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# Problematic Occurrence of the Upper Triassic Fossils from the Western Hills of Kyoto

By

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**Abstract**

The presence of an upper Triassic (probably Karnian) bed in the midst of the Mino-Tamba Belt in the Kinki District is confirmed by examining *Halobia* and conodont fossils from the western hills of Kyoto. Although the occurrence of these fossils is somewhat problematic geologically, the upper Triassic bed may be considered to have been shut in the Permian formations by fault. Reviewing the other occurrences of the Triassic fossils from the Mino-Tamba Belt, some considerations on the paleogeographical situation of this belt are made, along with a description of five species of *Halobia*.

## Preface

In 1959 a group of several geologists* made a geological excursion to the western hills (generally called Nishiyama) of Kyoto in southwest Japan under the guidance of Prof. S. SAKAGUCHI of Osaka University of Education. At that time they found a limestone block crowded with *Halobia* of late Triassic appearance at a road-side at Izuriha in Takatsuki City, Osaka Prefecture. The limestone was considered to have come from an exposure where the road was cut through. A small limestone lens was intercalated in slate there**. But according to the detailed survey of NAKAMURA *et al.* (1936), and SAKAGUCHI (1958, 1962), the fossil locality is in the midst of the Permian strata on the one hand, and the limestone lens had no fossils on the other. Thus some questions remained concerning the origin of the *Halobia* limestone. Several years later, beautiful specimens of *Halobia* were donated to the writers' department through the courtesy of Dr. T. MASUTOMI, Messrs. K. TAKAOKA and Y. ISHII, who collected them from the limestone lens at the same site about twenty years ago. Judging from the lithic nature and fossil

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** Unfortunately the limestone has been lost by crumbling of the road-cut, but small limestone lenses are found at the river floor beside the road, although barren of fossils.

contents, there is no doubt that all these halobias had been contained in the same limestone *in situ*. Very recently the junior writer (Y.N.) succeeded in getting Triassic conodonts from the limestone under problem. So it is safely concluded that the strata intercalating the limestone lens are the upper Triassic. Although the geological problem has not been solved yet, the writers would like to report the results of the present study, because the occurrence of the upper Triassic fossils from the "Permian" in this area is very important in considering the Permian-Triassic geohistory and paleogeography in Japan.

## Acknowledgements

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## Occurrence of the Triassic Fossils

According to NAKAMURA *et al.* (1936) and SAKAGUCHI (1958, 1962), the western hills of Kyoto are composed exclusively of upper Paleozoic sediments. SAKAGUCHI established the following succession in ascending order:

1) Tano Formation....Shales intercalating two layers of chert and schalstein with small lenses of limestone. 2300 m. thick.

2) Izuriha* Formation....Shales with intercalation of sandstones and lenticular beds of chert and schalstein, barren of fossils. 2800 m. thick.

3) Takatsuki Formation....Sandstones predominating, with smaller amounts of shale, barren of fossils. 1700 m. thick.

The following fusulinids and corals from the Tano Formation were described by SAKAGUCHI (1963), and SAKAGUCHI and YAMAGIWA (1958, 1963):

*Triticites montiparus* [(ERENBERG) MÖLLER], *T. longsonensis* SAURIN, *Fusulinella biconica* HAYASAKA, *F. bocki* MÖLLER, *Clisiophyllum awa* (MINATO) and others from limestones in the lower schalstein.

*Pseudofusulina tambensis* SAKAGUCHI, *Parafusulina japonica* (GÜMBEL) *Neoschwagerina craticulifera* (SCHWAGER) and others from a limestone in the slate at the middle horizon.

*Waagenophyllum indicum* (WAAGEN and WENTZEL) and bryozoas belonging

* SAKAGUCHI originally described as Izuruha, but this is usually called Izuriha.

to *Fistulipora, Fenestella* and *Batostomella* from limestones in the topmost schalstein.

Considering the fossils of Carboniferous type such as *Fusulinella* as derived ones, SAKAGUCHI correlated the main part of the formaion with the *Pseudoschwagerina* zone up to the *Neoschwagerina* zone, and the uppermost part to the *Yabeina* zone. The Triassic limestone was contained in the upper schalstein member. More exactly speaking, the upper schalstein member has two continuous schalsteins, and the Triassic limestone was between the two. Recently SHIMIZU (1967) examined the brachiopod fossils collected by MATSUSHITA from a limestone at Sugitani, considered to be the eastern extension of the bryozoa zone. He distinguished *Neospirifer* sp., *Hustedia* sp. and others in them, and confirmed the Permian age.

Text-figure 1 shows a geological route map around the upper Triassic fossil-locality. The area consists mainly of slates intercalating frequent sandstones of various sizes and several schalsteins (basic tuffs). Lenticular layers of chert are rarely found. Limestone lenses of two to fifteen meters in thickness are usually contained in schalsteins and yield fossils of fusulinid, coral, and bryozoa. The strata have a strike of east-west or north 70 to 80 degrees west, dipping to the south at 50 to 80 degrees in general. The graded texture of sandstones and schalsteins, which is rarely observed, indicates a normal order of succession, that is, the beds become stratigraphically younger to the south. The upper limit of the Tano Formation of SAKAGUCHI was defined as the top of the uppermost continuous schlastein developed at Izuriha and west of Shimojo. SAKAGUCHI (1961, 1963) described the following fusulinid fossils from the lowest limestone in the surveyed area (Loc. 1 in text-fig. 1):

> *Schwagerina japonica* (GÜMBEL), *S. gigantojaponica* KOBAYASHI, *Pseudofusulina tambensis* SAKAGUCHI, *Parafusulina edoensis* (OZAWA), *P. takatsukiensis* SAKAGUCHI, *P.* sp., *Pseudodoliolina ozawai* YABE and HANZAWA, and *Neoschwagerina craticulifera* (SCHWAGER).

In addition, *Waagenophyllum izuruhense* was reported by SAKAGUCHI and YAMAGIWA (1958). SAKAGUCHI related this horizon to the *Neoschwagerina craticulifera* subzone of the *Neoschwagerina* zone. MATSUSHITA once collected a coral from a limestone in the lower schalstein layer in this area about 500 m. above the *Neoschwagerina* limestone (Loc. 2 in text-fig. 1). This coral was named *Waagenophyllum tambense* by SAKAGUCHI and YAMAGIWA (1963). From a limestone in the upper schalstein lying at about 300 m. higher than the lower schalstein (Loc. 4 in text-fig. 1), *Waagenophyllum indicum* (WAAGEN and WENTZEL) has been found (SAKAGUCHI and YAMAGIWA, 1958). The uppermost part of the Tano Formation, characterized by predominance of schalsteins, as mentioned above, was assigned to the coral

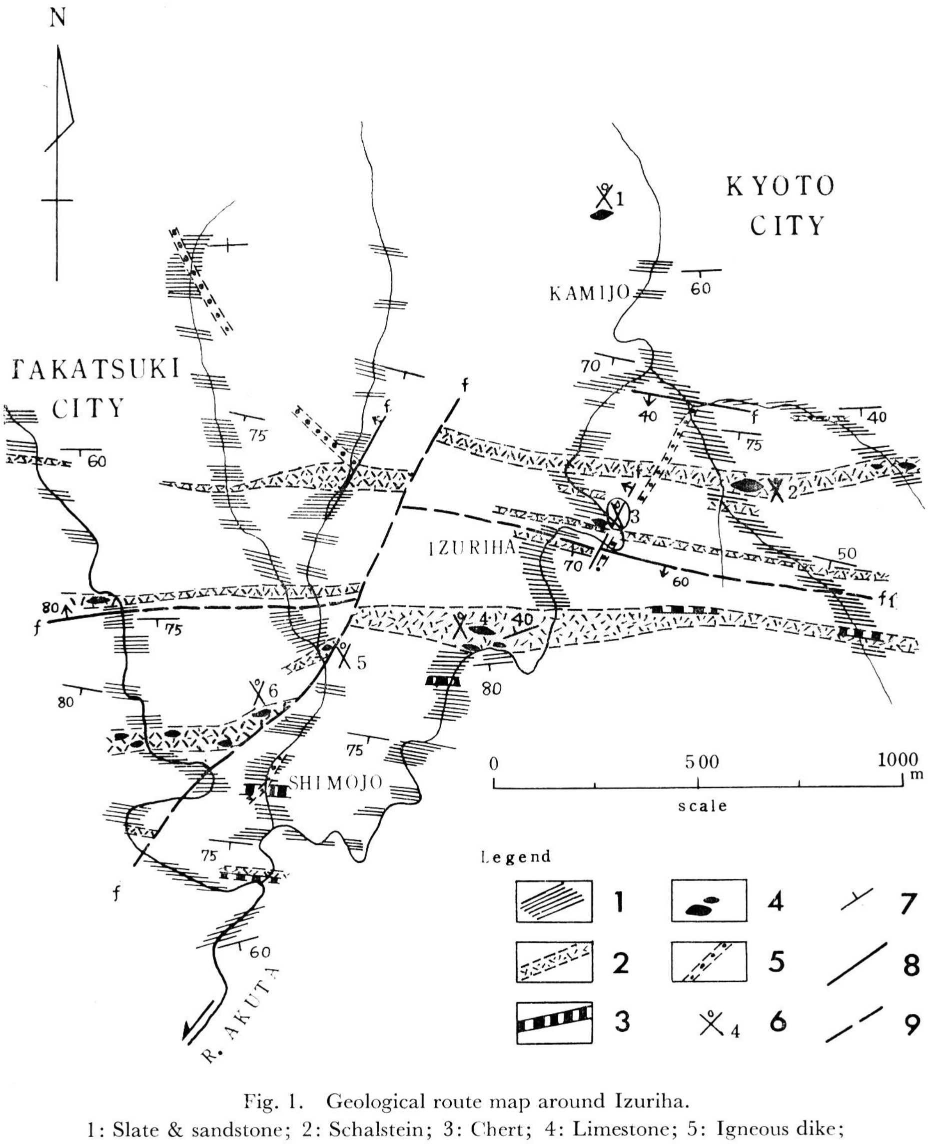


Fig. 1. Geological route map around Izuriha.
1: Slate & sandstone; 2: Schalstein; 3: Chert; 4: Limestone; 5: Igneous dike; 6: Fossil-locality; 7: Strike & dip; 8: Fault; 9: Inferred fault.

zone or bryozoa zone by common occurrence of bryozoas, and correlated to the *Yabeina* zone. The writers could find a small fusulinid, *Nankinella* sp., from limestones in the topmost schalstein at Shimojo (Loc. 6 in text-fig. 1). Between the two main schalsteins there are intercalated at least two subordinate schalsteins. The upper Triassic fossils have been found in a small limestone lens immediately below the upper schalstein of the two at Izuriha (Loc. 3, text-fig. 1). It is curious that the strata from the *Neoschwagerina* zone through the upper Triassic limestone to the coral or bryozoa zone seem to be conformable with each other and very similar in lithofacies. The possible explanations for the occurrence of the upper Triassic bed between the Permian are enumerated as follows:

1) isoclinal folding
2) imbricated structure
3) fault contact with the northern Permian and conformable to the southern Permian
4) fault contact with the southern Permian and conformable to the northern Permian

The first case is unlikely because there can be found no reverse bedding in the surveyed area. The third explanation is also impossible because the upper Triassic bed lies below the Permian in spite of the normal superposition of the strata. In fact, there is a somewhat remarkable strike fault accompanied by quartz veinlets along shear planes (f. 1 in text-fig. 1). The fault crops out at a riverside about 70 m. to the southeast of the *Halobia* limestone, running along north 70 degrees west direction and steeply dipping to the south. This may be a thrust fault separating the Triassic from the Permian in the south, but the last case cannot explain the other geological relation. The "lower" schalstein containing *Waageno-phyllum tambense* is considered to be roughly contemporaneous with the "upper" schalstein yielding *W. indicum*. Above the latter there are developed thick sediments of slate and sandstone accompanied by some cherts and schalsteins belonging to the Izuriha and the Takatsuki Formation. They amount to more than 4000 m. in total thickness (SAKAGUCHI, 1958). It is incredible that such enormous beds are lacking between the Triassic bed and the "lower" schalstein. Accordingly, the only possible explanation is that the upper Triassic bed is shut in between the Permian formations as a narrow stripe by fault, although the Triassic bed cannot be distinguished at all from the surrounding Permian in lithofacies, and the fault delimiting the northern boundary has not been confirmed yet.

## Age of fossils* and geological significance

(1) *Halobia* fossils

As the shells of *Halobia* are very crowded in the hard limestone, it is rather difficult to obtain complete specimens that enable the senior writer to determine them specifically. The following species are descriminated:

* NAKAZAWA is responsible for identification of *Halobia,* and NOGAMI for conodonts.

*Halobia* sp. cf. *talauana* WANNER .................. abundant
*Halobia* sp. aff. *superbescens* KITTL .................. rare
*Halobia* sp. aff. *sedaka* KOBAYASHI and AOTI ......... very rare
*Halobia* sp. aff. *disperseinsecta* KITTL ................. very rare
*Halobia*? sp. ind. ................................ very rare

When KRUMBECK (1924, p. 154) described *H. talauana* from Timor in Indonesia, he gave the age as the early Karnian, inasmuch as *talauana* co-exists with *H. charlyana* MOJSISOVICS, which occurs from the lower Karinan (*aonoides* zone) in the Alps (MOJSISOVICS, 1874, p. 27; KITTL, 1912, p. 108). According to WANNER (1931) and KOBAYASHI (1963), four specific assemblages of *Halobia* are distinguished in Timor and Rotti as follows:

3) Norian or lower Norian: *Halobia* cf. *salinarum, distincta,* cf. *lineata,* cf. *plicosa,* cf. *suprbescens, ? verbeeki.*
2) Upper Karnian (*subbullatus* zone): *H. austriaca, tropiticum.*
1b) Middle and lower Karnian limestone facies (*aonoides* zone): *H. charlyana, molukkana, talauana.*
1a) Lower Karnian Flysch-facies: *H. cassiana, comata, styriaca.*

KOBAYASHI (*ibid.*) reported the occurrence of *H. talauana* from the Karnian in Malaya. *H.* aff. *superbescens* in Japan is closely allied to *H. superbescens* KITTL from the lower Norian of the Alps, *H.* cf. *superbescens* described by KRUMBECK from the lower? Norian of Timor and *H.* aff. *superbescens* reported by KIPARISOVA from the Karnian of Siberia. *H. sedaka* is a middle Karnian species in Japan. *H.* aff. *disperseinsecta* is intimately related to the Norian type-species of the Alps and to *H. battakensis* VOLZ from the Karnian of North Sumatra, and shows intermediate characters between the two. From this assemblage it cannot be definitely concluded whether the Karnian age or the Norian is indicated. However, the most abundant species, *H.* cf. *talauana,* is almost identical with the type *talauana,* while the other species do not fit exactly to the allied species. So it is reasonable to consider the age of *Halobia* fauna to be the Karnian rather than the Norian.

(2) Conodont fossils

Several pieces of limestone weighing about 2 kg. were dissolved in 12% solution of acetic acid. About 150 conodonts, fragmental skeltons of crinoids and holothurians, small teeth of fishes, and others were found. Among the conodonts, 10 species belonging to 7 genera are recognized, as tabulated below:

*Gladigondolella tethydis* (HUCKRIEDE) ................ abundant
*Gondolella navicula* HUCKRIEDE ..................... very abundant
*Gondolella constricta* MOSHER and CLARK ............. common
*Gondolella* n. sp. ind. ............................ common

*Hindeodella petraeviridis* HUCKRIEDE .................. rare
*Lonchodina* sp. ind. .............................. rare
*Neoprioniodus kochi* (HUCKRIEDE) .................... rare
*Ozarkodina* sp. cf. *tortilis* TATGE .................... rare
*Prioniodella ctenoides* HUCKRIEDE .................... rare
*Prioniodella* sp. ind. .............................. rare

Among these fossils, species of *Gladigondolella* and *Gondolella* should be mentioned for age consideration. *Gl. tethydis* appears first in the upper Anisian and ranges up to the uppermost Karnian (HUCKRIEDE, 1958). The present specimens (Pl. 1, Fig. 14) are almost identical with the type specimens. *G. navicula* occurs from the Anisian to the Norian and its platform shows wide morphological variation, which is also useful for a horizon indicator (HUCKRIEDE, 1958). The specimens at hand are more similar to the type specimens from the Karnian than to those from the Anisian; a figured form (Pl. 1, Fig. 12) corresponds well to the type specimens illustrated in Pl. 12, Figs. 7, 8 and 22, and the other one (Pl. 1, Fig. 13) to the specimen shown in Pl. 12, Fig. 10.

On the basis of the constriction of platform, MOSHER and Clark (1965) described *G. constricta* from the Anisian Prida Formation of Nevada. The constriction is indeed prominent in the holotype, but this kind of feature is not constant and taxonomically not so useful. Anyhow, the present specimens (Pl. 1, Fig. 15) show an intermediate character between *G. constricta* and *G. navicula*. The platform of *Gondolella* n. sp. ind. (Pl. 1, Fig. 16) is extremly reduced or lacking. The species is not similar to any other Triassic species.

It is without question that the conodont fossils indicate the middle to late Triassic age. The more exact age is difficult to say, but, if anything, the Karnian age is better than the middle Triassic or the Norian. Considering both *Halobia* and conodont fossils, the limestone under discussion is most probably the Karnian in age.

(3) Geological significance

The Kinki District occupies the widest part of southwest Japan, and offers one of the most complete sections crossing the Japanese Islands. Two major geologic units of the islands, the Honshu Major Belt and the Shimanto Major Belt, are well developed in this district. The former belt is characterized by the younger Paleozoic geosynclinal sediments and suffered from the late Permian-early Mesozoic tectogenesis, while the latter is mostly made of Mesozoic and Paleogene geosynclinal sediments, which suffered from the Neogene tectogenesis. The northern half (inner side) of the Honshu Major Belt is subdivided into four belts, Hida, Chugoku, Maizuru, and Mino-Tamba from north to south, the latter three of which are widely distributed in the Kinki District (ICHIKAWA, 1964).

It is generally believed that the Honshu Major Belt was not invaded by the geosynclinal sea after the Permian-Triassic tectogenesis. In the Kinki District the marine Triassic deposits are confined to the Maizuru Belt located between the Mino-Tamba and the Chugoku Belt. The basement rocks of the Mino-Tamba Belt, which occupies a main part of the northern Kinki, are composed exclusively of thick Permian-Carboniferous sediments of eugeosynclinal origin. Recently a cobble of sandy shale containing *Monotis* (*Entomonotis*) *ochotica* and *M.* (*E.*) *ochotica densistriata* was discovered from a Pleistocene gravel bed in Sayo-cho (Loc. 1 in text-fig. 2) situated near the boundary of the Maizuru Belt and the Mino-Tamba (IKEBE and ICHIKAWA, 1965). Another *Monotis*-bearing boulder has been obtained from a river floor near Shuzan at about 15 km. north-northwest of Kyoto lying in the midst of the Mino-Tamba Belt (Loc. 2 in text-fig. 2). According to Dr. SHIMIZU* the boulder has probably come from a Pleistocene gravel bed cropping

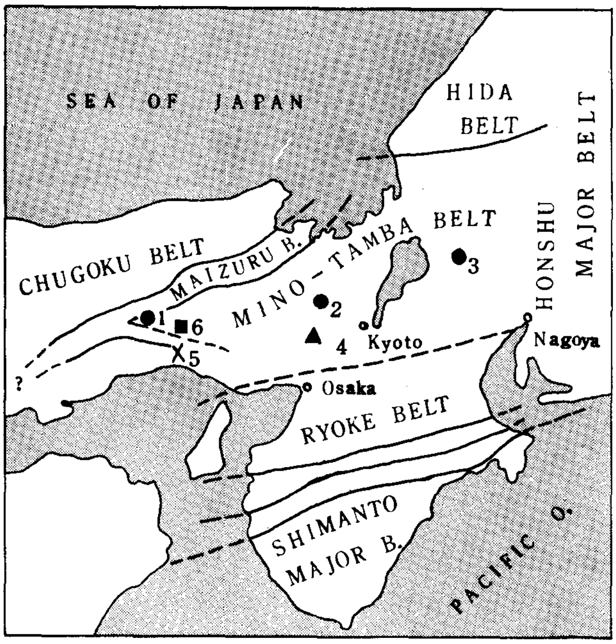


Fig. 2. Geological division of the Kinki District and Triassic fossil-localities in the Mino-Tamba Belt (about1 : 1,000,000).
● *Monotis* (Norian); 1. Sayo-cho; 2. Shuzan; 3. Myogatani
▲ *Halobia* (Karnian); 4. Izuriha
× *Daonella*? (Ladinian?); 5. West of Himeji
■ *Glyptophiceras* (Skythian); 6. Anji

* Oral communication.

out about 30 m. higher than the present river floor. Norian strata characterized by various kind of *Monotis* are rather widely distributed in the Chugoku Belt. The nearest Norian of the first locality is found 28 km. westward. In the Mino-Tamba Belt the *Monotis* beds are only found at Myogatani in Gifu Prefecture (Loc. 3 in text-fig. 2) as a narrow stripe shut in the Permian-Carboniferous formations by fault (ISOMI, 1956; ICHIKAWA et al., 1961). The Myogatani Formation is about 80 km. east-northeast away from the second locality of the *Monotis*-bearing boulder. These two gravels are considered not to have been transported from far. So it is highly possible that the Norian sea extended in an east-west direction obliquely crossing the arrangement of the aforementioned three belts, and once widely covered the Mino-Tamba Belt, although the sediments have scarcely been preserved withing the belt. The Karnian deposits are well developed in the Maizuru Belt and collectively named the Nabae Group (NAKAZAWA, 1958). The group is composed mainly of sandstones and shales intercalating thin coal seams, attaining to more than 1000 m. in thickness and containing a large number of shallow sea bivalves. There has been no information from the Mino-Tamba Belt. The discovery of a *Halobia* bed in the midst of this belt suggests the ingression of the Karnian sea into this province, as in the case of the Norian time. It is noteworthy that the bed indicates an off-shore facies consisting of slates and schalstein with limestone lenses. Analysing bio- and lithofacies of the Skythian-Anisian Yakuno Group in the Maizuru Belt, NAKAZAWA (1958) deduced the presence of an uplifting high land bordering the north rim of the belt and a questionable low land to the south. At that time he considered the *Glyptophiceras*-bearing cobble obtained from Hyogo Prefecture in the Mino-Tamba Belt (Loc. 6 in text-fig. 2) to be a remnant of an off-shore facies (NAKAZAWA and SHIMIZU, 1955). Furthermore, it is said that *Daonella* was once found during the construction of a railway tunnel near Himeji (Loc. 5 in text-fig. 2) (KOBAYASHI, 1950, p. 176).

It is a current opinion that the main part of the Mino-Tamba Belt raised into a denudation area after the Permian. But the discovery of *Halobia* limestone in the central part of the belt raises a question about this opinion. When we review the occurrences of the Triassic fossils of various ages from various places in this belt, the large part of the Mino-Tamba Belt is considered to have been submerged under the sea relatively far from land, at least, during the Skythian and the Karnian. On the contrary, the Chugoku Belt suffered from embayment transgression only during the late middle and/or late Triassic epoch. The Maizuru Belt was covered by a shallow, inland or neritic sea in the Skythian-Anisian time, and again in the Karnian. Whether the Mino-Tamba Belt remained under the sea throughout Skythian to Norian is a future problem. Even so, the deposits must have been thin, especially from the Skythian to the Karnian, in contrast to the coarse, thick deposits in the Maizuru Belt. The writers assume the presence of some kind of tectonic barrier between the two belts, which intefered with the free transportation of sediments into the Mino-Tamba Belt from the Maizuru Belt, and accumulated them in the narrow Maizuru Belt.

## Description of species of *Halobia*

### *Halobia* sp. cf. *talauana* WANNER

(Plate 1, Figures 1–5)

cf. 1892. *Halobia norica* ROTHPLETZ. S. 96, Taf. 14, Fig. 7 (non Fig. 8).
1907. *Halobia talauana* WANNER. S. 207, Taf. 10, Fig. 10, 11.
1912. *Halobia talauana* KITTL. S. 112.
1924. *Halobia talauana* KRUMBECK. S. 153, Taf. 189, Fig. 6-9.
1963. *Halobia talauana* KOBAYASHI. p. 122, Pl. 6, Fig. 14.

*Description*: Shell small, comparatively inflated, equivalve, very inequilateral, elongate-ovate, extended posteroventrally, longer than high with height/length ratio ranging from 0.64 to 0.70; beak prominent, salient above hinge margin, located a little posterior to one third of length from anterior extremity; radial ribs starting at 2–3 mm apart from beak, running slightly arcuate with concave side forward, in the middle and anterior part of shell relatively wide, and bifurcated, rarely trifurcated, becoming finer and weaker, and crowded posteriorly; concentric wrinkles weak, especially in anterior part of shell; anterior ear simple, narrow and inflated, demarcated from the rest of shell by radial depression; posterior ear not well defined.

*Comparison*: Most of *Halobia* specimens contained in the limestone block are referred to this species, but the shells are so crowded that it is very difficult to obatain complete specimens. The species is somewhat variable morphologically, but some specimens are almost identical to *Halobia talauana* described by WANNER and KRUMBECK in general outline, ornamentation and other specific characters. They differ only slightly in less developed anterior ear.

### *Halobia* sp. aff. *superbescens* KITTL

(Plate 1, Figures 6–8)

cf. 1924. *Halobia superbescens* KITTL. S. 153, Taf. 7, Fig. 21; Text-fig. 33a, b.
1924. *Halobia* cf. *superbescens* KRUMBECK. S. 317, Taf. 190, Fig. 21; Taf. 191, Fig. 1, 2.
1938. *Halobia* aff. *superbescens* KIPARISOVA. p. 26, Pl. 6, Fig. 8.

*Description*: Shell medium in size, subquadrangular-oval, a little inflated, equivalve, a little inequilateral, longer than high with height/length ratio of about 3/4; anterior margin well rounded, gradually continuing to broadly rounded ventral margin, then abruptly rising up to nearly straight posterior margin; hinge margin long and straight; beak lying anterior to the middle of shell in early growth stage but shifted to central position in later stage; anterior ear narrow, obscurely defined from main body by weak furrow, and provided with a shallow radial depression; posterior ear not well defined; surface covered by numerous, close-set, weak radial ribs gently arching forward in the main part of shell, and at about 12–19 mm from beak abruptly bending forward then backward making zigzag course, in the outer side of the bending zone ribs minutely waved, in the posteriro part sculptures weakened and gradually faded away, leaving smooth posterior area, where faint radials can be seen by magnifying glass only near shell margin; concentric wrinkles developed in umbonal half, and stronger in posteroventral part of shell.

*Remarks and comparison*: Three specimens considered to belong to the same species, are in hand. They are somewhat different from each other in ornamentation. Bending zone of radial ribs varies from 12 mm to 19 mm in distance from the beak. Concentric sculptures are weak in two specimens, while in the other one they are more strongly developed. The species is very similar to *Halobia superbescens* KITTL from the lower Norian of the Alps in weak, numerous radial ribs, smooth posterior area and in general outline, but differs in subcentral umbo, obscure posterior ear and probably in a little stronger radial ornaments. In the first point this is allied to *Halobia* cf. *superbescens* described by KRUMBECK from the lower Norian? of Indonesian Timor, but is distinguished from the latter in narrower anterior ear and less numerous radial ribs. *Halobia* aff. *superbescens* reported by KIPARISOVA from the Karnian of Kolyma in Siberia is another comparable species, especially in the radial ornamentation, but the smooth posterior area is seemingly narrower than the Japanese species, and the shell is taller if the shell is not deformed secondarily. The Siberian specimen is too incomplete for further comparison.

### *Halobia* sp. aff. *sedaka* KOBAYASHI and AOTI

(Plate 1, Figure 11)

cf. 1943. *Halobia sedaka* KOBAYASHI and AOTI. p. 247., Pl. 25, Fig. 7.

*Description*: Shell small, subcircular in outline, relatively inflated, 12 mm high and equally long in measurable part; beak rather strong, lying at about middle of shell; surface covered by weak radial ribs counting twenty, bifurcated in the medial part of shell, anterior and posterior sides lacking radial ornaments; concentric wrinkles being irregular in strength and arrangement; anterior ear small, simple, inflated and demarcated by a weak radial depression from the rest of shell;

*Comparison*: Only one left valve is available for study. The present species is very similar to *Halobia sedaka* KOBAYASHI and AOTI reported from the middle Karnian of Shikoku in Japan in tall and symmetric outline and radial ribs which are limited to the medial part of the shell. But *sedaka* has stronger primary ribs and well developed and regularly disposed concentric wrinkles.

### *Halobia* sp. aff. *disperseinsecta* KITTL

(Plate 1, Figure 10)

cf. 1912. *Halobia disperseinsecta* KITTL. S. 88, Taf. 1, Fig. 24-29.

*Description*: Shell small, subcircular in shape, moderately inflated, inequilateral, 14 mm high and longer than high; beak moderate, lying at rather anterior position; hinge line relatively short; surface ornamented by eleven, weak radial striae starting at 4–8 mm distant from beak, rather broadly and irregularly disposed, in addition, two secondary striae inserted in posterior part; posterior to main ribs about ten, weaker and shorter radial ribs being observable near peripheral margin; posterodorsal and, presumably, anterodorsal part lacking radial ornaments; concentic sculptures consisting of widely spaced wrinkles and closely set, distinct growth lines, the latter of which are absent in umbonal portion; anterior ear broken off, posterior ear not defined.

*Remarks and comparison*: Only one, incomplete right valve has been obtained, anterior margin of which is broken off. Judging from the concentric sculptures, height/length ratio is considered to be about 0.85 and the beak locates at about anterior two fifths of the shell. In the weak development of the radial ornaments and subcircular shape the described species belongs undoubtedly to *Gruppe der schwach verzierten Halobien* of KITTL (1912). The species is allied to *H. disperseinsecta* KITTL from the Norian of Alps and *H. battakensis* VOLZ (1899, S. 31, Taf. 1, Fig. 4, 5) from the Karnian of North Sumatra. The latter species is much like the present species in concentric sculptures consisting of wrinkles and growth lines, but radial ribs seem to be stronger and more numerous. Furthermore, wavy appearance of the radials cannot be seen in the Japanese species. The Alpine species is considered to be more intimately related to the present species, although it differs in more prominent beak and in lacking distinct growth lines.

### *Halobia*? sp. ind.

(Plate 1, Figure 9)

*Discussion*: A large, fragmentary left? valve is found. The species is characterized by strong, bundled ribs, each of which is ornamented by faint striae of three to five in number. The ribs are somewhat wavy in the posterior? part. Such type of ornaments is rather commonly found in *Daonella* and in some species belonging to the group of *Halobia rugosa*. Among them *Halobia ornatissima* SMITH (1927, p. 117, Pl. 97, Figs. 4–8) from the Karnian of Alaska is similar to this species in ornamentation mentioned above, but specific identification is impossible because of fragmentary preservation.

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## Explanation of Plate 1

Figs. 1–5. *Halobia* sp. cf. *talauana* WANNER ............................ p. 18
1. right valve, ×2, Reg. no. JM 11198b; 2. left valve, ×2, Reg. no. JM 11196a; 3. left valve, ×2, Reg. no. JM 11199; 4. right valve, ×2, Reg. no. JM 11198a; 5. left valve, ×2, Reg. no. JM 11199.

Figs. 6–8. *Halobia* sp. aff. *superbescens* KITTL ............................ p. 18
6. latex cast of left external mould (a) and internal mould (b), ×1.5, Reg. no. JM 11193; 7. right valve, ×1.5, Reg. no. JM 11194a; 8. left valve, ×1.5, Reg. no. JM 11195.

Fig. 9. *Halobia*? sp. indet. ............................ p. 21
Left valve ?, ×1.5, Reg. no. JM 11195.

Fig. 10. *Halobia* sp. aff. *disperseinsecta* KITTL ............................ p. 20
Right valve, ×2, Reg. no. JM 11197.

Fig. 11. *Halobia* sp. aff. *sedaka* KOBAYASHI and AOTI ............................ p. 19
Left valve, ×2, Reg. no. JM 11196c.

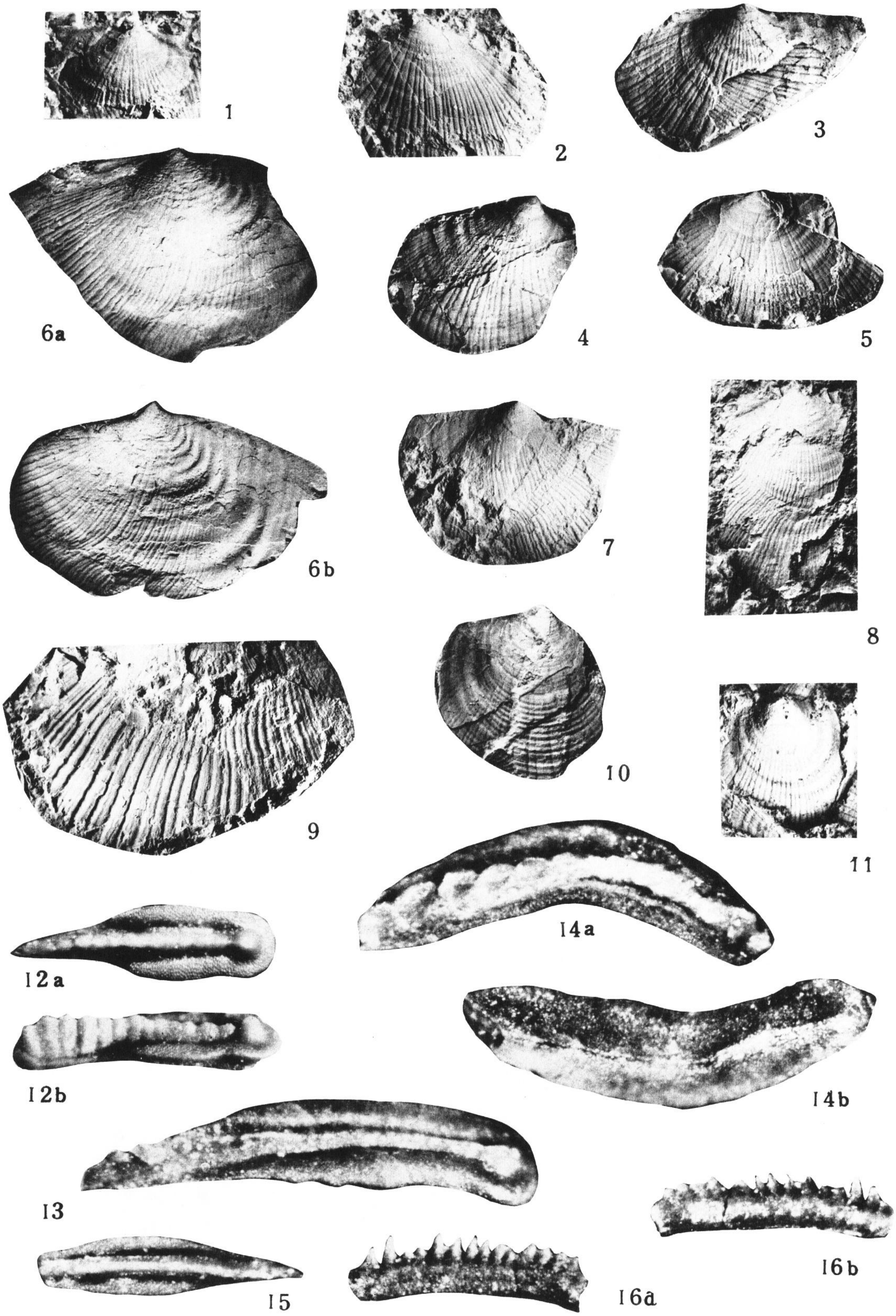
Figs. 12, 13. *Gondolella navicula* HUCKRIEDE
12. specimen with long free blade, upper view (a) and lateral view (b), ×about 50, Reg. no. JCD 1077; 13. elongated specimen, upper lateral view, × about 50, Reg. no. JCD 1078.

Fig. 14. *Gladigondolella tethydis* (HUCKRIEDE)
Upper lateral view (a) and lower view (b), ×about 50, Reg. no. JCD 1079.

Fig. 15. *Gondolella constricta* MOSHER and CLARK
Intermediate form between *Gondolella navicula* and *G. constricta*, upper view, ×about 50, Reg. no. JCD 1080.

Fig. 16. *Gondolella* n. sp. indet.
Specimen, of which platform is strongly reduced, outer lateral view (a) and inner lateral view (b), ×about 50, Reg. no. JCD 1081.

(Specimens of Reg. nos. 11193 and 11194 a, b were collected by MASUTOMI, TAKAOKA and ISHII)

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