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## France de Lapparent de Broin: Specialist of turtles and crocodiles

*France de Lapparent de Broin : spécialiste des tortues et crocodiles*

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## ARTICLE INFO

## Article history:

Received 19 November 2014

Accepted after revision 4 May 2015

Handled by Nathalie Bardet

## Keywords:

Paleontology

Vertebrates

Crocodilians

Chelonians

Mesozoic

Cenozoic

## Mots clés :

Paléontologie

Vertébrés

Crocodiles

Chéloniens

Mésozoïque

Cénozoïque

## ABSTRACT

France de Lapparent de Broin is an expert on extinct crocodiles and turtles who has made them known to the paleoherpetological community over almost 50 years. Her studies have dealt with fossils from the Mesozoic (mostly the Cretaceous) and the Cenozoic (mainly the Eocene and Miocene). She has been interested in faunas originating mainly from Europe, Africa and South America, and she produced large reviews of turtles from these continents. She erected several taxa, mostly of turtles. Among these taxa are some strange forms that appear to represent unique morphological types.

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## R É S U M É

France de Lapparent de Broin est spécialiste des crocodiles et tortues fossiles et, sur une période d'une cinquantaine d'années, elle les a fait largement connaître. Ses travaux ont porté essentiellement sur le Mésozoïque (surtout le Crétacé) et le Cénozoïque (surtout l'Eocène et le Miocène). Elle s'est intéressée principalement aux faunes fossiles d'Europe, d'Afrique et d'Amérique du Sud et a réalisé d'importantes revues des tortues de ces continents. Elle a créé de nombreux taxons, surtout pour les tortues. Parmi ces taxons figurent des formes étranges qui semblent appartenir à des types morphologiques uniques.

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France de Lapparent de Broin (Fig. 1) is a well-known expert in extinct turtles. She was born in 1938 and has been retired for some years. Her interest in paleontology has derived from familial roots. France is a member of the de Lapparent family, which is well-

known in the geological community. More specifically, her uncle Albert F. de Lapparent, who was a geologist in the broad sense of the word, oriented her towards paleontology.

She started paleontological research by studying Cretaceous crocodiles from the Sahara in her '3rd cycle thesis' (a

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**Fig. 1.** (Color online.) France de Lapparent de Broin, with Saïd Meslough (geologist), at Khouribga, Morocco, in May 2008. In the foreground: the skull of the strange turtle *Ocepechelon bouyai* described by Bardet et al. (2013).

**Fig. 1.** (Couleur en ligne.) France de Lapparent de Broin, avec Saïd Meslough (géologue), à Khouribga, Maroc, en mai 2008. Au premier plan : le crâne de l'étrange tortue *Ocepechelon bouyai* décrite par Bardet et al. (2013).

degree that no longer exists). This 'thesis' was defended in 1965 but it was not published (de Broin, 1965).

After her '3rd cycle thesis', she got a position at the Centre National de la Recherche Scientifique (CNRS) in 1966 and she turned to chelonians for a 'thèse d'état'

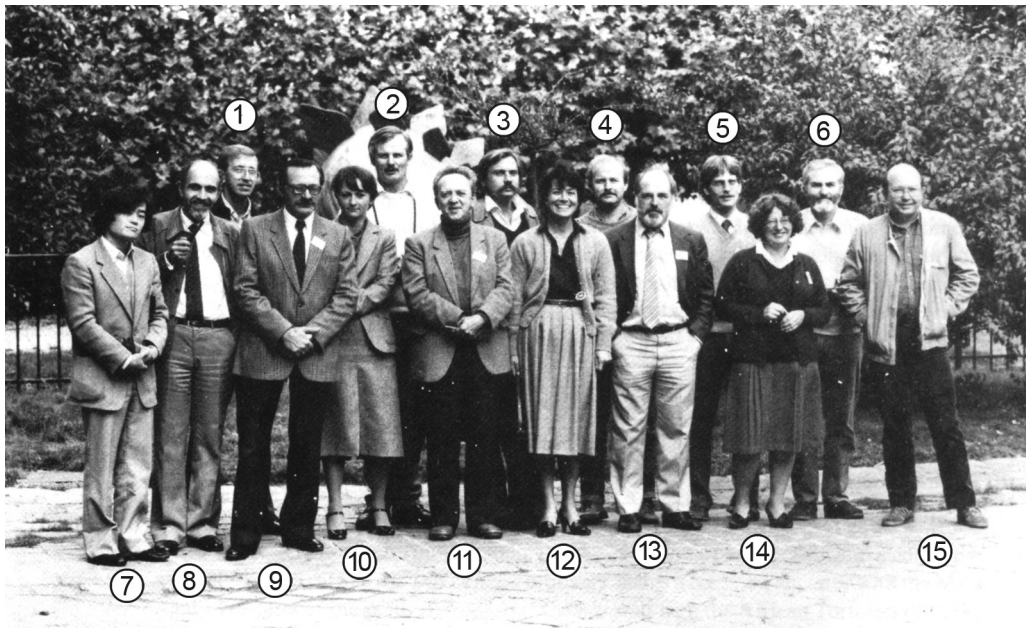
(approximately equivalent to a PhD) with Robert Hoffstetter as supervisor. However, she remained interested in crocodylians and during the course of her 'thèse d'état' (which has now been replaced by the 'Habilitation à Diriger les Recherches'), she exploited parts of the unpublished '3<sup>e</sup> cycle thesis' and published them.

A spectacular fallout of the '3rd cycle thesis' was the description of the gigantic pholidosaurid crocodile *Sarcosuchus imperator* from the Early Cretaceous (Aptian-Albian) of Africa. This taxon is one of the two largest known extinct or extant crocodiles, with a length above 10 m and a mass above 2.5 tons. An almost complete specimen is displayed in the exhibition gallery of the Muséum national d'Histoire naturelle of Paris. Part of the remains were first recovered from 1946 to 1959 by A.F. de Lapparent. A description was first made in the unpublished '3rd cycle thesis'; the following year, the description was published and the name was formally erected (de Broin and Taquet, 1966).

A late repercussion of the '3rd cycle thesis' is the description, in 2002, of the crocodile genus *Elosuchus* from the late Early Cretaceous of Africa. For this genus and another Cretaceous crocodile of Africa, she erected the family Elosuchidae (de Lapparent de Broin, 2002).

Other works dealing with crocodiles are scattered among articles on turtles. They sometimes consist in identifications of fossils requested by colleagues and published in papers of which she was not co-author.

The involvement of France in the study of turtles is best illustrated by the symposium 'Première table ronde internationale sur les tortues fossiles' that she organized at the



**Fig. 2.** Most of the participants of the 'Première table ronde internationale sur les tortues fossiles' held at the Paris Museum, 10–14 October 1983. 1: R.C. Wood, 2: P. Pritchard, 3: H.H. Schleich, 4: D. Smith, 5: P. Meylan, 6: E.S. Gaffney, 7: R. Hirayama, 8: T. Kotsakis, 9: E. Jiménez-Fuentes, 10: M.C. Groessens-Van Dick, 11: M. Młynarski, 12: Mrs Moody, 13: R.T.J. Moody, 14: F. de Lapparent de Broin, 15: R. Bour.

**Fig. 2.** La plupart des participants à la « Première table ronde internationale sur les tortues fossiles » tenue au Muséum, à Paris, les 10–14 octobre 1983. 1 : R.C. Wood, 2 : P. Pritchard, 3 : H.H. Schleich, 4 : D. Smith, 5 : P. Meylan, 6 : E.S. Gaffney, 7 : R. Hirayama, 8 : T. Kotsakis, 9 : E. Jiménez-Fuentes, 10 : M.C. Groessens-Van Dick, 11 : M. Młynarski, 12 : Mme Moody, 13 : R.T.J. Moody, 14 : F. de Lapparent de Broin, 15 : R. Bour.

Modified from a figure in de Broin (1984a).

Paris Museum in 1983, where 18 participants from nine countries met (Fig. 2). The papers were published the following year in *Studia Geologica Salmanticensia*, as a special volume 'Studia Palaeocheloniologica', of which she was co-editor (de Broin and Jiménez-Fuentes, 1984).

She published her first article on chelonians in 1969; although her 'thèse d'état' was devoted to chelonians from the French Cretaceous and Tertiary, this first paper was devoted to a fossil from Africa (de Broin, 1969), thus heralding her long-term interest in Africa. France defended her thesis in 1976, which resulted in a monumental publication issued in 1977 (de Broin, 1977). In this big work, she reviewed all turtles known at that time in the Cretaceous and Tertiary of France, i.e. from the Campanian to the Pliocene.

After her thesis, her work consisted of two main contributions: participation in collective studies of faunas (in which she took part for at least identifications of chelonians and, sometimes, crocodiles) and studies focused on turtles. Collaborative studies of faunas represent an important part of France's work. However, the most significant part is likely devoted to the study of chelonian taxa; she did not put geographical or stratigraphical limits to these studies. The stratigraphic range of studied fossils extends from the Triassic to the Holocene, but she mainly focused on those from the Cretaceous, Eocene and Miocene, which more or less reflects the number of localities bearing vertebrates. She is especially interested in Africa and South America. Assuming I correctly made the inventory of taxa that she erected as a co-author or, more often, alone, these include three families (one of crocodiles and two of turtles), 22 genera (three of crocodiles, 19 of turtles) and 40 species (three of crocodiles, 37 of turtles).

Studies of a turtle from the Late Triassic of Thailand range among the most significant contributions (de Broin, 1984b; de Broin et al., 1982). France described this turtle as a new species belonging to *Proganochelys*, a genus that was known elsewhere only from the Late Triassic of Germany. At that time, the species from Thailand and Germany were the earliest known turtles. Chelonians from the Triassic are still very rare and *Proganochelys* is the oldest known genus that developed a complete bony shell, i.e., a carapace firmly united to the plastron.

France also produced large and useful reviews. She started reviews with a catalog of the pleurodiran turtles from Gondwana, but the main purpose of this work was to evidence the consequences of the breakup of Gondwana on pleurodirans (de Broin, 1988). Another review deals with turtles from Africa (de Lapparent de Broin, 2000); from a taxonomic point of view, it is more detailed than that on Gondwana. This is a catalog of all chelonians recovered in Africa at that time, i.e. from the Early Jurassic to the Present. In addition, she stressed the main events that affected the faunas and discussed environmental and biogeographic aspects. Similarly, in another review (de Lapparent de Broin, 2001), she listed all European chelonians (i.e. from the Late Triassic to the Present) and she provided information on stratigraphy and biogeography. She also commented on the main faunal changes.

Among more specific outcomes, we may select out, for example, the report of the earliest pelomedusid turtles

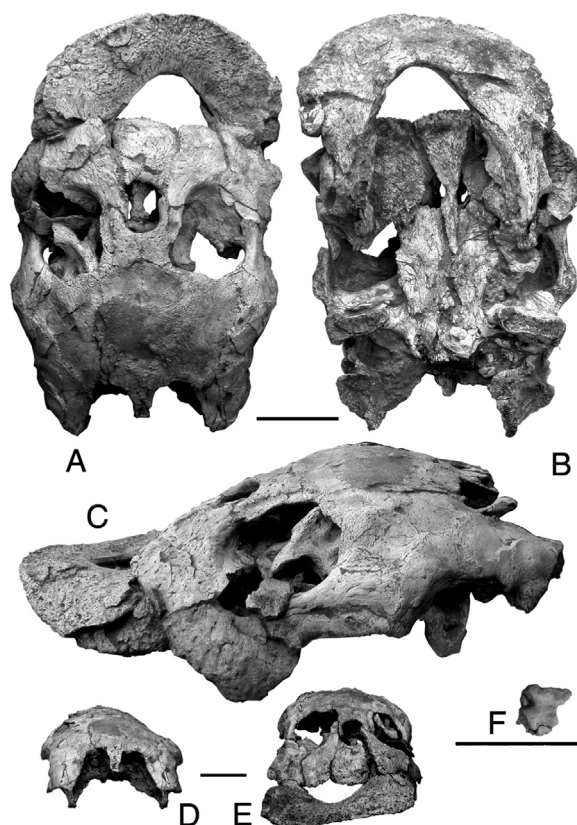


Fig. 3. *Alienochelys selloumi* de Lapparent de Broin et al., 2014a, from the Late Maastrichtian of Morocco. Holotype. Skull with its lower jaw in A, dorsal; B, ventral; C, left lateral slightly dorsal (with the axis vertebra lying in the orbit); D, dorso-posterior; and E, fronto-dorsal views. Atlas, F, left neural arch with a fragment of the intercentrum in left lateral view. Scale bars, 10 cm.

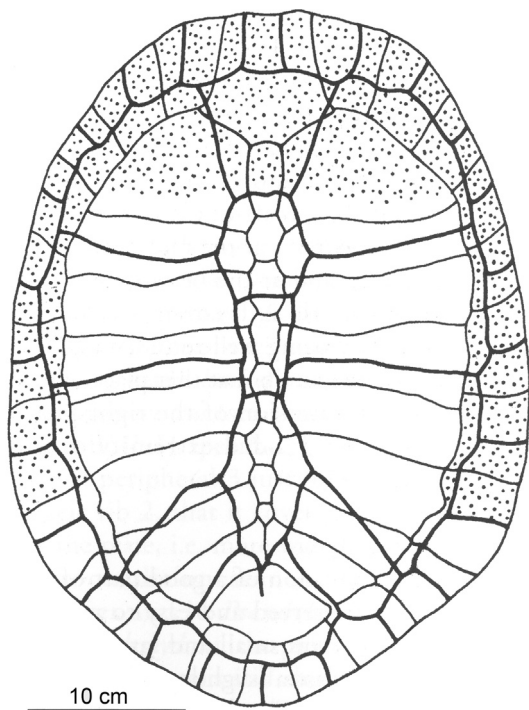
Fig. 3. *Alienochelys selloumi* de Lapparent de Broin et al., 2014a, du Maastrichtien supérieur du Maroc. Holotype. Crâne avec sa mandibule inférieure en vues dorsale (A), ventrale (B), latérale gauche légèrement dorsale, avec l'axis déplacé dans l'orbite (C), dorso-postérieure (D) et antéro-dorsale (E). Atlas, arc neural gauche avec un fragment de l'intercentrum, vue latérale gauche (F). Échelle, 10 cm.

Modified from de Lapparent de Broin et al., 2014a.

from the late Early Cretaceous (Aptian) of Niger (de Broin, 1980).

Recently, she described turtles with a peculiar feeding apparatus. Two of these specialized forms were recovered from the Maastrichtian levels of the phosphates of Morocco. The most surprising fossil is certainly a giant chelonoid turtle that developed a suction feeding system (Bardet et al., 2013). Although it shows convergences with beaked whales (and with syngnathid teleosts), its feeding apparatus is unique among tetrapods. The mouth of this turtle is rounded and located at the anterior extremity of the long and tubular snout (a pipette-like system!). Another chelonoid turtle from the same Maastrichtian levels displays a feeding apparatus characterized by a unique arrangement of bones (Fig. 3). This arrangement resulted in a powerful, crushing apparatus allowing feeding on hard preys (de Lapparent de Broin et al., 2014a). A third turtle having a peculiar feeding apparatus, again a chelonoid, was





**Fig. 4.** *Chelodina alanrxi* de Lapparent de Broin and Molnar, 2001, from the Eocene of Australia. Reconstruction of the carapace in dorsal view (dotted areas: missing parts).

**Fig. 4.** *Chelodina alanrxi* de Lapparent de Broin et Molnar, 2001, de l'Eocène d'Australie. Reconstitution de la carapace en vue dorsale (zones en pointillé : parties manquantes).

Modified from de Lapparent de Broin and Molnar, 2001. ©Scientific publications of the Muséum national d'Histoire naturelle, Paris.

recovered in the Eocene of the Iberian Peninsula. It fed on soft animals and occupied a specialized niche (de Lapparent de Broin et al., 2014b).

Aside from fossils, France has looked at living forms, obviously for comparisons, but also as objects of study. Thus, she was especially interested in the European and Anatolian species of the *Testudo hermanni* group. She regarded this assemblage as a distinct clade within *Testudo* s.l., separated probably since the Oligocene and surely by the Late Miocene (de Lapparent de Broin et al., 2006a). The parsimony analysis was based on a matrix that resulted from extended examination of the morphology of these turtles (de Lapparent de Broin et al., 2006b,c).

Obviously, the study of turtles and/or crocodiles, as that of any other fossils, from a locality is an opportunity to deal with paleoenvironments, and France took part in paleoenvironmental studies of several fossiliferous sites. However, she emphasized that chelonians should be used only cautiously as climatic indicators (de Broin, 1984c), a conclusion that may have surprised specialists of other taxa.

She studied the breakup of Gondwana and the paleogeographic relationships within that super continent, as did other experts in Mesozoic vertebrates. A peculiar study was the attempted reconstruction of Jurassic and Cretaceous coastlines of the Tethys from North America to Arabia; she initiated this work, which was based on

various extinct organisms (de Broin et al., 1991). In a paper with Marc Godinot, she questioned the widely-held view that terrestrial vertebrates dispersed from North America to Europe by the Paleocene-Eocene transition; instead, they suggested an inverted direction from Asia to Europe (Godinot and de Lapparent de Broin, 2003).

France greatly improved our knowledge of large-scale chelonian paleobiodiversity (Fig. 4). She spent her entire career at the Muséum national d'Histoire naturelle, at Paris. Retired in 2003, she still works there regularly, as shown by her latest publications (listed below).

#### Acknowledgements

I thank Nathalie Bardet and Michel Laurin for having invited me to write this article in this thematic issue. I am grateful to Corentin Séguin de Broin, Roger Bour, Igor Danilov and Michel Laurin for providing information and suggestions. This article benefited from reviews by Roger Bour, Igor Danilov and Philippe Taquet.

#### Appendix A. Scientific publications by France de Lapparent de Broin

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