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NEW FOSSIL REPTIL MATERIAL (REPTILIA: CHELONII, CROCODYLIA) FROM THE LOWER OLIGOCENE OF BORKEN (CENTRAL GERMANY: HESSE)

[Nuevo material reptiliano (Chelonii. Crocodylia) del Oligoceno inferior de Borken (Alemania Central: Hesse)]

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RESUMEN: Se describen tortugas fósiles del Oligoceno inferior de la cuenca de Borken, comparándolas con especies próximas de la misma edad. Se relata la historia de la investigación, paleogeografía y posición estratigráfica. Junto a los Trionychidae, Carettochelyidae y Testudinoidea figura el cocodrilo *Diplocynodon*.

Palabras clave: Testudines, Cryptodira, *Rafetoides austriacus* (Peters, 1858), *Allaeochelys parayrei* Noulet, 1867, Testudinoidea gen. et spec. indet., Crocodylia, *Diplocynodon* cf. *hantonensis*, Oligoceno inferior, Malanienton, cuenca de Hesse, Hesse, Alemania Central.

ABSTRACT: The fossil turtles and crocodiles from the marine Early Oligocene of the Borken basin are described and compared with related species of the same stratigraphical age. Additionally, an overview is given on the history of research, the palaeogeographic and stratigraphic situation as well as on the relationships of the species mentioned. Beside the known representatives of the Trionychidae, Carettochelyidae, Testudinoidea and *Diplocynodon* are described.

Key words: Testudines, Cryptodira, *Rafetoides austriacus* (Peters, 1858), *Allaeochelys parayrei* Noulet, 1867, Testudinoidea gen. et spec. indet., Crocodylia, *Diplocynodon* cf. *hantonensis*, Early Oligocene, Malanienton, Hessonian basin, Hesse, Central Germany.

INTRODUCTION

Remains of turtles are known from Eocene and Oligocene sediments in Borken for a rather long time. Some new taxa of turtles are described from here. The opinions concerning the validity of these taxa were already unclear and controverse discussed in time.

The new material would give a more complete picture of the turtle fauna of Borken.

The first materials of fossil turtles from the Early Oligocene of Borken were described from the lower Rupelian leyers called as "Melanian Clay" = Melanienton by GRAMANN (1956). The taxa *Anosteira crassesculpta* Harrassowitz, 1922 and *Trionyx (Amyda) borkenensis* Gramann, 1956 are described from the site of Gombeth (GRAMANN, 1956). SCHLEICH (1986) refers further remains to *Trionyx* aff. *borkenensis* Gramann, 1956, "*Anosteira*" aff. *crassesculpta* Harrassowitz, 1922 and Crocodylia indet. Other materials were discovered in 1984 and 1987 within the middle Eocene Lignite horizon of the open pit "Untertagebau Stolzenbach" during the development of the brown coal digging in the Borken area. From here SCHLEICH (1994) described the new emydid turtle taxa *Palaeoemys hessiaca* and *Borkenia oschkinisi* with too pure diagnoses; the material is deposited in the collection of the Kassel Natural History Museum, department Borken. After comparison with other materials from Europe, HERVET (2003) recognized that taxa as valid. This is followed preliminary in the present article.

PALAEOGEOGRAPHY AND STRATIGRAPHY

The whole Melanienton of Borken is of upper Priabonian age and is to be looked as about immediately to age with the marine Latdorfian layers of Central Germany, e. g. Weisselster basin (KARL, 2007). The progressive transgression in the Hessian depression in this late Priabonian cycle is readable in the Borkenian profile in the increasingly marine character of the fauna of the recumbent at the slope end. The horizons A and B counted up to now as continuous limnic. Nevertheless, in the fish fauna the first marine influencing in the horizon lets itself already ascertain B, among other things with episodic appearance by clupeid otolithes (MÜLLER, in prep.). The whole tetrapod remains come from explanations on the eastern side of the open pit Altenburg IV (figure 1). Partial profiles of the Melanienton have been accessible there in several points in larger slides, in particular in the sites 1 and 3 in fig. 2. The material comes completely from the deeper Melanienton (limnic zone, horizon B 1, see figure 3). Nevertheless, because of the very disturbed relations no more continuous profile could be provided in the locality 1. Nevertheless, in point 3 several partial profiles have been taken up, although also here stronger by slides disturbed. The localities 2 and 4 are interesting only by the fish fauna (MÜLLER, in prep.).

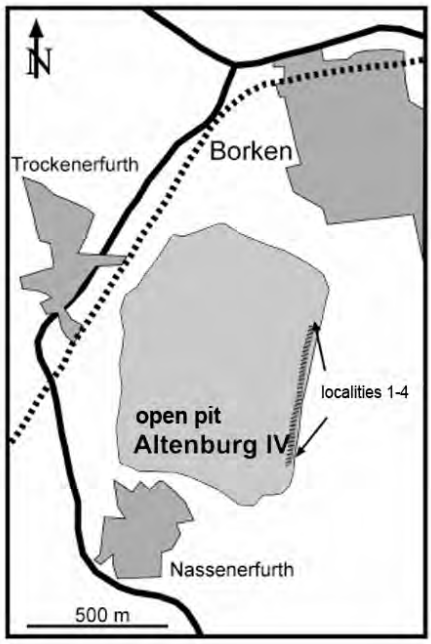

Figure 1. Distributional map of the Melanianton near Borken (Hesse, Germany).

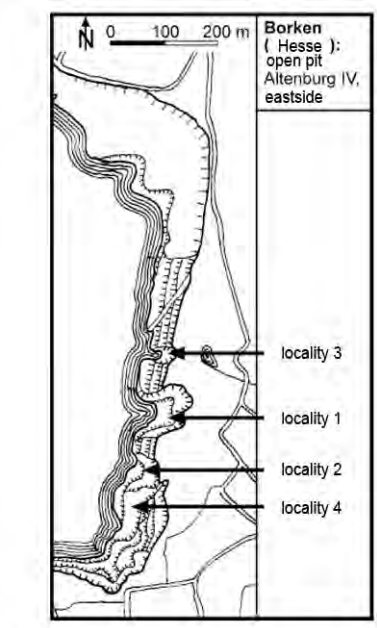

Figure 2. Position of localities into the old open pit Borken Altenburg IV.

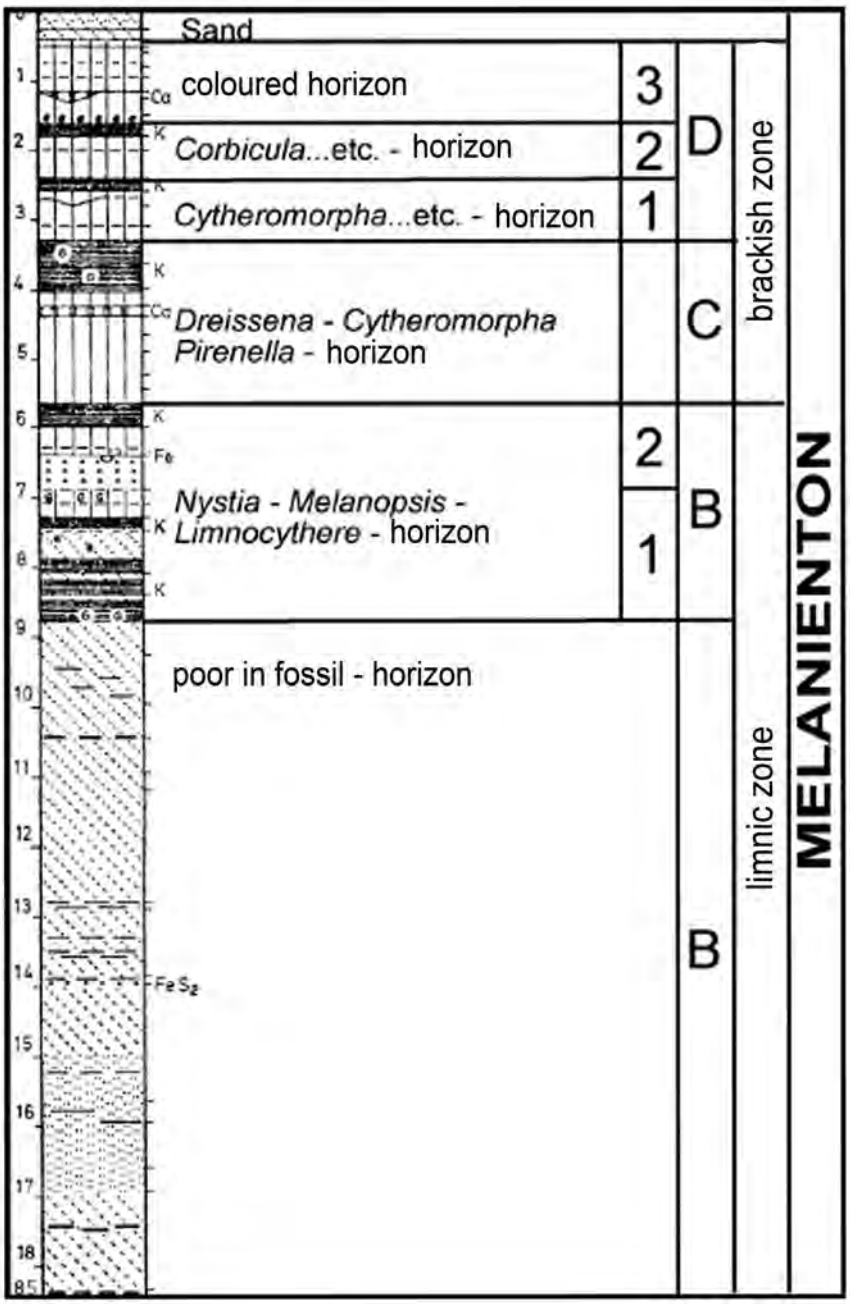

Figure 3. More precise position of the worked on fossil sites in the eastern Steilböschung of the open pit Altenburg IV. Locality 1 (big slide) is the main finding point of the tetrapod remains (layer B1). From the locality 3 (layer B2) there comes only lesser material.

TERMINOLOGY

Figure 4 shows the schematic reconstruction of carapace and plastron of testudine turtles (e. g. *Testudo* according to Karl Staesche [adapted]. Without scale.

Carapace plates: nuchal = nu, neurals = n I to n VIII, pleurals = pl I to VIII, peripherals = pe I to pe XI, metaneurals = mn I to II, pygal = py.

Carapace scutes: cervical = ce, centrals = c 1 to c 5, laterals = l 1 to l4, caudal = ca.

Plastron plates: epiplastrals = epi, entoplastron = ento, hyoplastron = hyo, hypoplastron = hypo, xiphiplastron = xiphi.

Plastron scutes: gulars = gu, humeral = hu, pectorals = pec, abdominals = ab, femorals = fe, annals = an.

Figure 5 shows the schematic reconstruction of carapace and plastron of trionychine turtles (e. g. *Pelodiscus sinensis* [Wiegmann, 1835] according to KARL [1998]). Without scale.

Carapace plates: N I to N VII = neurals I to VII, Nu = Nuchal, Pl I to Pl VIII = pleurals I to VIII, C I to C VIII = costae I to VIII, Fp = postnuchal foramina.

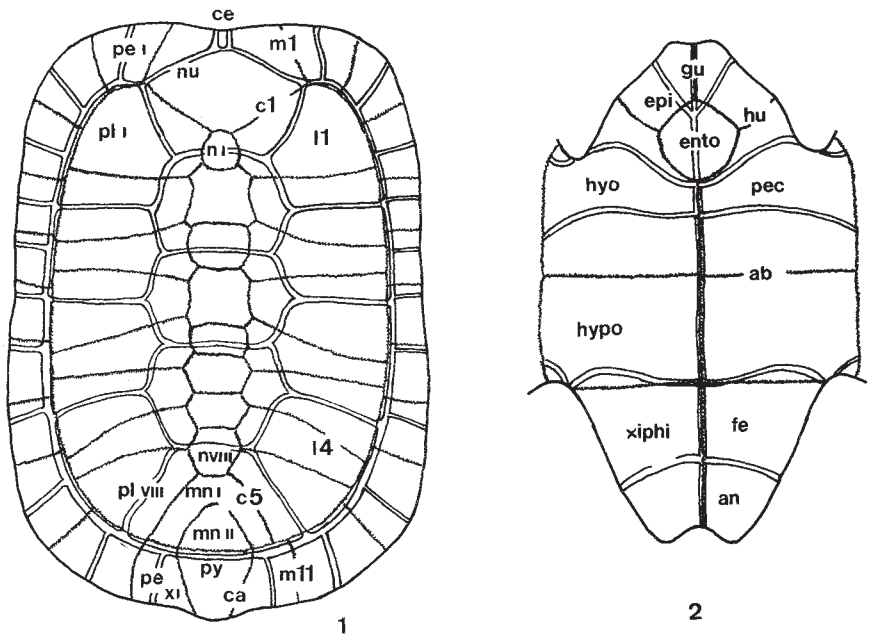

Figure 4. General terminology of a turtle shell, remarks: see in the text.

Plastron plates: Epi = epiplastrons, Ento = entoplastron, Hyo = hyoplastrons, Hypo = hypolpastrons, Xiphi = xiphiplastrons.

In figure 6 the schematic reconstruction of the plastron of trionychine turtles (e. g. *Amyda cartilaginea* [Boddaert, 1770] according to KARL [1998]) is shown. Without scale.

1 = Processus epiplastralis anterior, 2 = Processus epiplastralis posterior, 3 = Processus entoplastralis dexter, 4 = Processus entoplastralis sinister, 5 = Processus hyoplastrales media, 6 = Processus cardinus masculi anterior, 7 = Processus cardinus masculi posterior, 8 = Processus hypoplastralis medialis anterior, 9 = Processus hypoplastralis medialis posterior, 10 = Processus xiphiplastrales media, 11 = Processus xiphiplastrales anterior; I = Level of the Suturae hyohypoplastrales, II = Level of the Processus hypoplastrales media anterior, III = Level of the Processus epiplastrales posterior.

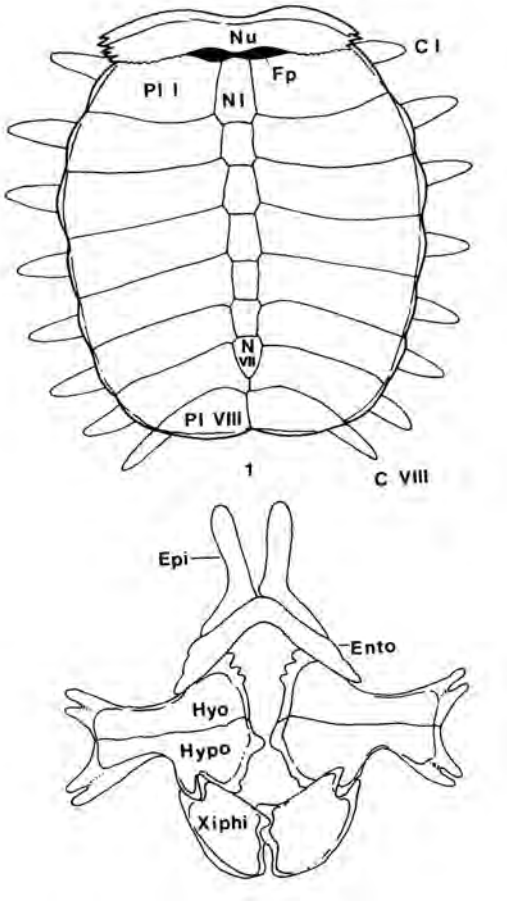

Figure 5. General terminology of the trionychid shell, remarks: see in the text.

SYSTEMATIC PALAEONTOLOGY

Order Chelonii Brongniart, 1800 (Latreille, 1800)

Infraorder Cryptodira Cope, 1868

Suprafamily Trionychoidea Fitzinger, 1826

Family Trionychidae Fitzinger, 1826

Subfamily Trionychinae Fitzinger, 1826

Tribe Trionychini Fitzinger, 1826

Subtribe Rafetoidina Karl, 1998

Genus *Rafetoides* Karl, 1998

***Rafetoides austriacus* (Peters, 1858)**

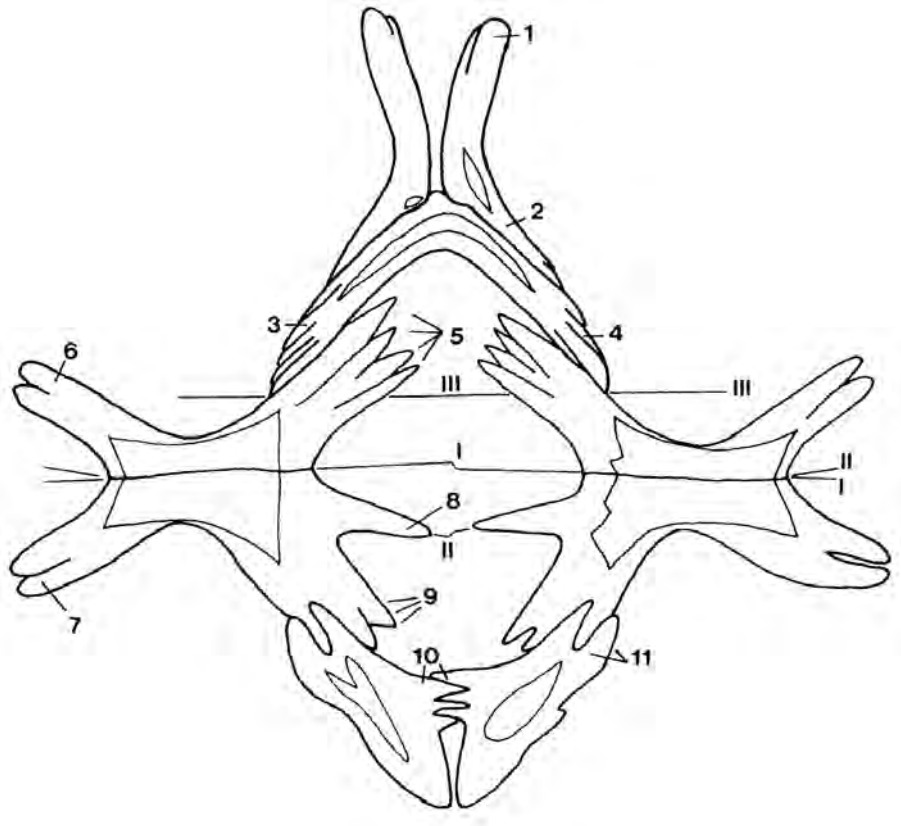

Figure 6. Terminology of the trionychid plastron, remarks: see in the text.

Synonyms:

- *Trionyx (Amyda) borkenensis* n. sp., GRAMANN, 1956: 17, Taf. 3, figs. 1-2;

- *Trionyx borkensis* Gramann, 1956, KUHN, 1964: 188 [ex errore *borkenensis*];

- *Trionyx* aff. *borkenensis* Gramann, 1956, SCHLEICH, 1986: 283;

- ?*Trionyx* sp., SCHLEICH, 1994: 93, pl. III, figs. 2-4;

- *Rafetoides austriacus* (Peters, 1858), KARL, 1999: supplement 1, fig. 10, point 5;

- *Rafetoides austriacus* (Peters, 1858), KARL, 2007: 34.

Known distribution of species: Early Eocene of Spain, France, Belgium, Italy, Austria, Germany, Hungary, Romania, Slovenia and many other European localities up to the lower layers of Rupelian (KARL, 1999, 2007).

Description: Ornament flat tesselat to knoblike with elated bulges in C/IV according to KARL (1998); both, processus cardinus masculi anterior and processus cardinus masculi posterior in pairs, multiple buildings of these are known.

Remarks: According to KARL (1997, 1998, 1999, 2007), due to present knowledge, only two species of the Trionychinae, each of it representing a separate genus, seem to have existed in the Paleogene of Central Europe. *Rafetoides austriacus* (Peters, 1858) is typical for the Eocene to the Early Oligocene in southeastern Europe. The most important synonym is *Trionyx messelianus* Reinach, 1900. GRAMANN's (1956) species *Trionyx (Amyda) borkenensis* from the early Oligocene "Melanienton" of Borken (Lower Hesse) is a synonym of the present species also, present up to the underlayer of Rupelian. Up from the late Early Oligocene (Rupelian), only *Trionyx triunguis* Forskål, 1775 is recorded. Its most important synonym for the Rupelian/Oligocene (Meeressand of Alzey) of Germany is *Trionyx boulengeri* Reinach, 1900. The most important synonym for the Chattian/ Oligocene (Trbovlje/Trifail in Slovenia formerly Southern Styria) south of the Alps is *Trionyx stadleri* Teppner, 1913. Beside the presence of, in particular, high vertical structures in the ornament like in *Rafetoides* Karl, 1998 are typical. *Trionyx* differs clearly by only one processus cardinus masculi anterior, whereas in *Rafetoides* and *Amyda* Geoffroy Saint Hillaire, 1809 it is commonly paired. The ornament characters of the present discus material PMLU HS 406a is related to the type of *Trionyx planus* Owen, 1849, it is a synonym of *Rafetoides henrici* (Owen, 1849) the type species of the present genus.

References/material: Borken: PMUL: HS 406 - nearly complete pleurals VII and VIII sin. (plate 1, figures 1-2); PMUL HS 407c-d-A10.02.07, two single pleural remains of different specimens in various age; PMUL HS 373-A10.02.03, one complete femor (length 40 mm, breadth prox. 14,5 mm, breadth dist. 9,5 mm).

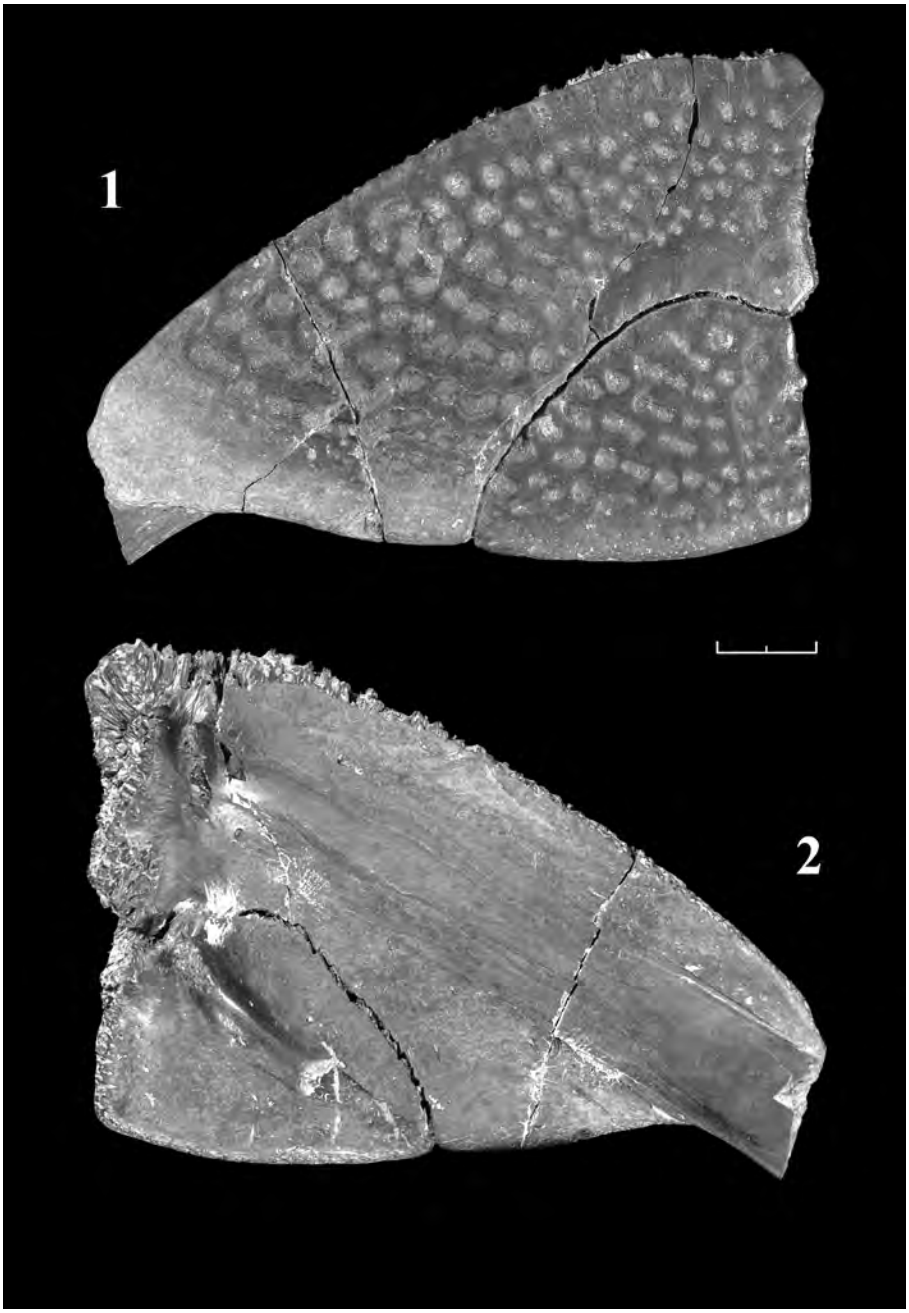

Plate 1. Rafetoides austriacus *(Peters, 1858), PMUL: HS 406 - nearly complete pleurals VII and VIII sin.; scale 1 cm.*

Family Carettochelyidae Boulenger, 1887

Subfamily Carettochelyinae Boulenger, 1887

Genus *Allaeochelys* Noulet, 1867

Allaeochelys parayrei Noulet, 1867

Synonyms:

- *Anosteira crassesculpta* Harrassowitz, 1922, GRAMANN, 1956: 18;

- *Anosteira crassesculpta* = *gracilis* Harrassowitz, 1922, KUHN, 1964: 181;

- "*Anosteira*" aff. *crassesculpta* Harrassowitz, 1922, SCHLEICH, 1986: 285;

- *Allaeochelys parayrei* Noulet, 1867 (syn. *Anosteira crassesculpta* et *gracilis* Harrassowitz, 1922), KARL, GRÖNING & BRAUCKMANN, 2006: 51-57;

- *Allaeochelys* Noulet, 1867 (syn. *Anosteira crassesculpta* Harrassowitz, 1922), KARL, 2007: 61.

Known distribution of the genus: Early Eocene to the late middle Eocene of Spain, England, Belgium, France and Germany. The only specimen hitherto known from the late Oligocene (Chattian: early "Eochattttian") from clay pit in the Elbe-bank near Steutz, approximately 12 km WNW Dessau, Sachsen-Anhalt in central Germany is described by KARL, GRÖNING & BRAUCKMANN (2006). JOYCE *et al.* (2004) described a related single peripheral plate from the Middle Miocene (MN 5) of the Hambach pit W of Cologne, western Germany.

Description: Ornament flat tesselat to knoblike without elated bulges in C/IV according to KARL (1998); bridge strong ossified, fontanelles absent, posterior part of carapace sharp carinate; sulci absent; usually six neurals present. The ornament of the shell varies both individually and ontogenetically.

Remarks: A survey of the genus is given by KARL, GRÖNING & BRAUCKMANN (2006). The most remarkable fossil of the present sample are the fused phalanges PMUL HS 326. This condition used HARRASSOWITZ (1922) for founding his *Anosteira gracilis* from the Messel shale. We can not interpreting that before present better material.

References/material: PMUL HS 385b-A10.02.04, one proximate pleural VI or VII remain dex. post. Connect to a alternate pleural at midline; PMUL HS 407a-b-A10.02.07, one nearly complete single peripheral plate from the posterolateral border (plate 2, figures 8-9) and one xiphiplastral remain sin.; PMUL HS 388-A10.02.05, one pleural remain; PMUL HS 372-A10.02.03, one complete posterior pleural dex. (plate 2, figures 3-4) and one peripheral sin. between the bridge butresses. Incerta: PMUL HS 327-A10.02.01, one metatarsus (length 21 mm); PMUL HS 328-A10.02.01, one phalanx (22,5 mm) ans one single claw phalanx (length 15,5 mm); PMUL HS 326-A10.02.01, phalanx I and II fused by synosteosis to a unit (complete length 28,5 mm, phalanx I 16,5 mm) (plate 2, figures 5-7); PMLU HS 368-A10.02.03, some

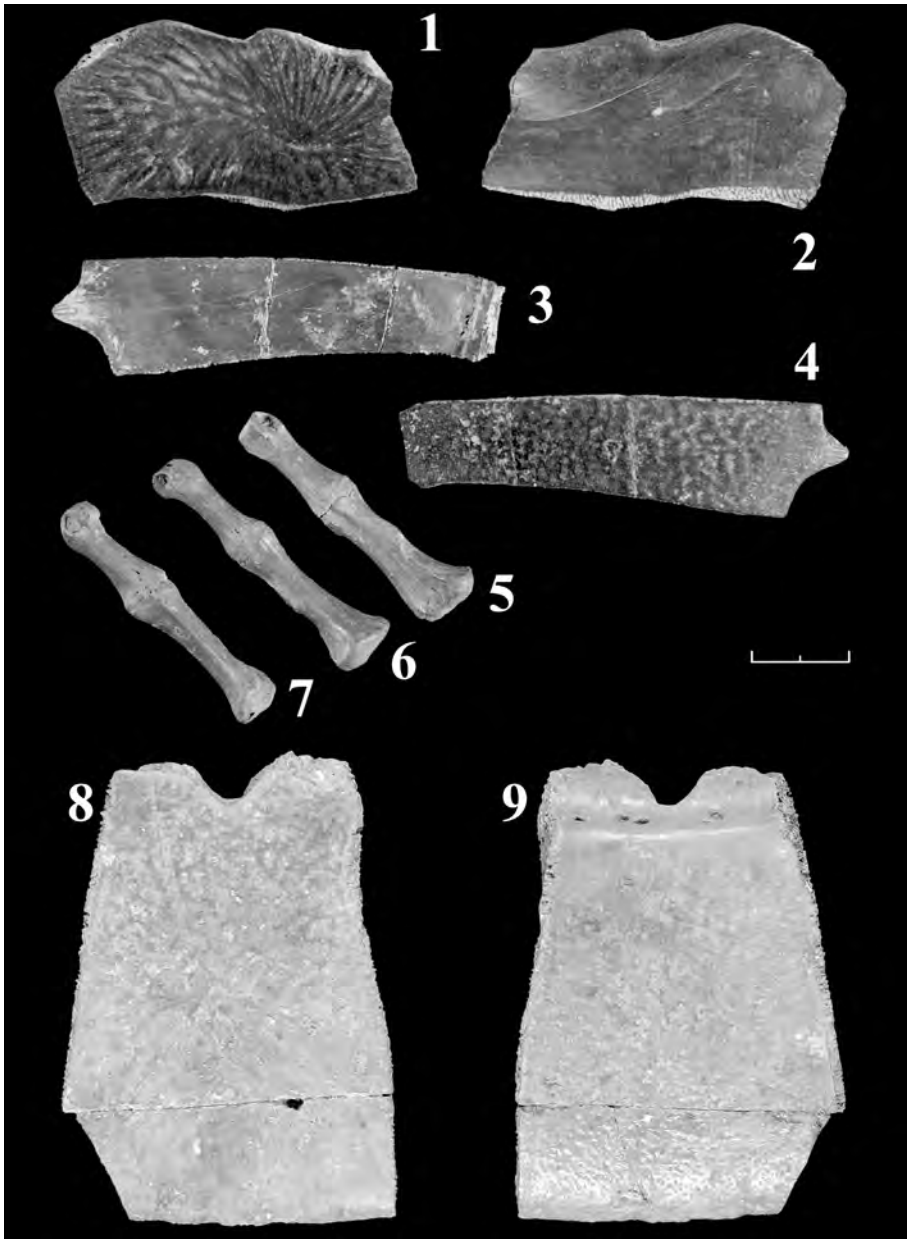

Plate 2. Allaeochelys parayrei *Noulet, 1867, PMLU HS 368-A10.02.03 complete pleural I dex.- figure 1 dorsal, figure 2 visceral; PMUL HS 372-A10.02.03 complete posterior pleural dex.- figure 3 visceral, figure 4 dorsal; PMUL HS 326-A10.02.01, phalanx I and II fused by synosteosis to a unit- figure 5 plantar, figure 6 dorsolateral sin., figure 7 lateroplantar dex.; PMUL HS 407a-b-A10.02.07, nearly complete single peripheral plate from the posterolateral border- figure 8 dorsal, figure 9 visceral.*

shell fragments o a very young specimen including a complete pleural I dex. (plate 2, figures 1-2); PMLU HS 374-A10.02.03, one nearly complete humerus dex. (length 29,5 mm, breadth prox. 10 mm, breadth dist 8 mm).

Superfamily Testudinoidea Batsch, 1788

Family Emydidae Gray, 1855

Genus *Borkenia* Schleich, 1994

Borkenia oschkinisi Schleich, 1994

Synonyms:

- *Borkenia oschkinisi* nov. gen., nov. spec., SCHLEICH, 1994: 87, pl. II, fig. 2a-b, figs. 4-5;

- *Borkenia oschkinisi* Schleich, 1994, HERVET, 2003: 623.

Known distribution: First appearance in the Middle Eocene of Lignite mine at Stolzenbach/Borken, Hesse, hitherto known from here only.

Description: The most characteristic shell element in the present material is the entoplastron HS 407e. It is much broader than long (1,5 time). The visceral surface show characteristic muscle insertions which are clearly differs to that of *Palaeoemys hessiaca* Schleich, 1994 with the same type locality like the present species. The gular sulci not connect the anterior borders of the plate, but the humeropectoral sulci partly crossing the posterior border.

Remarks: The taxonomic relations between the European genera *Mauremys*, *Ocadia* and *Palaeochelys* are still unclear. However, further taxa was described, based on characters with high individual and ontogenetic variability (KARL & TICHY, 2004).

References/material: PMUL HS 407e-A10.02.07, nearly complete entoplastron, right wing broken (plate 3, figures 1-2); PMUL HS 406b-A10.02.07, nearly complete peripheral VII sin. with the insertion of inguinal buttress (plate 3, figures 3-4); PMUL HS 384a-c-A10.02.04, three hyo or hypoplastron remains from the bridge region; PMUL HS 387a-c-A10.02.04, two pleural remains, one peripheral plate lost the marginal border; PMUL HS 385a-A10.02.04, one hexagonal neural 6A broader than long (1,6 time).

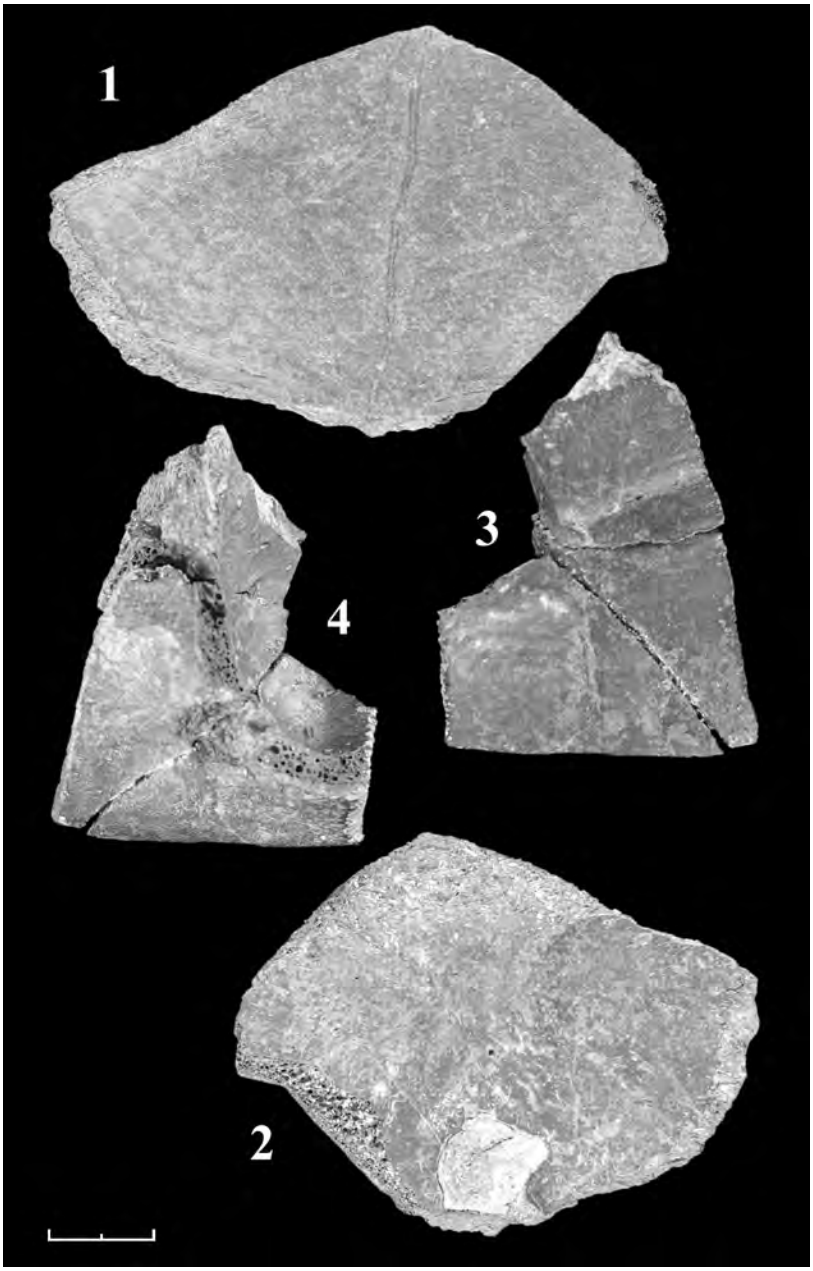

Plate 3. Borkenia oschkinisi *Schleich, 1994, PMUL HS 407e-A10.02.07, nearly complete entoplastron, right wing broken- figure 1 ventral, figure 2 visceral; PMUL HS 406b-A10.02.07, nearly complete peripheral VII sin. with the insertion of inguinal buttress- figure 3 dorsal, figure 4 visceral.*

Family Ptychogasteridae De Stefano, 1903

Genus *Ptychogaster* Pomel, 1847

***Ptychogaster* spec.**

Synonyms: None.

Known distribution: First appearance from Borken here.

Description: The most characteristic shell element in the present material is the hypoplastron remain dex. PMLU HS 390a. It show some characteristics of present movable plastral parts. The proximate pleural remain PMLU HS 388a show a neural alternation to a tetragonal. That condition is not present in the type specimen of *Hummelemys ambigua* Hervet, 2004 from the Lutetien (MP13) from Geiseltal.

Remarks: *Ptychogaster* Pomel, 1847 is the most important terrestrial emydid turtle genus for the German Oligocene. GROESSENS-VAN DYCK & SCHLEICH (1988) gave differential diagnosises for it taxa. An other important genus of the European Oligocene is *Clemmydopsis* Boda, 1927. *Clemmydopsis turnauensis* (H. v. Meyer, 1847) [syn. *Testudo riedli* Hoernes, 1892] is known from the Chattian/Oligocene from Trbovlje/Trifail in Slovenia formerly Styria. GROESSENS-VAN DYCK & SCHLEICH (1988) described further material of several Oligocene sites of the Mainz Basin and gave the follow taxa list: *Chelydropsis* Peters, 1868, *Trionyx* Geoffroy, 1809, "*Ocadia*" Gray, 1873, *Ptychogaster laurae* (Förster & Becker, 1886), *Ptychogaster laharpei* Portis, 1856, *Ptychogaster ronheimensis* Groessens-Van Dyck & Schleich, 1985, *Palaeochelys* Meyer, 1847, *Ergilemys* Ckhikhvadze, 1972, *Geochelone* Fitzinger, 1835, *Testudo* Linnaeus, 1758.

References/material: PMUL HS 390a-A10.02.05, hypoplastron dex.; PMUL HS 388a-A10.02.05, pleural remain prox.

Legion Archosauromorpha Huene, 1946

Supercohort Crurotarsi Sereno & Arcucci, 1990

Cohort Crocodylotarsi Benton & Clark, 1988

Magnorder Suchia Krebs, 1974

Superorder Crocodylomorpha Walker, 1968

Order Eusuchia emend. Huxley, 1875

Suborder Eusuchia Huxley, 1875

Infraorder Brevirostres (sensu Buffetaut, 1985)

Family Leidyosuchidae Rauhe & Rossmann, 1995

Genus *Diplocynodon* Pomel, 1847

***Diplocynodon* cf. *hantonensis* (Wood, 1846)**

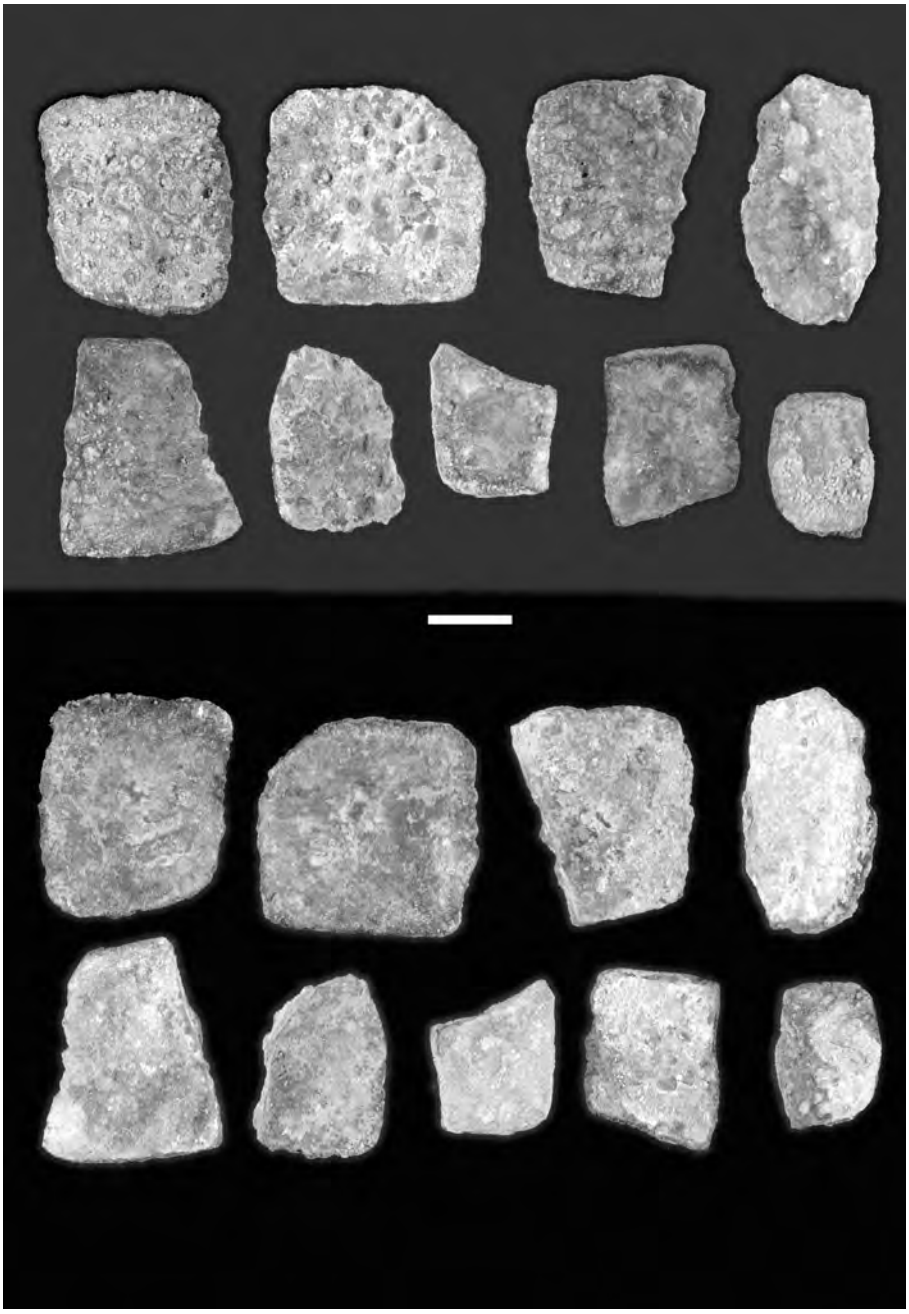

Plate 4. Diplocynodon *cf.* hantonensis *(Wood, 1846), PMLU HS 389-A10.02.05, eleven dermal ossifications by a young individual, two upper rows dorsal, two lower rows visceral.*

Synonyms:

- *Diplocynodon hantonensis*, (Wood, 1846), GRAMANN, 1958: 77, pl. 8, figs. 1-3;

- Crocodylia indet., SCHLEICH, 1986: 287;

- ?*Diplocynodon* sp., SCHLEICH, 1994: 93, pl. III, fig. 5.

Known distribution of the genus: First appearance in the Middle Eocene of both, Europe and North America. Although no subsequent occurrence has been reported from the Western Hemisphere it seems to have persisted in the Old World until the Middle Pliocene. *Diplocynodon* is the most common genus in European sites during the Oligocene.

Description: According to STEEL (1973), *Diplocynodon* is distinguished primarily by the double caniniform teeth in the upper jaw. The bridges of surface of dermal plates are broader than the diameters of holes; this is a significant character of *Diplocynodon* (KARL, 1990).

Remarks: GRAMANN (1958) describes a fragmentary left dental with 13 alveoles as *Diplocynodon hantonensis* (Wood, 1846) from the lower Oligocene Melanienton from the quarry "Altenburg III" of Borken. A survey to the genus is given by KARL (2007). SCHLEICH (1994) listed a very damaged and eroded single tooth remain as *Asiatosuchus* sp., but the specimen is too pure known for a determination.

References/material: PMLU HS 389-A10.02.05, eleven dermal ossifications by a young individual, the largest complete specimens are 26,5 x 26,5 mm and 26,5 x 22,5 mm (plate 4 for the complete sample); PMLU HS 370-A10.02.03, one dermal ossification and a vertebra remain; PMLU HS 388-A10.02.05, one small dermal ossification remain; PMLU HS 368-A10.02.03, one small dermal ossification remain.

PALAEOECOLOGICAL ASPECTS

Within the browncoal basin, there occur different ecological types of turtles: index genera for Paleogene fluviatil to brackish sediments as *Allaeochelys* and *Rafetoides* and the emydids as fluviatil to semiterrestrial element; and Testudinoidea as rare terrestrial/fluviatile elements. The European softshelled turtles group of the Pelaeogene genus *Allaeochelys* Noulet, 1867 is impartant. GRAMANN (1956) listed fragmentary material from the early to middle Oligocene "Melanienton" of Borken (Lower Hesse) as *Allaeochelys crassesculpta* Harrassowitz, 1922, origin described for the Geiseltalian (Lutetian, middle Eocene) of Messel hole. KARL, GRÖNING & BRAUCKMANN (2006) describes an actual occurrence from the late Oligocene (Chattian: early "Eochattian" = whole sequence Rupelian-Chattian) of a clay pit in the Elbe-bank near Steutz, approximately 12 km WNW Dessau, Sachsen-Anhalt. GROESSENS-VAN DYCK & SCHLEICH (1988) described further material of several Oligocene sites of the Mainz Basin and gave the follow taxa list: *Chelydropsis* Peters, 1868, *Trionyx* Geoffroy, 1809, "*Ocadia*" Gray,

1873, *Ptychogaster laurae* (Förster & Becker, 1886), *Ptychogaster laharpei* Portis, 1856, *Ptychogaster ronheimensis* Groessens-Van Dyck & Schleich, 1985, *Palaeochelys* Meyer, 1847, *Ergilemys* Ckhikhvadze, 1972, *Geochelone* Fitzinger, 1835, *Testudo* Linnaeus, 1758. Remains of such forms may be influenced in marine areas by rivers. The emydid genera *Palaeoemys* and *Borkenia* represents high fluviatile forms of turtles.

Crocodiles like *Diplocynodon* are a limno-fluviatil element, and may be influenced in marine areas by rivers also, some populations with adaption to brackish areas was possible (high number of juvenile specimens in the samples).

Abbreviations: PMUL = Paläontologisches Museum der Universität Leipzig.

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