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EOCENE LEATHERBACK TURTLE MATERIAL OF THE GENUS *EGYPTEMYS* (TESTUDINES: DERMOCHELYOIDEA) FROM DENMARK

[Restos del género de tortuga de cuero* Egyptemys *(Testudines: Dermochelyoidea) en el Eoceno de Dinamarca]

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RESUMEN: Se cita por primera vez el género de tortuga de cuero *Egyptemys* en las Formaciones Fur (Ypresiense inferior) y Lillebælt Clay (Ypresiense - Luteciense) del Eoceno de Dinamarca. Junto a ello se repasan los géneros y especies conocidos de tortugas de cuero en todo el mundo.

Palabras clave: Testudines, *Egyptemys*, Eoceno, Dinamarca.

ABSTRACT: The extinct leatherback turtle genus *Egyptemys* is reported for the first time from the Fur (lowermost Ypresian) and Lillebælt Clay (Ypresian-Lutetian)

formations of Denmark. In addition, a review of the known genera and species of leatherback turtles is given.

Key words: Testudines, *Egyptemys*, Eocene, Denmark.

INTRODUCTION

This paper is part of an ongoing collaboration to describe, revise and create a new checklist of the fossil turtles of Denmark. The present taxonomic and descriptive status the fossil turtle material from Denmark is at extremely different levels. Recently, the first Maastrichtian sea turtle remains were described from the white chalk of Stevns Klint (KARL & LINDOW, 2009). The turtle remains from the Palaeocene of Copenhagen (DAMES, 1894, 1897; ROSENKRANTZ, 1920, 1921, 1923) along with new soft shelled turtle material have recently been taxonomically revised and figured (KARL & LINDOW, in review). Descriptions are adequate for the Lower Eocene leatherback turtle material of *Eosphargis breineri* (NIELSEN, 1959, 1964), while new complete material from the Fur Formation was announced on-line recently. The material referred to the leatherback turtle *Psephophorus* from the Miocene Gram Clay Formation (ROSENKRANTZ, 1921; LINDOW, 2004) is currently under preparation and description. The youngest fossils are some shell remains of *Emys orbicularis* described by DEGERBÖL & KROG (1951). A survey of European fossil turtles is given by DE LAPPARENT DE BROIN (2001) and the distribution of sea turtles in Northwestern Europe is sketched by MOODY (1993).

FOSSIL LEATHERBACK TURTLE GENERA SO FAR DESCRIBED

A. ORIGINAL STAGE WITH THECAL SHELL

1. *Mesodermochelys* Hirayama & Chitoku, 1996; type species: *Mesodermochelys undulatus* Hirayama & Chitoku, 1996 (nearly all bone elements known, see also HIRAYAMA & CHITOKU, 1996).

B. SECOND STAGE WITH REDUCED THECAL SHELL

2. *Protosphargis* Capellini, 1884; type species: *Protosphargis veronensis* Capellini, 1884; syn. *Protosphargis capellini* Negri, 1893 (only thecal shell elements known with reduced epithecals), see KARL (2002).

C. TERTIARY STAGE WITH EPITHECAL SHELL (MOSAIC DERMAL OSSICLES)

I. With sculptured surface (hitherto only known from Africa)

3. *Arabemys* Tong, Buffetaut, Thomas, Roger, Halawani, Memesch & Lebret, 1999; type species: *Arabemys crassiscutata* Tong *et al.*, 1999 (only dermal ossicles known).

4. *Cosmochelys* Andrews, 1920; type species: *Cosmochelys dolloi* Andrews, 1920 (only dermal ossicles and ribs known).

II. Without sculptured surface (Cosmopolitan)

5. *Egyptemys* Wood, Johnson-Gove, Gaffney & Maley, 1996; type species: *Psephophorus eocaenus* Andrews, 1901 [redescription by KARL & TICHY, 2007; syn. *Psephophorus oregonensis* Packard, 1940, *Psephophorus terrypratchetti* Köhler, 1995] (humeri, dermal ossicles and ribs known).

6. *Natemys* Wood, Johnson-Gove, Gaffney & Maley, 1996, type species: *Natemys peruvianus* Wood, Johnson-Gove, Gaffney & Maley, 1996 (dermal ossicles known only). According to WOOD *et al.* (1996) "*Psephophorus*" *rupeliensis* Van Beneden, 1887 may be a separate genus, but it is from the Oligocene like *Natemys* and may be a member of the former taxon (humerus and ossicles known); or the synonym *Pseudosphargis* Dames, 1894, type species *Chelone ingens* Koenen, 1891 must be recognized as valid for all these (posterior skull remain known).

7. *Psephophorus* H. v. Meyer, 1847; type species: *Psephophorus polygonus* H. v. Meyer, 1847 [syn. *Psephophorus scaldii* Van Beneden, 1871, *Psephophorus calvertensis* Palmer, 1909, *Psephophorus pseudostracion* Gervais, 1849 (skull, trunks, girdles, extremities, dermal ossicles known).

D. RECENT STAGE WITH MOSTLY REDUCED EPITHECAL SHELL

8. *Dermochelys* Blainville, 1816; type species: *Dermochelys coriacea* (Linnaeus, 1766) (all bone elements known).

E. TERTIARY STAGE WITH EPITHECAL SHELL (BAR-LIKE DERMAL ELEMENTS)

9. *Eosphargis* Lydekker, 1889; type species: *Eosphargis gigas* (Owen, 1880), *Eosphargis breineri* Nielsen, 1959 (skull, trunks, girdles, extremities, dermal elements known).

10. *Maorichelys* Karl & Tichy, 2007; type species: *Maorichelys wiffenae* Karl & Tichy, 2007 (humerus known, referred to this genus by humerus morphology similar to *Eosphargis*) [According to GRANT-MACKIE *et al.* (in preparation) the name *Maorichelys wiffeni* is corrected to *Maorichelys wiffenae* Karl & Tichy, 2007. The corrected name retains the date and

authorship of the original, under Article 19.2 (ICZN, 1999) as a justified emendation].

The preserved materials of fossil leatherback turtles derive from different body areas and the basal are also different (DE LAPPARENT DE BROIN, 2001; KARL 2002; WOOD *et al.*, 1996). Figure 1 shows the stratigraphic distribution of the leatherback turtle remains described below.

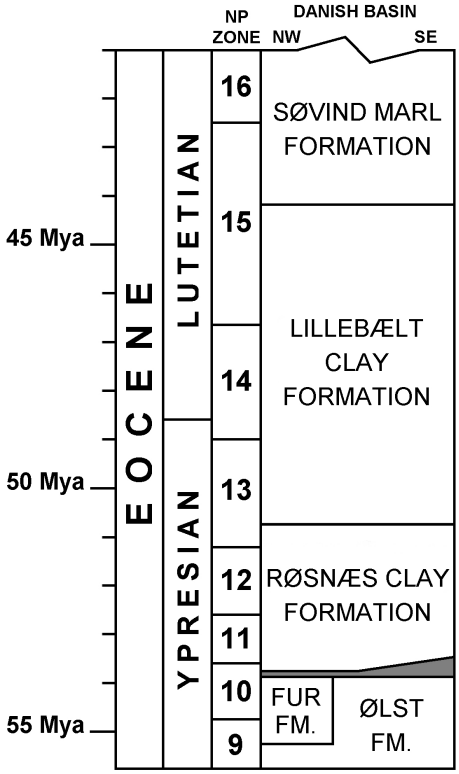

Figure 1. Stratigraphic column of the Danish Lower-Middle Eocene with the position of Lillebælt Clay Formation (after HEILMANN-CLAUSEN & SURLYK*, 2006).*

SYSTEMATIC PALAEONTOLOGY

Order Testudines Linnaeus, 1758 (Chelonii Brongniart, 1800; Latreille, 1800)

Infraorder Cryptodira Duméril & Bibron, 1835 [non Cope, 1871]

Family Dermochelyidae Gray, 1825

Genus *Egyptemys* Wood, Johnson-Gove, Gaffney & Maley, 1996

Egyptemys aff. *eocaenus* (Andrews, 1901)

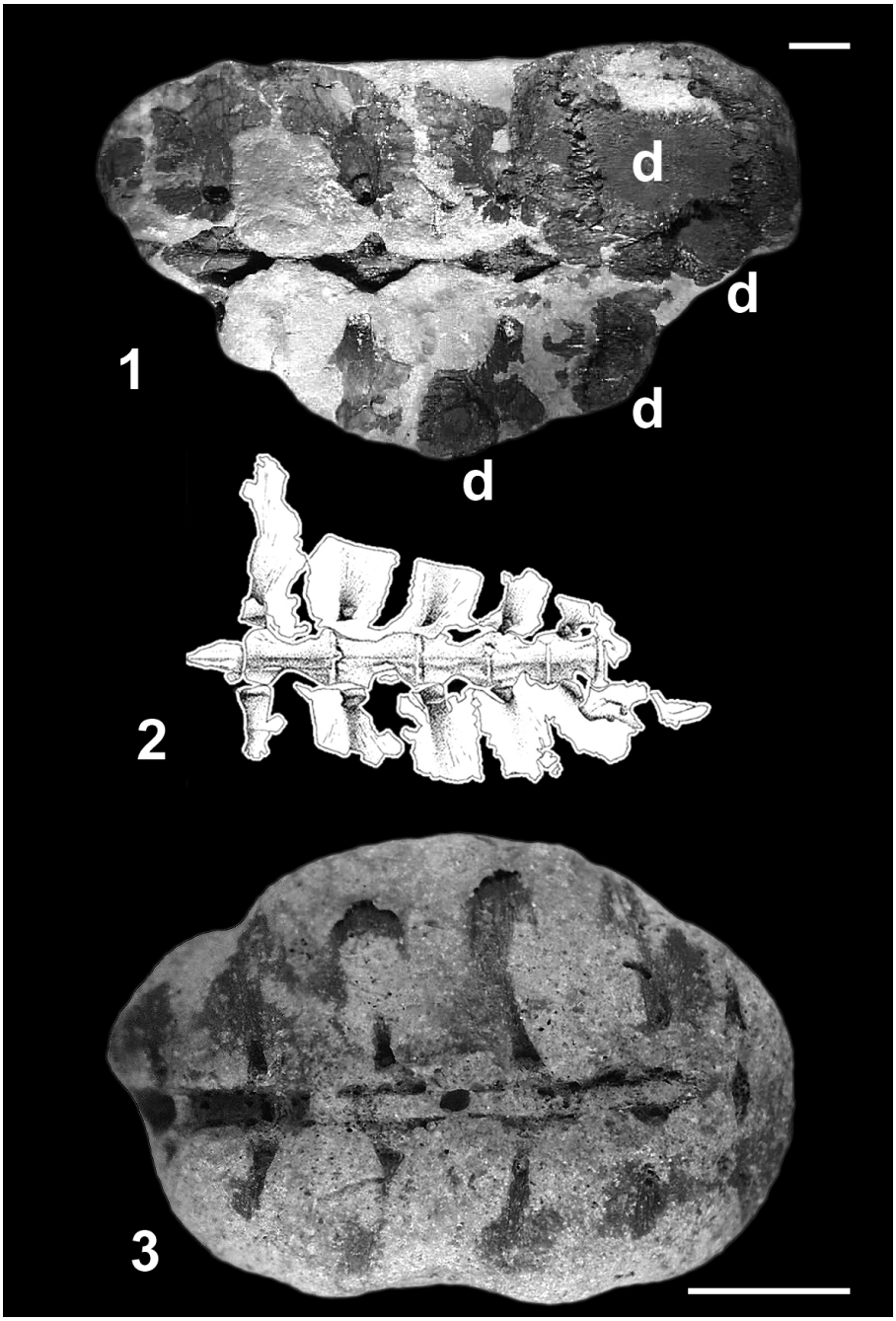

Plate 1. Egyptemys *aff*. eocaenus, *Steinkern, ribs, ossicles and trunk from the Danish Eocene, remarks see in text. Photos: Sten l Jakobsen, Copenhagen; Plate by Dirk Urban, Erfurt. Scale bar = 3cm.*

1. Cheloniid of NIELSEN (1959: Text-fig. 6 and plate 6: fig. 1): Partial vertebral column, ribs and pleural plates, locality unknown, Lower Eocene Fur Formation (lowermost Ypresian: BEYER *et al.*, 2001; CHAMBERS *et al.*, 2003). Currently in the collections of Fur Museum, Nederby, Fur, Denmark (plate 1, figure 2).

2. Steinkern with remains of ribs, vertebrae and ossicles, coast at Trelde Næs, Fredericia; Lower-Middle Eocene Lillebælt Clay Formation (Ypresian-Lutetian: (HEILMANN-CLAUSEN & SURLYK, 2006), leg. Mr. Søren Peter Andersen, collection number 1996 348 04, current whereabouts unknown (plate 1, figure 1).

3. Steinkern with remains of ribs and vertebrae, coast at Trelde Næs, Fredericia; Lower-Middle Eocene Lillebælt Clay Formation (Ypresian-Lutetian: HEILMANN-CLAUSEN & SURLYK, 2006), leg. Mr. John Skov, collection number JS0002 (plate 1, figure 3).

DESCRIPTION

Egyptemys may be the only Eocene genus of leatherbacks with mosaic dermal ossicles, unlike the bar-like epithecal shell of *Eosphargis*. The type species of *Egyptemys*, '*Psephophorus*' *eocaenus*, is based on a humerus. The material presented here is too poorly preserved for a comparison with ossicles or humeri. Only in the steinkern from the Lillebælt Clay Formation is one ossicle is preserved (plate 1, figure 1). The ossicles are much flatter than those of Neogene leatherback turtle taxa. Another important features are the widened and mostly unconnected ribs. WOOD *et al.* (1996: 267) gave further characters of the epithecal shell elements of *Egyptemys*: "Shell with at least five weakly-developed anteroposterior carapacial ridges; area between ridges flat or nearly so, with small number of ossicles (usually 1-2, occasionally 3) occupying areas between adjacent ridges; shell of fairly uniform thickness. Ridges semi-circular in cross-section and of essentially equal height above surrounding surfaces, except for middle ridge, which is slightly less prominent; ridges confined only to central portions of ossicles which they traverse; intervening distances between adjacent ridges somewhat variable; visceral surface of carapace smooth with no indication of ridges. Individual ossicles of carapace highly variable in size and irregular in shape; ossicles occupying intervals between ridges generally smaller than ossicles along ridges".

DISCUSSION

Material of the genus and only species of *Egyptemys* is hitherto known from Europe, Egypt, North America, New Zealand and Antarctica. In comparison to the distribution of Eocene whales, it is also possible that leatherbacks had a cosmopolitan distribution at the time.

From about the same time *Egyptemys* Wood *et al.*, 1996 (Late Eocene, northern Egypt, Eocene of Oregon, USA and Denmark) and *Natemys* Wood *et al.*, 1996 (Late Oligocene, southern coast of Peru) have been described. The genera *Eosphargis* (Eocene of England and Denmark) and *Maorichelys*

(Eocene of New Zealand) belong to a different evolutionary line. Albright *et al*. (2003) refers remains of Eocene leatherback turtles of a geologically very early onset of gigantothermy = homoiothermy in this group; presumably this was also the case for *Egyptemys*. The northern distribution of these turtles in the Danish subbasin may originate from a phase of climate change. The Lillebælt Clay Formation was deposited between 50 and 43 million years ago (Heilmann-Clausen & Surlyk, 2006), during the initial temperature drop after the Early Eocene Climatic Optimum (EECO). After this time, ocean temperatures have gradually cooled off, with later phases of global warming not reaching the heights of the EECO (Zachos *et al*., 2001). Based on the close correlation between the composition of membranous lipids of marine Crenarcheota and the average annual ocean surface temperature (TEX86-method), the surface temperature of the Arctic Ocean (at ~80° N) was estimated at 15 ± 1° C during the early Maastrichtian. In comparison, the yearly average surface air temperature at 80° N is around –15° C. On top of this was added the temperature increase of the Paleocene-Eocene Thermal Maximum (PETM), which lasted around 200.000 years around 55 million years ago. This resulted in a further increase of around 4-9° C in deep and surface ocean temperatures at lower and middle latitudes (f < 60° C) along with well-documented substantial changes in the marine and terrestrial biosphere (Zachos *et al*., 2001; Jenkins *et al*.; 2004, Moran *et al*.; 2006, Pagani *et al*., 2006; Sluijs *et al*., 2006). The drastic cooling of the oceans after these temperature peaks may well have been the determining impulse in the evolution of the Dermochelyidae.

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