THE GEOLOGY OF THE TEGLIAN CLAY AND ITS FOSSIL REMAINS OF RHINOCEROS

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AND

ITS FOSSIL REMAINS OF RHINOCEROS

ACADEMISCH PROEFSCHRIFT TER VERKRIJGING VAN DEN GRAAD VAN DOCTOR IN DE WIS- EN NATUURKUNDE AAN DE UNIVERSITEIT VAN AMSTERDAM, OP GEZAG VAN DEN RECTOR MAGNIFICUS Dr. H. BRUGMANS, HOOGLEERAAR IN DE FACULTEIT DER LETTEREN EN WIJSBEGEERTE, IN HET OPENBAAR TE VERDEDIGEN IN DE AULA DER UNIVERSITEIT OP DONDERDAG 23 JUNI 1927, DES NAMIDDAGS TE 4 UUR,

DOOR

JOANNES JACOBUS ATHANASIUS BERNSEN
(Pater Fr. Sanctes O. F. M.)
GEBOREN TE NEDERHORST DEN BERG

WITH 12 PLATES

C. N. TEULINGS' KONINKLIJKE DRUKKERIJEN — 'S-HERTOGENBOSCH

VOORWOORD.

Aan het einde mijner academische studiën gekomen, is het mij eene aangename taak, allen, die tot mijne natuurwetenschappelijke vorming hebben bijgedragen mijn oprechten dank te betuigen.

Vooreerst noem ik U, hooggeleerde Weber, Sluiter, De Meijere en Stomps, die mij leiding gaaft op het gebied der Biologie, een onmisbaren grondslag voor de studie der Paleontologie. Met weemoed gedenk ik het plotseling overlijden van Prof. Ed. Verschaffelt, wiens verscheiden voor mijne physiologische studie een groot verlies beteekende.

Hooggeleerde Dubois, hooggeachte Promotor, U ben ik bijzonderen dank verschuldigd. Uwe colleges hebben in mij eene blijvende liefde gewekt voor de studie der Geologie en vooral der Paleontologie. Uwe onverflauwde werkzaamheid op wetenschappelijk gebied zal mij ook verder ten voorbeeld blijven strekken. Voor Uwe belangstelling, voorlichting en steun tijdens de bewerking van dit proefschrift zal ik U steeds erkentelijk blijven.

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INTRODUCTION.

Since the first publication of Professor EUG. DUBOIS on the Teglian Clay in 1904, the number of determined mammalian species of the Teglian fauna has gradually increased. A considerable list may be composed from the works of DUBOIS, REID, NEWTON, and RICHARZ. As long as the question of the age of the Teglian Clay was the chief centre of interest, the study of the Teglian mammalia was for the greater part restricted to mere determination. Only the study of the *deer*-material in the Teyler Museum at Haarlem by DUBOIS and that of *Ursus etruscus* and a number of smaller mammalia by NEWTON are also of purely palaeontological value.

This investigation of the *Rhinoceros* material is intended as a palaeontological contribution to the knowledge of the Teglian fauna. I have prefaced it by a survey of the extensive literature which has arisen chiefly on the question of its age.

The palaeontological part deals with all the *Rhinoceros* remains found in the Teglian Clay. This material is distributed over four musea. I herewith express my sincere thanks to Professor EUG. DUBOIS, Curator of the Teyler Museum at Haarlem, the Rev. KARL RIOTTE, Conservator of the Natural History Museum of the Mission House at Steyl (near Tegelen), the Rev. JOS. CREMERS, Conservator of the Natural History Museum at Maestricht, Professor P. KRUSCH, President of the Preussische Geol. Landesanstalt in Berlin, who entrusted the Teglian material to me for investigation.

In this monograph I have tried in the first place to give a clear description with reproductions of the fossils treated, so as to enable also investigators interested in the subject, who have no opportunity to visit the musea mentioned, to form an idea of the Teglian material.

I have then compared the fossils studied with *Rhinoceros* material from other localities, with which I have made myself acquainted partly from the literature, but as regards the dentitions, chiefly through personal examination. My best thanks are due to Professor P. KRUSCH, President of the Preussische Geol. Landesanstalt in Berlin, to Dr. F. A. BATHER, Keeper of the Geological Department of the British Museum (Nat. Hist.) in London, to Dr. H. GERTH, Conservator of the Min. Geol. and Palaeont. Museum at Leyden, to Professor MAX. SEMPER, Vorsteher der Geol. Palaeont. Sammlung der Technischen Hochschule at Aachen, for the readiness with which they gave me an opportunity to study the necessary material for comparison in their musea. I also express my great indebtedness to Professor E. D. VAN OORT, Director of the Leyden Rijks-Museum van Nat. Historie, and Dr. L. F. DE BEAUFORT, Director of the Zoological Museum of the Society : Natura Artis Magistra (Zoological Gardens) of Amsterdam, who enabled me to study recent *Rhinoceros* material as well.

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For the sake of brevity the following abbreviations will be used to denote the musea in which the different fossils from Tegelen and from other localities, are found :

T. M. : Teyler Museum at Haarlem.
M. M. : Natural History Museum at Maestricht.
S. M. : Natural History Museum of the Mission House at Steyl
Br. M. : British Museum (Natural History) in London.
B. M. : Geologisches Landesmuseum in Berlin.
L. M. : Min. Geol. and Palaeont. Museum of the University of Leyden.
A. M. : Geol. Museum der Technischen Hochschule at Aachen.

The works from the list of works consulted for the Geological Part will be indicated by G. 1, G. 2, etc., those from the list of works consulted for the Palaeontological Part by P. 1, P. 2, etc.

All the measurements of teeth and bones are given in mm.

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LIST OF WORKS

CONSULTED FOR THE GEOLOGICAL PART.

Abbreviations :

A. = Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap.
B. = Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie.
J. = Jahrbuch der Königl. Preuss. Geologischen Landesanstalt in Berlin.
K. = Verslagen der Afd. Wis- en Natuurkunde der Koninkl. Akad. van Wetenschappen.
M. = Verhandelingen van het Geol. Mijnbouwkundig Genootschap voor Nederland en Koloniën.
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GEOLOGICAL PART:

THE GEOLOGY OF THE TEGLIAN CLAY.

This survey is exclusively based on the study of the literature.

Description of the deposits. On the eastern frontier of the Netherlands, along the middle third part of the province of Limburg, there is the steep western border of a plateau, made up of gravels and sands, which, for the greater part, is enclosed between the valleys of the Meuse, the Niers, and the Roer, and rises to an average height of about thirty meters above the adjoining low land. Opposite Venlo, Tegelen, and Belfeld, and further on the East of Swalmen and Herkenbosch this border lies within the Dutch frontier. This plateau was formerly much larger. It extended to Nimeguen and Cleves. According to Dr. LORIÉ, the Veluwe is also a part of the same massif. This author inclines to the view that the large massif was still intact at the time of the maximum extension of the Scandinavian Ice-sheet, and that only after the retreat of that ice-sheet, the great eroding process began, which divided it into a number of pieces, and also attacked each of them separately. LORIÉ showed that the northern and eastern parts of the plateau do not merely consist of "Rhine Diluvium", as STARING supposed for the whole as far as Nimeguen, but that these northern and eastern parts show traces of having been reached by the Scandinavian Ice-sheet of the great Glacial Epoch; hence they consist, at least at the surface, of "Mixed Diluvium". This is not the case with the western part of the plateau of gravel in Dutch territory. Here only stones are found which have been transported by the Rhine and the Meuse. The horizontal stratification has not been disturbed by an ice-sheet moving over the plateau.

Besides gravel and sand clay also is dug out of the plateau, which furnishes the material for the numerous brick and tile works, in many parts of the Dutch province of Limburg, and of the adjoining region of Rhenish Prussia, chiefly along the banks and the transverse valleys of the Swalm etc. The clay is overlain conformably by the "Rhine Diluvium". The plane of contact is almost horizontal and is not eroded. In the clay-pit belonging to the firm Canoy-Herfkens, on the western border of the Jammerdaalsche Heide, the upper surface of the layer of clay lies at 27 m. + A.P. (0 A.P. = sea level). East of Belfeld, near Maalbeek, 4.5 km. S.S.W. DUBOIS (from whose "On an Equivalent of the Cromer Forest-Bed in the Netherlands" I borrow this description) found that surface at 35 m. + A.P. East of Reuver and 8.5 km. S.S.W. of the pit opposite Tegelen, it is at 43 m. + A.P. East of Swalmen, near the Dutch custom-house on the frontier, at 50.5 m. + A.P. The same clay is also dug out roundabout Brüggen, on the Swalm, in the Rhine-Province, 5 to 8 km. east of the pit near the custom-house. It is probably the same clay which is found at the surface, east of the Zwartwater (north of Venlo), and west of the plateau in the communes of Tegelen, Belfeld, and Reuver. Evidently this clay constitutes a continuous bed underlying the "Rhine-Diluvium", which has a gradual gentle upward slope to the south.

As early as 1904 DUBOIS suspected that under the sand on which the clay rests, there would be found a deeper layer of clay. This conjecture was confirmed in Jan. 1906 through a boring made under his direction in the pit owned by the firm of Canoy, Herfkens & Co. The upper clay-layer is the so-called "Teglian Clay", under which was found a

thick gravel-layer of from 18 m. + A.P. to 5.5 m. + A.P., covering in its turn a second large clay-layer of from 4.5 m. + A.P. to 9.5 m. — A.P. (DUBOIS 1904, G. 2; 1906, G. 17).

It appears from what precedes that DUBOIS identifies the clay-bed at Reuver and Swalmen with that at Tegelen, chiefly on the ground of a survey by levelling executed with scrupulous care by himself. This opinion is not shared by most investigators. As the subject of our study is confined to the Teglian Clay with its fossils, this difficulty might be left out of consideration, if it were not closely related to the question of the age of the Teglian Clay. We shall deal with it after the discussion of the floras from the two clay-layers.

The question of the geological age of the Teglian Clay has given rise to a mass of literature. Not only have Dutch geologists participated in the contest, but also foreigners, Englishmen, Frenchmen, Belgians, and Germans.

DUBOIS, TESCH, CL. and EL. REID, HARMER, NEWTON, LAURENT, MARTY, and RUTOT have endeavoured to prove the Pliocene age of the clay, whereas LORIÉ, VAN BAREN, KLEIN, KRAUSE, FLIEGEL, STOLLER, WUNSDORF, WEBER, MAYET and ROMAN, are advocates of an Early Quaternary age. A third group of investigators: FORIR, SWEMLE and RUTTEN, BRIQUET, RICHARZ, HAAS(?), MOLENGRAAFF, and VAN WATERSCHOOT VAN DER GRACHT assign the clay-layer to the boundary between the Tertiary and Quaternary.

Advocates of a Tertiary age. In 1908 (G. 28) TESCH tried to demonstrate that the Teglian Clay belongs to the so-called "Kieseloolithstufe": In boring V on the South of Tegelen near the village of Leemhorst a clay-layer was met with under the gravel of the middle-terrace and over sharp-grained sands, which are characteristic of the Kieseloolithstufe. According to TESCH this clay-layer corresponds to the Teglian Clay. As FLIEGEL states, in many places in the bend of the Lower Rhine the Kieseloolithstufe is covered with clay-layers, containing a flora of a warmer climate, for which reason they are still reckoned to belong to the Kieseloolithstufe. The clay-layer in boring V lies likewise between Diluvium and Kieseloolithstufe, and corresponds to the Teglian Clay, which, as appears from the works by DUBOIS and REID, also contains a flora of a somewhat warmer climate than the present. In virtue of these facts the Teglian Clay may, according to TESCH, more aptly be reckoned to belong to the Kieseloolithstufe than to the principal-terrace, which it underlies.

In 1909 (G. 34) TESCH found a gravel-lenticle of typically oolitic gravel between two clay-layers near Tegelen in one of the pits lying near the boundary-stones 429 and 430 in German territory. TESCH considered this a conclusive proof that the clay itself belongs to the Kieseloolithstufe.

In neither paper does TESCH pronounce a positive opinion in favour of the Pliocene age of the Teglian Clay, and certainly not on the ground of its belonging to the Kieseloolithstufe. "Es liegt die Vermutung nahe (G. 28, p. 67), dasz auch diese Stufe selbst in mehreren z. T. jung-tertiären, z.T. schon altdiluvialen Horizonten zerlegt werden müsse". On p. 67 loc. cit. TESCH, indeed, expresses the supposition," dasz die Tegelen Tone möglicherweise gleichwertig sind mit dem Red Crag oder sogar mit dem Scaldisien," and he founds this supposition on its flora. But I am not certain whether he expresses here his own opinion or cites that of REID. However this may be, VAN BAREN (1909, G. 33) and DUBOIS 1911, G. 43) have considered TESCH as an advocate of the Pliocene age of the Teglian Clay on the ground of these two articles. KLEIN (1914, G. 52): "The finding of a quartzific gravel with siliceous oolites, by my colleague P. TESCH in the Teglian Clay, does not prove in my opinion the Pliocene age of this clay". Even though it were proved beyond doubt that the Teglian Clay belongs to the Kieseloolithstufe, this fact in itself would not be sufficient to prove its Pliocene age, because it lies entirely on the upper surface of the Kieseloolithstufe, hence it might also be Early Pleistocene.

A comparison with the Kieseloolithstufe from the niederrheinische Bucht brings no further light, because according to TESCH himself the flora from Tegelen is in any case much

younger than that from the German Kieseloolithstufe, which is said to belong to the Lower Pliocene. The fact that the clay belongs to the Kieseloolithstufe, however, is itself also disputed: DUBOIS (1911, G. 43) denies the equivalence of the gravel-layer found by TESCH in boring V under the clay-layer to the gravel-layer discovered by DUBOIS under the Teglian Clay. DUBOIS has not met with oolite-gravel under the Teglian Clay and points to the important fact that the boring in 1906 under his direction was made *in the plateau*, the Leemhorst-boring, however, *in the Meuse-valley*, where the layers have not been left undisturbed (DUBOIS 1911, G. 43, p. 244). FLIEGEL himself, on whom TESCH depends in his argument, includes the lower gravel-layer of Tegelen among the oldest "Diluvialschotter" [1]). KLEIN (1914, G. 52) attaches no value to TESCH's stratigraphic arguments, since according to him, it appears with great clearness that in this region the Meuse and the Rhine of the principal-terrace epoch have absorbed a great part of the older Pliocene gravel, and this principal-terrace can, therefore, have locally quite the same composition as the gravels of Pliocene age.

In 1910 (G. 40) TESCH gave two proofs for the Pliocene age of the Teglian Clay. The first is an indirect proof and comes to this: The Dutch soil being a delta-formation, there must be a transition from N.W. to S.E. from marine to fluviatile strata. If this is so, the same layers that build up the complex of the older fluviatile deposits, the same alternation of petrographically equal sand- and clay-layers, are also found in North- and South-Holland under the gravel Diluvium with Late Pliocene fauna. Hence it follows indirectly that the purely fluviatile beds in the South East part of our country are also Pliocene.

TESCH sees a direct proof in a boring near Gemert in North-Brabant, where in the 2nd clay-layer, which belongs to the older fluviatile strata, *Vitis vinifera* (equal to that from the Teglian Clay) and two Late Pliocene shells were found.

The indirect proof may be accepted in its generality, but I do not consider it as an argument for a definite clay-layer, especially when the case in question is a transition case (Late Pliocene or Early Pleistocene). The direct proof seems to me little convincing for those who consider the whole Diluvium to belong to the Quaternary, for *Vitis vinifera* has also been found in the Interglacial clay of the Wylerberg (G. 42).

RUTOT (1908, G. 31, 1911, G. 44, 1922, G. 66) is a defender of a *Middle* Pliocene age of the Teglian Clay, and this for the reason that the sand-layer of Moll in the Campine, which he considers equivalent to the Campine Clay, and to the Teglian Clay, forms a lenticle in the marine Poederlian (Middle Pliocene) and is covered with a marine deposit of sand, which he classes with the Amstelian (Upper Pliocene). This stratigraphic argument has several weak points. RUTOT himself points out two of them on p. 36 of G. 31: the attribution of the marine sand, in which the Sand of Moll forms a lenticle, to the Poederlian, and the exact place of the Sand of Moll in relation to the complex of the Campine Clay. Yet the whole stratigraphic argument depends on the validity of both these hypotheses, for the Sand of Moll and the Campine Clay are not directly correlated with each other; if, therefore the Poederlian does not occur under both layers, the argument for their equivalence is no longer valid. There are, however, other difficulties. The equivalence of the Teglian Clay to the sand-lenticle of Moll and to the Campine Clay must then still be proved. RUTOT bases himself on the results of borings carried out in 1906 in Dutch territory. According to him these go to show that in Limburg the Teglian (the Teglian Clay and the oolite-gravel) rests on marine Poeder-

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[1]) "In Grube II des Brachter Waldes, südlich vom Icksberg, ist das Liegende des Tones aufgeschlossen. Es besteht aus einem weiszen Quarzkies, darunter folgt glaukonitischer Sand. Der Kies führt trotz seiner weiszen Farbe nicht selten Gerölle von Grauwacke, Quarzporphir, Sandstein. Noch mehr aüszert sich seine Zugehörigkeit zum Diluvium in dem Auftreten groszer, kantiger Geschiebe, wir sahen z.B. einen Quarzitblock von 70 cm. Seitenlänge. Diese Beobachtungen über das Liegende der Tegelenstufe ergänzen in sehr erfreulicher Weise das von E. DUBOIS veröffentlichte Profil." etc. FLIEGEL, 1910, G. 42, p. 253.

lian. In 1908, however, after a renewed examination of the data obtained from the borings near Helenaveen, this so-called Poederlian was ascribed at that place at least, to the Miocene (VAN BAREN 1915, G. 56, p. 425). Considering the great distance of 43 km. between the Campine Clay and the Teglian Clay and the many intervening faults, the stratigraphic argument of RUTOT does not seem very convincing (FORIR 1905, G. 14). BRIQUET, who in 1909 (G. 37) classed the Teglian Clay, as equivalent to the sand- and clay-deposits in the Campine, with the Icenian ("Norwich crag = val d'Arno = sables de Velay"), says in 1922 (G. 68) that only the oolite-gravel of Tegelen belongs to the Icenian, and places the Teglian Clay on the boundary of the Tertiary and Quaternary.

DUBOIS (1905, G. 5) has ascribed two fragments of the antlers of *stag* from the Campine Clay to *Cervus Falconeri*, described by DAWKINS from the Norwich Crag. An almost complete horn (from Merxplas) is in T.M., also the cast of another smaller fragment (from Ryckevorsel. The plants from Ryckevorsel, determined by REID (1907, G. 22), are nearly all recent Belgian species (DUBOIS mentioned *Taxodium* from the Campine Clay, in "Taxandria" 1906), but they also occur as fossils at Tegelen. At all events, with richer finds of animals or plants in the Campine, more may be expected from the palaeontologic argument in the future. But even then it remains to be proved that the Campine Clay is equivalent to the Sand of Moll, which is covered by the Amstelian.

HARMER (1905, G. 12 and 13) considers the Teglian Clay as older, perhaps much older than the Forest-Bed. He does not regard, however, like DUBOIS (1905, G. 7), the underlying Weybourn Crag, as belonging to the Pleistocene, but to the Pliocene. Hence the Teglian Clay is considered by him as Pliocene.

LAURENT and MARTY (1923, G. 69) consider the Teglian Clay as a Middle Pliocene deposit, not so much on the ground of the flora found in it, as on the ground of the equivalence of the Teglian to the Campine Clay, which is reckoned by RUTOT to be Middle Pliocene.

The other advocates of the Pliocene age base themselves on floristic and faunistic evidence, as DUBOIS, CL. and EL. REID, and NEWTON. But decided opponents, as VAN BAREN and others, base themselves likewise on this same flora and fauna to demonstrate that the Teglian Clay is Diluvial, hence Quaternary. When, however, we examine where the different authors draw the line between the two epochs, we meet with a great diversity of opinion, which may partly be reduced to the question, whether the periods of the Ice-Age are to be counted as being wholly Quaternary, or whether the first part falls in the Tertiary. At first the glacial epochs were placed in the Quaternary, but it was customary to draw the line between Pliocene and Pleistocene according to the flora and fauna found. Now the difficulty arose, because under strata which on the evidence of their fossil contents were considered to be Pliocene, older beds were found, which seemed clearly to point to a glacial period. Thus DUBOIS 1906, (G. 17), who based himself on the flora and fauna found in the Teglian Clay, spoke of its Pliocene age, which he, however, placed in the First Interglacial period on account of the underlying fluvio-glacial gravel-layer. Pliocene and Pleistocene, and also Quaternary (contra Tertiary) are palaeontologic conceptions. Diluvium is considered to be characterized by glacial periods; hence part of the Diluvium can fall in the Pliocene (DUBOIS 1906, G. 17; 1911, G. 43; 1916, G. 58). LORIÉ on the contrary, who reckons the whole glacial period to belong to the Quaternary, started from the gravel-layers, between which the Teglian Clay lies. As, like DUBOIS, he attributed every gravel-layer to a glacial epoch, the upper layer to the Second North-German Glacial time, he considered the Teglian Clay as a deposit of the First Interglacial period, and called it, therefore, Diluvial and Quaternary.

It is clear that the two investigators mean the same deposits. When it is borne in mind that the ideas Diluvium and Pleistocene no longer cover each other, it is not surprising that RUTTEN (1909, G. 32), FORIR (1905, G. 15), and the "Eindverslag" (1918 G. 60) consider this question as a question of words.

Defenders of a Quaternary age.[1]) KRAUSE (1909, G. 36 and 1911, G. 47) sees the clay-layer in the high-terrace, among others near the Wylerberg between Nimeguen and Cleves, whose fossils bear an interglacial and not a glacial character, as an independent deposit, the high-terrace as a whole being the product of two ice-periods and the interglacial time between them. According to KRAUSE this intermediate layer is equivalent to the likewise interglacial Teglian Clay, for this, too, lies between the two gravel-layers of the high-terrace. According to KRAUSE the flora collected by STOLLER and himself from the clay of the Wylerberg and of Tegelen points to a Lower Diluvium age. Hence KRAUSE places the Clay of Tegelen, as well as that of the Wylerberg, in the First Interglacial period. TESCH opposes this view, maintaining that the clay-layer of the Wylerberg is one of the lenticle-shaped "Einlagerungen", occurring frequently in the high-terrace. With regard to the Teglian Clay itself TESCH asserts that it does not lie in, but under the high-terrace. For TESCH does not consider the gravel-layer under the Teglian Clay as Diluvial gravel, but as oolite-gravel[2]). KRAUSE (G. 47) meets TESCH'S first difficulty by the assertion that the clay-layer of the Wylerberg is not to be compared with a lenticle-shaped "Einlagerung" of the high-terrace, but that it represents a continuous interjacent layer of a meter's thickness. He replies to the second difficulty that DUBOIS' boring in the pit belonging to Canoy-Herfkens has conclusively proved that there follows a layer of Diluvial gravel under the Teglian Clay. We cannot enter more deeply into the question itself, but all the same it appears clearly that KRAUSE, though an advocate of the Quaternary age of the Teglian Clay, agrees with DUBOIS in placing it in the First Interglacial period. And when in 1914 (G. 51) KRAUSE finds, in the lowest layers of the large pit owned by Canoy-Herfkens, *Paludina diluviana* "ein Leitfossil des älteren Interglazials im Ostelbischen Diluvium", this fact pleads as much in favour of DUBOIS' view, as of his own.

FLIEGEL (1909, G. 35, 1910, G. 41, and 1910, G. 42) does not consider the intermediate layer of the high-terrace of the Wylerberg as an "Einlagerung", but as an independent, hence interglacial deposit, because this layer contains more or less lime, the gravel-layers themselves being free from lime. He compares the layer-complex near Tegelen with these layers of the high-terrace of the Wijlerberg (Berg en Dal), and draws attention to the lime-content of the clay between the lime-free gravel-layers. Hence he also takes the Teglian Clay for an interglacial deposit. In virtue of the flora found in it he places it in the First Interglacial period. TESCH (1911, G. 45) and KLEIN (1914, G. 52) deny the value of the lime-content as criterion. Leaving the question whether their criticism is justified or not on one side, I will only state that FLIEGEL attributes the Teglian Clay to the same interglacial period as DUBOIS. The same applies also to WUNSDORF (1910, G. 41).

STOLLER (1910, G. 42) regards the flora of the clay of the Wijlerberg as belonging to the First Interglacial period, and finds close resemblance between this flora and that from the Teglian Clay (*Vitis, Najas, Pterocarya, Acer, Trapa*). He considers them of the same age. With DUBOIS STOLLER classes the Teglian Clay in the First Interglacial period, but he looks on it as Diluvial (Quaternary). This, however, more on stratigraphic grounds for (G. 42 p. 251) he states explicitly that the Teglian flora may equally well be either Pliocene or Diluvial. He assumes, however, the Diluvial age, because the layer underlying the clay consists of Diluvial gravel.

WEBER (1908, G. 26) writes in a letter to VAN BAREN: "Ich neige darnach durchaus dazu, die Zeit, in der die Pflanzen von Tegelen lebten, dem Quartär und nicht dem Tertiär zuzurechnen. Das Auftreten ostasiatischer und nordamerikanischer Typen beweist m.E. nichts für das tertiäre Alter. Denn wir haben derartige genug noch in Ablagerungen, die sicher interglazial sind und vielleicht sogar z.T. der zweiten Interglazialzeit (Mindel-Risz Interglazialzeit) angehören". (Discussion of this letter: DUBOIS 1911, G. 43)

[1]) It will be clear that the above-mentioned LORIÉ and VAN BAREN also belong to these defendern.

[2]) DUBOIS did not meet with a single oolite pebble in the lower gravel-layer of his boring is an undisturbed part of the deposits.

MAYET and ROMAN (1923, G. 72) place the Teglian Clay as an equivalent of the Forest-Bed in the Early Quaternary. This view is based on the mammalian fauna of Tegelen as they find it mentioned in G. 2 (1904). Later finds are evidently unknown to them.

It appears sufficiently from what precedes that the German authors agree with DUBOIS as regards the placing of the Teglian Clay in the First Interglacial period, though the Germans consider the glacial periods to be Quaternary, whereas DUBOIS lays the First Glacial time in the Upper Pliocene, as French and English geologists also did. I suppose that the German investigators (perhaps with the exception of WEBER) mean the 1st Interglacial period of the North-German geologists ; but even if they should understand by the Earliest Interglacial period the First Interglacial period of the Ice-Age in the Alps, and if they should, therefore, call it Günz-Mindel, where DUBOIS (1923, G. 71) speaks of Mindel-Risz, this is only an apparent contradiction, for DUBOIS comes to the Mindel-Risz Interglacial period, because he takes this as the oldest. BOTKE (1917, G. 59, p. 656 and 657) seems to think that DUBOIS, besides the usual Diluvial ice-periods (Günz, Mindel, Risz, Würm) assumes two Pliocene glacial periods. This misunderstanding is sufficiently reputed in what precedes.

The question of the Pliocene or Pleistocene age of the Teglian Clay is, however, not merely a question of words. Between DUBOIS, REID, and NEWTON on one side, and the German authors and VAN BAREN on the other side, there exists very decidedly a difference in appreciation of the Teglian flora and fauna. According to the latter this flora and fauna, considered in itself, bears a later character than is assigned to it by the former authors and they arrive practically at the same conclusion as DUBOIS only for this reason that the latter is compelled to consider the Teglian Clay as interglacial on account of the underlying gravel-layer. (cf. p. 11—12).

From 1904 (G. 2) till 1923 (G. 71) DUBOIS maintained the Pliocene character of the flora and fauna of Tegelen, followed by CL. and EL. REID, NEWTON, and TESCH, whereas VAN BAREN threw more stress on the species agreeing with the recent flora, which outnumber the Pliocene forms by far. To form an opinion about the Pliocene or Pleistocene character of a flora and fauna, it is required in my opinion :

1. that the material found is sufficient to give an idea of the whole flora or fauna.
2. that there are sufficient data at our disposal about the duration in geologic time of the different species.

Now the controversy has been carried on for the greater part at a time when there was a great lack of knowledge with regard to both conditions. In the literature on Tegelen we repeatedly come across passages which give evidence of an altered appreciation of some mammalian species as criterion of the Pliocene age of the clay-layer, undoubtedly in consequence of the species being found in deposits of later date. Even now there are still too few data about the duration of existence of the separate species. Hence separate species of a fauna cannot prove a *definite* age. The fixing of the age of a layer must be drawn from the study of the whole flora and fauna.

The Flora. When studying the Teglian flora the best starting-point was the work of CL. REID and EL. REID, who have determined the seeds from the clay-layer of Tegelen, of Reuver and Swalmen, and of Cromer (1915, G. 53). LAURENT and MARTY (1923, G. 69) have examined the leaves from Reuver and Swalmen. Yet it is better to leave these out of the comparison. For according to some investigators the leaves of Reuver and Swalmen do not belong to exactly the same layer as the seeds. Besides, the leaves are not representative of the whole Reuverian flora. They are for the greater part leaves of trees, which is accounted for by the fact that leaves of trees remain on the whole better preserved than the generally frailer leaves of herbaceous plants (REID 1926, G. 77, p. 10). To this is added that the mostly intact leaves of Reuver and Swalmen cannot be assumed to have been brought from a distance before fossilisation. Seeds are better adapted to such a journey.

It follows that the leaves represent more the flora of the immediate neighbourhood (LAURENT et MARTY 1923, G. 69, p. 56). The Teglian Clay, however, has produced few leaves, if any. The seeds of Tegelen, as well as those of Reuver, represent not only the flora of the neighbourhood, but possibly also that of more distant areas. Thus the classified mosses represent fresh-water and marsh species, most of which still occur in North-West Europe. One species of Tegelen, however, *Pseudoleskea patens* LIMPR., is a moss of the highlands, which, according to DIXON, who has determined the mosses, cannot possibly have lived with the other species (B.T. XXI, Mémoires p. 585—586).

According to VAN BAREN (1915, G. 54, p. 520 s.s.) :

From the Reuverian Clay (Reuver, Swalmen and Brunssum). REID has succeeded in determining 84 species with certainty. Of these 52 % are extinct, 24 % [1]) still occur in North-Western Europe, 26 % in Central Europe, 31 % in Southern Europe, 26 % in the Caucasus, 24 % in the Himalayas, 52 % in China and Japan, 14 % in the Malay Archipelago, and 23 % in North America.

From the Teglian Clay 81 species have been determined with certainty. Of these 10 % are extinct, 76 % still occur in North-Western Europe, 76 % in Central Europe, 76 % in Southern Europe, 51 % in the Caucasus, 29 % in the Himalayas, 33 % in China and Japan, 11 % in the Malay Archipelago, 29 % in North America.

From the Cromer-Bed 123 species have been identified with certainty. Only 1 species of them, i.e. 1 %, is extinct, 98 % still occur in North-Western Europe, 95 % in Central Europe, 79 % in Southern Europe, 67 % in the Caucasus, 44 % in the Himalayas, 30 % in China and Japan, 7 % in the Malay Archipelago, 30 % in North America.

VAN BAREN (op. cit. p. 523) readily admits a Late Tertiary age of the Reuverian flora on the ground of its cosmopolitan and uniform character and its large percentage of extinct species. The Reuverian flora consists in the first place of leaf-trees, in the second place of water- and marsh-plants (p. 521). The Teglian flora (according to VAN BAREN) however differs remarkably from the Reuverian by the predominance of herbaceous water- and shore-plants and the scarcity of leaf-trees (p. 522). He ascribes to this flora a Quaternary age on the ground of its more European character, its small percentage of extinct species and on the fact that it has only 19 % of the species in common with the Reuverian flora.

The Reuverian seed-flora (described by CL. and EL. REID 1915, G. 53) is characterized by a large percentage of extinct species and a small percentage of recent North-West European species (species still living in N.W. Europa). The most striking feature, however, is a surprising resemblance to the living floras of East Asia and North America. The Teglian flora has more in common with the living flora of N.W. Europe, than the Reuverian. The Cromerian consists almost exclusively of recent N. W. European species.

CL. and EL. REID gave the following explanation of these facts (1920, G. 64) : They extended the theory put forward by ASA GRAY to explain the relationship between the living floras of Japan and North America — namely that they were two divergent streams of migrants from some Polar source.

"In the Pliocene (in the quoted text it says "Pleistocene", which must evidently be "Pliocene") Flora of Western Europe we recognised a third stream. All these were driven south by the ever-increasing cold of the Pliocene. For the East Asian and North American streams the way to the Tropics was open, and they escaped. For the West Asian and European stream, from the Atlantic seaboard till the coastal plain of China was reached, the way was everywhere closed in temperate regions by impassable East-and-West barriers of mountains, seas and, perhaps, deserts. Against these barriers successive waves of migrants were driven and perished, so that by the end of the Pliocene (Cromerian) scarcely a trace of their former existence was to be found, save in their fossil remains".

[1]) The allied species are included in every number and percentage.

"It will appear..... that the Chinese — North American species mark an *outgoing* flora, the living West European species and the other exotics, an *incoming* flora ; and that these two floras were derived from different sources, the one from a Polar, the other from some other source." (REID 1920, G. 64, p. 149).

"The *immense area of high land in Central Asia*, including Tibet, the Himalaya, and Western China, may have acted as *a second centre* for the origin and dispersal of temperate species, which radiated from these uplands when the climate became colder, just as they radiated from the shores of the Arctic Sea. If such a dispersal as this took place it must have been in Miocene or Pliocene times, when the Northern Hemisphere was cooling." (REID 1920, G. 64, p. 153).

In G. 63 and G. 64, of five "Pliocene" floras (Cromerian, Teglian, Castle Eden, Reuverian, Pont-de-Gail) Mrs. REID, basing herself on these two hypotheses, compares:

1. the percentages of *exotic and extinct* species, i.e. of all species not living now in Western Europe (Crom. 5 %, Tegl. 40 %, Castl. 64 %, Reuv. 88 %, P. d. G. 94 %) ;
2. the percentages of *Chinese—North American species*, i. e. species now inhabiting Japan, China, Indo-China, the Eastern Himalaya, Assam, Burma, Malaya, Australia, and North America, but not living now in Western Europe (Crom. 0.74 %, Tegl. 16 %, Castl. 31 %, Reuv. 54 %, P. d. G. 64 %) ;
3. the percentages of the total *incoming flora* which gradually supplanted the Chinese-North American flora, from the middle of the Miocene onwards (Crom. 96 %, Tegl. 84 %, Castl. 69 %, Reuv. 46 %, P. d. G. 36 % ;
4. the percentages of the exterminated element in the incoming flora (Crom. 5 %, Tegl. 24 %, Castl. 33 %, Reuv. 34 %, P. d. G. 40 %).

From this comparison Mrs. REID deduces that the Teglian flora would be of later date than the Reuverian, but older than the Cromerian. According to this author the Cromerian and the Teglian flora would be both Upper Pliocene, the one at the top, the other near the base (G. 63, p. 106). Mrs. REID starts with the Upper Pliocene age of the Cromer-Bed, a very uncertain base in several respects (cf. DUBOIS 1905, G. 7).

In 1915 (G. 53) Mr. and Mrs. REID classed the Reuverian seed-flora provisionally as Middle Pliocene. In 1920 as a result of the above mentioned comparison Mrs. REID came to another conclusion : "Lower Pliocene, and probably some way down in it."

The method of comparison used by Mrs. REID has several weak points. Out of each flora she *selected* the species for comparison. Besides certain species, she also selected more or less *dubious* ones. On comparing the lists of selected species given by her in 1920 with each other and with the lists of species in 1915, it is difficult to understand why she mentions some plants (species and genera) being exotic (cf. VAN BAREN, 1926, G. 78, p. 1215).

As to point 1, 3, and 4 of the comparison, Mrs. REID starts from the hypothesis, that "the immense area of highland in Central Asia may have acted as a second centre." LAURENT and MARTY (1923, G. 69, p. 67) *reject* this hypothesis : "Que les flores de graines puissent appuyer une telle hypothèse, nous l'ignorons ; mais, comme *elle est en contradiction avec tant de faits paléontologiques* et *géographiques*, il faudrait tout au moins des preuves éclatantes pour l'appuyer et lui donner tout le crédit, qu'on voudrait pouvoir lui accorder..... *Le peuplement qui existe aujourd'hui n'est point nouveau, même pour le Pliocène*, il constitue seulement une association d'où, certains termes ont été progressivement éliminés, la masse étant demeurée sur place après des oscillations plus ou moins étendues. En fait, les éléments floraux propres à l'Europe occidentale n'ont jamais abandonnés la region ; etc." If this should be true, then Mrs. REID's method of comparing loses much of its value. Then it follows, that in comparing the Reuverian and the Teglian seed-floras or in determining the age of the Teglian flora by itself, one may not lay too much stress on the number of the so-called recent species.

Besides neither Mrs. REID nor VAN BAREN take into account the possibility that the differences between the Reuverian and the Teglian seed-collections may have to

be ascribed to a locally different manner of sedimentation or to any other local cause.

In G. 43 (1911) DUBOIS points out another source of mistakes. REID obtained the seeds and fruits of the 51 Teglian species, described in G. 20 (1907), by washing on a sieve one cubic foot of clay dug out and packed in the presence of DUBOIS, when REID visited Tegelen in company of DUBOIS. By applying the same method the latter obtained only 8 or 10 species (the not determined ones included). By REID's method especially the smaller seeds are favoured, which in general come from herbaceous plants (DUBOIS, op. cit. p. 237).

The fact, that REID and DUBOIS obtained *considerably different results* from two *equal quantities* of clay from the *same* pit, both with regard to the number and the nature of species, should make one very careful in drawing conclusions about difference of age. The more so with reference to materials collected by *different persons* (the Teglian material chiefly by REID, the Reuverian by JONGMANS and TESCH), from pits lying at a *great distance* from each other and from *different quantities* of clay.

Besides LAURENT and MARTY doubt the correctness of the determination of some species : "l'ensemble des espèces décrites à Reuver dans le mémoire anglais (1915, G. 53) constitue un tout assez homogène, sous les réserves que nous avons faites plus haut, au sujet de certains types, qu'il ne nous appartient pas d'analyser, ni de critiquer, mais, qui nous paraissent si hasardés, que nous ne pouvons en tenir compte, pour le moment du moins" (1923, G. 69, p. 62). FLORSCHÜTZ (1925, G. 75) identified *Gnetum scandens* ROXB. var. *robustum* var. nov. with the living *Pseudolarix Kaempferi* GORD.

DUBOIS (1911 G. 43, p. 236) mentions the following Teglian species in evidence of the Pliocene age : *Magnolia Kobus, Pterocarya caucasica, Euryale limburgensis, Vitis vinifera, Juglans tephrodes, Staphylaea pinnata, Stratiotes elegans, Trapa Stijnsii* (differing from *Trapa natans*), and the following genera : *Sequoia, Glyptostrobus* (both determined from the wood by GOTHAN), a large-stoned *Prunus*, a *Picea* from the *Omorica*-group, but differing from the living species and from the fossil *Picea omorikoides*. [1])

In the Reuverian Clay DUBOIS found cones of *fir-trees* closely related to or identical with *Picea Morinda* and (probably) *Picea ~~nigra~~ alba*.

"These plants not only point to a milder climate, as the large-stoned *Prunus, Staphylaea* and *Vitis vinifera*, but most of these (DUBOIS is speaking of the Teglian species) belong to types characterizing the Tertiary in these parts of Europe, as in their Asian, American and Mediterranean character, they show themselves as relics of a more homogeneous palaearctic or circumpolar flora of that period" (DUBOIS 1911, G. 43, p. 236). On p. 237 (op. cit.) DUBOIS calls attention to the great palaeontological importance of the ligneous plants, mentioned by him, (only *Euryale, Trapa* and *Stratiotes* are herbs) compared with herbaceous species of plants, which are better adapted to a cool climate than trees and shrubs, because in winter they are protected against the cold as seed, rhizome, etc. in the ground. Accordingly trees and shrubs will sooner have been extirpated than herbs, as the temperature decreased in the Late Tertiary (DUBOIS 1911, G. 43, p. 237—238).

According to WEBER (1908, G. 26) the occurrence of East Asian and North American types proves nothing with regard to the Tertiary age of the Teglian flora. "Denn wir haben derartige genug noch in Ablagerungen, die sicher interglazial sind und vielleicht sogar z. T. der zweiten Interglazialzeit (Mindel-Risz-Interglazialzeit) angehören" (loc. cit. p. 377). DUBOIS (1911, G. 43, p. 239) however mentions six similar species, partly mentioned by WEBER himself : *Euryale europaea, Brasenia purpurea, Dulichium spathaceum, Vaccinium priscum, Picea omorokoides* and *Rhododendron ponticum*, which (with the exception of the two last mentioned) are all from *different* localities. Besides (with the exception of the two last mentioned) they are all *herbs* (op. cit. p. 239).

According to WEBER (DUBOIS 1911, G. 34, p. 240) the interglacial layers consist

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[1]) VAN BAREN mentioned only the Pliocene species described by REID (1915, G. 53).

partly of deposits from the middle (maximum) of an interglacial period, partly of deposits from the transition stage of a glacial to an interglacial period and vice versa. Hence, according to WEBER, the floras and faunas of the same interglacial period may show a totally different character whether they date from the beginning, the middle or the end of an interglacial period. According to WEBER the Teglian flora is from the middle of a Diluvial period, which is very near the Pliocene.

DUBOIS has the following objections to this: 1. The duration of the interglacial periods was most probably very long as compared with the transition stages. This is seen at Tegelen from the thick clay-layers and from the comparatively thin sand-layers, which form the transition to the gravel-layers. 2. The scarcity of exotic species of plants in the many interglacial layers described by WEBER does not agree with this. 3. The remains of the same species of plants and animals, though not equally numerous on all levels, are yet to be found almost throughout the whole Teglian clay-layer. 4. By the frequent necessary removals of plants and animals, especially many species, which suffered most from the unfavourable conditions had soon totally disappeared from the region. This appears from the character of the known interglacial floras and faunas. "Only Tegelen possesses *many* exotic types, a great many more than have been found in any Diluvial interglacial layer" (DUBOIS 1911, G. 43, p. 241).

LAURENT and MARTY (1923, G. 69) compared the Reuverian leaf-flora with that of the Pliocene floras of Central France. These authors give as extreme limits for the age of the Reuverian flora: Middle Pliocene and Upper Miocene. Lower Pliocene seems the most probable to them. They, following REID (1915, G. 53), start however from the equivalence of the Reuverian Clay to the *lower* Teglian clay-layer (G. 69, p. 4), and, following RUTOT, from the equivalence of the Teglian Clay (*upper* clay-layer) to the Campine Clay, which is reckoned by RUTOT (1908, G. 31) to be *Middle* Pliocene (LAURENT et MARTY 1923 G. 69, p. 4—5).

DUBOIS (1904, G. 2) considers the Reuverian (Reuver and Swalmen) and the Teglian Clay to be of the same age. It is one continuous clay-layer. In this DUBOIS bases himself chiefly on measurements carefully executed by himself by means of a surveyor's levelling, from which it appeared that the upper clay-layer of Tegelen gradually passes into the clay-layer of Reuver and Swalmen. REID (1915, G. 53) assumes faults in the high-plateau somewhat south of Tegelen. According to REID south of these faults the underlying Miocene floor is raised; only one clay-layer overlies it, which he considers being identical with the lower Teglian clay-layer. Of course the strength of DUBOIS' argument would be weakened through the existence of faults. It would, however, have to be proved that these faults are not older than the clay-layer of Reuver-Swalmen and the upper clay-layer of Tegelen.

On studying the Late Pliocene floras one must bear in mind that the terms: Upper Pliocene and Lower Pleistocene may be applied to the same period in *time*, because they chiefly indicate the character of a flora, not a definite *time*. In the transition time from the Tertiary to the Quaternary epoch one region might be characterized by an Early Pleistocene flora, whereas, in an area more favoured as regards its local climate, an Upper Pliocene still survived (cf. the division of the Palaeo- and the Neolithic periods). In the case of Tegelen we are confronted with another difficulty. The Teglian Clay contains a flora pointing to an Upper Pliocene age, but which also lies between two layers of gravel which according to the current opinion cannot be ascribed to anything but to glacial periods. If the Diluvium (glacial periods) is reckoned to belong to the Quaternary, the Teglian Clay would also have to be called Quaternary. This contradiction finds a logical solution, when with DUBOIS, BOULE, and others part of the Diluvium is considered to belong to the Pliocene. This solution is possible, because, as was said by DUBOIS (G. 43), Tertiary and Quaternary, Pliocene and Pleistocene, are palaeontological conceptions,

whereas Diluvium is a geological idea. It is rational, because then the classification of the Tertiary and Quaternary rests on one and the same foundation, and also applies to areas, where the ice-sheets do not appear to have had any direct influence on conditions.

The Climate. According to LAURENT and MARTY the Reuverian leaf-flora presents itself as an association with northern and southern elements. Such a combination, which always characterizes the southern border of a northern flora, is found at present at about 35° to 40° N.L. Since the Reuverian time the northern flora has, therefore, moved 10 to 15° more to the south. This applies both to the European species and to the East Asian — North American association. Also, from an analysis of the Reuverian flora, LAURENT and MARTY get the impression, that they have to do here with an association of plants requiring a humid climate.

Mr. and Mrs. REID (1915, G. 53) draw attention to the fact that the nearest congeners of the Reuverian plants, now inhabiting southern China, are nearly all mountain plants. In other words, though living in southern latitudes they are temperate forms, and belong to the moist and temperate forestbelt found only on the Chinese mountains and in the similar moist regions of the Himalayas and Japan. The same is true of nearly all congeners which inhabit southern latitudes in whatever part of the Northern Hemisphere they may occur. According to Mr. and Mrs. REID the Reuverian flora suggests a mean temperature not greatly differing from that found in southern France at the present day, or in the Mediterranean Region, though present-day conditions in the Mediterranean Region are unsuited to the Reuverian flora. This region is warm enough, but too dry for them, as are the lowlands of China.

DUBOIS (1911, G. 43, p. 236): „These (Teglian) plants not only point to a milder climate, as the large-stoned *Prunus, Staphylaea* and *Vitis vinifera*, [1]) but most of these belong to types characterizing the Tertiary in these parts of Europe, etc."

In 1926 G. 77 p. 28 Mrs. REID writes: "The question of climate can only be treated in a very general way when dealing with extinct species. It is not justifiable to lay too much stress on individuals: for whatever be the present habitat and climatic zone of the nearest allies, it can never be known with certainty that this was exactly shared by the fossils; although the probability that it was so for the majority of species is great. Yet even among allied living species we find often a variety in climatic preference; and may individual species have wide range".

On p. 23 of G. 77 Mrs. REID gives different instances of the discovery of tropical genera and species in the temperate forests of China.

The Fauna. According to the statement of DUBOIS, REID, NEWTON, HAASE and RICHARZ the Teglian Clay has produced a fauna composed of the following species:

Mollusca: *Paludina* 2 sp., *Planorbis* sp., *Helix hispida* L., *Helix arbustorum* L., *Helix* sp., *Limnea* sp., *Pisidium* 2 sp., *Unio* sp., *Bithynia tentaculata* L., *Paludina diluviana* KUNTH, *Helix tonnensis* SANDB., *Hyriopsis subschlegeli* HAAS, *Hyriopsis altealata* HAAS, *Rhombunio* sp.

Pisces: *Leuciscus cephalus* L. ?
Pinca vulgaris CUV.
Abramis brama L.
Cyprinoid teeth (not identified).
Esox lucius L.
Anguilla vulgaris L.

[1]) It might be supposed that *Vitis vinifera* might possibly belong to a more distant southern flora, and not to the flora of the immediate neighbourhood of Tegelen. The abundance, however, in which the seeds of *Vitis vinifera* occur, renders this supposition improbable. "Les graines les plus abondantes sont celles de *Vitis* et de *Pterocarya*" (DUBOIS G. 6).

Gasterosteus aculeatus L.
Perca fluviatilis L.
Lucioperca sandra CUV.
Amphibia: *Rana* sp.
Reptilia: *Cistudo lutaria* MARSILI.
Mammalia: *Equus Stenonis* COCCHI.
Rhinoceros etruscus FALC.
Rhinoceros Mercki JÄG. (determined by the author)
Sus sp. (*Strozzii* MENEGH. ? *scrofa* L. ?).
Hippopotamus sp. (*major* CUV.).
Cervus dicranius NESTI.
Cervus rhenanus DUB.
Cervus teguliensis DUB.
Elephas meridionalis NESTI.
Microtus (*Arvicola*) *pliocaenicus* MAJOR.
Microtus (*Arvicola*) *intermedius* NEWTON.
Castor europaeus L.
Trogontherium Cuvieri FISCHER.
Talpa europaea L. ?
Myogale sp.
Ursus etruscus CUV. (= *U. arvernensis* CROIZ.).
Hyaena Perrieri CROIZET.
Hyaena crocuta ZIMM.

Of the molluscan fauna *Helix hispida* occurs in the Loess (among others in the Loess-profile near Grevenbroick, Rheinland: Jahrb. XXXII, 1911, Teil II, p. 156, KRAUSE). *Bithynia tentaculata* is known from the Oldest Interglacial deposit of Hülserberg, which was reckoned by KRAUSE loc. cit. p. 144 to belong to the same horizon as Tegelen. *Paludina diluviana* is a zone-fossil of the Lower Interglacial in the Diluvium of the East Elbe (KRAUSE 1914, G. 51). *Helix tonnensis* appears, however, in the Second Interglacial deposits (RICHARZ 1921, G. 65). HAAS (1920, G. 61), who has determined a number of *Unionidae* from the Brachter-Wald near Venlo (i.e. the three last-mentioned of the list) does not pronounce an opinion about the age of the clay-layer in which they have been found.

The species of fish mentioned are of no importance for the fixing of the age, as they occur both in the Tertiary and in recent times.

The mammalian fauna of Tegelen has the following species in common with that of the upper layers of the Val d'Arno: *Equus Stenonis, Rhinoceros etruscus, Sus Strozzii* (?)[1], *Cervus dicranius, Elephas meridionalis, Microtus pliocaenicus, Castor europaeus* (= *C. fiber* L. = *C. plicidens* MAJOR) and *Ursus etruscus*. The Teglian Clay, however, lacks (so far ?) *Mastodon arvernensis*, which is typical for the Villafranchian, to which, with the upper layers of the Val d'Arno, also les breches de Perrier (Puy-de-Dôme), les sables à Mastodontes du Puy-en-Velay, les sables de Chagny (Saône et Loire), the Norwich Crag and the Mastodontenschotter of Hessen and Thuringia are considered to belong. Moreover the Teglian Clay has produced some species that do not occur in the faunas of the Villafranchian: as *Rh. Mercki, Hyaena crocuta, Talpa europaea* ?, *Myogale* sp., *Cervus rhenanus* and *Cervus teguliensis*. The two last-mentioned species are entirely new, but allied to the Pliocene forms of the Auvergne and the English Crag (DUBOIS 1905, G. 6). REID mentions in 1915 (G. 53): *Hippopotamus amphibius*, determined by DUBOIS. This author however identifies, as many others do, *Hippopotamus amphibius* with *Hippopotamus major*, as appears from p. 218—219 of G 2. REID (G. 53, p. 11) and WEINGÄRTNER mention the

[1]) RICHARZ mentions in G. 65 (1921) its occurring in the Teglian Clay. The remains (teeth) are in the Museum of the Mission House at Steyl (near Tegelen). The label gives however *Sus scrofa*

recent-Diluvial *Hyaena crocuta*, determined by NEWTON. DUBOIS mentions the *Hyaena Perrieri* (in T.M.), which occurs in the Villafranchian (SOERGEL G. 73, p. 203). *Myogale* sp. occurs in the fauna of the Forest-Bed; the recent *Talpa europaea* in the faunas of Forest-Bed, Mosbach and Süssenborn; *Trogontherium Cuvieri* both in the Villafranchian and in the Saint-Prestian. *Castor europaeus* likewise. *Microtus pliocaenicus* is found in the Norwich Crag, Weybourn Crag and Val d'Arno. *Microtus intermedius* in the Upper Fresh Waterbed, Estuarine Bed, and in the East Runton Bed (Weybourn Crag). Together they occur in the East Runton Bed. According to NEWTON (1907, G. 23 and 1910, 39) the Teglian Clay is, therefore, a later formation than the Norwich Crag and is slightly older than the Forest-Bed series. RUTTEN also considers both forms, specimens of which were found in a deep boring near Gorinchem by HARTING, and which have been classified by RUTTEN, as belonging to the "oldest" fauna characterised by *Elephas meridionalis* and *Rhinoceros etruscus*. The absence of *Mastodon arvernensis* is only a negative argument, which, however, is not devoid of importance considering the rich finds of other species at Tegelen. So long as this form has not been found, I do not feel myself justified in placing the Teglian fauna with the typical Villafranchian faunas, which are especially characterized by the simultaneous occurrence of *Mastodon arvernensis* and *Elephas meridionalis*. This will not say however that I consider the Teglian fauna to be of later date. The absence of *Mastodon arvernensis* in this fauna or in this locality may be only accidental. The specimens found of *Elephas meridionalis* are confined to two. The first is mentioned by RUTTEN (1909, G. 32): a "condylus mandibulae, welcher vielleicht zu *Elephas meridionalis* gestellt werden musz". The second is a fragment of a molar, of which three badly worn lamellae are preserved. Prof. SCHLOSSER (RICHARZ, 1921, G. 65) states: "es kann überhaupt nichts anderes als *Elephas meridionalis* in Frage kommen". His opinion is founded on the considerable breadth of the molar. Whether these data are sufficient to prove the occurrence of *Elephas meridionalis* must be left out of consideration in this study.

The Teglian fauna also presents close resemblance with that of the Saint-Prestian (Saint Prest, Sainzelles, Chalon-Saint-Cosme, Leffe), which is characterized by the absence of *Mastodon arvernensis* and the occurrence of *Elephas meridionalis, Rhinoceros etruscus, Equus Stenonis, Hippopotamus major*, and *Trogontherium Cuvieri*. It is, however, remarkable that *Alces latifrons, Cervus Depuisi, Bison priscus*, and a very large form[1]) from the group of the *Elaphidae*, which occur side by side with the first-mentioned species in the Saint-Prestian, have so far not been found in the Teglian Clay. In the great quantity of remains of *deer*, which has come to our knowledge since DUBOIS' determination, it is not impossible that typical Saint-Prestian species are present. In the fauna of Mosbach, also, *Elephas meridionalis* and *Equus Stenonis* are mentioned. This statement is, however, based on Museum material, the exact locality of which is not known with certainty. The other fauna of Mosbach seems to me of later date than the Teglian. The same remark also applies to the fauna of Süssenborn and Mauer. The Cromerian fauna displays such a mixture of earlier and later forms, that it should be considered as a double fauna. The bones from the Teglian Clay, on the other hand, exhibit no trace of having been rolled; they are, on the contrary, so well preserved that there can be no question of transportation before or after fossilisation.

So far *Rh. Mercki* has neither been found in the Villafranchian nor in the Saint-Prestian faunas. In this it should, however, be borne in mind that, though *Rhinoceros Mercki* is a geologically later form than *Rhinoceros etruscus, Rhinoceros Mercki* lived simultaneously not only with *Rhinoceros etruscus*, but also with *Elephas trogontherii* and *Equus* sp. aff. *Stenonis*, as appears from the fauna of the high-terrace of Amiens, even with *Elephas* cf. *meridionalis* as the fauna of Solilhac clearly shows. This latter fauna is of only slightly later date than that of Saint Prest (cf. G. 72 and G. 73).

[1]) This may possibly be present (T.M.).

In any case a determination of the age of the Teglian fauna on the ground of a few detached species is entirely unwarranted. When studying the separate species one is confronted with series of difficulties; e.g.: doubt about the validity of the determination in some cases, uncertainty about the age of the different localities, with regard to each other and in the chronology of the glacial periods. In order to reduce this difficulty to a minimum, it is safest to consider the fauna as a whole. In the light of the knowledge which we possess at present of the Teglian fauna and of those of other localities, we may take the mammalian fauna of Tegelen as similar to the Saint-Prestian faunas. It may, perhaps, be equivalent to the Villafranchian faunas. One geologist may count it among the Pliocene forms, another among the Pleistocene ones, according to where the line is drawn. Most authors look upon the Villafranchian as being Upper Pliocene, the French geologist HAUG however places it in the Quaternary. According to SOERGEL (1923, G. 73, the authors still disagree about the age of the Saint-Prestian: DÉPÉRET and LÉMOINE attribute it to the Upper Pliocene, WÜST and WIEGERS place it in the First Interglacial period (Günz-Mindel), which they reckon to the Quaternary. When, however, the Quaternary is considered to begin with the Risz, as DUBOIS, BOULE, and others do, it is, undoubtedly, Pliocene. "Many of the mammals which have already been found at Tegelen are characteristic of Pliocene strata" (NEWTON 1913, G. 50, p. 253).

The Climate. A land-fauna, as that of Tegelen, presents few data about the climate. Among its species, it numbers, indeed, several old forms. There are, however, several examples of animal species from the glacial period, akin to recent tropical forms, which evidently were adapted to a colder climate. The occurrence of *Hippopotamus*, however, seems to suggest a milder climate than the present one. Its presence seems at least to presuppose such a climate that the rivers and lakes were not frozen over in winter. This, at least, is necessary for recent *hippopotami*.

Conclusions.

1. DUBOIS has proved, through the boring in 1906, that the Teglian Clay is an interglacial deposit from the First Interglacial period (Mindel-Risz).
2. The Teglian flora and fauna contain many elements pointing to an Upper Pliocene age.
3. The arguments in favour of difference of age between the Reuverian (Reuver-Swalmen) and the Teglian Clay are debatable. The arguments of DUBOIS in favour of equivalence have not been refuted.
4. The Teglian flora and fauna point to a milder climate than the present one.

PALAEONTOLOGICAL PART:

ON THE FOSSIL REMAINS OF RHINOCEROS FROM THE TEGLIAN CLAY.

DENTITION

In the determination of the upper molar dentitions from Tegelen, I first compare them with that of *Rh. etruscus* FALC., for already in 1904 Prof. EUG. DUBOIS, who was the first to draw attention to the remarkable clay-bed of Tegelen, and who made a collection of fossils found there, now preserved in Teyler's Museum at Haarlem, ascribed the upper dentition of *Rhinoceros*, which was among the collected fossils, to *Rh. etruscus*. The dentitions from Tegelen should, however, also be compared with the upper molars of the closely allied species *Rh. Mercki* JÄG., which has some localities, inter alia Mosbach and Cromer, in common with *Rh. etruscus*. A comparison in the British Museum in London of upper molars of *Rh. megarhinus* DE CHRISTOL from English localities, of *Rh. hemitoechus* FALC., and of *Rh. leptorhinus* OWEN led to the conclusion that these three forms are identical with *Rh. Mercki* JÄG. (cf. P. 29, p. 105). *Rh. megarhinus* DE CHRISTOL from French localities, hence the real *Rh. megarhinus*, is left out of consideration, because among others this purely Pliocene form possesses no bony nasal septum, whereas the dentition in the Steyler Museum belonged to an individual of which also the nasal part, provided with a heavily developed bony partition, has been found.

Nor need *Rh. antiquitatis* BLUM. be considered, on account of the great differences which its easily recognisable upper dentition presents with the molars from Tegelen.

TERMINOLOGY OF THE UPPER MOLARS.

	SCHROEDER	RUTTEN	WURM		OSBORN	FALCONER	BOYD DAWKINS	CUVIER
Ectolophus	Lamina externa	Aussenwand	Ectoloph		Ectoloph	Outer ridge Longitudinal ridge	External lamina	Colline première
Protolophus	Vorderhügel	Vorderhügel	Protoloph		Protoloph	Anterior barrel	Anterior collis	Colline seconde
Metalophus	Hinterhügel	Hinterhügel	Metaloph		Metaloph	Posterior barrel	Median collis	La troisième colline
Medisinus	Haupttal Quertal	Vorderes Tal Vorderes Quertal	Haupttal Quertal		Medisinus	Middle valley Transverse valley	Anterior valley	Vallon oblique
Postsinus	Hinteres Tal	Hinteres Tal Hinteres Quertal	Hinteres Tal		Postsinus	Posterior valley	Posterior valley	Ecorchure au bord postérieur
Stelidion	Stelidion	Stelidion	Crochet		Crochet	Crochet	Posterior combing-plate	Crochet
Parastelidion	Parastelidion	Parastelidion	Crista		Crista	Combing-plate	Anterior combing-plate	
Antistelidion	Antistelidion	Antistelidion	Antecrochet		Antecrochet	—		
Cingulum	Cingulum	Cingulum	Cingulum		Cingulum	Cingulum Basal bourrelet	Guard Posterior collis = cingulum pro parte	

The above list shows sufficiently that uniformity in the application of terms is far to seek. Still the list is not yet complete.

The first five terms I have taken from OSBORN (P. 26), not only because they are also applicable to the molars of all Ungulata, but also, because most equivalent terms in the different languages are to be recognized in them.

The terms: stelidion, parastelidion and antistelidion I have taken as more recent terms for: crochet, crista and antecrochet from SCHROEDER (P. 29 and 30) and RUTTEN (P. 32), who in their turn have derived them from KOKEN: "Säugethiere von China".

Stelidion = process projecting from the metalophus into the medisinus.

Parastelidion = process projecting from the ectolophus into the medisinus.

DESCRIPTION OF THE PERMANENT UPPER MOLAR DENTITION IN T.M. [1]).

Rh. etruscus, Pl. I; Pl. V, fig. 2; Pl. VI, fig. 3.

The dentition in T.M. belonged to a perfectly adult, but not very aged individual. Mol. 3 was already taken into use, but the inner tops of the proto- and metalophus are not yet worn by mastication.

The left series is complete and consists of 3 premolars and 3 molars. Of the righthand series the last premolar and the last true molar are absent.

The left series is 234 mm. long.
The length of the premolars is 102.6 mm. } measured at the base of the crown.
The length of the molars is 136 mm.

Dimensions: the dimensions taken at the base of the crown are uniform with those of P. 8 and P. 29.

	pm. 3		pm. 2		pm. 1		mol. 1		mol. 2		mol. 3	
	left	right	left	right	left	right	left	right	left	right	left	right
1. antero-posterior diameter (taken along the outside of the crown)	28	29	35	35	37	—	42	42	46	45	50	—
2. antero-transverse diameter (taken across the protolophus)	31	32	45	46	50	—	49.5	50	55	55	51	—
3. postero-transverse diameter (taken across the metalophus)	35	36	43	43	48	—	49	49	51.5	50		

Left and Right Pm. 3 (Antepenultimate Premolar). Pl. I.

The antero-external angle of the outer surface (= first costa of BOYD DAWKINS) is but slightly produced. The second costa (= "Leiste" of SCHROEDER = 2nd costa of BOYD DAWKINS cf. P. 8 Pl. X) is only faintly developed, only limited in front by a broad shallow vertical groove. This groove disappears towards the base. The rest of the outer surface is regularly convex from the front backwards. Only, on the base of the outer surface there is a depression of the enamel above the place where the two roots meet. The back edge bears a rough ridge as indication of an outer cingulum.

The grinding surface is little sinuous, only excavated in the longitudinal direction of the tooth. In the lefthand premolar 3 the protolophus bears an egg-shaped disc, and is connected by means of a narrow vertical enamel ridge (lamella) with the ectolophus. This connection of the protolophus with the ectolophus lies considerably lower than the crown-surface, but somewhat higher than the anterior cingulum. Yet on further wear the isolation of the medisinus would have taken place first towards the inside and then towards the front, the point where protolophus and metalophus diverge lying considerably higher than the point where the vertical connecting ridge of protolophus and ectolophus meets the latter. With regard to the righthand pm. 3 it is not correct to speak of a connecting ridge. The protolophus itself gradually narrows towards the outside. With respect

[1]) In 1904 (G. 2) DUBOIS ascribed this dentition to *Rh. etruscus* FALC.

to the anterior cingulum the connection with the ectolophus lies still lower. There, too, the medisinus would have become closed first towards the inside, then in front, though the point, where the proto- and the metalophus part, lies somewhat lower with regard to the inner cingulum than in the left pm. 3.

The disc of the metalophus is about at right angles to that of the ectolophus, and is on the point of joining that of the posterior cingulum. The medisinus has the form of a deep triangular pit, terminating below in a point. From the ectolophus projects a large parastelidion into the medisinus, and from the metalophus a threefold stelidion. Parastelidion and stelidion are not in contact. On further wear the distance would have become greater and greater, till soon the whole stelidion would have vanished. The postsinus has the shape of a rectangular trapezium and terminates below in a point.

The cingulum on the front side is well developed, running from the interior side of the ectolophus about horizontally almost to the front-interior angle. In the middle it rises into a pillar, tending towards the grinding surface. It ends on the front of the protolophus turned upward like a hook. Accordingly the cingulum does not pass round the protolophus, but it commences anew on the inner side, runs a little upwards, to beyond the boundary of the proto- and the metalophus, then somewhat downwards, after which, halfway the inner side of the metalophus, it begins to ascend abruptly. The disc of the posterior cingulum is on the point of coinciding with that of the metalophus. The whole cingulum does not bear the character of a continuous series of tubercles, but of a sharply defined ridge of enamel.

The entrance to the medisinus lies high above the inner cingulum, forming in this way a high pass. This pass is rounded in the lefthand pm. 3 ; in the righthand pm. 3 this is not the case to the same extent. There the slopes of the two lobes form an angle of about 90°. The slopes themselves are, however, concave.

Left and Right Pm. 2 (Penultimate Premolar). Pl. I.

The second costa of the outer surface is more clearly to be distinguished than in pm. 3, in front bounded by a distinct furrow, at the back less sharply defined. The rest of the outer surface shows two very slight undulations. The back edge bears again a rough ridge. There is no depression of the enamel above the place where the outer roots meet.

The grinding surface is slightly more sinuous than that in pm. 3. The discs of the proto- and metalophus are confluent with that of the ectolophus. The discs of proto- and metalophus are still separate. In the left pm. 2 that of the posterior cingulum is on the point of uniting with that of the metalophus. In the right one this has just taken place. There is a clear parastelidion. More backward the right pm. 2 has a fold as suggestion of an accessory parastelidion. The stelidion is in the left pm. 2 bifid. In the right simple, but it bears a few secondary folds near the interior corner. Stelidion and parastelidion almost touch each other, so that on slighter wear they have possibly cut off an accessory fossette. They diverge downward.

On the front the cingulum forms a broad ridge, running obliquely down, and terminating abruptly at the antero-interior angle turned upward. The upturned position is not shown by the left pm. 2. On the inner side halfway the protoloph the cingulum recommences, it then slopes gently upwards as far as just past the boundary of the two lobes, then slowly down, rising finally steeply up along the slope of the metalophus, somewhat more steeply than in pm. 3. The entrance to the medisinus lies high above the inner cingulum. The bounding slopes of the lobes meet in a line, are slightly concave, and form an obtuse angle.

Left Pm. 1 (Last Premolar). Pl. I ; Pl. VI, fig. 3.

Behind the second costa, which becomes vaguer below there are two slight undulations. (Pl. VI, fig. 3). The first begins above, and becomes fainter below, the other begins above the last root, and becomes fainter at the top. Both folds are still a great deal less distinct than the pm. 1 reproduced by SCHROEDER (P. 29 p. 27) would lead us to expect. Between the two roots of the teeth the base of the outer surface is not depressed.

The discs of the metalophus and the posterior cingulum are still distinctly separated. The stelidion has four secondary folds on the inner side. The parastelidion is well developed, and almost touches the stelidion. Lower down they diverge more and more.

The cingulum at the anterior aspect is broad and not crenated. It ends just before the antero-internal angle turned up in a pronounced hook. There is no trace of a cingulum to be seen on the antero-internal angle. The inner cingulum is a broad ridge, and has the same shape as in pm. 2, with this difference, that it runs upwards towards the grinding surface more to the back, but then also more steeply. The posterior cingulum has the usual V-shaped incision.

Here, too, the entrance to the medisinus between the proto- and metalophus lies high above the inner cingulum ; it is distinctly rounded without division line between the lobes.

Left and Right Mol. 1. Pl. I ; Pl. V, fig. 2.

On its outer surface the upper part of the second costa is sharply defined both to the front and to the back. Below it gets more indefinite. Behind the second costa in the middle of the outer surface there is seen a broad tumidity. At the back the surface is concave, strongly leaning over to the inside. Above the last root there begins, at the base of the crown, a less distinct tumidity, which becomes less pronounced above. Between the two roots the base of the outer surface shows a depression. At the back edge there is to be seen a clear remainder of an outer cingulum, which is continued as far as the base of the crown.

The crown surface is more sinuous than in pm. 1, and narrows towards the back. The disc of the metalophus points more obliquely backwards than in the premolars.

The stelidion has a blunt shape, and a small fold in the inner corner. Also deep in the wide medisinus it does not change its direction, remaining several millimeters distant from the protolophus. The left mol. 1 has a small parastelidion in the antero-external corner of the medisinus ; the righthand mol. 1 has two small folds.

The anterior cingulum is a broad ridge, and ends at the antero-internal angle slightly turned up like a hook. On the inside of the protolophus there is no trace of a cingulum to be detected. An inner cingulum is only represented by a few small tubercles at the entrance of the medisinus, and a very faint indication of a cingulum along the slope of the metalophus. The cingulum on the back has again a V-shaped incision, and the inmost part has a disc of its own.

The entrance to the medisinus is formed by a pass, which lies lower than in the premolars, lower still than the inner endpoint of the anterior cingulum. The rest of the inner cingulum blocks up the entrance. The pass ascends gradually between the proto- and metalophus, after which it slopes down pretty abruptly to the deep sinus. The entrance is wide, in contrast with the mol. 1 of *Rh. etruscus* in L.M. described by STROMER VON REICHENBACH (P. 25), in which molar the entrance forms a very narrow slit. Strictly speaking the entrance in the mol. 1 in T.M. is not quite round. The proto- and metalophus meet in a line that proceeds to the inner cingulum, but of both the slopes are concave and diverge widely from each other, especially more inside. In the left and the right mol. 1 a clear vertical furrow is to be seen neither on the front side nor on the back of the protolophus. The inner side of the protolophus, however, possesses a vertical furrow in both molars. The metalophus, especially of the righthand molar, shows a beginning of the "peculiar twist". (P. 10, p. 365).

Left and Right Mol. 2. Pl. I ; Pl. V, fig. 2.

The outer surface shows the waves described for mol. 1, but more pronounced. The second costa is more sharply defined and the back part of the outer wall leans over still more distinctly to the inside.

Mol. 2 is less worn than mol. 1. The crown surface is more sinuous and narrower. The proto- and metalophus point still more obliquely backwards. At the back the base is comparatively narrower.

The stelidion is not so blunt as in mol. 1 : it is narrower and more pointed. Its direction is not changed near the bottom of the medisinus. There are small folds visible in the inner corner, in the righthand mol. 2 as a vertical enamel ridge, just on the point of being liable to being ground. These folds are also mentioned by TOULA (P. 31, p. 75 and 76) in mol. 2 of *Rh. hundsheimensis* and of *Rh. etruscus* FALC. Val d'Arno Mus. München. A parastelidion is visible near the bottom of the wide medisinus, in the right molar as one tubercle, in the left molar as two.

The anterior cingulum is well developed ; at the antero-internal angle of the tooth turned up so as to form a decided hook. Before the entrance of the medisinus there is a row of continuous, worn cusps, as remains of an inner cingulum, which is continued some distance on either side at the base of the two lophi, especially on the side of the metalophus, where it terminates in a slightly larger cusp. On both sides it does not ascend. The posterior cingulum has a deeper incision than in mol. 1. Strictly speaking it forms a zigzag line with two summits. This applies also to mol. 1.

The entrance to the medisinus still forms a pass. In mol. 2 this lies lower than in mol. 1, below the endpoint of the anterior cingulum, and only little above the enamel boundery of the inner surface. The pass rises less steeply and descends less abruptly than in mol. 1. The entrance is wider and rounder than in mol. 1 in T.M. owing to the greater concavity of the bounding slopes. Nevertheless the limit of the base of both of them is still visible as a line.

The back of the protolophus shows a faint vertical furrow. This is not the case with the front side. The peculiar twist of the top of the metalophus is clearly to be seen. Outer side and inner side of mol. 2 are more inclined towards each other than in mol. 1

Left Mol. 3. Pl. I ; Pl. V, fig. 2.

The right mol. 3 is missing. The left mol. 3 is only little worn. The basal plane is sub-triangular. The outer surface is little sinuous. The second costa is sharply outlined. In the middle of the outer surface there is a broad tumidity and above the last root a pronounced tumidity of the enamel. The back part of the wall inclines towards the inside as in mol. 2.

The medisinus is broad. A well developed stelidion issues from the metalophus. At the crown surface it is almost at right angles to the metalophus ; deeper in the medisinus it recedes to the outside, so that on further wear the stelidion would have formed an obtuse angle with the grinding surface of the metalophus. Also at the bottom the stelidion remains at a distance of at least 3 mm. from the protolophus. There two tubercles at the ectolophus placed one above the other, indicate the parastelidion, which, also when worn oft further would never unite with the stelidion.

The cingulum on the front side forms a broad ridge, and ends hook-shaped at the antero-internal angle. A low, faintly developed enamel ridge before the entrance of the medisinus represents the inner cingulum. The entrance itself is low, wide, and rounded without dividing line between the proto- and metalophus. It is hardly possible to speak of a pass here, for the entrance lies at the same level as the bottom of the medisinus, and reaches almost the crown base on the inside. The rest of the postsinus is formed by a shallow depression of the enamel on the back of the metalophus. This depression is bounded by an enamel ridge auricle-shaped, representing the posterior cingulum. From this posterior cingulum no ridges tend to the crown surface.

DESCRIPTION OF THE PERMANENT UPPER MOLAR DENTITION IN M.M. [1] IN SO FAR AS IT DIFFERS FROM THAT IN T.M.

Rh. etruscus, Pl. II ; Pl. IV. fig. 1 ; Pl. V. fig. 1.

The dention in M.M. belonged to an adult individual, which was, however, younger than the individual the remains of which are preserved in T. M. Mol. 3 had not yet been taken into use. The grinding surface of mol. 2 has not yet reached the inner top of the metalophus.

The series of teeth on both sides are complete. Only the back half is missing in the left pm. 2 and in the left mol. 3.

The right series of teeth is 259 mm. long
The length of the premolars is 113 mm.
The length of the molars is 154 mm.
} measured at the base of the crown.

Dimensions

	pm. 3		pm. 2		pm. 1		mol. 1		mol. 2		mol. 3	
	left	right	left	right	left	right	left	right	left	right	left	right
1. antero-posterior diameter	30	31	—	36	40	40	47	47	49	49	52	54
2. antero-transverse diameter	37.5	36	51	51	56	56	57*	56.5	56	56	—	52
3. postero-transverse diameter	37	35.5	—	43 à 44	51	51	52*	51	48	48		

* too large through conglutination

The upper dentition in M.M. is slightly larger than that in T.M.

Left and Right Pm. 3 (Antepenultimate Premolar). Pl. II.

They are somewhat larger than those in T.M. The basal plane has a different form the front and back width being about the same, whereas in those in T. M. the back width not inconsiderably exceeds the front width.

The second costa on the outer surface is more pronounced. The base of the outer surface exhibits no depression above the place where the roots meet.

The grinding-surface is more sinuous than in that in T.M. The protolophus bears a long narrow disc, which is not confluent with that of the ectolophus. The connection with the ectolophus lies here 6 mm. above the anterior cingulum, i.e. higher than in the specimens in T.M. Nevertheless, here too the medisinus would have been closed first towards the inside, then towards the front. For the discs of proto- and metalophus in the left pm. 3 are on the point of uniting, the disc of the protolophus, adjoining the ectolophus, still lying

[1] This dentition was found on the 18th of Dec. 1924 in the dark-blue clay of the pit owned by Canoy, Herfkens & Co. 18 to 19 m. below the surface of the ground.

several mm. below the disc of this latter. In the right pm. 3 the discs of proto- and metalophus have already become one, the medisinus still being open in front. To speak of a connecting enamel ridge is not quite correct, because the protolophus itself, though it becomes narrower, is continued to the inner side of the ectolophus.

Near the bottom of the medisinus the double parastelidion is faintly indicated. The stelidion is two-fold.

On the front side in the middle the cingulum has no pillar ; in both teeth it passes round the protolophus, and then rises gradually. The cingulum is crenated. The division between the cingulum on the anterior and inner aspect is visible by an obtuse angular depression, above which some tubercles are to be seen, lying above each other along the slope of the protolophus. The anterior cingulum is divided by an incision into a larger external and a smaller internal part. A vertical indistinct furrow runs from this incision to the base of the crown. This peculiarity of the anterior cingulum is more clearly marked in the right pm. 3 than in the left one. The anterior cingulum is not so strongly marked as in pm. 3 in T.M.

In the right pm. 3 the entrance to the medisinus lies still higher above the inner cingulum than in pm. 3 in T.M., and is besides rounded.

Left and Right Pm. 2 (Penultimate Premolar). Pl. II.

Of the left pm. 2 the outer posterior angle is quite broken off. The right one is intact. The basal plane has another form than in pm. 2 in T.M. The difference between front width and back width is much greater.

The outer surface is pretty flat. The second costa is clear, the undulations are broad and vaguely indicated. In the middle a broad, low tumidity is seen, which narrows towards the top, and a tumidity above the last root, which reaches no further than the middle of the height. Further also a very faint depression on the base of the crown between the two roots. Here, too, a rougher ridge on the back edge represents the remains of an outer cingulum.

The grinding surface is more sinuous than in pm. 2. in T.M. The stelidion is long and narrow, simple with two small folds in the inner corner, which are absent in the left. The top is at a distance of only $1^1/_2$ mm. from the protolophus. The distance is maintained also deep down in the medisinus. A parastelidion is only indicated by a tubercle near the bottom. The cingulum on the front side is well-developed and crenated. It does not pass round the antero-internal angle. On the inner side of the protolophus the cingulum begins again ; it then ascends at once, but not steeply, towards the back. The inner cingulum is not so clear as in pm. 2 in T.M., and is provided with tubercles. The posterior cingulum remains below the pass in the left pm. 2, and in the right pm. 2 it is about on the same level as the pass. The entrance to the medisinus lies higher, especially in the right pm. 2 than in pm. 2 in T.M., and it is rounded.

Left and Right Pm. 1 (Last Premolar). Pl. II ; Pl. V, fig. 1.

Both pm. 1 in M.M. are larger than pm. 1 in T. M. As regards shape of the basal plane they resemble pm. 1 in T.M. They are, however, less worn, hence higher, the grinding surface being more sinuous.

In no case does the outer surface show the folds of pm. 1 of *Rh. etruscus* from Mosbach (P. 29, p. 57). According to SCHROEDER this latter case is an exception. In pm. 1 in M.M. there is a distinct tumidity in the middle behind the second costa, which becomes narrower towards the top. Behind this the wall is concave with a slight swelling of the enamel base above the last root. Between the two roots the enamel is slightly depressed. A rough ridge on the back edge should be considered as the remains of an outer cingulum. The outside

(Pl. V, fig. 1) closely resembles that of the left pm. 1 of *Rh. Mercki* from Heggen reproduced by SCHROEDER P. 30, Taf. 4, Fig. 2. It is, however, comparatively less high, though it is slightly less worn. The index of height of pm. 1 of *Rh. Mercki* from Heggen is = 147. The index of height of pm. 1 in M.M. = 117.5.

The stelidion is double in the left, single in the right pm. 1, but here it has a fold in the inner corner. In both teeth it is long, and almost touches the protolophus. Deeper down it bends round to the antero-external corner of the medisinus, so that on further wear the direction would have become entirely different. Near the bottom there is a faint vertical enamel fold to be seen as parastelidion.

The cingulum on the front side is well developed and crenated. It does not pass round the protolophus, but stops on the front side, not turned up like a hook. An incision divides the anterior cingulum into a larger outer part, and a smaller inner part. A vertical furrow passes from the incision to the base of the crown. This furrow is most marked in the left pm. 1. Of the cingulum on the inside only the fairly steeply ascending part along the metalophus is present. This part is not sharply defined from the slope of the metalophus as in pm. 1 in T.M. Nor does it rise so steeply, but it already begins to ascend more to the front, i.e. halfway the inner side of the metalophus. The posterior cingulum shows the usual V-shaped incision, and lies far below the pass in the right pm. 1 ; in the left it lies on a level with the pass, the pass (entrance to the medisinus on the inside) itself lying lower here. The pass lies high above the inner cingulum, and is rounded, without dividing line of the protolophus and the metalophus in the middle. Pm. 1 in M.M. is less brachyodont than pm. 1 in T.M.

Left and Right Mol. 1. Pl. II ; Pl. IV, fig. 1.

Mol. 1 in M.M. is larger than mol. 1 in T.M. Also the shape of the basal plane is slightly different. The difference between front and back width is greater.

The outer surface has the same folds as in mol. 1 in T.M., but the broad tumidity in the middle is more pronounced. The back edge presents only a trace of an outer cingulum.

The crown surface is more sinuous than in mol. 1 in T.M., owing to less wear. The stelidion is longer, and draws near to the protolophus. Especially in the left mol. 1 the outer extremity of the medisinus is almost separated from the main part. This stelidion does not change its direction near the bottom of the sinus. In the right mol. 1 there is a small parastelidion at the place where protolophus and ectolophus meet. In the left mol. it seems rather to start from the protolophus, and would, accordingly, be an antistelidion. The stelidion bears no folds in the inner corner.

The cingulum on the front side is well developed, and consists clearly of a larger outer part and a smaller inner part. A vertical furrow runs under the incision to the enamel base. The anterior cingulum does not terminate turned up hook-shaped at the antero-internal angle.

An inner cingulum is not present, unless a smooth swelling of the enamel at the entrance of the medisinus against the base of the protolophus might, perhaps, be taken as such. The posterior cingulum has a V-shaped incision.

The entrance to the medisinus forms a pass. This pass lies much lower than in the premolars, but considerably higher above the enamel border than in mol. 1 in T.M. Besides the pass lies somewhat higher than the internal endpoint of the anterior cingulum. It ascends more steeply than in mol. 1 in T.M., after which it abruptly slopes down to the bottom of the medisinus. The proto- and metalophus meet in a line. The slopes are greatly concave, in consequence of which the entrance is wide, still wider than in mol. 1 in T.M.

On the front side of the protolophus a vertical furrow is very clearly to be seen. On the back of the protolophus a furrow is visible in the right mol. 1 ; it is, however, shallow, so that it is doubtful whether it can give rise on further wear to a trefoil shape

of the disc. On the left mol. 1 there is no furrow on the back of the protolophus, but a small excavation. The inner side of the protolophus bears no vertical furrow.

The base of the protolophus takes up more room compared with the base of the metalophus in mol. 1 in M.M. than in mol. 1 in T.M. The peculiar twist of the top of the metalophus is very marked.

Left and Right Mol. 2. Pl. II ; Pl. IV, fig. 1.

Mol. 2 in M.M. is slightly larger than that in T.M. As regards the form of the basal plane they differ in so far that mol. 2 in M.M. with greater outside length, is about equally broad in front and narrower at the back.

The outer surface shows the same undulations as mol. 1. The tumidity in the middle is, however, larger and higher than in mol. 1, also more pronounced than in mol. 1 in T.M. The swelling above the two roots is less than in mol. 2 in T.M. The lower part of the outer surface bears no traces of a cement layer, in mol. 1 and 2 in T.M. it does.

The stelidion is particularly long and lies almost in a line with the grinding surface of the metalophus. In the depth it reaches, with its inner surface, the back of the protolophus. They do not merge into each other, but in any case the outer part of the medisinus would have got isolated on further wear. The stelidion has no folds in the inner corner. In the left molar a comparatively large parastelidion, which has no grinding surface as yet, and remains 1 mm. distant from the stelidion, starts from the antero-external corner of the medisinus, but very clearly from the ectolophus. In the right mol. 2 the ectolophus bears, near the bottom, a small tubercle as parastelidion, and the protolophus a larger one as antistelidion. The medisinus itself is much narrower at the bottom than in mol. 2 of T.M.

The cingulum on the front side is developed as strongly as in mol. 2 of T.M. In contrast with this latter it shows a distinct division into two with a vertical furrow under the incision to the enamel border. The inner end is not turned up hook-shaped. There is no trace of a cingulum on the inner side. The posterior cingulum is V-shaped without an outer summit. On Pl. 2, fig. 1 b there is something visible in the right mol. 2 that resembles an inner cingulum. In reality it is a cut through the enamel. This is not found in the left mol. 2.

The entrance to the medisinus forms a pass, which lies lower than in mol. 1, but yet higher than in mol. 2 in T. M. The pass lies at about the same level as the inner end of the anterior cingulum. The entrance is wide, but not so wide as in mol. 1 in M.M., and as in mol. 2 in T.M. The slopes are, indeed, concave, but the metalophus makes a strong twist to the inside and to the front. The place where the slopes meet is a clearly defined line. The base of the protolophus occupies a comparatively greater place with respect to that of the metalophus than in mol. 2. in T.M. Consequently the boundary line of the proto- and metalophus points still more backwards.

On the front side of the protolophus a clear vertical furrow is to be seen only in the left mol. 2, not in the right one. The back of the protolophus has not such a furrow neither in the right, nor in the left mol. 2.

Left and Right Mol. 3. Pl. II ; Pl. IV, fig. 1.

The right mol. 3 is intact. Of the left mol. 3 the back half is broken off. The mol. 3 in M.M. is somewhat larger than that in T.M. The shape of the basal plane is about the same. The folding of the outer surface differs in so far that in mol. 3 in M.M. the tumidity in the middle is more developed, that above the last root much less developed than in mol. 3 in T.M.

The medisinus is wide ; near the bottom it makes, however, the impression of being less wide than in mol. 3 in T.M., because the stelidion is considerably longer than in mol. 3

in T.M. and bends over strongly to the antero-external corner, so that the bottom of the medisinus is covered by it for the greater part. At the crown surface the stelidion is about at right angles to the metalophus. A tubercle near the bottom of the medisinus against the ectolophus represents a parastelidion.

The cingulum on the front side is less developed than in mol. 3 in T. M., and does not terminate turned up like a hook. An inner cingulum is entirely absent. The entrance to the medisinus lies low, almost on the enamel border of the inner side. The entrance is wide, but not so perfectly rounded as in mol. 3 in T.M. Especially in the left mol. 3 there is still a trace to be seen of a division line between the proto- and metalophus. Nor has the pass entirely disappeared, for the bottom of the medisinus lies somewhat lower than the entrance. The slopes of proto- and metalophus are concave at their bases near the entrance.

The rest of the postsinus is a distinct triangular pit. It is bounded by a V-shaped posterior cingulum, the outer end of which is continued upwards as a faint enamel ridge to the crown surface. The inner end forms a point, which rises upwards from the metalophus.

DESCRIPTION OF THE PERMANENT UPPER MOLAR DENTITION IN S.M. [1] IN SO FAR AS IT DIFFERS FROM THAT IN T.M. AND M.M.

Rh. Mercki, Pl. III ; Pl. IV, fig. 2.

The upper dentition in S.M. belonged to an old individual. All the teeth are greatly ground off. In all the teeth (except of course in mol. 3) the postsinus is isolated. In the right mol. 1 it has even quite disappeared. The medisinus is isolated in the premolars in the left series of teeth, not yet in the molars. In mol. 1 the discs of proto- and metalophus are on the point of uniting. In the right series of teeth the medisinus is isolated also in mol. 1.

Of the righthand series of teeth only the outer part of pm. 2 is missing. Of the lefthand series the inner part of pm. 2 and the inner side of the metalophus of mol. 1. In both mol. 3 the inner top of the metalophus is damaged.

The right series of teeth is 255 mm. long.

The length of the premolars is 111 mm.

The length of the molars is 150 mm.

Dimensions :

	pm. 3		pm. 2		pm. 1		mol. 1		mol. 2		mol. 3	
	left	right	left	right	left	right	left	right	left	right	left	right
1. antero-posterior diameter	32	32	—	—	ca 40	ca 39	ca 43	ca 43	55	55	65	62
2. antero-transverse diameter	39	39	—	—	62	57	63	63	64	64	62	61
3. postero-transverse diameter	39	39	—	—	56	52	—	58 or 59	60	59		

It will at once strike the eye that the complete series of teeth of the dentition in S.M. is no longer than that of the dentition in M.M. A comparison of *Rhinoceros* dentitions of different ages in the B.M. has, however, taught that this great diminution in length is a result of age.

Left and Right Pm. 3 (Antepenultimate Premolar). Pl. III.

In form of the basal plane pm. 3 in S.M. resembles pm. 3 in M.M., but it is larger.

The second costa is as clear as in pm. 3 in M.M. Above the place where the two outer roots meet there is a weak depression of the enamel.

The grinding surface is little sinuous. The medisinus is perfectly isolated, both inwards and frontal. A strongly developed stelidion (with antistelidion?) connects proto- and metalophus, and separates, in this way the medisinus into two perfectly detached parts.

[1]) This upper dentition was found together with several fragments of the lower jaw and a great part of the skeleton in 1920 in the blue clay of the pit belonging to Denessen (3 m. below the surface of the clay) and ascribed in 1921 (G. 65) by RICHARZ to *Rh. etruscus* FALC.

Also the postsinus is quite closed. The left pm. 3 still shows a small ring of enamel as remains of the depression between protolophus and anterior cingulum.

In the left pm. 3 the anterior and inner cingulum is entirely worn away. In the less worn right pm. 3 the anterior cingulum is still perfectly intact. The connection of protolophus and ectolophus must have been situated high above the anterior cingulum. The cingulum on the front side is well developed. An incision divides it into a larger outer part and a smaller inner part. From this incision runs a vertical furrow to the base of the crown. We have seen the same thing, but in a less degree, in pm. 3 in M.M. The cingulum does not pass round the protolophus, but ends on the front side of the protolophus. The little developed inner cingulum runs at first horizontally, after which it rises along the inner side of the metalophus. Too little is left of this ascending part for us to be able to pronounce an opinion about the degree of steepness.

Left and Right Pm. 2 (Penultimate Premolar). Pl. III.

Of the left pm. 2 nothing remains but the outer wall. This is fairly flat. There is nothing to be seen of the second costa. It may have been broken off, for the extreme foremost part of the outer wall is missing.

Of the right pm. 2 the outer wall is missing. The grinding surface is little sinuous. The medisinus is entirely isolated. Only a trace remains of the postsinus. The anterior cingulum is worn away to the extreme inner end. At the base of the protolophus the inner cingulum is quite absent. On the boundary of the proto- and metalophus the *very* weakly developed inner cingulum begins ; it immediately rises up steeply along the inner side of the metalophus. A vertical groove with a line in the middle gives the inner limit of the protolophus and metalophus. These have, evidently, formed a pass, which itself is, however, worn away.

Left and Right Pm. 1 (Last Premolar). Pl. III.

The basal plane of the left pm. 1 in S.M. is considerably broader than that of pm. 1 in M.M. The basal plane of the right pm. 1 is only 1 mm. broader.

The lower part of the second costa is still to be perceived on the outer surface of both the pm. 1. The enamel on the outside shows a tumidity at the base above each root with a depression between. There is no layer of cement.

The medisinus and the postsinus are both perfectly isolated. In the right pm. 1 a medifossette (accessory sinus) has got detached from the medisinus in consequence of the union of stelidion and parastelidion. In the left pm. 1 there is nothing to be seen of a stelidion or parastelidion.

Of the anterior cingulum only the inmost part is left. It is not turned up like a hook, but runs obliquely down. The inner cingulum is as in pm. 2. The posterior cingulum is worn away. The proto- and metalophus must have formed a pass at an earlier stage.

Left and Right Mol. 1. Pl. III ; Pl. IV, fig. 2.

The teeth being glued together, it is not possible now to measure the outer length of mol. 1 accurately. In any case the length seems small with respect to the front and the back width.

The outer surface shows a tumidity above each of the two roots and a depression between them. The back part of the outer wall leans over more to the inside than the front part. The second costa is worn away. The enamel base is coated with a thick layer of cement.

In the right mol. 1 the medisinus is perfectly isolated, and the postsinus is quite worn away. In the left mol. 1 the medisinus has not yet got closed, and an enamel protuberance is left as remnant of the bottom of the postsinus. Nothing is to be seen of a steli-

dion or parastelidion. The bottom of the medisinus is much narrower than in mol. 1 in T.M. The condition comes nearer to that of mol. 1 in M.M.

The entrance of the medisinus forms a pass about on a level with the inner end of the anterior cingulum. Hence it lies higher above the crown base than in mol. 1 in T.M., more as in mol. 1 in M.M. The entrance itself is not rounded, nor wide. The proto- and metalophus meet in a line, the bounding slopes are not strongly concave, as in mol. 1 in M.M. and T.M., but they may more aptly be said to be convex. They form an acute angle.

Of the anterior cingulum only the inner end is left, which runs obliquely down. Not a trace is to be found of an inner cingulum, unless perhaps a smooth tumidity against the base of the protolophus at the entrance of the sinus might be taken as such. As we have seen, this also occurs in mol. 1 in M.M. In both mol. 1 in S.M. traces may be seen of a vertical furrow on the back of the protolophus.

Left and Right Mol. 2. Pl. III ; Pl. IV, fig. 2.

Mol. 2 in S.M. is considerably larger than mol. 2 in T.M. and M.M. It is relatively much longer than mol. 1 in S.M. The outer surface is little sinuous. Of the second costa the base is still clearly to be seen. Also the lower part of a tumidity in the middle. A thick cement layer covers the basal part of the outer surface.

The crown surface is more sinuous than in mol. 1. The medisinus is still open towards the inside. A large stelidion projects in it. The medisinus itself is narrower than in mol. 2 in T.M. Near the bottom it has about the same width as in mol. 2 in M.M. The postsinus is perfectly closed.

The anterior cingulum slopes down rapidly, and is not turned up like a hook at the inner end. An inner cingulum is only represented by a smooth enamel tumidity at the base of the protolophus beside the entrance to the medisinus. Of the posterior cingulum there is nothing to be seen.

The entrance to the medisinus forms a pass, which lies lower than in mol. 1, about as high as in mol. 2 in M.M. The pass rises less steeply than in mol. 1, and slopes down gently. The entrance is broad V-shaped. The proto- and metalophus meet in a line, their slopes are at most very slightly concave, and form an acute angle with each other. Accordingly the condition is entirely different from that of mol. 2 in M.M., and particularly from that of mol. 2 in T.M., in which the entrance is more or less rounded.

There is nothing to be perceived of a vertical furrow on the back of the protolophus ; there *is*, however, a remnant of such a furrow on the front side. As in mol. 2 in M.M. the base of the protolophus occupies a comparatively large place.

Left and Right Mol. 3. Pl. III ; Pl. IV, fig. 2.

Mol. 3 in S.M. is considerably larger than mol. 3 in M.M. and T.M. The shape of the basal plane is about the same. The outer surface behind the second costa is regularly convex and covered for the greater part with a layer of cement.

The entrance to the medisinus is low, wide, and rounded. Nevertheless the division between proto- and metalophus is still to be seen as a line. The slopes are concave at the place. The entrance lies somewhat higher than the bottom of the medisinus itself. In this a large stelidion projects in the direction of the antero-external angle of the tooth ; it reaches further than in mol. 3 in T.M., so that also in mol. 3 the medisinus seems narrower. This was also the case with mol. 3 in M.M. The stelidion has a decided fold in the inner corner.

The anterior cingulum points obliquely downwards, and is well developed. The inner cingulum is absent. The postsinus is a distinct pit bounded by a V-shaped posterior cingulum, the points of which stick out far from the wall. There is nothing to be found of ascending enamel ridges.

COMPARISON OF THE UPPER MOLARS FROM TEGELEN WITH THOSE FROM OTHER LOCALITIES.

Pm. 3.

According to SCHROEDER (P. 29) pm. 3 of *Rh. etruscus* is most easily distinguished from that of *Rh. Mercki* by the vertical ridge of enamel, which in *Rh. etruscus* connects the protolophus basalward with the ectolophus, whereas in *Rh. Mercki* the isolation of the protolophus extends almost universally to deep into the tooth, almost as far as under the cingulum. A consequence of this is that in *Rh. Mercki* the medisinus is first closed towards the inside, and towards the front only at an advanced age, whereas in *Rh. etruscus* the medisinus is closed simultaneously on the two sides, or first in front and not until then on the inside. On this point WURM (P. 33) shares SCHROEDER'S opinion. On material in London, Aixla-Chapelle and Tegelen, I have personally observed so many exceptions with regard to this character that I greatly question its general validity.

The way in which the medisinus is closed, depends on two factors : 1. the absence or presence of a connecting lamella between the protolophus and the ectolophus, projecting above the anterior cingulum, and 2. the height at which the proto- and the metalophus diverge from each other. This connecting lamella projecting above the anterior cingulum would be absent in *Rh. Mercki* according to SCHROEDER. He himself mentions an exception in pm. 3 of the Mainz skull, which he ascribes to *Rh. Mercki* (loc. cit. p. 107). All the same on further wear the medisinus in this pm. 3 would first have become closed towards the inside and not until then in front, owing to the great height at which the proto- and the metalophus remain connected. This is, however, a condition which is also quite common in *Rh. etruscus*. Thus e.g. in the pm. 3 in T. M. and in M. M., which I with certainty ascribe to *Rh. etruscus* for other reasons, the medisinus would first be closed inside, and only then in front, in spite of the presence of the connecting lamella. Inversely it occurs in *Rh. Mercki* by way of exception, that proto- and metalophus already diverge at the height of the cingulum, as SCHROEDER himself states (P. 29, p. 138). The plaster cast of pm. 3 of *Rh. Mercki* from Jerxheim in B.M. seems to confirm SCHROEDER'S opinion, but its original, which I studied at Aix-la-Chapelle, (A. M.) clearly shows that the connecting lamella is broken off.

Also in pm. 3 of *Rh. megarhinus* from Grays Essex (figured in BOYD DAWKINS : Nat. Hist. Rev. 1865, p. 409, fig. IX) the connecting lamella projects above the anterior cingulum. The same applies to pm. 3 of *Rh. megarhinus* from Grays Essex [Br. M. 18755 E], to pm. 3 of *Rh. megarhinus* from Grays Essex [Br. M. 18755 F] and to pm. 3 of the dentition in S.M.

In the pm. 3 of *Rh. etruscus* from Mosbach and Mauer the medisinus seems as a rule first to become isolated in front, and afterwards to the inside, which is in connection with a greater brachyodonty. WURM mentions two exceptions. The condition of pm. 3 of *Rh. etruscus* in T.M. occurs in pm. 3 in a fragment of an upper jaw from the collection of Darmstadt. He speaks here of an undeniable transition to *Rh. Mercki* (P. 33, p. 26).

In a pm. 3 of the Heidelberg collection (P. 33. Taf. IV, Fig. 1, p. 27) the protolophus is perfectly isolated.

The development of stelidion, antistelidion, and parastelidion varies so greatly that a comparison with regard to this character seems superfluous to me.

In all the pm. 3 of *Rh. etruscus* mentioned by SCHROEDER, WURM, and WÜST, and STROMER VAN REICHENBACH the cingulum passes round the protolophus, with the exception of pm. 3 of the Darmstadt fragment, which also in this respect resembles pm. 3 in T.M. closely. The only difference consists in this that the inner cingulum in pm. 3 in Darmstadt is not connected with the posterior cingulum, whereas in the specimens in T.M. it is. Also in pm. 3 of *Rh. etruscus* from Pakefield [Br. M. 43480] the cingulum sweeps round the protolophus, just as in pm. 3 of the dentition in M.M. I have observed the condition of pm. 3 of the dentition of T.M. in the Br. M. in pm. 3 of *Rh. etruscus* from Malaga [40955], in pm. 3 of *Rh. etruscus* from Bologna [40803] and in pm. 3 of *Rh. etruscus* from Trimmingham [M. 6632]. Also in *Rh. Mercki* the development of the cingulum varies on the antero-interior angle. Thus e.g. the cingulum does not pass round the protolophus in a pm. 3 of *Rh. megarhinus* from Grays Essex in Br. M. (figured: Nat. Hist. Rev. 1865 p. 409 Fig. IX), in pm. 3 of *Rh. megarhinus* from Grays Essex [18755 E] which very closely resembles pm. 3 in S.M. Nor does it do so in pm. 3 of *Rh. hemitoechus* [Br. M. 37404]. It *does* pass round the protolophus in pm. 1 of *Rh. megarhinus* from Grays Essex [Br. M. 18755 F].

Nor does the development and the direction of the inner cingulum furnish a sure distinctive character between pm. 3 of *Rh. etruscus* and *Rh. Mercki* on account of the great number of individual variations in both species. In general, however, the inner cingulum is more feebly developed in pm. 3 of *Rh. Mercki* than in that of *Rh. etruscus*. In this respect pm. 3 in S.M. even surpasses pm. 3 of the extreme *Mercki* form from Jerxheim.

The pass between proto- and metalophus is mostly more or less rounded in *Rh. etruscus*, the slopes are concave, whereas the pass in *Rh. Mercki* is almost always V-shaped. This distinction holds for all the premolars (pm. 3, pm. 2 and pm. 1), but it is not without exceptions. Thus e.g. the pass of the premolars of *Rh. etruscus* in the Museum of Bologna is distinctly V-shaped, whereas the pass of pm. 2 of *Rh. megarhinus* from Grays Essex [Br. M. 18797a], though not exactly rounded, has yet concave slopes. In the premolars of the dentition in T.M. and M.M. the pass is more or less rounded.

Pm. 2.

SCHROEDER describes (P. 29, p. 52 et seq.) a Mosbach premolar, which he considers though with some hesitation, as a penultimate. This premolar is characterized by great brachyodonty. The protolophus and the metalophus begin already soon to diverge on the inside, so that the cingulum, which is, throughout, exceedingly strongly developed, closes the entrance to the medisinus as a ridge. Behind the second costa the outer surface exhibits two slight undulations "welche keineswegs mit der einfachen Wölbung der Aussenwand der Zähne des *Rhin. Mercki* verglichen werden können".

According to SCHROEDER himself this premolar with its extraordinary brachyodonty forms an exceptional case. He mentions five more pm. 2 in which a high-situated pass is developed.

WURM knows several cases of pronounced brachyodonty in pm. 2. He writes P. 33 p. 29 "Fast alle Zähne sind ausgesprochen brachyodont. Bei den pm. 2 des Oberkiefers der Bad. Geol. Landesanstalt liegt die Trennungsstelle von Vorder-und Hinterhügel fast im Niveau des inneren Cingulums, oder nur wenig darüber, bei einem isoliert gefundenen pm. 2 aus der Heidelberger Sammlung liegt sie 7 mm. über dem Cingulum. Alle diese Merkmale sind characteristisch für *Rh. etruscus*. Eine bemerkungswerte Ausnahmestelle nimmt nun der Taf. IV, Fig. 2a, abgebildete Zahn ein, bei ihm sind Vorder- und Hinterhügel bis hoch (1.5 cm.) über dem Cingulum verwachsen. Es ist dies ein Fall von Hypsodontie, wie es sich bei *Rh. Mercki* gewöhnlich, bei *Rh. etruscus* seltener findet". Accordingly a high pass is the rule in pm. 2 of *Rh. etruscus* from Mosbach, and an exception in

pm. 2 of *Rh. etruscus* from Mauer. Pm. 2 of *Rh. Mercki* is almost invariably strongly hypsodont. In Br. M. I have always observed a high pass in the pm. 2 of *Rh. etruscus* from various localities.

Pm. 2 in T.M. and M.M. have a high pass. It lies 10.5 mm. above the inner cingulum in the left pm. 2 in T.M., 9 mm. in the right pm. 2. In the left one in M.M. 14 mm., in the right one 9 mm. In the right and in the left pm. 2 of S.M. the pass is already worn away.

The outer surface of pm. 2 in T.M. shows two very slight undulations behind the second costa. That of pm. 2 in M.M. has a tumidity in the middle. The principal distinguishing feature between pm. 2 of *Rh. Mercki* and *Rh. etruscus* is the comparatively much higher outer surface in pm. 2 of *Rh. Mercki*. This distinction is, however, only valid for the rare specimens which are not or very little worn.

There is, however, always found a distinct difference between the pm. 2 of the two species as regards development and especially direction of the cingulum.

The anterior cingulum runs more steeply down in pm. 2 of *Rh. Mercki* (and likewise in all the premolars and molars), than in *Rh. etruscus*. In this respect the pm. 2 in T.M. and M.M. present the pure *etruscus* condition. In pm. 2 in S.M. the inner rest of the anterior cingulum, the only thing that remains, points steeply down.

In *Rh. Mercki* the inner cingulum is nearly always much less developed, than in *Rh. etruscus*, or it is sometimes entirely absent. In this respect pm. 2 in T.M. shows the pure *etruscus* condition, for it forms there a sharply defined, strongly developed ridge. Pm. 2 in M.M. has a little developed inner cingulum, this latter being more feebly developed in pm. 2 in S.M., than in most *Mercki* specimens.

The inner cingulum is nearly always missing in *Rh. Mercki* on the protolophus, but, unless it is entirely absent, it begins to rise up steeply and obliquely across the inner side of the metalophus on, or even before, the dividing-line between the proto- and the metalophus, whereas the inner cingulum in *Rh. etruscus* generally runs about horizontally over the base of the protolophus to beyond the division line of the proto- and metalophus, after which it slopes upwards to the back. Also in *Rh. etruscus* it occurs that the inner cingulum already begins to rise before the boundary between the proto- and metalophus, but much less steeply than in *Rh. Mercki*, mostly in a curve. The latter thing is also the case with pm. 2 in M.M. Pm. 2 in T.M. presents the characteristic *etruscus* condition; pm. 2 in S.M. shows an almost extreme *Mercki* condition (equals pm. 2 of *Rh. Mercki* from Jerxheim).

SCHROEDER (P. 29, p. 55) has never observed a cingulum on the protolophus in pm. 2 of *Rh. Mercki*. In Br. M. a pm. 2 of *Rh. megarhinus* from Grays Essex (18797 a) is found, in which the anterior cingulum passes round the protolophus as far as the boundary line between proto- and metalophus. The tooth is unworn and so hypsodont, that there can be no doubt that it belongs to *Rh. Mercki*. In B.M. I have also observed something of the same kind in pm. 2 of *Rh. Mercki* from Rabutz.

In all the pm. 2 of *Rh. etruscus* mentioned by SCHROEDER, WURM, and WÜST the cingulum passes round the protolophus, except in pm. 2 of the dentition in the Museum of Darmstadt. Of the pm. 2 of *Rh. etruscus* in Br. M. the cingulum sweeps round the protolophus in pm. 2 from Pakefield [43480], Perolles and Malaga [40955] It is absent on the antero-interior angle in the specimens from Florence [40813], Bologna [40803] and Forest-Bed [M. 6632]. This is also the case with the specimens from Tegelen.

The more or less rounded pass in pm. 2 in T.M. and M.M. as a distinctive character of *Rh. etruscus* has already been discussed in pm. 3.

Pm. 1.

Pm. 1 of *Rh. etruscus* and *Rh. Mercki* show the same specific characters as pm. 2, but in a larger degree.

In pm. 1 of *Rh. etruscus* the anterior cingulum is but slightly inclined. The inner cingulum is mostly strongly developed. It runs almost horizontally over the inner side of the tooth, and begins to ascend only at the second half of the metalophus. The pass is high and rounded. In *Rh. Mercki* the anterior cingulum slopes down steeply. The inner cingulum, at least when it is present, ascends steeply either on or just before the boundary of the proto- and metalophus, and is mostly only little developed. The pass lies high and is V-shaped. Frequently, too, pm. 1 of *Rh. Mercki* differs from that of *Rh. etruscus* in the more pronounced and single tumidity of the outer surface behind the second costa. But with reference to the folding of the outer surface of pm. 1 I have observed so many variations both in *Rh. Mercki* and in *Rh. etruscus*, that I do not attach much systematic value to it.

In most pm. 1 of *Rh. etruscus* studied by me the cingulum runs round the protolophus. This is, however, not the case with pm. 1 of *Rh. etruscus* in the Darmstadt Museum (according to WURM), with the specimens from Bologna and from the Forest-Bed [M 6632] in Br. M. Also in pm. 1 in T.M. and M.M. the cingulum is absent on the antero-internal angle. On the other hand the cingulum passes round the protolophus by way of great exception in *Rh. Mercki* from Rabutz in B.M., in *Rh. megarhinus* from Grays Essex (Br. M. 19841 b) in three specimens.

The anterior cingulum in pm. 1 in T.M. and M.M. shows the usual *etruscus* condition. In pm. 1 in S.M. there is nothing left but the inmost part, which slopes down, and seems, therefore, to point to *Mercki*.

In pm. 1 in T.M. the inner cingulum, though not occurring on the antero-internal angle, is not feebly developed. On the contrary, it extends as a sharply defined ridge along the boundary between proto- and metalophus, almost horizontally, rising, however, very steeply on the back of the metalophus. It shows, therefore, the *etruscus* form.

In pm. 1 in M.M. the inner cingulum is absent on the inner side of the protolophus. About the middle of the inner side of the metalophus it rises up, feebly developed, fairly steeply. Hence the inner cingulum deviates from the form usually found in *etruscus*, but it does not reach the typical *Mercki* form.

In pm. 1 in S.M. the inner cingulum on the protolophus is absent. It starts on the boundary between the proto- and metalophus, and slopes immediately steeply upwards. It is exceedingly feebly developed. It exhibits, therefore, the typical *Mercki* form, and equals, as regards its slight degree of development, the extreme cases. (Inner side of pm. 1 in S.M. resembles very closely that of pm. 1 of *Rh. Mercki* from Jerxheim).

The rounded pass in pm. 1 in T.M. and M.M. points to *Rh. etruscus*. The passes in all the *Mercki* pm. 1 which I have examined, both German ones and English ones, are V-shaped, when not too far worn off. In pm. 1 in S.M. the pass has disappeared.

The folding of the outer surface in pm. 1 in T.M. comes nearest to that in pm. 1 of *Rh. etruscus* reproduced by SCHROEDER (P. 29, p. 57). Behind the second costa there are two vertical folds. They are, however, only faintly indicated. Such a clear and marked folding as the premolar figured by SCHROEDER shows, occurs very rarely. I have observed a very clear third costa behind the second costa in pm. 1 of *Rh. leptorhinus* OWEN from Grays Essex, in pm. 1 of *Rh. hemitoechus* [37404], and in *Rh. leptorhinus* OWEN from Gibraltar [47647], all in Br. M.

The outer surface of pm. 1 in M.M. bears a very close resemblance to that of pm. 1 of *Rh. Mercki* from Heggen (P. 30, Taf. 4, Fig. 2). The outer surface of the former is, however, with less wear, considerably lower than in the *Mercki* specimen.

The outer surface of pm. 1 in S.M. is too much worn for a comparison to be possible.

Mol. 1.

According to SCHROEDER (P. 29, p. 61) mol. 1 of *Rh. etruscus* is distinguished from the corresponding tooth of *Rh. Mercki* by the vertical furrows on the protolophus and

the cingular tubercle at the entrance to the medisinus and the flatness of this entrance.

The *etruscus* mol. 1 from Mosbach and Mauer are characterized by a vertical furrow on the front and the back of the protolophus. On sufficient wear the disc of the protolophus assumes in consequence of this a trefoil shape. Also mol. 1 of *Rh. etruscus* from Malaga [Br. M. 40955], Pakefield [43480], Bologna [40803], and Trimmingham [M 6632] show a clear trefoil design.

But SCHROEDER mentions vertical furrows also (loc. cit. p. 108, 111, 115, 141) in *Rh. Mercki*, though generally only on the front side. I have observed the same thing in mol. 1 of *Rh. leptorhinus* OWEN from Ilford Essex (Ant. Brady coll. Br. M.) and in mol. 1 of *Rh. leptorhinus* OWEN from the valley of the Thames (Br. M.). The disc of the protolophus of a mol. 1 of *Rh. leptorhinus* OWEN from Grays Essex (Br. M) and of mol. 1 of *Rh. Mercki* from Mosbach (B. M. V28) shows a clear trefoil shape.

In mol. 1 in T.M. a distinct vertical furrow is not to be seen either on the front or on the back. At most there is a vague indication, so that both the presence or the absence can be called in question.

In mol. 1 in M.M. a clear furrow is visible on the front. On the back a shallow furrow is found in the right mol. 1, a slight depression in the left one.

In both molars 1 in S.M. traces are to be seen of a vertical furrow on the back of the protolophus. Whether also the front bore a furrow, is not to be decided on account of the far advanced wear.

Nor is the decided occurrence of the cingular tubercle at the entrance to the medisinus of much use to us as a distinctive mark of *Rh. etruscus*, at least not as regards the molars 1 from Tegelen.

In mol. 1 in T.M. the inner cingulum consists only in two tubercles at the entrance of the medisinus, and a very faint indication of a cingulum along the metalophus. In mol. 1 in M.M. and S.M. there is no inner cingulum present, unless a low flat tumidity of the enamel at the entrance of the medisinus might be considered as such. This condition is very common in *Rh. Mercki*, but occurs also for *Rh. etruscus*.

The best distinctive character of *Rh. etruscus* seems to me the wide, rounded, sometimes even flat entrance to the medisinus. In mol. 1 of *Rh. etruscus* from Mosbach and Mauer the entrance is flat. The cross-section on the inside behind the cingulum is ⌊⌋-shaped, further to the outside V-shaped. A similar flat entrance is also found in *Rh. etruscus* in Br. M. from Malaga [40955], from Forest-Bed [33323], Val d'Arno, Bologna [40803] and Trimmingham [M 6632]. In others, however, the entrance is, indeed, wide, though not flat, but more or less rounded, as in *Rh. etruscus* from Pakefield [Br. M. 43480], in mol. 1 in T.M. and in mol. 1 in M.M.

In *Rh. Mercki*, both from German and from English localities, the entrance is V-shaped, though with varying width. In mol. 1 in S.M. the entrance to the medisinus has the V-shape. None of the *etruscus* mol. 1 known to me can be compared with it, except mol. 1 of *Rh. etruscus* (?) in L.M.

A second practical distinctive mark is the inclination of the anterior cingulum. In mol. 1 of *Rh. Mercki* the anterior cingulum slants considerably more steeply down than in *Rh. etruscus*. Mol. 1 in T.M. and in M.M. are similar to *Rh. etruscus* in this respect, whereas mol. 1 in S.M. shows the *Mercki* condition.

Mol. 2.

The mol. 2 of *Rh. Mercki* and of *Rh. etruscus* may be distinguished by the same criteria as the mol. 1. Unworn molars are, of course, easy to distinguish by the difference in height of the outer wall. Most of the molars found of both species being, however, worn and this in a different degree, this character is of little practical use. All the same even on far advanced wear, there are some criteria left by which the species may be known.