CONTRIBUTION TO THE KNOWLEDGE OF THE FOSSIL MAMMALIAN FAUNA OF JAVA

PROEFSCHRIFT

TER VERKRIJGING VAN DEN GRAAD VAN DOCTOR IN DE WIS- EN NATUURKUNDE AAN DE RIJKS-UNIVERSITEIT TE UTRECHT, OP GEZAG VAN DEN RECTOR MAGNIFICUS DR. L. S. ORNSTEIN, HOOGLEERAAR IN DE FACULTEIT DER WIS- EN NATUURKUNDE, VOLGENS BESLUIT VAN DEN SENAAT DER UNIVERSITEIT TEGEN DE BEDENKINGEN VAN DE FACULTEIT DER WIS- EN NATUURKUNDE TE VERDEDIGEN OP VRIJDAG 8 JULI 1932, DES NAMIDDAGS TE 4 UUR

DOOR

FRANCISCUS HENDRICUS VAN DER MAAREL

GEBOREN TE AMSTERDAM

CONTRIBUTION TO THE KNOWLEDGE OF THE FOSSIL MAMMALIAN FAUNA OF JAVA.

BY

F. H. VAN DER MAAREL.

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INTRODUCTION.

The material, the description and determination of which forms the subject of the present paper, was part of an extensive collection, brought together by the exertions of the Geological Survey („Opsporingsdienst") of the Dutch East Indies, and entrusted to the author for examination. The specimens of this collection had been procured, partly from a new finding spot in the vicinity of Bumiaju (Central Java), partly from Javan localities already known for a long time. A renewed reconnoitring of the latter took place namely, in order to prepare a scheme, which had in view cooperation between the Survey mentioned and the American Museum of Natural History. On that occasion a rather great number of mammalian remains was collected, among which were some very fine specimens. The plan above mentioned was not carried into effect, so that the latter material was also sent to the writer.

The reader may form himself an idea of the extensiveness of the whole collection, if is mentioned that this consisted of four sendings, containing in total 31 cases, partly of considerable size [1]). The first, third and fourth sending consisted exclusively of specimens, obtained from the vicinity of Bumiaju. The second sending (18 cases) contained the material, collected in the other localities.

The packing was so excellent that most of the specimens either had experienced no harm whatever, or had hardly suffered any injury on the long journey. Only one specimen viz., a cranium of *Bibos sondaicus fossilis*, arrived in a very damaged condition. This was, however, not owing to the packing, but a result of the small degree of fossilization of that specimen.

Though in Bandung already much time was spent on the preparation, it appeared that by prolonged preparation a good deal of the specimens described could be brought into a considerable better condition. This work, which required both patience and skill, has aptly been done by Mr J. VAN DIJK, amanuensis of the Geological-Mineralogical Institute of the University of Utrecht.

The collection sent to Utrecht consisted for the greater part of mammalian remains. The cranial and dental remains of *Buffelus*, *Bibos*, *Rhinoceros*, *Hippopotamus*, "*Elephas*", *Stegodon*, "*Mastodon*",

[1]) Beside these 31 cases one more case was received, comprising molluscs from, and samples of rocks of the vertebrate bearing strata, near Bumiaju. The writer intends to examine the rocks, possibly the molluscs too.

and also the proboscidean limb bones have been selected for examination.

In accepting the examination the writer had undertaken to care that the greatest possible number of specimens should be returned before the beginning of the fourth Pacific Science Congress (Bandung 1929). Consequently, the specimens, after having been carefully examined, described, measured and pictured, immediately set out on the return journey, provided or not with a provisional name. It will hardly be necessary to point out that this working method involved difficulties. On the other hand, it yielded an advantage, which is not to be underestimated. The very fact that the fossils were sent back before their determination was definitely ended, gave rise to an absolutely objective description of each specimen, and as a matter of necessity the description had to remain objective, as later on its contents could not be changed any more.

In what follows the reader will find an enumeration of all the specimens described, and of the localities [1]) from whence they have been obtained [2]).

Residency: **Pekalongan.**

Regency: **Brebes.**

District: **Bumiaju.**

Locality: Bumiaju.

a. Excavation 1—4.

Tetralophodon bumiajuensis nov. spec.:
Fr. upper jaw with inj. l. and r. M^3.
Fragment of cranium with l. and r. M^3.
Incisive tusk.
? Fr. pelvis.

Mastodon sp.:
Inj. molar.

? *Mastodon* sp.:
Posterior portion of cranium.

Hippopotamus sp.:
R. horizontal mandibular ramus.
Lower jaw.

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[1]) See also maps n^{os}. 1 and 2.

[2]) In this list "fr." means fragmentary and "inj." injured. A sign of interrogation in front of the circumscription of a specimen indicates its *possible* belonging to the form under which it is mentioned.

b. Excavation 6.

Stegodon airâwana MARTIN:
Inj. cranium.

Stegodon sp.:
Nine fragments of grinding teeth.

c. Excavation 8.

Tetralophodon bumiajuensis nov. spec.:
Fr. r. mandibular ramus with M_3.
? Two femora (nos. 2 and 6).
? Three ulnae (nos. 1—3).
? Two radii (nos. 1 and 2).
? Tibia (no. 2).

Hippopotamus sp.:
Fr. upper jaw with l. and r. M^1—M^3.
Four detached lower C.

d. Excavation 9.

Hippopotamus sp.:
One detached lower C.

e. Excavation 11.

Stegodon sp.:
Three fragments of grinding teeth.

f. Excavation 13(?).

Hippopotamus sp.:
Fr. lower jaw.

g. Tji Saät.

Genus and species undetermined:
Proboscidean femur (no. 4).

h. Kali Biuk.

? *Archidiskodon planifrons* (FALC. et CAUTL.):
Fr. l. horizontal mandibular ramus with m_3(?).

i. Tji Pangglosoran.

Stegodon airâwana MARTIN:
Fragment of cranium with l. M^3.
Archidiskodon planifrons (FALC. et CAUTL.):
Detached l. M^1.

k. Tji Djedjawai.

Genus and species undetermined:
Proboscidean femur (no. 3).

l. Exact locality unknown.

Stegodon airâwana MARTIN:
Detached fr. l. M^3 and ditto r. M^3.
Detached M_1.

Residency: **Bodjonegoro.**

Regency: **Bodjonegoro.**

District: **Tambakredjo.**

Locality:

a. Mendut near Tinggang.

Bibos sondaicus (SCHL. et MÜLL.) *fossilis*:
Detached horn-core.

Stegodon trigonocephalus MARTIN:
Inj. cranium with r. M^3.

b. Lepen Alit near Tinggang.

Stegodon airâwana MARTIN:
Fr. lower jaw with l. and r. M_3.

Genus and species undetermined:
Proboscidean tibia (nº. 1).

c. Tegaron.

Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Fr. cranium and two detached horn-cores.

Residency: **Rembang.**

Regency: **Blora.**

District: **Randublatung.**

Locality:

a. Sentang Kedung Klampo near Kuwung.

Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Fr. cranium.

Elephas ?maximus L. *fossilis*:
Fr. lower jaw with l. and r. M_3.

b. Bondol near Kuwung.

Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Three fr. crania.

Rhinoceros sondaicus DESM. *fossilis*:
Cranium.

Rhinoceros ?sondaicus DESM. *fossilis*:
Fr. cranium.
Stegodon bondolensis nov. spec.:
Fr. lower jaw with l. and r. M_3.
Genus and species undetermined:
Proboscidean femur (n°. 1).

c. Tegal Sambiduwur near Kuwung.
Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Two fr. crania.

d. Wedilembut [1]).
Genus and species undetermined:
Proboscidean femur (n°. 5).

Residency: **Madiun.**

Regency: **Ngawi.**

District: **Ngawi.**

Locality:
a. Watualang.
Bibos sondaicus (SCHL. et MÜLL.) *fossilis*:
Cranium with both horn-cores preserved. Crushed cranium.
Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Two fr. crania.
Hippopotamus sp.:
Hinder portion of cranium.
Genus and species undetermined:
Proboscidean humerus (n°. 2).

b. Pitu.
Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Fr. cranium.

District: **Dero.**

Locality:
Redjuno.
Genus and species undetermined:
Proboscidean humerus (n°. 1).

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[1]) On the leaf of the staff-map (1 : 25.000), relating to the matter in question, we only found "Alas Wedilembut". Alas means forest.

Government: **Surakarta.**

Regency: **Sragen.**

District: **Sragen.**

Locality:

Kedung Kendang [1]).

Bibos sondaicus SCHL. et MÜLL. *fossilis*:
Cranium with one horn-core preserved.

Buffelus bubalus (L.) ?var. *sondaicus* (SCHL. et MÜLL.) *fossilis*:
Fr. cranium.

Genus and species undetermined:
Proboscidean femur (n°. 7) and humerus (n°. 3).

First we will occupy ourselves with the new localities NNW. of Bumiaju.

According to ZWIERZYCKI [2]) the first finds were made by Mr. N. DE ZWAAN at Limbangan, who discovered in 1922—'23 some loose specimens in the Kali Glagah and Tji Saät [3]). It lasted till March 1923 before Mr. BUNING of Cheribon announced these finds in the papers. The result was that VAN DER VLERK, at that time palaeontologist of the Geological Survey, by order of that Survey made inquiries on the spot. A brief communication of his experiences will be found in the "Mijningenieur" of 1923 [4]).

The specimens found by VAN DER VLERK, together with the collection presented by DE ZWAAN to the Geological Survey, were sent for examination to STEHLIN in Bale. The results of this investigation were embodied in a paper entitled: "Fossile Säugetiere aus der Gegend von Limbangan (Java)" [5]).

All of STEHLIN's specimens had been obtained from the Kali Biuk and Tji Saät [6]). They were considerably rounded, distinctly indicating river transport. Only a few specimens allowed of determining the species. Noteworthy is that STEHLIN recognized

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[1]) According to the list of localities, which accompanied the second sending, and also to the labels, Kedung Kendang is situated in the residency Madiun. From the staff-map it appeared, however, that a campong of that name does not occur in the residency mentioned. As it does occur in the government Surakarta, and as it is this campong, which VAN ES (1931) mentions as a locality of vertebrate remains, we may be sure that both list and labels contained an erroneous statement.

[2]) De Mijningenieur, Jrg. 7, 1926, p. 229.

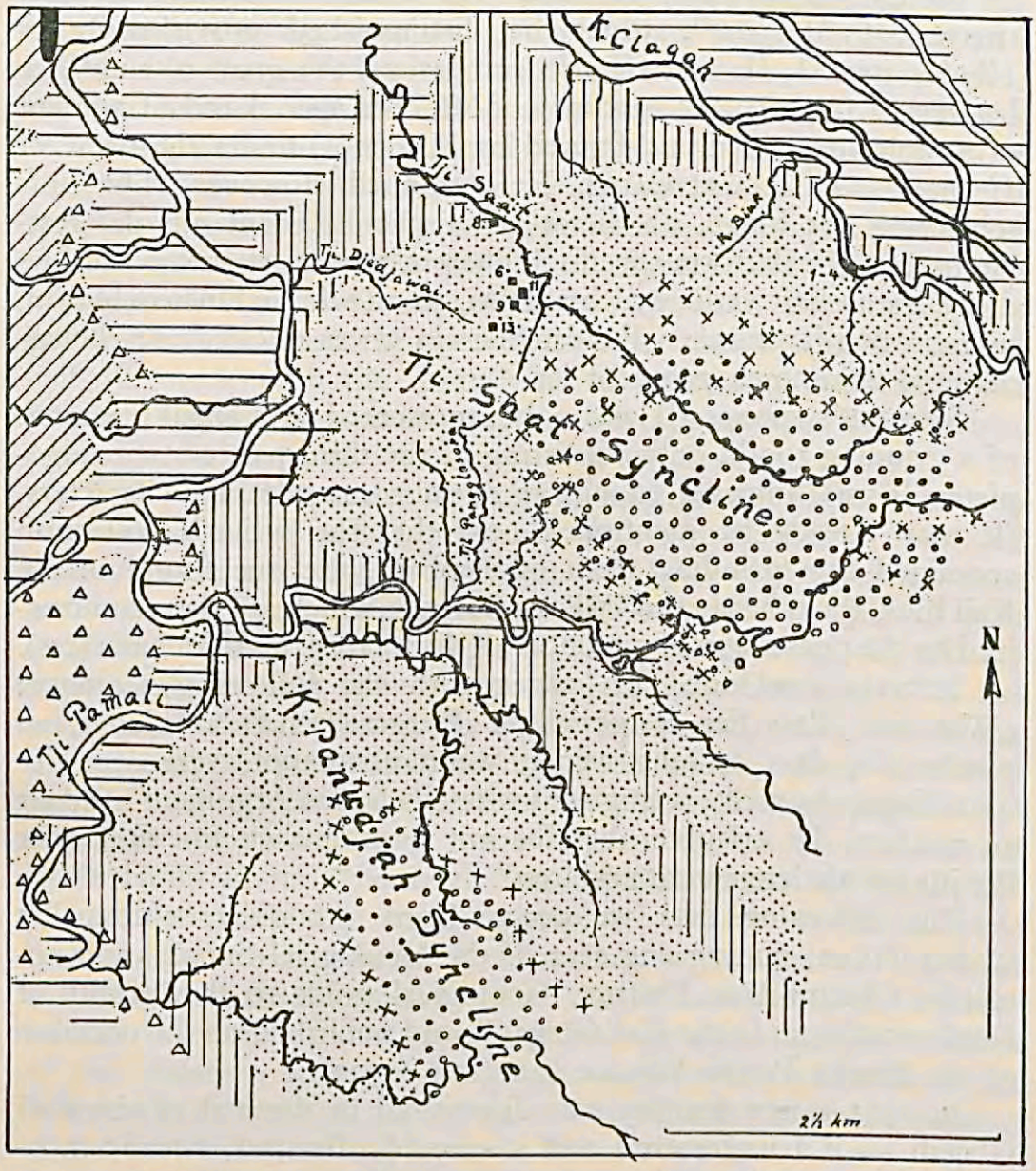
[3]) See for the topographic names map n°. 1.

[4]) Jrg. 4, p. 967.

[5]) Wetensch. Mededeelingen, Dienst v. d. Mijnbouw in Ned.-Indië, n°. 3, 1925.

[6]) I cannot see, therefore, how TER HAAR (1929) came to the assertion that all of STEHLIN's specimens ".....had been collected from the higher strata".

Map n°. 1.



Quaternary.

Upper conglomerate group with tuff beds. } Vertebrate zone.

Lower sandstone-conglomerate group. }

Turritella zone.

Breccia zone.

Limestone-marl zone.

Andesite (pipes and sills).

Excavation.

among the stegodont remains *Stegodon airâwana* MARTIN, and that he thought it necessary to accept the presence of three different species of "*Elephas*", which he distinguished provisionally as *Elephas* spec. I, II, and III. He emphasized the great resemblance between a fragmentary specimen of M^3(?) of spec. I and a fragment of a molar described and figured by MARTIN [1]) under the name of *E. hysudricus* FALC. et CAUTL. He continued, however, "Die Entscheidung der Frage, ob dieser javanische Elephant mit der festländischen Siwalikform specifisch übereinstimmt, ist cura posterior; die Wissenschaft verliert nichts dabei, wenn wir sie hinausschieben, bis von den javanischen Fundstellen ein etwas reichlicheres Belegmaterial zusammen gebracht ist" [2]).

STEHLIN's species III was only represented by a small fragment of a grinding tooth, only consisting of the third part of two ridge-plates. It was, however, enough to reveal some primitive characters. (It may already be mentioned now that the writer's collection contained two grinding teeth of elephant, the one found in the Kali Biuk, the other in the Tji Pangglosoran, which are also characterized by the possession of a number of distinctly primitive characters).

STEHLIN concluded his paper with the following sentence: „Was das Alter der festgestellten Tiergesellschaft anbelangt, so glaube ich, dass es sehr wenig, wenn überhaupt, von dem der Trinilfauna abweicht; wenigstens wüsste ich kein Argument namhaft zu machen, das erlaubte, dieselbe mit Bestimmtheit für älter oder für jünger als letztere zu erklären".

The following data we derive from a booklet, written by C. TER HAAR, mining engineer of the Geological Survey, and entitled: "Boemi-Ajoe District. Geological guide to the locality of fossil vertebrates in the Kali Glagah", and published on the occasion of the fourth Pacific Science Congress (1929).

In 1925 a new locality was discovered in the bed of the Kali Glagah — if I understand well — by Mr. BUNING, already mentioned. As a result of his report a renewed investigation was made by OPPENOORTH, at that time superintendant of the Java party of the Geological Survey. In June 1925 VAN ES [3]), mining engineer of the Geological Survey, had visited the spot, on which occasion he had got the impression that more and better preserved material might be obtainable in excavating the bones. Accordingly OPPENOORTH's investigation had for its object to ascertain whether it

[1]) Samml. Geol. Reichs-Mus. Leiden, IV, (1887), p. 57, pl. VI, figs. 2—2*a*.

[2]) This quotation has been given, because of the fact that sometimes (ZWIERZYCKI, 1926, p. 229, and 'T HOEN, 1930, p. 29) erroneously is maintained that STEHLIN determined one of his specimens as *E. hysudricus*.

[3]) See L. J. C. VAN ES. The Age of *Pithecanthropus*. The Hague 1931. Dissertation Delft 1931, p. 16.

would be possible to find the bones in situ, and if so, whether excavations would take effect. This appeared indeed to be the case. And it is the specimens, which have been excavated and collected in the years 1925 and 1926, which were sent to the writer for examination. At the same time some geological researches were made in the neighbourhood by the mining engineer TER HAAR and ZWIERZYCKI. All the excavation operations were put to a temporary standstill during the negotiations about the cooperation already mentioned of the Geological Survey and the American Museum of Natural History. When it appeared that these plans had to be abandoned, the operations were continued in the second half of 1928, with the result that an interesting collection was brought together, containing remains of hippopotamus, ruminants, crocodile and tortoise.

The writer received a geological map of the region between Limbangan and Bumiaju, together with two sections. Map and sections were made by ZWIERZYCKI. We were told that they were not intended for publication. Nevertheless, we are able to give a geological map of that region. The geological guide, already mentioned, contains namely a geological map. Our map n°. 1 has been made after a part of the latter. For the sake of clearness the site of only those excavations has been added, which furnished part of the specimens described in the following pages. One of the two sections, which were sent to us, has been published by 'T HOEN in the "Jaarboek van het Mijnwezen in Ned.-Indië" (Verhandelingen), Jrg. 1929, 1930, p. 30, so that we should have been entitled to reproduce it. From reasons which will be dealt with presently, we refrained from it. Already now it may be mentioned that 'T HOEN's publication contains also a stratigraphic column of the different strata of the region under consideration (after ZWIERZYCKI), and that according to this column the total thickness of the vertebrate bearing layers is about 1200 m.

It is easily to see that the section, published by 'T HOEN, is more or less perpendicular to the strike. No mention was made, however, of the exact situation of the section. It will be desirable, therefore, to mention that, according to the unpublished map, received by us, the section is situated in the south-easterly part of both synclines, more particularly going via that place between both synclines, where the lower sandstone-conglomerate group crops out between two strips of the Turritella zone. A superficial comparison between map (TER HAAR) and section (ZWIERZYCKI) will reveal that in the latter respect no perfect accordance exists between the two, the section showing a more simple structure. On the other hand the section shows the presence of a vertical fault

in the southwestern syncline, whereas on the map no fault will be found. VAN ES [1]) remarked that the tectonic structure is not so simple as would appear from the section published. Be that as it may, from the map it will be seen that the following statement holds good.

NNW. of Bumiaju a double syncline occurs with approximately NW.-SE. strike. TER HAAR calls the northeastern syncline: K. Saät Syncline, the southwestern one: K. Panudjah Syncline. At the time of TER HAAR's publication (1929) the exact length of the former (and probably also of the latter) was not known yet. Both synclines are separated by an anticline, in the core of which the clay-marls of the Turritella zone make their appearance. The region is intersected by the Tji Pamali and its tributaries. According to VAN Es (l.c.) the "..... region shows signs of recent upheaval; erosion still has great effect and in the valleys landslips frequently occur".

As to the exact stratigraphy an extensive enumeration has been given in a report of the Geological Survey [2]). In consequence of new determinations by VAN ES and VON KOENIGSWALD, the former was able to make some additions. The list, which follows below, has mainly been composed in combining that of the Geological Survey and that of VAN ES. The mention of *Mastodon perimensis* (one of the provisional determinations of the present writer) has been replaced by *Tetralophodon bumiajuensis*.

Zone		Sediments	Fossils	Appr. thickness in meters
Pliocene.	Vertebrate zone.	1. conglomeratic series with sandstone layers.	Scattered remains of vertebrates	250
		2. tuff horizon of grayish white sandstones.		150
		3. sandstone-conglomerate series with argillaceous sandstones, clay and marl, locally with beds of lignite, and mostly bearing lime.	*Tetralophodon bumiajuensis* nov. spec. *Stegodon airâwana* MARTIN. *Hippopotamus* sp. Several species of *Melania* and *Corbicula*, 69 % of which recent species. Some marine molluscs and foraminifera.	200

[1]) L. c. p. 48.

[2]) Jaarb. v. h. Mijnwezen in Ned.-Indië. Algemeen ged., 1930, p. 49.

Zone		Sediments	Fossils	Appr. thickness in meters
Pliocene.	Turritella zone.	blueish-gray and greenish argillaceous marls, subordinate sandy marls. mollusc bed.	Molluscs, 56 % of which recent species.	175
	Conglomerate zone.	andesitic sandstones and conglomerates.	In the upper part locally coral reefs.	200–250
Miocene.	Breccia zone.	hard, usually coarse basic andesitic breccia. Intercalations of tuff beds, and –at 300 m. from the base– a horizon of pumice-stone breccia of a thickness of 200 m; locally lava.		1000
	Tuff-sandstone zone.	fine and coarse greenish andesitic sandstones and lime bearing sandstones with intercalations of marl beds. more towards the top the sandstones become more conglomeratic and "breccia-like". a characteristic horizon is formed by a series of light coloured tuff-sandstones and grit with pieces of pumice stone.		?
	Argillaceous marl-limestone zone.	greenish, concretionary Globigerina marls, in the upper part bedded by thin layers of sandstones; more towards the base grayish-green marls with limestones, containing many foraminifera; finally unstratified concretionary argillaceous marls.	*Trybliolepidina rutteni* with several varieties. *Cycloclypeus neglectus*. *Cristellaria* sp. *Operculina* sp. *Operculinella* sp. *Amphistegina* sp. *Gypsina globulus*. *Rotalidae*, *Algae*, and pricks of echinids.	?

Both the author of the report as well as VAN ES agree as to the pliocene age of the series composed by the Vertebrate zone, Turritella zone and Conglomerate zone. I do not know, however, on what grounds the lowest boundary of the Pliocene has been drawn between the Conglomerate zone and the Breccia zone, which are both unfossiliferous. Furthermore, it may be pointed out that in all probability in TER HAAR's map (and therefore also in our map n°. 1) both Conglomerate zone and Turritella zone have been indicated by the same vertical signature. I do not know, however, with which zone the Tuff-sandstone zone has been united.

It will be remembered that in the foregoing part has been stated that according to the original opinion of ZWIERZYCKI the total thickness of the vertebrate bearing layers is about 1200 m. The above list shows that according to more recent opinions, the thickness is but 600 m. As ZWIERZYCKI calculated the thickness from the sections, it is highly probable that the section published by 'T HOEN — and already mentioned in the foregoing pages — does not hold good any more. That is, therefore, the reason why I have refrained from reproducing it.

From the report of the Survey we borrowed what follows.

The Vertebrate zone lies at the K. Glagah conformably on the Turritella zone [1]); an interjacent zone of some tens of meters consists of alternating Turritella layers and vertebrate layers, and begins with conglomeratic, andesitic sandstones, containing lumps of lignite. The latter horizon is better developed (ca. 150 m.) in the Bentarsari basin, and shows there a series of layers of impure lignite, containing 50 % of water, which high percentage should indicate a pliocene age. The lowest vertebrate bearing layers are argillaceous marls and tuffoid sandy marls of andesitic material. In the Turritella zone, thus called on account of the frequence of *Turritella djadjariensis*, 46 species of molluscs (gasteropods and lamellibranchiates) were found, 22 of which, i. e. 48 % are recent. This percentage was, however, not used as an argument for a pliocene age. According to TER HAAR [2]) this fauna has been examined by GERTH, who established the age of the Turritella zone as older Pliocene. In the report stress has been laid upon the fact that the fauna shows resemblance to that of Tjidjurai (Cheribon), examined by MARTIN, and held to be Pliocene by this investigator.

As an argument for the pliocene age of the vertebrate bearing sandstone-conglomerate series the occurrence of *Mastodon peri-*

[1]) According to TER HAAR (1929) this is invariably the case.

[2]) L. c. p. 11.

mensis, *Stegodon airâwana* and *Hippopotamus* sp. [1]) is mentioned. Though in a final chapter we shall return to the age of these beds on the basis of the determination of the mammalian remains, already now it may be pointed out that the cogency of the argument mentioned, cannot be called sufficient. It must not be forgotten that *St. airâwana* is an upper pliocene species according to DUBOIS [2]), a lower pleistocene species according to MARTIN [3]), a middle pleistocene species according to OSBORN [4]), and an upper to youngest pleistocene species according to DIETRICH [5]). As to *Hippopotamus*, it must be borne in mind that according to PILGRIM the youngest horizon in which this genus occurs, is the Boulder Conglomerate zone (uppermost Upper Siwaliks). PILGRIM [6]) regards the Upper Siwaliks as of pliocene age. MATTHEW's [7]) recent investigations on the Siwalik fauna led him, however, to the conclusion that there are no valid reasons for referring the Upper Siwaliks fauna to the Pliocene. Accordingly he reckons the Upper Siwaliks to the lower Pleistocene. Finally it may be mentioned that according to OSBORN [8]) *Mastodon (Anancus) perimensis* is an upper miocene species. I must admit, however, I do not know on what grounds.

VAN ES (l. c.) determined in cooperation with VON KOENIGSWALD, one of the palaeontologists of the Survey, part of a collection of gastropods and lamellibranchiates from the Turritella beds, collected by him and C. A. DE JONGH. The following values were found. Of 34 species determined, 19 or 56 % were still living. In VAN ES's opinion this percentage points decidedly to a pliocene age, which would be confirmed by the fact that 24 species are known to occur in the Miocene, against 33 in the Pliocene. If one compares this percentage of 56 % with the value found by VAN ES and VON KOENIGSWALD for the fauna (76 species) of the Turritella beds of Sangiran (45 %), and with those established by MARTIN [9]) for the rich marine fauna (150 species) of Sonde (53 %), and for the marine fauna (64 species) of Tjidjurai (51 %), one would be

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[1]) The mention of these forms was based on provisional determinations of the writer. It may be repeated that in the writer's present opinion the mastodont of Bumiaju is not identical with *Mastodon (Anancus) perimensis*, but represents a new species *(Tetralophodon bumiajuensis)*.

[2]) Tijdschr. Kon. Ned. Aardr. Gen., ser. 2, XXV, 1908, p. 1257. DUBOIS reckons *St. airâwana* to *St. ganesa, var. javanicus* DUB.

[3]) Unsere palaeozoologische Kenntnis von Java. Leiden 1919, p. 144.

[4]) Proc. Amer. Philos. Soc., LXX, 1931, n°. 2, p. 189.

[5]) Sitz.ber. Ges. Naturf. Fr. Berlin, Jhrg. 1924, 1926, p. 139.

[6]) Rec. Geol. Surv. India, XLIII, 1913, part 4, p. 324.

[7]) Bull. Amer. Mus. Nat. Hist., LVI, 1930, p. 445.

[8]) Proc. Amer. Philos. Soc., LXIV, 1925, p. 27.

[9]) See VAN ES's correlation table.

inclined to believe that the Turritella beds of Bumiaju show the greatest affinity to the Sonde beds. It must not be forgotten, however, that resp. 22 and 21 Bumiaju species were found to occur in Sangiran and Tjidjurai, against but 10 in Sonde. VAN ES, therefore, concluded: "A comparison with Sonde shows a great disparity to exist, but the resemblance to Sangiran and Tjidjurai is very obvious. As Sangiran (.....Lower Pliocene) and Tjidjurai (Middle Pliocene) are different in age, the almost equal affinity to both faunas makes it rather difficult to decide from this point of view to what horizon the Turritella bed of Bumiaju belongs. However, considering the rather high percentage of living species there is more reason to accept a Middle Pliocene age"[1]). In connection with the latter quotation, and with the percentages mentioned above, I should like to point out that the difference between the percentages of Sangiran (45 %) and of Tjidjurai (51 %) is 6 %, and between those of the latter and Bumiaju (56 %) is 5 %. Whilst VAN ES regards the fauna of Sangiran to belong to the Lower Pliocene, he considers the fauna of Bumiaju to be of the same age (Middle Pliocene) as that of Tjidjurai, in spite of a difference of 5 % between Bumiaju and Tjidjurai. Herewith I do not intend to maintain that an equal age of both is to be excluded. It must not be forgotten that the percentage of 56 %, found for the fauna of Bumiaju, is based on but 34 species, whereas in Tjidjurai almost twice as many species have been found.

VAN ES gave also the results of the determination by GERTH of a collection of fresh-water molluscs (*Corbicula*, *Unio*, *Melania*, *Paludina)* from the vertebrate bearing layers of Bumiaju. Of 13 species determined, 9 or 69 % appeared to be still living. From this VAN ES drew the conclusion: "This percentage points to an Upper Pliocene age of the fresh-water beds" [2]). 13 species, however, form too small a number to justify so resolute a conclusion. VAN ES's statement is the more remarkable, because on p. 26 he himself points rightly out that it is ".....necessary to exercise great caution in determining the age of the beds from the ratio of living species when too few Molluscs are present". He even set some examples, one of which is very noteworthy. In Sangiran MARTIN found a percentage of 33 % living species on 21 species; VAN ES was able to determine a ratio of 45 % out of 76 species.

GERTH[3]) advanced another objection against VAN ES's determinations of the age. He remarked namely that VAN ES, in placing

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[1]) L. c. p. 50.

[2]) L. c. p. 52.

[3]) Tijdschr. Kon. Ned. Aardr. Gen., ser. 2, XLIX, n°. 2, 1932, p. 345.

the young tertiary fauna of molluscs with 50—60 % living species [1]) in the Middle Pliocene, started from a supposition, which lacks sufficient ground, as long as we do not know that this percentage is indeed a characteristic of the middle pliocene strata of Java. We may add that MARTIN — without doubt the best connoisseur of the Tertiary of Java — has hitherto refrained from subdividing the Javan Pliocene [2]).

Later on we shall have the opportunity to return to VAN ES's very important paper. For the present we will pay attention for a moment to another argument, mentioned by VAN ES to prove the tertiary age of the vertebrate bearing strata of Bumiaju, viz., their strong folding. The report, already mentioned, of the Geological Survey even speaks of very intense folding. And as — VAN ES remarks — quaternary beds with a steep dip are unknown till now, a tertiary age is most likely. That also this argument has no absolute cogency, may be proved by a quotation, which we borrow from VAN ES himself: "Arguments derived from the dip of the beds are but of relative and local value and are insufficient to serve as a proof for the age of the beds....." [3]).

We shall now proceed with the consideration of the other localities. We may begin to ask ourselves whether detailed stratigraphic and tectonic data of these localities are available. In 1927 the state of affairs was still such that RUTTEN [4]) — after the discussion of the vertebrate bearing layers of Java — had to make the bitter remark, that not only the tectonic structure and the stratigraphy of the Trinil beds was very insufficiently known, but also the startling fact occurred that our knowledge of the geology of the surroundings of Trinil, famous by DUBOIS's discoveries of *Pithecanthropus erectus* and of a very rich fauna of vertebrates, was but very small. And had VAN ES not published the results of his extensive investigations, we should have been compelled to make exactly the same remarks. Just because we had to criticize VAN ES's paper in the foregoing pages, we are the more eager to avail ourselves of the opportunity afforded of throwing light upon the great merits of this work. It is entirely due to VAN ES that at present we dispose of a lot of stratigraphic and tectonic particulars of numerous localities, all embodied in detailed geological maps and sections. Moreover, VAN ES made extensive collections of molluscs from the

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[1]) See the very instructive table given by VAN ES (l. c.).

[2]) See his recent paper: "Wann löste sich das Gebiet des Indischen Archipels von der Tethys?" Leidsche Geol. Meded., IV, 1, 1931.

[3]) L. c. p. 7.

[4]) Voordrachten over de geologie van Ned. Oost-Indië. Groningen 1927.

marine layers, which occur almost everywhere below the vertebrate bearing series. And though GERTH's remark may be true, namely, that only the relative age has been established by the determinations of these fauna by VAN ES (and VON KOENIGSWALD), it must not be forgotten that VAN ES, in publishing so many new data, considerably enriched our knowledge of these marine sediments.

I should like to draw attention to some more merits. On the occasion of the 70th birthday of Professor K. MARTIN a jubilee book was published[1]), which is a sort of reasoned fossil catalogue of the entire East and West Dutch Indies. This work has been brought about by cooparation of a number of Dutch and some foreign investigators. The *Mammalia* have been dealt with by the present writer. The various localities, which I found mentioned in the papers relating to the subject, were united in a small sketch map[2]). If that map be compared with a similar map, occurring in VAN ES's paper, it will be seen that also in this respect VAN ES collected many new data.

Noteworthy furthermore is the way in which VAN ES discussed the problem of the age of the Trinil beds. As will be known, the number of publications, dealing with this problem, is considerable, and the number of opinions is hardly less large. Consequently difficulties are met, if one tries to form a definite opinion from the chaos of assertions and opinions. VAN ES, however, had the original idea to class the arguments, advanced by the various authors, with eleven different headings viz., 1. Orogenic movements, 2. Vulcanism, 3. River terraces, 4. Culture remains, 5. The anatomical features of *Pithecanthropus erectus*, 6. The process of fossilization, 7. Marine molluscs, 8. Fresh-water molluscs, 9. Plant remains, 10. Vertebrates, 11. Climate. In this way an excellent synopsis originated.

After this expatiation, which appeared to us as wholly justified, we return to our starting-point. We shall begin with the localities Watualang, Pitu and Kedung Kendang, all situated near the Solo river[3]). It will be known that the famous localities Trinil and Sonde are also situated on that river.

VAN ES's publication contains a geological map of the Solo river region between Gesi (N. of Sragen) and Ngawi. According

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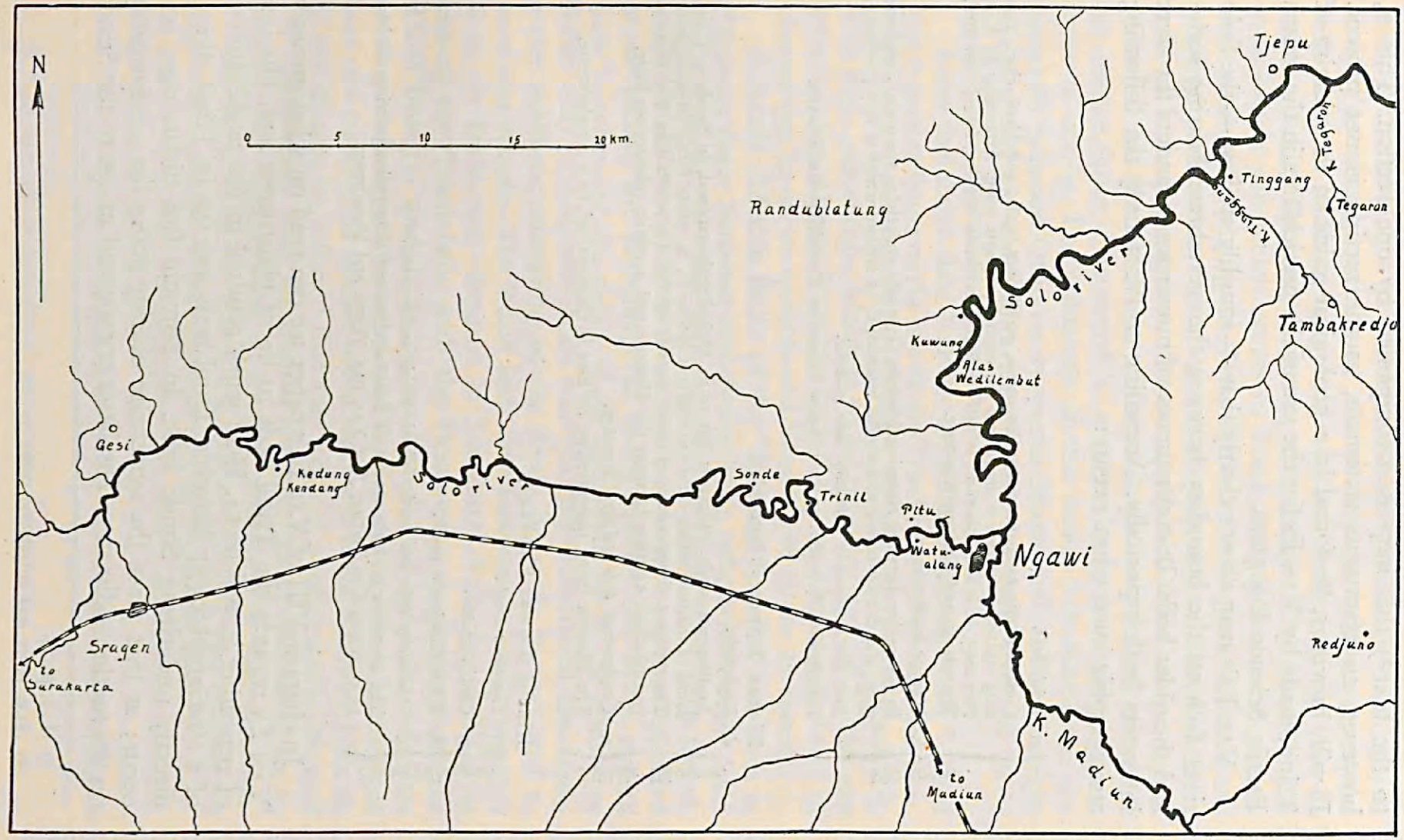
[1]) Leidsche Geol. Meded., V, 1931.

[2]) L. c. p. 471.

[3]) See map n°. 2.

Map n°. 2.


N
0 5 10 15 20 km.
Tjepu
K. Tegaron
Tinggang
Tegaron
K. Tinggang
Randublatung
Solo river
Tambakredjo
Kuwung
Alas Wedilembut
Gesi
Kedung Kendang
Solo river
Sonde
Trinil
Pitu
Watu-alang
Ngawi
Srugen
to Surakarta
Redjuno
K. Madiun
to Madiun

to the text [1]) this map is accompanied by one section. This is, however, an erroneous statement, as the section is not present. It will, however, be found in a geological guide of the vicinity of Trinil, made by VAN ES for the use of the participants in the fourth Pacific Science Congress.

VAN ES's map shows clearly that — roughly spoken — the Solo river follows the boundary between the vertebrate bearing series and the older beds. In consequence of numerous meanders the river intersects both repeatedly. According to VAN ES [2]) the following stratigraphic succession occurs:

Pleistocene.

a. Trinil beds.
Conglomeratic sandstones, conglomerates, sandstones, tuffs, and black clay. This very variable succession represents the main Vertebrate zone. According to VAN ES's map, it is also this zone, which yields the vertebrate remains, found near Pitu, Watualang, and Kedung Kendang.

b. Volcanic boulder breccia.
In the region between Ngawi and Sonde. Generally underlying the main Vertebrate zone, and corresponding to a similar horizon, E. of Ngawi, which is very persistent.

c. Sand and conglomerate containing older material.
Locally directly covering the pliocene limestone. Containing fossil bones.

Hiatus (Upper Pliocene).

Middle Pliocene.

d. Sonde beds.
Argillaceous sands. Thickness but 50 m. Only locally exposed. In Sonde with rich fauna of marine molluscs. On 150 different species 53 % recent forms (MARTIN 1919). The apparent disappearance of Sonde beds E. of Trinil is ascribed by VAN ES to an unconformity existing between the Pliocene and overlying pleistocene beds.

e. Conglomeratic beds and coral limestone.
The Pliocene being transgressive, its base is characterized by a conglomerate.

Hiatus (Lower Pliocene).

Upper Miocene.

f. Transition marls.

g. Coral limestone.

h. White Globigerina marls.

i. Alternating tuffs and marls, volcanic breccia and limestone.
The limestone contains species of Lepidocyclina and Miogypsina proving the beds to correspond to Tertiary *f* of VAN DER VLERK and UMBGROVE.

In chapter VIII of VAN ES's paper we can read on what grounds VAN ES regards the Trinil beds to be of pleistocene age. His line of reasoning is as follows. Field work resulted in the establishment of a stratigraphic gap between Trinil beds and the in Trinil almost directly underlying Sonde beds. In Bumiaju this hiatus does not occur; at that place the vertebrate bearing series lies conformably on the marine sediments. The latter correspond in age to the Sonde

[1]) L. c. p. 75.

[2]) L. c. p. 75 and correlation table.

beds, each showing a percentage of recent species between 50 and 60 %. (As already mentioned this percentage surely proves the beds to be of pliocene age; their supposed belonging by VAN ES to the Middle Pliocene, however, remaining to be solved). The stratigraphic gap which occurs in Trinil, corresponds to the vertebrate beds of Bumiaju. In Java, therefore, an upper pliocene and a lower pleistocene fauna of vertebrates occur. The vertebrate beds of Bumiaju represent, however, only one facies of the Upper Pliocene. No less than four different facies were found, of which the marine facies, discovered N. of Djombang, is of great importance of course. For sediments of that facies VON KOENIGSWALD found 66 % recent forms on 71 species determined [1]) (Sumberringin layers 2 and 3), while MARTIN established a percentage of 70 % on 50 species determined [2]) (fauna of Kedungwaru).

From the above data VAN ES drew the conclusion that "……if ever a marine fauna of the age of the Trinil beds is discovered in Java, it will show to contain more than 70 % living species of Molluscs" [3]). This high percentage, which is to be expected, would fill the gap between the Upper Pliocene and the post pleistocene beds of Grissee (90 % on 30 species) and Batavia (86 % on 22 species).

A totally different facies of the "Bumiaju beds" is met with in Surakarta (near Sangiran and Baringinan), where freshwater lake-deposits occur. In these beds 16 different forms have been found, 9 of which have been determined hitherto. As only 3 species appeared to be recent, the percentage of living species can never exceed 62½ %, whatever the result of the determination of the remaining forms may be. MARTIN-ICKE and MARTIN determined the fresh-water molluscs, occurring in the Trinil beds: 83 % appeared to be recent species. The Trinil beds therefore are decidedly younger than the fresh-water deposits in Surakarta. Accordingly VAN ES classed the Trinil beds with the Pleistocene. As furthermore the Trinil beds (1) underlie a mighty complex of volcanic sediments (Notopuro beds) in the vicinity of Pandan and (2) occur in the basal part of a complex of at least 500 m. thickness in the Kendeng Hills N. of Djombang, he inferred that they occupy a rather low horizon of the Pleistocene. VAN ES regards the presence of *Mastodon?* sp. [4]), *Stegodon* and *Hippopotamus* as another indication in that direction.

For the present the above will suffice. In our final chapter we shall return to the problem of the age of the Trinil beds.

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[1]) See VAN ES (1931), p. 115.

[2]) See VAN ES (l.c.), p. 117. VAN ES borrows these particulars from a report by MARTIN not yet published. It may be emphasized that MARTIN concludes to a pliocene age.

[3]) L. c. p. 134.

[4]) This form will be dealt with in the sequel.

Before passing on to the consideration of the other localities, it will be desirable to bring forward the following particulars concerning the Trinil beds between Gesi and Ngawi.

According to VAN ES the bones seldom occur as abundantly as in Trinil. The bone beds of a. o. Watualang and Kedung Kendang are mentioned as deposits, that might compete with those of Trinil. VAN ES protests against the opinion of some, that the origin of the bone beds should be a result of the destruction of the existing fauna by volcanic eruptions. He points out that in many cases the bones were found in cross-stratified sandstones, containing rounded pebbles indicating true river deposits. In his opinion the animals died through natural causes; they were swept by flooded rivers to some wirl-pool bend where they sank, or to sandy banks where they finally decomposed. In several cases the bones were already broken and weathered, before they were burried in the sand. Crocodiles often caused accumulation of the bones.

"In other cases the bone-bearing bed consists of black clay, containing fresh-water Molluscs and remains of fishes, crocodiles and turtles [1]). This black clay has been formed in stagnant pools and marshes or even in big lakes. Sometimes nearly complete skeletons of larger Vertebrates occur, owing to the fact that marshes often form the dwelling place of big animals." [2])

That river accumulation, not volcanic activity, was predominant is — according to VAN ES — proved by the fact that the bone beds contain detritus of miocene strata. It is these detrital products which VAN ES holds responsible for the solidification of sandstones and conglomerates.

Then VAN ES discusses the opinion, that the bones should have been washed off from the older beds. Admitting the preponderant influence of erosion, this possibility may not be immediately excluded. Many bones, however, do not show traces of wear. Furthermore, he rightly points out that *Stegodon* tusks and crania with the horn-cores attached, are too brittle in a fossil state to allow of any transport. Moreover, bigger bones and skulls often occur in medium-grained sand, containing only small pebbles, whilst big boulders are absent. Transport of the bones in a fossil state is in such cases highly improbable, as the specific weight increases by the process of fossilization.

As to the tectonic structure of the Trinil beds he mentions that the general dip is 6—10° S., showing the influence of tilting or folding movements. Several transverse faults show, moreover, that the beds did not remain undisturbed.

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[1]) Meant is tortoises.

[2]) L. c. p. 79.

We think it entirely superfluous to occupy ourselves with the geology of the surroundings of Redjuno. From that locality, namely, we are able to mention only one specimen viz., a proboscidean humerus, which did not even allow of determining the genus with sufficient reliability. Those who are interested in the stratigraphy and tectonic structure of the region, I may refer to VAN Es's publication.

As to the localities, which are situated in the districts Randublatung and Tambakredjo, we are forced to be brief, because VAN Es did not make detailed investigations in these regions. On p. 19 VAN Es mentions that he discovered in 1927 an occurrence S. of Randublatung, which appeared to be very rich in vertebrates. As Kuwung is situated SE. of Randublatung, it is highly possible that our specimens from Randublatung have been obtained from that locality. "The beds mainly consist of sandstone and gravel of volcanic origin and overlie the Miocene hills. There is a very pronounced unconformity between the slightly N.-dipping vertebrate beds and the steeply folded Miocene marls."

Still on p. 19 he cursorily deals with the localities in the neighbourhood of Tinggang. In 1926—1927 he collected there a large number of vertebrate remains from gravel beds, mostly containing pebbles of volcanic origin. "Owing to the bad exposures no data were obtainable concerning the relations to the underlying Tertiary beds. In the vertebrate beds in several spots a slight dip to the N. not exceeding 5° was established."

It may be mentioned that it is highly probable that the remains of our collection derived from these localities have been collected by VAN Es, the label of numerous specimens of the second sending bearing the mention: "Collection VAN Es".

We shall now drop the subject of the consideration of the localities, and pass on to a discussion of the few "*Mastodon*" remains which were hitherto found in the Dutch East Indies.

MARTIN [1]) described and figured under the name of *Mastodon* sp. the posterior portion of a grinding tooth, and the distal portion of an incisive tusk. DUBOIS [2]) did not agree with the generic determination. According to this investigator both specimens might rather belong to *Stegodon*. The fragment of the incisor shows a distinct flattening as a result of wear. DUBOIS rightly pointed out that this feature is not an exclusive character of the tusk of mastodonts.

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1) Samml. Geol. Reichs-Mus. Leiden, IV, 1888, p. 90, pl. XI, figs. 1—2*a*.

2) Nat. Tijdschr. v. Ned.-Ind., LI, 1892, p. 95.

LYDEKKER [1]) recorded from British Borneo a l. M^3 of *Mastodon latidens* CLIFT. [2]) The determination is certainly correct. At present this form is reckoned to the new genus *Stegolophodon* SCHLESINGER (*Prostegodon* MATSUMOTO), which OSBORN reckons to the subfamily of the *Stegodontinae*. But as far as I can see, this is merely a matter of taste.

VAN ES [3]) gave under the name of *Mastodon*? sp. two fine figures of a fragmentary grinding tooth, obtained from Sangiran, and from beds, which he regards to be of lower pleistocene age. In a note on p. 54 he mentions, furthermore, that DUBOIS showed him part of a similar molar, collected from the Kendeng Hills. In the latter's opinion these specimens might represent an atavistical deviation of a *Stegodon* molar. The writer should not like to endorse this statement. Be that as it may, VAN ES's specimen does not in the least resemble the specimens obtained from Bumiaju. As to the latter, these were originally determined as belonging to *Mastodon longirostris* by STEHLIN [4]). As already mentioned, originally the writer identified the form of Bumiaju provisionally with *Mastodon perimensis*.

Some forms of our collection appeared to be specifically identical with still living species (kerabau, banting, Javan rhinoceros and Indian elephant). In this connection I should like to make some remarks.

It is clear that everyone, who has to occupy himself with the examination of a relatively young fauna, will make comparisons with the recent fauna. In doing so, it is of the first importance that not one or some specimens of the recent species be used, but the greatest number possible. STREMME — in determining the greater part of the mammalian remains of the Trinil collection of Mrs. SELENKA — neglected this requirement, and it played tricks on him. As a matter of fact the German museums of Natural History will not contain so great a number of Dutch East Indian specimens as the Dutch museums do. I have not got the impression, however, that STREMME troubled himself sufficiently. Moreover, he apparently did not feel fully the seriousness of the requirement mentioned. Otherwise he would not have ventured to draw such resolute inferences by the help of so small a material for comparison.

As mentioned, the writer was in a far better position. And he has made an eager use of the opportunity afforded. Not because measuring skulls and composing tables of measurements is a plea-

[1]) Proc. Zool. Soc. London, 1885, p. 777, pl. XLVIII, figs. 1—2.

[2]) VON KOENIGSWALD (De Mijningenieur, n°. 11, 1931) pointed out that this specimen has possibly been imported from China!

[3]) L. c. p. 66.

[4]) See De Mijningenieur Jrg. 7, 1926, p. 230. As far as my knowledge goes STEHLIN only received photographs.

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PLATE IV.

Rhinoceros sondaicus DESM. *fossilis.*

Fig. 1. Front view of cranium no. a. *
Fig. 2. Left profile view of ditto.
Fig. 3. Palatal view of ditto.

} 0.21 nat. size. p. 58. (Occipital view in fig. 1, pl. V).

* See table of measurements K.

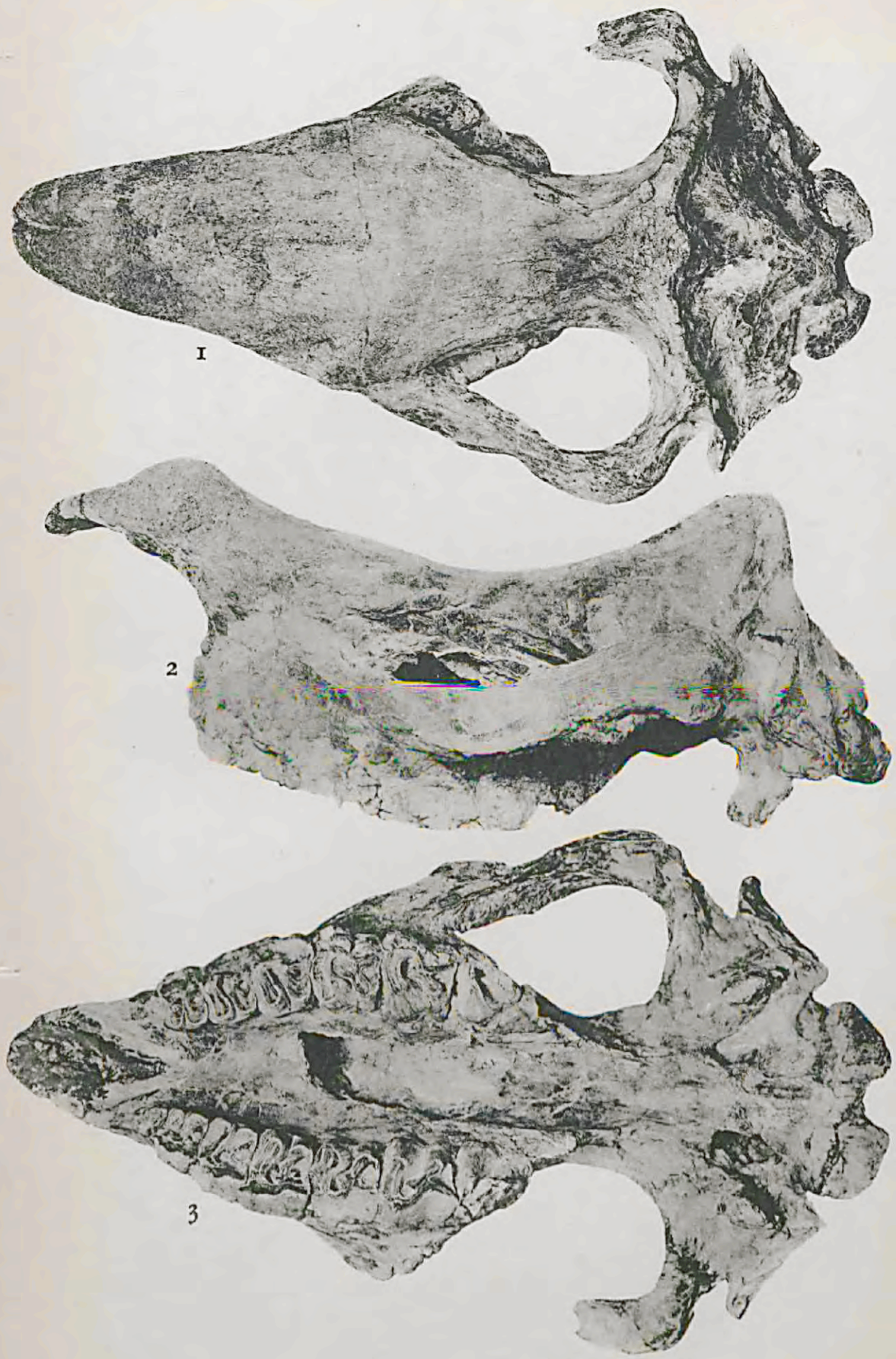

PLATE V.

Rhinoceros sondaicus DESM. *fossilis.*

Fig. 1. Occipital view of cranium no. a. * 0.23 nat. size. p. 58. (The same specimen as of figs. 1—3, pl. IV).

Fig. 2. Outer view of right P^4 of ditto. 0.95 nat. size. p. 61.

Fig. 3. Right P^1—M^3 of ditto, viewed from the grinding surface. 0.60 nat. size. p. 59.

Fig. 4. Reflected image of the inner view of the same tooth row. 0.52 nat. size. p. 59.

Hippopotamus spec.

Fig. 5. Outer view of right detached lower canine (specimen a). 0.50 nat. size. p. 88.

* See table of measurements K.