

# PLIOCENE MOLLUSCA FROM A CORAL LIMESTONE OF A HILL NEAR SEKOERAU, E. BORNEO

BY

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## INTRODUCTION.

The present paper deals with a small collection of Neogene fossils which has been made by the geologist Dr. M. SCHMIDT in the Sangkoelirang area<sup>1</sup>), East Borneo. The locality is defined in GERTH's (1923) and KRIJNEN's papers (1931, loc. no. 175, p. 535).

It must be stated here that this locality has been mentioned incorrectly in literature, viz., as "Hill near Sekoerau" instead of "Coral limestone, Hill near Sekoerau". Dr. SCHMIDT's collection, which was sold to the Leyden Geological Museum in 1920 — about twenty years after being made — contains two different faunas from Sekoerau: vide infra.

GERTH (l. c.) was the first to describe material (corals) from SCHMIDT's collections. The corals from Sekoerau were listed under the locality number 21 (GERTH, 1923, pp. 41, 45), their age being regarded as Pliocene. GERTH added the following remark: "Diese kleine Fauna ist von der lebenden nur wenig verschieden" (l. c., p. 41).

JEANNET and MARTIN (1937, pp. 250, 304) identified a single echinoid. Unfortunately, its locality was mentioned differently on the pages cited, viz., as "Kabasian river" and "Sekoerau" respectively.

The mollusca of this locality are discussed below and all fossils known are listed in Chapter II.

As mentioned above Dr. SCHMIDT's collection contains two fossil faunas from the Hill near Sekoerau. One is a beautiful collection of dwarf mollusca undoubtedly being of Miocene age<sup>2</sup>). It is labelled "Hill near Sekoerau". To avoid any further misunderstanding I checked the original labels of all corals from SCHMIDT's collections which were identified by GERTH. All species mentioned by the latter, derived from Sekoerau, proved to be labelled "Coral limestone, Hill near Sekoerau", like the mollusca to be described below (the Miocene fauna proved to contain no corals identified by GERTH). GERTH used in his text (systematic part) the following indications for the corals from one and the same Pliocene locality: "Hill near Sekoerau", or "Sekoerau". In one case only, *Prionastraea borneënsis* GERTH, he mentioned the "Coral limestone".

VAN DER VLERK (1925) published a stratigraphical table of the eastern Borneo Tertiaries which shows the Pliocene (coral) fauna of Sekoerau as an equivalent of the Kembang beds of Central Koetei (JEZLER's "Miopliocene"): cf. the table opposite page 31: d ("Hill near the Soengei

<sup>1</sup>) Dutch orthography *oe* corresponds with English *oo*.

<sup>2</sup>) This fauna will be fully described in another paper.

Sekoerau"). Later investigations proved that the stratigraphical subdivision of the Sangkoelirang area had to be changed<sup>1)</sup>: the limestones meant here will be identical with the Domaring limestone series of northern Koetei.

# I. The mollusca from the coral limestone of Sekoerau Hill.

Classis *Gastropoda*.  
Subclassis *Prosobranchia*.  
Familia *Angariidae*.  
(Syn. *Delphinulidae*).

Genus *Angaria* ROEDING, 1798.  
Sectio *Angaria* ROEDING.

## ANGARIA (ANGARIA) DELPHINUS (LINNÉ).

1921. WANNER, pp. 155, 156 (*Delphinula* cf. *fossilis* MART.).  
1934. NOMURA & ZINBÔ, p. 148 (*Angaria formosa* REEVE).  
1936. PANNEKOEK, p. 62, pl. 3, fig. 41 (*Angaria* cf. *formosa* REEVE).  
1938. VAN REGTEREN ALTENA, p. 286 (with further syn.).  
1939. KRUIZINGA, p. 264 (*Delphinula laciniata* LAM.).  
non 1941. BEETS, pp. 17, 168, 175 (excl. syn. tantum<sup>2)</sup>).

This characteristic species is represented by a single large specimen being 46.5 mm high and about 60 mm wide. The shell is very well preserved and may be compared with recent material of the same size. It belongs to the forma *atrata* (REEVE) and exactly resembles a recent specimen from Singapore (coll. STILLIER) in the British Museum of Natural History to which I compared it some time ago.

*A. delphinus* has been recorded from the Javanese Lower Miocene Rembang beds, from JUNGHUHN's localities K (Tjidamar: doubtful) and P (Lio-tjitjangkang: doubtful) and the Pliocene of Timor and Java (Upper Kalibeng layers). Finally, it has been mentioned from the Quaternary of Soemba (East Indies) and the Riu-Kiu islands.

Familia *Potamididae*.

Genus *Pyrazus* MONTFORT, 1810.

## PYRAZUS WITKAMPI spec. nov.

Figs. 1—2.

This is a remarkable species which is also found in WITKAMP's collection from E. Borneo in the Geological Institute, Utrecht<sup>3)</sup>.

The holotype figured herewith is in a fairly bad condition but it is so characteristic that the species may be named without objection. The type is 72 (+ ?) mm long, being partly corroded and also perforated at many places. The eldest whorls preserved are swollen, but before and behind the middle portion they are flat to concave (posteriorly). A striking feature is the axial sculpture, consisting of a few straight ribs developed especially on the lower half of the whorls. On both shells available the arrangement

<sup>1)</sup> Cf. LEUPOLD and VAN DER VLEKK, 1931: stratigraphical table.

<sup>2)</sup> This material belongs to *A. distorta* (LINNÉ). The revision will be discussed in another paper.

<sup>3)</sup> No. 771. 1934. This specimen was collected in the Kabasian river and must have been derived from Neogene, probably Miocene strata.

of the ribs on the elder whorls is rather irregular but on the younger shell portions we see six rows of ribs lying at regular intervals.

The spiral sculpture consists of some fairly strong spiral threads being approximately of equal strength and covering the whorls regularly. The course of the spirals is slightly wavy. The same applies to the sutures between the flat whorls forming the six-sided younger part of the shell.

The mouth of the shell is wide, the columella concave and smooth, the inner lip lamellate and well-defined. The base bears some obsolete (?) spirals and an outer, posterior, canal of the mouth is well-defined by a

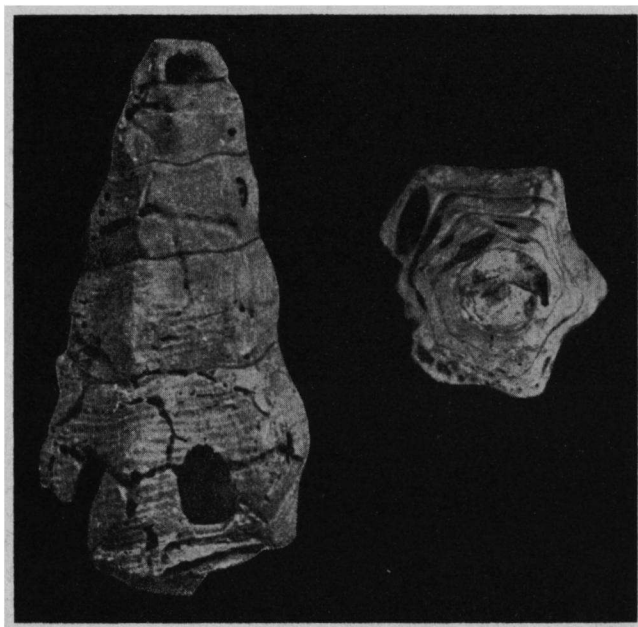


Fig. 1.

Fig. 2.

Figs. 1—2. *Pyraeus witkampii* spec. nov. Holotype. Length 72 mm.

strong spiral lying close to the upper part of the right lip; this canal is filled with shelly material at some distance from the mouth.

I failed to discover any related species, either recent or fossil.

#### Familia *Cerithiidae*.

Genus *Cerithium* BRUGUIÈRE, 1789:

#### **CERITHIUM TRAILLII** SOWERBY.

† 1935. NOMURA & ZINBÔ, pp. 47, 48, pl. 5 (1), fig. 3.

A single specimen available. Its length is nearly 34 mm and it resembles slender recent shells of the same size which have slightly flatter whorls, and which I compared in the "Rijksmuseum van Natuurlijke Historie", Leyden. The secondary spiral between the first and second primary spiral (from behind) is better developed than in most other shells, and consequently the specimen finally bears four instead of three primary spirals.

I know this species from Quaternary deposits of East Borneo<sup>1)</sup>, while a few unusual specimens from RUTTEN's localities 141, Goenoeng Batoeta and the Gelingsch beds ("layer 1") will be described in another paper<sup>2)</sup>.

According to the figure, the specimen identified by NOMURA & ZINBÔ seems to be a doubtful representative.

Familia *Muricidae*.  
Subfamilia *Muricinae*.

Genus *Murex* LINNÉ, 1758.

Subgenus *Hexaplex* PERRY, 1811.

Sectio *Phyllonotus* SWAINSON, 1833.

**MUREX (PHYLLONOTUS) RUTTENI** spec. nov.

Figs. 3—4.

This species is represented by the holotype only. Unfortunately its apex and outer lip are missing but the remainder is well preserved. Its length is 45 mm, its maximum width 29 mm. The spire is high, the whorls rather flat, the first whorls being corroded.

The spire is covered with regular rows of varices and ribs, three rows of varices being arranged symmetrically, two ribs in each interstice. The whorls are broadly depressed behind and bear a spiral swelling anteriorly on which the ribs are better developed. The spiral sculpture consists of

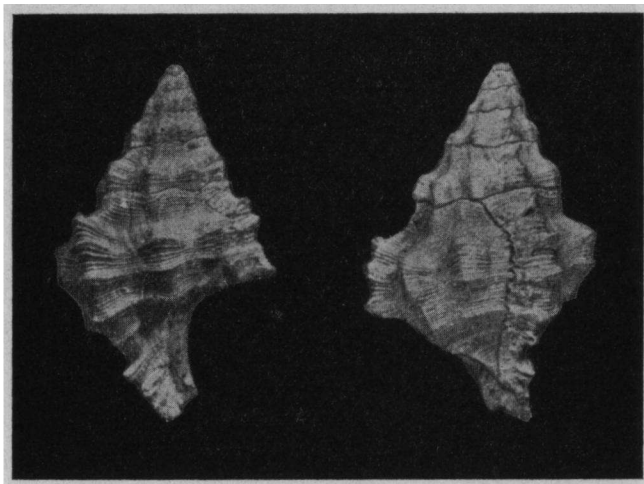


Fig. 3.

Fig. 4.

Figs. 3—4. *Murex ruttenei* spec. nov. Holotype. Length 45 mm.

numerous spirals being cancelled by growth-lines. One spiral, marking the shoulder of the whorls, is fairly strong and almost the same applies to another spiral lying behind the shoulder. The last-mentioned thread is obsolete between the varices and it is only clearly developed on them, even

<sup>1)</sup> As will be mentioned in a paper on mollusca from the islands of Boenjoë and Tarakan.

<sup>2)</sup> Mollusca from these localities have been mentioned some time ago: BEETS, 1941.

tubercle-like finally, as in the case of the spiral mentioned before. On the penultimate whorl and especially on the body-whorl, the posterior strong spiral on each varix develops a dorn which served as a canal. The sutures are wavy. Sometimes a third strong spiral is visible in the suture; it marks a shoulder which is well-defined on the body-whorl.

The body-whorl bears four (three) other strong and dorned spirals. The end-varix presumably would show dorns on all primary spirals. The ribs become obsolete at a short distance before the suture. The inner lip is strongly lamellate, its outer zone bearing a row of some ten short teeth of unequal size. Their interstices vary; the first (upper) tooth is stronger than the other ones. The anterior canal is developed spirally.

I do not know any Indo-Western Pacific species being clearly related to the new form, either recent or fossil. The new species is named after the late Prof. L. M. R. RUTTEN.

#### Subfamilia *Drupinae*.

Genus *Drupa* ROEDING, 1798.

Sectio *Morula* SCHUMACHER, 1817.

#### DRUPA (MORULA) CONCATENATA (LAMARCK).

1907. SCHEPMAN, p. 179.

1907. ICKE & MARTIN, p. 237.

1915. TESCH, 1915—1920, I, p. 66, pl. 10, fig. 144 a—b.

1931. VAN DER VLIERK, p. 238.

1941. DE BRUYNE, p. 29.

Only a single shell is available. It is well-preserved and resembles particularly the slenderer recent and fossil (*Kajoe ragi*) specimens.

*D. concatenata* occurs also in "Miocene" deposits at Kari Orang (coll. WITKAMP; no. 806. 1934, Geological Institute, Utrecht); this Kari Orang specimen is a small one which will be discussed in another paper.

Fossil occurrences: "Miocene" of Kari Orang, E. Borneo; Pliocene of Timor and Nias; Quaternary of Celebes (*Kajoe ragi*) and Tarakan.

#### Familia *Fasciolaridae*.

Genus *Peristernia* MÖRCH, 1852.

#### PERISTERIA JONKERI (KOPERBERG).

1931. KOPERBERG, p. 96, pl. 3, fig. 35.

1941. DE BRUYNE, p. 28.

This species is represented by a single specimen showing both a damaged spira and anterior canal. It resembles the type material (Mining Institute, Delft) and other shells which are available from the Pliocene of Timor (Nitoe papan; coll. "SNELLIUS"-expedition, Geological Museum, Leyden) and of Borneo (Tanah belang; coll. M. SCHMIDT, Geological Museum, Leyden).

The Sekoerau specimen belongs to the forma  $\alpha$ . Its columella bears an obsolete plait at the beginning of the anterior canal.

*P. jonkeri* was described from the Pliocene of Timor.

#### Familia *Mitridae*.

Genus *Mitra* MARTYN, 1784.

Sectio *Nebularia* SWAINSON, 1840.

**MITRA (NEBULARIA) LIMOSA MARTYN var. AMBIGUA SWAINSON.**

1935. DAUTZENBERG, p. 73.

A single specimen is available which is partly damaged. I compared it with recent material and found the identification fairly certain.

This recent species has not been recorded from any deposit up to now.

Familia *Turridae*.  
(Syn. *Pleurotomidae*).

Genus *Turris* ROEDING, 1798.  
Sectio *Turris* ROEDING.

**TURRIS (TURRIS) BREVICAUDATA (REEVE).**

1907. SCHEPMAN, p. 158.  
1911. MARTIN, pp. 35, 45 (*Pleurotoma* spec. 3).  
1931. VAN DER VLIERK, p. 218,

A single specimen is available. It is well preserved although its spire is partly damaged. The shell agrees in every respect with a recent specimen from the Philippine islands, in the "Rijksmuseum van Natuurlijke Historie", Leyden.

SCHEPMAN recorded this species from the Quaternary of Celebes (Kajoe ragi). I compared the Sekoerau specimen with the Kajoe ragi material. *T. brevicaudata* also occurs in the Younger Miocene of Sekoerau (coll. M. SCHMIDT in the Geological Museum, Leyden). A larger and fine specimen is available from the Tjilanang beds, Java: locality Tji Kapoetih; no. 7867, Geological Museum, Leyden: labelled "*Pleurotoma* spec. 3".

Familia *Conidae* s.str.

Genus *Conus* LINNÉ, 1758.

**CONUS ODENGENSIS MARTIN.**

Syn. *Conus* cf. *Junghuhnii* MARTIN (1914).  
1914. MARTIN, p. 330.  
1941. BEETS, pp. 4, 132, 170, 173, 188, 193 ["*Conus* spec. (neu)"], 194 (pars: only loc. no. 144 RUTTEN<sup>1</sup>), 197, 201.

An immature specimen is available. Comparison with a large series of representatives of *C. odengensis* indicates this identification is correct.

For geological distribution: cf. BEETS, l.c. This species also occurs in the Lower Miocene (Rembangian) of Balikpapan (E. Borneo) and the Miocene of Western Borneo: Soengei Orau — Soengei Toesan, Tandjong Batoe<sup>2</sup>).

Classis *Pelecypoda*.  
Ordo *Taxodonta*.  
Familia *Arcidae*.

Genus *Arca* LINNÉ, 1758.  
Sectio *Arca* LINNÉ.

**ARCA (ARCA) ANTIQUATA LINNÉ.**

1935. OOSTINGH, pp. 132, 218.  
1936. SAUREN, p. 234.  
1938. WEER, p. 67.

<sup>1</sup>) The material mentioned from RUTTEN's loc. 150 (with doubt), represents *C. virgo* LINNÉ, as will be discussed in another paper.

<sup>2</sup>) These collections will be described in other papers.

1939. MONTANARO GALLITELLI, pp. 220, 254, 255.  
 1940. VAN BENTHEM JUTTING, pp. 15, 16, 17, 18, 19, 20.  
 1941. BEETS, pp. 153, 171, 175, 177, 180, 188, 194.  
 1941. DE BRUYNE, p. 31.  
 1945. ALTENA & BEETS, pp. 51, 61.

A rather low valve is available, perfectly agreeing with other fossil and also recent specimens. For synonymy and fossil distribution one may refer to the papers cited.

*A. antiquata* also occurs in the Lower Miocene (Rembangian) of Langkang, Palembang area, Sumatra; the Miocene of Western Borneo (Lutong coast), the Younger Miocene of Sekoerau (coll. M. SCHMIDT), Neogene strata of N.W. New Guinea (two localities) and the Quaternary of Goenoeng Mendong, E. Borneo. These collections are kept in the Geological Museum, Leyden, and will be discussed in other papers.

Sectio *Scapharca* GRAY, 1847.

#### ARCA (SCAPHARCA) RUSTICA MARTIN.

- Syn. *Anadara rectangularis* COSSMANN, 1924.  
 1885. MARTIN, 1883—1887, p. 248, pl. 13, fig. 253.  
 1887. MARTIN, 1883—1887, p. 308.  
 1890. MARTIN, p. 279.  
 1920. TESCH, 1915—1920, II, p. 96, pl. 20, figs. 257 a—b.  
 1924. COSSMANN, p. 95, pl. 5, figs. 13—16.  
 1931. VAN DER VLIERK, p. 272.

This species is represented by a single left valve agreeing in every respect with TESCH's material (Mining Institute, Delft) and some of MARTIN's types in the Leyden Geological Museum.

Comparison of the types revealed much more variation than indicated by the description and figures. The holotype proves to be a rather extreme low form, whereas TESCH's figures represent a high valve connected with the type by all possible intermediate forms.

The specimen from Sekoerau has 31 ribs, TESCH's Timor specimen 27. MARTIN mentioned 25—27 ribs but his types in fact show 25—33 ribs:

Locality	Kassi Marinoe:	28 ribs (a small valve, perfectly agreeing with COSSMANN's types).
"	"	: 33 ribs (a bigger specimen).
Locality	Fatœ Loeli	: 26—27 ribs (type).
"	"	: 26—27 ribs.
"	"	: 27—28 ribs.
"	"	: 28 ribs (two valves).
"	"	: 29—30 ribs.
"	"	: 31 ribs.
Two other valves from Timor:		30—31 ribs.

The posterior ribs may be narrower than those of MARTIN's type, and more numerous.

The valves may be winged posteriorly (dorsal side), exactly agreeing with COSSMANN's types which cannot be separated from a small type of *A. rustica* from Kassi Marinoe, Timor. All East Indian shells bear an obsolete depression on their umbonal part, as in *A. rectangularis*. COSSMANN's description mentions about 40 ribs, but his figures clearly show 30—31 ribs, so this number obviously is a misprint.

As MARTIN did not figure a series of specimens, COSSMANN could safely describe and name a new species which now, in our opinion, proves to be synonymous with *A. rustica*.

The recent *A. gubernaculum* REEVE var. *luzonica* REEVE (REEVE, 1843—'78, Monog. *Arca*, 1844, pl. 7, spec. 44; LAMY, 1907, p. 239) which is only known from the Philippines (and an unknown locality) resembles the higher forms of *A. rustica*. I compared *A. rustica* with complete recent specimens (locality: "Indian Ocean") in the "Rijksmuseum van Natuurlijke Historie", Leyden, which had been incorrectly identified as *A. jousseaumei* LAMY, and also with the type material in the British Museum of Natural History, London. *A. rustica* is clearly flatter than *A. luzonica*, its ribs behind the middle portion of the shell are more oblique. The teeth at both ends of the hinge are as a rule also more oblique and the hinge is more strongly developed.

Another related form is *A. terhaari* OOSTENGH (1935, p. 139, pl. 12, figs. 114—121).

*A. rustica* has only been recorded from Pliocene strata: Timor, Java, and India (Karikal).

Ordo *Eulamellibranchiata*.

Familia *Crassatellidae*.

Genus *Crassatella* LAMARCK (1799), 1801.

#### CRASSATELLA RADIATA SOWERBY.

1885. MARTIN, 1883—1887, p. 227, pl. 11, fig. 228.

1887. MARTIN, 1883—1887, p. 347.

1919. MARTIN, pp. 62, 121, 146.

1931. VAN ES, pp. 58, 96, 116, 119.

1931. VAN DER VLERK, p. 275.

1932. PRASHAD, p. 141.

1935. OOSTENGH, pp. 165 (textfig. 20), 218.

This species is represented by a single, rather young right valve with finely crenulated inner ventral border, as in the case of other specimens, both recent and fossil.

*C. radiata* has been recorded from the Javanese Lower Miocene (Rembangian), Pliocene and Quaternary. It occurs also in the Younger Miocene Gelingsch beds of East Borneo (loc. 149 RUTTEN) and the Quaternary of N.E. Borneo<sup>1</sup>).

Familia *Tridacnidae*.

Genus *Tridacna* LAMARCK, 1799.

#### TRIDACNA SQUAMOSA LAMARCK.

1907. SCHEPMAN, p. 197.

1931. VAN DER VLERK, p. 275.

1932. PRASHAD, p. 290.

1933. NARDINI, p. 169 (det. FAUROT: non vidi).

1934. NARDINI, p. 172 (id.).

1934. NOMURA & ZINBÔ, p. 163 (cf.).

1935. NOMURA & ZINBÔ, pp. 41, 43, pl. 5 (1), fig. 2.

1940. VAN BENTHEM JUTTING, pp. 16, 17, 19, 20.

A partly damaged valve is available, perfectly agreeing with the fossil valve from Celebes (Kajoe raji), in the Leyden Geological Museum, and also with recent specimens. The present-day distribution of this species is intimately connected with coral reefs.

Fossil distribution: Pliocene and Quaternary.

Genus *Hippopus* LAMARCK, 1799.

<sup>1</sup>) To be mentioned in papers on Miocene fossils from E. Borneo and Quaternary fossils from the islands of Boenjoë of Tarakan, respectively.



## HIPPOPUS HIPPOPUS (LINNÉ).

Syn. *H. maculatus* LAMARCK.

1925. OOSTINGH, pp. 280, 321.

1932. PRASHAD, p. 293.

1933. NOMURA, pp. 5, 72.

1934. LADD, p. 186.

1941. BEETS, pp. 193, 194, 197.

This characteristic species is represented by two partly damaged valves which agree in every respect with recent specimens and with fossils from the Gelingsseh beds (mentioned in 1941), also with material from the Quaternary of Goenoeng Mendong, East Borneo (to be mentioned in another paper).

Fossil distribution: Younger Miocene of E. Borneo (Gelingsseh beds), and Quaternary of E. Borneo (G. Mendong), Formosa and the Fidji islands.

Familia *Aloididae*.

(Syn. *Corbulidae*).

Genus *Aloidis* MEGERLE VON MÜHLEFELD, 1811.

## ALOIDIS ERYTHRODON (LAMARCK).

Syn. *Corbula socialis* Martin var., Martin Ms., 1912; *C. bonneti* Coessmann.

1922. YOKOYAMA, p. 122, pl. 6, figs. 8, 9.

1924. COSSMANN, p. 146, pl. 8, figs. 23—24.

1926. YOKOYAMA, pp. 318, 348, pl. 41, fig. 3.

1927. MAKIYAMA, p. 55.

1928. YOKOYAMA, pp. 9, 16, 19, 70.

[1929. YOKOYAMA, p. 364 (= subspec. *nisataiensis* OTUKA)].

1932. NOMURA, p. 93.

1933. NOMURA, pp. 7, 105, 108.

[1934. OTUKA, pp. 586, 590, 596, 620, pl. 48, figs. 43—45 (subspec. *nisataiensis*)].

1935. RIN, p. 23.

[1937. OTUKA, p. 29 (subspec. *nisataiensis*)].

1941. BEETS, pp. 193, 197.

A partly damaged valve is available. It agrees perfectly with recent material from Japan and the East Indies, also with fossils from Java (Goenoeng Gombel: St. no. 6896, in the Leyden Geological Museum) which had been identified by MARTIN in 1912 as *Corbula socialis* var.<sup>1)</sup>. The specimens also agree with YOKOYAMA's figure (1926). COSSMANN's material agrees very well with the Sekoerau specimen and also with other fossil and recent specimens at my disposal (judging from the beautiful figures given by COSSMANN).

Fossil distribution: Younger Miocene: Gelingsseh beds, E. Borneo (and Y. Miocene of Sekoerau: to be mentioned in another paper); Y. Miocene and Pliocene of Japan (common), Formosa and India (Karikal); Quaternary of Formosa and Japan.

The Japanese Miocene subspecies *nisataiensis* OTUKA is smaller than the typical form and bears an obviously finer concentric sculpture.

<sup>1)</sup> The gastropods of this fauna were discussed in the second part of MARTIN's "Vorläufiger Bericht" (1911—'12).

## II. List of fossils from the Coral Limestone, Hill near Sekoerau.

In the following list some abbreviations have been applied:

Am: Lower Miocene	n : "Neogene"
M : Miocene	P : Pliocene
Aj : Younger Miocene	pf: Pliocene or Quaternary
m : "Miocene"	Q : Quaternary

Mollusca	Am ... M ... Aj ... m ... n ... P ... pf ... Q ... Recent.
<i>Angaria (Angaria) delphinus</i> (LINNÉ).....	Am ..... !Aj ..... !n ... P ... pf ... Q ... Recent.
<i>Pyrazus witkampii</i> spec. nov. ....	..... n .....
<i>Cerithium traillii</i> SOWERBY .....	Am (cf.) ... Aj (cf.) ..... Q ... Recent.
<i>Murex (Phyllonotus) ruttensii</i> spec. nov. ....	.....
<i>Drupa (Morula) concatenata</i> (LAMARCK) ...	..... m ..... P ..... Q ... Recent.
<i>Peristernia jonkeri</i> (KOPERBERG) .....	..... P .....
<i>Mitra (Nebularia) limosa</i> MARTYN	
var. <i>ambigua</i> SWAINSON .....	..... Recent.
<i>Turris (Turris) brevicaudata</i> (REEVE) .....	..... Aj ..... Q ... Recent.
<i>Conus odengensis</i> MARTIN .....	Am ... M ... Aj ... m ... n ... P .....
<i>Arca (Arca) antiquata</i> LINNÉ .....	Am ... M ... Aj ..... n ... P ... pf ... Q ... Recent.
<i>Arca (Scapharca) rustica</i> MARTIN .....	..... P .....
<i>Crassatella radiata</i> SOWERBY .....	Am ..... Aj ..... P ..... Q ... Recent.
<i>Tridacna squamosa</i> LAMARCK .....	..... P ..... Q ... Recent.
<i>Hippopus hippopus</i> (LINNÉ) .....	..... Aj ..... Q ... Recent.
<i>Alodis erythron</i> (LAMARCK) .....	..... (M) ... Aj ..... P ..... Q ... Recent.

### Echinoidea (det. JEANNET & MARTIN)

*Lagunculum multiforme* MARTIN

### Corallia (det. GERTH)

*Mussa* spec.  
*Prionastraea borneensis* GERTH  
*Prionastraea* spec.<sup>1)</sup>  
*Favia pallida* (DANA) forma *doreyensis* EDWARDS et HAIME  
*Favia favius* (FORSKÅL) forma *caavernosa* FORSKÅL  
*Meandrina lamellina* (EHRENBERG)  
*Orbicella felizi* GERTH<sup>2)</sup>  
*Cyphastraea micropthalma* (LAMARCK)  
*Cyphastraea chalcidum* (FORSKÅL)  
*Seriatopora ornata* FELIX  
*Stylophora pistillata* (ESPER)<sup>2)</sup>  
*Stylophora subseriata* (EHRENBERG)<sup>2)</sup>  
*Fungia (Cycloseris) decipiens* (MARTIN)  
*Porites (Synaraea) amplexans* FELIX  
*Goniopora* spec.<sup>1)</sup>

<sup>1)</sup> identified by GERTH, but not mentioned in his paper (1923).

<sup>2)</sup> not mentioned in GERTH's list (1923, p. 45), only quoted in the systematic part of his paper.

### III. Conclusions.

a) The molluscan fauna described above is small but it contains some interesting elements. *Mitra nebulosa* has not been recorded as a fossil up to now. *Aloidis erythron* is a fairly rare element of the typical Indo-Western Pacific fauna, and the following species, though well-known from recent fauna, are rarely found in fossil faunas: *Cerithium traillii*, *Turris brevicaudata* (a rare recent form), *Tridacna squamosa* and *Hippopus hippopus*. Two species had to be described as new ones, viz., *Pyrazus witkampii*, a remarkable Potamid, and *Murex ruttenei*. The fauna is typically Indo-Western Pacific, being characteristic of the East Indian region in particular.

According to the sediment content of some shells the fauna was collected from a sandy marl which might have alternated with the coral limestone or more probably was deposited between the higher parts of a reef. The fossil fauna, as in most cases, presumably does not represent a pure biocoenosis. The distribution of *Tridacna squamosa* is very intimately connected with reef-building corals, and the shell belonging to this species will have been displaced from a reef to sandy marls nearby<sup>1)</sup>, the "milieu" of *Cerithium traillii*, *Peristernia jonkeri*, *Mitra limosa*, *Turris brevicaudata*, *Conus odenensis*, *Arca antiquata*, *Arca rustica*, *Hippopus hippopus* (?) and *Aloidis erythron*.

*Angaria delphinus*, *Murex ruttenei*, *Drupa concatenata*, *Crassatella radiata* and *Hippopus hippopus* are species which, as at the present time, may have lived in both milieux, some presumably preferring the coral reef, e.g., *Angaria*, *Murex*, *Drupa*, *Hippopus*. This view is supported by the damaged condition of the shells of *Murex ruttenei* and *Hippopus hippopus*. The *Angaria* is a fine specimen which cannot have been transported over a long distance and therefore presumably lived on the sandy marl shortly before being embedded.

*Pyrazus witkampii* most probably lived in brackish water, as the genus prefers warm brackish regions. The condition of the shell indicates rather long transportation.

#### b) Age of the fauna.

The molluscan fauna contains only fifteen species. Consequently the percentage figure of recent elements cannot be of great value for age identification. The number of species which are still living is ten: 66.6 %. This figure might indicate Pliocene, even Younger Pliocene in East Indian sense ("Sondien"). For gastropods only, the figure is 55.5 %, for the bivalves, 83.3 %. Unfortunately no Pliocene faunas have been described from Borneo up to now<sup>2)</sup>, so no comparison can be attempted. No Pliocene fauna outside Borneo, moreover, allows of direct comparison. The fauna from Sekoerau bears on the other hand resemblance to Quaternary faunas from Borneo, although it certainly does not belong to the Quaternary.

<sup>1)</sup> Probably marly deposits filled the deeper portions of spaces between the higher parts of the reef.

<sup>2)</sup> 1944.

The combined stratigraphic distribution of the species is as follows:

Miocene	Pliocene	Quaternary	Recent	
8	9	9	10	(13 species; <i>Pyrazus</i> and <i>Murex</i> not considered).
8	12 (P only: 2)	9	10	(The Pliocene figure has been corrected for those species which are known from Miocene-recent and must have lived in Pliocene time).

These figures lay the stress on a Pliocene age for the fauna. *Peristernia jonkeri* and *Arca rustica*, moreover, are only known from Pliocene deposits, and, although they may not be regarded as guide-fossils at the moment, they have more value than most of the other species, of which no less than 8 lived from the Miocene to recent.

The restricted number of species, and the percentage of bivalves being greater than in most fossil East Indian faunas (40 %), limits the value of the arguments given above, but on the other hand typical Miocene species are absent and the composition of the entire fauna certainly does not contradict a Pliocene age. The coral fauna also points to a Pliocene age. Finally, most species have been recorded frequently from Pliocene deposits, more than from Miocene or other deposits.

The stratigraphic distribution of the species may also be illustrated as follows:

Miocene	Pliocene	Quaternary	Recent	
←			→	7
	←		→	2
	P Only	-----	-----	2
			R Only	1
←	→	-----	-----	1
8	12	9	10	(13 species)
(1)	(5)	(2)	(3)	(6 species) Omitting the long-living species (Miocene-recent), we obtain figures which more definitely point to a Pliocene age, although the number of species is restricted.

It must be emphasized that every method used above, points to a Pliocene age, or at least does not contradict this age and the results obtained by GERTH's study of the corals. Any addition of material from the "Coral limestone" of Sekoerau will help us, of course, to fix the age of the entire fauna more precisely. For the moment being, Pliocene, perhaps Upper Pliocene age may be assumed.

## IV. Literature.

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