ridges. It is distinguished from *S. naumanni* by its radial ridges and more irregular convexity. It differs from *Inoceramus talovens* PERGAMENT (1974, pl. 12, figs. 3–6) in having three weak radial ridges and more acute umbonal inflation.

Occurrence.—These specimens occur in siltstone calcareous nodule in the lower part of the Upper Haborogawa Formation of the Haboro and Kotanbetsu areas.

Sphenoceramus haboroensis sp. nov.

Pl. 27, Figs. 12a-b

Material.—Holotype (GK. H8198), a right valve collected by S. UCHIDA and S. TOSHIMITSU from loc. RH7176c1 in the Detofutamata-gawa. Other imperfectly preserved specimens referable to this species came from loc. RH7176a1 (GK. H8199) in the Detofutamata-gawa and loc. RK3015b (GK. H8200) in the Onkono-sawa.

Specific characters.—Shell small, subrhomboidal in general outline, moderately convex, extending very obliquely to the posteroventral extremity with a nearly straight growth-axis which forms an angle (β) of about 50° with the hinge-line. Posterior wing fairly broad, definitely demarcated from the main part of disk. Hinge-line about three-fifths of shell-length, with an obtuse anterior ($\alpha=110^\circ$) and posterior angle ($\gamma=145^\circ$), but the angle (β) of umbonal inflation somewhat acute (81°). Anterior margin gently convex, turning abruptly to the ventral margin, which is nearly straight or gently concave on the anterior half of the valve and asymmetrically and fairly narrowly rounded on the central part; posterior margin long and nearly straight, but the posterodorsal margin abruptly turned toward the umbo to merge into the hinge-line. Three weak radial ridges perceptible; the first close to the anterior margin, the second along the growth axis and the third along the boundary between the main disk and the posterior wing. A faint sulcus developed between the central and posterior ridges.

Test relatively thin, but somewhat thicker on the posterior wing. Main part of disk ornamented with numerous, regular concentric ribs, but numerous and dense striae run on the posterior wing in parallel with posterior margin.

Measurement of holotype (in mm).—

specimens	h	l	l/h	H	L	L/H	b	b/h	s	s/l	α	β	γ	δ
Holotype	43.5	40.0	.92	51.0	(35.0)	(.69)	13.5	.31	(24.0)	(.60)	110°	81°	145°	50°

Remarks.—This species is distinguished from *S. sanrikuensis* by its subrhomboidal outline, larger convexity and coarser ornamentation.

S. haboroensis differs from *S. lingua*, *S. cf. lingua* and *S. juv. cf. lingua* of SEITZ (1965) in having a broader posterior wing, larger convexity of valves and long and straight or slightly concave anteroventral margin.

Occurrence.—The holotype and two conferable specimens were obtained from sandy siltstone in the upper part of the Upper Haborogawa Formation along the Detofutamata-gawa of Haboro and the Onkono-sawa of the Kotanbetsu River.

Sphenoceramus kiritachiensis sp. nov.

Pl. 27, Figs. 13a-c

Material.—Holotype (GK. H8201a), a right valve from RK0011a9 in the Kotanbetsu River. Other specimens are GK. H8201b (left valve) associated with holotype, GK. H8202 (articulate valves) from loc. RH5007j5 in the Chimei-zawa, GK. H8203 (right valve) from loc. RH7176b7 in the Detofutamata-gawa. A conferable specimen (GK. H8204) from loc. RH7176a1 in the Detofutamata-gawa (right valve).

Specific characters.—Shell small, very convex, extending very obliquely to the posteroventral extremity with a straight growth-axis which forms an angle (δ) of about 50° with the hinge-line. Posterior wing fairly broad, definitely demarcated from the main part of disk. Hinge-line about two-thirds of shell-length, with obtuse anterior (α =ca. 100° – 120°) and posterior angles (γ =ca. 120°), the angle (β) of umbonal inflation ranging from 98° to 64° . Anterior margin very gently arcuate with convex anterodorsal and anteroventral edges; ventral margin nearly straight on the anterior part and asymmetrically and fairly narrowly rounded on the central part of shell; posterior margin long and very gently arched, and the posterodorsal margin turning toward the umbo to merge into the hinge-line. Test relatively thin, but thick below the posterior wing. Main part of disk ornamented with numerous, regular concentric rings on the internal mould, but numerous and dense lirae and striae on the outer surface, running also on the posterior wing in parallel with posterior margin. Irregular concentric undulations weakly developed in the late growth stage.

Measurements (in mm).—

specimens	h	l	l/h	H	L	L/H	b	b/h	s	s/l	α	β	γ	δ
Right valve														
Holotype	32.0	36.0	1.13	40.0	30.0	.75	14.5	.45	22.5	.63	118°	98°	122°	53°
GK. H8203	21.0	20.0	.95	24.5	19.0	.78	10.0	.47	—	—	99°	64°	—	56°
Left valve														
GK. H8201b	22.0	23.5	1.07	30.0	(20.5)	(.68)	6.5	.30	—	—	103°	86°	—	48°

Remarks.—This species resembles *S. haboroensis*, but is distinguished in having much denser concentric rings, more convex valves and no radial ridges. *S. kiritachiensis* is distinguished from *S. naumanni* and *S. yokoyamai* by its broader posterior wing, subrhomboidal instead of sphenoid outline and more convex valve.

Occurrence.—The holotype and other specimens occurred in calcareous nodules of sandy siltstone in the upper part of the Upper Haborogawa Formation in the Haboro and Kotanbetsu areas.

Family Collignoniceratidae WRIGHT and WRIGHT, 1951

Subfamily Texanitinae COLLIGNON, 1948

Genus *Protexanites* MATSUMOTO, 1955

Subgenus *Miotexanites* MATSUMOTO, 1970

Protexanites (*Miotexanites*) *minimus* MATSUMOTO, 1970

1970. *Protexanites* (*Miotexanites*) *minimus* MATSUMOTO, *Mem. Fac. Sci. Kyushu Univ.*, ser. D, Geol., vol. 20, p. 246, pl. 33[37], figs. 1–3.

Pl. 28, Figs. 3a, b, 4a–d

Material.—Specimens (GK. H8204, 8205) from loc. RH1204a and RH1267d in the Sakasa-gawa loc. RH2895e1 (GK. H8206) in the Shimizu-zawa, loc. RH3126 (GK. H8207, 8208) in the Kotodo-zawa, loc. RH5047c7 (GK. H8209) and RH5049c4 (GK. H8210) in the Chimei-zawa, loc. RH7207c1 (GK. H8211) in the Pisshiri-zawa, loc. RK0037f1 (GK. H8212) and RK0037j (GK. H8213) along the

Kotanbetsu River, and loc. RK1007b3 (GK. H8214) in the Kamino-sawa. A considerable specimen (GK. H8215) from loc. RH5132c1 in the Chimei-zawa.

Remarks.—*Protexanites* (*Miotexanites*) *minimus* MATSUMOTO (1970) is monotypic. Its holotype (GK. H5166) is 52.5 mm in diameter and its inner whorl is also illustrated down to 5 mm in whorl height. Still younger part is not well shown. The specimens obtained from the Haboro and Kotanbetsu areas are mostly smaller than that inner whorl. However the narrow umbilicus, weak tubercles, the whorl sections and sutural pattern of these specimens are similar to those of inner whorls of the holotype. Therefore they are tentatively identified with *P. (M.) minimus*.

There are two types of ornamentation: the ornate form (e.g. GK. H8207, 8208) and the smooth form (e.g. GK. H8210, 8214). Both of them have relatively coarse and strong rectiradiate lateral ribs and ventrolateral tubercles on inner whorls. The former has weak but distinct ribs and ventrolateral tubercles on the outer whorl, while the latter is nearly smooth. There are no difference of stratigraphic distribution between the two forms.

Measurements (in mm).—

specimens	D	U	U/D	H	B	B/H
GK. H8204	12.5	4.1	.33	4.9	4.8	.98
(-180°)	—	—	—	3.9	3.8	.97
GK. H8207	13.8	5.8	.42	4.9	4.4	.90
GK. H8208	12.2	4.5	.32	4.6	4.0	.87
GK. H8209	(12.0)	(4.7)	(.39)	—	—	—
(-180°)	—	—	—	3.5	3.3	.94
GK. H8212	7.2	2.3	.32	3.7	3.3	.89
GK. H8213	13.8	5.8	.42	5.3	4.5	.85
GK. H8214	10.5	3.3	.31	4.7	3.4	.72
(-180°)	—	—	—	3.2	3.0	.94

D: diameter, U: umbilicus, H: whorl-height, B: whorl-breadth

Occurrence.—The described specimens occurred in claystone and siltstone calcareous nodules of the middle and upper parts of the Middle Haborogawa Formation and the lower part of the Upper Haborogawa Formation in the Haboro and Kotanbetsu areas.

Genus *Haboroceras* gen. nov.

Type-species.—*Haboroceras haboroense* sp. nov. to be described below.

Generic diagnosis.—Shell small, discoidal and rather evolute with a somewhat narrow umbilicus. Whorl subquadrangular in coastal section and somewhat higher than broad.

Shell ornamented with faint, prorsiradiate and flexuous ribs, with frequent bifurcation or intercalation and with strong projection on venter, and tuberculation less developed. Entire ventral keel slightly undulated in correspondence with the ribbing.

Sutural pattern of collignoniceratid type, and pseudoceratitic.

Haboroceras haboroense sp. nov.

Pl. 29, Figs. 3a-e

Material.—Holotype (GK. H8216) and another specimen (GK. H8217) are obtained from loc. RH1200f and 1204a, a road cut on the Sakasagawa Forest Road; collected by T. MATSUMOTO, M. NODA, S. UCHIDA and S. TOSHIMITSU. Some other specimens came from loc. RH1219a (GK. H8218) in the Sakasa-gawa, loc. RH4069a (GK. H8219) in the Otodo-zawa, and loc. RH5047c7 (GK. H8220, 8221), RH5049c4 (GK. H8222) and RH5086e2 (GK. H8223, 8224) in the Chimei-zawa. Another conferable specimen (GK. H8225) from loc. RO1047b along the Jugosen-zawa.

Description.—Shell very small, discoidal and rather evolute. Whorl somewhat higher than broad in the younger stage and much higher in the late stage. Venter gently arched, passing through the slant and blunt ventrolateral shoulders to the slightly convex or nearly flat and parallel flanks, and umbilical shoulder abruptly rounded, low wall surrounding somewhat narrow umbilicus.

Shell ornamented with very faint, prorsiradiate and flexuous ribs, with frequent bifurcation or intercalation on inner flank, and with strong projection on venter; median keel slightly undulated in correspondence with constriction and an associated flare runs near the apertural margin in the holotype. Constrictions may be marked on the earlier part of the body-chamber or even on the phragmocone. Umbilical tubercles faintly bullate and somewhat elevated at the umbilical shoulder, but other tubercles undeveloped. Ventral keel bordered by narrow and shallow furrows on both side.

Sutural pattern collignoniceratid and pseudoceratitic with undeveloped incision (Pl. 29, Fig. 3e). Lateral lobe (L) broad, shallowly incised toward the umbilicus but secondary lateral lobe (U2) very small. Lateral saddles massive and low.

Measurements (in mm).—

specimens	D	U	U/D	H	B	B/H
GK. H8216	19.2	6.7	.35	7.2	4.6	.64
(-180°)	—	—	—	6.0	4.0	.67
GK. H8217	—	—	—	5.5	3.7	.67
GK. H8218	—	—	—	3.3	3.2*	.97
GK. H8219	—	—	—	5.0	3.8	.76
GK. H8220	14.4	5.0	.35	5.6	4.2	.75
(-180°)	—	—	—	4.3	4.0*	.93
GK. H8222	11.7	3.7	.32	5.2	3.8	.73
(-180°)	—	—	—	3.6	2.8	.78
GK. H8223	(13.9)	(4.4)	(.32)	(6.3)	(3.8)	(.60)
(-180°)	—	—	—	4.1	3.6	.88
GK. H8224	12.9	3.8	.29	5.8	4.2	.72
(-180°)	—	—	—	3.9	3.0	.77

(Symbol*=x2)

Remarks.—This species resembles the above-mentioned young shell of *Protexanites* (*Miotexanites*) *minimus*, but is distinguished in having smoother inner whorls and less incised suture, and a constriction near the apertural margin.

Haboroceras haboroense is similar to *Lymaniceras planulatum* MATSUMOTO (1970, p. 31, pl. 6, figs. 1–2, pl. 7, figs. 1–5, pl. 8, figs. 1–8) from the uppermost Turonian in central Hokkaido, but the latter has more distinct ventrolateral tubercles and more finely serrated median keel. *L. planulatum* show a remarkable variation in the strength of ornaments, and the weakly ornamented specimens (MATSUMOTO, 1965, pl. 6, figs. 1–2) are closely similar to *H. haboroense*. Therefore this species may be a homeomorphy of *L. planulatum*.

Occurrence.—Most of the examined specimens occurred in claystone and siltstone restrictedly in the middle part of the Upper Haborogawa Formation of the Haboro area. A specimen which is to be called *Haboroceras*(?) cf. *H. haboroense* was obtained from claystone of the uppermost part of the Middle Haborogawa Formation along the Jugosen-zawa.

Haboroceras sp. aff. *H. haboroense* sp. nov.

Pl. 28, Figs. 5a–d

Material.—Two specimens (GK. H8226, 8227) from loc. RH2873b5 in the Shimizu-zawa.

Remarks.—Only two small fragmentary specimens are available for this study. Their ribs on the body chamber are somewhat coarser and stronger and their whorls are broader than those of *Haboroceras haboroense*. Tuberculation is undeveloped. Their suture pattern resembles that of *Haboroceras haboroense*. Thus these two specimens are allied to *Haboroceras haboroense*, but cannot be identified with it.

Measurements (in mm).—

specimens	D	U	U/D	H	B	B/H
GK. H8226	—	—	—	4.1	3.2	.78
GK. H8227	—	—	—	3.1	2.5	.81

Occurrence.—The above-mentioned two specimens occurred from claystone calcareous nodule in the upper part of the Middle Haborogawa Formation.

Genus *Submortonicer* SPATH, 1921

Explanation of Plate 29

Fig. 1. *Submortonicer* sp. cf. *S. condamyi* COLLIGNON

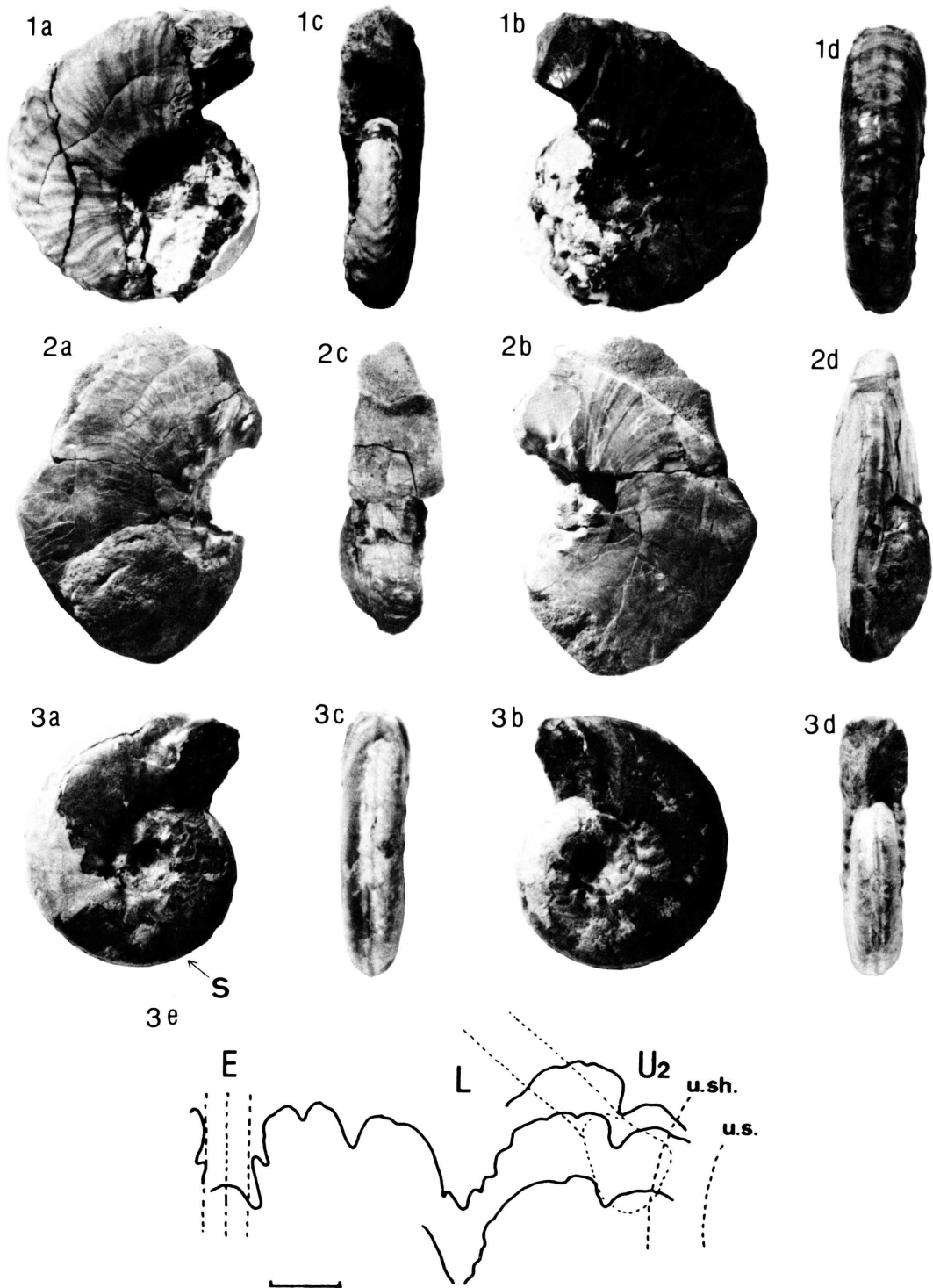
GK. H8228 from loc. RH7013a, a road-cut on the Simofutamata Forest Road, collected by Y. KANIE and S. T. Lateral views (a, b); frontal view (c); ventral view (d). $\times 1$.

Fig. 2. *Metaplacenticer* *subtilistriatum* (JIMBO)

GK. H8249 from loc. KTG043a in the Gakkono-sawa in the Saku area. Lateral views (a, b); cross-section (c); ventral view (d). $\times 1$.

Fig. 3. *Haboroceras haboroense* sp. nov.

GK. H8216, holotype, from loc. RH1200f, a road-cut on the Sakasagawa Forest Road, collected by T. MATSUMOTO, M. NODA, S. UCHIDA and S. T. Lateral views (a, b); ventral view (c); frontal view (d), $\times 2$; suture line (e), scale bar=1 mm. S indicates the position of the suture line sketched.



Submortonicerias sp. cf. *S. condamyi* (COLLIGNON, 1932)

1932. *Mortonicerias condamyi* COLLIGNON, *Ann. Paléont.*, vol. 9, p. 36, pl. 5, fig. 3-3b.
1948. *Submortonicerias condamyi*, (COLLIGNON); COLLIGNON, *Ann. Géol. Serv.*, vol. 13, p. 100, pl. 18(12), fig. 2-2b, pl. 15, fig. 1.
1980. *Submortonicerias condamyi* s. l. (COLLIGNON); KLINGER and KENNEDY, *Ann. S. Afr. Mus.*, vol. 80, p. 260, figs. 200a, 201-209, 212-213.
Pl. 29, Figs. 1a-d

Material.—A specimen (GK. H8228) from loc. RH7013a, at a road-cut on the Shimofutamata Forest Road; collected by Y. KANIE and S. TOSHIMITSU. A specimen (GK. H8229) from loc. RH7302a1, at a road-cut on the Nakafutamata-goe Forest Road.

Remarks.—The specimens obtained in the Haboro area are small, but their weak ornamentation and whorl sections agree to those of *Submortonicerias*. COLLIGNON (1948a, b) established many species of this genus in Madagascar, and MATSUMOTO (1959) suggested COLLIGNON's species may be grouped into a small number of species. KLINGER and KENNEDY (1980) described *Submortonicerias woodsi* s. l. (SPATH) and *S. condamyi* s. l. of Zululand, and pointed out that some of COLLIGNON's species are synonyms of these species. Although there are a few differences between the two specimens, GK. H8228 and 8229, that is, the former has a wider whorl section and stronger ribs than the latter, their narrow umbilicus ($U/D=30\%$) is compatible with that of *S. condamyi* s. l. As the crenulated venter observed in the Haboro specimens has not been reported in Zululand and Madagascar specimens, the former may be differentiated from the latter. But the characters of the young stage of the specimens from Zululand and Madagascar have not been described. Under these circumstances, the two specimens from Haboro are tentatively referred to *S. condamyi*.

Measurements (in mm).—

specimens	D	U	U/D	H	B	B/H
GK. H8228	42.0	12.5	.30	19.0	13.0	.68
GK. H8229	—	—	—	11.1	9.5	.86
(-180°)	—	—	—	5.3	4.3	.81

Occurrence.—These two specimens occurred in siltstone calcareous nodules in the middle part of the Upper Haborogawa Formation along the Detofutamata-gawa, Haboro.

The repositories of the above mentioned specimens are: Geological Collections, Kyushu University, Fukuoka [GK], and Uchida Specimen Room, Iwamizawa [USR].

VII. Conclusion

(1) The Cretaceous Upper Yezo Group exposed in the Haboro area consists of the Lower, Middle and Upper Haborogawa Formations, which are also recognized in the northerly adjacent Chikubetsu and the southerly neighbouring Kotanbetsu and Obira areas.

(2) Through the biostratigraphic study of the Middle and Upper Haborogawa Formations, the following conclusions are made:

a) These formations can be divided into four zones by means of inoceramids, i.e., in ascending order, the *Inoceramus uwajimensis*—*I. mihoensis* Zone, the *I. amakusensis* Zone, the *Platyceramus japonicus* Zone, the *Sphenoceramus orientalis* Zone and *S. schmidtii* Zone. The subzone of *S. sanrikuensis*—*S. cristatus*—*Inoceramus* (*Cordiceramus*) *kanmerai* can be established in the upper main part of the *P. japonicus* Zone.

b) The succession from the middle part of the Middle Haborogawa Formation to the middle part of the Upper Haborogawa Formation is divisible into two zones on the basis of texanite ammonites, i.e. the zone of *Texanites collignoni*—*T. quinquenodosus* below and the zone of *Plesiotexanites kawasaki*—*P. pacificus* above. The latter may further be subdivided into two or three subzones of *Texanites amakusensis* lower, the subzone of *Protexanites bontanti shimizui*—*P. fukazawai* and/or the subzone of *Submortonicerias* cf. *condamyi* in ascending order.

c) The zone of *Texanites collignoni*—*T. quinquenodosus* is correlated with the Lower Santonian, and the base of the *Inoceramus amakusensis* Zone is very close to or nearly at the same level as that of the zone of *T. collignoni*—*T. quinquenodosus*.

d) Taking the occurrences of *Submortonicerias* cf. *condamyi*, and *Menabites mazenoti* into consideration, the *Platyceramus japonicus* Zone should be assigned to the Lowest Campanian. This correlation is also supported by the occurrence of *Globotruncana arca*, provided that the first appearance of this species is recognized as a criterion of the base of the Campanian.

e) The *Inoceramus uwajimensis*—*I. mihoensis* Zone indicates the Coniacian Stage. Only the *Inoceramus amakusensis* Zone represents the Santonian Stage in Japan. The *Platyceramus japonicus* Zone and the subzone of *Sphenoceramus sanrikuensis*, *S. cristatus* and *I. (C.) kanmerai* represent the Lowest Campanian, whereas the *Sphenoceramus orientalis* Zone and *S. schmidtii* Zone indicate the Lower Campanian.

(3) A large number of molluscan fossils were obtained from the study area. Palaeontological descriptions were given on some selected species of the inoceramid bivalves and the texanite ammonoids. Among them, three new inoceramid species, i.e. *Sphenoceramus cristatus*, *S. haboroensis* and *S. kiritachiensis* were established on the specimens from the Lowest Campanian, and one texanite ammonoid came from the upper part of the Santonian and the lowest part of the Campanian was described as a new genus and new species, *Haboroceras haboroense*.

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Appendix

Figures (7-27) and Tables (1-8)

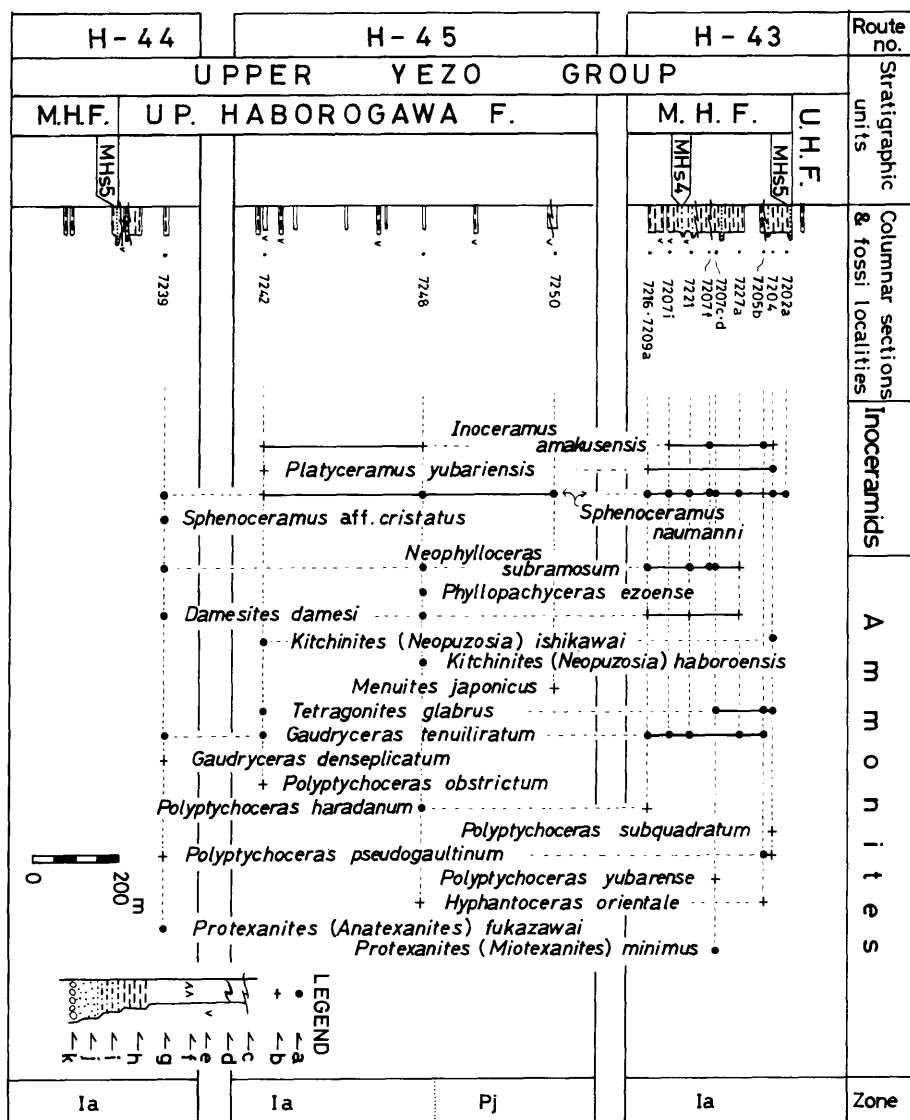


Fig. 7. Biostratigraphic successions of the Upper Yezo Group along the Pisshirizawa in the Haboro area, Hokkaido. Route numbers are shown in Figs. 2, 3. Put prefix RH on each locality number.

Ia: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone

legend; a: point of occurrence of fossils, b: point of occurrence of incomplete fossil specimens to be compared to the noted species, c: fault, d: slump bed, e: tuff or tuffite, f: fine-grained volcanic debris bed, g: claystone, h: siltstone, i: alternation of sandstone and mudstone, j: sandstone, k: conglomerate

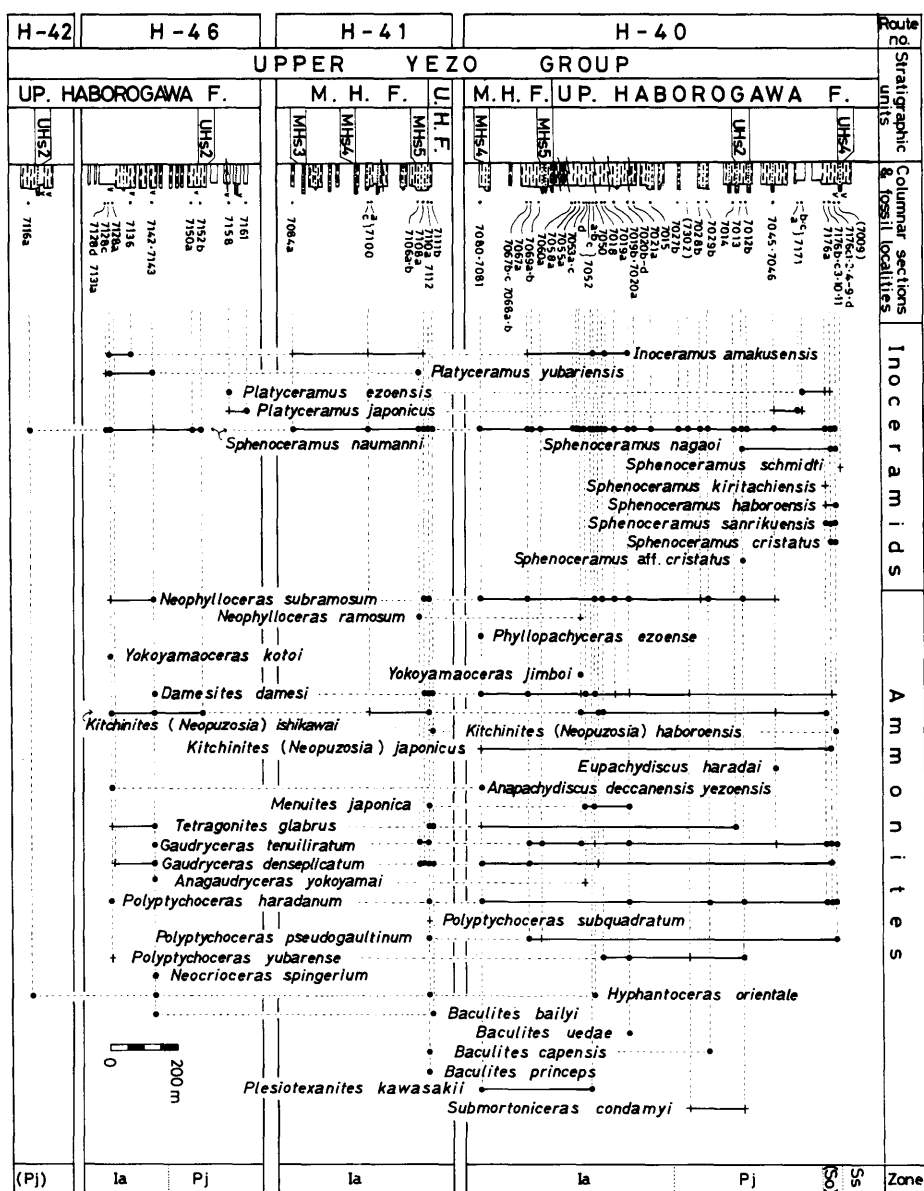
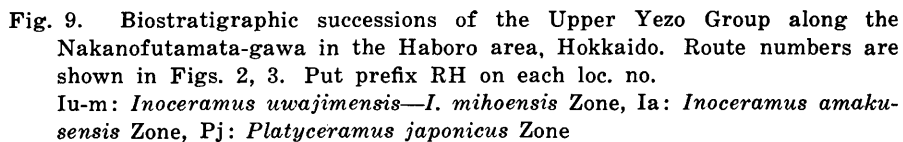


Fig. 8. Biostratigraphic successions of the Upper Yezo Group along the Deto-futamata-gawa in the Haboro area, Hokkaido. Route numbers are shown in Figs. 2, 3. Numbers in parentheses show inferred horizon from the neighbouring route. Put prefix RH on each loc. no.

Ia: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone, So: *Sphenoceramus orientalis* Zone, Ss: *S. schmidt* Zone



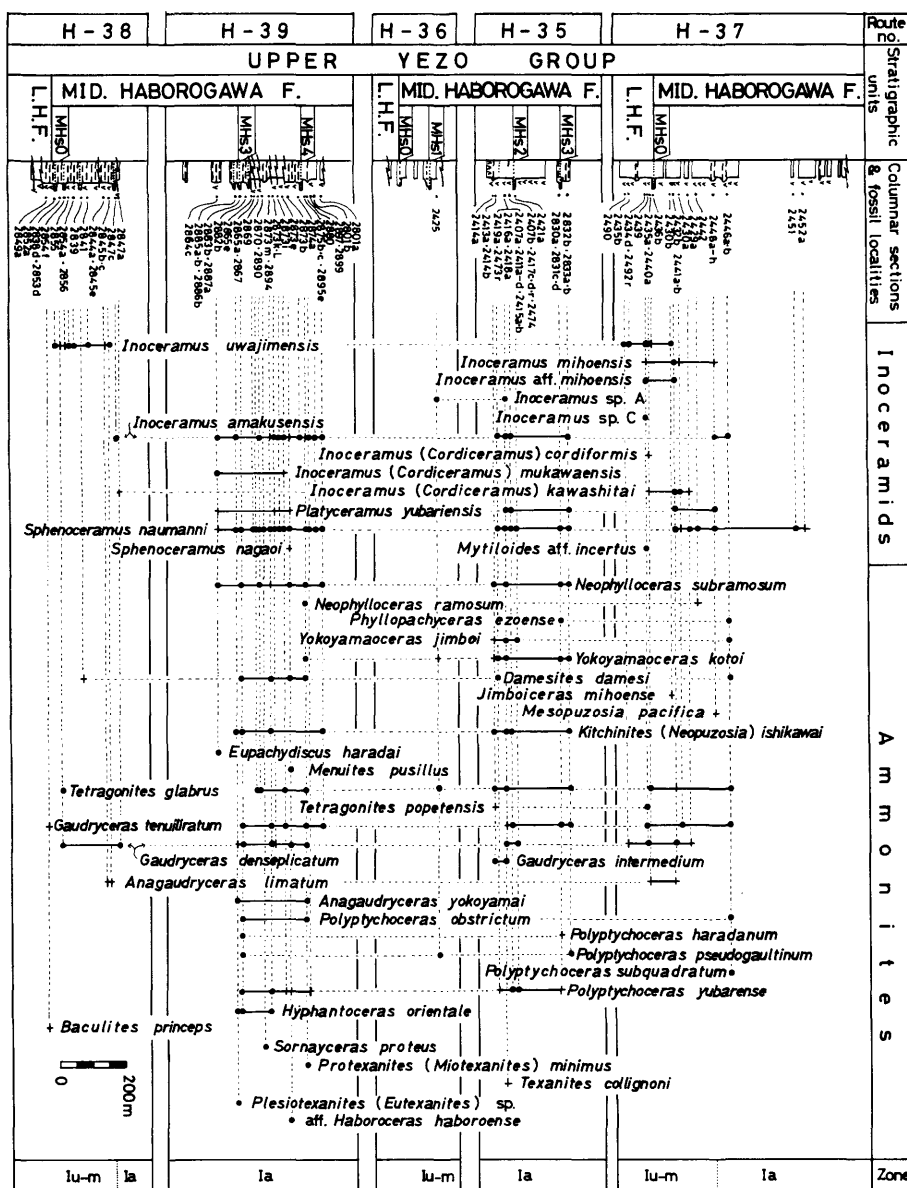


Fig. 10. Biostratigraphic successions of the Upper Yezo Group along the Machiyoi-zawa and Shimizu-zawa in the Haboro area, Hokkaido. Route numbers are shown in Figs. 2, 3. Put prefix RH on each loc. no.

lu-m: *Inoceramus uwajimensis*—*I. mihoensis* Zone, la: *I. amakusensis* Zone

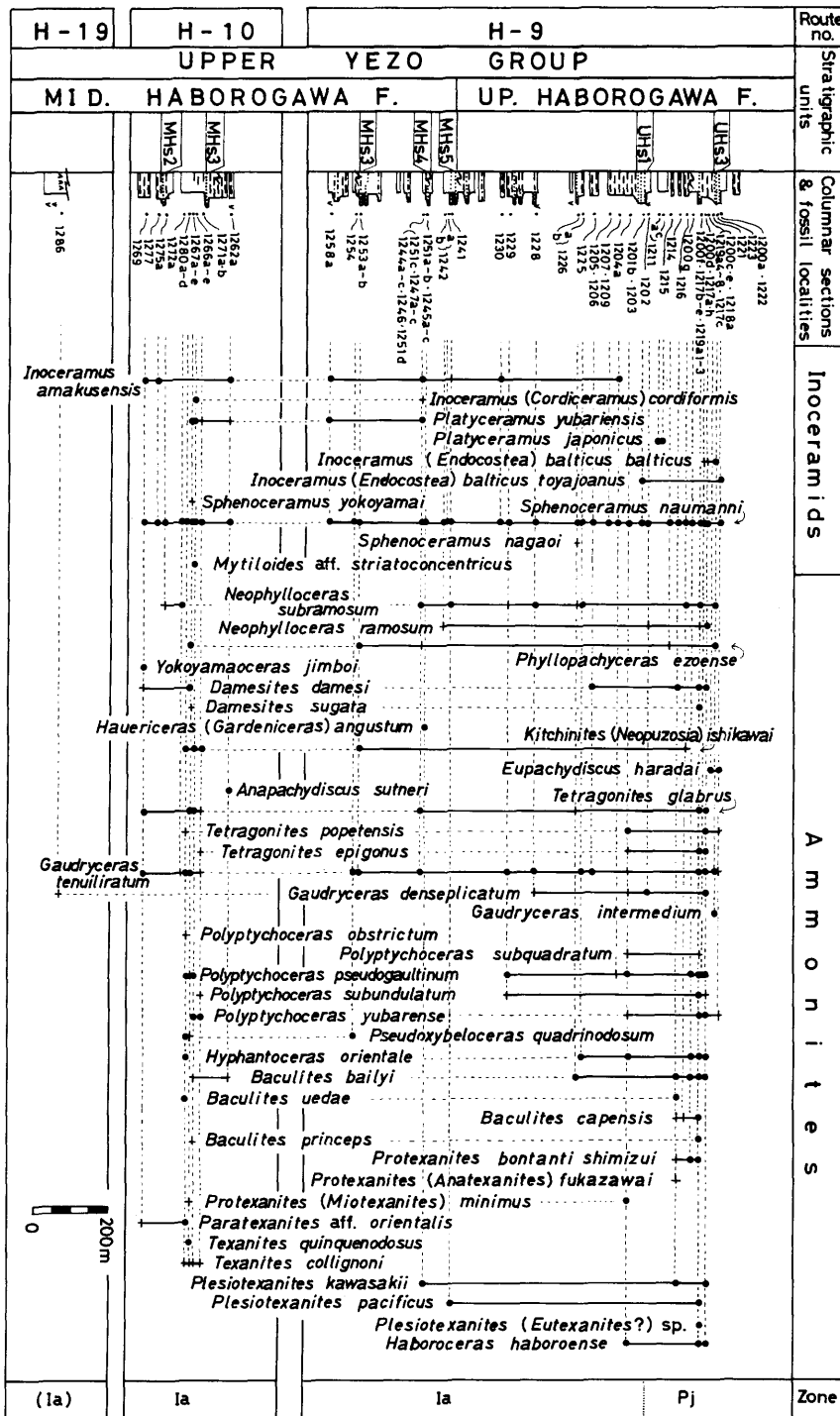


Fig. 11. Biostratigraphic successions of the Upper Yezo Group along the Sakasa-gawa in the Haboro area, Hokkaido. Route numbers are shown in Figs. 2, 3. Put prefix RH on each loc. no.

1a: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone

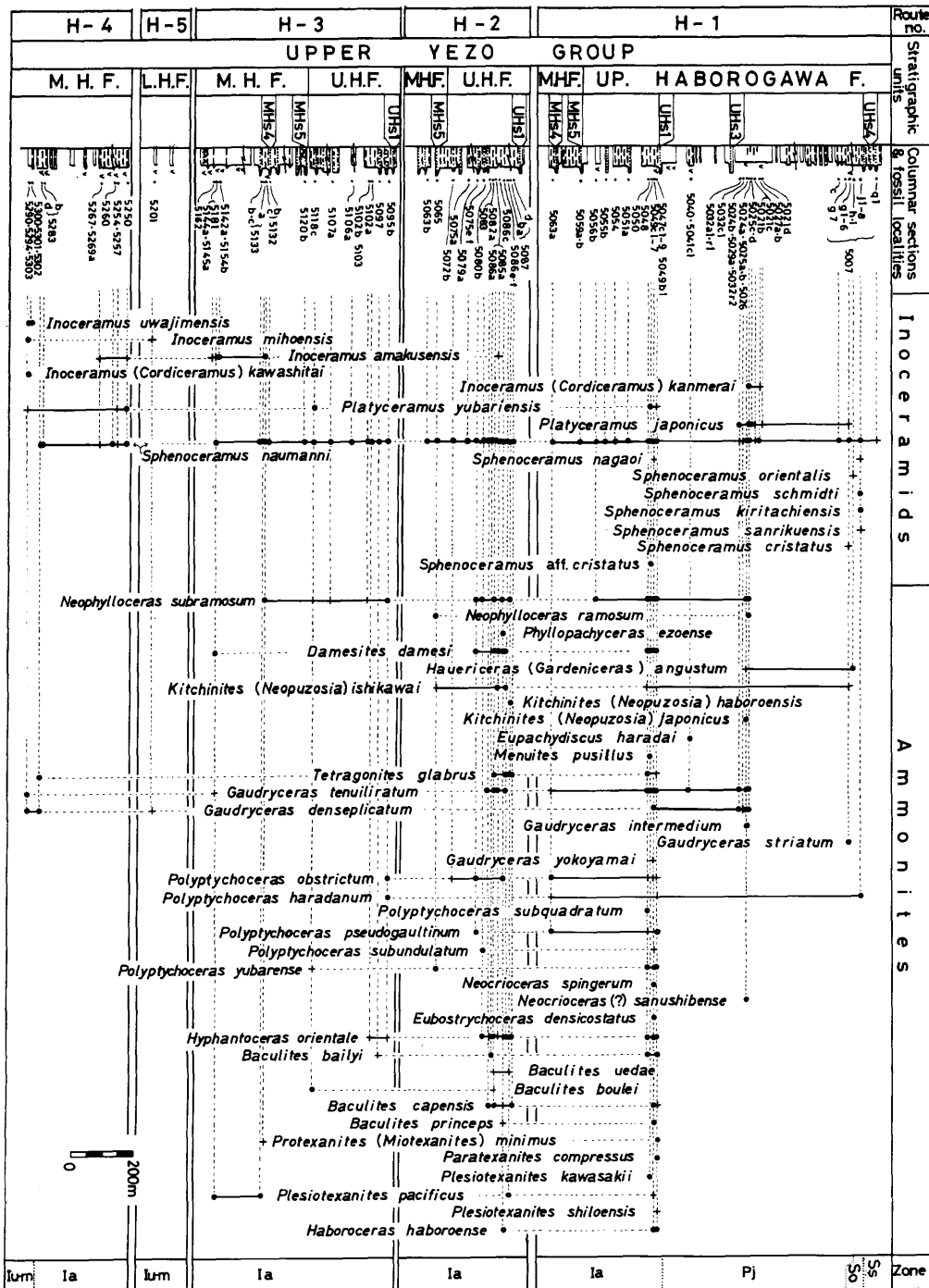


Fig. 13. Biostratigraphic successions of the Upper Yezo Group along the Chimei-zawa in the Haboro area, Hokkaido. Route numbers are shown in Figs. 2, 3. Put prefix RH on each loc. no.

Iu-m: *Inoceramus uwajimensis*—*I. mihoensis* Zone, Ia: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone, So: *Sphenoceramus orientalis*, Ss: *S. schmidt* Zone

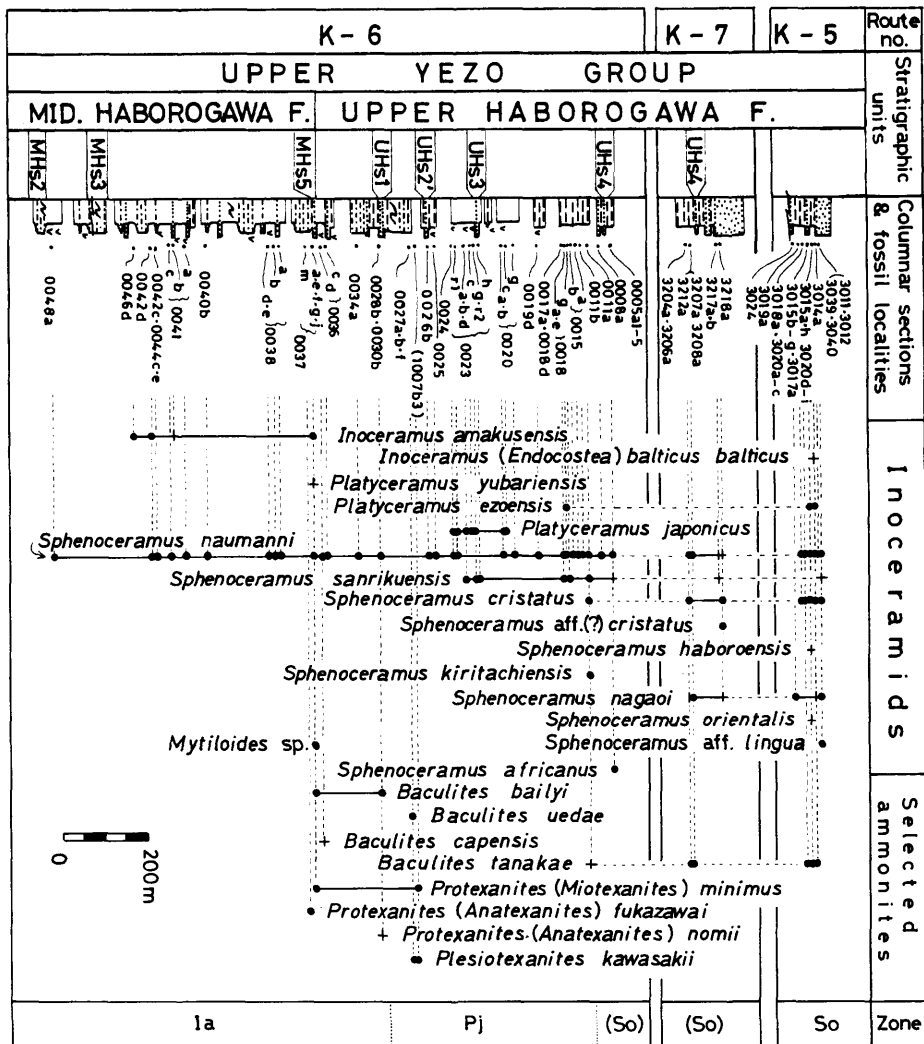


Fig. 14a. Biostratigraphic successions of the Upper Yezo Group along the Kotanbetsu River, Hokkaido. Route numbers are shown in Figs. 2, 3. Put prefix RK on each loc. no.

1a: *Inoceramus amakusensis* Zone Pj: *Platyceramus japonicus* Zone, So: *Sphenoceras orientalis*, Ss: *S. schmidtii* Zone

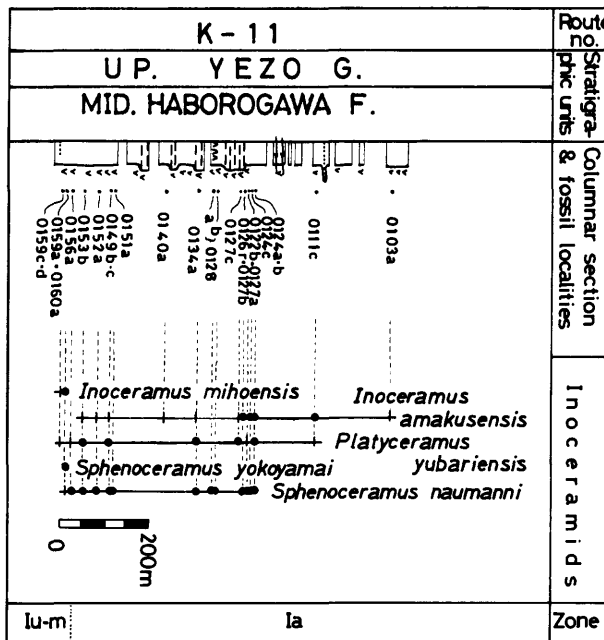


Fig. 14b. Biostratigraphic successions of the Upper Yezo Group along the Futamata-zawa in the Kotanbetsu area, Hokkaido. Route number is shown in Figs. 2, 3. Put prefix RK on each loc. no.

Iu-m: *Inoceramus uwajimensis*—*I. mihoensis* Zone, Ia: *Inoceramus amakusensis* Zone

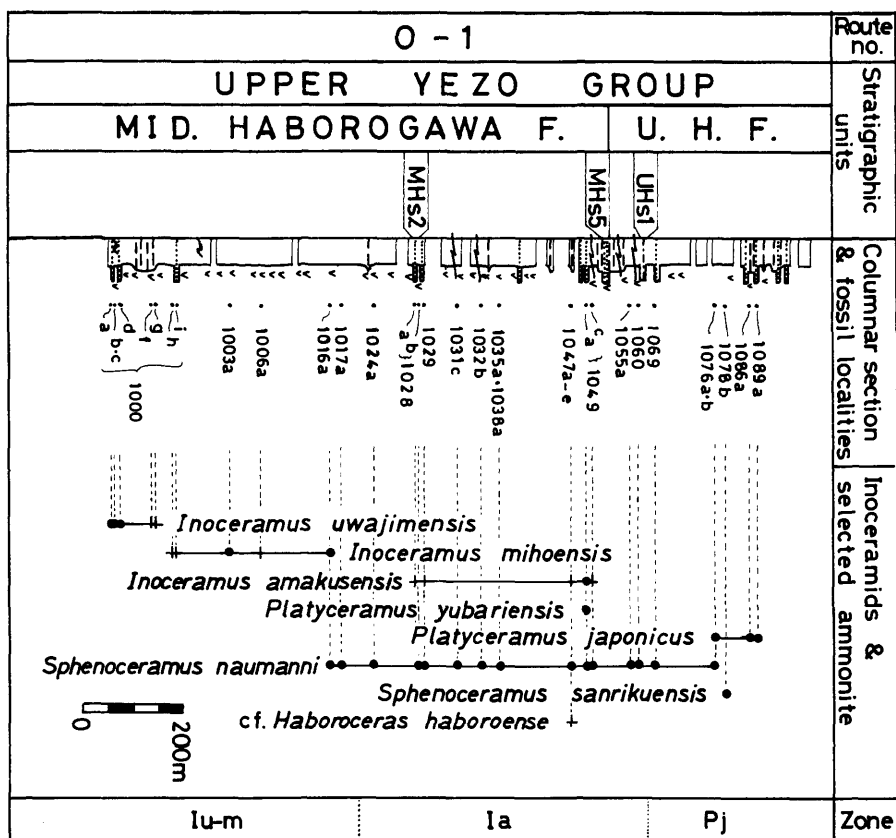


Fig. 15a. Biostratigraphic successions of the Upper Yezo Group along the Jugosen-zawa in the Obira area, Hokkaido. Route number is shown in Figs. 2, 3. Put prefix RO on each loc. no.

Iu-m: *Inoceramus uwajimensis*—*I. mihoensis* Zone, Ia: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone

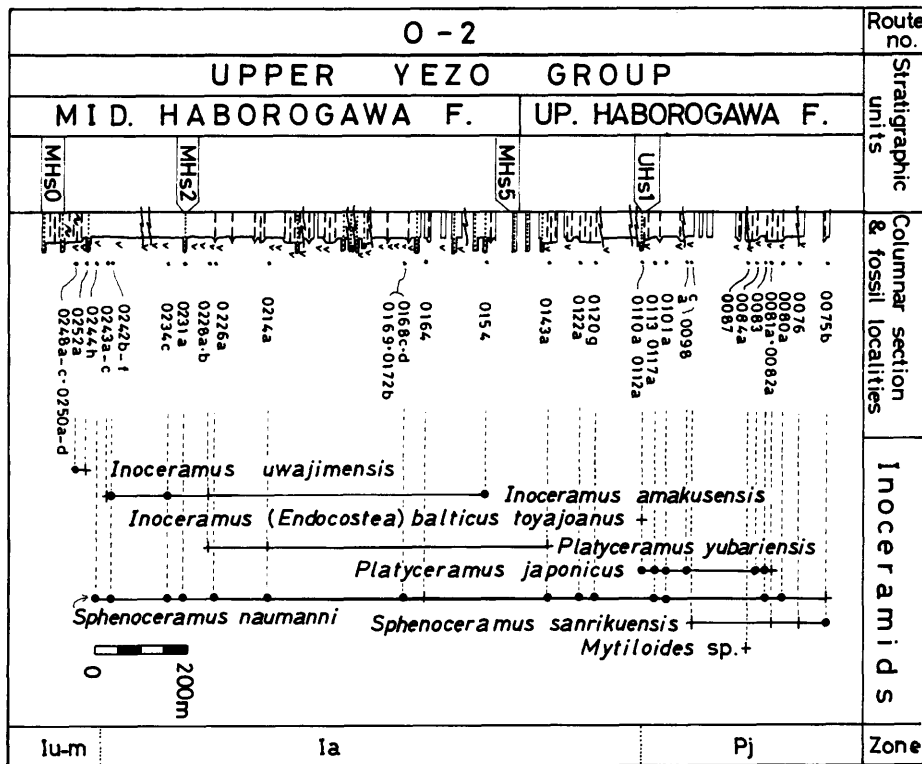


Fig. 15b. Biostratigraphic successions of the Upper Yezo Group along the Akano-sawa in the Obira area, Hokkaido. Route number is shown in Figs. 2, 3. Put prefix RO on each loc. no.

Iu-m: *Inoceramus uwajimensis*—*I. mihoensis* Zone, Ia: *Inoceramus amakusensis* Zone, Pj: *Platyceramus japonicus* Zone

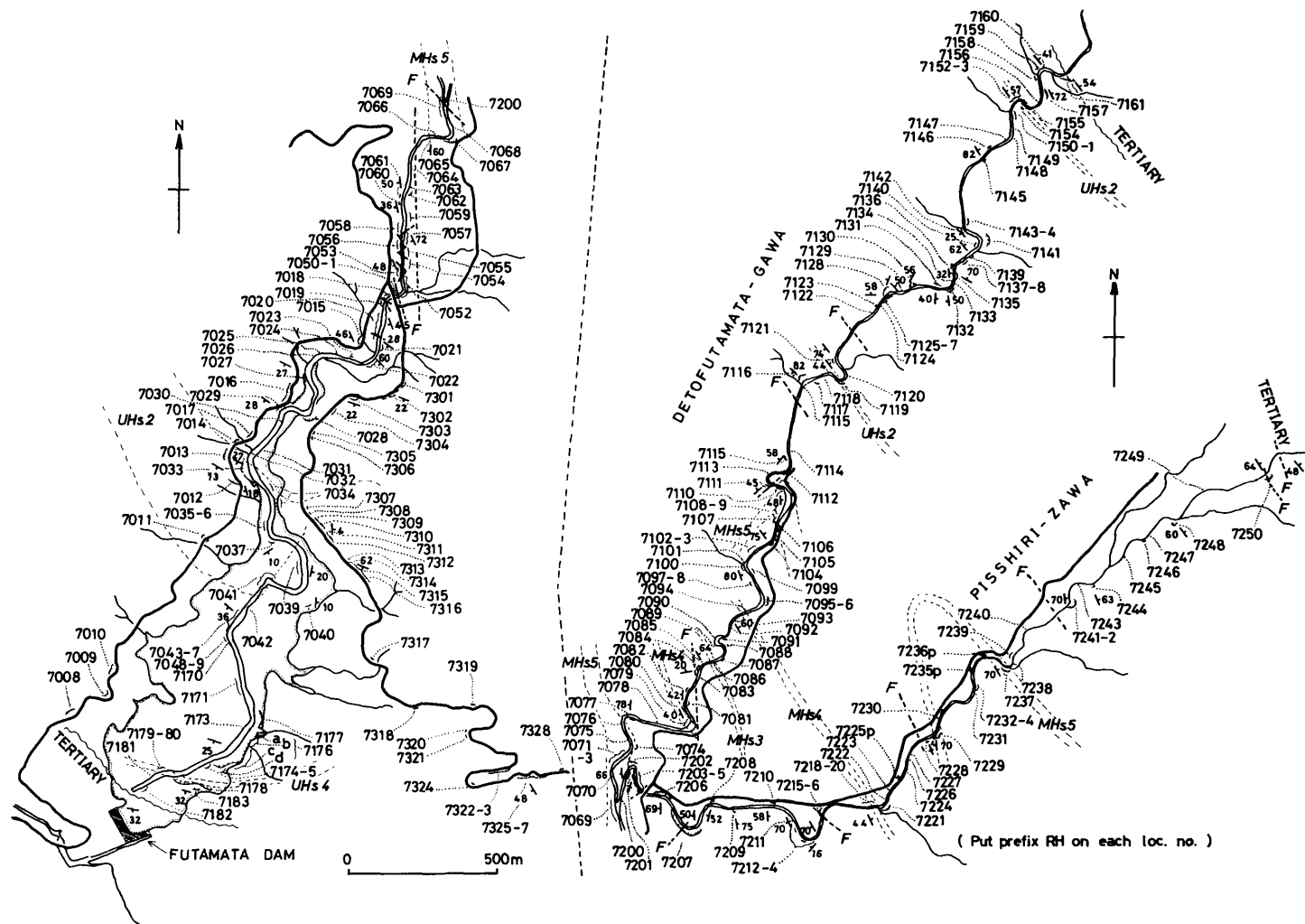


Fig. 16. Route map along the Detofutamata-gawa in the Haboro area. *F'*: fault

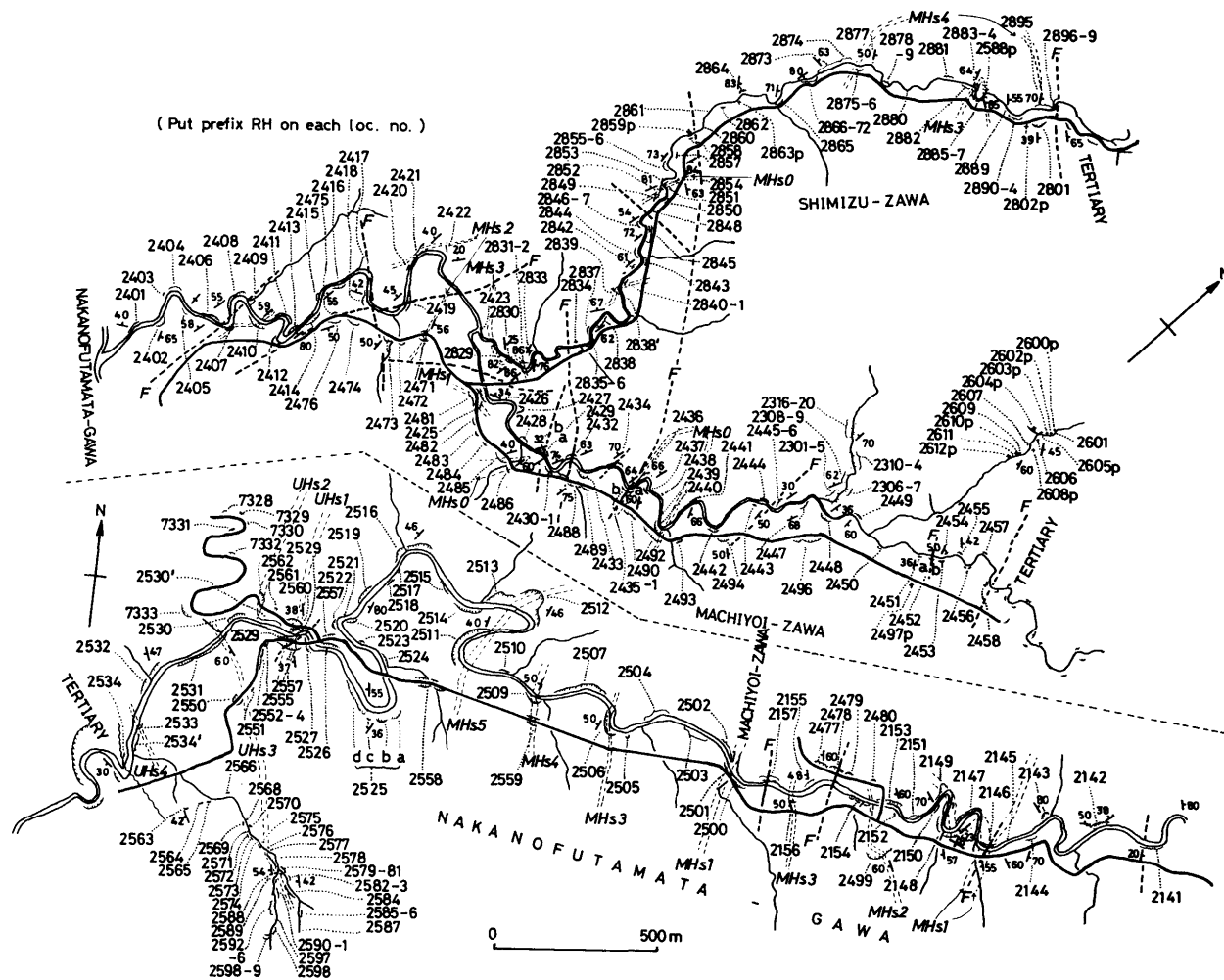


Fig. 17. Route map along the Nakanofutamata-gawa in the Haboro area.

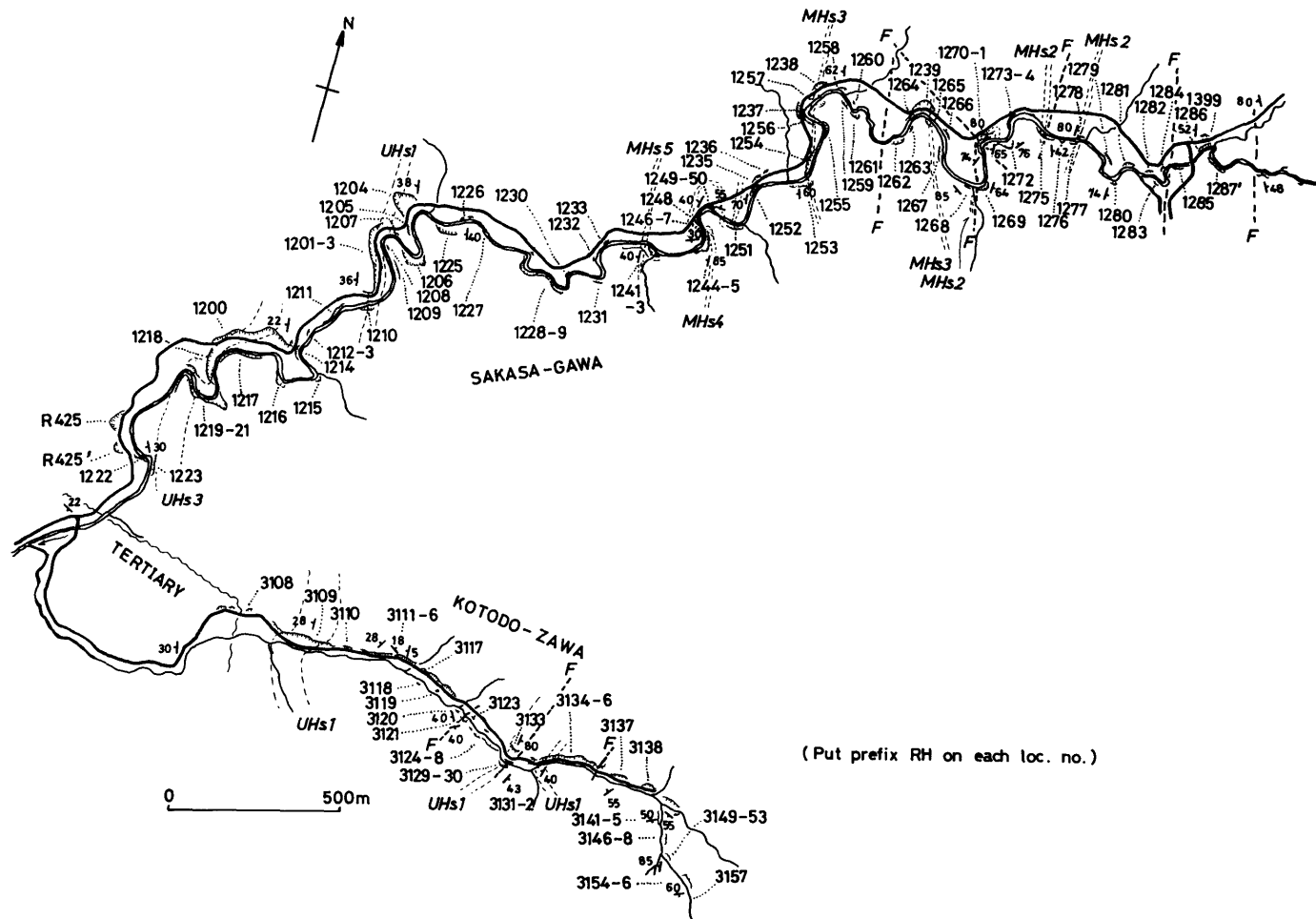


Fig. 18. Route map along the Sakasa-gawa in the Haboro area.

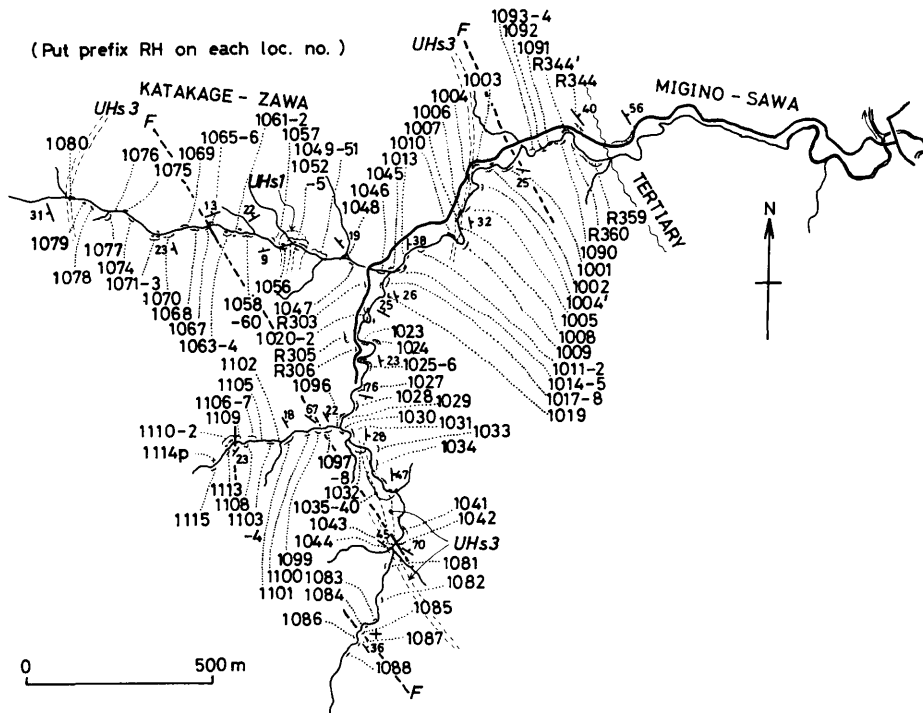


Fig. 19. Route map along the Migino-sawa in the Haboro area.

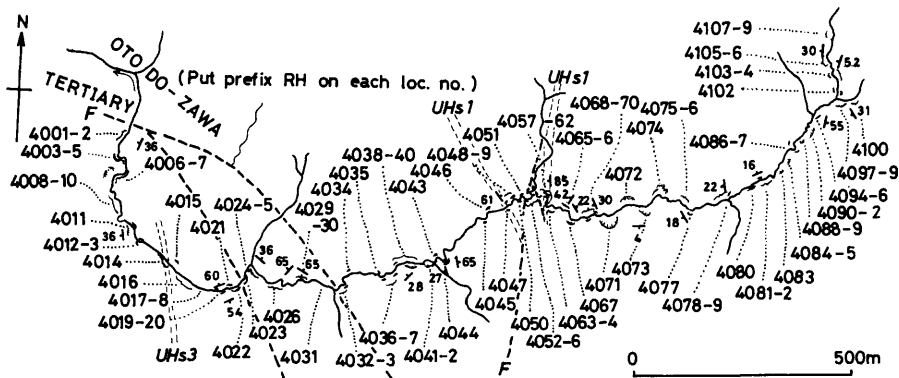
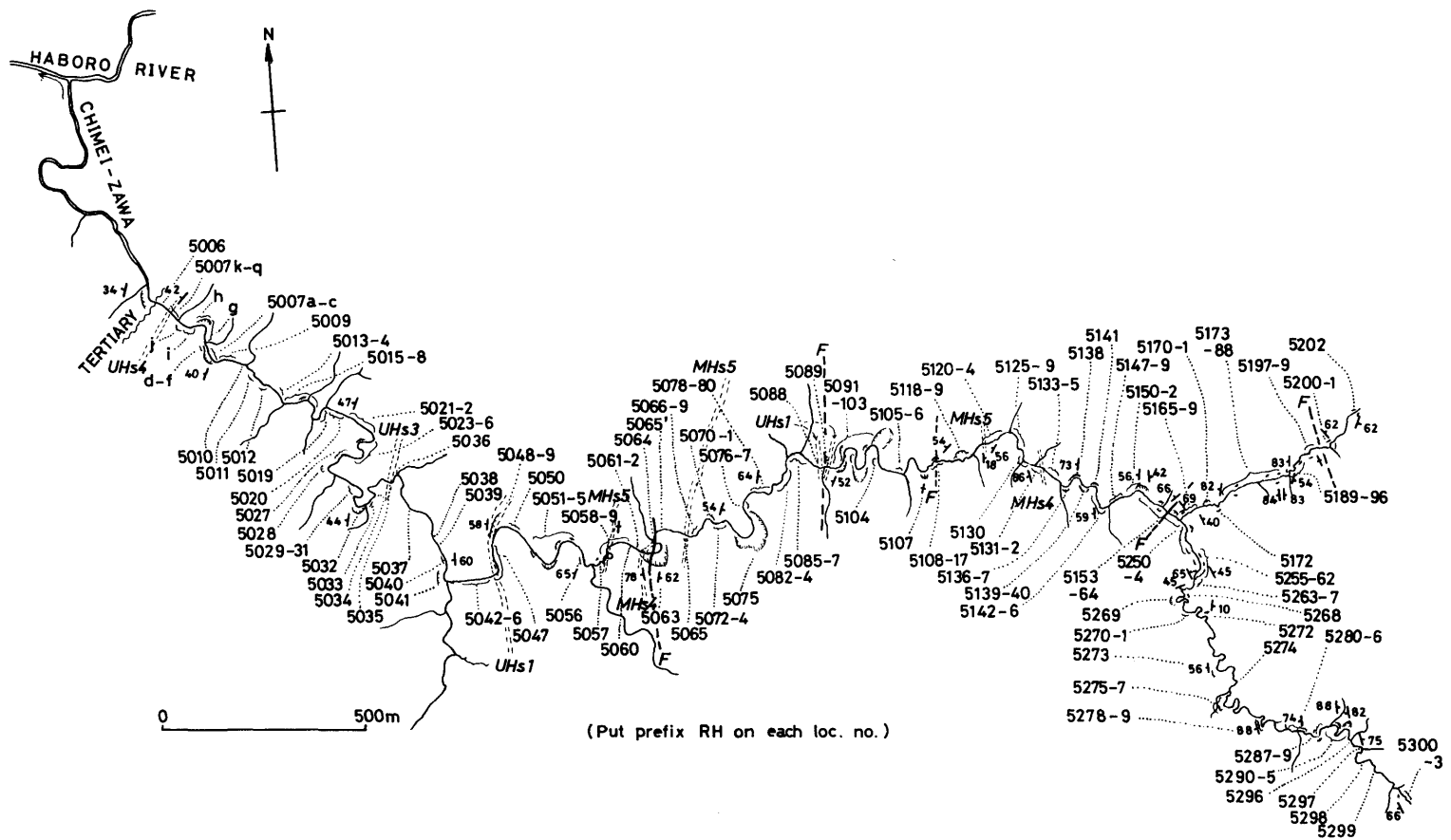


Fig. 20. Route map along the Otodo-zawa in the Haboro area.



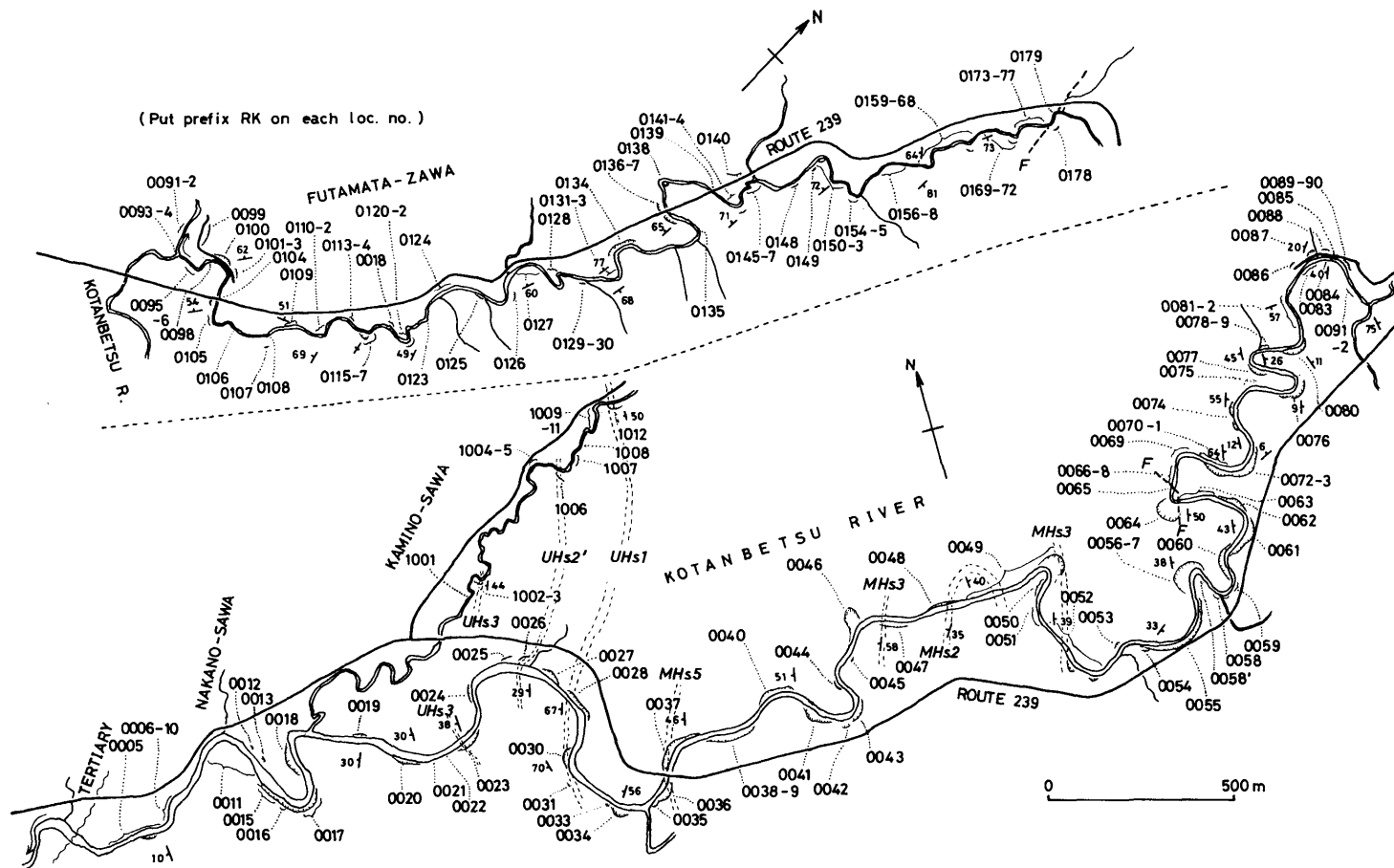


Fig. 22. Route map along the Kotanbetsu River.

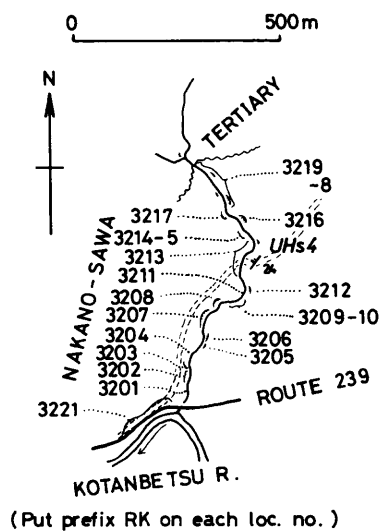


Fig. 23. Route map along the Nakano-sawa in the Kotanbetsu area.

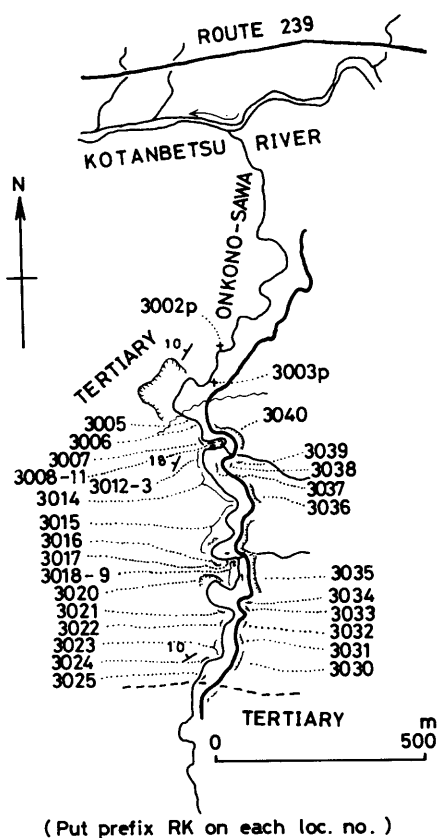


Fig. 24. Route map along the Onkono-sawa in the Kotanbetsu area.

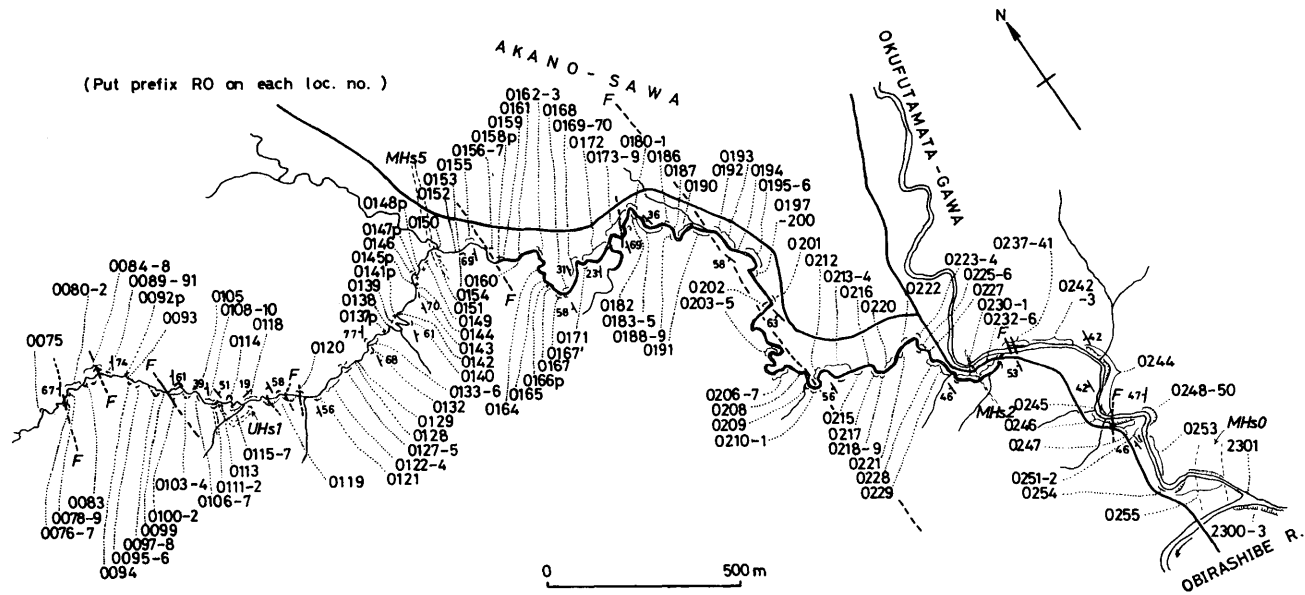


Fig. 25. Route map along the Akano-sawa in the Obira area.

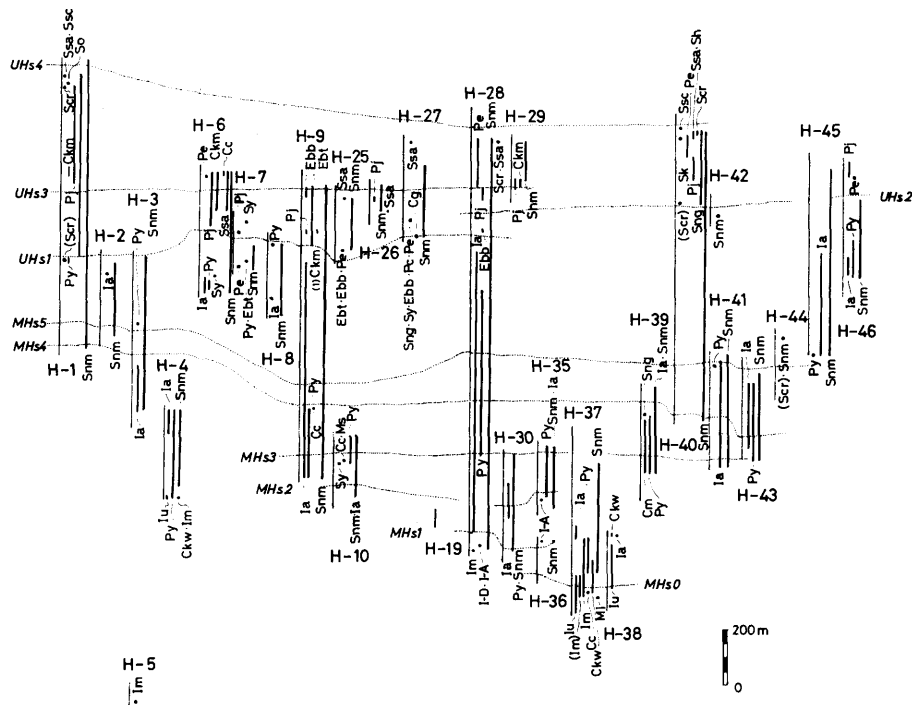


Fig. 27a. Compiled inoceramid successions of the Upper Yezo Group in the Haboro area, Hokkaido. (1) is horizon of specimens collected by OKADA and MATSUMOTO (1969).

Iu: *Inoceramus uwajimensis*, Im: *I. mihoensis*, (Im): *I. aff. mihoensis*, I-A: *I. sp. A*, I-C: *I. sp. C*, I-D: *I. sp. D*, Ia: *I. amakusensis*, Cc: *I. (Cordiceramus) cordiformis*, Cm: *I. (C.) mukawaensis*, Ckw I. (*C.*) *kawashitai*, Ckm: *I. (C.) kanmerai*, Ebb: *I. (Endocostea) balticus* s.s., Ebt: *I. (E.) balticus toyajoanus*, Py: *Platyceramus yubariensis*, Pe: *P. ezoensis*, Pj: *P. japonicus*, Sy: *Sphenoceramus yokoyamai*, Snm: *S. naumanni*, Sng: *S. nagaoi*, So: *S. orientalis*, Ssc: *S. schmidtii*, Sk: *S. kiritachiensis*, Sh: *S. haboroensis*, Saf: *S. africanus*, Ssa: *S. sanrikuensis*, Scr: *S. cristatus*, (Scr): *S. aff. cristatus*, Mi: *Mytiloides aff. incertus*, Ms: *M. aff. striatoconcentricus*

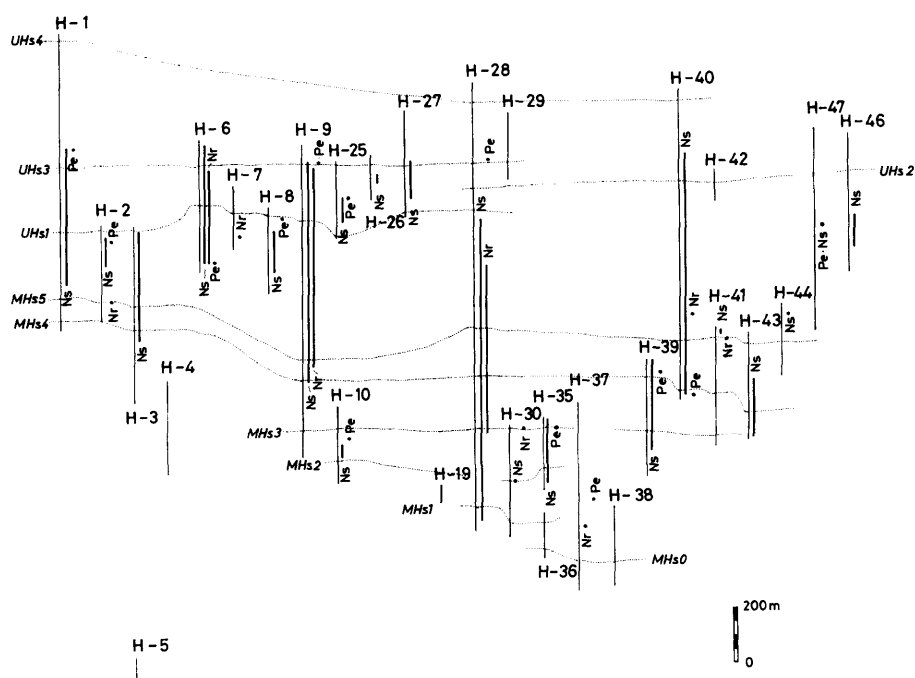


Fig. 27b. Compiled phylloceratid ammonoid successions in the Upper Yezo Group of the Haboro area, Hokkaido.

Nr: *Neophylloceras ramosom*, Ns: *N. subramosum*, Pe: *Phyllopachyceras ezoense*

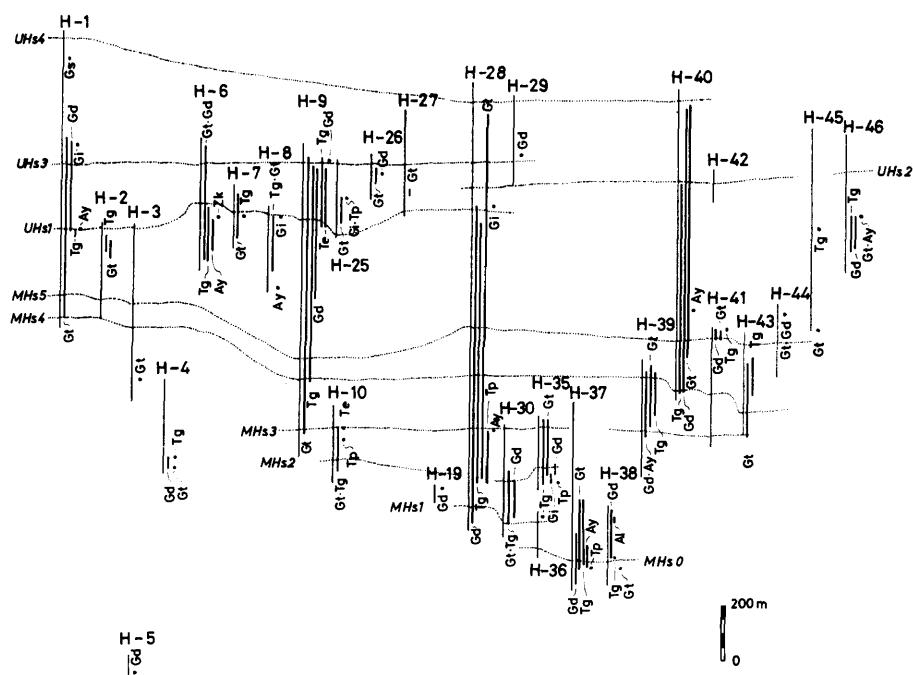


Fig. 27c. Compiled tetragonitid ammonoid successions in the Upper Yezo Group of the Haboro area, Hokkaido.

Tg: *Tetragonites glabrus*, Tp: *T. popetensis*, Te: *T. epigonus*, Zk: *Zelandites kawanoi*, Gt: *Gaudryceras tenuiliratum*, Gd: *G. denseplicatum*, Gi: *G. intermedium*, Gs: *G. striatum*, Al: *Anagaudryceras limatum*, Ay: *A. yokoyamai*

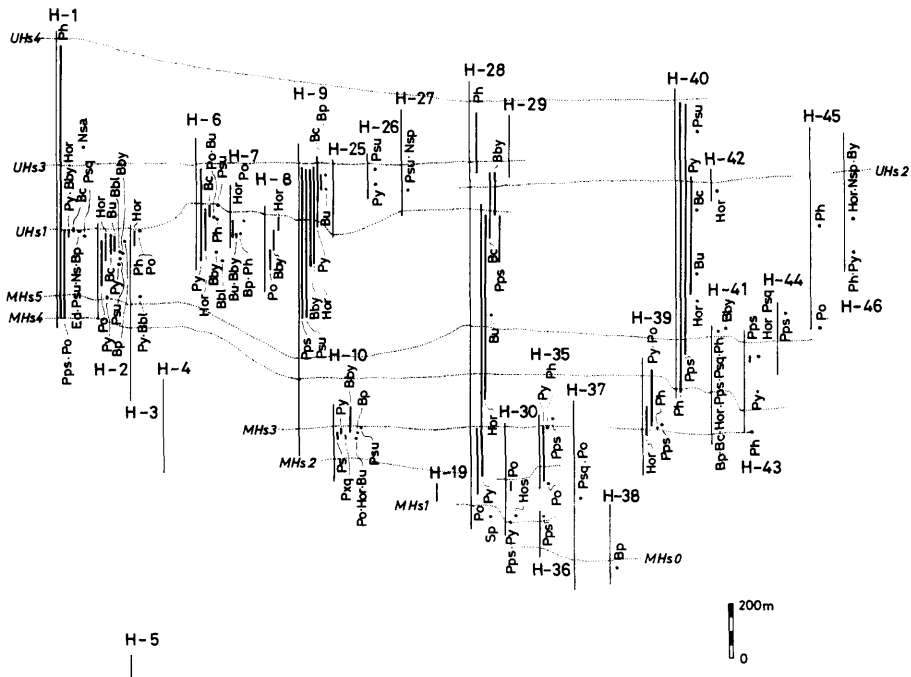


Fig. 27d. Compiled heteromorph ammonoid successions in the Upper Yezo Group of the Haboro area, Hokkaido.

Bby: *Baculites bailyi*, Bu: *B. uedae*, Bbl: *B. boulei*, Bc: *B. capensis*, Bp: *B. princeps*, Hos: *Hyphantoceras oshimai*, Hor: *H. orientale*, Ed: *Eubostrioceras densicostatus*, Nsp: *Neocrioceras spingerum*, Nsa: *N. (?) sanushibensis*, Pxq: *Pseudoxylloceras quadrinodosum*, Po: *Polyptychoceras obstrictum*, Ph: *P. haradanum*, Psq: *P. subquadratum*, Pps: *P. pseudogaultinum*, Psu: *P. subundulatum*, Py: *P. yubarensense*, Sp: *Scaphites pseudoequalis*.

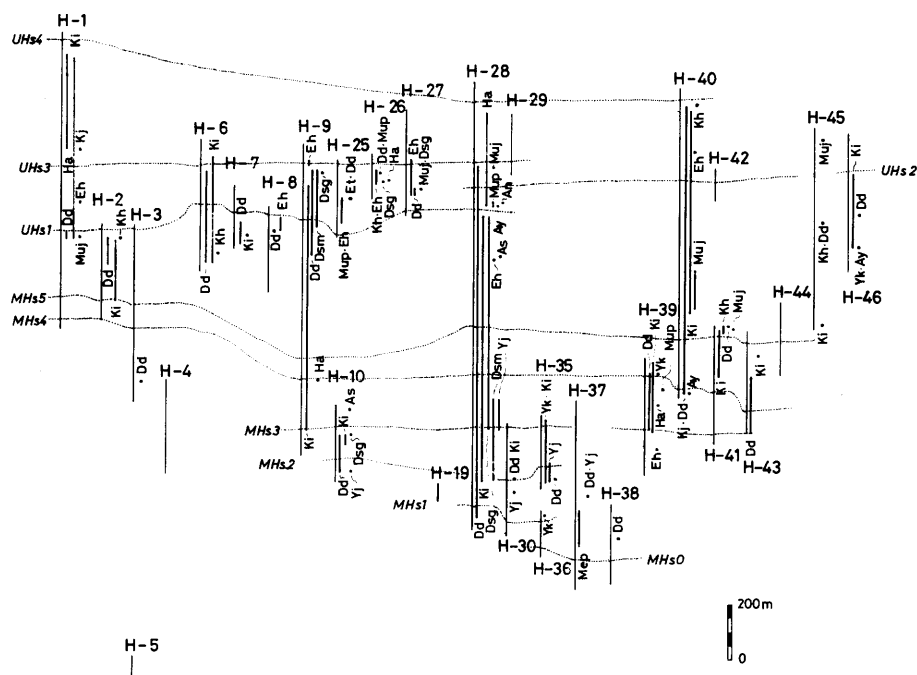


Fig. 27e. Compiled desmoceratacean ammonoid successions in the Upper Yezo Group of the Haboro area, Hokkaido.

Jm: *Jimboiceras mihoense*, Mep: *Mesopuzosia pacifica*, Ki: *Kitchinites ishikawai*, Kh: *K. haboroensis*, Kj: *K. japonicus*, Dd: *Damesites damesi*, Dsm: *D. semicostatus*, Dsg: *D. sugata*, Ha: *Hauericeras angustum*, Yk: *Yokoyamaoceras kotoi*, Yj: *Y. jimboi*, As: *Anapachydiscus sutneri*, Ay: *A. deccanensis yezoensis*, An: *A. naumanni*, Muj: *Menuites japonicus*, Mup: *M. pusillus*, Eh: *Eupachydiscus haradai*, Et: *E. teshioensis*

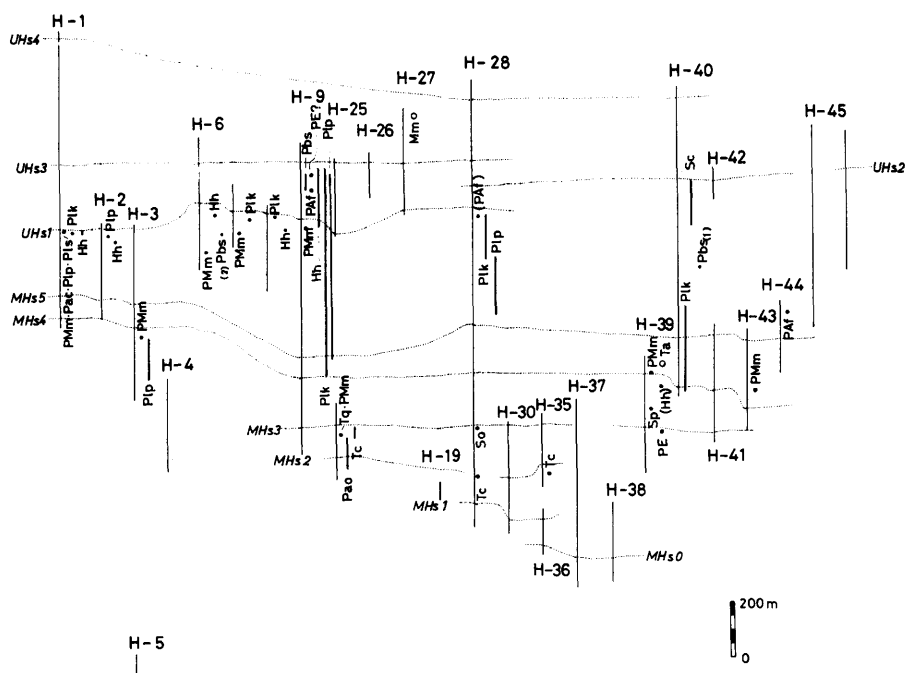


Fig. 27f. Compiled texanite ammonoid successions in the Upper Yezo Group of the Haboro area, Hokkaido. Open circles are inferred horizon of floated nodules. (1) is adopted from MATSUMOTO and HIRANO (1976), (2) from MATSUMOTO (1970) and (3) from MATSUMOTO and TAKAHASHI (1986).

Sp: *Sornayceras proteus*, So: *S. omorii*, Pbs: *Protexanites bontanti shimizui*, Paf: *P. fukazawai*, (Paf): *P. aff. fukazawai*, PMm: *P. minimus*, Pao: *Paratexanites aff. orientalis*, Pac: *P. compressus*, Plk: *Plesiotexanites kawasaki*, Plp: *P. pacificus*, Pls: *P. shiloensis*, PE: *P. (Eutexanites) sp.*, Tq: *Texanites quinquenodosus*, Tc: *T. collignoni*, Ta: *T. amakusensis*, Sc: *Submortoniceras condamyi*, Hh: *Haboroceras haboroense*, (Hh): *Haboroceras, aff. haboroense*, Mm: *Menabites mazenoti*

Table 1. List of inoceramids and ammonites from the Upper Yezo Group in the Haboro area.

Species	Locality
<i>Inoceramus uwajimensis</i> Yehara	2430b2, 2434d1, (d2), dr1, (dr2); 2435(a1), b1; (2439); 2440a1, (a3); 2441c; 2490; 2492r1; 2841; 2845c1, (e1); 2852a; (2853d); 2854a1, a2, a3, a4, (f1); (2855); (2856); (5278); (5300); (5301); 5302; 5303
<i>Inoceramus mihoensis</i> Matsumoto	(2430a); (2434dr1); 2441(a), b; (2448a); 2500e; (5201); (5290b1); 5294(a1), a2
<i>Inoceramus</i> sp. aff. <i>I. mihoensis</i> Matsumoto	2432b; 2434d3
<i>Inoceramus</i> n. sp. A	2415a; 2425c; 2500c
<i>Inoceramus</i> n. sp. C	2434dr1
<i>Inoceramus</i> n. sp. D	2500a
<i>Inoceramus amakusensis</i> Nagao and Matsumoto	1205b2; 1230; (1241b); 1246; 1258a; 1262a; 1269a2, r1; 1277; 2153a1; 2154a, b; (2401); 2407(a2), (b); 2413a; (2414b); 2416a1; 2417r1; 2419a1; 2446a2; 2448b, (c); 2474; (2478b); 2480a; 2499ar1; (2501a); 2506a, (c); 2507(a1), d1; (2527); 2801a, b; 2832b1; 2833a1; (2847c2); 2864c1, (c3); 2869; 2873(b2), (b4), e1, i1, k1, Ll, (m1); 2874a; (2875c1); 2885b1; 2895e1; 3147'; (4079); 4095(a), b; (4099); 4102; (5086a1); (5132e1); (5142a1); (5145a); 5154b1; (5162); (5181); 5250(a1), (a3); 5252p1; (5269a); 7019a; 7020b2; 7052b; (7068a1); (7084a); 7100(c1), (c2); (7108a1); 7128c2; 7136a; (7204); 7205b1; 7207f1, (i2); (7242b1); (7248b1)
<i>Inoceramus</i> (<i>Cordiceramus</i>) <i>cordiformis</i> Sowerby	(1247a1); 1266d; (2439); (4006a); (4007b); (4027p1); 7176crl
<i>Inoceramus</i> (<i>Cordiceramus</i>) <i>mukawaensis</i> Nagao and Matsumoto	2507d1; 2864c3; (2873e1)
<i>Inoceramus</i> (<i>Cordiceramus</i>) <i>kawashitai</i> Noda	(2429a); (2430a); 2432b; (2439); (2441a); 2847(a1); 5290c1, c2
<i>Inoceramus</i> (<i>Cordiceramus</i>) <i>kanmerai</i> Toshimitsu	R303p; 2565p1; 2584r1; (2585a); 2589a; 2591a; (4004a); 4007c; 4010c; (4010'p1); 4016a; (4019b1); 4023(b1), c1, cr; 5025a; (5027b)
<i>Inoceramus</i> (<i>Cordiceramus</i>) <i>gilberti</i> White	1052b
<i>Inoceramus</i> (<i>Cordiceramus</i>) sp.	2442; 2800p2; (2581a); 2845e2; (2854f1); 5301
<i>Inoceramus</i> (<i>Endocostea</i>) <i>balticus balticus</i> Bohm	1025g; (1060c); (1200d); (1219a6); 1223(a1), d1; 2533p1; 2560a3, (b1); 2581p2
<i>Inoceramus</i> (<i>Endocostea</i>) <i>balticus toyajonus</i> Nagao and Matsumoto	1060a; 1200a; 1203; (3126)
<i>Inoceramus</i> (<i>Endocostea</i>) sp.	1200f, (r3); 1202r8; (1219a4); 3130
<i>Platyceramus yubariensis</i> (Nagao and Matsumoto)	1247a3; 1251d; (1258a); (1262a); 1266a, d; 1267d; (1271a); 2148e1, e2, f1; 2149a; 2153a2; (2154b); 2156a; (2407a1); 2411d; 2417c; 2441a; 2448(a), b; 2499ar1; 2506(c), (e1), (e2); 2507a3, (d1); 2512; 2516d; 2525dr; 2832b1; (2864c3); 2873(b4), (k1); 3126; 3134c1; 4046p; 4082; 4102; 5047c7, c8; 5048b; 5118c1, c2; 5250a1; (5254); (5294a2); 7106a1; 7128c2; (7131a); 7142a2; 7204; (7209a3); (7242b1)
<i>Platyceramus ezoensis</i> (Yokoyama)	(1025c); 1060c; (2531a); 2532d; (3126); 4006b; 7158; 7171b; 7176(a4), (b4)
<i>Platyceramus cycloides</i> (Wegner)	(1025b)
<i>Platyceramus japonicus</i> (Nagao and Matsumoto)	(R303p); 1009r1; 1019a; 1025b, c; 1027a; 1029c; (1082); 1202r1, r2, r3, r4, r6; 1211a, c; 2530a; 2531a, b1, b3; 2575a; 2578a; 2585a; 2589a; 3109r1; 3130; 4004b; 4005; 4007(a), b; 4010b; 4010'p1; 4016a, p4; (4022a1); 4023a1; 4025(a1), a2; 4026a2; 4027p1; (4031p); 4032; (4042); 4044; 4048c, d; 4049; 4056a, b; (5007g4); 5021b, (d); (5024a1); 5025b2, (c), d; (5026); 5032a1; (7046b); (7158); 7161a; 7171(a1), a2, (c2); 7301; 7302; (7318)
<i>Platyceramus</i> sp.	1222b; 2417b, r1; (7136d)

Put prefix RH on each loc. no., () : cf., p: floated sample

Table 2. Continued.

Species	Locality
<i>Sphenoceramus yokoyamai</i> (Nagao and Matsumoto)	(1025c); (1267c); (3108b2); (4082)
<i>Sphenoceramus naumanni</i> (Yokoyama)	(R303p); 1003a, b, c, d; 1009(a), b; 1019a; 1025b, c, d, g; 1027(a), b; 1028a, b; 1029a, b, c; 1031a, b; 1032a; 1034a; 1042a; 1045a, b; 1052a, b; 1060a, (b); 1070a, b, c, e; 1079; (1082); (1094); 1097a, b; 1099; 1109; 1110; 1111; 1115b; 1200a, c1, c2, d, e1, e2, f, g, r1, r4, r5; 1202d, r5, r7, r9; 1203; 1204a, (r5); 1205a; 1206c; (1207); 1209; 1214a, b; 1215; 1216a, (b); 1217c, d, e, h, i; 1218a1, a2; 1219a1, a3, a4, a5, a6, a8; 1222a; 1225a, b; 1226a1, b1; 1228a, g, h1; 1229a, b; 1230; 1241a, b; 1242a, b; 1244a, b, c; 1245a, b; 1246; 1247a1, a2, a3, (b), c; 1251a, b1, b2, b3, c1, c2, c3, c4, d; 1253a1, a2, a3, b2; 1254b; 1258a; 1262a; 1266a, b, d, e; 1267a, b, c, d; 1269a1, (a2); 1271a, b; 1272a; 1275a; 1277; 1280a, c, d; 1248e1, e2, f1; 1249a; 1250a; 1253a2; 1254b; 1256a, b; 2402a; 2405; 2406a; 2407a1; 2411a, d; 2413a; 2414b; 2415a, b; 2417c, d; 2419a; 2421a; 2425c; 2429a; (2430a); 2432b; 2441a; 2442; 2448c; 2451; (2452a); 2473r; (2474); 2478a; 2499a1; 2500a, (c), (d), e; 2506c, d; 2507a1, a3, d1; 2508a; 2511b, c, d, e, f, g, h1, k1; 2516a, d; 2518p1; 2520a, b; 2526d; 2530a, b, c, d, e, f; 2531b1, b3; 2532b, (f), i; 2533p1; 2556c1, f1, f2; 2560a1, b1; (2564a); 2565p1; 2575a; (2581p2); 2801a; 2802p1; 2830a; 2831c1, d1; 2832b1; 2833a2, b1; (2864c3); 2865a1, e1; 2867; 2869; 2873b2, b3, b4, b5, e1, i, k1, L1; 2875c1; 2880; 2882b1; 2883b1, b2, b3; 2885a1; 2886b2; 2887a; 2888p1; 2890; 2894; 2895e1, p1; 2897; 2899; 3109d1, d2, d3, d4, d5; 3114; 3120; 3123b; 3126; 3128a; 3129b; 3134c1, (c2), c3, c4; 3135a, b, c; 3137; 3138; 3147; 3155; 4005; (4007b); 4010a, c; 4011(a1), br; (4016a); (4021a1); 4022a1; 4023(c1), (cr); 4025a1; 4026a1; 4031p; 4032; 4042; 4046p; 4052p1; 4061; 4062; 4063; 4065; 4069a, b; 4072a; 4073; 4074, p; 4080a; 4082; 4095a; 4099; 4102; 4103; (4106); 4109; 5007c1, c2, g2, g3, j2, j5, (j7), (q1); (5021c); 5024a1, b; 5025b; 5027b; (5029a); 5032a1, (c1), (r1), r2; 5047c1, c2, c3, c4, c5, c6, c7, c8, c9; 5048b; 5049b1, c1, c2, c4, c5; 5050; 5051a; 5054a, b; 5055b1; 5056b; 5059a1, (b1); 5063a2, a3, a4, b1; 5065b, c, d; 5072b1; 5075a1, e1, f1, f2; 5079a1, a2; 5080b1; 5082a1, a2, a3; 5083; 5085a; 5086a1, c1, e1, e2, f1; 5087a1, b1, d2; 5095b1, b2; 5097; 5102a3, b1, b2; 5103; 5106a; 5107a1; 5118c1, c2; 5120b1, b2; 5132b1, c1, (c2); 5133a1, a2, a3, b2; 5152; 5181; 5250a1, a2; (5256); 5257; 5260; (5267); 5283(b1), b2, (b3), b4, d1; (7011); 7012b; 7013a, b, c; 7014a, r1; 7015a, b; 7018a1, b; 7019a, b2; 7020a2, b1, b2, c, d1, d3; 7021a; 7027b1; 7028b1, b2, b3; 7029b1, (b2), b3; 7045; 7046a, b; 7050a, b; 7052a, b, c; 7053c1; 7055a; 7058a; 7060a; 7067a, b1, b2, c1, c2; 7068a1, a2, b; 7069a, b; 7080a, d, e; 7081a, b, c; 7084a; 7100c1, c2; 7106a, b1; 7108a1; 7110a1, a2; 7111b1; 7112a1, a2, b; 7116a; 7128c2, c3, d1; 7142a1, a2; (7143a); 7150a1, (a3); 7152b1, b2; 7176a1, a2, a3, a4, a5, (b1), b3, b4, (b5), (b6), b7, c2, c3, c4, c5, c6, c7, (c8), c1, d1; 7202a1; 7204, (7205b1); 7207c1, d1, f2, i2; 7209a3; 7216a, b, c, d; 7221a, b1, b2, b3, b4; 7227a; 7239a, b; (7242b1); 7248r1, r2, r3, r4; 7250a; (7301b2); 7302a1; (7310a); 7311b1, (b2)
<i>Sphenoceramus nagaai</i> (Matsumoto and Ueda)	R346p6; (1045a); (1226b1); (2873b3); (5007j2); (5049c1); 7013a, c; (7174a); 7176(b4), b6, c4, (c1); 7302a1
<i>Sphenoceramus orientalis</i> (Sokolow)	(5007h1)
<i>Sphenoceramus schmidt</i> (Michael)	5007j1; (7009a)
<i>Sphenoceramus kiritachiensis</i> sp. nov.	5007j5; (7176a1)
<i>Sphenoceramus haboroensis</i> sp. nov.	7176(a1), c1
<i>Sphenoceramus africanus</i> (Heinz)	2511k1
<i>Sphenoceramus sanrikuensis</i> Matsumoto and Sugiyama	R346p6; R359c, d; 1079; (1109); (1111); 2532f, h; (4010c); (4023c1); (5007j8); 7176a1, a2, b3, (c4), c8, (c1), (c10), c11
<i>Sphenoceramus cristatus</i> sp. nov.	R346p6; 2532i; (5007g1); 7176b7, c4, c1; 7311b1
<i>Sphenoceramus</i> sp. aff. <i>S. cristatus</i> sp. nov.	5049c4; 7013a; 7239a
<i>Sphenoceramus</i> sp.	(2883b1); 4014a; 4074p; 5269a; 7014a; 7020a1; 7111b1; 7128a1; 7158; 7176c2, c1; 7311b1

Table 3. Continued.

Species	Locality
<i>Mytiloides</i> sp. aff. <i>M. incertus</i> (Jimbo)	2434dr1
<i>Mytiloides</i> sp. aff. <i>M. striatoconcentricus</i> (Gumbel)	1266d
<i>Mytiloides</i> sp.	R303p; 1052b; 1099; 1217i; (2417d); (2506d); 2533p1; 2849a; 5049c4; 5050; 7018a1; 7052a; (7132a); 7207d1
<i>Neophylloceras ramosum</i> (Meek)	1200c2, (f); (1202b); 1219a5, a6; (1242b); 2156r1; (2442); 2506c; 2507d1; 2516d; (3126); 4032; 4102; 5065a; (7055a); 7106a
<i>Neophylloceras subramosum</i> Spath	R303p; 1003a, d; 1025d; (1029c); 1060a; 1070e; (1097a); (1110); 1200r5; 1216a; (1217c); 1219a3; 1223d1; 1225b; 1226a1, (b1); 1228a, h1; (1229b); 1241a; 1244(a), c; 1247(a2), (b), c; 1272a; (1275a); 2406a; 2414a; 2419a1; 2473r; 2499ar1; 2500a; 2507d1; (2516a); 2526d; (2556f1); 2581p2; 2801a; 2831c1, (d1); 2832b1; 2864c1; 2869; 2873b4, b5; 2883b3; (2894); 2895e1; (3135c); 3137; (3138); 3147'; 4007b; 4010'p1; 4016a; 4021a1, (a2); (4023cr); 4031p; 4052p1; (4063); 4069a; 4074p; 4095a, b; 4102; 4109; 5024a1; 5025b; 5029a; 5032r2; 5047c1, c2, c5, c6, c7, c9; 5048b; 5049c2, c4; 5050; 5056b; 5075f2; 5079(al), a2; 5085a; 5086e2, f1; 5087b1; 5095b1; (5102b2); (5107a1); (5118c1); 5132c1; 7013a; 7018a1; 7019b2; 7020c; (7028b2); 7029b1; (7046a); 7052b; 7067b2, c1, c2; 7068a1; 7081b, c; 7108a1; 7110a2; 7112a1; (7128c2); 7142a2; 7207c1, f2; 7216a; 7221b1, (b3); (7227a); 7239a; 7248r2
<i>Neophylloceras</i> sp.	1009a; 1027b; 1031a; 1042a; 1060b; 1070a, b; 1099; 1109; 1200d, e2; 1202d, r9; 1203; 1204a; 1229a; 1241b; 1242a; (1251d); 1253a3; 1262a; 1266d, e; 1267a, d; (1271b); 1280a, d; 2153a2; (2411d); (2435a1); 2507a1; 2511d; 2530d; 2873b2, e1, L1; 2883b2; 2885a1; 3108b2, br1; 3109d1, d3; 3114; 3120; 3134c1; 3135b; 4005; 4010; 4011a1, br; 4061; 4065; 4069b; 4082; 4102; 5032r1; 5047c8; 5049b1, c1, c3; (5063a4); 5075f1; 5080b1; 5082a2, a3; 5085a; 5086a1; 5087a1, d2; 5095b2; 5106a; 5152; 5181; 5283d1; 7012a; 7014r1; 7018b; 7028b1; 7050a; 7052a; 7053c1; 7067b1; 7068a2, b; 7110a1; 7111b1; 7112a1; 7128c3, d1; 7142a1; 7150a3; 7152b1, b2; 7176b3, c4; 7204; 7205; 7207d1; 7209a3; 7213; 7216b; 7221b4; 7239b; 7242b1; 7250a; 7302a1; 7311a1
<i>Phyllopachyceras ezoense</i> (Yokoyama)	1070b, e; (1215); 1223d1; (1247b); 1253a3; 1267c; 2446a1; (2531a); 2831c1; 2895e1; (3134c3); (4074p); 4102; 5024a1; 5086e2; 5086f1; 7081c; 7248r2
<i>Phyllopachyceras</i> sp.	1019a; 1025c; 1028a; 1031a, b; 1070a, c; 1097a; 1099; 1200f; 1202r3, r5; 1203; 1204a; 1216b; 1219a6; 1251d; 1266d; 1271b; 2148e2; 2406a; 2414a; 2446a2; 2500b; 2506c; 2511h1; 2530f; 2533p1; 2560b1; 2581a; 2801a; 2873e1; 2894; 2895e1; 3128a; 3134c1, c2; 4016a; 4042; 5007g3; 5025b; 5027b; 5032r1; 5047c5; 5049b1, c5; (5050); 5086e1; 5133b2; 5294a2; 7018b; 7020b1, b2; 7029b3; 7046a, b; 7052a, b; 7053c1; 7055a; 7067c2; 7081b; 7108a1; 7112a1; 7128c2; 7142a1; 7152b2; (7161a); 7176a1; 7207c1, f2, i2; 7227a; 7239a
<i>Anagaudryceras limatum</i> (Yabe)	(2432b); (2439); (2844a); (2845b1)
<i>Anagaudryceras yokoyamai</i> (Yabe)	1241r2; (2506c); 2885a1; 2895e1; (3155); 4069b; 4095a; (5049c2); (7053a1); 7142a1
<i>Anagaudryceras</i> sp.	1115a; 1200c2; 1267c; 2406a; 2436a; 2873b5, k1; 2883b2; (2895e1); 3120; 4063; 5047c7, c9; 5063a4; 5079a2; (5087a1); 7106a; 7108a1; 7248r1, r2; 7302a1
<i>Zelandites kawanoi</i> (Jimbo)	1202r7; 4069a
<i>Zelandites</i> sp.	1099; (2506c); 2849a; 5047c6; 7110a2
<i>Gaudryceras denseplicatum</i> (Jimbo)	1029c; 1202a; 1204a; (1205a); 1219a6; (1228h1); (1286); 2150a; 2402a; 2421a; (2429a); 2432b; 2434dr1; 2473r; (2490); 2499ar1; 2500b, (e); 2560b1; (2575a); 2838d1; 2847c3; 2873b4, b5, (L1); 2883(b2), b3; (2885a1); 2894; 2895e1, (p1); 4007b; (4011br); 4022c1; (4025a1); (4032); 4042; 4048b; 4095a; 4102; 5024a1; 5025b; 5032(c1), r1, r2; 5049c2, c5; (5201); 5283d1; 5290c1; 5294a2; (7050a); (7067c1); 7068a1; 7080a; 7106a; (7108a1); 7111b1; 7112a1; (7128a1); 7142a2; 7176b5; (7239a)

Table 4. Continued.

Species	Locality
<i>Gaudryceras tenuiliratum</i> Yabe	(R303p); 1019a; 1025d; (1027c); 1029a, c; 1031a, b; 1060a; 1070e; 1109; 1115b; 1200(a), c2, e2, f, (r5); 1201b; 1202d; (1204a); 1217(b), c; (1218a2); 1219(a4), (a5), (a6), (a8); 1223d1; 1225b; 1228h1; 1229a; (1247a2); 1251d; 1253a3; 1254b; 1267c; 1269a2; (1271b); (1272a); 1280a; 2148e1; 2153a2; 2154b; (2406a); 2417d; (2419a1); 2421a; 2430a; 2434dr1; 2446a2; 2499ar1; 2506c; 2507d1; 2516(a), d; 2530f; 2531b1; (2533p1); 2556f1; 2581p2; 2801a; 2802p1; 2831c1; 2832b1; (2849a); 2873e1; 2883b2; 2887a; 2894; 2895e1; 3108br1; 3109d2; (3114); 3134c3; (3147'); (4007b); 4016a; 4027p1; 4032; 4042; 4052p1; 4063; 4069a, b; 4095a; 4102; 5024a1; 5025b; 5032a1, r1, r2; 5041c1; 5047c1, c2, c3, c5, (c6), c7; 5048b; 5049b1, c2; 5050; (5063a4); 5075e1; 5082a3; 5086a1, e1, e2, f1; (5181); 5294a2; 7020d1; (7046b); (7052a); 7055a; 7067b1; 7069a; 7106a; 7112a1; (7142a1); 7142a2; 7176a1, a4, a5, b5, c2, c4, c9, d1; 7205b1; 7207i2; 7216a, b; 7221b1; 7227a; 7239a; 7242b1
<i>Gaudryceras intermedium</i> (Yabe)	(R303p); 1070d; 1223d1; 2414a; 2419a1; 2473r; 2560b1; 3134c4; 5029a
<i>Gaudryceras striatum</i> (Jimbo)	(5007g6)
<i>Gaudryceras</i> sp.	1009a; 1025g; 1027b; 1034a; 1070b; 1079; 1202r5, r9; 1228a; 1230; (1247c); 1253b2; 1254d; 1262a; 1267b; 2148f1; 2149a; 2434d3; 2436(a), b; 2440a3; 2442; 2500a; 2520a; 2530d; 2560a1; 2801a; 2864c3; 2873L1; 3109d3, d5; 3123b; 3126; 3130; 3134c1, c3; 4010'p1; 4011br; 4021a1; 4023c1, cr; 4032; 4048a; 4049; 4061; 4072a; 4102; 5021a; 5047b2, c9; 5079a2; 5087d2; 5088b; 5107a1; 5250a2; 7013a; 7018b; 7033a1; 7046a; 7100c2; 7176cr1; 7207d1, f2; 7221b4
<i>Gaudryceratinae</i> gen. et sp. indet.	1242a; 1267d; 1271a; 2887a; 2895e1; 4063; 4074p; 4082; 4102; 4109; 5082a3; (5294a2); 7014a; 7018a1; 7053c1
<i>Tetragonites glabrus</i> (Jimbo)	R303p; (1200r5); 1217c, i; 1218a; (1226a1); 1247a1, (a2); 1251c2, c3; 1266e; 1267(a), d; 1269(a1), a2; (1271a); 2148e2; 2153a2; (2154b); 2402a; 2411(a), d; 2414a; 2419a1; 2425c; (2432b); 2440a1; 2446a2; (2473r); 2499ar1; 2506c; 2508a; 2511h1; (2527); 2832b1; 2838d1; 2865a1; 2869; 2873e1; 2895e1; 3129b; 3134(c1), (c3); (3147'); (4063); 4069(a), b; 4072a; 4102; 5047(c5), (c6); 5050; 5082a3; 5086(e2), f1; 5087a1, b1; 5283d1; 7014a; (7081a); 7111b1; 7112a1; (7128c2); 7142a1; 7204; 7205b1; 7207d1; 7248r3
<i>Tetragonites epigonus</i> (Kossmat)	1200f; (1204a); 1219a6; (1271b)
<i>Tetragonites popetensis</i> Yabe	(1070a); (1200c2); 1204a; 1219a5; (1222a); (1280a); (2402a); (2414a); 2434dr2; (2506c)
<i>Tetragonites</i> sp.	1003a; 1025d; 1031a; 1045a; 1070b; (1202r9); (1204r5); 1214a; 1219a4; 1229a; 1251d; 1253b2; 1262a; 1280d; 2148e1; 2506b; 2406a; 2417a; 2429a; 2434dr1; 2436a, b; 2478a; 2507a3, d1; 2516h1; 2530f; 2556f1; 2831d1; 2847c3; 2849a; 2864c1; 2873b3, b4, L1; 2883b1; 2894; 2895e1, p1; 3114; 3128a; 4011br; 4032; 4042; 4062; 4082; 4095a; 4102; (5032r1); 5047b2, c3; 5048b; 5049c2, c5; 5075f1; 5080b1; 5086a1, e1; 5087d2; 5095b2; (5152); 5185; 5250a1, a2; 5283b4; 5294a2; 7029b1; 7050a, b; 7053c1; 7055a; 7080a, e; 7081b, c; 7108a1; 7112a1; 7128c3; 7142a2; 7207c1, f2; 7216a, (b); 7221a; 7227a; 7242b1; 7248r2, r4; 7250a; 7310a
<i>Tetragonitidae</i> gen. et sp. indet.	1215; 2560b1; 2873b5; 4046p; (4062); 4063; 4072a; 5047c6, c7; 5049c4; 5086e2; 7029b3; 7069a; 7106b1; 7239b; 7311b2
<i>Baculites bailyi</i> Woods	1200f, g; 1204r2; 1214a; 1219a3, a6; 1226b1; (1262a); (1266d); 2530e; 2556f1; 3114; 3126; 3135b; 3137; 4082; 5047(c5), c7; 5050; 5082a2; (5097); 7111b1; 7142a2; (7204)
<i>Baculites uedae</i> Matsumoto and Obata	1214a; 1280a; (2511i); 3114; 3126; 4069a; (5083); (5087b1); 7020c
<i>Baculites boulei</i> Collignon	4102; (5082a3); 5118c1
<i>Baculites capensis</i> Woods	1200f; (1214b); (1216b); 2526d; 2530f; (2849a); (4062); 4069a; 5049c5, (c9); 5080b1; 5085a; 5086(a1), (e1); 5087d2; 7029b2; 7112a2
<i>Baculites princeps</i> Matsumoto and Obata	1200f; (1266d); 3126; 5049c2; (5086e2); 7112a1

Table 5. Continued.

Species	Locality
<i>Baculites</i> sp.	1200a, c2, r5; 1203; 1204a, r1; 1207; 1214c; 1217i; 1219a4, a5; 1247a3; (1271b); 2440a1; 2520a; 2530c, d; 2534c; 2560b1; 2802p1; 2865a1; 2883b1; 3126; 3129b; 3134c1; 4069b; 4102; 5048b; 5049b1; 5290c1; 7012b; 7013a; 7027b1; 7029b1, b3; 7055a; 7058a; 7067a; 7069b; 7100c1, c2; 7112a1; 7142a1; 7143b; 7239a; 7248r2; 7310a
<i>Hyphantoceras oshimai</i> (Yabe)	(2150a)
<i>Hyphantoceras orientale</i> (Yabe)	1200f, g, r5; 1204a, r2; 1217c, (d); 1218a2; 1219a4, a5, a6; 1226a1; 1280(a), c; 2507d1; 2516a, d; 2556f1; 2802p1; 2883b2, (b3); 2885a1; 2894; 3114; 3128a; 3134c1, (c3); 3135a, (c); 4046p; 4052p1; 4063; 4069a; 4095a; 5047c1, c2, c4, c5, c6, (c8); 5049b1, c1, c2, c4, c5; 5050; 5075e1, f1, f2; 5082(a2), a3; 5086a1, (c1), (e2), f1; 5087a1, b1, d2; 5095(b1), (b2); 5102a3, (b2); 7014r1; 7052b; 7112a1; 7116a; 7142a2; (7205b1); (7248r2)
<i>Hyphantoceras</i> sp.	1045a; 1204r1; 1229a, b; 2499ar1; 4061; (5079a2); 7013b; 7019b2; 7100a2; 7106b1; (7150a1)
<i>Yezoceras</i> sp.	5290c1; 5294a2
<i>Eubostrioceras densicostatus</i> Matsumoto	2802p1; 5049c4
<i>Eubostrioceras</i> sp.	4061; 5294a2
<i>Nipponites</i> (?) sp.	2838d1; 2844a
<i>Neocrioceras spingerum</i> (Jimbo)	(1019a); 5049c2; 7142a1
<i>Neocrioceras</i> (?) <i>sanushibense</i> Wright and Matsumoto	5032r1
<i>Neocrioceras</i> sp.	2533p1; (2839); 2873L1; (4011br); 5025b; 5047c6; 7152b1
<i>Pseudoxybeloceras quadrinodosum</i> (Jimbo)	1254c; (1267a); 1280a
<i>Pseudoxybeloceras</i> sp.	1031c; (1045a); 1070b; 1087; (1226a1); 1247a1, a3; 1267b; 2414a; 2894; (3126); 7110a1
<i>Scalarites</i> sp.	2436b; 5283d1; 5290b2
<i>Glyptoxocers</i> (?) sp.	2446b1
<i>Polyptychoceras obstrictum</i> (Jimbo)	(1280a); 2153a2; (2401); 2402a; 2414a; 2446a1; 2499ar1; (2506c); 2863p1; 2883b2; 2895e1; (3128a); (3137); (3147'); 4069a; (5047c9); (5049c5); (5050); 5063a4; (5072b1); 5079a2; 5086e2; 5095b1; (7242b1)
<i>Polyptychoceras haradanum</i> (Yokoyama)	(2530b); 2532i; (2831c1); 2887a; (3126); 4069b; 5007j5; 5047(c2), (c4); (5063a4); 5095b1; 7013a; 7020c, (d1); 7029b1; 7080a; 7112a1; 7128c2; 7176a1, a3, (a4), b3, (b4), b7, c5, c7, d1; (7209a3); (7216b); 7248r2
<i>Polyptychoceras subquadratum</i> (Yokoyama)	(1200f); (1204a); 2446a1; 5050; (7112a1); 7176c4, (cr1); (7204)
<i>Polyptychoceras pseudogaultinum</i> (Yokoyama)	1200c2, d, (e1), e2, (f), g; 1204a; (1207); (1217c); 1219(a1), a3, (a4), (a5), a6, a8; 1229a; 1266a; (1267a); 1280d; 2148f1; 2425c; 2516d; 2526d; 2556f1; 2832b1; 2883b2; 4046p1; 5047c6, c7, c8; (5050); 5063a4; 5079a2; 7067c1; (7069a); 7112a1; (7204); (7205b1); (7239a)
<i>Polyptychoceras subundulatum</i> (Yokoyama)	(1019a); (1031b); 1217c; (1219a6); (1229a); (1271b); (4063); (5049c2); 5075f2; (7171c1); (7311b1)
<i>Polyptychoceras yubarens</i> (Yabe)	(R303p); 1109; 1200f; (1204a); 1219a5; (1222a); 1266d, e; 1271b; 2148e1, f1; 2406a; (2413a); 2417d; 2421a; (2474); 2507d1; (2560b1); (2830a); 2873b(5), (e1); (2880); (2883b3); 2894; (4016a); (4026a1); 4095a; 4102; 5007g7; 5047c9; (5049b1); 5050; 5065d; (5118c1); 7013a; 7018a2; 7020b1; (7128c3); (7207c1); (7302a1)

Table 6. Continued.

Species	Locality
<i>Polyptychoceras</i> sp.	1003a, d; 1009a; 1020a; 1025b, c; 1027b; 1028a; 1029a; 1034a; 1045a, b; 1051; 1052b; 1060a, b; 1070b, c, e; 1082; 1097a; 1099; 1110; 1200a, c1, r1, r4, r5; 1202r5, r7, r9; 1203; 1204r2; 1206c; 1209; 1214a, b, c; 1215; 1216b; 1217d, h, i; 1218a2; 1225a; 1225b; 1226a, b1; 1228a, f, h1; 1229b; 1230; 1241a; 1242a, b; 1244c; 1247a1, a2, a3, b, c; 1251b3, c2, c3, c4, d; 1253a2, a3; 1262a; 1266b; 1267b, c, d; 1269a1, a2; 1275a; 1280c; 2414a, b; 2417c; 2419a1; 2421a; 2441a; 2473r; 2499ar1; (2500d); 2511a, f, g; 2516a, c; 2518p1; 2520b; 2526a2; 2530a, d, e, f; 2531b1, b3; 2532b; 2533p1; 2534c; 2560b1; 2581p2; 2801a; 2802p1; 2831b1; 2833a1, a2; 2847c3; 2864c1, c3; 2865a1; 2880; 2882b1; 2883b1, b2, b3; 2885a1; 2886b2; 2894; 2895e1; 3108b2, b1; 3109d2, d3, d5; 3114; 3129b; 3134c1, c2, c3; 3135a, b, c; 3138; 3155; 4007b; 4010; 4014a; 4021a1; 4023c1, cr; 4025a1; 4032; 4042; 4048b; 4052p1; 4061; 4062; 4063; 4065; 4069b; 4074p; 4079; 4082; 4095b; 4102; 4109; 5007g2, g3, j2, j3; 5024a1; 5032a1, r2; 5047c1, c3, c5, c7; 5048b; 5049c1, c2, c3, c4, c5; 5055b1, b3; 5063a2; 5072b1; 5075a1, e1, f1, f2; 5079a1; 5080b1; 5082a1, a2, a3; 5083; 5085a; 5086a1, c1, e1, e2; 5087b1, d2; (5088b); 5095b2; 5097; 5102a3, b1, b2; 5118c2; 5132c1; 5133a1, a2, a3, c1; (5201); 5250a1; 5269b; 5283d1; 5290(a), c1; 7011; 7012a; 7013c; 7014a, r1; 7018a1, b; 7019b2; 7020a1, b2, d1; 7027b1; 7028b1, b2; 7029b2; 7033b1; 7046a, b; 7050a, b; 7052a, b, c; 7053c1; 7055a; 7058a; 7067b1, 7067c2; 7068a1, a2; 7069b; 7080d, e; 7081a, b, c; 7084a; 7100(c1), c2; 7106a, b1; 7108a1; 7110a1, a2; 7111b1; 7112a2, b; 7142a1, a2; 7174a; 7176a1, a2, b4, b5, b6, c2, c3, c8; 7202a1; 7207c1, d1, i2; 7216c, d; 7221a, b1, b2, b3, b4; 7227a; 7239b; 7248r3; 7302a1; 7310a
<i>Scaphites pseudoequalis</i> Yabe	(2500c)
<i>Scaphites</i> sp.	2849a
<i>Clioscapites</i> sp.	(2838d1)
<i>Otoscapites</i> sp.	2849a; 2855
<i>Jimboiceras mihoense</i> Matsumoto	(2430b1)
<i>Mesopuzosia pacifica</i> Matsumoto	(2448a)
<i>Mesopuzosia yubarensis</i> (Jimbo)	(2500b)
<i>Mesopuzosia</i> sp.	2432b; 2440a1
<i>Kitchinites</i> (<i>Neopuzosia</i>) <i>ishikawai</i> (Jimbo)	1204r5; (1216a); 1253a3; 1266e; 1271b; 1280a, (d); (2142a); 2402a; 2414a; 2417c; 2419a1; (2499ar1); 2506c; 2507a2; 2511h2; (2556f1); 2801a; 2832b1; 2883b1; 2885a1; 2894; (3126); (4011br); (4021a1); 4042; (4069a); 4072a; 4074p; 4102; 5007(g2), g5; (5050); (5065b); 5085a; 5086e1; 7018b; (7045); 7050a; 7055a; (7100a1); 7112a1, a2; 7128c2; 7142a1; 7152b1, b2; 7176a1, a3, a5; 7204; (7242b1); (7302a1)
<i>Kitchinites</i> (<i>Neopuzosia</i>) <i>haboroensis</i> Matsumoto and Inoma	(1031a); 1109; 1202r7; 4095a; 5087a1; 7111b1; 7176c6; 7248r2
<i>Kitchinites</i> (<i>Neopuzosia</i>) <i>japonicus</i> Spath	5032r2; (7080c); 7176b4
<i>Kitchinites</i> (<i>Neopuzosia</i>) sp.	1019a; 1045a; 1070a, b, e; 1079; 1109; 1202r5; 1208a; 1228g; 1275a; 2417c; 2455b; 2499ar1; 2507a3; 2831b1; (2864c1); 2885a1; 2895e1; 3135d; 4025a1; 5007j2, j6; 5024a1; 5025b; 5065c; 5075e1, f2; 5082a3; 5086f1; 5088b; 5181; 5250b; 5283b1; (7013a); 7046b; 7050b; 7150a2, a3; 7176b4; 7205; 7207c1, f2; (7216b); 7239a, b; 7242b1; 7248r1
<i>Puzosiinae</i> gen. et sp. indet.	(1009a); 1025d; 1027b; 1028a; 1200d, e2; 1202d, r9; 1204a; 1209; 1214a; 1226a1; 1228a, h1; 1267a, b; 1269a2; 1280c; 2148e1; 2150a; 2153a2; 2406a; 2411a; 2434dr2; 2478a; 2511k1; 2516a; 2518p1; 2532b; 2838d1; 2855; 2865a1; 2873b4, b5; 2883b2; (2895e1); 3108b2, b1; 3120; 3134c1; 3137; 4062; 4072a; 4102; 5032r1; 5047(b1), c2; 5074b; 5082a3; 5086a1; 5202; 5283d1; 7019b2; 7020d1; 7067b1; 7080e; 7081a, b, c; 7108a1; 7112b; 7128c3; 7142a2; 7176b1, c2, c8; (7227a)

Table 7. Continued.

Species	Locality
<i>Damesites damesi</i> (Jimbo)	R303p; 1019a; (1025d); (1029a); (1070e); 1200f; 1214a; 1217c, i; 1219a1, a3, a5, (a7); 1225a; 1267b; (1269a1); 2411d; (2414a); 2415a; 2419a1; (2425c); 2473r; 2499ar1; (2500d); 2506c; 2507d1; 2531b1; (2556f1); 2560b1; 2831d1; 2832b1; (2839); 2873b4, b5; 2875c1; 2887a; 2894; 2895e1; (3109d5); (3120); (3123b); (3126); 3135a, (b), c; 4016a; 4046p; 4052p1; (4063); 4069a, b; 4074p; 4102; 5047c2, c3, c7; 5048b; 5049c2, c4, c5; 5050; 5079a1, (a2); 5082(a1), (a2); 5086a1, c1, e1, f1; 5087a1; 5181; (7018a1); 7020(a1), (c), (d3); 7052a; 7053c1; (7055a); (7067c2); 7081b; 7108a1; 7110a1; 7111b1; (7112b); 7142a1, a2; (7176b6); (7216b); (7221b1); (7227a); 7239a; 7248r2; (7302a1); 7311b1, b2
<i>Damesites semicostatus</i> Matsumoto	1200f; 1204a; 1217c; 1219a5; 2402a; 2413a; 2446a1, a2; 2506c, d; (2507d1)
<i>Damesites sugata</i> (Forbes)	(1019a); 1109; 1219a3; (1267a); 2506c; 2556f1
<i>Damesites</i> sp.	R303p; 1003a, d; 1027b; 1045a; 1070b; 1097a; 1099; 1200r1, r5; 1202r7, r9; 1203; 1206c; 1209; 1215; 1217h; 1219a4; 1226a1, b1; 1228a; 1229a; 1230; (1242a); 1262a; 1277; 1280d; 2150a; 2153a2; 2154b; (2156b); 2406a; 2414b; 2415b; (2436b); 2478a; 2500a; 2507a1; 2516a; 2516d; 2530a; 2831b1; 2864c1; 2865a1; 2873e1, (L1); 2883b2; 2885a1; 2895e1; 3129b; 3137; 3147'; 4021a1; 4032; 4042; 4072a; 4082; 4095a; 4102; (5032r1); 5047c1; 5036a3; 5082a2, a3; 5085a; 5086a1; 5106a; (5107a1); 5283b4; 5290c1; 5294a2; 7018b; 7028b1; 7046a; 7050a, b; 7106a; 7112a1; 7116a; 7128c2, c3; 7207c1, (d1); 7216d; 7239b; 7242b1; 7248r1, r3; 7250a
<i>Hauericeras</i> (<i>Gardeniceras</i>) <i>angustum</i> Yabe	1115b; 1253b3; 2532e; (2560b1); 2894; 4016p5; 4019p; 4030p; 4031p; 500711; (5029a)
<i>Hauericeras</i> sp.	(1060a); 1097a; 1202r7; (1204a); 2564b; 2585a; 2895e1; 4007b; 4010c; 4010'p1; 4023c1, cr; 4025a1; 4026a1; 4102; 5007j3; 5024a1, b; 5025b; 7112a1; 7158
<i>Yokoyamaoceras kotoi</i> (Jimbo)	2895e1; 7128c2
<i>Yokoyamaoceras jimboi</i> Matsumoto	1269a2; 2153a2; (2414a); 2419a1; 2421a; 2446a2; 2506c; 2507d1; 7055a
<i>Yokoyamaoceras</i> sp.	2411a; 2873b2, b5, L1; 7128d1; 7205; 7221b3; 7248r4
<i>Anapachydiscus sutneri</i> (Yokoyama)	1262a; 2516b1; 7301b1
<i>Anapachydiscus deccanesis yezoensis</i> Matsumoto	(2560b1); 7081b; 7128c1
<i>Anapachydiscus</i> sp. aff. <i>A. fascicostatus</i> (Yabe)	1200r5
<i>Anapachydiscus</i> (<i>Neopachydiscus</i>) <i>naumanni</i> (Yokoyama)	(2556c1)
<i>Anapachydiscus</i> sp.	1003a; (1020a); (1031b); (1060a); (1109); 1200f; 1202r7; 1204a, r5; 1215; 1217a; 1225b; 1226a1, b1; 1266e; 2415a; 2417d; 2419a1; 2425c; 2444; 2506c; 2507d1; 2511h1; 2526a2; 2556f1; 2864c3; 2895e1; 3109d2; 3134c3; 3135a; (4052); 4061; 4063; 4082; 4102; 5047c6; 5048b; 5075f1; 5086a1, e2
<i>Menuites pusillus</i> Matsumoto	1029a; 1060a; 1070c; 2560a1, b1; 2873b5; 5048b
<i>Menuites japonicus</i> Matsumoto	(1019a); 2531b3; 7020d2; 7052b; 7053c1; 7110a1; (7250a)
<i>Menuites</i> sp.	1019a; 1219a8; 2560b1; 5086a1
<i>Eupachydiscus haradai</i> (Jimbo)	1003a; 1031b; 1060a; 1070b; (1109); 1200a; (1020c); 1221b; (2516a); 2864c3; 3134c3; 3135a; 5040; (7013p1); 7046b
<i>Eupachydiscus teshioensis</i> (Jimbo)	1070b
<i>Eupachydiscus</i> sp.	1019a; 1020a; 1060a; 1070a, b, e; 1099; 1200f; 1202r7; 1204a, r5; 1225a; 1226b; 2154b; 2507d1; 2533p1; (2534c1); 2556f1; 3109d3; 3126; 3135b; 5145a; (5167); 7142a2

Table 8. Continued.

Species	Locality
Pachydiscidae gen. et sp. indet.	1025c; 1027b; 1046; 1070c; 1200d5, e1, e2; 1203; 1217c, i; 1219a6; 1242a, b; 1266d; 1280a, c, d; (2499a1); 2560b1; 2801a; 2802p1; 2831b1; 2832b1; 2873b4, b5; 2883b1, b2; 2885a1; 2887a; 2894; 3128a; 3134c1, c4; 3137; 3147'; 3155; 4007b; 4032; 4063; 4069a, b; 4082; 4102; 4109; 5024a1; 5047c2, c4; c5, c6, c7, c9; 5048b; 5049c1, c2, c3, c4, c5; 5050; 5063a2; 5075e1; 5080b1; 5082a2, a3; 5083; 5086a1, e2, f1; 5087a1, b1, d2; 5095b1, b2; 5102a3, b1, b2; 5103; 5118c2; 5132c1; 5294a2; 7014a, r1; 7018a1; 7020b2; 7028b3; 7046b; 7052c; 7081a; 7106b1; 7111b1; 7112a1; 7128c3; 7142a1, a2; 7178a1; 7205b1; 7207i2; 7216b; 7221b1, b3, b4; 7239b; 7302a1; 7311b2
Sornayceras proteus Matsumoto	2870a
Sornayceras omorii Matsumoto	2506c
Protexanites (Protexanites) bontanti shimizui Matsumoto	1200f, g; (1214a)
Protexanites (Anatexanites) fukazawai (Yabe and Shimizu)	(1214c); 7239a
Protexanites (Anatexanites) sp. aff. P. fukazawai (Yabe and Shimizu)	2529r1
Protexanites (Miotexanites) minimus Matsumoto	1204a; (1267d); 2895e1; 3126; 4082; 5047c7; 5049c4; (5132c1); 7207c1
Protexanites sp.	(5086a1)
Paratexanites (Paratexanites) sp. aff. P. orientalis (Yabe)	(1269a1); 1280a
Paratexanites (Paratexanites) compressus Matsumoto	5047c8
Paratexanites (Paratexanites) muramotoi Matsumoto	2518p1
Plesiotexanites kawasakii (Kawada)	(1200r2); 1204r1; 1214b; 1219a4, (a7); 1251b3; (2516a); 2525p1; (2556f3); 3128a; 3134c3; 5048a; 7052d; 7080e
Plesiotexanites pacificus (Matsumoto)	1200f; 1241b; 2511b; (2516c); (4046p); 4052p1; (5049c2); 5087b1; 5133a1; 5144a
Plesiotexanites shiloensis (Young)	(5047c6)
Plesiotexanites (Eutexanites) sp.	(1217b); 2886b1
Plesiotexanites sp.	1200a; 1219b1; 5082a2
Texanites quinquenodosus (Redtenbacher)	1267a
Texanites collignoni Klinger and Kennedy	(1266c1); (1267d); (1271b); (1280b); (2406b); (2418a)
Texanites amakusensis (Yabe)	(2802p1)
Texanites sp.	1262a; 4069b
Submortonicerias condamyi (Collignon)	(7013a); (7302a1)
Haboroceras haboroense gen. et sp. nov.	1200f; 1204a; 1219a6; 3135c; 4069a; 5047c7; 5049c4; 5086e2
Haboroceras sp. aff. H. haboroense sp. nov.	2873b5
Texanitinae gen. et sp. indet.	1200r5; 1217c; 1219a3, a6; 2406a; 2507d1; 2533p1; 2556f1; 2885a1; 2888p1; 2894; 3135a; 4095a; 4102; 4109; 5049b1, c2; 5082a3; 5086a1; 5106a; 7013a; 7014r1; 7052b; 7067c1; 7110a1; 7142a2; 7311a2
jaw of ammonites	1034a; 1070e; 1204r5; 1217c; 1244a; 1267a; 2406a; 2419a1; 2432b; 2440a1; 2499a1; 2507d1; 2801a; 2831b1; 2849a; 2873b5; 2883b2; 2895e1; 3147'; 4025a1; 4031p; 4042; 4069b; 4082; 4095a; 4102; 5032c1; 5086a1; (5087d2); 5290c1; 5294a2; 7020b2; 7046a; 7106a; 7108a1; 7128c2, d1; 7142a1; 7152b2; 7239a
jaw of coleoidea	1242b; 4032; 5086e2; 7050b; 7132a; 7216b