OSTREA (*TURKOSTREA*) *DOIDOIENSIS* HASIBUAN FROM THE BAYAH FORMATION, WEST JAWA: A NEW FIND

Fauzie Hasibuan *)

ABSTRACT

A species of Ostreidae conspecific with *Ostrea* (*Turkostrea*) *doidoiensis* Hasibuan from the Middle Eocene Malawa Formation, South Sulawesi, was also discovered from Bayah Formation, Banten, West Jawa. A juvenile form of the taxon is thought to occur in the Nanggulan Formation, Central Jawa. Correlation of the age of the formations is considered. Paleoenvironmental implication of the taxon and its distribution in Indonesia are discussed.

Keywords: Ostrea (Turkostrea) doidoiensis, Bayah Formation, Malawa Formation, Middle Eocene, RV (right valve), LV (left valve)

SARI

Satu jenis Ostreidae yang sama dengan jenis *Ostrea* (*Turkostrea*) *doidoiensis* Hasibuan dari Formasi Malawa dan berumur Eosen Tengah, Sulawesi Selatan juga ditemukan di dalam Formasi Bayah, Banten, Jawa Barat. Satu spesimen yang belum dewasa diduga terdapat dalam Formasi Nanggulan, Jawa Tengah. Korelasi umur antara formasi-formasi tersebut dibahas. Implikasi spesies ini untuk lingkungan pengendapan, dan penyebarannya di Indonesia juga dibahas.

Kata kunci: Ostrea (Turkostrea) doidoiensis, Bayah Formation, Malawa Formation, Middle Eocene, RV (right valve), LV (left valve)

INTRODUCTION

The presence of *Ostrea* (*Turkostrea*) *doidoiensis* in the Bayah Formation is very important for the depositional environment analysis and age correlation of the formation locally and regionally. The environment where Ostreidae lives, covers a very wide area ranging from shallow, brackish to marine water. It is attached to hard substratum such as rock, shell of its kind, plant, or other objects. Therefore, its presence as fossil in a rock formation will show the precise depositional environment of the rock. Naturally, transported Ostreidae into different environment is also possible, but usually not to a very far distance on account of its heavy shells. Bilaterally, the shells is asymmetrical and many species are highly asymmetrical.

Chemically, the shell of Ostreidea is composed of calcium carbonate with minor amount of conchiolin. The two allomorphs of calcium carbonate, aragonite and calcite, are present, the latter is in greater abundance. Ostreidae shells are excellent source of high purity lime for various industries.

Ostreidae is an immobile animal, living permanently and having no direction of movement and pleurothetic on the left side/left valve (LV). It also tolerates periodic exposure to sunlight.

Although the dispersal of Ostreidae is very much controlled by water current, climate and salinity barriers, the paleoenvironment analysis and correlation are very useful for both local and regional extent.

Aim of study

The presence of *Ostrea* (*Turkostrea*) *doidoiensis* in the Bayah Formation, West Jawa, is considered for age and paleoenvironment correlations of the unit with Malawa Formation in South Sulawesi.

Method

The specimens collected are prepared in the Paleontology Laboratory, Geological Research and Development Centre. The rock materials adhered to most of the specimens were removed by using vibrator needle, soaked and washed in water as clean as possible.

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The specimens are not so numerous and preservation is also not perfect. However, description and identification of the specimens are the first priority to be used as the basic information in obtaining the optimum species name for the age, paleo-environmental analysis, and other geological interpretations.

Studied area

The studied area is located at Cibobos Bay, west of Bayah Subdistrict at S 06°53'17.4" and E 106°07'09.9" belonging to the Bayah Formation. Locality of the collection and the geological map of the area is shown in Figure 1.

Geological setting

The studied area is included in the geological map of the Leuwidamar Sheet, Jawa scale 1:100.000 (Sujatmiko and Santosa,1992). The area has also been mapped at different scales by previous researchers such as Ziegler (1918), Van Es (1918), Koolhoven (1933), Musper (1939), *etc*.

Bayah Formation was coined by Sujatmiko and Santosa (1992) who subdivided the lithostratigraphic unit into three members. These members are the Conglomerate Member (probably Early Eocene), which is equivalent to the "Bajah Formation in south facies" (van Bemmelen, 1949), "Bajah lagen in zuidelijk paralische facies" (Koolhoven, 1933), "Bajah Coal Beds" (Marks, 1956), and "Bajah Beds paralic facies" (Katili and Koesoemadinata, 1962); the Claystone Member (Early Eocene to Middle Eocene), which is equivalent to the "Bajah Formation in north facies" (van Bemmelen, 1949), "Bajah lagen in noordelijk mariene facies" (Koolhoven 1933). "Bajah Beds marine facies" (Katili and Koesoemadinata, 1962), and "Formasi Cipager" (Prasetyo, 1979), and the Limestone Member (Early Eocene to Middle Eocene) which is in an interfingering contact with the Claystone Member.

Kusumahbrata *et al*. (2005) divided the Bayah Formation into lower and upper Bayah Formation. The lower part of the formation is composed of well bedded quartz sandstones. These sandstones range from medium to grained to coarser and conglomeratic upward the sequence. Ostreidea in the present study was collected from this lower part of the formation.

The base of the upper Bayah Formation consists of claystones which contain coal beds. Going up the sequence, the formation bears numerous coal beds which are physically fragile (splitting), wedging, and easily washing out. The thickness of the coal beds reaches 1.0 m.

Kusumahbrata (pers. comm), considered that the Limesone Member of the previous authors should be included within the other unit, the Cicarucup Formation of Sudjatmiko and Santosa (1992).

The age of the Bayah Formation is Middle Eocene (Koolhoven, 1933) based on the presence of foraminiferal species assemblage.

Paleontology

The diversity of the molluskan fauna in the Bayah Formation is very low. *Ostrea* (*Turkostrea*) *doidoiensis* occurs in association with rare gastropods and trace fossils. The gastropods belong to the family Cerithiidae and only steinkern (internal mold) are left making identification to species level impossible (indeterminate) (Figure 2).

The horizon from which *Ostrea* (*Turkostrea*) *doidoiensis* has been collected is highly bioturbated (Figure 3). A few trace fossils such as *Scolicia, Ophiomorha, Skolithos, Teichichnus, Thalassinoides, Planolites, Chondrites, Phycodes* have been also identified from other parts of the formation (Figure 4-11). The specimens were collected from a lensoidal bed in the Bayah Formation (Figure 12-13). It is considered that the specimens were not in situ (displaced), because they are not in their growth position. However, it is assumed that the specimens were only displaced into different environment, not reworked from any older stratigraphic horizon. Fossils of arthropod are also found with the trace fossil (Figure 14).The specimens were not numerous and embedded in a sandy limestone bed (Figure 15), making collecting somewhat difficult. The Bayah specimens have a range of ontogenetic stages from juvenile to adult, as is the case with those collected from Malawa.

The presence of *Ostrea* (*Turkostrea*) *doidoiensis* in the Nanggulan Fomation is still uncertain. However, the specimen figured by Martin (1914-1915) as *Ostrea* (*Ostrea*) *jogjacartensis* is more likely a juvenile individual which is conspecific with the present specimens.

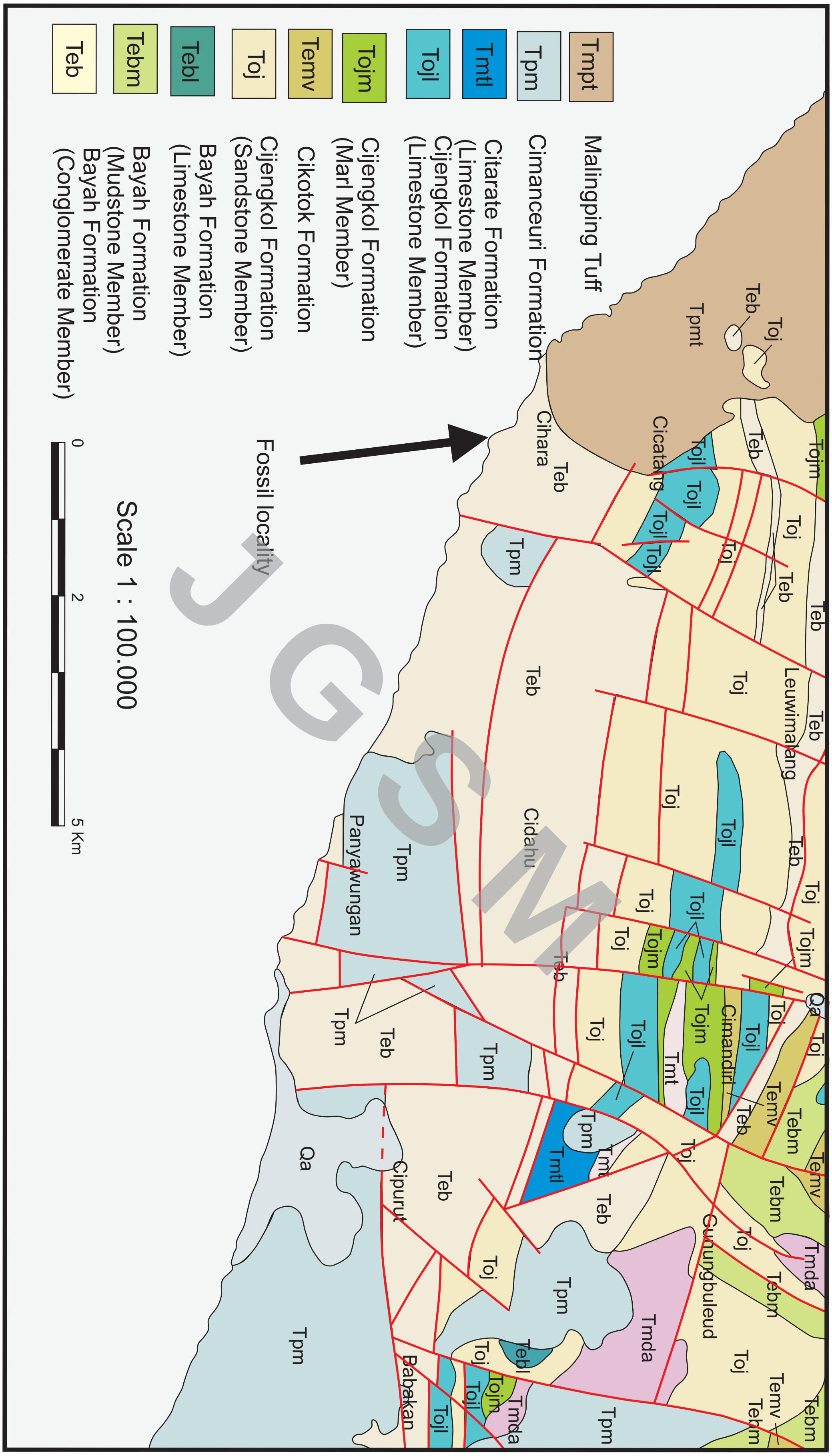

Figure 1. Regional geological map of the study area. (Part of Sujatmiko & Santoso, 1992)

Figure 2. Cerithiidae indet. Internal mold (steinkern only).

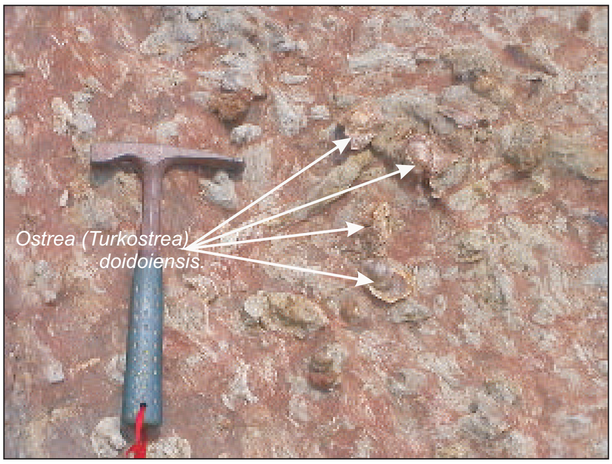

Figure 3. Highly bioturbated horizon with *Ostrea* (*Turkostrea*) *doidoiensis*.

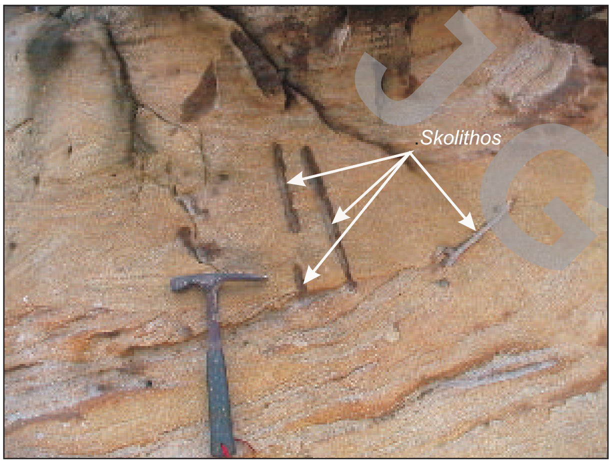

Figure 4. Trace fossil: *Skolithos*.

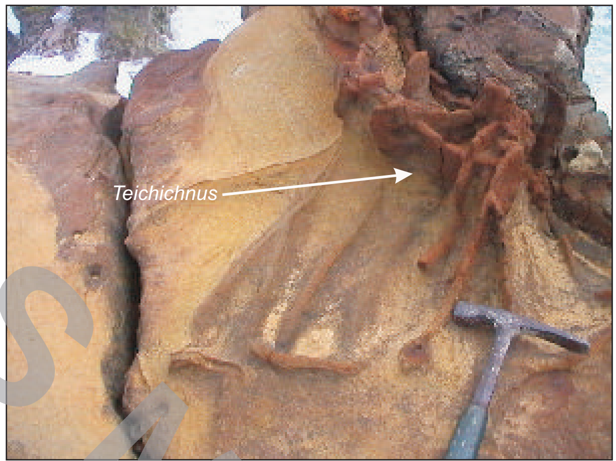

Figure 5. Trace fossil: *Teichichnus.*

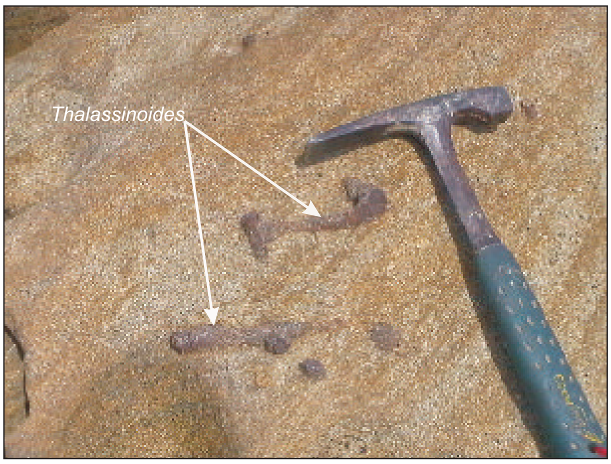

Figure 6. Trace fossil: *Thalassinoides.*

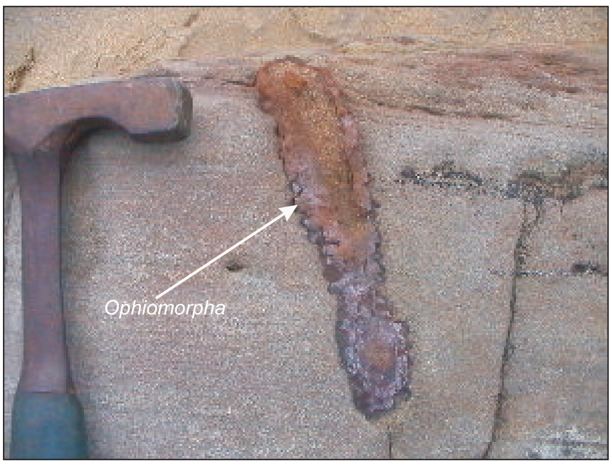

Figure 7. Trace fossil: *Ophiomorpha.*

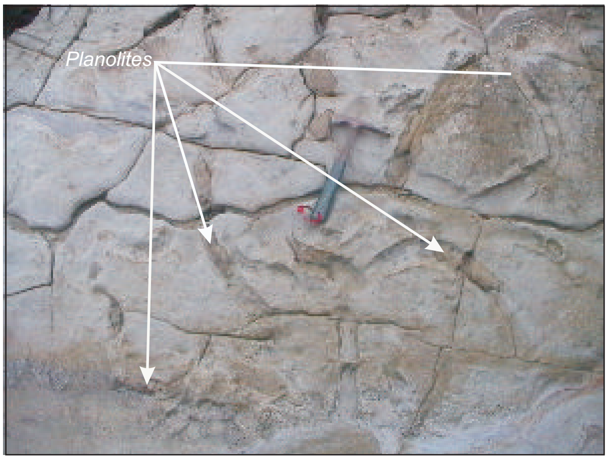

Figure 8. Trace fossil: *Planolites*.

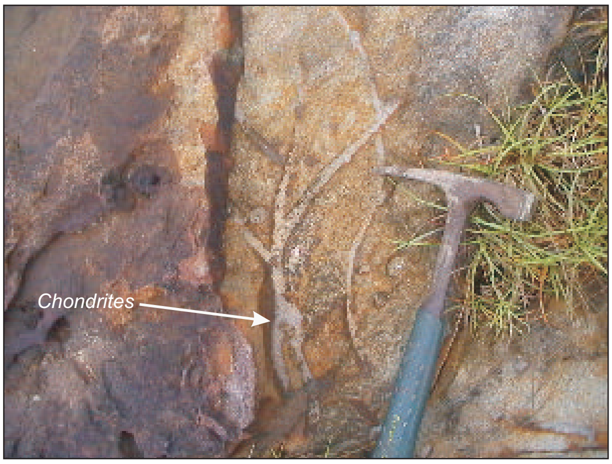

Figure 9. Trace fossil: *Chondrites*.

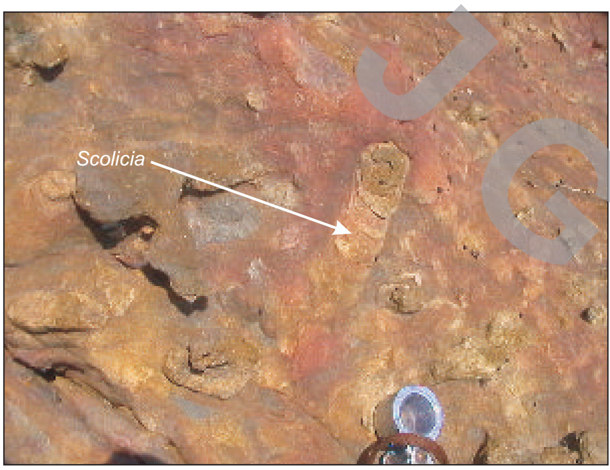

Figure 10. Trace fossil: *Scolicia*.

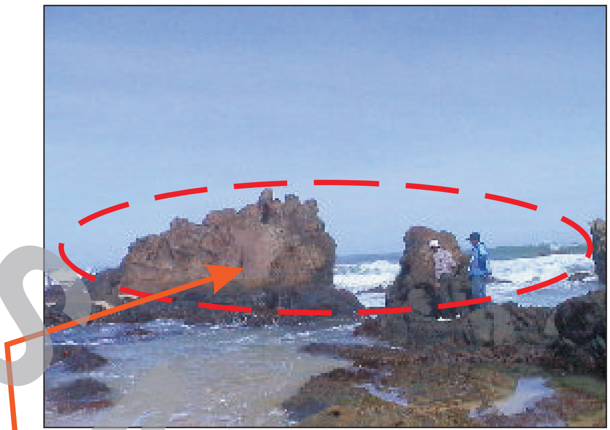

Figure 12. Lensoidal shape of highly bioturbated bed in the Bayah Formation.

Figure 11. Trace fossil: *Phycodes*.

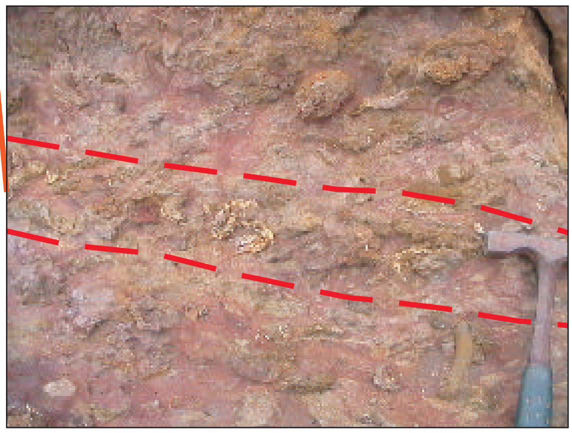

Figure 13. *Ostrea* (*Turkostrea*) *doidoiensis* shell bed.

Figure 14. Fossil *Arthropoda* (crab fossil).

Figure 15. Fossils are embedded in the rock, making collecting difficult.

Systematic

Phylum	:	MOLLUSCA Linnaeus, 1758
Class	:	BIVALVIA Linnaeus, 1758
Subclass	:	PTERIOMORPHIA Beurlen, 1944
Order	:	PTERIODA Newell, 1965
Suborder	:	Ostreina Ferussac, 1822.
Superfamily	:	Ostreacea Rafisneque, 1815.
Family	:	Ostreidae Rafinesque, 1815
Subfamily	:	Ostreinae Rafinesque,1815.
Genus	:	*Ostrea* Linné, 1768. Type species : *Ostrea edulis* Linné.
Subgenus	:	*Turkostrea* Vyalov, 1936. Type species : *Ostrea turkensis* Romanovsky, 1878 (= *O. Stricti-plicata* Raulin & Delbos, 1855).

Ostrea (*Turkostrea*) *doidoiensis* Hasibuan

Plate 1, fig. 1-4; Plate 2, fig. 5-10

Ostrea (*Turkostrea*) *doidoiensis* n.sp. Hasibuan, 2001: Pl. 1. Fig. 1-6.

Material

About 14 specimens of different stages of preservation (poorly to moderately preserved) and some incomplete fragments of the species are available for the study.

Description

The morphological features of our specimens meet the description of the genus *Ostrea* by Cox *et al*. (1971) based on the presence of anachomata on RV (right valve) (Pl. 1, fig. 2a), catachomata on LV (left valve) (Pl. 1, fig 3b; Pl. 2, fig. 5), strong and continuous radial ribs. The presence of chomata on the internal margins of the valves, their shape and ornamentation make them referable to subgenus *Turkostrea*. This species is conspecific with that described from Malawa Formation by Hasibuan (2001).

Compared with the Malawa specimens the present ones are thicker, more irregular in shape, with stronger radial ribs on LV (left valve). Both RV and LV are moderately convex. The substrate to which the specimens had been attached were more varied like plants (e.g. mangrove) or shell of its kind. Most of ostreidea are gregarious in life. The attachment area is moderately large to very large in size (Pl.1, fig.1b,3a).

Remarks

Prior to 1936, *Turkostrea* was known only from Early to Middle Eocene age sequences of North Africa and Central Asia (USSR). Recently, more published information have enriched our knowledge. *Turkostrea*, seems to be widely spread around the world such as Indonesia (Middle Eocene, Hasibuan, 2001), Mexico (Lower Eocene, Perrilliat & Vega, 2001), Alabama (Cretaceous, Kinsberg, 1998), and Bolivia (Middle Eocene, Pierce, 1960).

Perrilliat and Vega (2001) recorded Lower Eocene *Ostrea* (*Turkostrea*) sp. from the Viento Formation in La Popa basin, Nuevo Leon, Mexico. It differs from *Ostrea* (*Turkostrea*) *doidoiensis* in being remarkably larger in size, and more ovate in shape. The mean height of the former is 200 mm, while our specimens is only 75 mm high. They are different in age. *Ostrea* *strictiplicata major* Locard from the Eocene beds in Tunisia is similar to the Mexican ostreidea with its triangular shape of LV and more numerous and more closely spaced ribs (Perrilliat and Vega, 2001). The same features distinguished our specimens from *Ostrea arrosis* Aldrich occurring in the Eocene of Texas, both are large in size.

Rindsberg (1998) reported the presence of *Turkostrea sloani* (Stephenson, 1923) and *Turkostrea littlei* (Gabb, 1876) from the Upper Cretaceous of Alabama. However, as figures are not provided, a comparison with Bayah specimens is not possible to make at present.

Cox *et al*. (1971) recorded *Ostrea* (*Turkostrea*) *duvali* Gardner from the Lower Eocene, Caldwell Knob Oyster Bed, Wilcox Group, Moss Branch, Bastrop County, Texas. The specimen is a fully grown (mature) individual and is estimated to be of 15 years old. It has catachomata that flank the margin of the anterior bourrelet. They are relicts of former growth stages, indicating a mature individual. One of the Bayah specimens is also a fully grown individual based on its catachomatic life stage as shown by the Texas specimen.

Pierce (1960) reported *Ostrea* (*Turkostrea*) *fraasi* from Pagüey Formation, Bolivia. Middle Eocene age conclusion for this species has been based on the occurrence of foraminiferal species *Bulimina jacksonensis* and *Lepidocyclina* (*Pliolepidina*) *pustulosa.*

Table 1 shows the distribution chart of ostreidea in Indonesia. The table shows that no ostreidea were found in Paleocene and Oligocene times. This indicates that the environments were not suitable for ostreidea to live in the area during the periods.

Age

The age of *Ostrea* (*Turkostrea*) *doidoiensis* in the Malawa Formation is Middle Eocene. The age is concluded on the basis of the presence of palynomorphs species *Retitribrevicolpories matamanadhensis*, dinoflagellates species *Muratodinium fimbriatum* and *Homotryblium floripes* (Croty and Engelhardt, 1993). An Eocene age is assigned to the formation by Hazel (in Sukamto, 1982) based on the occurrence of ostracods.

In the Umpung River section, District of Ralla, Barru, South Sulawesi, the lower part of the Tonasa Formation contains *Fasciolites* sp. and *Nummulites javanus* indicating a Middle Eocene age for the part of the formation (Sudijono, 1995). As the thickness from the marine part of the Malawa Formation to the Tonasa Formation containing *Fasciolites* is not so great, it is concluded that part of the formation is still Middle Eocene in age.

An Eocene age has been assigned to the Nanggulan Formation by Martin (1882) based on the presence of *Nummulites*. Rutten (1927) came to the same conclusion based on the percentage of extant species of mollusks. Hartono (1969) concluded that the age of the Nanggulan Formation is Middle Eocene based on its foraminiferal fauna. Okada (in Saito, 1981) reported nannofossil zonal markers species for Middle Eocene age of Nanggulan Formation.

Ostrea (*Turkostrea*) *doidoiensis* in the Bayah Formation is also Middle Eocene in age as concluded by Koolhoven (1933) and Suparka *et al*. (1979).

Occurrence

The specimens were collected from the Bobos Bay, in a lensoidal bed of sandy, muddy, highly bioturbated limestone, of the lower part of the Bayah Formation at locality FH017 (S 06°53' 17.4" and E 106°07' 09.9").

Paleoenvironmental analysis

Ostrea (*Turkostrea*) *doidoiensis* was found from a muddy, sandy limestone bed in association with trace fossils.

The occurrrence of these trace fossils indicates that this part of the Bayah Formation has been deposited in the tidal to neritic zones or continental shelf with moderate to high energy water. The thick shells show the deposition took place during the tropical climate. The lensoidal shape of the bed is probably an indication of a bay or lagoonal environment with high nutritious material.

Generally, large size and thick shells of ostreidea indicate a tropical climate for their living environtment. The facies where ostreidea live usually represents a fluvial landscape, with considerable amounts of organic matter from the rivers which prevailed during the regression.

Ostreidea which exposed to sunlight had stronger, harder, and denser, more chunky compact shells; their left valves more convex, and their shell walls had higher specific gravities. The ostreidea growing in the shade mostly had flat or concave right valves; many of those growing under the sunlight had convex right valves (Cox *et al*., 1971).

The Bayah materials show stronger, harder, and denser, more chunky compact shells; their LV an RV are convex and chunky. It can be concluded that *Ostrea* (*Turkostrea*) *doidoiensis* in the Bayah Formation lived and exposed to sunlight, in a tropical climate. On the other hand, *Ostrea* (*Turkostrea*) *doidoiensis* from the Malawa Formation probably lived and exposed to sunlight and sometimes in the shade, in a tropical climate, in the Middle Eocene time.

Based on the type of trace fossils which are associated with the specimens, it can be concluded that the paleodepositional environment of this part of the Bayah Formation was tidal to neritic zones or continental shelf.

CONCLUSION

It can be concluded that *Ostrea* (*Turkostrea*) *doidoiensis* from the Malawa and the Bayah Formations have the same age (Middle Eocene) and they lived in a tropical climate along the coast of the Sundaland, in tidal to neritic zones or continental shelf (Figure 16, map after Simandjuntak and Barber, 1996)

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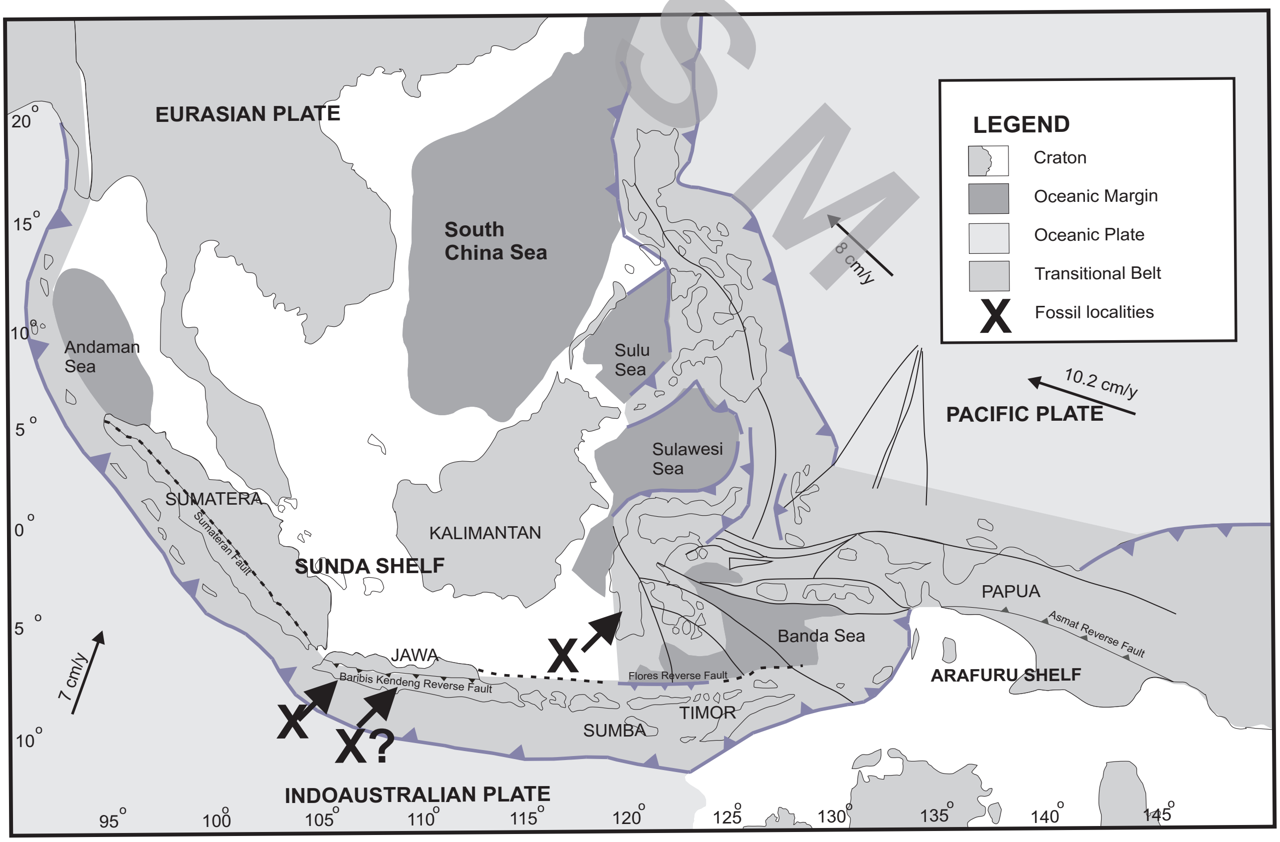


Figure 16. Tectonic setting of Indonesian Regional (Simandjuntak & Barber, 1996).

Table 1 . Distribution chart of Ostreidae in the Indonesian Archipelago (Modified from Hasibuan, 2001)

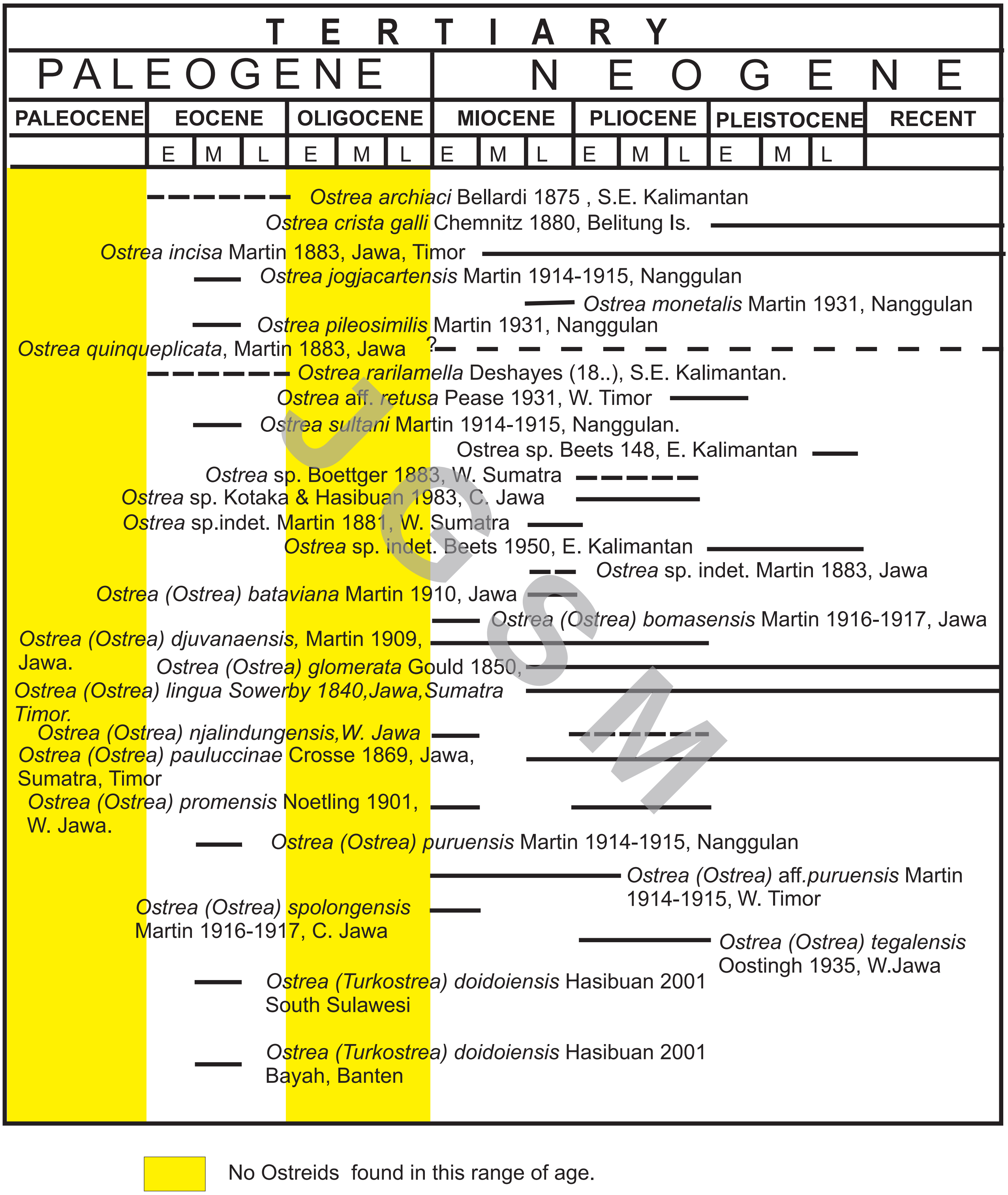


PLATE 1

Explanation:

Ostrea (Turkostrea) doidoiensis Hasibuan.

Fig. 1a. LV, external, 1.18 X.
Fig. 1b. LV, external, the same specimen, showing large attachment area, probably on the shell of the same species, 1.35 X.

Fig. 2a. Two LVs, external, and one RV, marginal area, 0.84 X.
Fig. 2b. RV, external from the same slab, 0.79 X.

Fig. 3a. LV, external with attachment area, 1.04 X.
Fig. 3b. LV, internal of the same specimen, 1.0 X.

Fig. 4a. LV external, broken shell, 0.76 X.
Fig. 4b. LV internal of the same specimen, covered by sediment, 0.79 X.

PLATE 2

Explanation

Ostrea (Turkostrea) doidoiensis Hasibuan.

Fig. 5. LV, internal, 0.71 X.

Fig. 6. LV, internal, 0.56 X.

Fig. 7a. RV, external, 1.75 X.
Fig. 7b. RV, internal of the same individual covered by sediment, 1.70 X.

Fig. 8a. RV, internal, 1.22 X.
Fig. 8b. LV, external of the same individual, part of the ornamentation is missing, 1.22 X.

Fig. 9. RV, external, 1.26 X.

Fig. 10. LV, external, incomplete specimen, 0.68 X.

Plate 1

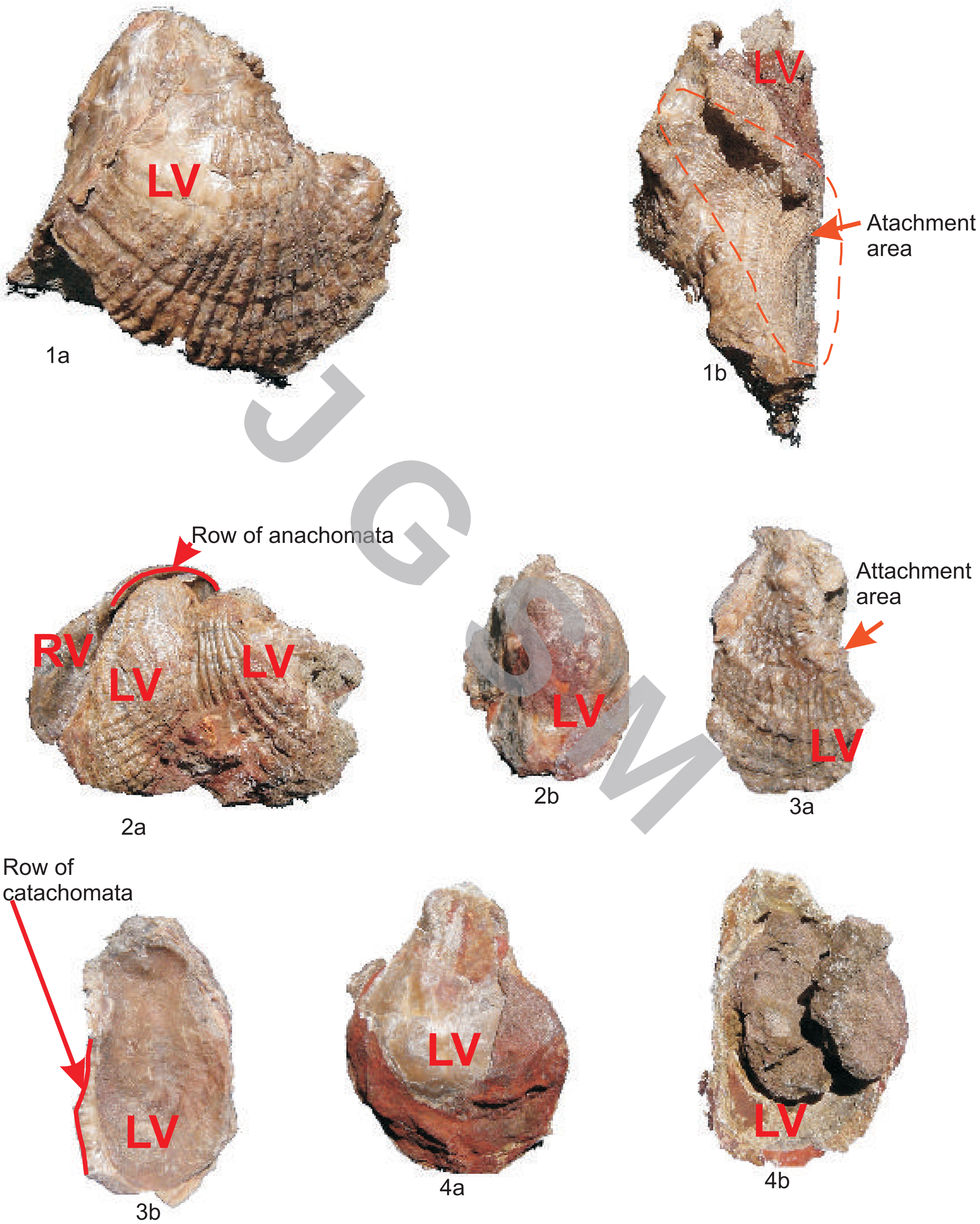
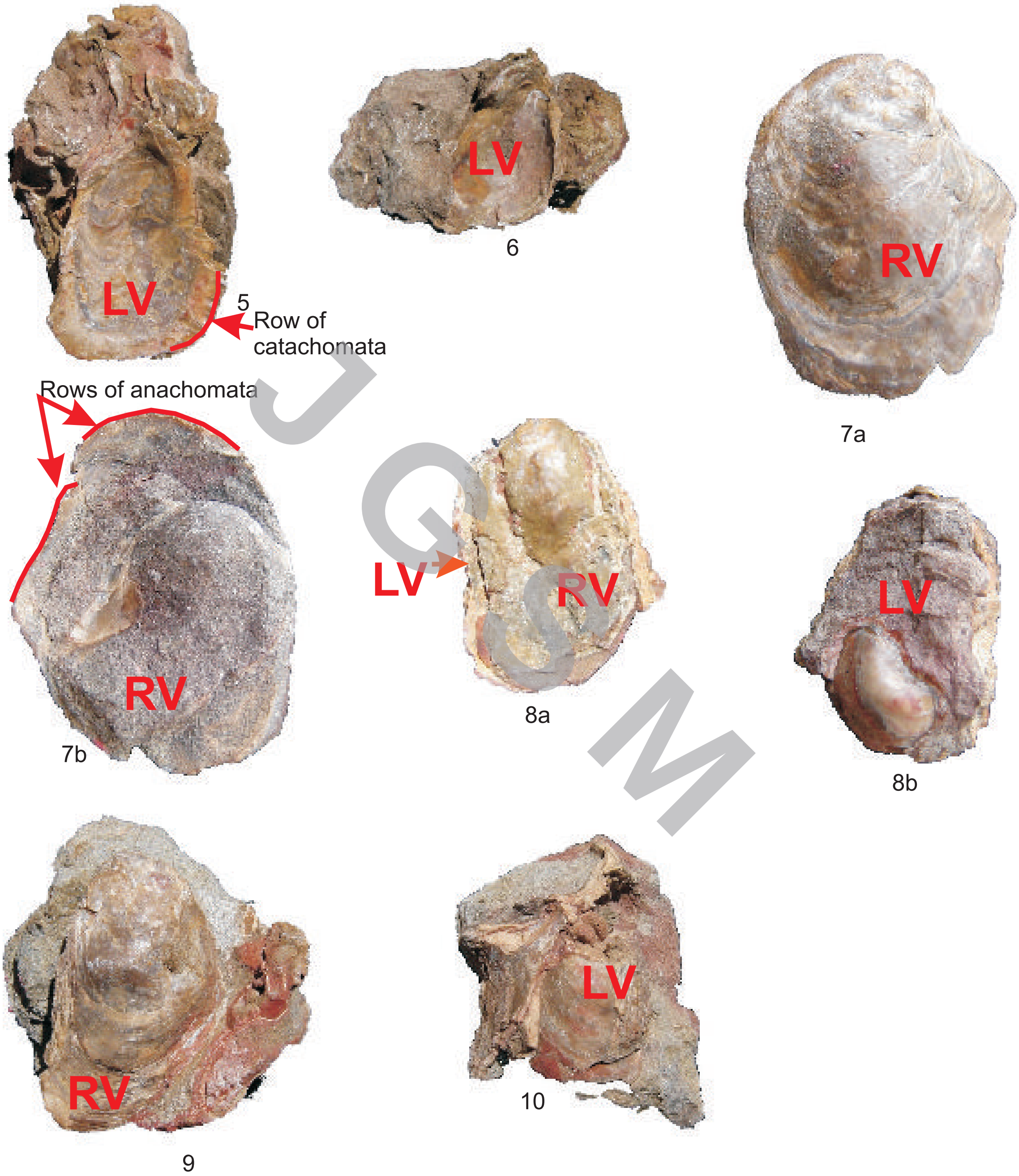

LV
1a
LV
Atachment
area
1b
Row of anachomata
RV
LV
LV
2a
LV
2b
Attachment
area
LV
3a
Row of
catachomata
LV
3b
LV
4a
LV
4b

Plate 2


LV
5
Row of
catachomata
LV
6
RV
7a
Rows of anachomata
RV
7b
LV
RV
8a
LV
8b
RV
9
LV
10

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