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**Geology.** "On the Miocene Fauna of the West-Progo Mountains in Java". By Prof. K. MARTIN.

(Communicated in the meeting of June 30, 1917).

Some years ago I made a few communications to this society on the mountain range extending on the right bank of the Kali Progo, west of Jogjakarta, and on the limestone found in these "West-Progo Mountains" <sup>1)</sup>. For the geographical and geological details I refer to these provisional communications and to the more elaborate description in my travelling journal, in which this limestone is determined as lower Miocene, although the fauna found in it had not been completely studied then <sup>2)</sup>. All the material has now been worked up, and in what follows I propose to give a short survey of the chief results of the examination of this fauna <sup>3)</sup>.

Two finds of fossils are of special importance, the Goenoeng Spolóng, near Djoenggrangan, and the Kembang Sokkóh, close to Bomaas, of which the former yielded 69 different species and the latter 84, excepting corals and some echinoidea, the investigation of which proved impossible on account of the present circumstances <sup>4)</sup>.

The determined fossils are in the first place mollusca, especially gastropoda, a few scaphopoda, some thirty lamellibranchiata and a small number of foraminifera which have been examined by Dr. L. RUTTEN.

The fossils of the G. Spolóng have changed into a fine-grained mass of clear transparent calcite, but nevertheless possess only very little rigidity and easily disintegrate, when the marl filling their cavities absorbs water. They are therefore difficult to prepare.

<sup>1)</sup> "Enkele beschouwingen over de geologie van Java" (Verslag Mei 27, 1911) and "Verdere beschouwingen over de geologie van Java" (Verslag Maart 30, 1912).

<sup>2)</sup> Sammlungen des Geolog. Reichs-Museums in Leiden, Ser. I, Vol. 9, pp. 56—76 and 108—111.

<sup>3)</sup> The complete publication will appear in the organ of the Geological Mineralogical Museum at Leiden, partly in order to retain the connection with other related papers and partly on account of the circumstance that the special descriptions are to be accompanied by a number of plates which could not very well be incorporated in the Proceedings of the Academy.

<sup>4)</sup> The material necessary for comparison and the literature required were inaccessible through the stagnation of international collaboration

Still, a very suitable material is finally obtained. The fossils from the Kembang Sokkóh, originating from clay, have been excellently preserved like most objects from the Miocene strata of Java; often their lustre is still present and even remnants of colours are occasionally seen.

The fauna examined shows that the formation in which it is found, must have been deposited in shallow water, for all genera and also the species, as far as they still exist, are found at the present day along the coasts at a small depth. This agrees with the circumstance that many corals occur locally and lithothamnia are generally spread. Moreover the limestone, which is the main constituent of the just-mentioned formation, represents a thick closed cover, such as is only possible with genuine shore-formations.

There are facies differences, however; for the clay on the Kembang Sokkóh has been deposited in the neighbourhood of a river mouth, as may be inferred from the very frequent occurrence of *Potamides*. Insignificant layers of lignite between the clay must probably be attributed to land plants that were buried near the mouth in the river mud. This reminds of what I have on a former occasion communicated on the eocene sediments of the Kali Poeroe, where in the vicinity of the lignite many *Melanidae* were found<sup>1)</sup>. On the G. Spolóng, however, shells of *Potamides* are not numerous, lignite is absent and the distribution of the genera of mollusca and foraminifera in these two finds, is very different. Notwithstanding this almost half the fossils of the G. Spolóng are also found on the Kembang Sokkóh.

The mollusca clearly present an Indopacific character, for not only the species surviving to the present day that are found in the deposits of the West-Progo Mountains, belong to the area of the Indian fauna, but also there exists in the latter a whole series of relatives of the examined fossils. Moreover the habitat of all related recent species taken together lies almost entirely within the present Indopacific region, especially in the area of the islands between Asia and Australia. It extends on one side from the Chinese coast to the Admiralty Islands and Australia, on the other side as far as Madagascar and The Cape.

From the Neogene fauna of Europe the mollusca of the West-Progo Mountains are entirely different. The foraminifera on the other hand present a different picture: of the eight species of this animal group that were determined with certainty in the deposits

<sup>1)</sup> Die Fauna des Obereocäns von Nanggulan auf Java (Sammlgn. Neue Folge, II, p. 213).

here described, no fewer than four are also found in European strata, namely in the Eocene *Clavulina angularis* d' Orb. and *Cl. parisiensis* d' Orb., in the Miocene *Spiroloculina crenata* Karrer, in the Miocene and Pliocene *Gypsina globulus* Reuss. This widespread horizontal distribution in the Tertiary period corresponds to a still wider distribution at the present day, for the mentioned *Spiroloculina* and *Gypsina* inhabit the Atlantic and the Indian and Pacific Oceans; both species of *Clavulina* occur in the Atlantic, the former also in the Indian Ocean and the latter in the Pacific. Of the remaining surviving species found in the formation here dealt with, *Orbitolites marginalis* Lamk. occurs again in the three Oceans, while *Polystomella craticulata* F. e. M. is spread from the Mediterranean through the Indian Ocean to the Pacific and the uncertainly determined *Orbiculina adunca* F. e. M. is found from the Atlantic as far east as the Philippines.

Also the vertical distribution of the foraminifera differs from that of the mollusca, as is best seen from the numbers of the surviving species in both groups. Among 103 determined mollusca 7 recent forms are found, among 9 determined foraminifera 6—7. Hence the Rhizopoda would make a much younger impression when compared with the mollusca if it were not that also the extinct subgenus *Flosculinella* was found in it, besides *Lepidocyclina* and *Miogypsina*.

From what precedes it follows:

1. That the foraminifera mentioned do not alter in the least the Indopacific character of the Neogene Indian fauna, though they may occur outside the Indopacific area and partly in the European tertiary.

2. That the foraminifera, generally speaking, cannot serve in the same way as the mollusca for determining the age of the strata and that this animal group is also less serviceable for investigations on marine geography.

As to this latter point we may remember here the extraordinarily wide horizontal and vertical distribution of *Orbitolites complanata* Lamk., whereas the highly developed nummulinidae have proved eminently suitable for an exact determination of the age of deposits.

How shall we now explain the difference in distribution observed between mollusca and foraminifera and between the groups of the foraminifera among themselves? To me it would seem that it is closely related to our conception of a species. The species namely with which one has to deal in palaeontology are no physiological but morphological species. The individuals of such species of mollusca and foraminifera as we are here only concerned with, agree in a single anatomical element, the shell. Such an agreement may exist,

however, while other elements are absolutely different. An excellent illustration of this is afforded by *Marginella glabella* L. and *Pseudomarginella v. Maltzan* from the isle of Gorée, for here gastropod shells which are quite indistinguishable from each other are inhabited by entirely different animals. Lowly developed forms of foraminifera, however, are much more difficult to distinguish than shells of mollusca. so that not only the "species", but also even the genera are often connected with each other by transitions. It is easily understood that for this reason such morphological species may have a large horizontal and vertical distribution, while with the nummulinidae, the structure of which is so very complicated, this is by no means the case. The premised longevity of so many foraminifera is probably only the result of our incapacity to distinguish the species on account of their simple shells.

However this may be, the whole character of the Tertiary fauna of the West-Progo Mountains is in complete agreement with the theory formerly developed by me, according to which the Javanese Sea was separated from the Tethys since the upper Eocene.

For a determination of the age of the deposits we have in the first place the fact that out of 103 determined species of mollusca no more than 7, i.e. 6,8 %, survive to the present day. Moreover of the species described as new, relatively few related forms could be noted in the recent fauna. In the oldest Neogene sediments until now known in Java, the lower Miocene strata of Rembang, slightly more than 13% recent species are found; hence the deposits of the West-Progo Mountains cannot be younger than these. The question even arises whether they should not perhaps be reckoned to the Oligocene.

If we investigate the relationship between the fauna of the West-Progo Mountains and the younger and older Tertiary faunas of the Indian Archipelago, it appears that 24—25 species from the strata here dealt with are found in the Neogene deposits of the Dutch East Indies, none, on the contrary, in the upper Eocene of Nanggoelan. Further there exist relations with the Gaj-group of Sind (Burdigalian). From what precedes it appears that the West-Progo beds must be placed at the base of the Neogene and cannot belong to the Oligocene. So they are of lower Miocene age.

For the above reasons the foraminifera cannot serve for a percentage calculation of forms still existing; for the Indian Archipelago material for comparison in this respect is entirely lacking. But among this animal group the lower Miocene *Miogypsina thecideaformis* Ruten occurs in the fauna of the West-Progo Mountains,

which is found near Balik Papan in East Borneo together with *Alveolinella bontangensis* Rutten and *Lepidocyclina flexuosa* Rutten<sup>1)</sup>, and with these two latter species *Alveolinella globulosa* Rutten and *Lepidocyclina spec.* from the deposits here dealt with are closely related. So what we know about the foraminifera agrees with the conclusion derived above from the mollusca.

The examination of the foraminifera has also confirmed that a foraminiferal (globigerina) ooze occurring on the brook Tegalsari, in the vicinity of Nanggoelan, is equivalent with the lower Miocene sediments of the West-Progo Mountains. This equivalence had formerly been derived from general geological considerations.

When attempting more accurately to fix the age of the West-Progo deposits (within the older Miocene period) in respect to the just-mentioned Rembang beds, we meet with great difficulties. For the foraminifera of Rembang, which have been studied by DOUVILLÉ<sup>2)</sup>, in all probability belong to the Middle Aquitania stage, while those of the West-Progo Mountains according to our present knowledge point to a younger formation, Upper Aquitania or even Burdigalian. On the other hand the Rembang beds, as stated above, present a higher percentage of still living mollusca and on this account must be considered as younger than the West-Progo beds.

The chief difficulty is that in these latter deposits also *Miogypsina* occurs. In my opinion it is possible, however, that this genus is found in still older sediments than has been assumed until now. For when grouping rocks on account of the foraminifera, hardly any attention has yet been paid to the different facies, and especially to the depth at which they originated. The circumstance that according to the more recent investigations of DOUVILLÉ<sup>3)</sup> *Orthophragmina* and *Lepidocyclina* occur simultaneously in the American Oligocene, which until recently was considered impossible, shows that one has to be very careful when classifying deposits only on account of the foraminifera.

Meanwhile the mentioned incongruity cannot be solved for the present and one must be content to assign to the deposits of the West-Progo Mountains here dealt with, the general term lower Miocene, without being able to clear up their relation to the Rembang strata, which also belong to the lower Miocene.

<sup>1)</sup> L. RUTTEN, Studien über Foraminiferen aus Ost-Asien. (Sammlgn. I. Bd. 9, p. 287).

<sup>2)</sup> Les foram. d. couches de Rembang (Sammlgn. I, Bd. 10, p. 19).

<sup>3)</sup> Les Orbitoïdes de l'île de la Trinité (Compt. rend. d. séanc. de l'Acad. d. Sciences. T. 161, p. 87. 1915).