Eocene Turtles from Denmark

by

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Preface

The present paper deals with some remnants of turtles derived from the Lower Eocene deposits in the Limfjord area of Jutland, and belonging to the small museum in Nederby on the island of Fur.

To the leader of the Fur museum, Mr. M. BREINER JENSEN, who has personally collected the greater part of the fossils of the museum, I owe sincere thanks for the permission to describe the finds of turtles from the Mo Clay Formation, to my knowledge the only finds of this kind ever made.

During my work on the material it proved necessary to make comparisons with certain other fossil turtles, and for that purpose I visited, in the summer of 1958, the British Museum of Natural History, London, and the Institut Royal des Sciences Naturelles de Belgique, Brussels. In both places I was received with the greatest kindness and helpfulness, for which I here express my cordial thanks to Dr. ERROL S. WHITE from the British Museum, and to Dr. L. CASIER from the Belgian institution.

To the Rask Ørsted Foundation my grateful thanks are due for a grant enabling me to visit London and Brussels.

I am also highly indebted to Dr. R. ZANGERL, of the Museum of Natural History, Chicago, U. S. A., for valuable advice regarding my material.

The preparations and the investigation of the turtles from the Mo Clay Formation were carried out in the Department of Vertebrate Paleontology of the Mineralogical and Geological Museum of the University of Copenhagen. To two members of the staff of this museum, Mr. CHR. HALKIER, who did the photographic work, and Miss GUNNI JØRGENSEN, who prepared the drawings, I express my best thanks for their skillful work.

Finally, my thanks to stud. mag. HANS BJERRING, who undertook a considerable part of the tedious work of cleaning the skull of *Eosphargis* from the hard matrix in which it was embedded.

Introduction

On the initiative of some of the inhabitants, a small museum was founded in 1953 in the village Nederby on the island of Fur.

From its start this museum possessed fairly considerable collections of fossils from the Mo Clay Formation[1]), and since then the collections have been steadily increasing, partly due to occasional gifts, partly to the more systematic search undertaken by the leader of the museum, Mr. M. BREINER JENSEN.

In 1954 Mr. BREINER JENSEN asked me to assist him in arranging the exhibition of the fossils in the museum, and during my inspection of the collections I discovered among other particularly interesting specimens the incomplete skeleton of a small turtle in a piece of cement stone, which also contained a great number of well preserved gastropods.

Some months later I subjected this small turtle to a closer examination in Copenhagen but returned it afterwards to the Fur museum, as I considered it too incomplete to justify a separate publication.

In the following years Mr. BREINER JENSEN at intervals sent me for examination finds from his continued search for fossils in the Mo Clay Formation, and in one of these collections I received, in the spring of 1957, a nodule of cement stone containing the greater part of an extremely well preserved skull of a large turtle.

The snout region of the skull was missing, but as the fracture seemed to be of quite recent date, I immediately wrote to Mr. BREINER JENSEN asking him, if possible, to make an attempt to secure the missing part of the nodule; I added that if he did not succeed, I would come to Fur and try my luck myself. Actually, of course, I judged the chances for a positive result of a search for the missing snout to be extremely small, and great, therefore, was my astonishment when shortly after asking Mr. BREINER JENSEN to look for the snout, I received the message that he had actually

[1]) The Mo Clay Formation is a Lower Eocene marine deposit exposed in many places on Fur as well as in the vicinity of this island, i.a. on the larger island of Mors.

The mo clay is a light grey, easily, crumbling, argillaceous diatomaceous sediment, in places containing subordinate layers or nodules impregnated with lime to such an extent that they can most adequately be described as impure grey limestone, the cement stone, which is much harder and heavier than the mo clay. The mo clay series also contains numerous beds of tuffs and volcanic sand.

succeeded in finding it. The snout according to this message, was collected under difficult conditions, the finding place being submerged owing to a storm and the nodule containing the fossil had been very difficult to handle on account of its great weight. This last mentioned piece of information puzzled me, for judging by the shape of that part of the nodule which contained the first discovered fragment of the skull the missing part of the nodule should at most be of size of a clenched fist. When, however, very soon afterwards the find arrived at my laboratory, the riddle was solved. The stone in which the skull was embedded was a double nodule, consisting of two partially fused oblong lens-shaped nodules of very different size (cf. pl. 1).

Furthermore, during a visit to the Fur museum in the summer of 1957 I identified a small fragment of the same skull, and on this occasion I also discovered, among the specimens on exhibition, the remnants of a third turtle skeleton preserved as an impression in a piece of mo clay.

In the autumn of 1957 I began a closer examination of all three specimens of turtles from the Mo Clay Formation, and as a necessary link in this investigation I undertook, in the summer of 1958, a journey to London and Brussels to compare my material with other early Tertiary turtles. On account very valuable suggestions as to the systematic position of the big skull in my material received from Dr. R. Zangerl, my attention on this journey was especially directed towards the known finds of fossil Dermochelyids

The final results of my investigation of the turtles from the Mo Clay Formation can be summarised as follows:

1) The big skull represents a new species of the genus *Eosphargis* LYDEKKER, a primitive member of the family *Dermochelyidae*. This new species I have named *E. breineri* in honour of the finder, Mr. M. BREINER JENSEN.
2) The smallest of the three turtles belongs to the Cheloniid genus *Glarichelys* ZANGERL the only species of which described so far, *G. knorri*, is known from a few specimens from the Lower Oligocene of Switzerland. The Danish specimen seems to differ in certain respects from *G. knorri*, but is too incomplete to justify the erection of a new species.
3) The third turtle specimen from the Mo Clay Formation is probably a Cheloniid, but cannot be referred to a definite genus.

Eosphargis LYDEKKER

Some remnants of a very large turtle from the London Clay Formation on the island of Sheppey were described by R. OWEN as *Chelone gigas* (R. OWEN 1849; 1880). In 1889 LYDEKKER pointed out that these remnants, which included the proximal end of a femur, an almost complete skull, and an incomplete skull found together with part of the body skeleton, differed from *Chelone* (*Chelonia*) in a number of characters, as to which they showed close agreement with *Dermatochelys* (*Dermochelys*) (LYDEKKER 1889, pp. 239–241).

These characters are the following: The lack of a secondary palate and in accordance with this a forward position of the choanae, details of the contours of the bones of the palate and of the occipital region, the upward direction of the nares, the narrowness of that part of the cranial roof which separates the nares from the orbital opening, and the lack of long descending parietal flanges.

According to LYDEKKER *'Chelone' gigas* could not be referred to the genus *Dermochelys* because its skull was relatively more broad and flat in which respect *'Chelone' gigas* closely agreed with the genus *Psephophorus* v. MEYER, a Tertiary close relative to *Dermochelys*.

LYDEKKER, therefore, at first was inclined to place *'Chelone' gigas* in the genus *Psephophorus* (LYDEKKER 1889, p. 240), but after having investigated the remnants of the body skeleton he found that the carapax in *'Chelone' gigas* comprised a median series of ossification and probably also a series of marginals but that an armor of small polygonal tesserae as in *Psephophorus* was not developed. Of other differences between *'Chelone' gigas* and *Psephophorus* LYDEKKER mentions the absence in *'Chelone' gigas* of the descending process of the premaxillary, which is found not only in *Psephophorus* but also in *Dermochelys*.

Accordingly, LYDEKKER (1889, p. 241) for OWENS *Chelone gigas* erected a new Dermatochelyid (Dermochelyid) genus, *Eosphargis*, for which he gives the following diagnosis:

Skull and humerus of the general type of *Psephophorus*; carapace consisting of a median dorsal row of large carinated plates, of which the width largely exceeds the length, and probably also of a series of large marginals.

In 1906 an almost complete skeleton of *Eosphargis gigas* was discovered in the Lower Eocene of Belgium. This highly interesting find has never been described in detail, but only dealt with in great shortness by DOLLO (1907), who only states that *Eosphargis* is a Thecophor, not as assumed by LYDEKKER, an Ateque.

Eosphargis breineri n. sp.

(Text-figs. 1–4; pls. 1–3; pl. 4, figs. 1–3).

Material and localities.—The material comprises a single skull found together with a few indeterminable fragments of bone in a nodule of cement stone, and undoubtedly belonging to the same skeleton.

The specimen was found on the beach below Knudeklint on the northwestern part of the island of Fur. According to verbal information from the state geologist, dr. HELGE GRY, the nodule must be supposed to have weathered out from that part of the Lower Eocene mo clay series, which is situated between the tuff layers +1 and ÷11, (cf. O. B. BØGGILD 1918) which part of the series is exposed in the steep Knudeklint at the finding place.

The skull which is slightly compressed in an almost dorso-ventral direction is not quite complete. This is due partly to the fact that the skull not have been completely enclosed in the nodule of cement stone, and partly to the loss of smaller fragments when the skull in recent time was fractured as mentioned in the introduction.

The parts of the skull which are missing because they never have been embedded in the hard cement stone are the posterior part of the alveolar borders of the maxillaries, the ventral part of the jugals, the quadrates and the quadratojugals, the whole or almost the whole of the squamosals, and the posterior marginal zone of the parietals and postorbitals. If the cement stone nodule had been discovered in situ in the wall of the cliff, one would presumably have found traces of these missing parts of the skull in the surrounding soft diatomaceous earth.

The more important of the smaller pieces of bones which have been lost by fracturing of the skull are fragments of the interorbital part of the cranial roof as well as smaller fragments of the foremost part of the vomer and of that part of the prefrontal which partakes in the formation of the anterior vertical walls of the orbits.

As to the isolated fragments of bone found together with the skull little can be said. The largest of these fragments is a triangular plate which as shown in pl. 2 covered the formost part of the ventral face of the skull, and which before it was completely exposed by preparation looked rather much as a secondary palate. It probably is a fragment of one of the elements of the carpax. The other fragments are situated in the cement stone just anterior to the snout of the skull and might eventually represent parts of the hyoid skeleton.

Description.— In its present state of preservation the skull measures 22.7 cm in length, and as part of the hind border of the left half of the cranial roof is preserved the total length of the skull has hardly been more than 23 cm.

The greatest width of the preserved part of the skull is about 17 cm, measured a short distance behind the orbital openings. Most probably the width of the complete skull increased slightly from here backwards almost to the hind border of the skull, but considering that the skull, as mentioned above, is somewhat dorso-ventrally compressed, the maximal width of the undamaged skull hardly surpassed 18 cm.

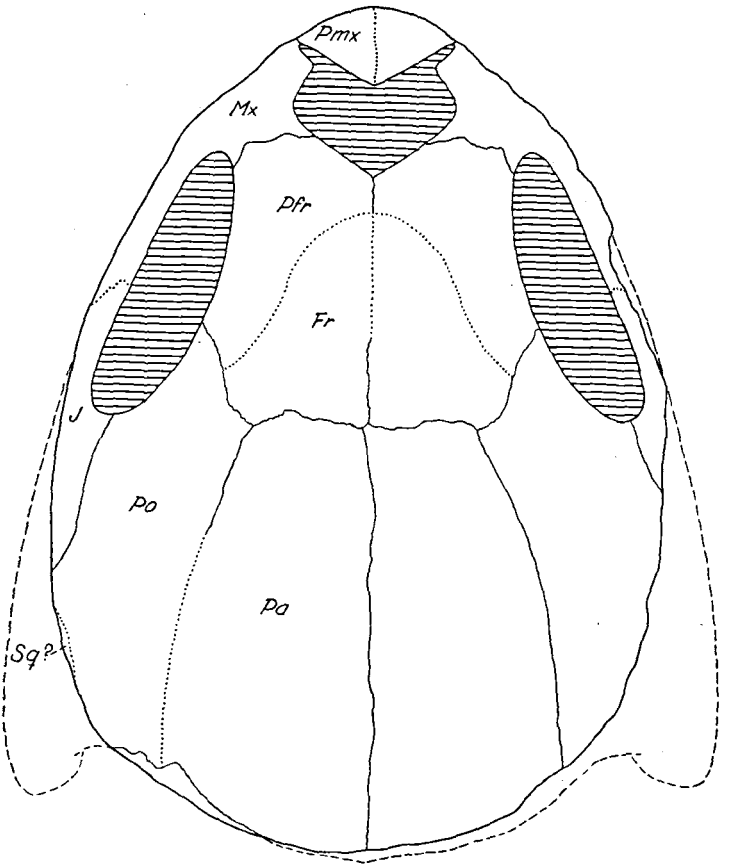
In height the skull near the anterior ends of the orbital openings measures slightly more than 6 cm and about the same from the level of the articular processes of the quadrates to the level of the anterior margin of the parietals. Considering the compression of the skull, and the fact that the articular process of both quadrates lacks a smaller distal part, the maximal height of the complete skull can be estimated to be about 7 cm.

The relations between the estimated height and length is thus $\frac{1}{3.3}$ and between the estimated width and length $\frac{1}{1.3}$. The corresponding relations in *Eosphargis gigas* are almost the same, viz. $\frac{1}{3.3}$ and $\frac{1}{1.3}$, but very different in *Dermochelys coriacea* where measurements on a big skull give the values. $\frac{1}{1.8}$ and $\frac{1}{1.2}$.

The skull of *E. breineri* is of pronounced stegal type with practically no indications of beginning excavation from the posterior rim of the cranial roof.

The pattern of the dermal bones of the roof of the skull bears a close resemblance to that of *Dermochelys*, from which it differs only in minor

details as to the relative proportions of certain bones. Thus the parietal, which has a length of 11.5 cm and a width at its anterior end of ca. 3 cm, increases relatively less in width in a posterior direction than in Dermochelys, its width farthest posteriorly being no more than 6.5 cm, in agreement with which the posterior part of the postorbital is relatively broader than in *Dermochelys*.

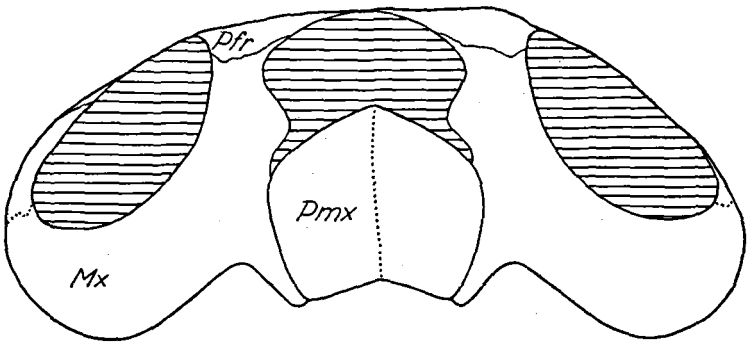


Text-fig. 1.

Eosphargis breineri n. sp. Dorsal view of the skull. Slightly restored. (Ca. 0.5×) *Fr*, frontal; *J*, jugal; *Mx*, maxillary; *Pa*, parietal; *Pfr*, prefrontal; *Pmx*, premaxillary; *Po*, postorbital; *Sq*?, possibly part of squamosal.

The suture between the frontal and the prefrontal cannot be traced directly owing to damage of the interorbital part of the roof of the skull. However, it can be stated with certainty that the frontal reached neither the margin of the orbital or of the external nasal opening, and, therefore, as indicated in text-fig. 1 and in pl. 1 this bone probably had about the same relations to the adjoining bones of the roof of the skull as in *Dermochelys*.

The orbital openings are very large, measuring no less than about 8 cm in length and about 5 cm in greatest height. The large unpaired external nasal opening, which is directed much more dorsally than anteriorly, has much the same outline as in *Eospargis gigas*, differing especially from that in *Dermochelys* in possessing a long, narrow, antero-lateral extension between the backwardly curving upper part of the premaxillary and the



Text-fig. 2.
Eosphargis breineri n. sp. Anterior view of the skull. (Ca. 0.6 ×).
Mx, maxillary; *Pfr*, prefrontal; *Pmx*, premaxillary.

antero-dorsal part of the maxillary. Posteriorly the nasal opening is bounded by the antero-medial margins of the prefrontal, which margins meet at an anteriorly opening angle of about 90°. The distance from the anterior end of the suture between the two prefrontals to the pointed hindmost end of the backwardly inclined upper part of the firmly joined, premaxillaries is 3.7 cm and the greatest width of the nasal opening measured a short distance anterior to the antero-medial end of the suture between the maxillary and the prefrontal is 4.4 cm.

As in *Dermochelys* the bony bridge between the orbital openings is extremely broad, its minimals width, measured a short distance behind the nasal opening, being about 7 cm.

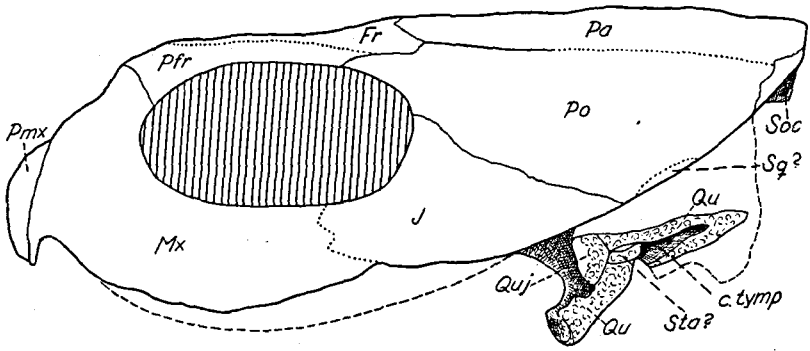
The bony bridge separating the orbital opening from the external nasal opening is relatively broader than in *Dermochelys*. Its smallest width is 2.1 cm.

A short distance behind the junction with the premaxillary the biting edge of the maxillary has a rather deep notch, and as the biting edge of the premaxillary from its junction with that of the maxillary extends not only in a medial and slightly anterior direction but also slightly upwards, that part of the jaw border formed by the foremost part of the maxillary and the adjoining part of the premaxillary protrudes as a pointed ventrally directed process corresponding to, but much less pronounced than the tusk-like process of the jaw border of *Dermochelys*.

Anterior to this process the jaw border is developed as a sharp cutting edge but behind the point of the process and as far back as to the area below the anterior end of the orbit the alveolar division of the maxillary

shows a rather wide, ventrally directed face instead of a cutting edge as in *Dermochelys*. Farther back the actual jaw border is not preserved.

Although the jugal farthest ventrally is damaged to some extent it is possible to see that just anterior to the quadrate this bone is excavated to some extent from the ventral rim as is also the case in *Dermochelys*.



Tex-fig. 3.

Eosphargis breineri n. sp. Lateral view of the skull. (Ca. 0.5×).
Fr, frontal; *J*, jugal; *Mx*, maxillary; *Pa*, parietal; *Pfr*, prefrontal; *Pmx*, premaxillary; *Po*, postorbital; *Qu*, quadrate; *Quj*, quadratojugal; *Soc*, supraoccipital; *Sq*?, possibly part of squamosal; *Sta*?, possibly part of stapes; *c. tymp*, cavum tympani.

No part of the supraoccipital is visible on the external face of the cranial roof of which, however, as already mentioned the posterior marginal zone is missing. In some specimens of *Dermochelys* the supraoccipital is visible on the dorsal face of the skull, in others it is completely hidden beneath the parietals (Nick 1912, p. 24). The crista supraoccipitalis in *E. breineri* most probably was developed much as in *Dermochelys*, but its actual extent cannot be made out, as its hindmost part is lacking.

Most of the bones of the skull roof are ornamented with numerous extremely delicate, often ramifying grooves, but the premaxillary, the maxillary and the suborbital part of the jugal present a coarser ornamentation consisting of relatively large rounded pits, or, especially the premaxillary, rather short, oblong grooves. The cranial roof shows no traces of having been protected by a system of horny scutes.

The bones of the roof of the mouth presents much the same arrangement as in *Dermochelys* and agree as far as could be made out extremely closely in development with those of *Eosphargis gigas*.

The parasphenoid attains its greatest width near its posterior, probably fairly straight or somewhat concave margin and is here relatively much broader than in *Dermochelys*. It covers ventrally the basisphenoid with which it probably as in *Dermochelys* (Versluys 1909, pp. 287–288; Nick 1912, p. 33) is intimately connected, but also a considerable postero-medial part of the pterygoids. The last-mentioned bone forms a considerable part of the posterior and medial borders of the subtemporal fenestra but is separated from the palatal division of the maxillary by the palatine,

and *Dermochelys*, the ratios width-length and height-length being $\frac{1}{1.5}$ and $\frac{1}{1.9}$, respectively.

The laterally expanded, anterior division of the vomer in *Psephophorus*? *oregonensis* has about the same rostro-caudal extent as in *Dermochelys*, but a distinct maxillary-palatine crest or edge is not seen in *P.*? *oregonensis* and moreover the foremost part of the alveolar border of the maxillary and the adjoining part of the cutting margin of the premaxillary in this species is not developed as a tusk-like process as in both *Eosphargis* and *Dermochelys*. Especially the last-mentioned point makes it impossible to place *Psephophorus*? *oregonensis* on an eventual phyletic line connecting *Eosphargis* and *Dermochelys*.

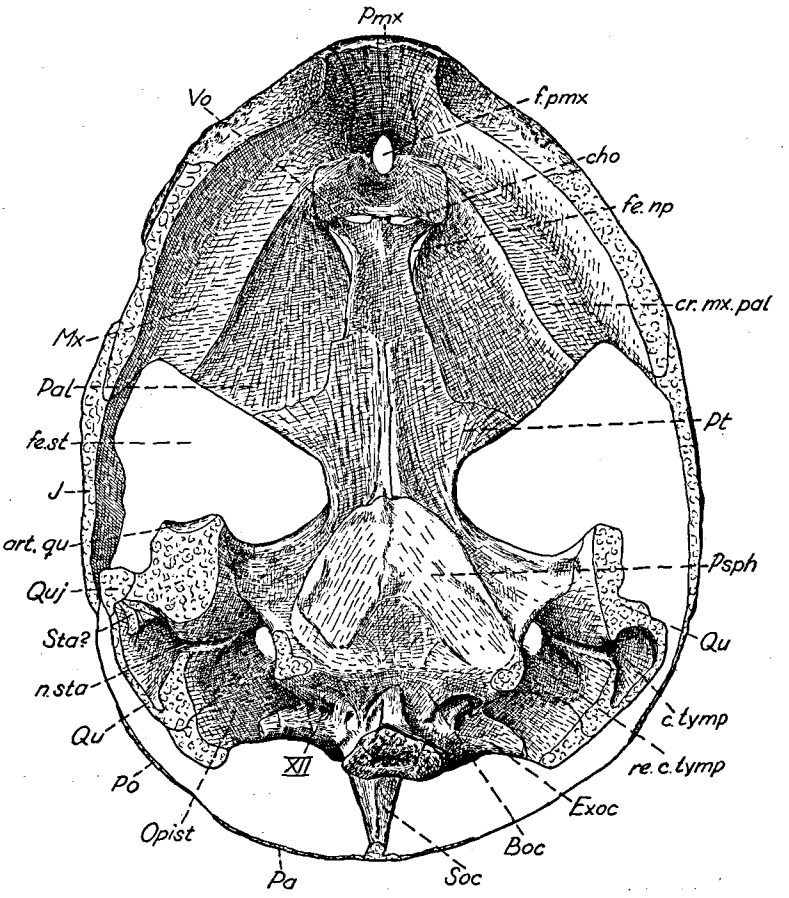
The genus *Pseudosphargis* DAMES with the species *P. ingens* is based on a single find from the Oligocene of the posterior part of a very large skull (DAMES 1894, pp. 206–212). According to DAMES *Pseudosphargis* agrees with both *Eosphargis* and *Psephophorus* in possessing a broad and relatively flat skull, but differs from *Eosphargis* in having well developed descending parietal flanges reaching downwards to the basisphenoid.

However, LYDEKKER's statement (LYDEKKER 1889, p. 240) that descending parietal flanges are missing in *Eosphargis* is as far as I can see open to doubt. The fragmentary skull on which LYDEKKER bases this claim shows the proximal parts of such flanges, but how far downwards these flanges reached in the undamaged skull cannot be decided. On the basis of our present knowledge *Pseudosphargis* thus cannot be distinguished from *Eosphargis* and, as a matter of fact, also not from *Psephophorus*. Accordingly, before better material of *Pseudosphargis* has been obtained, it cannot be decided if this genus is valid, or if the name *Pseudosphargis* is a synonym for either *Eosphargis* or *Psephophorus*.

LYDEKKER (1889), DAMES (1894), and DOLLO (1903, 1907) have mentioned a number of features as to which *Eosphargis* seems to be intermediate between the Cheloniid and the *Dermochelys* type, and the same writers as well as i.a. NICK (1912) and VERSLUYS (1913) have pointed out that many structural details in *Dermochelys* indicate a relationship with the Chelonioids.

To the phyletic series *Toxochelys* → *Eosphargis* → *Psephophorus* → *Dermochelys* suggested by DOLLO (1903, p. 57) I shall make a few comments.

The special development in *Dermochelys* of the anterior part of the alveolar border of the maxillary and of the adjoining part of the cutting border of the premaxillary is more advanced than in *Eosphargis*, and as to this character *Eosphargis* might without difficulty be considered as ancestral to *Dermochelys*. The peculiar development in *Dermochelys* of the anterior division of the vomer and the relations of this division to the other elements of the anterior part of the roof of the mouth, is considered by DOLLO (1903) and other writers as the result of the reduction of a secondary palate present in forms ancestral to *Dermochelys*. As described earlier in this paper the anterior division of the vomer in *Eosphargis* has a greater rostro-caudal extent that in *Dermochelys* and can in fact be regarded as a small, secondary palate, which speaks in favour of DOLLO's view. If



Text-fig. 4.

Eosphargis breineri n. sp. Palatal view of the skull. (Ca. 0.5 ×).
Boc, basioccipital; *Exoc*, exoccipital; *J*, jugal; *Mx*, maxillary; *Opist*, opistotic; *Pa*, parietal; *Pal*, palatine; *Pmx*, premaxillary; *Po*, postorbital; *Psph*, parasphenoid; *Pt*, pterygoid; *Qu*, quadrate; *Quj*, quadratojugal; *Soc*, supraoccipital; *Sta?*, possibly part of stapes; *Vo*, vomer; *art. qu*, articular facet of quadrate; *c. tymp*, cavum tympani; *cho*, choana; *cr. mx. pal*, maxillary-palatine edge; *fe.np*, fenestra naso-palatinus; *fe. st*, fenestra subtemporalis; *f. pmx*, opening between the premaxillaries; *n. sta*, stapedial notch; *re. c. tymp*, recessus cavum tympani; *XII* external openings of canals for hypoglossal nerves.

which extends backwards to the subtemporal fenestra as shown in text-fig. 4 and in pl. 3. The posterior part of the pterygoid forms a part of the anterior border of the postotic fenestra and reaches backwards to the tubercula basioccipitalis. The right and left pterygoid meet anteriorly to the parasphenoid separating this bone from the vomer. The suture between the pterygoids and the vomer is impossible to trace, its most probable course is indicated with a broken line in text-fig. 4.

The vomer is developed in principally the same way as in *Dermochelys*, consisting of a rather extensive posterior division provided with a ventral unpaired longitudinal crest, the foremost part of which widens distally to form the short and very broad anterior division of the vomer. The posterior division is a four-sided plate with a posterior, probably fairly straight, a somewhat concave, paired lateral, and a short anterior margin. The antero-lateral corners are drawn out in long and narrow dorsally curving processes, which adjoins the vertical plate of the prefrontal separating the nasal cavity from the orbit. These processes border the choanae posteriorly and the naso-palatine fenestrae antero-medially as shown in text-fig. 4.

The median crest on the ventral face of the posterior division of the vomer is less pronounced than in *Dermochelys*. It decreases in height backwards to disappear completely at about equal distances from the anterior and posterior margins of the bone. Anteriorly it continues beyond the anterior margin of the vomer as the wall between the passages from the nasal cavity to the choanae. The short and broad anterior division of the vomer forms the floor for these nasal passages and is thus developed as a secondary palate of a somewhat greater rostro-caudal extent than in *Dermochelys* (see further p. 107). The anterior division of the vomer adjoins anteriorly the premaxillary and the palatal division of the maxillary and also the anterior pointed process of the palatine, which excludes the maxillary from partaking in the bordering of the choana as shown in text-fig. 4. Posterior to the naso-palatine fenestra the palatine adjoins the posterior division of the vomer and the antero-lateral part of the pterygoid. Laterally or antero-laterally the palatine adjoins the palatal division of the maxillary forming a very pronounced edge on the oral face of the roof of the mouth, the lateral marginal zone of the palate curving straight downwards, while the medial marginal zone of the palatal division of the maxillary is fairly horizontal. As to the palatal division of the maxillary its ventral surface is rather strongly concave in a transverse direction, and thus appears as a pronounced groove extending parallel to the alveolar border of the jaw. This groove is especially deep farthest anteriorly, where it merges into a very deep median concavity on that part of the roof of the mouth, which is formed by the ventral face of the palatal laminae of the premaxillaries and to a smaller extent by the anterior division of the vomer. This very deep median concavity as in *Dermochelys* evidently received the beak of the lower jaw, when the mouth closed. In the roof of this concavity we find between the palatal laminae of the premaxillaries a small oblong opening which probably as the corresponding opening in *Dermochelys* was closed complete by soft tissues in the living animal (Nick 1912, p. 60).

As already mentioned, the quadrates are rather badly damaged and only very little is preserved of the qudratojugals. It can be stated, however, that the articular process of the quadrate which is situated relatively more medially than in *Dermochelys*, has a relatively considerable length, in which respect as well as in the development of the tympanic cavity *E. breineri* shows closer agreement with *Dermochelys* than with the Cheloniids. On the concave face of that part of the right quadrate, which bor-

ders the external division of the tympanic cavity is found a fragment of bone, which might represent a distal part of the stapes.

The basioccipital, exoccipitals, and opistotic probably were relatively lightly ossified, as they evidently have suffered more by pressure than the more anterior elements of the skull. In their present state of preservation they differ in no notable respects from the corresponding bones in *Dermochelys*.

Discussion.—The state of preservation of the sparse material on which the genus *Eosphargis* with the type species *E. gigas* is erected is rather unsatisfactory and does not by far permit so close a study of the detailed structure of the skull, as the still undescribed find from Belgium referred to *E. gigas* by DOLLO in 1906. Having had the opportunity to see both the English and the Belgian material, I am no quite convinced that DOLLO was right in referring the Belgian specimen to the species *E. gigas*, although it certainly belongs to the genus *Eosphargis*.

According to LYDEKKER (1889, p. 240) a ventrally directed process as in *Dermochelys* is not formed on the jaw border of *E. gigas*. Such a process is present in the Belgian specimen referred to *E. gigas* and is here even more pronounced than in *E. breineri*, and if LYDEKKER's observation is correct, the Belgian specimen cannot possibly belong to the species *E. gigas*. However, on account of the poor state of preservation of the English material I feel unable to judge in this matter.

In the Belgian specimen the medial part of the palatal division of the maxillary curves strongly downwards, its medial marginal zone obtaining a practically vertical position, and as the lateral marginal zone of the palatine curved downwards to the same degree, the maxillary and the palatine join in such a way, that they form a very high and narrow crest on the oral face of the palate. In *E. breineri*, as described above, a very conspicuous edge is formed by the junction of the maxillary and the palatine, but in the only English specimen of *E. gigas* showing the roof of the mouth, no well defined maxillar palatine crest or edge is seen. If this seemingly important difference between the English and the Belgian material is due only to the different state of preservation is difficult to decide.

The ornamentation of the premaxillary, the maxillary, and the jugal is somewhat more pronounced in the Belgian specimen than in the English ones, which in this respect agree rather closely with *E. breineri*. A slight difference as to the ornamentation, however, hardly gives sufficient evidence for establishing the Belgian specimen as a species of its own, and, everything considered, I prefere to leave the question open until better preserved material of *E. gigas* has been obtained from the London clay.

E. breineri differs as to the characters described above quite distinctly from the Belgian specimen, and even if the Danish species in these respects agrees better with the English specimens, it differs in certain details both from the English and Belgian specimens of *Eosphargis*. These details are the following:

The articular process of the quadrate has a less lateral position. The subtemporal fenestra is broader in proportion to its length, and the same although to a slighter degree is the case with the orbital opening.

Diagnosis.—Anterior part of the alveolar border of the maxillary and the adjoining part of the premaxillary forming a short ventrally directed process. Maxillary and palatine forming by their joining each other a distinct edge on the oral face of the palate. Ornamentation of premaxillary, maxillary, and jugal rather coarse. Ratio between width of interval between the articular processes of the quadrates and maximal width of skull $\frac{1}{1.3}$. Ratio between height and length of orbital opening $\frac{1}{1.2}$. Ratio between length and width of subtemporal fenestra $\frac{1}{1}$.

Remarks on the family *Dermochelyidae*

In the nearly complete reduction of horny shields, the great reduction of the thecal shell, the relatively considerable development of an epithecal armor, and certain seemingly primitive features of the skull, the recent leathery turtle, *Dermochelys coriacea L.* differs so radically from all other living members of the order *Chelonia* that its systematic position has remained a matter of discussion to the present day.

I do not intend to give a long historical account of this discussion, it will suffice to mention that a number of writers have maintained that *Dermochelys* together with a few fossil genera evidently closely related to *Dermochelys* represents a line, which issued from the main group of Chelonians very far back in time, while other writers are of the opinion that the *Dermochelys* line issued from the Chelonioid stock not earlier than in the Cretaceous.

The present study of *Eosphargis breineri* gives strong support to the last-mentioned view, which to-day is shared by a majority of writers.

The genus *Dermochelys* which appears already in the Miocene has close relatives in the genera *Psephophorus* v. MEYER (Eocene to Pliocene) and *Cosmochelys* ANDREWS (Eocene), both of which have a strongly developed epithecal armor consisting of a mosaic of polygonal tesserae.

The skull of the only known species of *Cosmochelys* (ANDREWS 1919) is unknown and, apart from a description of an almost complete skull of *Psephophorus? oregonensis* from the Miocene of Oregon (PACKARD 1940), the only important information of the structure of the skull of *Psephophorus* seems to be DOLLO's short statements, repeated by many later writers, that the skull of *Psephophorus* differs from that of *Dermochelys* in being shorter, broader and lower (DOLLO 1887, p. 150; ZITTEL 1911, p. 254; 1923, p. 308). On which specimens these observations are based is hard to tell, only few and incomplete remnants of the skull being found in the large material of *Psephophorus* in the possession of the Institut Royal des Sciences Naturelles de Belgique, and no information can be found in the literature of more complete skulls from other collections.

As to the proportions of the skull *Psephophorus* thus deviates from *Dermochelys* in the same direction as *Eosphargis*, but how close, in this respect, the similarity is between *Psephophorus* and *Eosphargis* is unknown.

In *Psephophorus? oregonensis* PACKARD the skull as to relative length, width, and height represents an intermediate stage between *Eosphargis*

reduction of the secondary palate takes place within the *Eosphargis-Dermochelys* line, forms ancestral to *Eosphargis* most probably possessed a secondary palate still less reduced than that of *Eosphargis*, and here DOLLO suggests *Toxochelys*. In my opinion we might quite as well look for the ancestor of *Eosphargis* within the family *Cheloniidae*, and as a possibility I mention *Eochelone*, a genus, which according to DOLLO (1903) presents a reduced secondary palate, and, as far as I have seen, less reduced than that known in *Eosphargis*. However, our knowledge of the fossil Cheloniids is very unsatisfactory and I prefer at present to leave the question as to the ancestry of *Eosphargis* open, but having mentioned *Eochelone* in this connection I will not omit citing ZANGERL's recently expressed views (ZANGERL 1958, p. 38, footnote) on the palate in this genus. ZANGERL's statement is as follows: "Wenn zum Beispiel DOLLO (1903) in der Beschreibung des Schädels (ohne Abbildung) von *Eochelone brabantica* sagt: "Choanes très antérieures, et du type de Dermochelys" so besteht kein Zweifel, dass es sich um primäre Gaumenverhältnisse handelt, was bei Cheloniiden von grossem Interesse ist. Es gibt noch andere marine Schildkröten, bei denen ein primäres Gaumendach vorkommt, so bei Desmatochelys, den Protostegiden und den primitiven Toxochelyiden, wo sich die Entwicklung eines sekundären Gaumens bei den Ctenochelyinen und den Osteopyginen verfolgen lässt (ZANGERL 1953). Die blosse Feststellung primärer Gaumenverhältnisse bei Eochelone ist deshalb für den näheren Vergleich unzureichend".

As to *Psephophorus* the present quite insufficient knowledge of its skull makes it impossible to decide if this genus can be considered as a true connecting link between *Eosphargis* and *Dermochelys*, although the development of the armor in this genus speaks rather in favour of such a view.

Taking in account the conspicuous resemblances in several respects between the skull of *Eosphargis* and that of *Dermochelys* it seems most reasonable at present to include the genus *Eosphargis* in the family *Dermochelyidae*, even if the excessive development of an epithecal armor typical for the other Dermochelyid genera not yet has started in *Eosphargis*.

Glarichelys Zangerl.

The genus *Glarichelys* was erected by ZANGERL in 1958 for a very rare, small Cheloniid species from the famous Lower Oligocene fish-bearing shales at Matt in Kanton Glarus, Switzerland, previously dealt with by several writers under various names (cf. ZANGERL 1958, pp. 6–9).

ZANGERL (1958, pp. 48–49) gives the following diagnosis:

"Cheloniiden von wahrscheinlich bescheidener Grösse. Schädel mit mässig verlängertem Schnauzenteil und sehr schmaler Interorbitalbrücke; sekundäres Gaumendach von geringer Ausdehnung; Unterkiefersymphyse relativ kurz; Schildgrensen auf dem Schädeldach sichtbar, von ähnlicher Anordnung wie bei "*Chelonia*" *gwinneri*, aber Parietalschild paarig. Carapax wahrscheinlich zeitlebens mit Intercostalfontanellen; Plastron mit relativ grossen Zentral- und Lateralfontanellen; Brückenindex des

Plastron ±70. Schultergürtel primitiv: Scapulafortsätze ungefär gleich lang; Coracoid nicht verlängert. Radius und Ulna wahrscheinlich über einander gelegen, aber ohne Kontaktrugosität (wenigstens im Jugendstadium); Paddel und Pes bedeutend länger als bei rezenten Cheloniiden".

Glarichelys sp.

Text-fig. 5; pl. 5, fig. 1–2; pl. 6, fig. 2)

Material and localities.—The material consists of parts of the skeleton and of the horny shields of a single small specimen preserved in a piece of cement stone which also contains other macrofossils, especially gastropods.

The specimen was collected in 1953 on Færkerhede on the island of Fur in a quarry belonging to the "Dansk Moler Industri". It was found by one of the workers and presented to the Fur Museum by the leading engineer, Mr. E. NIELSEN. The discovery of the specimen happened during the work of crushing a number of big nodules of cement stone in order to facilitate their removal from the quarry, and as these nodules originally had been gathered from different places in the quarry, it was no longer possible to decide from which exact layer the nodule containing the remnants of the turtle skeleton was derived. However, according to the information obtained by Mr. BREINER JENSEN, the fossil in question most probably came from the same horizon as the specimen of *Eosphargis breineri* dealt with previously in this paper.

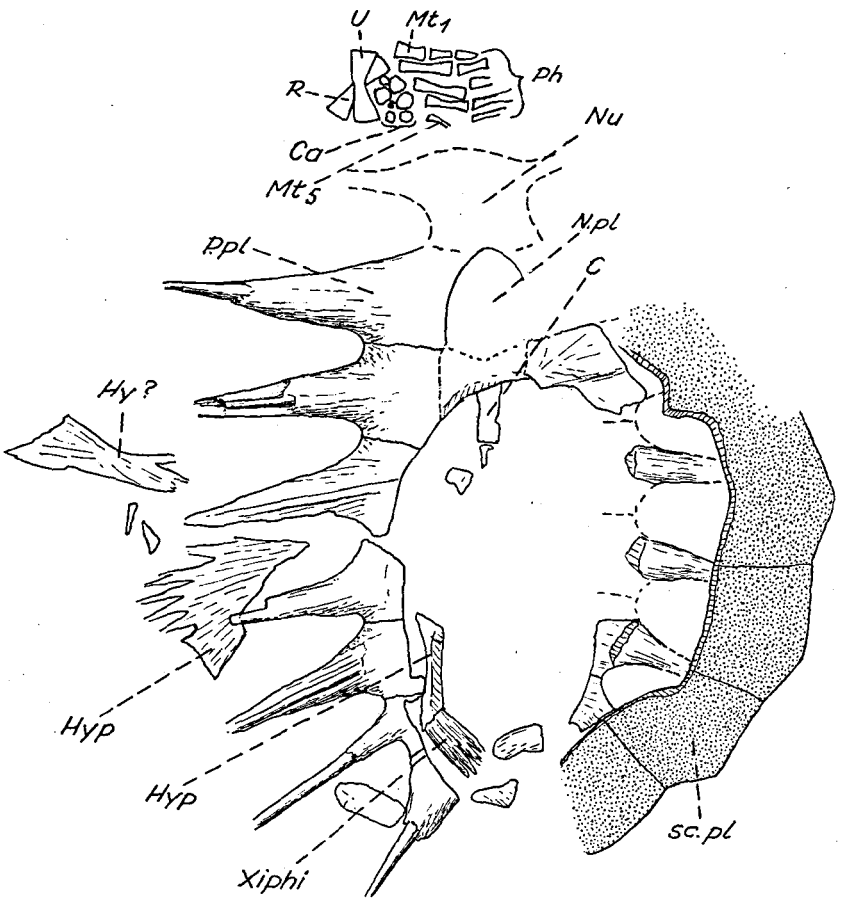
The remnants of the small turtle from the Færkerhede quarry comprise parts of the carapax, plastron, vertebral column, ribs and left paddle. Evidently much of the missing parts of the skeleton was present in those pieces of the nodule, which were not taken care of, and the possibility still exists, that these pieces can be saved, as they are very easy to recognise on account of their unusual large content of gastropods.

Description.—In its present state of preservation the slightly deformed carapax measures 7.9 cm in length and its left half 3.3 cm in greatest width. The length of the complete carapax can be estimated to be between 8 and 9 cm and the maximal width to be about 7 cm.

The specimen is thus slightly smaller than the type specimen of *Glarichelys knorri*, the smallest known specimen of this species (ZANGERL 1958, pp. 10–11, 19, 53).

By comparing the degree of ossification in the type specimen and in the slightly larger *"ovata"* specimen of *Glarichelys knorri* with the degree of ossification in specimens of various age of the recent *Eretmochelys ingens* ZANGERL (1958, pp. 10–11) arrived at the conclusion, that the two specimens of *Glarichelys* probably are juvenile individuals although not far from the adult stage. The same argumentation holds good for the Færkerhede specimen, the degree of ossification of which seems to be about the same as in the type specimen of *Glarichelys knorri.*

The incomplete carapax of the Færkerhede specimen is exposed from its dorsal side and shows the following elements: The badly preserved



Text-fig. 5.
Glarichelys sp. Incomplete skeleton in mainly dorsal view (Ca. 1.2×).
C, centrum; *Ca*, carpals; *Hy*?, possibly part of hyoplastron; *Hyp*, hypoplastron; Mt_1, Mt_5, first and fifth metacarpal; *N. pl*, foremost neural plate; *Nu*, nuchal plate; *Ph*, phalanges; *Ppl*, pleural plate; *R*, radius; *U*, ulna; *Xiphi*, xiphiplastron; *sc. pl*, pleural shield.

nuchal plate, the foremost part of the series of neural plates, behind which part of the vertebral column is visible, the eight pleural plates of the left and remnants of most of the pleural plates of the right half of the carapax. Peripheral plates are completely lacking, which might be due to post-mortem damage to the specimen, and if not, eventually to its juvenile state.

The outline of the carapax cannot be reconstructed with certainty, but is probably more like that in the type specimen of *G. knorri* than in the "*ovata*" specimen of this species (cf. ZANGERL 1958, text-fig. 9–10).

Of the plastron, the greater part of which is hidden beneath the carapax,

parts of the left hypoplastron, the whole of the left xiphiplastron, and remnants of an ossification which might represent the left hyoplastron, are visible. A reconstruction of the complete plastron cannot be carried out without a further preparation of the specimen, which undoubtedly would endanger the remnants of the carapax.

Those parts of the carapax and the plastron which can be examined at present show good agreement with the corresponding structures in *G. knorri*, apart from the foremost neural plate, which in the Færkerhede specimen is relatively much larger than in *G. knorri*.

The external faces of the elements of the carapax present an extremely delicate ornamentation of short grooves as seen in pl. 6, fig. 2, but no traces of impressions of the covering of horny shields. However, remnants of the horny shields themselves, are present on the right half of the specimen situated above the distal ends of the pleural plates and ribs. These horny shields are preserved as a dark substance, which by weathering attains a lighter grey hue. Judging from their relations to the elements of the carapax the horny shields preserved are pleural shields, and as far as can be made out their number is four or perhaps even five.

The right half of the specimens is fractured lengthwise in such a way that a section through some of the ribs and of the overlying horny shields can be studied. On this section (pl. 5, fig. 1) we observe a thin dark line extending beneath and between the ribs in such a way that it must be interpreted as the inner layers of the soft body wall.

Of the skull no remnants are found, but of the left paddle a number of still articulated elements are preserved as clear impressions, viz. the ulna, the radius, the carpals, the metacarpals, and the proximal phalanges. The relation between the length of the metacarpals and the length of the ulna and radius are about the same as in *G. knorri*, a point of importance, as *G. knorri* as to the relative length of the elements of the skeleton of the paddle according to ZANGERL (1958, pp. 21–24, text-fig. 13, 15) differs markedly from the recent Cheloniids.

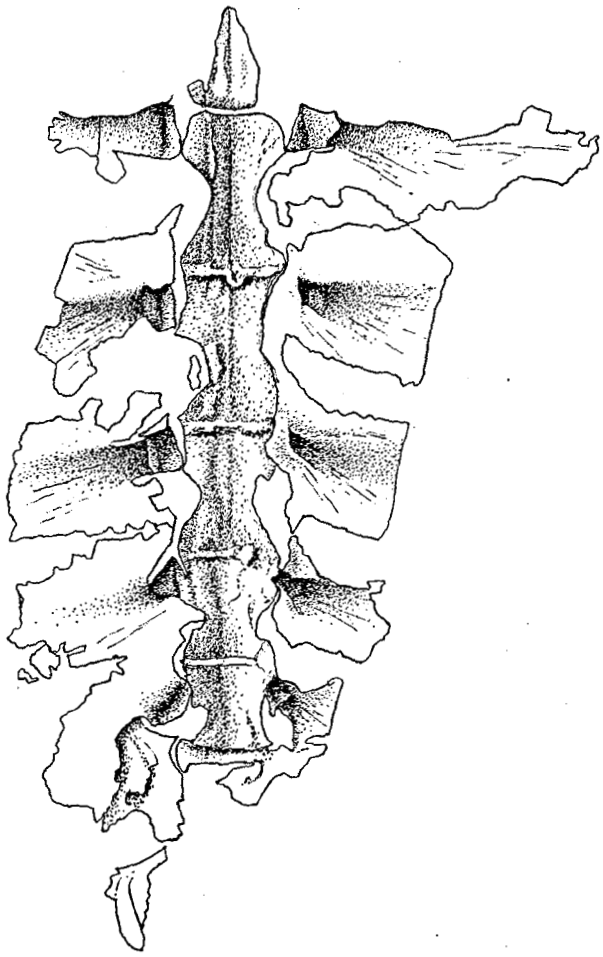
Unidentified turtle (Cheloniid?)

(Text-fig. 6; pl. 6, fig. 1)

Material and localities: The material comprises part of an articulated skeleton preserved as a cast on a piece of mo clay from an unknown locality.

Description.—The specimen shows six dorsal vertebrae still forming an articulated series and also articulating with the combined ribs and pleurals on both sides. All the elements are preserved as impression of their ventral faces only.

Apart from the foremost one the impressions of the vertebrae give their complete outlines, but of the ribs and pleurals the impressions only comprise their proximal parts, and have moreover suffered so much damage,



Text-fig. 6.
Unindentified turtle (Cheloniid?). Impression of ventral faces of remnants of vertetral column, ribs and pleural plates. (Ca. 1.4×).

that their original contours cannot be traced. It is therefore impossible to ascertain if the carapax possessed fontanelles as in *Glarichelys* and other Cheloniids and although nothing definitely speaks against considering the remnants as those of a Cheloniid or even a large *Glarichelys*, the evidence is not sufficient to prove this point.

The only information gained by this incomplete specimen is that the fauna of the Mo Clay Formation includes a turtle with a carapax length of roughly 20 cm and thus, as to size, intermediate between the two better known specimens of turtles from this fauna, described in this paper as *Eosphargis breineri* n. sp. and *Glarichelys* sp., respectively.

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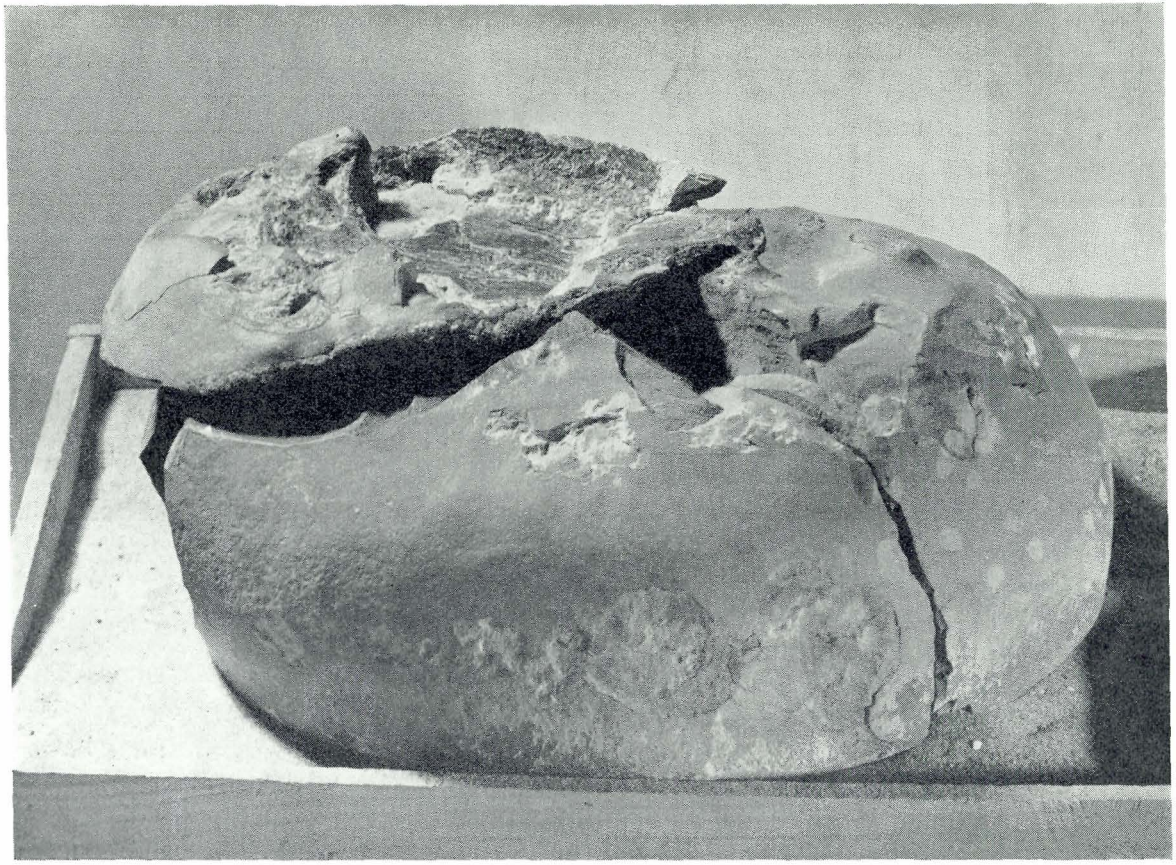


Plate 1. *Eosphargis breineri* n. sp. Skull and smaller parts of the skeleton in situ in the two fused nodules of cement stone. (Ca. 0.4×).

Plate 2.

Eosphargis breineri n. sp. Dorsal view of the skull. (Ca. 0.7×).

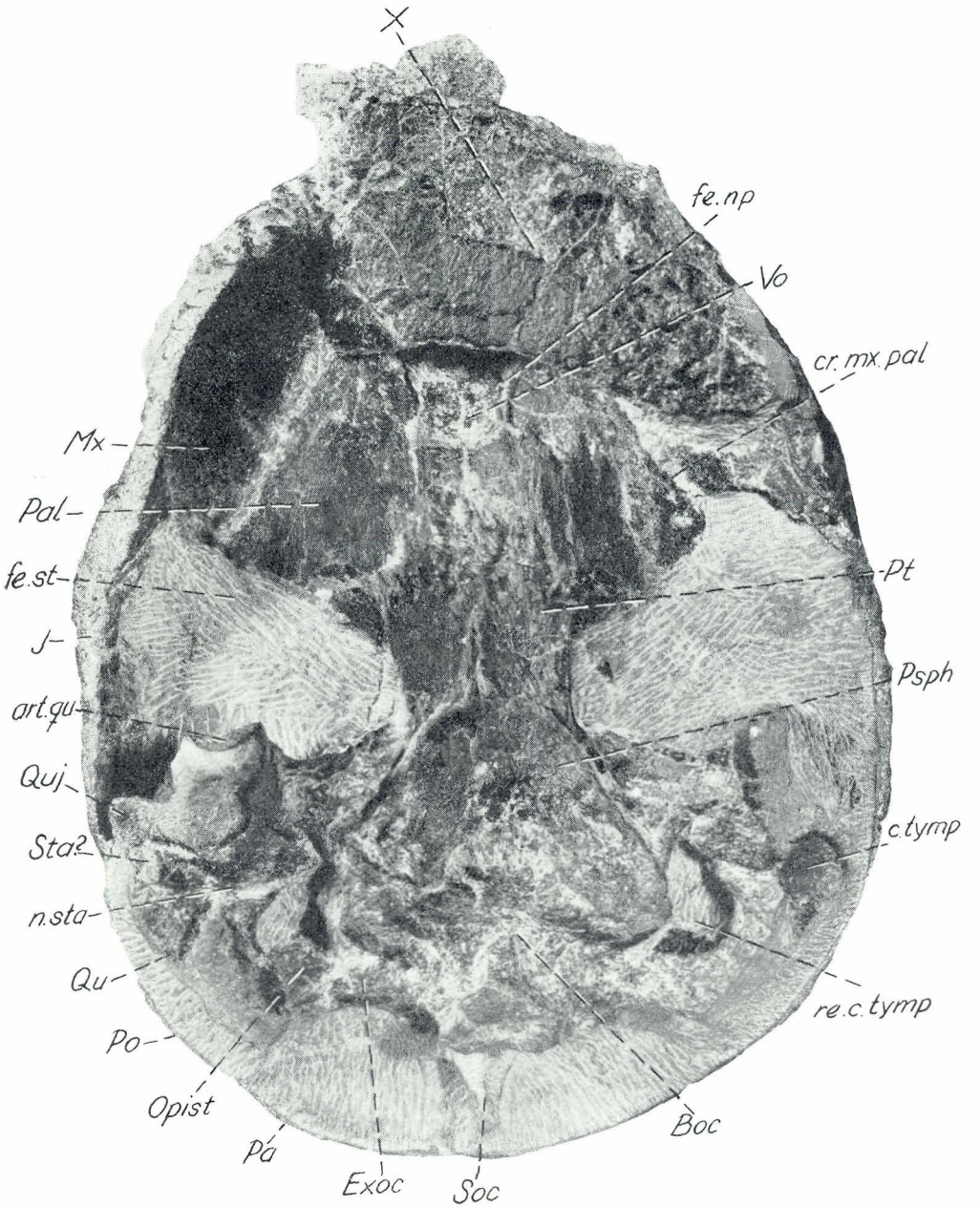
Fr, frontal; *J*, jugal; *Mx*, maxillary; *Pa*, parietal; *Pfr*, prefrontal; *Pmx*, premaxillary; *Po*, postorbital; *Sq*?, possibly part of squamosal; *X*, unidentified ossification.


Pmx
X
Mx
Pfr
J
Fr
Po
Pa
Sq?

Plate 3.

Eosphargis breineri n. sp. Palatal view of the skull, the foremost part of which is hidden beneath a large unidentified plate of bone, possibly belonging to the carapax. (Ca. 0.7×).

Boc, basioccipital; *Exoc*, exoccipital; *J*, jugal; *Mx*, maxillary; *Opist*, opistotic; *Pa*, parietal; *Pal*, palatine; *Pmx*, premaxillary; *Po*, postorbital; *Psph*, parasphenoid; *Pt*, pteryoid; *Qu*, quadrate; *Quj*, quadratojugal; *Soc*, supraoccipital; *Sta*?, possibly part of stapes; *Vo*, vomer; *art. qu*, articular facet of quadrate; *c. tymp*, cavum tympani; *cr. mx. pal*, maxillary-palatine edge; *fe. st*, fenestra subtemporalis; *fe. np*, fenestra naso-palatinus; *n. sta*, stapedial notch; *re. c, tymp*, recessus cavum tympani; *X*, unidentified ossification.


X
fe.np
Vo
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n.sta
Qu
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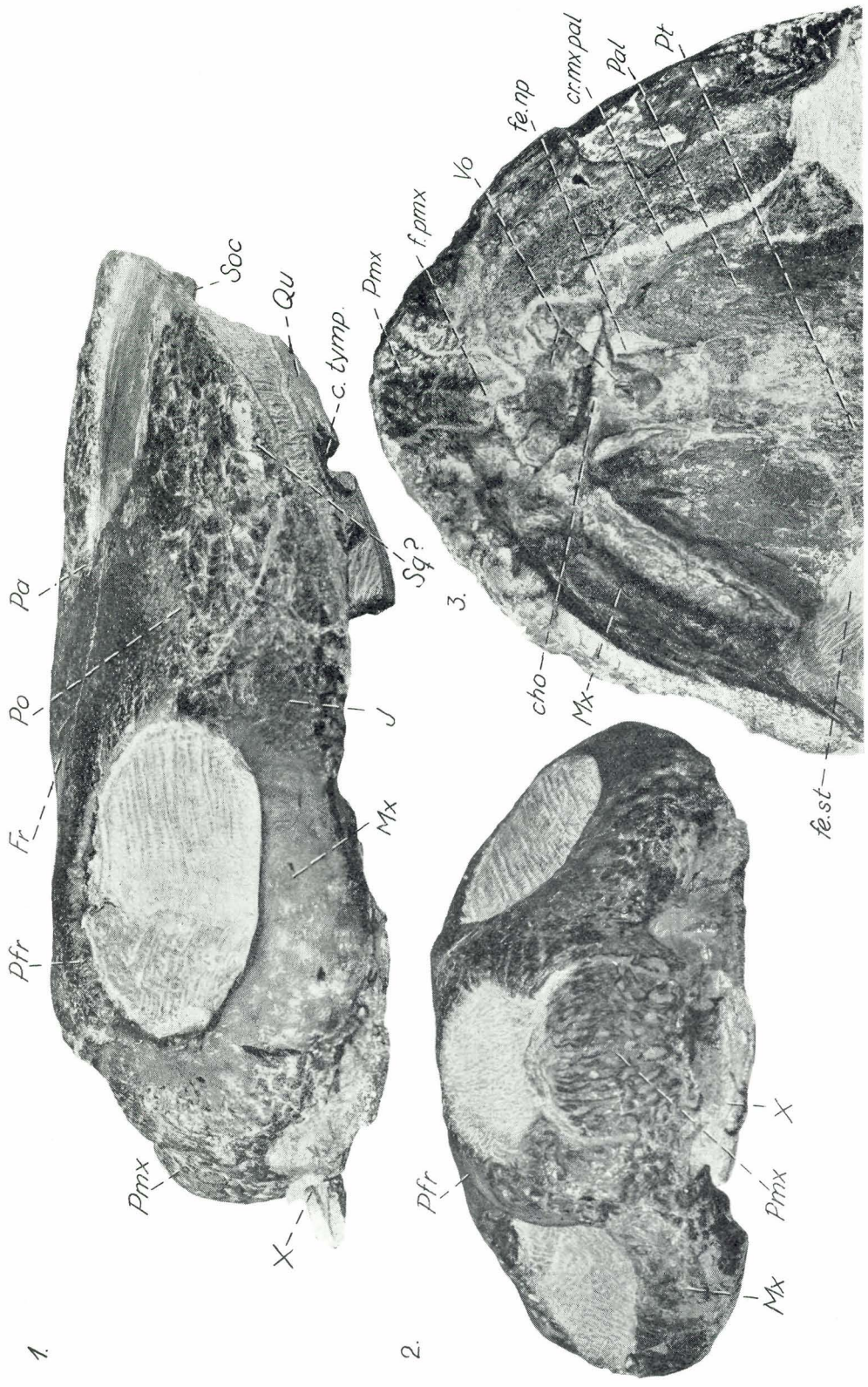
Exoc
Soc
Boc
re.c.tymp
c.tymp
Psph
Pt

Plate 4.

Fig. 1: *Eosphargis breineri* n. sp. Lateral view of the skull. (Ca. 0.7×).
– 2: *Eosphargis breineri* n. sp. Anterior view of the skull. (Ca. 0.7×).
– 3: *Eosphargis breineri* n. sp. Palatal view of the anterior part of the skull. (Ca. 0.7×).

Fr, frontal; *J*, jugal; *Mx*, maxillary; *Pa*, parietal; *Pal*, palatine; *Pfr*, prefrontal; *Pmx*, premaxillary; *Po*, postorbital; *Psph*, parasphenoid; *Pt*, pterygoid; *Qu*, quadrate; *Soc*, supraoccipital, *Sq*?, possibly part of squamosal; *Vo*, vomer; *X*, unidentified ossification; *c. tymp*, cavum tympani; *cho*, choana; *cr. mx. pal*, maxillary-palatine edge; *fe. np*, fenestra naso-palatinus; *fe. st*, fenestra subtemporalis; *f. pmx*, opening between the premaxillaries.


1.
Soc
Qu
c. tymp.
Sq?
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f.pmx
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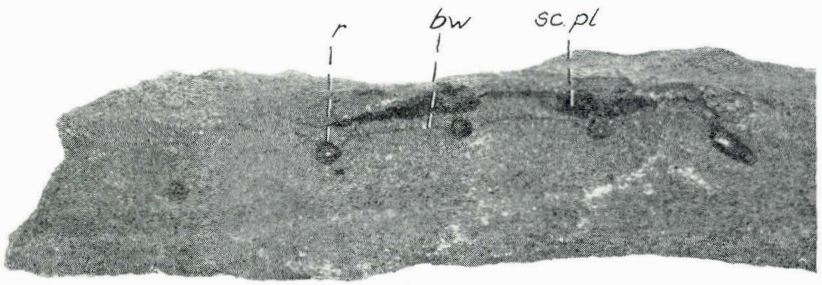
Plate 5.

Fig. 1: *Glarichelys* sp. Sagittal section through the dorsal part of the body wall. (Ca. 1.5×).

– 2: *Glarichelys* sp. Incomplete skeleton in mainly dorsal view. (Ca. 1.0×).

C, centrum; *Hy*?, possibly part of hypoplastron; *Hyp*, hypoplastron; *N. pl*, foremost neural plate; *Nu*, nuchal plate; *P. pl*, pleural plate; *Xiphi*, Xiphiplastron; *bw*, inner layers of body wall; *r*, rib; *sc. pl*, pleural shield.

1.



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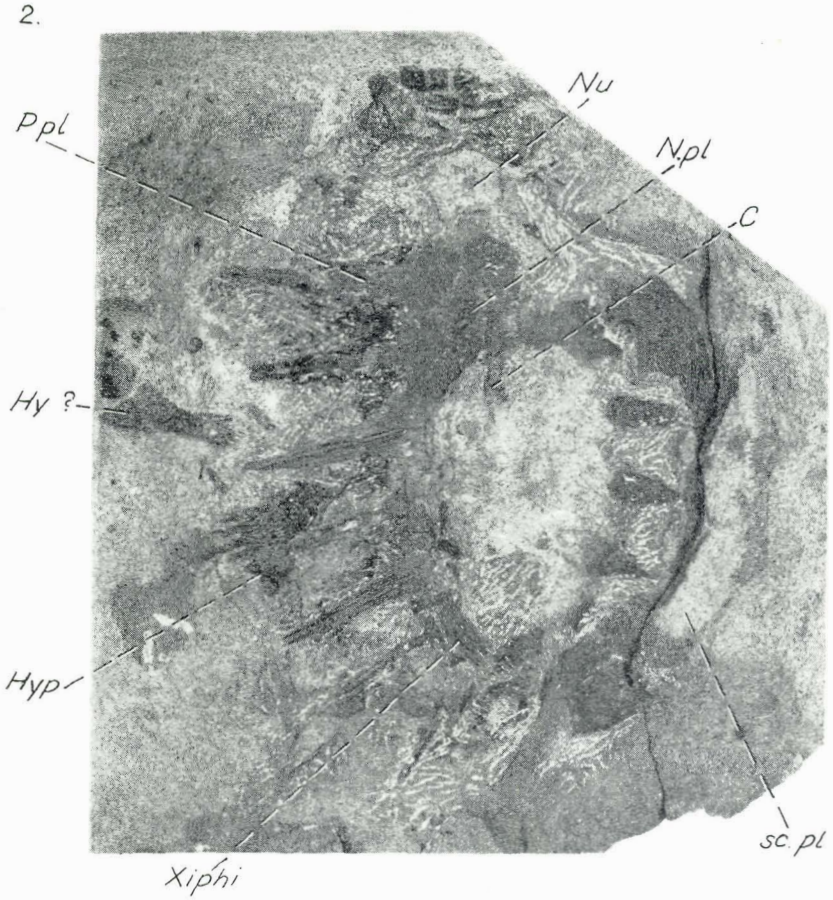

Plate 6.

Fig. 1: Unidentified turtle (Cheloniid?). Impression of ventral faces of remnants of vertebral column, ribs and pleural plates. (ca. 1,1x).

– 2: *Glarichelys* sp. Part of the left paddle and of the carapax of the skeleton shown in pl. 5, fig. 2. (ca. 1,5x).

Ca, carpals; Mt_1, Mt_5, first and fifth metacarpal; *Ph*, phalanges; *R*, radius; *U*, ulna.

1.