UPPER-PLIOCENE PROBOSCIDEA OUT OF THE SCHELDT AND THE LOWER-RHINE

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ANANCUS ARVERNENSIS (CROIZ. ET JOB.).

Pl. III and text figs. 1 and 2.

The first time that an Upper-Pliocene Proboscidean was mentioned for the Netherlands was in 1938 when Professor VAN DER VLERK, in his inaugural address at the Leiden University made mention of the remains of a "very large" proboscid which, thanks to the presence of a grinding tooth among the material, could be introduced as *Mastodon arvernensis,* to which species Dr VON KOENIGSWALD, on a visit to the Leiden Museum of Geology, provisionnally referred the tooth. I am much indebted to Professor VAN DER VLERK for putting the specimen at my disposal for description and comparison.

The molar has been fished out of the Eastern-Scheldt, in the neighbourhood of Ierseke, on the island of Zuid-Beveland, in the province of Zealand, and is preserved in the National Museum of Geology, at Leiden.

The tooth is damaged by fracture at the base of the crown, so that a strip of enamel, about one centimeter broad, has been lost. The object does not present the appearance of having been rolled; the fracture-edges are sharp. On the whole the molar is black, but the enamel layer is stained with many colourless spots, best to be seen at the fractured places. Where, by the lack of the enamel, the core of dentine of the cones has been exposed, this appears to be of a very dark brown colour. At the least exposed spots the tooth is covered by Bryozoa (*Membranipora*) and basal plates of *Balanus.* These organisms settled on the tooth when it had been washed out of the sediments by the stream and lay on the bottom of the river. On the photo (Pl. III, fig. 1*a*) the broad valleys look greyish from the mingling of the rough, black cement and the light Bryozoa.

The length of the tooth is ± 170 mm and the width 75 mm. (The molar having lost the enamel layer on the base of the crown (text figure 1), twice the thickness of that layer has been added to the length and to the width of the object, in order to compute the above-mentioned measurements which the tooth originally must have had.)

The molar consists of five ridges, three of which have been worn, and the posterior talon. Of the anterior talon merely some traces can be observed. The pretrite half has not been worn much more than the posttrite half, and a median groove separating both these halves can hardly be detected. The number of the ridges proves that we have to do with a last molar, and the strong convexity of the crown in longitudinal direction, combined with the fact that the strong buttress blocking up the valleys is pushed forewards, points to an upper molar. As the pretrite side of an upper molar is the lingual side, the molar at hand is m^3 dext.

Ridge I has been worn so much that two large lobed islands of dentine have resulted, bordered by an enamel wall which is lacking at both ends of the ridge. At the pretrite half a main cone and a narrow inner one can be observed (SCHLESINGER's Nebenpfeiler), which latter touches the posttrite half of the ridge. The posterior buttress (SCHLES.'s hinterer Sperrknopf) can be observed between the main and the inner cone. It is pressed against the anterior buttress of ridge II. The strong anterior buttress (SCHL.'s vorderer Sperrknopf) of ridge I is pressed forwards so that it now lies somewhat before the posttrite half, and touches in the median line a remainder

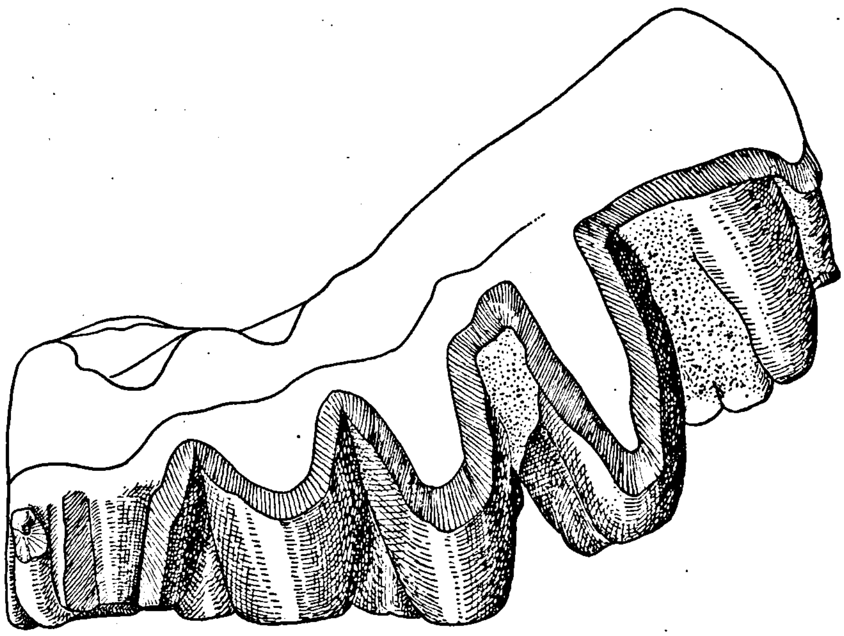


Fig. 1. *Ananous arvernensis*, M^3 dext., lingual side; $\pm\ ^2/_3 \times$. (cfr. Pl. III, fig. 1). The enamel is hatched; the cement is spotted.

of the anterior talon. The posttrite half of the first ridge consists of two cones of about equal strength. There is an indication that the main cone has been divided by a longitudinal crack. The remainder of the anterior talon is pressed against the anterior side of both posttrite cones.

In ridge II the isle of dentine on the different cones is still independent.

The petrite side displays 1. the very strong main cone, 2. the inner cone oppressed between the latter and the posttrite half, and 3. a strong anterior buttress which is pressed against the posterior buttress of ridge I and interrupts completely the transverse continuity of the first valley, changing it into a narrow inner, and a wider outer, gorge. The latter, posttrite, gorge is situated somewhat nearer to the front of the tooth than the former, and is filled with a considerable quantity of cement. A posterior buttress at the posttrite inner cone, together with the anterior pretrite buttress of the following ridge shuts off the posttrite gorge of valley II in the median line, where the cement almost reaches the wearing surface. The posttrite half of ridge II is built up of 1. a main cone which displays its double nature by a constriction of the dentine island, 2. the inner cone, and 3. a posterior buttress situated against the latter.

Ridge III has not been worn off far enough, for any dentine to become exposed, but a flat wearing-surface occurs at the summit of the whole ridge. The petrite main cone touches the posttrite inner cone, because the pretrite inner cone has been pushed quite out of the row, and in combination with the anterior buttress blocks up the second valley. Pretrite posterior buttresses are absent at all ridges, except the first. The posttrite half of ridge III consists of a main and an inner cone of equal strength connected by two cones which are so much compressed transversally that the max. width of each of them is not yet one-third of the ant.-post. diameter. The weak posterior buttress at the posttrite inner cone does not reach the equally weak pretrite anterior buttress of ridge IV, and thus valley III remains wide open from end to end. It is coated with much cement, but not yet in so large a quantity as the following valley, where it reaches the top of the anterior buttress of ridge V.

Ridge IV is of similar build as ridge III, but for the presence of an adjacent cone at the outer side of the posttrite main cone. It has the same ant.-post. diameter as the latter, but it is much lower. Moreover, the posttrite inner cone is divided into two small cones by a transversal constriction, or perhaps the posterior of these two is analogous to the posterior buttress of the ridges II and III. Further there exists but one, much compressed, cone between that double cone and the main cone. In the pretrite half the inner cone is absent, perhaps it has fused with the anterior buttress. At the anterior side of the latter a low, broad adjacent buttress can be detected which, as we saw, does not by far reach the equally weak posttrite posterior buttress of ridge III.

In ridge V the pretrite half consists of three cones, situated in a row nearly parallel to the length of the tooth. The main cone is the strongest, both the others are equally small, and interrupt the wide valley IV which is filled with cement up to the tops of the smaller cones. The posttrite half of ridge V too, consists of three cones, but ranged in a transverse row which ends in the middle cone of the pretrite half.

Valley V, situated in front of the posterior talon, is not quite so wide as the preceding valley. It is filled with cement up to the top of the talon which consists of a single cone in the median line, surrounded by some nodules (remains of the posterior cingulum?), two of which shut off valley V at the outer end, and one at the inner. Whether there have been more similar nodules at the posterior end of the tooth cannot be made out, as the crown is damaged all round the base. A minute nodule, covered with cement, lies at the inner end of the third as well as of the fourth valley.

Of the anterior talon no more can be detected than a fragment of one cm at the mastication surface, pressed against the frontal side of the posttrite half. From there a trace runs down the frontside of the crown, and ends in a nodule at the base of the pretrite main cone of ridge I.

A glance at the molar convinces us that the animal belonged to the group of Mastodontoidea termed Bunodont Tetralophodontinae. Of this group there exist no more than two European species of moderate size, namely, *Tetralophodon longirostris* and *Anancus arvernensis*.

In order to decide to which of these species the molar must be referred, we will test the tooth successively by the features being characteristic I. of *Anancus arvernensis* and II. to *Tetralophodon longirostris*.

I. 1. The chief character of *A. arvernensis* is the alternation between the pretrite and the posttrite halves of the ridges. Now, as a rule this feature is by far more distinct in lower than in upper molars where the alternation can often hardly be detected in slightly worn molars, at least when an alternation of the main cones also is meant, whereby the whole pretrite half of the ridge has moved foreward. This situation is rare, and in upper molars of the species seldom distinctly present.

2. Characteristic of *A. arvernensis* is the extraordinary enlargement of the anterior pretrite buttress which is pushed foreward obliquely towards the median line of the crown, and thus helps to form the alternation, especially in much worn teeth.

3. The reduction of the posterior pretrite buttress begins already at the first ridge.

4. Also the pretrite inner cone in *A. arvernensis* is oppressed, beginning with ridge I.

II. 1. In *T. longirostris* there is no trace of alternation.

2. The pretrite halves of upper molars show one or two anterior buttresses before the inner cone, parallel to the length axis of the crown.

3. The pretrite halves have a posterior buttress behind the inner cone.

4. The pretrite inner cone is present up to the last ridge.

Testing the Zealand molar by these four characters we find:

1. Although the alternation is hardly perceptible, the large anterior buttress has shifted so much forward and towards the median line, that it now lies between the inner ends of the posttrite halves. Thus, by proceeding wear, the alternation will become more and more distinct.

2. The anterior pretrite buttress has come into prominence. It is of the same height as the main cones, and alone blocks up the valley. The vallecular origin seems to be distinct. It remains independent in all ridges. It never becomes lined up in the row.

3. A pretrite posterior buttress seems to occur at ridge I only. At all the other ridges no trace can be detected. However, the inner cone of the posttrite half of ridge II displays a distinct posterior buttress, and ridge III a low, insignificant one; at the other ridges there are no posterior buttresses at all. Where the posterior buttress exists it is so firmly connected with the posterior inner cone, and its connection with the pretrite half of the following ridge so loose (ridge II of the Zealand molar), or totally absent (ridge III), that there can be no question here of the posterior buttress having split off from the pretrite half of the following ridge, as it has been assumed by SCHLESINGER (1922, p. 65) to be the case in some Hungarian molars of *A. arvernensis*.

4. The reduction of the pretrite inner cone is apparent, and the oppression already distinct in ridge II. In ridges III and IV that cone seems to be totally absent. Perhaps it may have been incorporated in the anterior buttress. It seems to be present again in ridge V in the form of a small, unoppressed cone.

All in all, the molar from Ierseke must be referred without any doubt to *Anancus arvernensis* (Croiz. et Job.).

Such a thick coat of cement as is present in the Zealand molar, is not common in *A. arvernensis.* This is apparent from the fact that LARTET (1859, p. 493) did not observe any cement on the French molars. WEITHOFER (1890) describing among the Italian molars of the species a lower molar from Poggio, terms it "eine sehr bemerkenswerte Eigentümlichkeit, dass in den letzten Thälern eine ziemlich beträchtliche Menge von Cement eingelagert ist." He observed the same on a single specimen of the upper molars from Italy.

Also SCHLESINGER (1922, p. 66) terms it interesting that in two molars of the species from Murány some cement occurs at the bottom of the three last valleys.

FALCONER (1857, p. 330) does not write about cement on the molars from the Crags, but in his figures (Pl. XIII, figs. 3 and 4) of the last lower molar of *A. arvernensis* from Suffolk has been drawn a considerable coat of cement in all valleys. And that this occurrence of cement is no exception in Crag teeth of the species, is testified by the specimen from Doveholes (Derbyshire), a cave-deposit which is synchronical with the Red Crag, in which "the crown is covered with cement." (DAWKINS (1903). Also VON FRITSCH (1884) mentions a coat of cement in a molar from Thüringen. On the whole, it will be the geologically youngest, most evoluated, form in which cement is present on the molars.

The size of the Zealand molar (± 170 × 75 mm) most agrees with the English form.

TABLE.

Measurements (length and max. width) of last upper molars of *A. arvernensis.*

France		Italy		Hungary		Germany		English Crags				Zealand	
DEPÉRET 1885		WEITHOFER 1891		SCHLESINGER, 1912		KLÄHN 1932		FALCONER 1857		DAWKINS 1903			
l.	w.	l.	w.	l.	w.	l.	w.	l.	w.	l.	w.	l.	w.
200	80	184	76	169.6	84.6	?	100	177	72	175	74	170	75
192	77	182	77	172.7	81.4	196	89	180	78	182	72		
190	80	164	86	196	87	—	90					Lower-	
190	75	—	94	202	—	—	84					Rhine	
204	84	—	96	191	99								
320	90			—	81							l.	w.
218	85			205	97							± 180	84

The continental species are, as a rule, larger, and always broader. A similar combination of shortness and narrowness approaching that of the Dutch molar, is mentioned only, in some upper third molars from England (DAWKINS, 1903); namely, in a specimen from the Red Crag the length is 182 and the width 72 mm, in another specimen the origin of which is not mentioned, the length is 175 and the width 74 mm. Two beautiful specimens from the Norwich Crag, figured by FALCONER and CAUTLEY (1846, Pl. 36), are approximately the same size. Measured on fig. 8 the "famous Whitlingham tooth" (m³ dext.) must have a length of 177 mm and a max. width of 72 mm. The other (fig. 9) is 180 mm long and 78 mm broad. The molar from Whitlingham shows a similar injury as the Zealand tooth. Both are mutilated by fracture, without any mark of rolling. The fractured edges of the enamel are sharp, according to FALCONER (1857). Our Diagram clearly demonstrates that the Zealand molar belongs to the smallest specimens ever described. However, I do not think that there is any reason to separate it, like KLÄHN did the pair of small molars from Rakoskeresztúr (Hungary) from the others and to term them with those of the Crags *Anancus minutoarvernensis* (small letters in the diagram), as contrasted with the other Hungarian, the German and the French, *Anancus gigantarvernensis* (capitals in the diagram). As a matter of course in so fast a region there lived some geographical races. A possibly existing sexual difference of size was perhaps of some importance, too.

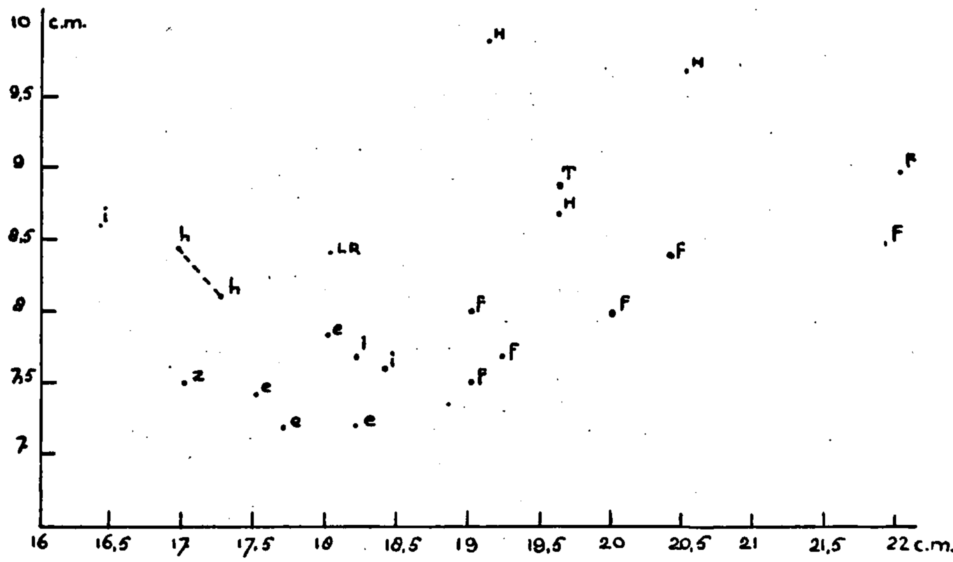


Fig. 2. Relation between length (horizontal axis) and max. width (vertical axis) of last upper molars of *Anancus arvernensis*, from England (e), France (F), Hungary (H & h), Italy (i), Thüringen (T), Lower-Rhine (LR), Zealand (z). Each dot marks one specimen. ---- unites the pair in the skull from Rakoskeresztúr.

Besides the molar in the Leiden Museum of Geology, described above, there must be still another molar of a Mastodont, and that in the Museum of the Zeeuwsch Genootschap der Wetenschappen, at Middelburg. According to the kind informations of Mr. P. J. VAN DER FEEN, Keeper of the palaeontological collection, an annotation is present there recording a tooth of "Mastodon (N°. 1846, winter 1934—'35, opgevischt in the Wester-Schelde)".

Also in the Leiden Museum of Geology must exist still a fossil of a Mastodont (?), fished out of the Scheldt, mentioned in a card-system, as Mr. ZONNEVELD wrote me. Whether this is the metapodium of a Proboscidean, shown a few years ago by Professor VAN DER VLERK to Dr BRONGERSMA in the Leiden Natural History Museum, as the latter told me, I do not know. It is much to be regretted that it has been mislaid in the Museum of Geology, and that the circumstances of the war render it impossible now to find these objects again.

In the Museum of the Zeeuwsch Genootschap, at Middelburg, a molar is preserved, indicated as "Mastodon spec. N°. 1351", which does not come out of the Scheldt. Mr. VAN DER FEEN kindly put it to my disposal and informed me that this tooth was found in a heap of gravel unloaded by a German ship at Kamperland (on the island of Zuid-Beveland, in the province of Zealand). It was found there by Mr. FLIPSE, head-master of the public school at that place, and presented to the Museum above-mentioned. The harbour-master of Kamperland presumed that the gravel had been dredged out of the Rhine between Emmerich and Ruhrort.

The anterior portion of the tooth is lacking. The large fragment present (Pl. III, fig. 2) consists of three ridges and the posterior talon; moreover, the posterior half of a preceding ridge forms the front of the fragment. No mark of pressure can be observed at the rounded posterior end. This may be the proof that we have to do with a last molar, of which ridge I and the anterior portion of ridge II have got lost, just as have the roots. The anterior buttresses being pressed forward it is evident that it is an *upper* last molar.

All four ridges have been worn, and so is the median cone of the talon, which, just as the last ridge, shows a flat wearing-surface without islands of exposed dentine. Distinct islands of dentine can be observed only on the pretrite halves of the three other ridges.

In contrast with the molar out of the Scheldt, described above, this tooth is of a stout build, the cones are thick, there is a considerable difference in the degree of wear between both halves, and the median cleft, too, is distinct. All valleys are narrow and some cement can be observed only at the posttrite side of the base of the crown, but not *in* the valleys.

Of the damaged anterior ridge which is ridge II of the molar, when complete, merely the median portion of the enamel posterior wall has been saved. It is divided by the median cleft into a pretrite and a posttrite half. The latter indicates to be composed out of three parts, viz. the main cone, the inner cone and a small posterior buttress which is fused with the inner cone.

Valley II, which separates the broken ridge from ridge III, is completely obstructed by the very strong anterior buttress of the pretrite side of ridge III. By this blocking up, valley II is changed into two gorges, the pretrite one being situated distinctly more forwards than the posttrite one.

Ridge III is complete. At the pretrite side the main cone is very strong, and so are the fused inner cone and anterior buttress. A small posterior buttress fills up the space between the main cone and the posttrite half. At the latter the inner cone exhibits a posterior adjacent buttress almost completely fused with it.

Valley III has quite the same appearance as valley II, and ridge IV shows the same build as ridge III.

Valley IV is an almost uninterrupted cleft, because the anterior pretrite buttress of ridge V is almost incorporated in the row of this ridge.

Besides the main cone, ridge V exhibits in its pretrite half a rozette of four cones of about equal size. Anteriorly lies the transversely doubled anterior buttress. The two other components are the much oppressed inner cone, and the posterior buttress which is larger than in the foregoing ridges. The posttrite posterior conule, on the contrary, is much smaller than in the ridges II—IV, and does not reach the wearing-surface. The posttrite inner cone shows an adjacent anterior component which touches the pretrite rozette.

Valley V is very shallow, and obstructed by the small posttrite posterior conule of ridge V, mentioned above, and by the most lingual conule of the talon.

The latter is complicated, and consists of about six tubercles, three belonging to the, larger, pretrite half, and three to the much smaller posttrite portion.

Traces of the cingulum can be detected around the posterior end of the tooth, beginning beneath the posttrite main cone of ridge V and surrounding the talon.

Just as has been described by FALCONER (1857, p. 333) for molars of *Anancus arvernensis* of the Crags: "There is a peculiar wavy and finely grooved rugosity of the surface, which is seen on the enamel near the base of the crown. It may be compared to the appearance yielded by a bound book when the edges of the leaves slightly overlap, and they are bent in a flexuous curve."

When the molar is put to the test of the four features mentioned above as being characteristic of *Anancus arvernensis,* we come to the following result:

1. The alternation, "dadurch erreicht, dasz praetriterseits der mit dem (allein entwickelten) vorderen Sperrpfeiler verschmelzende Nebenhügel nach vorne gequetscht wird" (SCHLESINGER, 1918, p. 138), is distinct at the anterior half of the fragment.

2. That the very strong anterior buttress is not the sole buttress at the pretrite side is of little significance, as a small posterior buttress at the pretrite inner cone occurs sometimes in typical molars of *Anancus arvernensis,* viz. in the specimens figured by SCHLESINGER, 1922, Pl. X, fig. 5 at the ridges I, III and V, and on Pl. XII, fig. 2, at ridge II.

3. The pretrite posterior buttress is absent a ridge II, very insignificant at the ridges III and IV. At ridge V it seems to be somewhat larger.

4. The pretrite inner cone is not so much oppressed as in the Scheldt molar, as it is present up to the last ridge. However, this is the case also in the penultimate molar from the Crag, figured by FALCONER (1857, Pl. XII, fig. 1).

All in all, it is certain that the tooth has to be referred to *Anancus arvernensis,* as the chief character of the latter species (some alternation, caused by a very strong vallecular anterior buttress, of nearly equal size as the main cone) predominates over the features which also occur in *Tetralophodon longirostris,* namely, the presence of a small posterior buttress at the pretrite inner cone which is present, although oppressed, up to the last ridge. Moreover, true *Tetralophodon longirostris* does not occur in Western Europe. It is typical of the Lower-Pliocene of Central Europe, and has not been found further north than Eppelsheim in Rhein-Hessen.

The molar out of the Rhine is considerably broader than the Zealand specimen.

With its max. width of 84 mm it fits in very well in the width of variety mentioned above regarding the molars of Central Europe. The length has not been much more than in the Zealand molar, namely about 180 mm, which is beneath the average in third upper molars of continental *Anancus arvernensis.*

In the Upper-Pliocene (Amstelian) the coast of the North Sea in the Netherlands run from the north of Zealand to the east, over Gorinchem-Tiel, and, crossing the region of the present river-branches, to the north in the direction of Zwolle. Consequently in the times that *Anancus arvernensis* lived in Zealand (see p. 55) it could occur also in the woods along the banks of the river (Rhine?), between Cologne and Arnhem. The molar in question will have been denuded by the stream out of Upper-Pliocene deposits, near the present Dutch-German frontier. Dr TESCH kindly informed me that the pleistocene Rhine-bed did cross the former coast of the sea in the line Cleves—Emmerich.

Thanks to a few rather complete skeletons gathered in Italy good reconstructions of the animal could be made (ABEL, 1922). The bones show a striking resemblance to those of the elephant. The build of the body, however, was different, less high and short. Compared by *Archidiskodon meridionalis,* the largest land-mammal known, the animal was by no means gigantic. The height of the shoulder, namely, reached about 2.5 m, against 5 m in the Southern-elephant. The bones are even somewhat smaller than those of the recent elephants. The trunk of our mastodont was as long as the tusks which were directed forward and downward, and their tips nearly approaching eachother, served as a lever to dig out roots and tubers. Tusks were lacking in the lower jaw, in the upper they reached a length upto 2.5 m.

In Upper-Villafranchian faunas equivalent to that of Tegelen, e.g. Senèze (Haute-Loire), *Anancus* does not occur any more. Therefore it is highly astonishing that in the lower sands of Mosbach the anterior half of a second lower molar has been found. SCHMIDTGEN (1910) who gathered the fragments, was firmly convinced that the specimen is a true Mosbach fossil, possibly belonging to the earliest assemblage (Mosbach I). SOERGEL (1923) does not know what to think of this find. So we read on p. 236 that whereas *Anancus arvernensis* in the soft climate of France did not survive the first glaciation and was already lacking in the later Villafranchian, it is highly improbable that the species survived the Günz-glaciation in the rawer climate that ranged eastern to the Vosges—Hardt—Hunsrück-line. But, on the other hand (p. 237), the possibility is expressed that in the basal layers of Mosbach the last European mastodont may have lived, as a relict of the Pliocene, together with the Southern-elephant, *Hippopotamus,* etc.

According to SCHLESINGER (1918) "ruhte der Molar sicherlich in Mosbach auf sekundärem Lager", which I think is probable. Also HELLER (1936, p. 148) shares this opinion.

Another much discussed occurrence is that in the fluvio-marine Norwich Crag and in the still younger Chillesford horizon in East-England (BELL, 1873). Also here the fossils will have been removed, namely, from the Red Crag.

For the rest, *Anancus arvernensis* is characteristic of the late Pliocene, and does not occur in the Pleistocene, nor in the Lower-Pliocene (Pontian). The vertical range is limited to the layers beneath those with *Archidiskodon meridionalis,* archaic form, and above those with *Tetralophodon longirostris.* Thus, palaeontologistis who term the period of the Southern-elephant Upper-Pliocene assign as Middle-Pliocene (Levantin) the period characterized by *Anancus arvernensis*; those drawing the limit between Plio- and Pleistocene earlier, term *Anancus arvernensis* characteristic of the Upper-Pliocene.

According to SCHLESINGER (1922, p. 215, etc.), the coexistence of both Proboscideans has nowhere been irrefutably proved.

Anancus arvernensis invaded Europe in the Middle-Pliocene, post-Pontian times and persisted until the Red Crag (Upper-Pliocene) which is termed the very base of the Calabrian (= Villafranchian) by the French authors. It is the last mastodont in Europe and it died out almost a million years ago.

It is apparent from the small size and the large quantity of cement of the molar that the Zealand mastodont, just as that of the English Crags, belonged to the last representatives of the species.

After the Amstelian period, in the Lowest-Pleistocene thus, the coast of the Icenian sea in the Netherlands transgressed so far east and southward, that its coast-line approached that of the Middle-Pliocene (Scaldisian) sea. It is tempting to ascribe tentatively this transgression to a melting of the ice-masses of the Günz I glaciation which, according to MILANKOVITCH's calculations (1938), was followed by an interstadial of notably great radiation-intensity of the sun. On the other hand the strong regression of the sea in the period of *Viviparus glacialis* might be the result of a new accumulation of ice-masses caused by the approach of the Günz II glaciation. In the scheme (p. 56), based on the occurrence of the Proboscidae, a trial has been made to coördinate the Plio-Pleistocene in West- and Middle Europe, etc.

Although the older palaeontologists draw the limit between both periods above the Forest Bed, thus placing the whole of the Cromerian and the Villafranchian (inclusive Tegelen, etc.) in the Upper-Pliocene, and others (e.g. PILGRIM, 1940 and MOTTL, 1941), on the contrary, draw the dividing line as low as the very beginning of the Villafranchian, thus incorporating the Newer Red Crag and the Amstelian in the Pleistocene, for the sake of unity among Dutch investigators dealing with the research of the Pleistocene I think it advisable to follow the grouping of the Geological Map of the Netherlands (TESCH, 1942), whereby the Pleistocene begins with the base of the Norwich Crag in England. In the Netherlands the dividing-line between Plio- and Pleistocene lies then between the top of the Amstelian and the base of the Icenian. That there is much to say, however, in favour of PILGRIM's point of view, also as regards our country, I have noticed in an article which will be published before long in the Verh. v. k. Geol. Mijnb. Gen.

Since KLÄHN (1932) has given a map of the horizontal distribution of *Anancus arvernensis* it will suffice to refer to his publication. The new finds from Zealand and out of the Lower-Rhine fill fortunately the gap between Thüringen and East-England.

The species most allied to *Anancus arvernensis* are *Pentalophodon sivalensis*, *P. sinensis* and *P. cuneatus*. Already FALCONER (1857) made a comparison between the last molars of the European and the Indian species, and figured them side by side in his Fauna Antiqua Sivalensis, Pl. 36. The greatest difference is, that *P. sivalensis* has one ridge more in m^3; moreover, the alternation of both crown-halves is more distinct. The difference, however, is so unsignificant that HOPWOOD (1938, p. 478) wrote: "The mastodonts found in the two deposits (Pinjor stage of the Siwaliks and the Villafranchian of the Val d'Arno) are so closely alike in the characters of their skulls and teeth that there is no justification for keeping them apart as separate genera.

Indeed, it is not imposible that in course of time evidence will accumulate to show that they are geographical races of one species."

The third closely allied species was recorded by HOPWOOD (1935) from an unknown locality in China, and termed *Pentalophodon sinensis*. The single m^3 known of this form is much larger than the Crag specimens, and equals the largest molars of *Anancus arvernensis* known from France and from Germany. Characteristic of the Chinese species is the alternation, due to a definite dislocation of the ridge-halves, so definite, that the pretrite half has its inner cone in front of the inner cone of the posttrite half. There is no question of an oppression of the pretrite inner cones (HOPWOOD, 1935, Pl. 7, fig. 2). If *Pentalophodon cuneatus* Teilh. & Trass. (1937) of the same "zone" is not identic with *Pent. sinensis* Hopwood, the firstnamed is a species the molars of which more resemble those of *Anancus arvernensis* from the Crags than those of the latter, and that by the presence of a considerable quantity of cement and by the slightness of the alternation (chevron disposition).

Unlike the German authors OSBORN evidently denies any phylogenetic relation between *Tetralophodon longirostris* and *Anancus arvernensis*, as we read in his publication of 1925, p. 25: "Race VI, The Tetralophodonts. — Compared with the excessively long slender jaw of *Trilophodon* (*Trilophodon angustidens*), the jaw of *Tetralophodon* is of medium size, although the first species discovered was named by KAUP *Mastodon longirostris*. The earliest appearance of members of this phylum is in the Miocene of Italy, whence they apparently migrated into the region of Eppelsheim, and thence eastward across India into North-America, where they are first discovered in the Lower-Pliocene *Tetralophodon campester*, Kansas." And p. 27 reads as follows: "Race X, The Brevirostrines. — The short-jawed Mastodonts which apparently originated in the Upper-Miocene *Anancus perimensis* of India, were first distinguished by a peculiar twisting of the inner and outer cones of the grinding teeth, a character clearly displayed by the Upper-Pliocene *Anancus arvernensis* of Auvergne." Also in his diagrams of the chief lines of descent of the Proboscidea, the Longirostrines (Tri- and Tetra-lophodonts) and the Brevirostrines arise and die out independently of each other.

These bold conclusions of OSBORN (1907—1935) (termed by the author himself "startling and novel to those conservatives who would embrace all the 290 odd species described from all parts of the world in two genera, namely: *Mastodon* and *Elephas*!"), have been ignored by SCHLESINGER (1917—1922). Also ABEL (in WEBER's Säugetiere, 1928) repeatedly mentions the studies of SCHLESINGER, SOERGEL and himself respecting the phylogeny of the Proboscidea, but makes no mention of OSBORN's results. It is MAX WEBER who, among the literature on the Subungulates in his book, gives an almost complete list of OSBORN's papers on the subject, and dedicated this standard work to OSBORN in the first place.

In contrast to the German authors, HOPWOOD (1935), in studying the fossil Proboscidea of China, takes into full account the results of OSBORN, without, however, copying slavishly all the names created by the eminent American investigator.

ARCHIDISKODON PLANIFRONS (FALCONER & CAUTLEY)

Pl. IV and text fig. 3.

Like the molar of *Anancus arvernensis*, described above, a molar of an elephant has been fished out of the Scheldt, in the neighbourhood of Ierseke. It, too, is preserved in the National Museum of Geology, at Leiden (St. 20033), and must be referred to *Archidiskodon planifrons* (Falc. & Caut.). The cylindrical base of the anterior root, as well as the much elongated base of the posterior root are present (Pl. IV, figs. *b* and *c*). Taking into consideration the place of the roots in *Archidiskodon*, no more than the anterior talon and the anterior half of the first ridge can have got lost (cfr. FALCONER & CAUTLEY in F. A. S., Pl. 12, fig. 12 and Pl. 14, fig. 17*a*, MAYET et ROMAN (1923, p. 105), and DIETRICH (1942, Pl. X, fig. 70)). It is apparent from these figures, that as a rule the third or the second ridge stands above the space between the anterior and the posterior root.

The lamellar formula of the complete tooth is then × 9 ×. Posterior to ridge 7 the enamel ridges are so much hidden by the thick coat of cement that it is merely on the lingual side of the base of the crown that the three hindermost ridges (8, 9 and the posterior talon) are to be seen (Plate IV, fig. *c*. The course upward of ridges 8 and 9 can only be guessed, the top of the talon is more distinct, as it causes a bulge on the posterior surface of the tooth.

The length of the complete molar will have been 270 mm, the max. width is 117 mm.

I agree with ZONNEVELD (1942) that, although the wearing-surface is not concave (but neither distinctly convex), the form of the tooth is that of a *lower* molar, the more so as the enamel figures on the crown-surface are all somewhat concave to the front. The fact that the wearing-surface slopes down to the labial side is no objection. DIETRICH (p. 85) wrote of a lower molar of *Archidiskodon* from East-Africa: „Die Kaufläche fällt nach aussen, die Krone ist innen höher als aussen; dieses regelwidrige ("mastodontide") Verhalten des Bisses kommt öfter vor."

Thus we have to do with a large, particularly broad, left lower last molar, consisting of a very small number of ridges. The lamellar frequency is 4, measured in the median plane of the tooth. The thickness of the enamel varies between 4 and 5 mm.

The median top of the enamel figure of ridge 7 has been exposed by chiseling away the cement. Ridge 6 has hardly been touched by wear. The ridges 4, 5 and 6 are annular from end to end (cf. F. A. S., Pl. 11, fig. 2). At the labial side, which is most worn off, a lateral lamellar figure first evolves. In the ridges 3 and 2 the tripartition of the figure, which comes definitively into being in ridge 1, is already indicated. If the tooth had been worn down one centimeter more an uninterrupted figure would have been formed (fig. 3). The enamel ribbon is slightly festooned, and that merely in the median part of the foremost ridges. For the rest it is straight and smooth. The median expansion

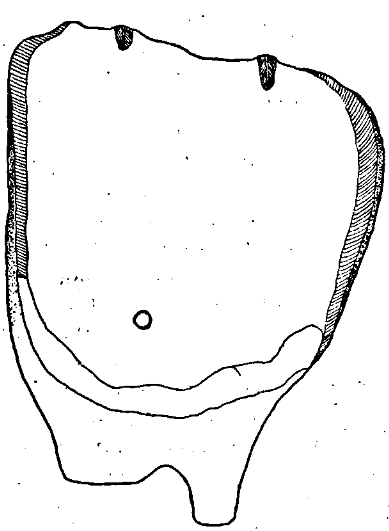


Fig. 3. *Archidiskodon planifrons*, M_3 sin. Fracture-surface, ½ ×. (cfr. Pl. IV). Ierseke; coll. Geol. Mus. Leiden (St. 20033).

of the ridges 1—3 forms a very distinct posterior loop. That of ridge 1 is so large as almost to touch the following ridge.

MAYET et ROMAN (1923, p. 99) gave the following definition of last molars of *Archidiskodon planifrons*: "volumineuses, longues, très larges, très basses, à lames rares, épaisses, au nombre de 8, 9, 10, plus les talons. Émail très épais avec expansion losangique plus ou moins marquée ou même boucle au milieu des cordons d'émail (dilatation, sinus loxodonte), rubans d'émail à larges ondulations. Abondance considérable de cément remplissant les espaces interlaminaires." On p. 100 the authors wrote that the "repli médian d'émail perpendiculaire à la lame (sinus loxodonte) est le plus souvent en arrière". PONTIER (1924, p. 156) in his study of *Archidiskodon planifrons* from the Red Crag adds still another character, viz. "cordon libre de tout plissement", and p. 158: "sans festonnement marqué."

All these characters we also meet in the molar from Ierseke.

It is necessary, however, to enter now into the question as whether the height of the crown is consistent with the definition "très basse". As a rule the molars of *Archidiskodon* are covered with a thick coat of cement, which makes it difficult to distinguish the limits of crown and roots. The inner of the pulp-cavity is seldom exposed, so that it is often impossible to measure the exact height of the crown in the median plane. Moreover, as a matter of course it is only the unworn ridges which can indicate the maximal-height. Altogether it is advisable to exercise caution when height-measurements of molars of *Archidiskodon* are mentioned in literature. SCHLESINGER (1916) took much trouble to calculate the maximal height of the crown of two last lower molars of *Archidiskodon* from India. In the highest specimen of the two, figured on Pl. II (fig. 5*b*) of F. A. S., he found it to be 116.5 mm. The same height can be measured on that figure, on the understanding that the figure is ½ × nat. size.

In a molar from Laaerberg (Nieder-Oesterreich) the same author calculated 121 mm. It is possible to measure the maximal height of the Ierseke molar, as the pulp-cavity is exposed (Pl. IV, fig. *b*). The measurements have been taken from the median top of the enamel ridge down to the lowest point of the corresponding ondulation of the ceiling of the pulp-cavity, in the same way as I did on fig. 5*b* in F. A. S. Of the ridges 4—7 of the Zealand molar I found the height to be 119, 125, 126 and 124 mm respectively.

It is clear that a maximal height of the crown of 126 mm at the unworn ridge 6 in the Ierseke tooth, although it is rather high, cannot be an obstacle of referring the molar to *Archidiskodon planifrons*, the more so as all its other features are so typical of the species.

The state of conservation is quite the same as that of the molar of *Anancus arvernensis* from the same locality. Where the object has not been covered by Bryozoa and *Balanus* the colour is black, caused by the black cement and enamel. On a closer inspection some colourless spots can be detected in the enamel ridges at the base of the lingual side of the crown. The coat of cement is thicker on the concave outer side than on the high, convex inner side. It must have got partly lost here, as the enamel ridges are exposed in places on this side (Pl. IV, fig. *c*). Some scales of the enamel crust have been preserved along the base of the crown.

In describing a skull of *Choneziphius planirostris* (G. Cuvier), fished out of the Scheldt, MAX WEBER (1917) mentions a somewhat lustrous, as it were polished, surface of the object where it has not been settled by *Membranipora* or by basal plates of *Balanus*. This glance has been caused by the moving sands on the bottom of the river, which incessently scour the objects lying in their way. Now, the convex side of our molar as well as the most projecting parts of the root-stumps show a similar glance. A round, narrow hole pierces the anterior end of the tooth (text fig. 3). I think it will have been tenanted by a Piddock (*Pholas*).

A remarkable kind of corrosion can be observed on the wearing-surface at the hardly, or not at all, worn ridges (Pl. IV, fig. *a*). There the enamel layer thus still covers the tops of the plates of dentine. These ridges consist in a row of rings the enamel wall of which appears to crumble away on its inner side, and the centre, being preserved, becomes isolated from a thin wall by a more and more broad circular furrow. The centre, as well as the thin wall, easily breaks off. When the centre only has disappeared we see a central pit surrounded by a sharp wall (see the middle of ridge 6). Often, too, the wall has disappeared, and then the former ring is hardly perceptible (lingual rings of ridge 6). By continuing wear the sharp walls become blunt again and broader, and the centre quite filled with dentine; thus the normal state is then reached again (ridge 4, labial side). An unworn molar of *Archidiskodon meridionalis,* also fished out of the Scheldt (Leiden Museum, St. 40094) displays at places, where the crust of cement has got lost from the future wearing-surface, too, rows of rings consisting of an isolated centre surrounded by a broad circular furrow and a wall with a sharp crest. The phenomenon will be caused by the fact that the enamel coat covering the dentinal plates, is less resistant near the top than at the sides of the plates; the pattern of slightly more worn ridges therefore, is normal, as the enamel being more resistant there, was not attacked by the corrosion of the flowing water and sand when the object was lying at the bottom of the river.

Archidiskodon planifrons is nearly as large as *Arch. meridionalis,* thus it, too, was of gigantic size. Its most typical character is the presence of a voluminous osseous projection in front of the mandibular symphyse, directed downwards and somewhat forewards and ending abruptly. In *Arch. meridionalis* the symphyse is short and massive. Another typical character is found only in young skulls, viz. the existence of true premolars (p 3 and p 4) which shed vertically and are succeeded by the penultimate and the ultimate milk-molars, respectively. The genus *Archidiskodon* appears not to have lost this ancient character during its long existence, as PONTIER & ANTHONY (1933) recorded an ultimate lower premolar in a mandible of its youngest species, the Upper-Pleistocene *Archidiskodon maibeni* OSBORN (= *Elephas imperator* LEIDY), from Mexico.

According to OSBORN (1935) the Mastodontoidea, Stegodontoidea and Elephantoidea form three separate lines of descent. The latter split up again into six generic lines of descent, one of which is the branch of *Archidiskodon,* coming into being in the Middle-Pliocene of South-Africa with *Archidiskodon proplanifrons,* a very primitive elephant, with a molar-crown-pattern like that of a mastodont. OSBORN (1935) : "This is the first time that the evolution of the elephantoid molar from a theoretic mastodont prototype has ever been actually demonstrated."

The genus *Archidiskodon* had a world-wide migration through North-Africa, Europe, British and Netherlands India, and China to North-America. Body and limbs remain unspecialized, but an extreme gigantism is reached. It died out in the Upper-Pleistocene with *Archidiskodon maibeni* of southern North-America.

A quite different opinion is that of the German palaeontologists, WEITHOFER, SOERGEL, SCHLESINGER and ABEL. The latter (1928) wrote: "Die Gattung *Elephas*, die mit *Elephas planifrons* zuerst erscheint, ist, soweit die bisherigen Untersuchungen gelehrt haben, durch ein *Stegodon*-Stadium durchgegangen." In DEPÉRET & MAYET (p. 196), on the contrary, we read: "Nous laisserons de côté... les Stégodontinés dont OSBORN fait avec raison un group évolutif tout à fait apart."

As for the descendant of *Archidiskodon planifrons* there is, as far as I am aware, no difference of opinion among palaeontologists that this is *Archidiskodon meridionalis* into which it passes by imperceptible transitions.

I agree with VAN DER VLERK (1938) that most probably the "black fossils" from the Scheldt to which belong both molars from Ierseke, described above, have been washed out of one and the same deposit. This would be in accordance with the fact that *Anancus arvernensis* and *Archidiskodon planifrons* also lived together in the English Red Crag, as well as in the Lower-Villafranchian of Auvergne, Italy and Austria. As regards *Arch. meridionalis* this has nowhere been found together with *Anancus* (SCHLESINGER, 1922, p. 215, etc.). The Southern-elephant, in its archaic form, indicates the Upper-Villafranchian (Teglian), as *Arch. planifrons* does the Lower.

To find out the stratigraphical position of the deposit out of which the molars from the neighbourhood of Ierseke may have come from, we have to consult the Geological Map of the Netherlands, single card 49 (Bergen op Zoom) I and III. Both these leaves, published in 1940, give an instructive profile through the underground of the eastern part of the province of Zealand. The northern profile, running from east to west over Halsteren (Noord-Brabant)—Tholen—Maartensdijk, the southern over Woensdrecht (Noord-Brabant)—Bath—Waalsoorden (Zeeuwsch-Vlaanderen), demonstrate that upon marine Pliocene layers the Lower-Pleistocene (Icenian) sea laid down its sediments (II 0 m of the map) which, in their turn, have been covered by the Old-Holocene. In the northern profile the terrestrial Tegelian is intercalated between the marine II 0 and the Holocene.

Dr REINHOLD, who for years studied the situation in the estuaries of the Scheldt, kindly informed me that the soil of the Eastern-Scheldt has much been churned up by the continually changing currents of the river. Practically nothing is lying in its original place. Even now, of recent times, there are at some places, very locally, holes 60 and even 100 m deep, hollowed out by the stream. Sometimes these holes have a short existence, so that possibly the following season they may be filled up or removed. Thus we may expect at the river-bottom of the present day in the neighbourhood of Ierseke, fossils of the Tertiary, the marine and the terrestrial Lower-Pleistocene, and of the Old-Holocene. The heavy molar of *Anancus*, weighing 1100 gram, and the still much heavier one of *Archidiskodon planifrons* (5750 gram), both without any marks of rolling, will have been churned up out of a deep pot-hole, and, having been carried a very short distance, will have been deposited again a little beyond the current of the stream, where the sandy bottom is rather hard, and from where they got into a ground-net.

In this way it is impossible to determine the deposit the fossil comes from, but taking into consideration that *Anancus*, as well as the elephant are land-mammals, we can estimate when they may have lived in Zealand, when we know in which period the region emerged above the sea-level.

During the whole Tertiary the North Sea was a bay of the ocean. The Upper-Pliocene coast-line run over Tiel—Gorkum—Schouwen (TESCH, 1942).

In accordance with this, marine Amstelian deposits are absent in the underground of Zealand (Schouwen excepted). In this period, when the region, thus, emerged above the sea, both Proboscidea, and other elements of the Lower-Villafranchian fauna, such as *Tapirus,* Antelopes, etc. may have wandered in from England and from Germany. *Anancus* occurs in the English Red Crag as well as in Germany (Thüringen), where remains have been gathered in river-sands, covered by gravels of the Günz-glacial (HECK, 1929). As we saw above, the molar of the Zealand Mastodont more resembles the Crag molars than the very broad German teeth. Also *Archidiskodon planifrons* lived in England in Red Crag times; from Germany the species has not yet been recorded with certainty.

It might be remarked that the absence of Amstelian deposits in the greater part of Zealand is no proof that they were never formed. Like so many layers in Zealand, they may have been denuded later. That this has not been the case is proved by the nature of the Amstelian in the island of Schouwen. Here it consists of coarse sand alternating with thin layers of gravel, pointing to a transition from sea to land (littoral deposits).

In the borings at Woensdrecht and in the Zandkreek, localities lying in one line, respectively to the east and to the west of Ierseke, the base of the marine Icenian lies upon the Middle-Pliocene at a depth of ± 40 m, the Amstelian being absent in both borings. Thus the molars may have come from a depth of about 40 m beneath the sea level.

Although above the Icenian occur again terrestrial deposits (Teglian) in the north-eastern part of Zealand, it is precluded that the molars of *Anancus* and *Archidiskodon planifrons* can have been denuded from those, as nowhere in Europe did *Anancus* survive the first glacial period (Günz-glacial I) which is distinctly indicated in the Netherlands by the presence of many arctic molluscs (TESCH, 1934) as well as by foraminifers, such as *Elphidiella arctica* (TEN DAM & REINHOLD, 1941) in the Icenian sea, beneath the Teglian. Moreover, in the forty years that the Tegelen Clay has scientifically been observed not a single fragment of a tooth of *Anancus* has ever been gathered, and it is impossible that such robust objects can have escaped the attention of the workmen.

Another species of the "black fossils" of the Scheldt has been described by KUNST (1937), viz. *Cervus falconeri* Dawk. She wrote: "Das Typusexemplar stammt... aus dem Norwich Crag. Im Katalog des British Museum werden aber unter dem Namen *C. Falconeri* noch verschiedene, wenig charakteristische, Geweih-Fragmente genannt welche hauptsächlich dem Red Crag entstammen." Regarding the type from the Norwich Crag, however, we read (p. 110): "Das Fragment ist zwar stark vom Wasser abgeschliffen...", a fact which may point to its secondary situation in the Norwich Crag.

Another of the "black fossils", viz. a walrus, *Odobenus huxleyi,* too, occurs in the Red Crag also (NEWTON, 1882, p. 27). I do not share VAN DER VLERK's assumption that the black fossils would be synchron with those of the English Norwich Crag. In my opinion they are distinctly older and belong to animals living in Red Crag times, thus in the Upper-Pliocene (Amstelian). It is a Lower-Villafranchian, Prae-günzian assemblage, sufficiently characterized by *Anancus arvernensis* and by *Archidiskodon planifrons.*

It is to be hoped that it may soon be possible to resume the geological research in Zealand, and to preserve more fossils of this, the oldest, Dutch assemblage of land-mammals.

SUMMARY.

An upper molar of *Anancus arvernensis* (Croiz. & Job.), fished out of the Eastern Scheldt, near Ierseke, and belonging to the so-called black fossils, shows more affinity with the specimens from the English Crags than with those from Thüringen. Another upper molar of the species has been dredged out of the Lower-Rhine.

A lower molar of *Archidiskodon planifrons* (Falc. & Caut.) from the same locality as the first-named tooth, and displaying the same kind of fossilization has most probably been washed out of the same deposit. Also in other parts of Europe the two animals lived together in the Upper-Pliocene, prae-Günzian period. Marine Amstelian deposits being absent in the greater part of Zealand, it is highly probable that a fauna of land-mammals to which also both Proboscidea, belong, thus resembling other Lower-Villafranchian faunas like those of Italy, Auvergne and the English Red Crag, also lived in Zealand when this region emerged above the sea.

LITERATURE.

ABEL, O., 1922. Lebensbilder aus der Tierwelt der Vorzeit. Fischer, Jena.
——, 1928, in MAX WEBER: Säugetiere. Fischer, Jena.
ANTHONY, R., 1933. See PONTIER.
BELL, ALFRED & ROBERT, 1873. On the English Crags, etc. Proc. Geol. Ass. *2*, pp. 185—218.
BLANCKENHORN, M., 1909. Ober-Pliozän mit *Mast. Arvernensis* auf Blatt Ostheim vor der Rhön. Jahrb. Preuss. geol. Anst. *22*, pp. 364—371, Pl. VIII. Berlin.
CAUTLEY, P. T., 1836. Note on the teeth of *Mastodon* à dents étroites of the Sewâlik Hills. Journ. Asiat. Soc. Bengal *5*, pp. 294—296, 1 Pl.
CAUTLEY, P. T., 1845—1849. See FALCONER.
CROIZET & JOBERT, 1828. Recherches sur les Ossemens fossiles du département du Puy-de-Dome. Paris, Clermont-Ferrand.
DAM, A. TEN, 1941. See TH. REINHOLD.
DAWKINS, B., 1903. On the discovery of an ossiferous cavern of Pliocene age at Doveholes. Quart. Journ. Geol. Soc. *59*, pp. 105—132, 5 Pls. London.
DEPÉRET, CH., 1885. Description geologique du Bassin du Roussillon. Ann. Sc. géol. *17*. Paris.
DEPÉRET, CH. & L. MAYET, 1923. Les éléphants pliocènes. Ann. Univ. Lyon, N. S. Fasc. *43*. Lyon.
DIETRICH, W. O., 1942. Ältestquartäre Säugetiere aus der südlichen Serengeti, Deutsch-Ostafrika. Palaeont. *94*, Abt. A, pp. 44—133, 21 Pls., 2 maps. Stuttgart.
FALCONER, H., 1857. On the species of *Mastodon* and Elephant occurring in the fossil state in Great-Britain. Quart. Journ. Geol. Soc. *13*, pp. 307—360, 2 Pls. London.
——, 1868. Palaeont. Memoirs and Notes edited by Charles Murchison, 2 Vols. London.
FALCONER, H. & CAUTLEY, P. T., 1845—1849. Fauna antiqua sivalensis. Atlas and 1 Vol. text (Proboscidea). The explanation of the plates in: FALCONER (1868), Vol. I, pp. 421—556.
FILHOL, H., 1891. Étude sur les Mammifères de Sansan. Ann. Sc. géol. *21*, 319 pp., 46 Pls. Paris.
FRITSCH, K. VON, 1885. Das Pliozän im Thalgebiet der Zahmen Gera in Thüringen. Preuss. geol. Anst. 1884, pp. 389—437, Pls. 23—26. Berlin.
GERVAIS, P., 1859. Zoologie et Paléontologie françaises. Paris.
HECK, H., 1928. Beitrag zur Talgeschichte der oberen Leine. Jrb. Preuss. geol. Anst. *49*, pp. 427—453, 5 text figs., 6 charts. Berlin.
HOPWOOD, A. T., 1935. The fossil Proboscidea of China. Pal. Sin. C. 9, fasc. 3, 108 pp., 8 Pls. Peiping.
——, 1938. Appendix on the correlation of certain Tertiary deposits of Europe and India, in PILGRIM, GUY, E.: Are the Equidae reliable for the correlation of the Siwaliks with the Coenozoic stages of North America? Rec. Geol. Surv. India *73*, Pt. 4, pp. 437—482.

KLÄHN, H., 1932. *Mastodon arvernensis* Croiz. & Job. aus dem Mittelpliocän von Willershausen und die Bedeutung des Vorkommens für Pliocänfragen. Neues Jrb. Min., etc. Beil. Bd. *68* B, pp. 149—178, 1 Pl., 4 Text figs. Stuttgart.

KAUP, J. J., 1835. Description des Ossements fossiles. Text, map and Atlas. Darmstadt.

KORMOS, T., 1931. Oberpliozäne Wühlmäuse von Senèze (Haute-Loire) und Val d'Arno (Toscana). Abh. schweiz. pal. Ges., *51*, pp. 1—14, 12 text figs. Basle.

——, 1934. Première preuve de l'existence du genre *Mimomys* en Asie orientale. Trav. Lab. Géol. Lyon *24*, 5 pp., 1 text fig.

KUNST, C. E., 1937. Die niederländischen pleistozänen Hirsche. 130 pp., 4 Pls., 28 t. figs. Diss., Leiden.

LARTET, E., 1859. Sur la dentition des Proboscidiens fossiles et sur la distribution géographique et stratigraphique de leur débris en Europe. Bull. Soc. géol. France (2e série) XVI, pp. 469—513, 3 Pls. Paris.

LAURENT et MARTY, P., 1923. Flore foliaire pliocène des argiles de Reuver et des gisements synchroniques voisins. Meded. R. Geol. D., Série B, No. 1. 's Gravenhage.

LORTET, L. et CHANTRE, E., 1878. Recherches sur les Mastodontes. Arch. Mus. Lyon *2*, pp. 285—311, 7 Pls.

LYDEKKER, R., 1886. Note on some vertebrata from the Red Crag. Quart. Journ. Geol. Soc. *42*, pp. 364—368, 2 figs. London.

MAAREL, F. H. VAN DER, 1932. Contribution to the knowledge of the fossil mammalian fauna of Java. 208 pp., 20 Pls., 29 text figs. Diss., Utrecht.

MAYET, L. & ROMAN, F., 1923. *Elephas planifrons* Falconer, in DEPÉRET & MAYET: Les Éléphants pliocènes. Lyon.

MAYET, L., 1923. See DEPÉRET.

MILANKOVITCH, M., 1938. Astronomische Mittel zur Erforschung der erdgeschichtlichen Klimate. Handb. d. Geophysik, Bd. IX, Lief. 3. Borntraeger, Berlin.

MOTTL, MÁRIA, 1941. Die Interglazial- und Interstadialzeiten im Lichte der ungarischen Säugetierfauna. Mitt. Jahrb. Kgl. Ung. Geol. Anst. *35*, H. 3. Budapest.

NEWTON, E. T., 1882. Vertebrata of the Forest Bed Series of Norfolk and Suffolk. Mem. Geol. Surv. United Kingdom. London.

——, 1891. The Vertebrata of the Pliocene deposits of Britain. Ibid.

OSBORN, H. F., 1921. Evolution, Phylogeny and Classification of the Mastodontoidea. Bull. geol. Soc. America *32*, pp. 327—332. Washington.

——, 1925. Final Conclusions of the Phylogeny, Evolution and Classification of the Proboscidea. Proc. Am. Phil. Soc. *64*, pp. 17—35. Philadelphia.

——, 1934. Primitive *Archidiskodon* and *Palaeoloxodon* of South-Africa. Am. Mus. Nov. *741*, 15 pp., 5 figs. New-York.

——, 1935. The ancestral tree of the Proboscidea. Proc. Nat. Ac. Sci. *21*, pp. 404—412, 5 figs. Washington.

PAVLOV, M., 1890. Les Mastodontes de la Russie. Mem. Ac. Sc. St. Petersbourg *8*, 1 (3).

PILGRIM, GUY, 1940. The Application of the European Time Scale to the Upper Tertiary of North America. Geol. Mag. *77*, pp. 1—27. London.

PONTIER, G., 1923. Étude sur certains points intéressants de l'évolution des Dinothériums et des Mastodontes européens. Ann. Soc. Géol. du Nord *47*, pp. 142—160, Pl. II. Lille.

——, 1924. Étude sur l'*Elephas planifrons* (Falconer) du Pliocène supérieur de l'Angleterre. Ibid. *48*, pp. 153—159, Pl. II.

——, 1928. Les Eléphants fossiles d'Abbeville. Ibid. *53*, pp. 20—46, 5 Pls.

PONTIER, G. & ANTHONY, R., 1933. Présence d'une prémolaire chez l'*Elephas imperator* Leidy. C. R. Ac. Sci. 29 Mai, *196*, pp. 1686—1687. Paris.

REINHOLD, TH. & A. TEN DAM, 1941. Die stratigraphische Gliederung des niederländischen Plio-plistozäns nach Foraminiferen. Meded. Geol. Stichting C. V. 1. 's Gravenhage.

ROMAN, F., 1923. See L. MAYET.

RUTTEN, L. M. R., 1907. Over fossiele Trichechiden uit Zeeland en België. Versl. K. Ak. W. (2), pp. 798—811, 3 Pls. Amsterdam.

SCHLESINGER, G., 1912. Studien über die Stammesgeschichte der Proboscidier. Jrb. Geol. Anst. *62*, pp. 87—182, 2 Pls. Wien.

——, 1914. Ein neuerlicher Fund von *Elephas planifrons* in Niederösterreich. Ibid. *63*, pp. 711—742, 2 Pls., 4 text figs.

——, 1916. Meine Antwort in der Planifronsfrage. Ibid. *66*, pp. 96—136, 14 figs.

——, 1917. Die Mastodonten des K. K. Naturhist. Museums. Denkschr. Naturhist. Hofmus. 1, 230 pp., 36 Pls. Wien.

——, 1918. Die stratigrafische Bedeutung der europäischen Mastodonten. Mitt. geol. Ges. *11*, pp. 129—166, 7 Pls. Wien.

——, 1922. Die Mastodonten der Budapester Sammlungen. Geologica hungarica *2*, 284 pp., 22 Pls. Budapest.

SCHMIDTGEN, O., 1910. *Mastodon arvernensis* aus den Mosbacher Sande. Notizbl. Ver. Erdk. Darmstadt 4, Folgeheft 31, pp. 135—138, 1 Pl. Darmstadt.

SCHREUDER, A., 1943*a*. The Tegelen fauna, with a description of new remains of its rare components (*Leptobos, Archidiskodon meridionalis, Macaca* and *Sus strozzii*). Arch. Néerl. Zool. *7*, pp. 153—204, 1 Pl., 13 text figs. Leiden.

——, 1943*b*. Fossil Voles and other Mammals (*Desmana, Talpa, Equus*, etc.) out of Well-borings in the Netherlands. Verh. Geol. Mijnb. Gen., *13*, pp. 405—439, 7 text figs. 's Gravenhage.

SOERGEL, W. Die diluvialen Säugetiere Badens. Mitt. Bad. geol. Anst. *9*, 255 pp., 5 Pls.

TEILHARD DE CHARDIN, P. et TRASSAERT, M. 1937. The Proboscidians of South-Eastern Shansi. — Pal. Sin. C. *13*, fasc. 1. Peiping.

TESCH, P. 1934. De opeenvolging van de oud-plistoceene lagen in Nederland. Tijdschr. Kon. Ned. Aardr. Gen. *51*, pp. 649—675. Leiden.

——, 1942*a*. De Noordzee, van historisch-geologisch standpunt. Meded. Rijks Geol. Dienst, serie A, no. 9, 14 maps. 's Gravenhage.

——, 1942*b*. De geologische kaart van Nederland en hare beteekenis voor verschillende doeleinden. Mededeel. geol. Sticht., serie D, no. 1, with charts and table. 's Gravenhage.

VLERK, I. M. VAN DER, 1938. Nederland in het ijstijdperk. Inaug. address, Leiden.

WEBER, MAX. 1917. Ueber *Choneziphius planirostris* (G. Cuv.) aus der Wester-Schelde. Samml. Geol. Reichsmus., N. F. II, pp. 309—313. Leiden.

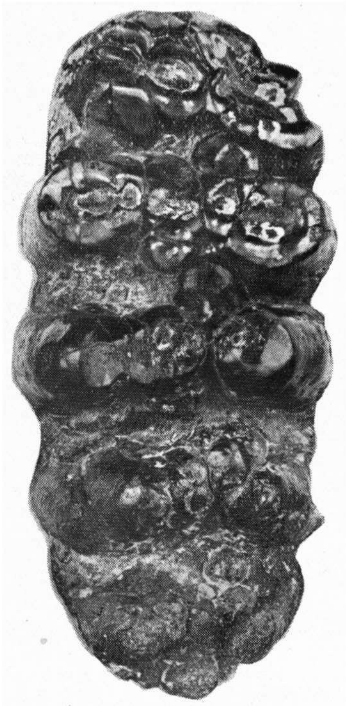
WEITHOFER, K. A. 1891. Die fossilen Proboscidier des Arnotales in Toscana. Beitr. Palaeont. Oest-Ung. *8*, pp. 107—241, 15 Pls. Wien.

	S.E. ENGLAND	NETHERLANDS AND BELGIUM		FRANCE	GERMANY	HUNGARY	CHINA	INDIA	
Lower-Pleistocene	Upper Freshwater Bed of Bacton *Homo, Arvicola, Elephas antiquus*	Praerissian deposits with *Arvicola*		Abbeville *Homo, Elephas antiquus, El. trogontherii*	Mosbachian *Homo, El. trogontherii, Arvicola*	Mosbachian Brassó, *Arvicola*		Siwalik Hills	Java
	Cromer Forest Bed *Archidiskodon meridionalis* (modern type), *Mimomys intermedius*	Günz-Mindel-interglacial *Mimomys intermedius*		*Archidiskodon meridionalis* (modern type)			Choukoutien *Sinanthropus*		
	Weybourne Crag	Günz II			Gundersheim *Mimomys pliocaenicus, Mimomys newtoni*	Villány, Beremend, etc. *Mimomys pliocaenicus Mimomys newtoni*			Trinil *Pithecanthropus*
	Chillesford Crag		regression of North Sea						
	Norwich Crag *Archidiskodon meridionalis* (arch. type), *Mimomys pliocaenicus* and *newtoni*	Teglian *Archidiskodon meridionalis* (arch. type), *Mim. plioc.* and *newtoni*	Günz-interstadial	Upper-Villafranchian Senèze, etc. *Archidiskodon meridionalis* (archaic type) *Mim. pliocaenicus, Mim. newtoni*		Gravels with *Archidiskodon meridionalis*	Sanmenian *b*		
		Icenian marine	transgression of North Sea				Nihowan *Mimomys newtoni*		
	Günz I		Günz I		Günz I				
Upper-Pliocene		Zealand	regression of North Sea	Lower-Villafranchian *Anancus arvernensis, Archidiskodon planifrons, Mimomys stehlini*	Mastodongravels in Thuringia, Hessen, etc.	Arnian	Sanmenian *a*		Bumiaju *Archidiskodon planifrons*
	Newer Red Crag	terrestrial *Anancus arvernensis, Archidiskodon planifrons*	Amstelian marine	Perrier, Vialette, Val d'Arno pr. p.	*Anancus arvernensis, Archidiskodon* (*planifrons*?)	Mastodongravels of Rakoskeresztúr, etc. *Anancus arvernensis*	*Archidiskodon planifrons* zone	Pinjor stage *Archidiskodon planifrons, Pentalophodon* (= *Anancus*) *sivalensis*	
Middle-Pliocene	Older Red Crag (Walton Crag) *Anancus arvernensis, Archidiskodon planifrons*	Poederlian, Scaldisian } marine		Astian { Roussillon, Montpellier *Anancus arvernensis* marine			*Pentalophodon sinensis* *Pentalophodon cuneatus*		

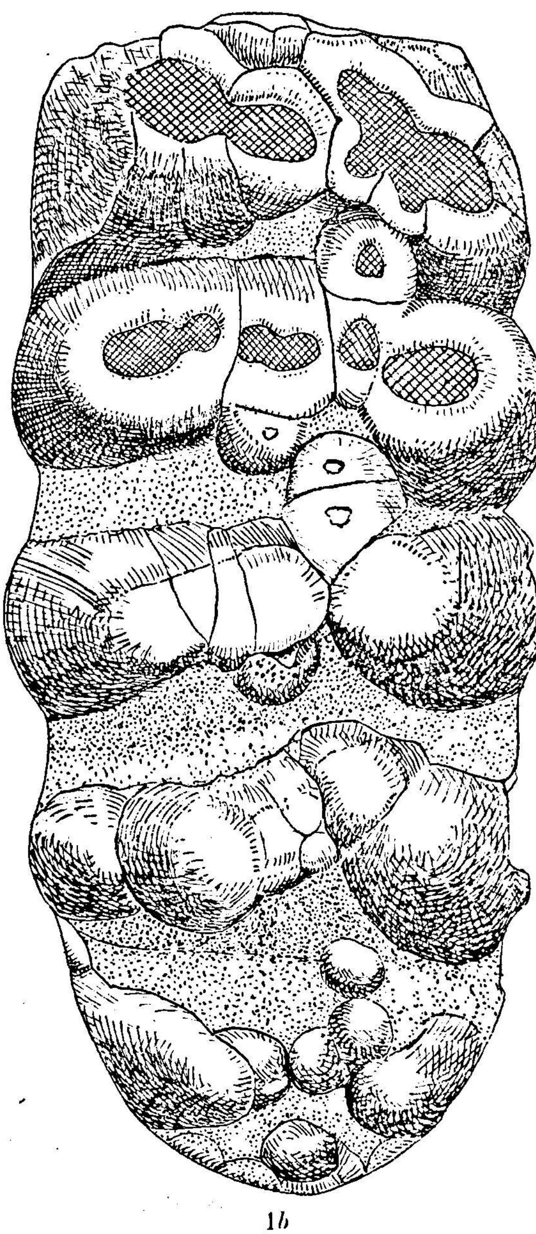
——— limit between Plio- and Pleistocene after the ancient authors (EUG. DUBOIS, REID, SCHLESINGER, a. o.).

═══ limit after TESCH.

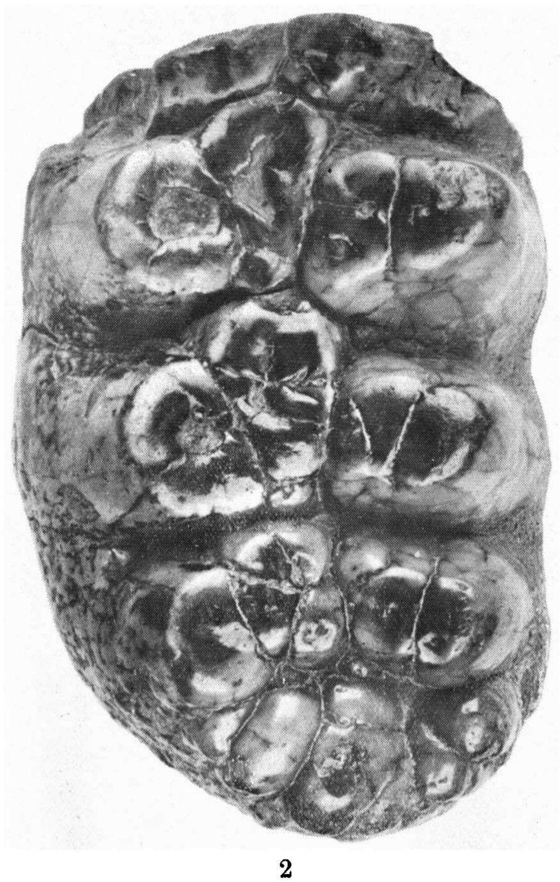
······· limit after HAUG, PILGRIM, MOTTL, a. o.



1a



1b

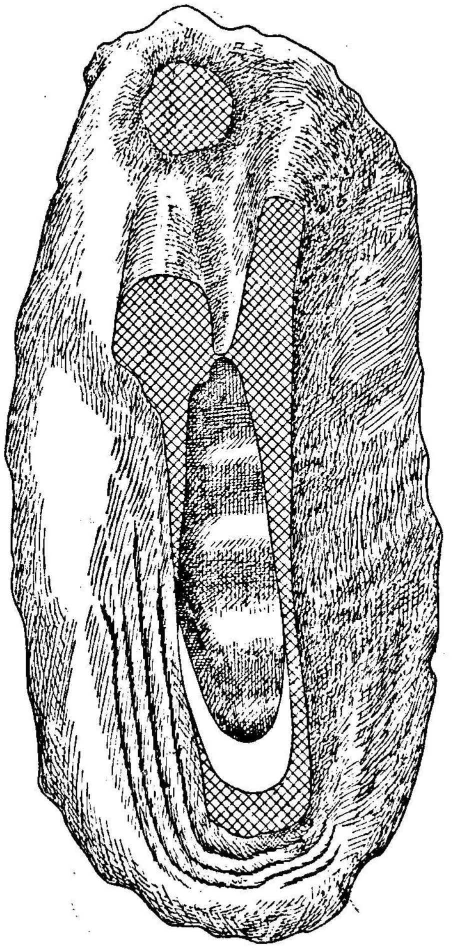


2

Fig. 1. *Anancus arvernensis* (Croiz. et Job.). M³ dext. Coll. Geol. Mus., Leiden. Eastern-Scheldt, near Ierseke, Zealand. Crown-view; *a* somewhat over ½ × nat. size; *b* nearly nat. size (elucidation of fig. 1*a*).

Fig. 2. *Anancus arvernensis* (Croiz. et Job.). M³ sin. (fragment). Coll. Mus. Zeeuwsch Genootschap, Middelburg, No. 1351. Lower-Rhine, near Emmerich; nat. size.

a



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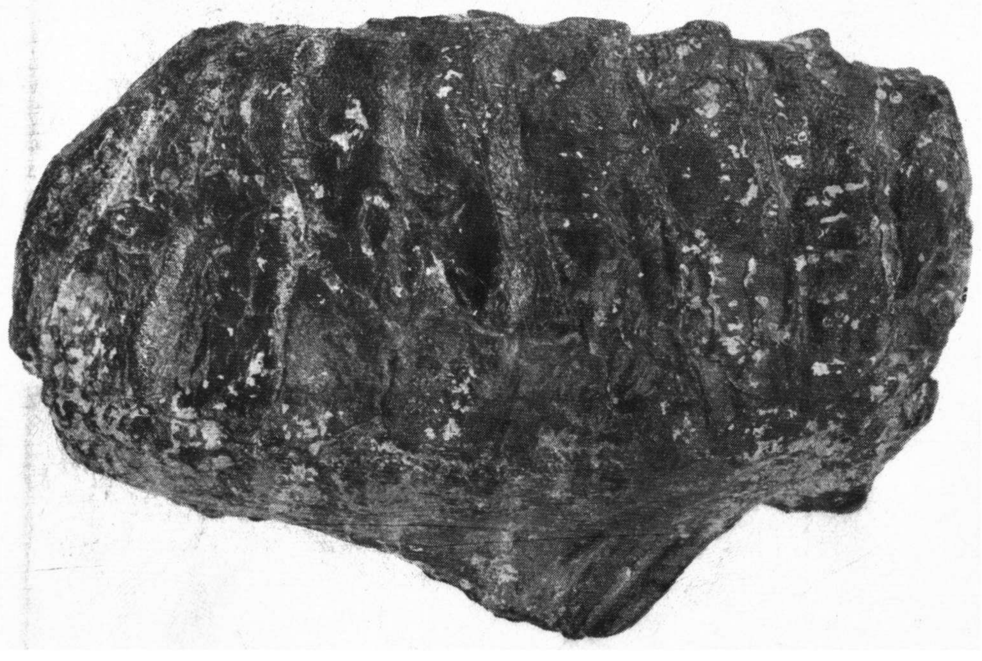

c

Fig. 1. *Archidiskodon planifrons* (Falc. & Caut.). M_3 sin.; Coll. Geol. Mus., Leiden, St. 20033. Eastern-Scheldt, near Ierseke, Zealand. About ½ × nat. size.
a crown-view; *b* root-side (fracture-surfaces are crossed-hatched); *c* inner side.