ON PROBABLY YOUNG MIOCENE FOSSILS FROM THE COAL CONCESSION BATOE PANGGAL, NEAR TENGGARONG (SAMARINDA), EASTERN BORNEO

BY

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With a contribution by F. G. Keyzer

INTRODUCTION.

In the collections of the Leyden Geological Museum is a set of fossiliferous clay-stones which was long ago collected by the mining engineer HULSHOFF-POL in the coal quarries of Batoe Panggal [1]), Eastern Borneo. He presented the collection in 1902 to Dr M. SCHMIDT, who at that time was making geological investigations in Borneo. After Dr SCHMIDT's appointment to a professorship in Stuttgart, the fossil collections made by him in Borneo were acquired by the Leyden Geological Museum (1920).

Fig. 1 roughly indicates the locality of Batoe Panggal, while Fig. 2

Fig. 1.

Fig. 2.

depicts the delta area of the Mahakkam or Koetei river and its neighbouring areas. The dotted area is again represented in Fig. 3 below.

Up till now, neither mollusca nor foraminifera have ever been recorded from the Neogene of Batoe Panggal. Their examination in 1943/1944 resulted

[1]) Dutch orthography *oe* corresponds with English *oo*.

in an age identification which was surprising, because up till now the series of the Hill or "Goenoeng" of Batoe Panggal was regarded as Lower Miocene (upper part of Tertiary-E according to VAN DER VLERK & UMBGROVE's subdivision), whereas the mollusca would point to Young Miocene. This determination was not contradicted by the examination of the foraminifera kindly undertaken by F. G. KEYZER, though it proved impossible, for the time being, to fix the age of the fauna more precisely than as Tertiary-F. The mollusca would point to Tertiary-F. 3.

The writer is much indebted to the "Zoölogisch Insulinde Fonds" for financial support of this and other studies on East Indian mollusca.

GENERAL STRATIGRAPHICAL REMARKS.

The Neogene formation of Eastern Borneo is characterised by widely distributed, and usually thick, shelf deposits. For a general survey we may refer to RUTTEN's studies (1927, p. 191). This formation shows in many places coaly intercalations. J. HOOZE's activities in the past century marked the beginning of a systematical exploration of the Bornese coaly deposits, the results of which investigations were compiled by RUTTEN (1927, pp. 209—211, 225—226).

From the frontier of Pasir in the South to Sangkoelirang in Northern Koetei the deepest part of the Neogene is developed as solid claystones, quartzitic sandstones and calcareous deposits. Coaly deposits are almost entirely absent in this lowest Neogene complex, the thickness of which is at least some 1500 m. It is also known from the neighbourhood of Samarinda.

This series is overlain by a 1000 to 2000 m thick succession of claystones, less solid sandstones, limestones, marls, and numerous coaly intercalations. The Batoe Panggal series, which occurs in the lower part of the succession (cf. also RUTTEN, 1916) was hitherto referred to as Lower Miocene: Tertiary-E. Higher up in the succession follow sandstones and clays which become increasingly soft, and coaly deposits gradually becoming more peat-like.

For our purpose the deposits of the so-called "middle series" are most important. Their coaly intervals generally show 10—14 % water content, which would point to their being Lower Miocene.

The coaly deposits of Batoe Panggal show a water content of 9.9—13.3 %, according to HOOZE (1887). JEZLER (1916) called them Prangat Beds and dated these as the equivalents of RUTTEN's Pamaloeang Beds, without palaeontological evidence. Therefore, LEUPOLD & VAN DER VLERK (1931) correlated RUTTEN's palaeontologically characterised stages much more exactly with the "letter-subdivision" than JEZLER's stages. The former considered the Prangat Beds near Samarinda as an approximate equivalent of the upper parts of Tertiary-E: Pamaloeang Beds of another part of Eastern Borneo.

As far as the writer is aware, no more detailed observations have been made on the coal quarries of Batoe Panggal since 1887. Therefore, we shall follow HOOZE's narrative of the coal explorations in Eastern Borneo.

In 1883, HOOZE started his investigations along the Mahakkam river, more particularly in the Batoe Panggal coal area which had been exploited for some years by the Sultan of Koetei. On the left bank of the Mahakkam lies the concession Batoe Panggal, named after sandstone blocks which are visible at low tide, somewhat to the East along the bank. The range of hills forming the Goenoeng Batoe Panggal is composed of fine-grained sandstones alternating with claystone beds. In the coaly area (cf. Figs. 3—4), some coal layers are present in a series which grades to the left[1]) of the section into a sterile series. Each coal layer is over- and under-lain by somewhat coaly shales which are either hard or softer. HULSHOFF-POL seems to have sampled both varieties of claystone.

In 1887, the coal layers 2 and 5 (cf. Fig. 4) were exploited. Consequently,

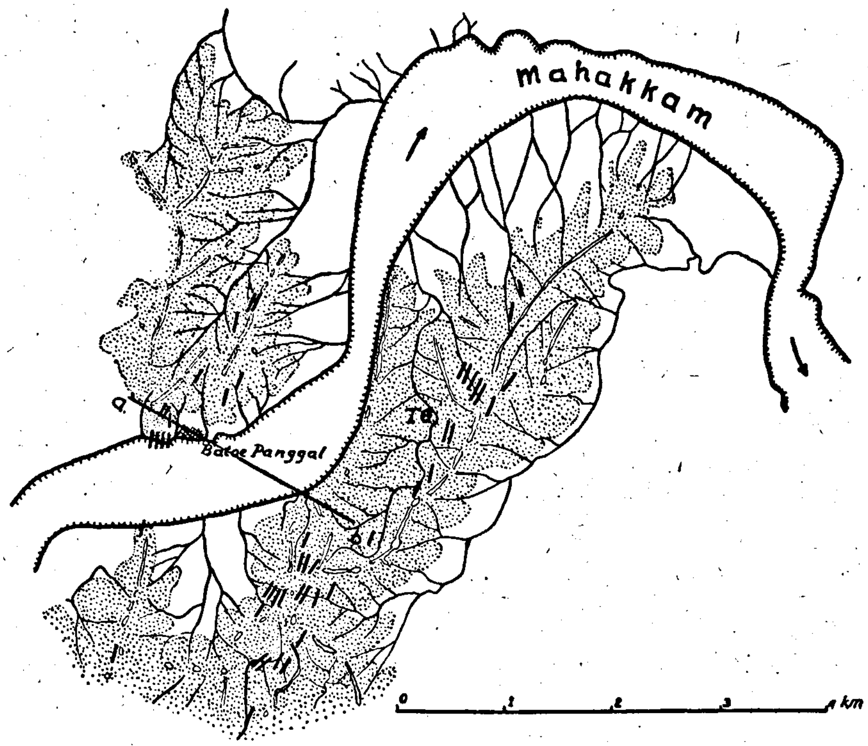

Fig. 3. Dotted: hills.
— : coal seams.
T. A.: Soengei Tenggalong Ajam.
After HOOZE's Map I.

Fig. 4. Section a—b (See Fig. 3), after HOOZE's section A—B (scale 1 : 10.000).

there is a possibility that the fossils discussed below have been collected approximately in the complex formed by these layers, but unfortunately it is not on record as to which part of the section was being exploited in the period 1887—1902, in which HULSHOFF-POL made his collections.

Text and section of HOOZE's paper (1887, pp. 57, 72, 73) show that the assumed an "old miocene" or even "oligocene" age for the coaly complex of

[1]) According to HOOZE "downwards", but he has overlooked the presence of an anticline, as JEZLER has proved: See Fig. 5.

Batoe Panggal. However, a "possible miocene age" was also mentioned (l. c., pp. 60, 91). This possibility, it is certainly no more than that, was mainly based on the water content of the coal layers. RUTTEN (1927) published a clear survey on this method for relative age identification, and we may quote

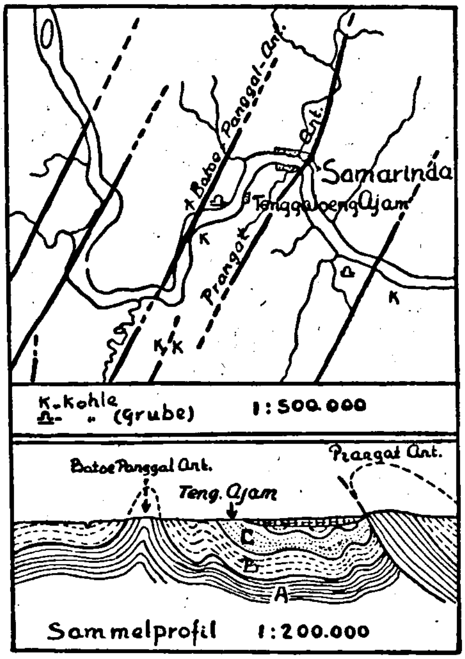

Fig. 5. A: Prangat Beds.
B: Sanga-Sanga Beds.
C: Moeara Djawa Beds.
After JEZLER, 1916.

more particularly SCHÜRMANN's enlightening study (1925) to avoid having to point out again the unreliability of the method. Correlation over large distances on lithological grounds, moreover, may be extremely unreliable, especially so since all geologists familiar with the stratigraphy of Eastern Borneo, have stressed the presence of rapid lithological variation (cf. also JEZLER, 1916).

DESCRIPTION OF THE CLAY SAMPLES.

Some of the samples examined by the writer consist of soft clays with poorly preserved fossils which cannot be specifically identified. They are partly of marine and partly of lacustrine character, though both do not occur in the same samples.

The greater part of the collection, however, consists of fossiliferous claystones with iron-containing concretions, which usually have been formed around fossils. HOOZE has mentioned the sulphur content, in the form of marcasite, of the coal layers of Batoe Panggal. One should perhaps ascribe the concretions to migration of the products of weathering of the marcasite from the peat layers to the clays, during the compaction of the peat, but clays usually have little permeability, so a forming *in situ* of the iron concretions seems more likely. On the other hand, it is quite possible that weathering of marcasite has caused the soft character of the first-mentioned variety of clay.

The fossils may be subdivided into three groups, viz.,

(*a*) Fossils from the solid claystones, which are very fossiliferous and according to the predominant element should be called *Nucula*-clays. Tellinidae and Aloididae ("Corbulidae") likewise are well represented. The majority of the bivalves is completely preserved, although the composition of the fauna points to a deposition under shallow-water conditions, mainly marine, but with a certain influx of brackish-water conditions.

(*b*) Poorly preserved fossils in soft clays. These fossils generally point to the same conditions of deposition as the first group.

(*c*) Two remains of "Cyrenidae" (Corbiculidae) which, like the group (*b*), must have been derived from a bed other than the fossils of group (*a*).

We may add that group (*a*) contains a great number of mechanically compressed shells. Of two valves belonging to one specimen, often only one has been flattened, i. e., shows a "flat" but irregular surface and cracks. This is undoubtedly the result of compaction of the original *Nucula*-mud. The fossils of group (*b*) are even more compressed and normally preserved only as prints, though shelly remains are also present and a part of the foraminifera also quite well preserved.

DESCRIPTION OF THE FOSSIL CONTENT.

I. MOLLUSCA.

Group a comprises the following mollusca:

NATICA MAROCHIENSIS (GMELIN).

This wide-spread species is represented in the Batoe Panggal collection by two juvenile specimens which were compared with similar recent and fossil representatives. Refs.: VAN REGTEREN ALTENA, 1941, p. 79; BEETS, 1941, pp. 75, 169, 175, 190, 192, 196, 201; VAN REGTEREN ALTENA & BEETS, 1945, pp. 39, 60.

This species is also present in the following collections from Eastern Borneo: Loc. 114-LEUPOLD; Goenoeng Madoepar (not mentioned before); Gelingseh Beds; Lower parts of the "Sumatrensis Limestone Series".

NUCULA (NUCULA) SEDANENSIS HAANSTRA et SPIKER.

Refs.: HAANSTRA & SPIKER, 1932, a, pp. 1097, 1102, plate, figs. 13—14; PANNEKOEK, 1936, p. 9. The species is also represented in collections from Madoera (Rembang equivalents) and Western Borneo (Njalindoeng-Tjilanang equivalents in Broenei and Sarawak) which are being examined by the writer and the results of which will be published in near future.

The collection from Batoe Panggal contains a great number of specimens which generally are smaller than normal. Many specimens are compressed, though sometimes one of the valves is well preserved. About half the number of specimens could be measured. Fig. 6 gives a list of measurements made. It should be realised that a part of the larger specimens could not be measured because of damage by compression.

L	H	D	L	H	D	L	H	D	L	H	D
10.5	7.8	—	7.8	5.2	3.9	7	5	—	6.2	4.9	3.6
9.6	7	—	7.7	5.5	4.2	7	4.9	3.8	6.2	4.6	3.4
9.4	7	—	7.7	5.2	4.1	7	4.8	3.7	6.2	4.6	3.2
9.3	6.8	5.5	7.6	5.7	4.1	6.9	5	3.6	6.2	4.6	3.1
9.3	6.4	5.2	7.6	5.4	3.8	6.9	4.9	3.7	6.2	4.4	3.2
9	6.3	5	7.5	5.6	4	6.9	4.9	3.5	6.2	4.4	3.1
9	6.2	4.2	7.5	5.5	4.2	6.8	5	3.5	6.2	4.3	3.5
9	6	5	7.5	5.5	3.8	6.8	4.7	3.3	6.2	4.3	3.1
8.6	6.1	4.5	7.4	5.3	3.9	6.7	5	3.4	6.1	4.6	3.2
8.6	6	4.9	7.4	5.2	3.9	6.7	5	3.4	6.1	4.1	3.1
8.6	6	—	7.4	5.2	3.8	6.7	4.8	3.4	6	4.3	3.5
8.4	6.1	4.9	7.4	5.1	3.7	6.6	4.9	3.4	6	4.3	3
8.4	5.9	—	7.4	5	3.8	6.6	4.9	3.3	6	4.2	3.2
8.1	5.7	4	7.3	5.3	4.1	6.6	4.8	3.3	5.9	4.2	2.9
8	6.1	5	7.3	5.1	3.4	6.6	4.8	3.2	5.9	4	2.8
8	6	—	7.2	5.5	4.2	6.6	4.6	3.3	5.7	4.5	3.4
8	6	—	7.2	5.2	—	6.6	4.6	3.2	5.7	4	3
8	5.9	4.2	7.1	5	4	6.5	5	3.4	5.6	4.1	—
8	5.8	4.5	7.1	5	3.5	6.5	5	3.3	5.4	4	2.7
8	5.7	4	7	5.1	4	6.5	4.9	3.1	5.4	3.8	2.7
8	5.6	4	7	5.1	3.9	6.5	4.8	3.3	5	3.9	3
8	5.4	—	7	5	3.9	6.5	4.6	3.2	4.6	3.6	2.5
7.9	6	4.3	7	5	3.8	6.4	4.9	3.5	4.5	3.5	2.2
7.9	5.7	4.3	7	5	3.5	6.4	4.7	3.2	4.4	3.2	2.3
7.9	5.5	4.2	7	5	3.5	6.3	4.8	3.2	4.3	3	2
7.8	5.7	4	7	5	3.5	6.3	4.6	3.2			
7.8	5.5	4.1	7	5	3.5	6.3	4.5	3.1			

Fig. 6. Measurements, in mm, of the valves of *Nucula sedanensis*.
L: Length; H: height; D: diameter (2 valves).

The correlation between the dimensions measured is shown in Fig. 7. Though the coefficient of correlation was not determined, it is clear from the spreading of the correlation points that the relationships between length and height of the shells, are very close, while the diameter of the valves is more variable than either of the other dimensions measured.

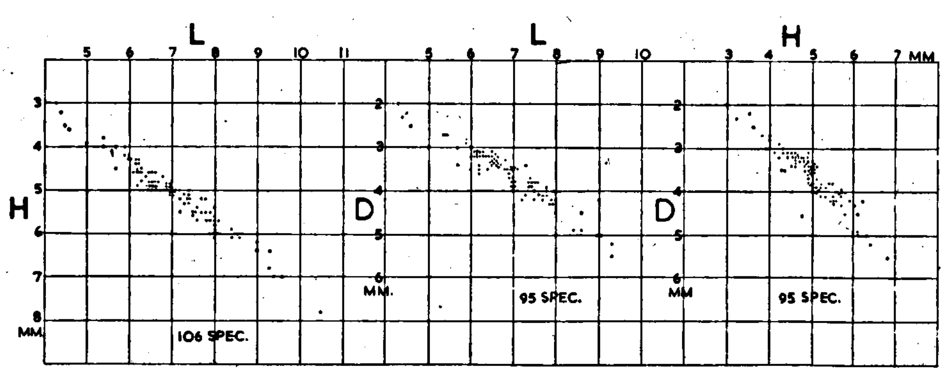

Fig. 7.

The recent species *N. cumingii* HINDS is at first sight very similar to *N. sedanensis*: See HINDS, 1844, p. 62, pl. 18, fig. 1; HANLEY *in* SOWERBY, 1842—1887, III (20), 1860, Nuculidae, p. 157, pl. 4 (229), fig. 117; PRASHAD, 1932, p. 14. A close comparison with the figures and material of the Siboga Expedition, however, convinced the writer that these species are not identical at all. The posterior rostrum of *N. sedanensis* is more clearly defined and *N. cumingii* is usually much flatter; its maximum height is measured more anteriorly than in the former species, and its anterior margin more widely rounded instead of rather pointed. Moreover, its posterior area is very shallow and the corresponding part of the dorsal margin nearly straight (in *N. sedanensis* this margin is concave and the area often deep). Again, the anterior area of *N. cumingii* is never as concave as in *N. sedanensis.*

CRASSATELLA TENGARONENSIS spec. nov.

Figs. 8—10.

This species is represented by two specimens, the holotype quite well preserved, the other type being a fragmentary larger specimen. The dimensions of the holotype figured herewith are: length 10.5 mm, height 7.6 mm, diameter 4.8 mm.

The shell is distinctly rostrate, its anterior dorsal margin short, the anterior margin well rounded, gradually grading into the dorsal and ventral margins. The ventral margin is slightly concave below the rostrum. The greater part of the surface of the shell is covered with fine and quite distant concentrical ribs. These occur at regular intervals. They are quite low and

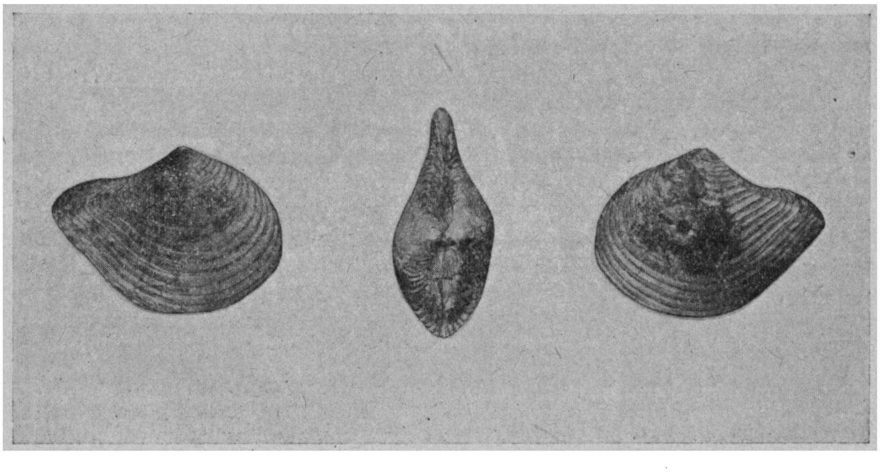

Fig. 8. Fig. 9. Fig. 10.

Crassatella tengaronensis sp. n., Holotype.

usually more or less complex; often they are partly double, or more obsolete ribs may appear close to the primary ones in their intervals. The intervals are covered with delicate growth-lines.

The umbo is connected with the rostral extremity by an obsolete rib in which the concentrical ribs form a rather sharp bend, continuing across it towards the dorsal margin. Near the latter, the ribs end at a sharp rib defining the small and excavated area. The lunule is relatively wide and rather long, being less sharply defined than the area and not clearly excavated. The concentrical ribs become suddenly obsolete at a radial line running on either side of the lunule, but they continue quite clearly across the latter as elevated lines. Radial sculpture seems to be absent, though it is possible that a number of delicate radial lines in the intervals between the ribs in both specimens should be considered as sculpture and not as a result of fossilization. These radial lines are visible only with the aid of a strong lens.

Closely related species have not been described until now. The new species is named after Tengaron (= Tenggarong).

JOANNISIELLA OBLONGA (DESHAYES).

Synonyms are the recent *J. lamyi* PRASHAD and the fossil "*Diplodonta*" *everwijni* MARTIN. The species is represented by a small specimen which was compared with other small fossils from Western Borneo which will be discussed in a separate paper. The species is also available from Young Neogene deposits in New Guinea (Bird's Head). Refs.: See OOSTINGH, 1935, pp. 171, 219.

LAEVICARDIUM NJALINDUNGENSE (MARTIN).

This species is available from a number of localities in Eastern and Western Borneo and may only in exceptional cases be slightly older than the Javanese Njalindoeng-Tjilanang complex. It is represented in the Batoe Panggal collection by three valves, one being well preserved, another partly compressed by sediment compaction, the third fragmentary. The material was easily identified by means of comparison with abundant material from Eastern Borneo (Loc. 114-LEUPOLD, Island of Mandoel) and Western Borneo (Broenei-Sarawak) which will be described in separate papers. *Cardium* spec. as recorded by HAANSTRA & SPIKER from Sumatra (1932, b, p. 1315) proved actually to belong to *L. njalindungense*. There are good reasons for accepting *L. njalindungense* as a valuable age indicator. Refs.: See BEETS, 1941, pp. 162, 171, 186, 200.

CLEMENTIA (CLEMENTIA) PAPYRACEA (GRAY).

An extremely wide-spread species, represented in the Batoe Panggal collection by two juvenile, but well-identifiable shells, one being partly compressed by sediment compaction, the other preserved as a cast.

OOSTINGH published a survey of the occurrences of the species: 1935, pp. 193, 219. See also VAN ES, 1931, pp. 39, 116; PANNEKOEK, 1936, pp. 9, 12, 13.

C. papyracea is also available from the following localities: Langkang in S. Sumatra (Rembang equivalents), Pliocene? of the Island of Mandoel, Eastern Borneo, and some Young Miocene localities in Western Borneo (Broenei-Sarawak: Njalindoeng-Tjilanang equivalents). This material will be discussed separately.

APOLYMETIS GRIMESI ELONGATA (HAANSTRA et SPIKER).

This subspecies is represented by three shells which are partly damaged. They were compared with the types and are well separable from *A. kehreri* (OOSTINGH). The material proved to be identical with the smaller specimens among the types. The latter prove that the *Tellina*-fold may be bent as in *A. kehreri*. Refs.: HAANSTRA & SPIKER, 1932, b, pp. 1315, 1323, plate, figs. 36—37; OOSTINGH, 1934, pp. 19, 20, 21 (textfig. 3); OOSTINGH, 1938, pp. 511, 512.

It may be mentioned here that *A. kehreri* (OOSTINGH, 1934, pp. 20, 21 (textfigs. 4—6); 1938, p. 510) could be identified also in the Java collection of the Leyden Geological Museum: St. Nr. 7215, *Tellina* (*Arcopagia*) spec. from the Tjilanang Beds (Tji Boerial), and St. Nr. 7039, *Tellina* spec. from the Rembang Beds (Ngampel). The first-mentioned specimens are full-sized and show resemblance to the recent *A. contorta* (Deshayes). The specimen from Rembang is juvenile.

CULTELLUS TJIGUHANENSIS MARTIN.

This species is represented by a specimen which is very similar to the type. The species was recorded exclusively from the Javanese Njalindoeng Beds. Ref.: VAN DER VLERK, 1931, p. 282.

ALOIDIS TJIGUHANENSIS (MARTIN).

Some fairly well preserved specimens are available, being characteristic representatives of the species. Refs.: See OOSTINGH, 1935, pp. 205, 211, 219. See also Jaarb. v. h. Mijnwezen in Ned. Indië, jrg. 60 (1931), Alg. Ged., pp. 178, 179.

The majority of the specimens belongs to the delicately ornamented form, which is represented by similarly small shells in the Javanese Njalindoeng Beds. The concentrical riblets of other specimens are lying at increasing intervals towards the ventral margin, while in a few specimens the riblets are lying at regular intervals.

The species is also available from Neogene localities in Eastern Borneo, and New Guinea (Geol. Institute, Utrecht University).

CRYPTOMYA (TUGONELLA) DECURTATA (ADAMS).

An interesting find, as the genus is rarely being observed in the recent seas, and more rarely even in a fossil state. Recently, the writer identified a representative of *Cryptomya* in a Quaternary collection from the Island of Boenjoe, Eastern Borneo, and a few more fossil species are recorded below.

C. decurtata is represented in the Batoe Panggal collection by a complete specimen, a single valve and a fragmentary specimen. The valve agrees well with recent material; its posterior portion is preserved as a cast. The frontal part of the complete specimen has been compressed by sediment compaction and is consequently stunted, instead of normally expanded. The posterior part is also damaged. The specimens show the characteristic radial lines very well.

Refs.: SOWERBY, *in* REEVE, 1843—1878, 20, Monogr. *Mya*, pl. 3, spec. 11; LAMY, 1926, p. 173.

It may be mentioned here that a revision was undertaken of certain species present in the collections of the Leyden Geological Museum and the Mining Institute, Delft. The following three species proved to be Cryptomyas.

Corbula sinuosa MARTIN from the Javanese Tjilanang Beds: MARTIN, 1879—1880, p. 93 (1879). This species should be called *Cryptomya sinuosa* (MARTIN). It recalls in many respects the recent species *C. divaricata* (REEVE): LAMY, 1926, p. 175. It is, however, easily distinguished from the latter by its characteristic sinus, from which its name was derived.

Leda radiata MARTIN from the Javanese Westprogo Beds: MARTIN, 1916—1917, p. 266 (1916). This species, which should be called *Cryptomya radiata* (MARTIN), resembles the recent species *C. semistriata* (HANLEY): LAMY, 1926, p. 170. The fossil shows, among other differences, radial lines lying at wide intervals. The area of the fossil is exposed due to the fossilization process.

The Timor collection of the Mining Institute, Delft, contains the holotype of *Sphaenia marci* KOPERBERG: KOPERBERG, 1931, p. 9. This species should be called *Cryptomya marci* (KOPERBERG). It is very similar to the recent species *C. semistriata* (see above), but it is distinguished from the latter by its much less widely rounded anterior margin, its anterior dorsal margin running obliquely downwards, and its straight, instead of rounded, posterior ventral margin.

Appendix.

Group (*a*) comprises some more fossils, which for the time being could not be specifically identified. It may be possible to identify at least a part of these fossils when comparable material is available. The following fossils may be mentioned:

Small Crabs: *Myra* spec. (1 specimen), *Myra?* spec. (4 specimens), *Leucosia* spec. (2 specimens), and *Actaea?* spec. (1 specimen and a manus).

Small Corals.

Mollusca: *Arca* spec.; *Nuculana* spec.; *Volsella* spec. 1, 2; *Cuna?* spec. 1, 2; *Joannisiella* spec.; *Lucina* (*Belluoina*) spec.; Tellinidae; *Dosinia* spec.; *Tonna* spec. (closely related to *T. costata*); *Murex* spec.; *Latirus?* spec.; *Oliva* spec. (perhaps *O.* aff. *australis* DUCLOS); *Nassarius* spec.; *Cylichna* spec., and *Acteon* spec.

Group b contains some mollusca which could not be identified because of their poor state of preservation.

Group c consists, as mentioned above, of no more than two bivalves, which are comparable to the fossils of a collection of bivalves from Sambodja (to the South-East of Samarinda) kept in the Leyden Geological Museum (St. Nrs. 41608—41635). The latter were preliminarily identified by Prof. MARTIN as "Cyrenas" (Corbiculas), although doubtfully, as the hinge of none of the shells is preserved. Corbiculas live exclusively in brackish and sweet water in coastal areas, and the shells of Batoe Panggal, like those of Sambodja, are very similar in appearance to fossils from other brackish-water deposits in Borneo and elsewhere, which were compared in the Leyden Geological Museum. The features of this doubtful *Corbicula*-deposit of Batoe Panggal would tally well with the picture of swampy areas in Eastern Borneo in Neogene time, the deposition resulting in coaly sediments.

II. FORAMINIFERA

by F. G. KEYZER.

Two samples of coaly clay were examined for foraminifera, the sediment of group (*c*) of the mollusca being devoid of foraminifera. The wash residues[1]) of both fossiliferous samples are quite sandy, the amount of foraminifera being small.

[1]) These are kept in the Geological Institute, Utrecht University.

1. The deposits yielding group (*a*) of mollusca discussed above, contain a fair number of species, viz.,

Textularia ? agglutinans d'Orbigny	3
Quinqueloculina spec.	7
Triloculina labiosa? d'Orbigny (fragment)	1
Spiroloculina spec. (fragments).	3
Flintina bradyana Cushman	11
Trochammina spec.	10
Pseudoglandulina laevigata? (d'Orbigny) (very small)	1
Lagena globosa Montagu	1
Lagena laevis Montagu	2
Nonion scapha (Fichtel et Moll)	1
Nonion spec.	1
Elphidium craticulatum (Fichtel et Moll)	13
Elphidium minutum (Reuss)	4
Operculinella venosa (Fichtel et Moll)	frequent
Bolivina spec.	2
Reussella spinulosa (Reuss) (very small)	1
Siphonodosaria lepidula? (Schwager) (very small)	2
Rotalia beccarii Linnaeus (very small)	15
Rotalia gaimardi (d'Orbigny) var. *compressiuscula* Brady	abundant
Orbulina universa d'Orbigny	1
Globorotalia menardi? (d'Orbigny) (very small)	1
Lepidocyclina (*Nephrolepidina*) *epigona* Schubert	1

As shown by the above list, in which the species names precede the number of specimens counted, certain forms are predominant, particularly *Rotalia gaimardi* var. *compressiuscula* and *Operculinella venosa*, their representatives being of normal size. *Elphidium craticulatum* and *Flintina bradyana* are also normally developed. All the other forms are, however, of smaller than normal size, the fauna as a whole having a rather poor appearance. The presence of a fair number of *Trochammina*'s may be an indication that the fauna lived in brackish water, as normally would be expected from the nature of the sediment.

As *Lepidocyclina epigona* has been quoted many times in literature, but has never been fully described, some remarks on this species are added below. The data is assembled from the results of an examination of the vertically sectioned specimen of Batoe Panggal, and from a median section of a specimen collected from a Neogene marl of Eastern Celebes. The specimens were perfectly similar in outward appearance.

LEPIDOCYCLINA (NEPHROLEPIDINA) EPIGONA Schubert.

Refs.: R. Schubert (1911) — Abhandl. d. k. k. geol. Reichsanst. Wien, vol. 20, p. 118, pl. 5, fig. 2.
L. Rutten (1914) — Nova Guinea (Geol.), vol. 6, prt. 2, pp. 37, 50, pl. 8, fig. 3.
L. Rutten (1924) — Verslagen Kon. Akad. v. Wetensch. Amsterdam, vol. 33, No. 6, p. 543.
I. M. van der Vlerk (1928) — Wetensch. Mededeel. Dienst Mijnbouw Ned. Indië, No. 8, p. 26, fig. 19.

A very small, stellate (pentagonal) *Lepidocyclina*, horizontal diameter 0.95 mm, thickness 0.55 mm. Pillars are visible on the whole surface, the central ones having a diameter of 40 μ or slightly more, the peripheral ones being smaller. The lateral chambers appearing on the reticulate surface have an average diameter of 80 μ. The outline of the test is pentagonal, with slightly protruding points, no "collar" being present.

Median section (specimen from E. Celebes): stellate arrangement of equatorial chambers, the diameter of the hexagonal chambers being 40 μ. The embryonic apparatus consists of: the protoconch, round, the thickness of its wall being 12 μ, its diameter 120 μ (incl. of wall). The deuteroconch embraces the protoconch pronouncedly nephrolepidine; the thickness of its wall is 30 μ, its largest diameter 250 μ (incl. of wall), its smallest 190 μ (incl. of wall).

Vertical section (specimen from Borneo): slightly off the precise median position, though vertical. It tallies very well with SCHUBERT's figure.

2. The deposits containing group (*b*) of (unidentifiable) mollusca yield a poor fauna of Smaller Foraminifera, viz.,

Elphidium craticulatum (FICHTEL et MOLL) .... some specimens.
Operculinella venosa (FICHTEL et MOLL) .... frequent.
Rotalia gaimardi (D'ORBIGNY) var. *compressiuscula* BRADY ... abundant.

AGE DETERMINATION.

I. Mollusca.

The following is a list of the specifically identified mollusca belonging to group (*a*).

In the following list, some abbreviations have been applied

Re : recent.
Q : Quaternary.
p? : Pliocene or Quaternary.
P : Pliocene.
yn : "Young Neogene".
n : "Neogene".
mp : "Miopliocene".
m : "Miocene".

Ym : Young Miocene.
To : Tji Odeng fauna (Java).
Ta : Tjadasngampar (Java).

NT : Young Miocene, equivalent of the Njalindoeng and Tjilanang faunas.

Bo : Middle Bodjongmanik Beds, Bantam (Java), equivalent of the Njalindoeng-Tjilanang complex.
Nj : Njalindoeng } Beds (Java).
Tj : Tjilanang } Beds (Java).

Lp : Lower Palembang Beds, S. E. Sumatra, a fauna which was described by HAANSTRA and SPIKER.

Lm : Lower Miocene.
G : Gaj Series (India).
R : Rembang Beds (Java).
Rl : „ „ (Langkang, S. E. Sumatra).
Rm : „ „ (Madoera).
W : West Progo Beds (Java).

The general character of the molluscan fauna is Indo-Western Pacific, and, as would be expected, more particularly East Indian. Nearly all the species of group (*a*) point to marine conditions, but some brackish-water influence is certainly expressed as well by the presence of *Aloidis* and *Joannisiella*.

It is a striking fact to note that the representatives of the specifically identified forms are generally smaller than normal (compare Foraminifera). The same applies to the unidentified mollusca, corals and crabs. Dwarfing may be assigned to various causes, but in this case the type of deposition and the combination of a small number of species with an occasional abundance of individuals (i.e., the rather monotonous character of the fauna), may point to rapid deposition of clayey and fine sandy-coaly matter, with poor, or at least unvaried, feeding conditions leading to the monotonous character of the fauna.

	W B Bl Rm G Lm	Lp	Nj Tj Bo NT	Ta To Ym	m mp n yn P p? Q Re
Natica marochiensis (Gmelin)	W B .... Lm	......	Nj Tj .... NT	Ta .... Ym	m mp .... P p? Q *Re*
Nucula sedanensis Haanstra et Spiker	... B ... Rm	......	.... NT	....	....
Crassatella tengaronensis spec. nov.	....	......	....	....	....
Johannisiella oblonga (Deshayes)	....	......	Nj Tj .... NT	.... Ym	.... yn P ... Q *Re*
Laevicardium njalindungense (Martin)	....	Lp	Nj .... NT	....	....
Clementia papyracea (Gray)	W B Bl ..... G Lm	......	Nj Tj .... NT	.... To Ym	m mp n yn P ... Q *Re*
Apolymetis grimesi elongata (Haanstra et Spiker)	....	Lp	Nj Tj Bo	....	....
Cultellus tjiguhanensis Martin	....	......	Nj ...?...........	....	....
Aloidis tjiguhanensis (Martin)	....	......	Nj	.... Ym	.... n yn P ....
Cryptomya decurtata (Adams)	....	......	....	....	.... *Re*

The age of fauna (*a*) is not easily fixed, that of groups (*b*) and (*c*) cannot be determined directly, although we may assume that very little difference in age from that of group (*a*) exists.

Group (*a*) comprises merely 10 specifically identified mollusca, of which *Crassatella tengaronensis* is of no use in age identification, for the time being. The percentage of forms still living in recent waters is 40 %, which would point to a Miocene, more particularly Young Miocene, age in the East Indian sense. However, the number of species on which this figure is based is far too low to render the identification reliable. Moreover, the majority of identified species comprises bivalves and it is a well-known fact that these are usually longer ranging forms than the gastropods (cf. also BEETS, 1941, p. 182). The possible errors of an application of this method for fixing the relative age of a fauna is clearly demonstrated by the *Tonna* species. Were this actually *T. costata*, which is a recent species, the percentage figure would rise to 46 %.

The distribution of the species over the time table is a more important age indicator, in this case:

Recent:	4
Quaternary:	3
Pliocene:	4
Young Miocene:	8
Old Miocene:	3

This distribution chart, although representing no more than nine species, would again point to a Young Miocene age, and considering the list of species given above, more precisely to the Njalindoeng-Tjilanang level within the Young Miocene. No less than 8 of the 9 species considered are represented in this particular zone of the Javanese Miocene, or in equivalent deposits.

These striking relationships with the Njalindoeng-Tjilanang Beds are not exceptional among Eastern Bornese faunas. UMBGROVE has stressed similar features shown by a coral fauna containing no more than 8 species, from LEUPOLD's locality 114 (UMBGROVE, 1929, p. 54). His conclusions and age identification were fully confirmed by the examination of the mollusca of the same fauna (BEETS, 1941).

The distribution of the species over the time table may also be illustrated in the following manner. The same figures as quoted above re-appear here.

Old Miocene	Young Miocene	Pliocene	Quaternary	Recent	
----	-------	-------	-------	----	2
----	----	....	....	....	1
	--.....	....	....	....	3
	----	----.....	....	....	1
	----	-------	-------	----......	1
				----....	1
3	8	4	3	4	(9 species)

Three of the species are particularly interesting, as they have been exclusively recorded from the Young Miocene, at least, up till now. That is a quite considerable percentage, considering the restricted number of species.

Two of these species are, moreover, probably to be considered useful guide forms for the Miocene, more particularly Young Miocene, viz., *Apolymetis grimesi elongata* and *Laevicardium njalindungense.*

Naturally, one should not consider merely the age indication provided by the stratigraphical range of these guide fossils, or rather, possible guide forms, as our present knowledge of the East Indian Neogene faunas still prevents placing full reliance on the "guide forms" recommended up till now. Nevertheless, to all appearances, the Batoe Panggal fauna may belong to the Njalindoeng-Tjilanang level (Tertiary-F. 3) which may be recognised at a great number of localities in Eastern and Western Borneo.

It may be pointed out, however, that the Batoe Panggal fauna is very incompletely known, and, although we cannot think of a possible West Progo age (Tertiary-F. 1—2) and though doubtless no even older, Tertiary-E fauna is represented by it, the writer refrains from placing it straight into Tertiary-F. 3. The Neogene of Eastern Borneo has provided some stratigraphical and faunal surprises which makes us prefer to wait until more data has been fully worked out.

The age determination of the Batoe Panggal fauna would result in an alteration of the correlation of the Eastern Bornese subdivisions as accepted heretofore (cf. Fig. 11). The position of the Sanga-Sanga and Moeara Djawa

	LEUPOLD & VAN DER VLERK (1931)		Revision
	(RUTTEN)	(JEZLER)	
H	"Plio-Miocene"	Kembang Beds	
G			
F 3	"Upper Mentawir Beds"	Moeara Djawa Beds	
F 2	*"Lower Mentawir Beds"*	Sanga-Sanga Beds	*Prangat Beds*
F 1	Poeloebalang Beds	Prangat Beds	
E	Pamaloean Beds		

Fig. 11.

Beds cannot be reconsidered here, but the writer proposes to place the Prangat Beds at a p p r o x i m a t e l y the same level as the Lower Mentawir Beds. These have been placed in Tertiary-F. 2 on account of their foraminiferal fauna, but these beds also contain mollusca which, however, would point to a Tertiary-F. 3 age. The following species from these beds are available (results partly published by the writer in 1941):

Turris imitatrix (MARTIN)
Nucula njalindungensis MARTIN
Cerithium bayeri BEETS
Cerithium leupoldi BEETS
Cerithium karangense MARTIN
Aloidis solidula (HINDS)
Turritella cingulifera SOWERBY
Smaragdia spec. (also occurring in the Gelingseh Beds)

Nucula njalindungensis in particular would indicate a Tertiary-F. 3 age, but our knowledge of the molluscan faunas of the Bornese Neogene deposits is still too scanty to allow of far-reaching conclusions based on small numbers of species.

On the other hand, one may put the question whether or not the foraminifera of the Neogene of Borneo, at least in part will show stratigraphical ranges comparable in degrees with the peculiarities revealed by the study of the mollusca. As the writer pointed out before, particularly in 1941 (l. c.), a number of molluscan species may occur in Eastern Borneo in higher levels (Young Miocene-Uppermost Miocene) than in Java (Lower Miocene, or Lower Miocene-lower Young Miocene). The same peculiarity may be assumed to be expressed in the ranges of larger foraminifera and corals. This would explain why certain Bornese deposits, when considered from their foraminifera content (for which the peculiarity mentioned has not been studied yet), have been placed in the Lower Miocene, whereas the examination of their molluscan content would point to a Young Miocene age.

II. Foraminifera: by **F. G. Keyzer.**

The "Smaller Foraminifera" cannot provide any reliable indication as to the position of the fauna in some particular part of the Neogene. The presence of *Lepidocyclina epigona*, however, would indicate a Tertiary-F age, according to VAN DER VLERK's investigations.

REFERENCES.

ALTENA, C. O. VAN REGTEREN (1941) — The marine mollusca of the Kendeng Beds (East Java), prt. 2; Leidsche Geol. Mededeel., vol. 12, pp. 1—86.

ALTENA, C. O. VAN REGTEREN & C. BEETS (1945) — Eine neogene Molluskenfauna vom Tji Gugur (Priangan), W. Java; Verhand. Geol. Mijnbouwk. Genootsch. v. Ned. en Kol., Geol. Ser., vol. 14, pp. 37—69.

BEETS, C. (1941) — Eine jungmiocäne Mollusken-Fauna von der Halbinsel Mangkalihat, Ost-Borneo; Ib., vol. 13, pp. 1—218.

Es, L. J. C. VAN (1931) — The age of *Pithecanthropus*; Thesis, Delft.

HAANSTRA, U. & E. SPIKER (1932, a) — Über Fossilien aus dem Altmiocän von Rembang (Nord Java); Proc. Kon. Ak. v. Wetensch. Amsterdam, vol. 35, pp. 1096—1104.

HAANSTRA, U. & E. SPIKER (1932, b) — Über jungneogene Molluskenfaunen aus den Residenzen Benkoelen und Palembang; Ib., pp. 1313—1324.

HINDS, R. B. (1844) — Mollusca, in: Zoology of the voyage of H. M. S. "Sulphur", vol. 2.

HOOZE, J. A. (1887) — Onderzoek naar kolen in het Rijk van Koetei ter Oostkust van Borneo; Jaarboek Mijnwezen Ned. Indië, jrg. 16, Techn. Adm. Ged., pp. 5—94.

JEZLER, H. (1916) — Das Oelfeld "Sanga-Sanga" in Koetei (Niederl.-Ost-Borneo); Zeitschr. f. prakt. Geol., Jrg. 24, pp. 77—85, 113—125.

LAMY, ÉD. (1926) — Révision des Myidae vivants du Muséum national d'Histoire naturelle de Paris; Journ. d. Conchyl., vol. 70, pp. 151—185.

LEUPOLD, W. & I. M. VAN DER VLERK (1931) — The Tertiary; Leidsche Geol. Mededeel., vol. 5, pp. 611—648.

MARTIN, K. (1879—1880) — Die Tertiärschichten auf Java, nach den Entdeckungen von F. JUNGHUHN; Leiden, BRILL.

MARTIN, K. (1916—1917) — Die altmiocäne Fauna des West-Progogebirges auf Java; Samml. Geol. Reichsmus. Leiden, N. S., vol. 2, pp. 223—296.

OOSTINGH, C. H. (1934) — Aanteekeningen over eenige bivalven uit het Neogeen van Java; De Ingenieur in Ned. Indië, jrg. 1, prt. IV, pp. 19—22.

OOSTINGH, C. H. (1935) — Die Mollusken des Pliozäns von Boemiajoe (Java); Wetensch. Mededeel. Dienst Mijnbouw Ned. Indië, No. 26.

OOSTINGH, C. H. (1938) — Mollusken als gidsfossielen voor het Neogeen in Nederlandsch-Indië; Handel. Achtste Nederl. Ind. Natuurwetensch. Congres, Soerabaja, pp. 508—516.

PANNEKOEK, A. (1936) — Beiträge zur Kenntnis der altmiozänen Molluskenfauna von Rembang (Java); Thesis, Amsterdam.

PRASHAD, B. (1932) — The Lamellibranchia of the Siboga Expedition, Syst. Part. II, Pelecypoda (excl. of the Pectinidae); Uitkomsten Siboga, Monogr. 53. c.

REEVE, L. A. (1843—1878) — Conchologia Iconica (continued by G. B. SOWERBY).

RUTTEN, L. (1916) — Veranderingen der facies in het Tertiair van Oost-Koetei (Borneo); Versl. d. Kon. Ak. v. Wetensch. Amsterdam, vol. 25, pp. 700—709.

RUTTEN, L. M. R. (1927) — Voordrachten over de geologie van Nederlandsch Oost-Indië; Groningen, WOLTERS.

SCHÜRMANN, H. M. E. (1925) — Over jong tertiaire bruinkolen in Oost-Borneo; Verhand. Geol. Mijnbouwk. Genootsch. v. Ned. en Kol., Geol. Ser., vol. 8, pp. 429—440.

SOWERBY, G. B. (1842—1887) — Thesaurus Conchyliorum.

UMBGROVE, J. H. F. (1929) — Anthozoa van N. O. Borneo; Wetensch. Mededeel. Dienst Mijnbouw Ned. Indië, No. 9, pp. 45—76.

VLERK, I. M. VAN DER (1931) — Caenozoic Amphineura, Gastropoda, Lamellibranchiata, Scaphopoda; Leidsche Geol. Mededeel., vol. 5, pp. 206—296.