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699. OCCURRENCE OF CRETACEOUS SHALLOW-SEA BIVALVES  
FROM THE NORTHERN BORDER OF SHIMANTO TERRAIN,  
KII PENINSULA, SOUTHWEST JAPAN\*

KEIJI NAKAZAWA, FUJIO KUMON and KATSUMI KIMURA

Department of Geology and Mineralogy, Kyoto University, Kyoto, 606

**Abstract.** Bivalve fossils collected from the northern border of the Shimanto Terrain are characterised by shallow marine species, such as *Spondylus* aff. *decoratus*, *Plicatula* aff. *hanaii*, *Amphidonte* cf. *subhaliotoidea*, *Rastellum*? sp., *Ostrea* sp. and others, the age of which is considered to be early Cretaceous. The fossil-bearing sandstones also show a shallow shelf environment, while the surrounding sandstones indicate turbidity current origin under bathyal environment. The presence of shallow-sea sediments among the turbidite sequence is explained by sea-level change and not by submarine slide of the shallow-sea sediments.

**Introduction and acknowledgments**

The Shimanto Terrain represents one of the major geosynclinal belts in Japan, extending along the Pacific coast of Central and West Japan and ranging from late Jurassic to earliest Miocene in age. In Kii Peninsula it is divided into two belts, namely, the northern Hidakagawa belt occupied by the late Mesozoic Hidakagawa Group and the southern Muro belt made of the Paleogene to earliest Miocene Muro Group. The former consists mainly of flysch-like alternations and shales intercalated with cherts, conglomerates, submarine basic rocks, and acid tuffs. Very few fossils have been discovered so far. Only *Inoceramus* cf. *amakusensis* NAGAO and MATSUMOTO, *I.* cf. *cycloides* WEGNER, and *I.* cf. *ezoensis* YOKOYAMA have been described, which indicate the late Urawan (=Santonian) age (MOROZUMI, 1970).

HASHIMOTO (1968, 1970) reported the occurrence of several late Cretaceous bivalves belonging to *Acila*, *Mesosaccella*, *Nanonavis*, *Inoceramus*, and *Periploma*, and NOHDA (1966, MS) collected *Inoceramus concentricus costatus* NAGAO and MATSUMOTO of early Gylakian (=Cenomanian) age. Very recently NAKAJO (oral comm.) distinguished early Cretaceous and latest Jurassic-earliest Cretaceous radiolarian assemblages in chert. All of these fossils have not been described yet, however. In the present article the authors will describe newly discovered bivalves of very shallow-sea origin and discuss the sedimentological significance.

The authors take this opportunity to express their cordial thanks to the members of the Kishu Shimanto Research Group for their help in sampling fossils and to Dr. N. YAMAGIWA of Osaka University of Education for his identification of corals. Dr. I. HAYAMI of the University of Tokyo and Dr. A. MATSU-

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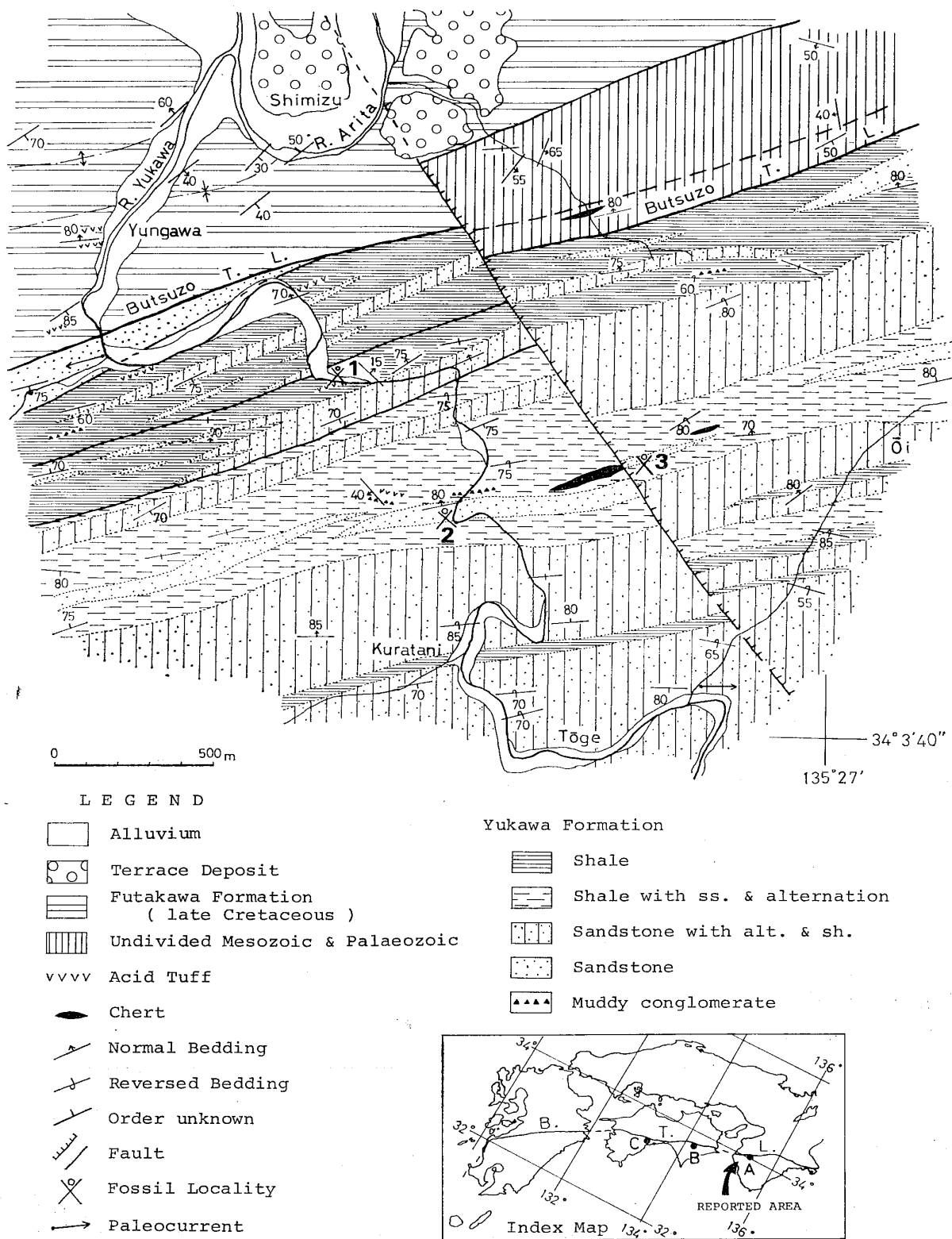


Figure 1. Index map (lower right) and geological map around fossil locality.  
A: Shimizu, B: Nonoshiri, C: Doganaro

KUMA of Kyushu University gave the senior author facilities in examining the allied species kept at their universities. Thanks are due to these gentlemen.

### Geological note and age-assignment

The Hidakagawa belt is bordered with the Chichibu belt on the north by the Butsuzo Tectonic Line. The Hidakagawa Group constituting the former belt in the central Kii Peninsula is divided from north to south into four formations, namely, the Yukawa, the Miyama, the Ryujin, and the Nyunokawa Formations (NAKAZAWA, 1973; KISHU SHIMANTO RESEARCH GROUP, 1975). The Yukawa Formation is in fault contact with the Miyama Formation which overlies conformably the Ryujin Formation. It consists mainly of bedded sandstones, flysch-like alternations, and shales with a small amount of acid tuff, lenticular chert, and conglomerate in the surveyed area. The beds have a general strike of E-W direction dipping to north or south at steep angle (45° to 90°). North-dipping strata show a normal order while south-dipping ones are reversed, and therefore, the structure is as a whole simple, becoming younger to the north, although several strike- and oblique faults are observed (Fig. 1).

Early Gyliakian *Inoceramus concentricus costatus* was once collected by NOHDA from shale in the northern part (Fig. 1, loc. 1).

The fossils under consideration are contained in medium- to coarse-grained sandstones in the middle part at about 3 km upper stream of the R. YUKAWA from SHIMIZU (Fig. 1, loc. 2). Fragmental shells were also found in its eastern extension (Fig. 1, loc. 3). These fossils are identified as in Table 1.

It is interesting to note that most of these fossils show characteristics of a very shallow sea environment, having thick, sessile shells which are frequently burrowed by other organisms. Three bivalve species, *Spondylus decoratus*, *Amphidonte subhaliotoidea*, and *Plicatula hanaii*, allied to the present materials were all described from the Miyako Group in Northeast Japan, the type of the Miyakoan (Aptian-Albian). The subgenus *Rastellum* (*Rastellum*) ranges from Middle Jurassic to Late Cretaceous and *Rastellum* (*Arctostrea*) is confined to Late Albian-Early Cenomanian in age (STENZEL, 1971). According to Dr. YAMAGIWA, associating corals belong to *Calamophyllia* and are most similar to the Alpine *C. schmidtii* (Koby) of Neocomian age. Judging from these fossils mentioned above, the fossil-bearing sand-

Table 1. List of fossils and the occurrence of the allied species.

species	occurrence of allied species
<i>Spondylus</i> sp. aff. <i>decoratus</i> .....	Lower Miyako Group (Aptian)
<i>Amphidonte</i> sp. cf. <i>subhaliotoidea</i> ....	Miyako Group (Aptian-Albian), Inubo Formation (Aptian), Doganaro Formation (Aptian-Albian)
<i>Plicatula</i> sp. aff. <i>hanaii</i> .....	Miyako Group (Aptian-Albian)
<i>Ostrea</i> sp. ind.	
<i>Rastellum</i> ? (s.l.) sp. ind.	
<i>Astarte</i> ? sp. ind.	
Bivalvia, gen. et sp. nov. ind.	
<i>Calamophyllia</i> sp. ind. ....	<i>C. schmidtii</i> (Koby), Neocomian, Alps

stones are assigned to be early Cretaceous and consequently earlier than the *Inoceramus*-bearing shales in this region. This accords with the stratigraphic succession.

In addition to these fossils, an incomplete shell of *Spiriferina*-like brachiopod has been collected from Loc. 3 in association with Cretaceous fossils. This may be a secondarily derived fossil.

### Sedimentological consideration

The studied area is composed mostly of bedded sandstones, sandy alternations,

and shales as already stated. Muddy conglomerate or pebbly siltstone, thin acid tuff, and lenticular chert are also found. Sandstones are usually thick-bedded and massive, but graded texture and flute casts on the sole surface are often observed, suggesting the turbidity current origin of these sandstones. Bedded sandstones and sandy alternations around fossil locality are, therefore, considered to have been deposited at proximal site of turbidite deposition. This is supported by grain-size distribution of sandstones as will be stated later. In spite of such environment the fossil as-

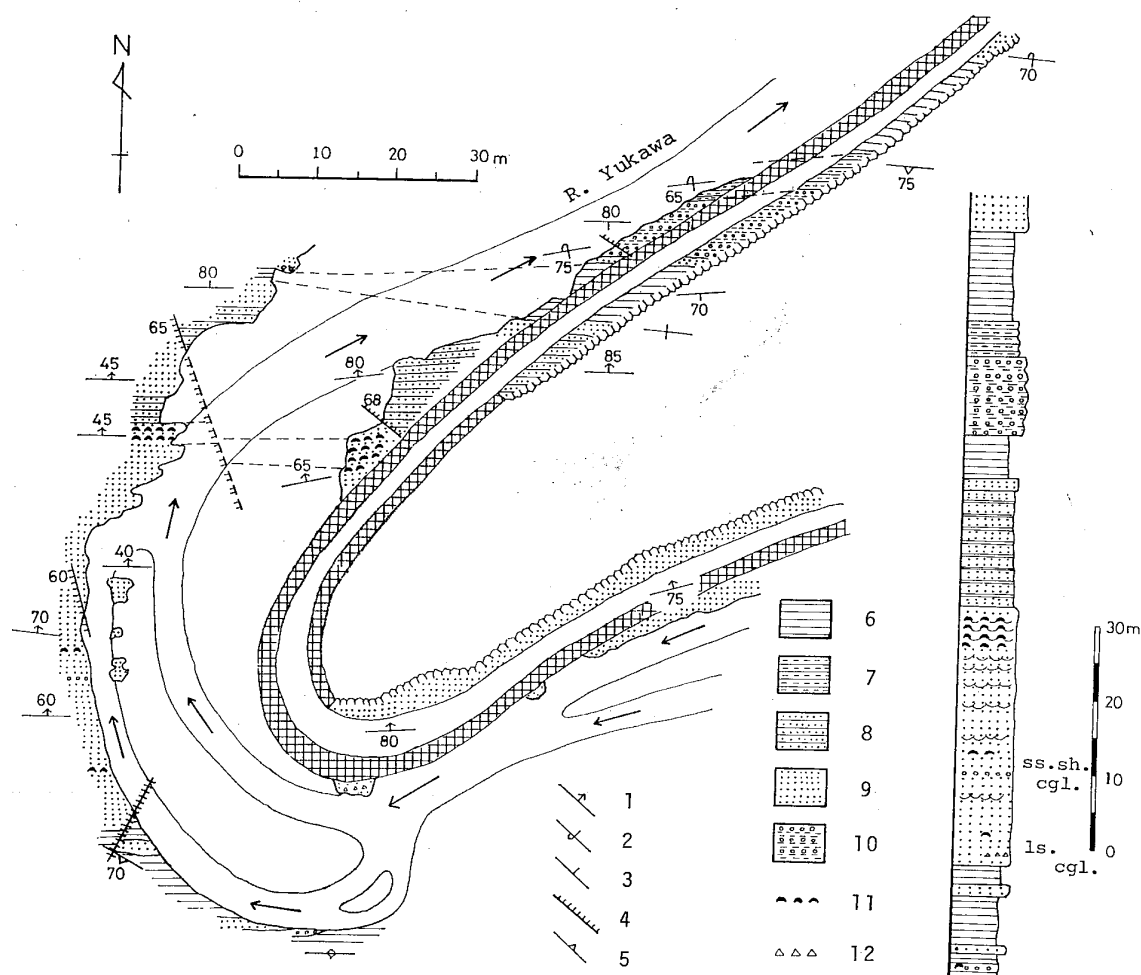


Figure 2. Route map and columnar section near fossil locality. 1: strike and dip, normal, 2: reversed, 3: unknown, 4: fault, 5: fissility, 6: shale, 7: laminated shale with sandstone, 8: bedded sandstone with shaly parting, 9: sandstone, 10: muddy conglomerate or pebbly siltstone, 11: fossil, 12: subangular pebble conglomerate.

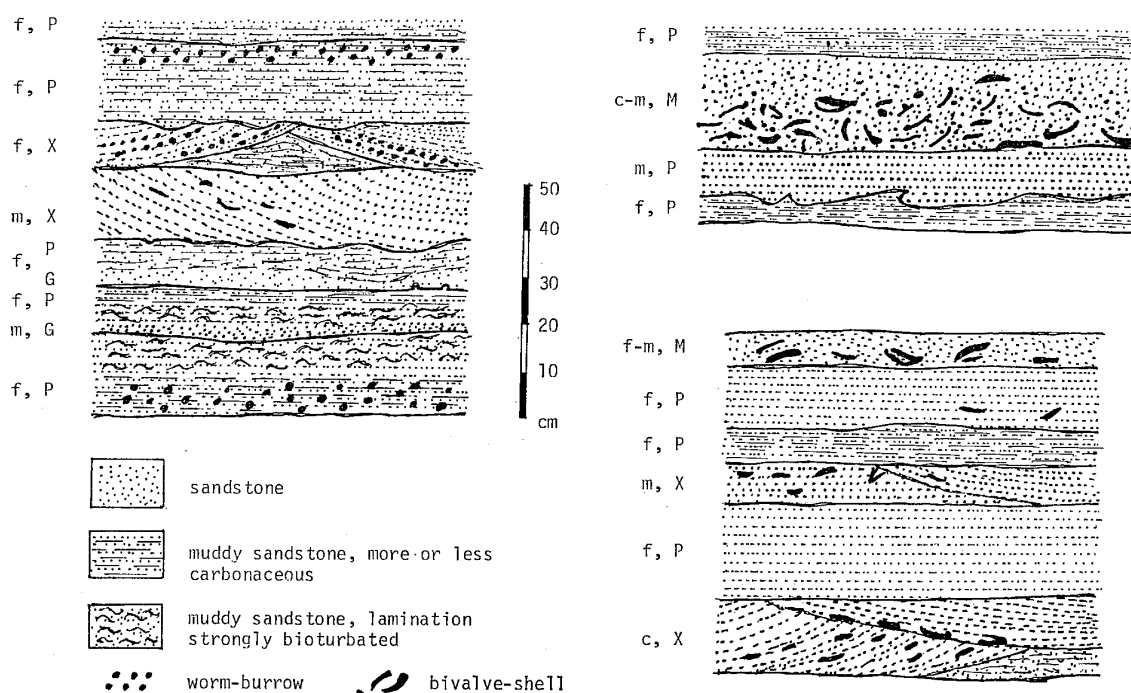


Figure 3. Sketch showing sedimentary structures and fossil occurrence.  
 c: coarse-, m: medium-, f: fine-grained sandstone, P: parallel-laminated, X: cross-laminated, G: grated.

semblage shows a very shallow habitat, and detailed survey was done around the fossil locality, paying special attention to the sedimentological features (Figs. 2 and 3).

Fossil-bearing sandstone beds are 35 m thick along the R. YUKAWA and in beds 10–60 cm thick. It is traceable laterally over 1 km, conformably overlying fissile shales and is graded into bedded sandstones with shale parting. The latter is in turn covered by black laminated sandy shales, black shales, and muddy conglomerates or pebbly siltstones. The conglomerates contain round to subangular pebbles of sandstone surrounded by sandy mud matrix, presumably formed by submarine slumping.

The fossil-bearing sandstone beds are intercalated with lenticular conglomerates at two horizons; one contains many limestone pebbles of round to

irregular shape and the other shale and sandstone clasts. Trough- and wedge-shape cross lamination and parallel lamination are common throughout. Shells are crowded in the uppermost part of the beds, sometimes making cross laminae (Fig. 3). Coarse-grained, fossil-bearing portion contains angular fragments of highly carbonaceous black shale of various sizes. Worm-burrows are especially abundant in muddy part and muddy laminae arranged parallel or oblique to the bedding plane. These sedimentary features indicate a high energy condition of flow regime under shallow environment.

Composition of sandstones is essentially not different between fossil-bearing sandstones and the surrounding turbiditic ones (Fig. 4), all plotted within a compositional area of Cretaceous sandstones in other regions of the Hidakagawa belt

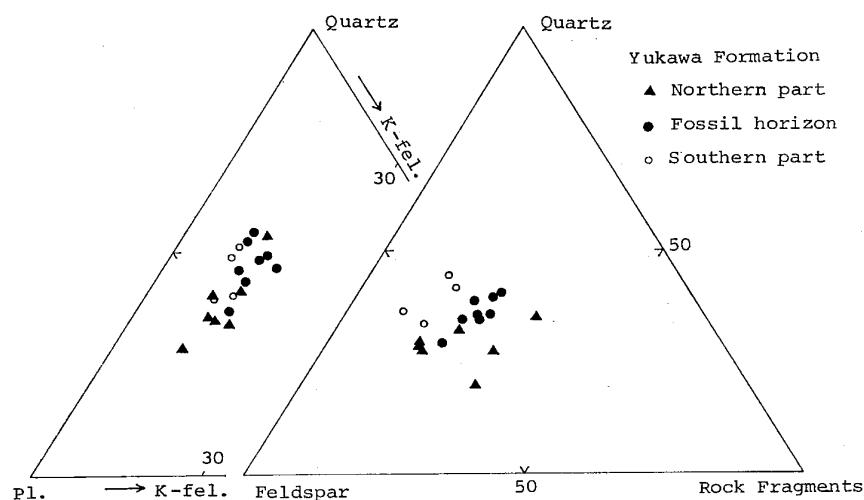


Figure 4. Triangular diagram showing composition of sandstone.

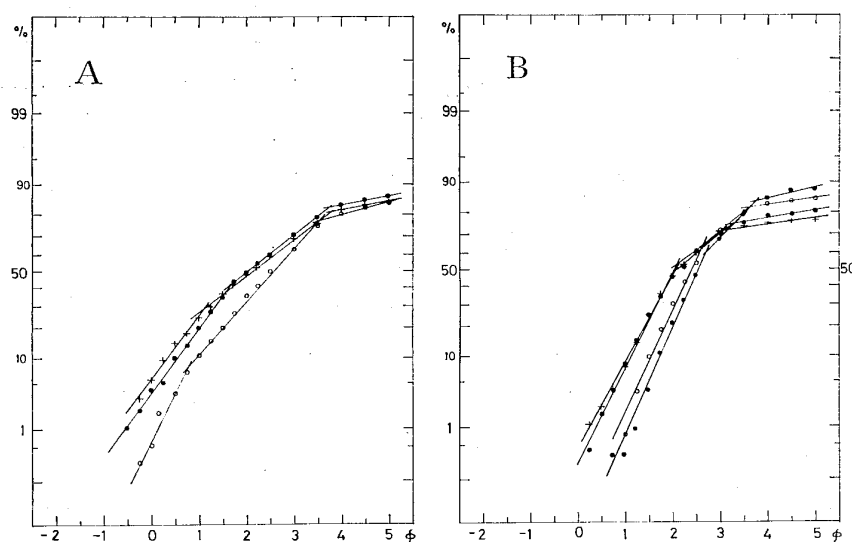


Figure 5. Cumulative curves on log-probability scale graph.

A: turbiditic sandstones, B: sandstones of fossil horizon.

(KISHU SHIMANTO RESEARCH GROUP, 1977), and clearly distinguished from that of the Paleogene Muro Group in less amount of quartz and larger amount of rock fragments. It also resembles that of the Cretaceous Hinodani Formation (KUMON, 1976, MS) and the Hayama Formation (MIYAMOTO, 1976) in Shikoku. There is a tendency in this area that rock fragments increase from south to north (Fig. 4, right).

On the other hand, grain-size analysis under microscope shows a different sedimentary mechanism between the two. Cumulative curves of the fossil-bearing sandstones plotted on log-probability scale graph (Fig. 5) indicate that distribution curves consist of two major segments with a small transitional part, which represent suspension population and well-sorted saltation population. Such distribution pattern is somewhat

similar to that of ancient fluvial sandstones or channel sands of VISHER (1969), although the latter usually lacks transitional part. Contrarily to this, the turbiditic sandstones consist of rather poorly sorted three populations and the distribution curves are not comparable to any shape of recent sediments studied by VISHER (1969). He included such type in the miscellaneous curve shapes and suggested debris flow origin. According to VISHER turbidity current sediments consist of two populations only, namely, ill-sorted saltation population and suspension population. However, similar pattern to the present sandstones is frequently found in the typical turbidite sandstones of the Cretaceous rocks in Shikoku (KUMON, unpublished data) and the Miocene Kumano Group in Kii Peninsula (HISATOMI, unpublished data), especially in coarse-grained ones. It is probable that this pattern of grain-size distribution represents another distribution shape of turbidity current sediments.

All of these sedimentological data stated above strongly suggest different sedimentary environments between the fossil beds and the surrounding ones, that is, a shallow shelf environment of the former and bathyal one of the latter. How, then, can be explained such a shallow sediment intercalation among the turbidite sequence? There is no disturbance even at the contact of the sandstone beds with the underlying shaly beds. This favours a continuous sedimentation of the sandstones on the shales rather than submarine sliding.

In this connection, it should be mentioned that in the Chichibu belt immediately north of this area, the late Urakawan (=Santonian) Futakawa Formation directly overlies the so-called Paleozoic beds with a remarkable clinounconformity, lacking the lower Cretaceous

and Jurassic rocks in between (HIRAYAMA and TANAKA, 1956; SAKA, 1968). This fact means that the sea coast must have been situated close to the Butsuzo Tectonic Line in the early Cretaceous time. In other words the fossil locality was very near the sea coast (Fig. 6B). Direction of trough-type cross lamination indicates the supply of the sediments from the north. Predominance of proximal turbidite facies of this area also suggests a relatively shallow environment in the geosynclinal sea. Consequently, it is possible that a shelf condition was locally generated due to relative sea-level change.

Overlying shaly beds with slump conglomerates may be a proof of rapid deepening of the sea after the deposition of the fossil-bearing beds. A huge lenticular body of chert, about 30 m thick and more than 200 m long, is found in the eastern extension of the slump conglomerate horizon. The very contact with the surrounding rocks is difficult to be examined owing to thick cover of chert debris, but a small exposure of the lower surface of another chert lens is wavy and the underlying shale containing small blocks of sandstone is a little disturbed. The chert mass may be an exotic block derived presumably from the Chichibu belt. It contains sphaerical radiolarian remains, but unfortunately, the preservation is too bad for age determination.

Lastly, it is noticeable that shallow marine faunas of similar age to this area are found near the northern border of the Shimanto Terrain not only in this area but also in Shikoku, such as the Miyakoan Doganaro fauna of Kochi Prefecture (HAYAMI and KAWASAWA, 1967) and the lower Cretaceous (Neocomian?) fauna of Nonoshiri, Tokushima Prefecture (SHINOAKE, 1958) (see Fig. 1,

index map).

**Systematic description**

(by K. NAKAZAWA)

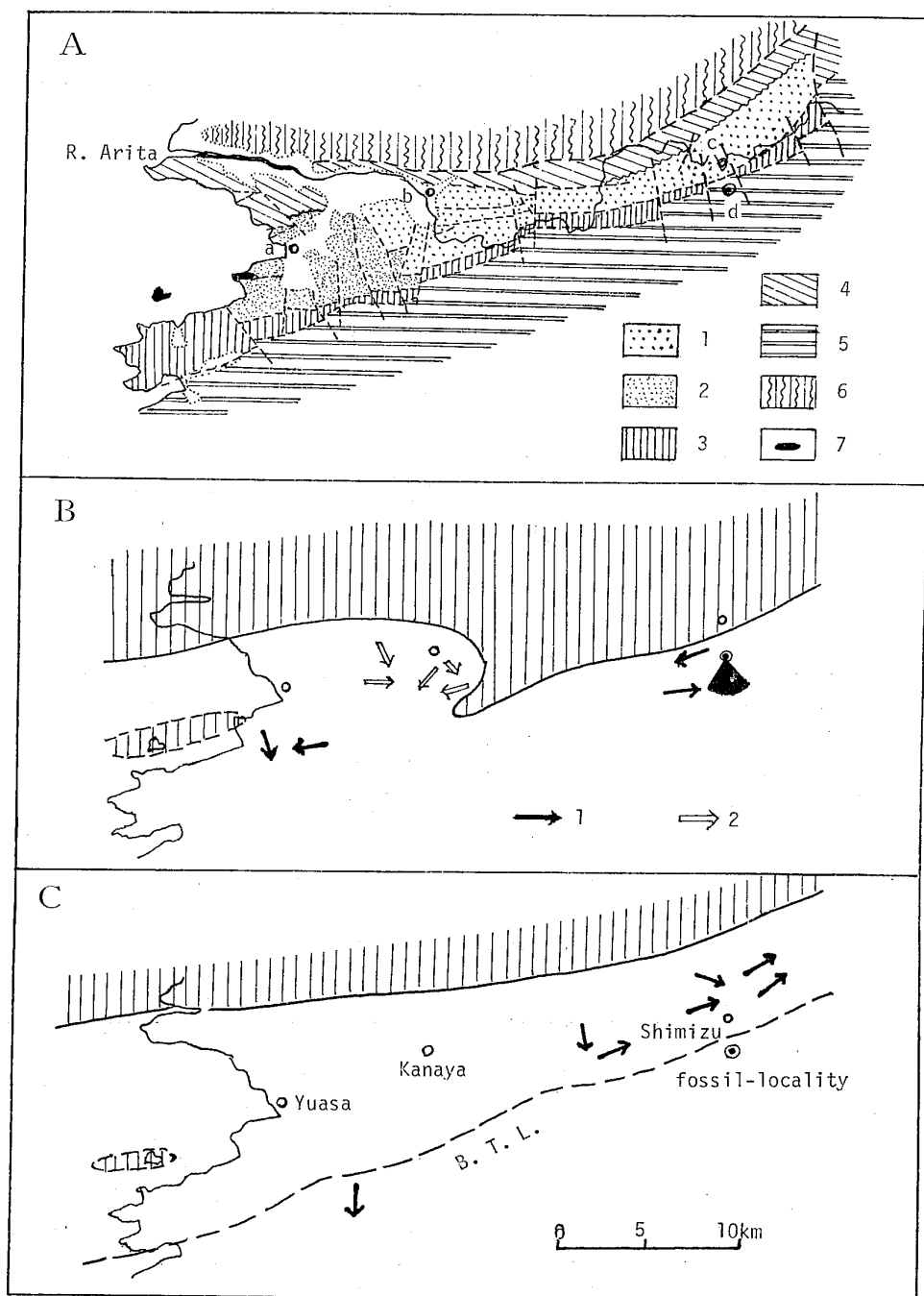
Order Pterioda NEWELL, 1965

Superfamily Pectinacea

RAFINESQUE, 1815

Family Spondylidae GRAY, 1826

Genus *Spondylus* LINNÉ, 1758



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*Spondylus (Spondylus) sp. aff. S.**decoratus* NAGAO, 1934

Plate 2, Figures 1-6

*Compare:—*

1934. *Spondylus decoratus* NAGAO, p. 210, pl. 27, figs. 2, 5-7.  
 1934. *Spondylus sp. aff. decoratus*: NAGAO, p. 211, pl. 27, fig. 8.  
 1965a. *Spondylus decoratus*: HAYAMI, p. 324, pl. 47, figs. 4-9; pl. 52, fig. 1.  
 1975. *Spondylus (Spondylus) decoratus*: HAYAMI, p. 84, pl. 3, figs. 11, 12.

*Description:—*Shell medium in size, suboval, a little inaequilateral, inaequivalve, extended posteroventrally. Left valve moderately inflated, slightly prosocline, a little higher than long, hinge length short, posterodorsal margin longer than anterodorsal one; umbo pointed, orthogyrate, a little salient above hinge margin having apical angle of about 90°; hinge consisting of two, stout, granular cardinal teeth intervened with two subcircular cardinal sockets which have a narrow resilifer pit in between, bordered by ridge-like projection on both sides; cardinal area amphidetic, obtusely triangular; surface sculptured with numerous radial ribs, primary ones six or seven in number, more or less stronger than

secondaries, which amount 4-7 in each interspace between primaries, and in some cases provided with irregularly spaced short spines. Right valve only a part of ventral margin being preserved, ornamented by concentric costae.

*Remarks and comparison:—*Most of the materials are represented by left valve, and the exact comparison with known species is difficult.

Strength of primary ribs of left valve is fairly variable; in many specimens not so broader than secondaries and provided with no spines, but some have relatively wide primaries with short spines (Pl. 1, Fig. 4).

There are known four species belonging to *Spondylus* in the Mesozoic in Japan, namely Aptian *S. decoratus* NAGAO, 1934 of the Miyako Group in northeast Japan, Santonian *S. pseudocalcaratus* TASHIRO, 1976 and *S. sp.* (TASHIRO, 1976) of the Himenoura Group in Kyushu, and the Upper Cretaceous *S. amanoi* HAYAMI, 1975 (= *S. japonicus* AMANO and MARUI, 1958) in Central Japan. The present species is distinguished from *S. amanoi* in much smaller size, less numerous radial ribs in the left valve, and weaker concentric sculpture in the right valve. *S. pseudocalcaratus* differs from this species in more de-

Figure 6. Generalized geological map and paleogeography

## A. Geological map of Yuasa-Shimizu area.

1: Upper Cretaceous, 2: Lower Cretaceous, 3: Upper Paleozoic to Jurassic, 4: Upper Paleozoic and Triassic, 5: Hidakagawa Group (Cretaceous) of Shimanto Supergroup, 6: Sambagawa metamorphic rocks, 7: Kurosegawa complex (Silurian and pre-Silurian), a: Yuasa, b: Kana-ya, c: Shimizu (Modified from TANAKA, 1974).

## B. Paleogeography and paleocurrent direction of Miyakoan-Early Urakawan stage.

1: paleocurrent direction of Miyakoan-Gyliakian,

2: paleocurrent direction of Early Urakawan.

(Data added to those of TANAKA, 1974)

## C. Paleogeography and paleocurrent direction of Late Urakawan stage.

B. T. L.: Butsuzo Tectonic Line.

(Paleocurrent data after TANAKA, 1974)

veloped primary ribs in the less convex left valve and stronger concentric ornaments in the right. In general outline and ornamentation, it is most allied to *S. decoratus* which has some resemblance with the early Cretaceous *S. roemeri* DESHAYES, 1842 and *S. gibbosus* D'ORBIGNY, 1847 of west Europe, but slightly differs in less developed primary ribs.

Nearly complete shell is 50 mm long, 58.5 mm high, 16 mm deep and has  $L/H = 0.85$ . Umbo lies at about 27 mm behind anterior end, that is, a little anterior to the middle of shell.

#### Family Plicatulidae WATSON, 1930

#### Genus *Plicatula* LAMARCK, 1801

*Plicatula* sp. aff. *P. hanaii* HAYAMI, 1965

Plate 3, Figures 5-7

#### Compare:—

1965a. *Plicatula hanaii* HAYAMI, p. 322, pl. 47, figs. 1-3.

**Description:**—Shell medium in size, a little inaequilateral, inaequivalve, variable in shape but usually ovate, higher than long, ranging from 24 to 45 mm in length and from 34 mm to 50 mm in height; hinge consisting of two divergent cardinal teeth in each valve, intervening a resilifer pit at the center of hinge plate, that of left valve bounded by ridges on both sides; posterior adductor muscle scar large, circular, lying a little posterior to the middle of shell, anterior one not observed; left valve more convex than the right, consisting of inflated umbonal half and less convex ventral part, the latter of which is sculptured with eleven, weak radial ribs arranged at wide interval; right valve nearly flat, sculptured with irregular radial ribs

broader than those of left valve and very weakly nodose.

**Remarks and comparison:**—Shell is fairly thick being about 5 mm and in some cases bored by organisms. Convex umbonal half of left valve is considered to correspond to attachment area of right valve judged from the recent species. In Japan one Triassic species of *Plicatula* (*P. hekiensis* NAKAZAWA, 1955), five Jurassic species (*praenipponica* HAYAMI, *dichotomocosta* TAMURA, aff. *dichotomocosta* TAMURA, *subcircularis* HAYAMI and *yatsuiensis* TAMURA) and two Cretaceous ones (*kiiensis* HAYAMI and *hanaii* HAYAMI) have been described. Among them *P. kiiensis*, *P. praenipponica*, *P. dichotomocosta* and *P. aff. dichotomocosta* are easily distinguished from the present species in close-set, strong radial ribs. *P. hekiensis* and *P. subcircularis* also differ in spinose reticulate surface sculpture.

*Plicatula hanaii*, though only left valve is known, is very similar to this species in shape, size and hinge character, but differs from the latter in having central crenulation and smaller size. Further comparison is impossible due to the lack of right valve of *hanaii*.

#### Measurements:—

valve	length	height	L/H	depth
Right	24.0	34.0	0.71	—
Left	37.0	50.0	0.74	9.5
Left	27.0	40.0	0.69	—
Left	45.0	39.5	1.13	—

#### *Plicatula* sp. ind.

Plate 3, Figure 8

There is a left internal mold which considerably differs in outline from the preceding species. Shell is roundly crescent, extending posteriorly. Hinge is of

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*Plicatula*-type. It is not certain whether this is a varietal form of the preceding species or not.

Superfamily Ostreacea  
RAFINESQUE, 1815

Family Ostreidae RAFINESQUE, 1815

Genus *Ostrea* LINNÉ, 1758

*Ostrea* sp. ind.

Plate 3, Figures 9, 12

A complete left internal mold and several incomplete shells are observable. A complete one shows suboval outline meridionally elongated and gently inflated. Ligament area is relatively narrow provided with a shallow, wide, indistinct ligament pit. Presence of radial ribs in left valve is suggested by plication along posterior margin. Right valve is nearly flat, sculptured with concentric costae only. Identification is difficult due to poor materials.

Genus *Rastellum* FAUJAS-SAINT-FOND, 1799

*Rastellum*? s.l. sp. ind.

Plate 2, Figure 7

Only a convex marginal part of strongly plicated shell is at hand. It is very difficult to determine even generically based on such fragmentary specimens. However, the characteristic plication of the shell margin reminds one of that seen in strongly plicated oysters, such as *Rastellum* s.s. or its subgenus *Arctostrea*, and the species is tentatively referred to *Rastellum* s.l.

Family Gryphaeidae VYALOV, 1936

Subfamily Exogyrinae VYALOV, 1936

Genus *Amphidonte* FISCHER DE  
WALDHEIM, 1829

Subgenus *Amphidonte* FISCHER DE  
WALDHEIM, 1829

*Amphidonte* (*Amphidonte*) sp. cf. *A.*  
*subhaliotoidea* (NAGAO)

Plate 3, Figures 1-4

Compare:—

- 1934. *Exogyra subhaliotoidea* NAGAO, p. 203, pl. 30, figs. 1-4.
- 1965a. *Amphidonte* (*Amphidonte*) *subhaliotoidea*: HAYAMI, p. 343, pl. 50, figs. 6-9; pl. 51, figs. 1, 2.
- 1967. *Amphidonte* (*Amphidonte*) *subhaliotoidea*: HAYAMI and KAWASAWA, p. 78, pl. 9, fig. 5.
- 1972. *Amphidonte* (*Amphidonte*) *subhaliotoidea*: SHIKAMA and SUZUKI, pl. 5, figs. 10-14.

*Description*:—Shell relatively small, suboval, inaequivalve, inaequilateral, spirogyrate backward, higher than long, test fairly thick, provided with no radial ornament. Left valve moderately inflated having sharply rounded spiral keel along anterior margin which is broadly rounded; posterior margin nearly straight or a little arcuate with concave side backward, not raised; umbonal portion not well preserved, ligament area relatively short, elongated along dorsal margin forming shallow groove. Right valve a little inflated along weak, rounded spiral keel and nearly flat in posterior part; ligament area short and almost flat; anterior margin well rounded, posterior margin weakly curved with convex side backward; adductor scar being large and ovate lying a little posterior to the middle of shell.

*Comparison*:—The described species is

most allied to *Amphidonte* (*Amphidonte*) *subhaliotoidea* (NAGAO) reported from the Miyako Group, the Inubo Formation of Choshi Group and from the Lower Cretaceous in Shikoku, which is only one known species of *Amphidonte* s. s. in Japan, but slightly differs from the latter in smaller size and absence of chomata along shell margin.

Order Veneroida ADAMS and  
ADAMS, 1856

Superfamily Crassatellacea  
FERUSSAC, 1882

Family Astartidae D'ORBIGNY, 1884

Genus *Astarte* SOWERBY, 1816

*Astarte?* sp. ind.

Plate 3, Figure 13

The present species is represented by a left internal mold which preserves impressions of a trigonal cardinal tooth and a socket. It is suboval in shape, 25.0 mm long, 21.0 mm high and 6.5 mm deep in the internal mold and has minute crenulation along the margin and a sub-circular posterior adductor muscle scar at posterodorsal position of the shell interior. It is difficult to determine even generically, because of poor preservation of the hinge.

However, this species may belong to the genus *Astarte* in general outline and marginal crenulation. It is similar to *Astarte* aff. *shinanoensis* YABE and NAGAO described by HAYAMI (1965b, p. 94, pl. 9, fig. 1; pl. 14, fig. 9) from the upper Neocomian Hanoura Formation in Shikoku and *A. akatsui* HAYAMI (1965b, p. 95, pl. 9, figs. 2-5; pl. 14, figs. 10, 11) of the Albian Yatsushiro Formation in Kyushu in transversely elongate form and mode of crenulation.

Systematic position uncertain

Bivalvia, gen. et sp. nov. ind.

Plate 3, Figure 11

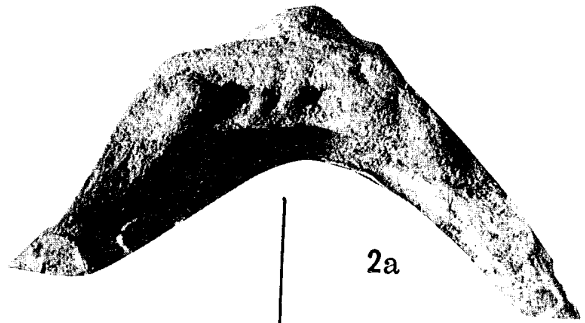
This unique bivalve is represented by a left internal mold with external mold of marginal part. Shell is suboval in shape, 37.0 mm long, 45.0 mm high and 14.0 mm deep with thick test reaching at least 10 mm near the margin. Surface is covered by relatively strong growth-lines of irregular strength. Hinge consists of two cardinal teeth, two cardinal sockets and a large socket-like depression along the posterodorsal margin. Anterior cardinal tooth is stout, trigonal and pointed; posterior one strong and elongate. Cardinal sockets are trigonal and deep, each situated anterior to the cardinal tooth respectively. Socket-like

#### Explanation of Plate 2

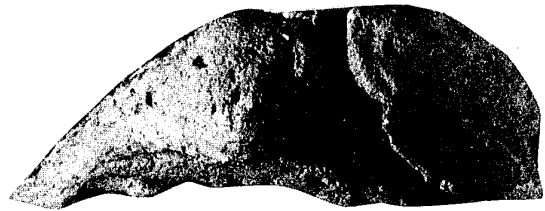
- 1-6. *Spondylus* sp. aff. *S. decoratus* NAGAO
  1. External gypsum cast of left valve, JM. 11294.
  2. Rubber-compound cast of left valve, 2a: hinge area, 2b: dorsal view, JM. 11295.
  3. External gypsum cast of left valve, 3a: side view, 3b: anterior view, JM. 11296.
  4. External rubber-compound cast of left valve, JM. 11297.
  5. External mold of left valve (5a) and the rubber-compound cast (5b), JM. 11298.
  6. External gypsum cast of marginal part of right valve, JM. 11296.
7. *Rastellum*? s.l. sp. ind., external gypsum cast, JM. 11299.  
(All in natural size. Photo by K. NAKAZAWA.)



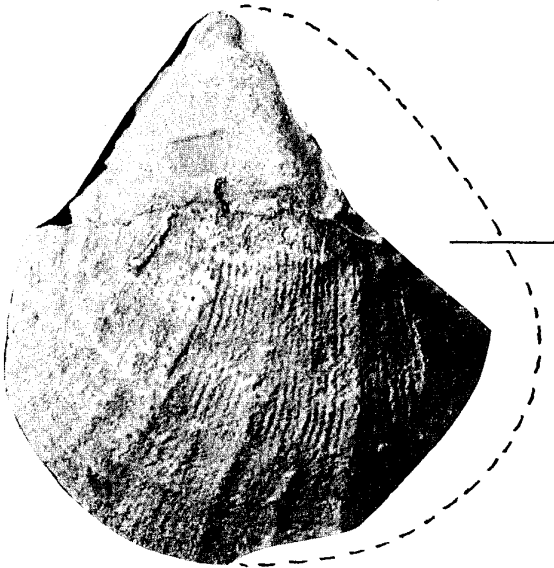
1



2a



2b



3a



3b



4



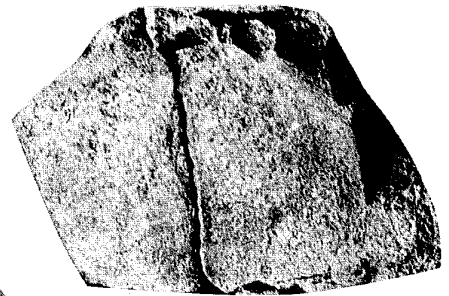
7a



7b



6



5a



5b

depression is large and elongate-oval, sculptured with vertical crenulation. It is not certain whether this is a real socket receiving a tooth of the opposite valve or not, because of its peculiar shape and serration. If this is a ligamental recess, ligament is internal. Lateral tooth or socket is seemingly lacking and, if present, completely reduced. Posterior adductor muscle scar is subcircular, large, situated at the middle of posterior half of the shell; anterior one is considered to be small, lying close to the anterior cardinal socket.

The thick and tall shell provided with robust cardinal teeth and sockets remind one of some megalodontid species, such as *Neomegalodon* GUEMBEL, 1863, and *Pachymegalodon* GUEMBEL, 1862, but the hinge characters and mode of muscle scar are different. *Megapraeonia* CHAVAN, 1952 of veneroids is somewhat similar to the present species in outline, thick shell, and strong dentition, but also distinguishable in musculature and dental formula. No comparable species could be found. More materials are required for full description and comparison.

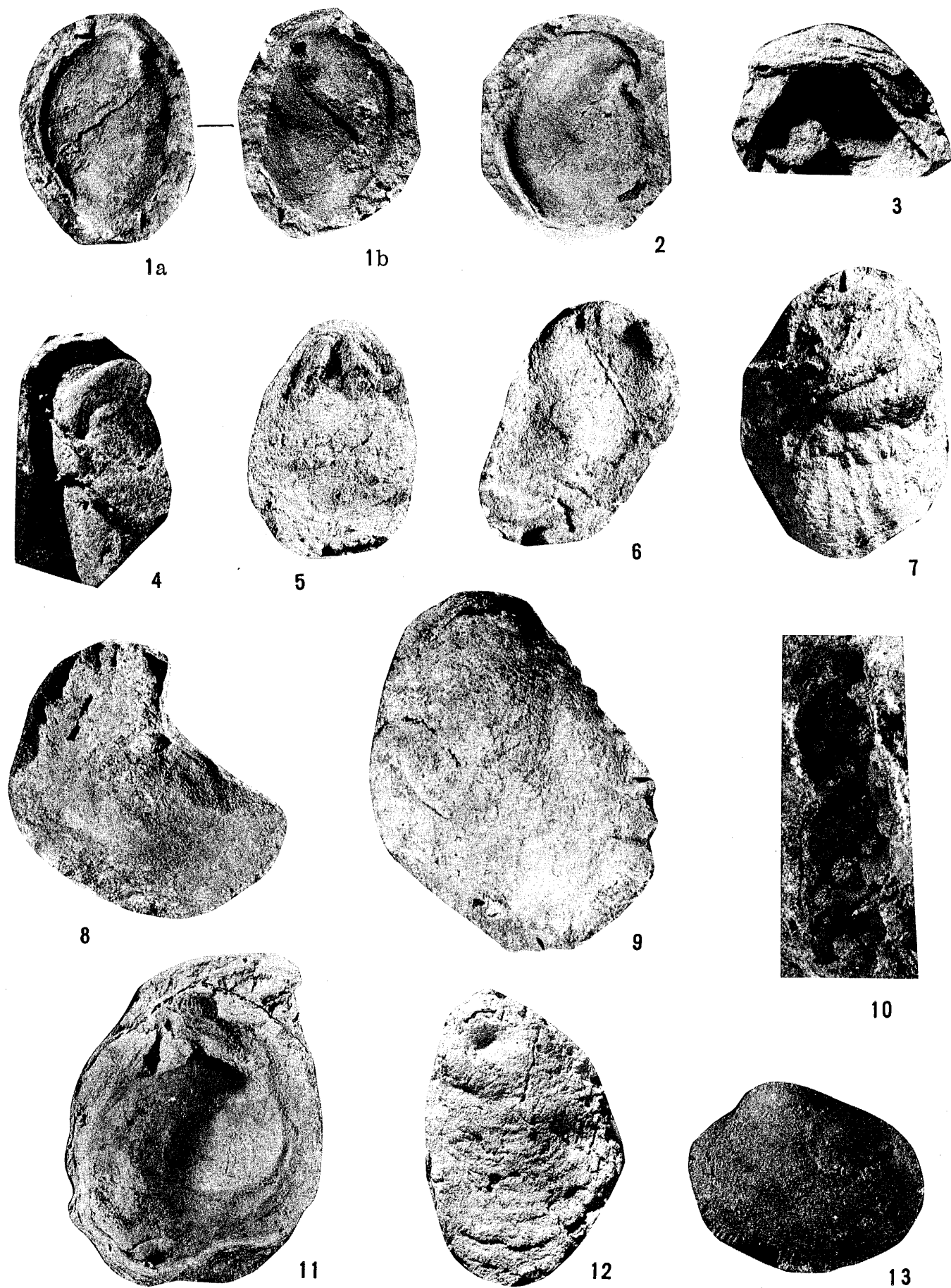
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### Explanation of Plate 3

- 1-4. *Amphidonte* (*Amphidonte*) sp. cf. *A. subhaliotoidea* (NAGAO)
    1. Internal mold (1a) and the gypsum cast (1b), JM. 11300.
    2. Internal gypsum cast of right valve JM. 11301.
    3. Rubber-compound cast of right valve, showing umbonal part,  $\times 1.5$ , JM. 11302.
    4. Internal mold of right valve,  $\times 1.5$ , JM. 11303.
  - 5-7. *Plicatula* sp. aff. *P. hanaii* HAYAMI
    5. Internal gypsum cast of right valve, JM. 11304.
    6. Internal rubber-compound cast of left valve, JM. 11305.
    7. External rubber-compound cast of right valve, JM. 11306.
  8. *Plicatula* sp. ind., left internal mold, JM. 11307.
  - 9, 12. *Ostrea* sp. ind.
    9. Left internal mold, JM. 11308.
    12. External rubber-compound cast of right valve, JM. 11309.
  10. *Calamophyllia* sp. ind., internal and external molds,  $\times 1.5$ .
  11. Bivalvia, gen. et sp. nov. ind., internal rubber-compound cast of right valve with other shell, JM. 11310.
  13. *Astarte* ? sp. ind., right internal mold,  $\times 1.5$  JM. 11311.
- (All in natural size excepting Figs. 3, 4, 10 and 13. Photo by K. NAKAZAWA)



699. *Cretaceous Bivalves from Shimanto Terrain*

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Doganaro 堂ヶ奈路, Nonoshiri 野々尻, Kanaya 金屋, Kuratani 倉谷, Shimizu 清水,  
Yuasa 湯浅, Yukawa 湯川, Yungawa 湯子川

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西南日本，紀伊半島四万十帯北縁より白亜紀浅海性二枚貝の産出：和歌山県清水町の湯川川下流，湯川層砂岩より *Spondylus* aff. *decoratus*, *Plicatula* aff. *hanaii*, *Amphidonte* cf. *subhalioidea*, *Ostrea* sp. などの二枚貝や，さんご *Camalophyllia* sp. が発見された。二枚貝は宮古統のものに類似し，時代は古白亜紀とみなされる。厚殻，付着，固着性の二枚貝を主体とし，ごく浅い海的环境を示している。これは砂岩の堆積学的研究からも支持される。周囲はやや深い地向斜性の堆積層であるが，このような浅海性の地層の存在は，海底地汭りによるものではなく，海水準の相対的变化によるものと結論した。

中沢圭二・公文富士夫・木村克己