KONINKLIJKE AKADEMIE VAN WETENSCHAPPEN
TE AMSTERDAM.

"On the so-called atolls of the East-Indian Archipelago."

By Prof. A. WICHMANN.

Reprinted from

Proceedings of the Meeting of Saturday January 27, 1912.

February 22, 1912.

Geology. — "*On the so-called atolls of the East-Indian Archipelago*". By Prof. A. WICHMANN.

(Communicated in the meeting of December 30, 1911).

The geographer J. F. NIERMEYER pretended a short time ago that hitherto it was generally held that barrier-reefs and atolls "were entirely or almost entirely denied to the coasts of the Archipelago", that "this view was an error" and that the structure of these barrier-reefs "was a new evidence against the theory of DARWIN". [1])

This "generally" supposed absence of barrier-reefs and atolls had hitherto not been evidenced at all, though a great number of naturalists will have been convinced, that they are wanting, because the reports lacked sufficient conclusive force, and moreover the Archipelago in general bears the character of an extensive upheaval territory in which there is no place for such like coral-formations. In order to remove as much as possible every uncertainty, I intend to investigate in how far these reports are well founded.

When about 80 years ago CHARLES DARWIN first published [2]) his

[1]) Barrière-riffen en atollen in de Oost-Indiese Archipel. Tijdschr. K. Nederl. Aardr. Genootschap. (2) XXVIII. 1911, p. 877, 893. — Barrière-riffen in den Oost-Indischen Archipel. Handelingen van het 13de Nederl. Natuur- en Geneesk. Congres te Groningen. Haarlem 1911, p. 368.

[2]) The Structure and Distribution of Coral Reefs. London 1842., 2nd ed. 1873, 3rd ed. by T. G. BONNEY, 1889., new. ed. by JOHN W. JUDD, 1900.

work, the evidence he disposed of was still very incomplete and not in every respect to be relied upon, so that he was not always able to decide into which category the mentioned reefs were to be placed. He came to the result that, with sufficient certainty, only fringing-reefs could be pointed out in the East Indian Archipelago, yet he was inclined to think the existence of other forms of reefs possible and even probable. We shall first submit the latter to a further investigation.

According to the then existing charts he thought it possible, as regards the *Aru*, *Tanimbar* and *Timor Laut Islands*, that they were surrounded by barrier-reefs, but on account of the prevailing uncertainty he desisted from colouring them as such on his map[1]). From the reports of F. A. A. Gregory it appears already that there can only be question of fringing reefs[2]), extending, according to the most recent reports, generally 1—6 sea miles, S. W. from the island of *Trangang* even as far as 13 from the shore.[3])

Sumba or *Sandal-wood Island*. On account of a statement of James Horsburgh regarding a reef, extending at the southern shore of this island as far as 4 miles, and of the great depth of the sea in the neighbourhood[4]) Darwin thought the existence of a barrier-reef there likewise probable (p. 174). From recent information it appears however that only a fringing-reef exists.

Luang. According to a statement[5]) that the extensive reef of this island is steep outside and there within has a depth of 12 feet, Darwin supposed that it might be a barrier-reef. The most recent statements however prove it to be a fringing-reef.[6])

Ceram Laut, *Goram* and *Kefjing*. In his supposition that the reefs extending from these islands into deep water belong to the barrier-reefs, Darwin refers to G. W. Earl[7]). According to the most recent evidence however the *Ceram Laut Islands* are situated, on a large "very steep coral-reef, extending eastward to the North of *Suruaki*. "In this coral-reef some deep gullies are found among which the

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[1]) The Structure and Distribution &c. 1842, p. 172.

[2]) Zeemansgids voor de Vaarwaters naar en door den Molukschen Archipel. Amsterdam. 1853, p. 263, 277, 284.

[3]) Zeemansgids voor den Oost-Indischen Archipel V. 's-Gravenhage 1908, p. 13, 17, 29, 55.

[4]) India Directory. 4th ed. II. London 1836, p. 607.

[5]) D. H. Kolff Jr. Reizen door den weinig bekenden zuidelijken Molukschen Archipel. Amsterdam 1828, p. 130, were it is said 9—12 feet.

[6]) Zeemansgids voor den Oost-Indischen Archipel V. 1908, p. 9.

[7]) Sailing Directions for the Arafura Sea. London 1837, p. 9.

"straits of *Keffing* and *Kilwaroe* are navigable for large ships. [1])

Further DARWIN writes (p. 176): "in the space of the sea, north "of the great volcanic chain, from *Timor* to *Java*, we have also "other islands, such as the *Postillions*, *Kalatoa*, *Tokan-Bessees*, &c., "which are chiefly low, and are surrounded by very irregular and "distant reefs. From the imperfect charts I have seen, I have not "been able to decide whether they belong to the atoll or barrier-"classes, or whether they merely fringe submarine banks, and gently "sloping land.

"In the Bay of *Bonin*, between the two southern arms of *Celebes*, "there are numerous coral-reefs; but none of them seem to have an "atoll-like structure. I have, therefore, not coloured any of the islands "in this part of the sea; I think it, however, exceedingly probable "that some of them ought to be blue. I may add that there is a "harbour on the S. E. coast of *Bouton*, which, according to an old "chart, is formed by a reef parallel to the shore, with deep water "within, and in the voyage of the Coquille, some neighbouring is-"lands are represented with reefs a good way distant, but I do not "know whether with deep water within. I have not thought the "evidence sufficient to permit me to colour them". As to the *Sabalana* [*Postillon*] Islands it is known that they form a group of low and overgrown islands, rising above a submarine plateau [2]). The 528 m. high *Kalao Tua* slopes steeply down towards the sea and is only provided with a fringing-reef [3]). *Binongka*, the principal island of the *Tukang Besi*-group, consists of terraces of coral-limestone and is surrounded by a narrow fringing reef [4]). What regards the reef on the south-east coast of *Buton* [5]), there reefs of any signification are in reality unknown [6]). DARWIN's expectation that atolls would be discovered in the bay of *Boni* was not realised. Only low coral-

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[1]) Zeemansgids etc. V. 1908, p. 141.

[2]) F. A. A. GREGORY. Zeemansgids 1853, p. 18. — Zeemansgids voor den Oost-Indischen Archipel V. 1906, p. 380-382. — MAX WEBER. Introduction et description de l'expédition. Siboga-Expeditie I. Leiden 1902, p. 23.

[3]) G. F. TYDEMAN. Hydrographic Results of the Siboga Expedition. Siboga-Expeditie III. Leiden 1903, p. 18.

[4]) MAX WEBER. Introduction et description, blz. 95—97. — G. F. TYDEMAN. Hydrographic Results, p. 41—42. — Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 208—209.

[5]) L. I. DUPERREY. Voyage autour du Monde sur la corvette La Coquille. Hydrographie. Atlas. Paris 1827, Pl. 37. Carte du détroit de Wangi-Wangi.

[6]) Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 214. — Aanvullingsblad 2. 1909, p. 28.

islands of the common character [1]) are found there. Two spherical-shaped reefs indicated on the chart, with deep water within, in the Straits of Makassar (4°55′ S.), showing a more atoll-like character than any other in the Archipelago, were left uncoloured, because Capt. R. MORESBY doubted this fact.

Karakelang (*Talaut-Islands*) was said by J. HORSBURGH to be lined by a dangerous reef, projecting several miles from the northern shore,[2]) DARWIN had left the whole group uncoloured, because he could not find any other account. According to recent, more reliable, statements only fringing-reefs are found near *Karakelang* [3]).

The *Aju* and *Mapia-Islands* belong indeed to the Dutch possessions, but are situated already in the Pacific Ocean, so that they should not be treated of here. Occasionally we may remark that it was DARWIN, who indicated the atoll-character of the *Mapia-Islands* according to the chart published by PHIL. CARTERET [4]). DARWIN was less well-informed with regard to the *Aju-Islands* [5]). These possess no atoll-forms.

Not until the year 1875 new atolls were supposed to have been discovered in the Indian Archipelago. On May 11th, 1875 the corvette "Gazelle" commanded by G. E. G. VON SCHLEINITZ anchored near the island of *Dana* [*Hoki*] situated between Sawu and Sumba 10°49′ S., 121°19′27″ E.[6]). According to TH. STUDER it consists of a ring-shaped wall of coral-limestone about 120 m. high[7]), and has an opening in the N.E. [8]). There is a cup-shaped valley within containing a saltwater-lagoon. According to other statements the island is low and only along the north-east coast a ridge of hills reaching a level of 170 feet extends, whilst on the westside a separate hill rises having the shape of a short horn [9]). There can be no doubt that

[1]) Ibid, p. 265 et seq.

[2]) India Directory. 4th ed. II. London 1836, p. 504.

[3]) F. A. A. GREGORY. Zeemansgids 1853, p. 320. — Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 68.

[4]) JOHN HAWKESWORTH. An Account of the Voyages etc. I. London 1773, p. 608

[5]) THS FORREST. A. Voyage to New Guinea and the Moluccas. London 1779, p. 82. — J. DUMONT D'URVILLE. Voyage de la Corvette l'Astrolabe. Atlas, Pl. 38.

[6]) Die Forschungsreise S. M. S. "Gazelle" 1874–1876. I. Reisebericht. Berlin 1889, p. 146.

[7]) Elsewhere (Travaux de l'assoc des Soc. Suisses de Géogr. II. 1882 Genève. p. 130), STUDER says, that that level amounts to 60 m.

[8]) Die Forschungsreise S. M. S. "Gazelle". III. Zoologie und Geologie. 1889, p. 197–199. According to VON SCHLEINITZ however the opening of that ridge is towards the W.

[9]) A. G. FINDLAY. A Directory for the Navigation of the Indian Archipelago. 3d ed. London 1889, p. 747—748. — Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 457–458. Acçording to the most recent report there are in

the upperpart of the mentioned ridge consists of coral-limestone, but whether — as STUDER supposes — it is an upheaved atoll may be doubted. For he says himself that there is found in it "streifenartig eingelagert ein röthliches Conglomerat von Kalk und dichtem Thon" which does not correspond with it. At any rate the island in its present condition is entirely normal, as it is surrounded by a fringing-reef of 0.2—0.3 miles.

Lucipara Islands [*Nusa Pari*]. This group situated in the Banda Sea, consists of 5 small islands of coral-limestone[1]), united by a

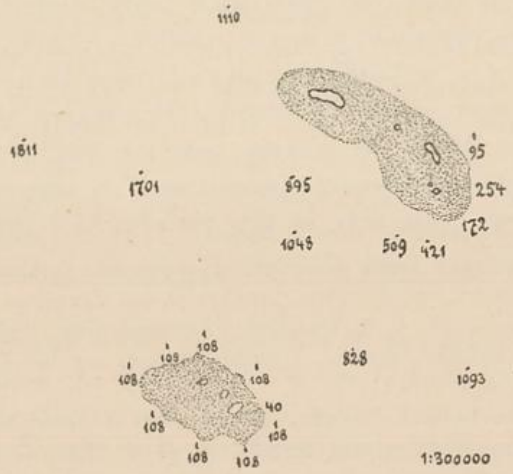

Fig. 1.

connecting reef about 9.3 km. long from N.W.—S.E, (Fig. 1). When in 1875 the above-mentioned "Gazelle" approached that group VON SCHLEINITZ supposed he ought to regard it as an atoll, but the boat that happened to come in the neighbourhood of the western island was not able to find the entrance to the "wie es schien, flache Lagune"[2]).

Since that time the *Lucipara Islands* were regarded as an atoll, though it was difficult to find a satisfactory explanation[3]) for it, and

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Dana 2 lakes with saltwater, and on the north coast rises a recognisable barren rock almost as high as the 120 feet high plateau in the eastern part of the island. (Zeemangids IV. Aanvullingsblad 3, 1910, p. 68).

[1]) R. D. M. VERBEEK. Molukken-Verslag. Jaarboek van het Mijnwezen in Ned. Oost-Indië. XXXVII. Wet.ged. Batavia 1908, p. 568—570, fig. 487. — Voorloopig verslag over een geologische reis naar het oostelijk gedeelte van den Indischen Archipel. Batavia 1900, p. 35.

[2]) Frhr. VON SCHLEINITZ. Die Expedition S. M. S. "Gazelle". Ann. d. Hydrographie. IV. Berlin 1876, p. 53. — Die Forschungsreise S. M. S. "Gazelle". I. Reisebericht, p. 157.

[3]) R. LANGENBECK. Die Theorieen über die Entstehung der Koralleninseln und Korallenriffe. Leipzig 1890, p. 141.

though from older descriptions and charts it was obvious that there was no sufficient foundation for this view [1]). It was undeniably refuted by the researches of the "Siboga" by which, at the same time, the southern island was determined at 5°30'40" S., 127°33'22" E. (Fig. 1) [2]). According to the recent investigations of VERBEEK there is no longer any foundation for the supposition that a volcano was hidden under these islands.[3])

Gisser [*Gèsir*] (3°52'29" S., 130°52'26" E.). Since the time of F. VALENTIJN we have known about *Gisser*, belonging to the *Ceram Laut Islands* that there was "een fraai bogtje vlak in 't midden" [4]) [a beautiful little bay exactly in the middle]. J. A. C. OUDEMANS too makes mention of a "schoone 4 à 5 voet diepe baai" [5]).

H. VON ROSENBERG called the island a ring-shaped upheaved sand-shoal [6]), whereas HENRY O. FORBES was the first to take it for "a mere horseshoe-shaped, cocoanut-fringed atoll" [7]) and most of the later visitors concurred with him in this view [8]). As I remarked before

[1]) W. H. ROMEOUT VAN LOON. Mededeeling aangaande de Lucipara- en Schildpadseilanden. Verhandel en Berigten betrekkelijk het Zeewezen IV. Amsterdam 1844, p. 752—757 — F. A. A. GREGORY. Zeemans Gids. 1853, p. 153—154. — Gevaren in de Indische wateren. Tijdschr. toegew. aan het Zeewezen. (2) IV. Medemblik 1844, p 317.

[2]) Siboga-Expeditie I. MAX WEBER. Introduction et description, p. 97—100., III. G. F. TYDEMAN. Hydrographic Results, p. 42, Pl. XII. — Maatschappij tot Bevordering van het Natuurk. Onderzoek der Nederl. Koloniën, No. 10, p. 14., No. 11, p. 3. — Zeemansgids voor den Oost-Indischen Archipel. V. 1908, p. 88.

[3]) R. D. M. VERBEEK and R. FENNEMA. Geologische beschrijving van Java en Madoera. I. 1896, p. 3. — R LANGENBECK l. c. — MAX WEBER l. c.

[4]) Oud en Nieuw Oost Indien. II. Dordrecht—Amsterdam 1724, p. 60. For the rest VALENTIJN was not thoroughly acquainted with the island, for he called it "high, narrow and mountainous".

[5]) Verslag van de bepaling der geographische ligging van eenige punten in de Molukken. Natuurk. Tijdschr. Ned. Ind. XXX. Batavia 1868, pp. 184—185.

[6]) Beschrijving van eenige gedeelten van Ceram. Tijdschr. voor Ind. T. L. en Volkenk. XVI. Batavia 1867, p. 132. — Der Malayische Archipel. Leipzig 1878, p. 295.

[7]) A Naturalist's Wanderings in the Eastern Archipelago . . . from 1878 to 1883. London 1885, p. 299. — Wanderungen eines Naturforschers im Malayischen Archipel. II. Jena 1886, p. 21. The cocoa-nut trees existed only in his imagination. These trees are not found in the island.

[8]) Siboga-Expeditie I. MAX WEBER l. c. p. 79, III. G. F. TYDEMAN l. c. p. 35—36 — Maatschappij tot Bevordering van het Natuurk. Onderz. Bull. No. 31. 1899, p. 12. — [N. M. VAN DEN HAM]. Mededeeling betreffende de reede van Gisser. Meded. op Zeevaartkundig Gebied, No. 17/46. 's-Gravenhage 1900. p. 8 — Zeemansgids voor den Oost-Indischen Archipel V. 1908, pp. 142—143. — H. HIRSCHI. Reisen in Nord-West Neu-Guinea. Jahresbericht der Geogr. Ethnogr. Ges. 1907—8, Zürich 1908, pp. 142—143.

Fig.2.

this view was erroneous [1]). The whole island is only the part of a shoal rising above high-water mark and chiefly consisting of coral detritus and foraminifera, and may be regarded as the upper part of a coral reef. The lagoon, ostensibly an excavation into this debris, drains itself entirely at ebb-tide, so that one can walk through it dry-shod. Its formation may be compared to that of *Europa Island* in the Canal of *Mozambique*, with this difference however that its bed remains below the level of low water [2]).

Pasigi (2°21′ N., 125°18′ O). From olden times the island of *Pasigi*, situated W. of *Taglandang* (*Sangi Islands*) was only known as a low, flat little island [3]).

A. J. VAN DELDEN added to this that it was lying on the top of a reef rising above the level of the water. [4]) J. SIDNEY HICKSON, who saw *Pasigi* in 1885 from the top of the volcano in the island of *Ruang* supposed that it might "serve as a diagram of an atoll" [5]). Afterwards he expressed himself thus: "The part above water covered with trees is only a small arc of the rim of a large almost ringshaped atoll" [6]). He considered this to be a fact not agreeing with the theory of DARWIN. M. KOPERBERG who had seen *Pasigi* from the same standpoint expresses a more reserved opinion. Moreover the commander of the Govern. S.S. "Raaf" J. KAAN had declared the island to be a coral bank [7]). None of them has ever observed

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[1]) Maatschappij tot Bevordering van het Natuurk. Onderzoek der Nederl. Koloniën. Bulletin, No. 43, 1903, p. 22, vide likewise R. D. M. VERBEEK. Molukken-Verslag. Jaarboek v. h. Mijnw. XXXVII. Wet. ged. 1908, p. 542.

[2]) ALFRED VOELTZKOW. Bericht über eine Reise nach Ost-Afrika. Zeitschr. Gesellsch. f Erdkunde. Berlin 1904, p. 428.

[3]) F. VALENTIJN. Oud en Nieuw Oost Indien. I. 1724, p. 61.

[4]) De Sangir-eilanden in 1825. Indisch Magazijn. 1ste Twaalftal, No. 4, 5 en 6. Batavia 1844, p. 356.

[5]) Omzwervingen in Noord-Celebes. Translated by P. P. C. HOEK. Tijdschr. Aardr. Genootsch. (2) IV. 1887, M. U. A, p. 141.

[6]) A Naturatist in North Celebes. London 1889, p. 44.

[7]) Verslag van een onderzoek naar de uitbarstingen in 1904 op het vulkaaneiland Roeang. Jaarboek van het Mijnw. N O.-Indië. XXXVIII. Wet. ged. 1909, Batavia 1910, p. 210.

any thing of a lagoon, and the somewhat bent shape does not authorise us to regard it as an atoll.

According to the most recent statements *Pasigi* has a diameter of about 0,5 mile, is a low coral island surrounded by a reef extended on the south side as far as 0,2, on the north-side as far as 2,5 miles [1]).

The statement of HICKSON that *Tagulandung* was surrounded by a barrier-reef has neither proved to be correct. Besides a reef in the fairway of Ruang and Tagulandang there is only a fringing-reef [2]).

Agnieten Islands [*Pulu Pangang*], *Hoorn Islands* [*Pulu Ajer*] and *Groot-Kombuis* [*Pulu Lantjang*]. C. PH. SLUITER was of opinion that he had discovered atolls in the Java Sea, namely in the Bay of Batavia. "Auch die grösseren Gruppen, die Agnieten-"Inseln und die Hoorn-Inseln, sowie die Inseln "Groote Kombuis" "oder "Pulu Lantjang" sind beträchtlich ältere Riffe, welche schon "deutliche Atolle bilden. Es ist allerdings bei den Agnieten- und "Hoorn-Inseln nicht unmöglich, dass dort ein anderer Zustand besteht, "wegen der ziemlich plötzlichen Senkung des Meeresbodens bis zu "50 Faden. Vielleicht kommt hier ein unterseeischer Kraterrand vor, "auf welchem die Korallen sich angesiedelt haben" [3]). SLUITER had previously asserted that in the *Emma Harbour* [*Brandewyns Bay*], near Padang, in the neighbourhood of the islands of *Krakatau* in straits Sunda, and *Bawean* in the Java Sea, barrier-reefs were found. Contrary to this assertion R. LANGENBECK had already remarked that in the above-mentioned regions all those reef-forms are wanting, and that they are to be regarded as coral-formations of the shallow seas (patch reefs), the rims of which are some times higher than the other parts [4]). With regard to the *Agnieten Islands* we are further informed that they consist of 5 low islands, lying on a common reef 4 miles long and 1,3 miles wide [5]). On these reefs one finds basins of which the western one is rather extensive, they can however no more than the others be compared to lagoons of atolls, but are to be regarded as depressions partly formed by sejunction, such as are

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[1]) Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 53-54.

[2]) Ibid. p. 52.

[3]) Einiges über die Entstehung der Korallenriffe in der Java-See und Branntweinsbai und über die neue Korallenbildung bei Krakatau. Naturrk. Tijdschr. Nederl. Indië. XLIX. Batavia, 1890, p. 378. — Ueber die Entstehung der Korallenriffe in der Java-See ... Biologisches Centralblatt. IX. Erlangen 1889-90, p. 751.

[4]) Die neueren Forschungen über Korallenriffe. Geogr. Zeitschr. III. Leipzig 1897, p. 570.

[5]) Zeemansgids voor den Oost-Indischen Archipel I. 's-Gravenhage 1899, p. 139.

frequently found on coral-reefs [1]). In the *Hoorn Islands*, the western ones of which — *Great* and *Little Tidung* — rest on a narrow and low reef, whilst the eastern one — *Pajung* — is surrounded by a separate reef I have not been able to detect any lagoons, no more could I do so in *Groot-Kombuis*, consisting of 2 low islands [2]).

Muaras [*umuras-*]*reef* (1°50′ N., 112°55′ O). This reef situated N. E. of Borneo has become known by the British war-ship "Samarang" which almost stranded on it [3]). It has in NW.—SE. a length of 30 km. and a breadth of 8.8 km. Whilst some parts fall dry at ebb-tide as shoals, a few rise as little islands above the level of high water. Inside the rim of the reef lies a deep basin which is however not navigable on account of the great quantity of stones [4]). Whilst MAX WEBER writes: "Ce récif rappelle, jusqu'au certain point, un atoll" [5]), J. F. NIERMEYER considers it an undubitable fact that we have here a real atoll-reef [6]). Though the reef shows indeed some resemblance with an atoll, the north-western part proves already that it is a coral-bank, which on account of the more rapid growth of the rims gave occasion to the formation of a basin.

Maratua (2.15′ N., 118°35′ E.). Until a short time ago very little was known about the group of the *Maratua-Islands* situated N.E. of Borneo. In the 18th century attention was first fixed on it by ALEXANDER DALRYMPLE [7]), and it was *Maratua* itself that was repeatedly touched at by the Sulu pirates on account of its fresh-water springs. It served likewise as temporal settlements of Badjos. Whilst the general very particular shape of the island had been known for a long time, a more careful survey was only undertaken in the beginning of this century by the Royal Dutch Navy (fig. 3). From this survey and

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[1]) The above-mentioned Zeemansgids (II. 1900, p. 542) says about the Thousand Islands: With some of these reefs one finds on the outer side dikes of coral stones lying dry, within them more or less deep basins occur. In some of the large reefs there are basins, in which a depth of 3 fathoms and more is sounded, and where proas entering at high-tide can find a safe anchorage.

[2]) Zeemansgids voor den Oost-Indischen Archipel I. 1899, pp. 132, 138. — Westelijke Vaarwaters naar Reede van Batavia. 's-Gravenhage. 1899. Dep. van Marine, No. 86.

[3]) SIR EDWARD BELCHER. Narrative of H. M. S. Samarang during the years 1843—46. I. London 1848, p. 247—248, chart at p. 223.

[4]) Zeemansgids voor den Oost-Indischen Archipel III. 1903, p. 843.

[5]) Introduction et description de l'expédition. Siboga-Expeditie I. Leiden 1902, p. 57.

[6]) Barrière-riffen en atollen enz. Tijdschr. K. Nederl. Aardr. Genootsch. (2) XXVIII. 1911, p. 890, kaart XIII, No. 13.

[7]) Oriental Repertory. I. London 1793, p. 530.

the additional description it appears that *Maratua* has the shape of a *V*, the opening of which is towards the S. E. It was represented

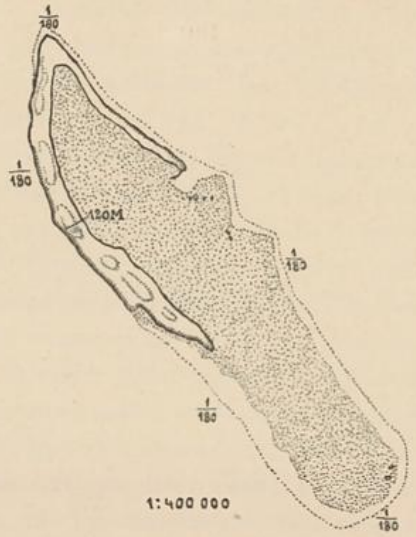

Fig. 3.

there in such a way, as if the *V*-shaped hill-ridge, the highest point of which is 400 feet high, represents the upheaved northern rim of an atoll, extending NW.—SW. over a length of 16 miles [1]). In this form this assertion is decidedly incorrect. The island is a ruin of an older date, the reef on the contrary a real fringing-reef — a recent formation. Whether in earlier times *Maratua* has been an atoll can only be decided by further investigation.

Kakaban. This island situated 4 miles S.W. of Maratua consists of a rock-wall 300 feet high, which in some parts is no more than 150 m. broad and encloses a large salt-water lake. According to the statement of natives this lake must be in connection with the sea, as it is influenced by ebb and tide. If another statement that only small fishes are found in it, should be true, there can be no question of an open connection. In most places the help of ladders is required to land on the island, because the rocks fretted by the sea, beetle. Only by careful investigation it can be decided whether *Kakaban* has in former times been an atoll. In its present state it cannot be regarded — as it is pretended — as an atoll [2]).

The fact that it is surrounded by a fringing-reef, which however is

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[1]) Zeemansgids voor den Oost-Indischen Archipel III. 1903, p. 849—851., vide likewise J. F. NIERMEYER. Barrierè-riffen en atollen, p. 890.

[2]) Zeemansgids voor den Oost-Indischen Archipel III. 1903, p. 851—852. — J. F. NIERMEYER. Barrière-riffen en atollen, p. 890.

nowhere broader than 100 m., proves that, for the rest, it is in a normal condition.

The *Bril* [*Taka Rewataya*] (6°4′ S., 118°55′ E.). This very dangerous reef, situated in the middle of the fairway has been known long since [1]). Not before 1792 however a local survey took place, when a boat of the "Pitt" found in some spots 2 feet of water and a sandy nature of the bottom [2]). Whereas in former times the *Bril* was always regarded as a bank [3]), the latest author calls it a coral-overgrown atoll-shaped bank, which is a *contradictio in terminis*. It runs dry for the greater part at ebb-tide, with the exception of the rather deep basin in the middle, and the southern part where from $3^1/_2$ to 5 fathoms of water stands [4]).

Brisbane-reef. On the 15th Januari 1880 the steamship "Brisbane" stranded on a hithertho unknown reef, which was called after this ship [5]). In 1902 a light-house was erected in the island *Meati Miarang* (4° $22^1/_2$′ S., 128° $29^1/_2$′ E.) situated near the southern point [6]). Between this island and the two *Ukenao Islands* (*Meati Rialam* and *Amortaun*) situated in the N., extends the very large reef $22^1/_4$ km. long and $9^1/_4$ km. broad, enclosing on the East-side a long basin, nearly for the whole length; the southern part only was explored. On the east-side there is an opening [7]). According to the researches of R. D. M. Verbeek the three islands mentioned consist of coral-limestone and are consequently older than the reef that is their common fringing reef [8]). There can be no question of the existence of an atoll, though Niermeijer calls it so [9]).

Angelica-reef [*Pasir Layaran*] (7°46,5′ S. 122°15′ E.) This reef was discovered on 3rd of July 1801 by the ship "*Angelica*" and described

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[1]) The *Bril* was apparently called after a ship of that name that was reported in 1694 (F. Valentijn. Oud en Nieuw Oost-Indien. I. 2. 1724, p. 29). The reef has been known by its present name since the beginning of the 18th century.

[2]) The Oriental Navigator. 2d ed. London 1801, p. 516. — J. Horsburgh India Directory. 4th ed. II. 1836, p. 532.

[3]) J. Schröder. Over de Bank de Bril. Verhandel. en Berigten betr. het Zeewezen. IV. Amsterdam 1844, p. 651—652.

[4]) Zeemansgids voor den Oostind. Archipel III. 1903, p. 608 2nd edit. 1909, p. 511. — J. F. Niermeyer. Barrière-riffen en atollen, p. 890, map XIV, fig. 18.

[5]) Rif en eiland ("Brisbane") ontdekt. Bericht aan Zeevarenden. 's-Gravenhage 1880, N°. 15/397.

[6]) Licht wordt ontstoken. Bericht aan Zeevarenden. 1903, N°. 229/1713, 248/1870.

[7]) Zeemansgids voor den Oost-Indischen Archipel. V. 1908, p. 8—9.

[8]) Molukken-Verslag. Jaarboek van het Mijnwezen. XXXVII Wet. ged. 1908, p. 445.

[9]) Barrière-riffen en atollen, p. 890, map XIV, fig. 17.

as of a circular shape, 4 miles in diameter and at the north- and south-end nearly dry [1]). Repeatedly ships were wrecked on it. When in 1846 the brig "Haai" ran aground on it, it was discovered that the reef was divided into three parts by two small gullies, on the middle-part rocks rose just above the level of the sea [2]) Not before 1908 an exact survey was made by the exploring vessel "Soembawa", which gave the very remarkable result, that the *Angelica-reef* was to be considered as an atoll, 6.95 km, in WNW.—ESE. long and 4.17 km. broad [3]). It is the first of all reefs that has a real atoll-shape, though it differs from the normal form, and two basins are found in it.

GosongBoni (8°23' S., 122°14' E.). This reef was discovered in 1851 by P. KONING [4]) and represented by him as a small island (*Pulu Boni*) [5]) with which a semi-circular reef was united that ran dry. According to the surveyings of the "Soembawa" this reef has likewise the shape of an atoll [6]). It has a diameter of $2^1/_2$ km., whilst the depth of the basin amounts to 40—50 fathoms [7]).

Lalanga-reef (1°2' S. 120°40' E.). This reef situated in the bay of *Tomini* is described as a large coral reef running for the greater part dry and steeply sloping down everywhere except on the east-side [8]), From the fact that there are on the east-side two diverging off-shoots NIERMEYER supposed he might conclude that the reef had the character of an atoll [9]). This conclusion has no foundation whatever, not even the shape reminds of an atoll.

Somewhat more than 1 km. to the south of the *Lalanga-reef*, a ring-shaped reef is found. A regular fishing is going on in the basin.

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[1]) JAMES HORSBURGH. India Directory. 4th ed. II. London 1836, p. 610.

[2]) C. F. STAVENISSE DE BRAUW. Het vastzeilen van Zr. Ms. brik De Haai op de Argelika's Droogte. Verhandelingen en Berigten betr. het Zeewezen. VIII. 1848, p. 704. H. D. A. SMITS. Zeemansgids voor de Eilanden en Vaarwaters beoosten Java. 2nd ed. Amsterdam 1859, pp. 39—40.

[3]) Bericht aan Zeevarenden. 's-Gravenhage 1908, No. 154/232. — Zeemansgids voor den Oost-Indischen Archipel IV. Aanvullingsblad 2, p. 91. — J. F. NIERMEYER. Barrière-riffen en atollen, p. 891. map XIII, fig. 16.

[4]) Chart of part of the North-coast of Flores, Novbr. 1851 (J. G. F. BRUMUND. Indiana. I. Amsterdam 1853, at p. 131).

[5]) Boni is the name of the Malay navigators, the inhabitants of the neighbouring north-coast of Flores call it Taping.

[6]) Zeemansgids voor den Oost-Indischen Archipel. IV. Aanvullingsbl. 2. 1909, p. 90. It is remarkable, that the bottom of the basin consists of white clay.

[7]) NIERMEYER reports l. c. p. 891 l. 5 f. t. a depth of 885 m., l. 9 f. b. of 105 m.and according to map XIV. fig. 19. of 85 m.

[8]) Zeemansgids voor den Oost-Indischen Archipel IV. 1906, p. 138.

[9]) Barrière-riffen en atollen blz. 891, chart XIV, fig. 21.

This reef is however no atoll. NIERMEYER still supposes that he must regard another reef, likewise in the bay of *Tomini* SW. of the town of *Tomini* about 0°24′ N., 120°32′, as belonging to the atoll-formations. It is impossible for me to recognise an atoll-formation in it [1]).

At last two more reefs in the Java-Sea remain, situated NNE. of *Boompjes Island* [*Pulu-Rakit*], which NIERMEYER considers as two remarkable curiosities, beautiful atoll-shaped bars. "One would certainly "call them atolls, if the notion deep-sea upheaval were not insepar- "ately connected with this name" [2]).

The result of the above considerations is, that among the islands of the East Indian Archipelago, that are supposed to be atolls, *Dana*, the *Luciparas*, *Maratua*, *Kakaban* and *Meati Miarang* are formations of no recent date and provided with fringing-reefs, whilst *Gisser*, *Pasigi*, the *Agnieten Islands* etc. represent coral formations of the shallow sea. Consequently J. F. VAN BEMMELEN's words are still valid: "However rich the Indian Archipelago may be in "such coral reefs, yet the two most known types of coral formations "are wanting: *Barrier-reefs* and *Atolls*" [3]). As to the reefs, that rise only partly above the level of the sea, among these we meet no more atoll-form with the exception of the Angelica-reef and the Boni-reef.

Inseparately connected with this question about atolls is that about barrier-reefs. As stated above those reported in former times do in reality not exist. J. F. NIERMEIJER supposes he has discovered them now on a much larger scale, and adds the following explanation to his report: "They are always built up along the rims of the "sub-marine plateaus .... It is easily seen that, as a rule, they "begin as isolated small reefs ...., which can afterwards arrange "themselves and form longer bars and islands. This structure is a "new proof against DARWIN's theory, according to his theory the "barrier-reefs would have originated in fringing-reefs. For in that "case they would as a rule appear in more serried rows" [4]). It is not very well possible to contest a theory when choosing as point of issue another notion than the author's. DARWIN considered as barrier-reefs "those, which like a wall with a deep moat within" surround the islands, and held that "the lagoon-channels may be compared "in every respect with true lagoons" [5]). The further explanations

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[1]) Ibid. p. 891, map XIV, fig. 20.

[2]) Ibid. p. 892, map XIV, fig. 22.

[3]) Encyclopaedie van Nederlandsch-Indië. II. 's-Gravenhage—Leiden, [1899], p. 290.

[4]) Barrière-riffen en atollen, p. 879, 893.

[5]) The Structure and Distribution of Coral Reefs. 1842, p. 41, 43.

which he gives of these formations do not leave the least doubt that his barrier-reefs are different from those described by NIERMEIJER. These are formations of the shallow seas, patch reefs, or pelagic reefs and no other reefs could be expected in an area of upheaval.