



On the presence of the plethodid fish *Dixonanogmius* (Teleostei, Tselfatiiformes) in the marine Upper Cretaceous of Burma (Myanmar), tropical Asia

Sur la présence du poisson plethodidé *Dixonanogmius* (Teleostei, Tselfatiiformes) dans le Crétacé supérieur marin de Birmanie (Myanmar), Asie tropicale

Louis TAVERNE¹ & Jeff LISTON²

Résumé: Une nouvelle étude des fragments d'un poisson fossile provenant du Cénomaniens marin de Birmanie et rapporté jadis à *Neopachycormus birmanicus* (Pachycormidae) montre que ces attributions générique et familiale étaient erronées. La morphologie très spécialisée d'un rayon de nageoire indique que ce poisson appartient en réalité au genre *Dixonanogmius*, un pléthodidé connu dans le Crétacé supérieur de l'Europe et de l'Amérique du Nord. L'espèce birmane diffère des autres espèces du genre par la forme de son préoperculaire et mérite un statut spécifique particulier. Le nom de *Dixonanogmius birmanicus* est attribué à ce poisson fossile. Jusqu'ici la présence de la famille des Plethodidae et de l'ordre des Tselfatiiformes en Asie tropicale n'était pas connue.

Mots-clés: Teleostei, Tselfatiiformes, Plethodidae, *Dixonanogmius birmanicus*, rayon de nageoire, Cénomaniens marin, Birmanie, Asie tropicale.

Abstract: A new study of the fossil fish fragments recorded from the marine Cenomanian of Burma and formerly reported to *Neopachycormys birmanicus* (Pachycormidae) shows that these generic and familial attributions were erroneous. The highly specialized morphology of a fin ray indicates that this fish belongs in reality to the genus *Dixonanogmius*, a plethodid known in the Upper Cretaceous of Europe and North America. The Burmese species differs from the other species of the genus by the shape of its preopercle and deserves a peculiar specific status. The name *Dixonanogmius birmanicus* is given to this fossil fish. Until now, the presence of the family Plethodidae and of the order Tselfatiiformes in tropical Asia was not known.

Key-words: Teleostei, Tselfatiiformes, Plethodidae, *Dixonanogmius birmanicus*, fin ray, marine Cenomanian, Burma, Tropical Asia.

INTRODUCTION

Two slabs (imprint and counter-imprint) with fossil fish material were discovered during the geological investigations performed in May 1973 by Dr. Franz GRAMANN (Niedersächsisches Landesamt für Bodenforschung, Hannover-Buchholz, Germany) in the marine Cenomanian deposits of the Kyi-Chaung river (GRAMANN, 1974), up-stream of the village of Kyi, Pakokku District, Magway Division, central Burma [Myanmar] (Fig. 1).

These slabs were studied four years later by TAVERNE (1977: pl. 1, 2). They bear some isolated bones, fin rays and scales of a rather large fish (ibid., 1977: fig. 1-4) and the skull roof of a small primitive member of the Dercetidae (Teleostei, Aulopiformes), with large parietals meeting on the mid-line (ibid., 1977: fig. 5).

The fin ray of the large fish is very peculiar, extremely elongated and ornamented all its length by a row of pseudo-fringing fulcra. This strange ray was interpreted as a morphological precursor of the highly specialized pectoral fin of the Cenomanian-Senonian pachycormid genus *Protosphyraena* LEIDY, 1857 (ibid., 1977: fig 4). According to that interpretation, the large fish was reported to the family Pachycormidae (Neopterygii, Pachycormiformes) and named *Neopachycormus birmanicus* TAVERNE, 1977.

However and unfortunately, TAVERNE (1977)'s point of view was totally wrong, as we shall see hereafter. The proposed systematic position within the pachycormid family was erroneous.

The aim of the present paper is thus to re-describe that fossil fragments and to determine the true identity of that large Cenomanian Burmese fish.

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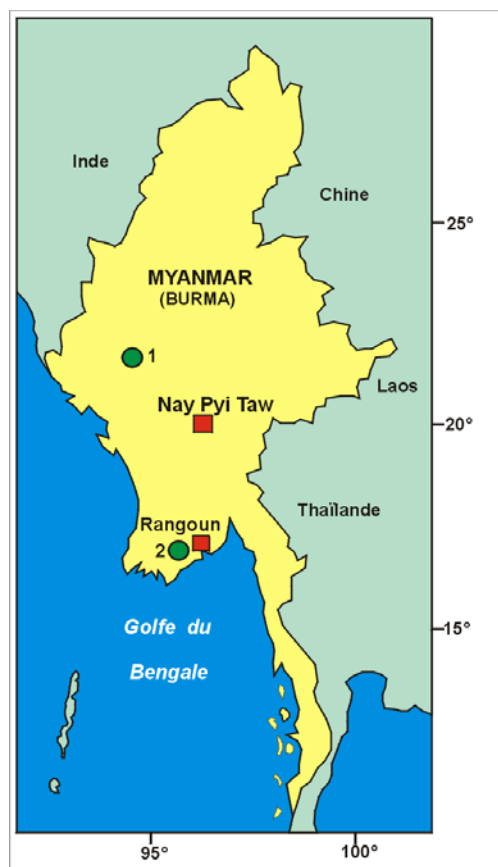


Figure 1: Map of Burma (Myanmar): (1) Pakokku, (2) Rangoun

MATERIAL AND METHOD

The hereafter studied material belongs to the collections of the Bundesanstalt für Geowissenschaften und Rohstoffe of Hannover-Buchholz (BGRHB), Germany, and was studied with a stereomicroscope Wild M5. The drawings of the figures were made by the first author (L. T.) with a camera lucida and on the basis of photos. The photos are provided by the second author (J. L.).

The comparative material used in our paper came from the Museo Civico di Storia Naturale di Verona (MCSN), the Paleontological Museum of the Kansas University in Lawrence (KUP) and the Booth Museum of Natural History of Brighton (BMNH).

SYSTEMATIC PALEONTOLOGY

Division **Teleostei** MÜLLER, 1846

Order **Tselfatiiformes** NELSON, 1994

Family **Plethodidae** LOOMIS, 1900

Genus ***Dixonanogmius*** TAVERNE, 2000

Type-species: *Dixonanogmius oblongus* (DIXON, 1850)

Species ***Dixonanogmius birmanicus*** (TAVERNE, 1977)

Diagnosis

Dixonanogmius differing from the other species of the genus by the shaped of its preopercle, with a broad triangular dorsal branch.

Holotype

Specimen BGRHB Nr Kc 65, isolated bones, fin rays and scales on two facing slabs (Fig. 2).



Figure 2: The two slabs (imprint and counter-imprint) BGRHB Nr Kc 65, containing the fossil fish material from the Cenomanian deposits of the Kyi-Chaung River, Pakokku District, central Burma (Myanmar).

Synonymy

Neopachycormus birmanicus TAVERNE, 1977

Osteology (Fig. 3-6)

Almost all the isolated bones of the large fish present on the slabs are broken and not easily identifiable. Within these bony fragments, there are a few large circumorbital bones, some long and broad branchiostegal rays and a cleithrum with a short and slightly enlarged dorsal limb and a long rectilinear ventral branch (Fig. 3).

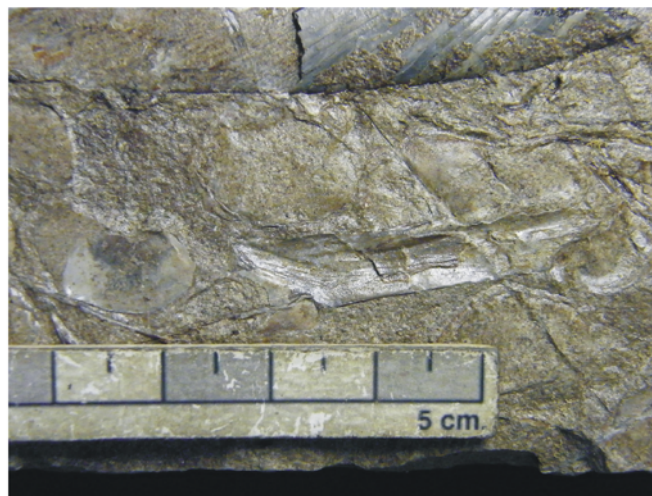


Figure 3: Cleithrum of *Dixonanogmus birmanicus* (TAVERNE, 1977), holotype BGRHB Nr Kc 65. The most anterior part of the bone is missing.

The best preserved bone is the preopercle (Fig. 4A). Its dorsal branch is broad and triangular, with an acuminate apex and a small pointed process on its posterior margin. Its ventral branch also is broad but a little shorter. This branch bears numerous long and well marked secondary tubules of the preopercular sensory canal.

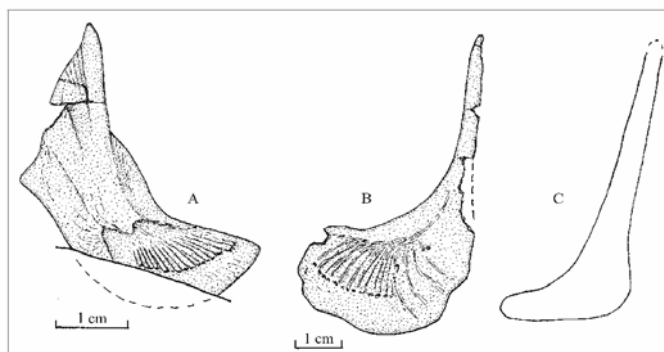


Figure 4: (A) Preopercle of *Dixonanogmius birmanicus* (TAVERNE, 1977), holotype BGRHB Nr Kc 65. (B) Preopercle of *Dixonanogmius oblongus* (DIXON, 1850), specimen BMNHB 007301 (former no 154 in WOODWARD, 1899: pl. 14, fig. 1, 1a). (C) Preopercle of *Dixonanogmius dalmatius* (BARBACK & TELLER-MARSHALL, 1980) (modified from BARBACK & TELLER-MARSHALL, 1980: fig. 4).

A well preserved large hyoid bar is also visible (Fig. 5). The anterior ceratohyal is elongate, with a concave upper margin and a convex lower margin. There is no berycoid foramen. The posterior ceratohyal is much shorter but a little deeper. Fragments of five branchiostegal rays are attached to the anterior ceratohyal.



Figure 5: Hyoid bar of *Dixonanogmius birmanicus* (TAVERNE, 1977), holotype BGRHB Nr Kc 65.

The preserved fin rays are elongated. The first ray of the series is very peculiar and highly specialized (Fig. 6). Its two halves are dissociated due to a taphonomic artefact. One half is located just before the other. The basis of this ray is rather broad and undivided. A division in two parts, one posterior and one anterior, occurs a little higher on the ray. The posterior part is constituted by a long and extremely thin branch irregularly segmented. This irregular segmentation perhaps is caused by a *post-mortem* breaking of the ray. The anterior part is broader and divided in long and narrow segments obliquely oriented, forming a row of pseudo-fringing fulcra. Fragments of three other long and thin rays are preserved just behind the first ray. They seem irregularly segmented but, once again, this fragmentation perhaps is due to the fossilization.

The scales are large, thick, cycloid, with a depth of 12 to 15 mm and a length of 10 to 12 mm. These scales are covered with thin concentric *circuli*. Numerous *radii* are located near the posterior margin. They are short and do not reach the centrum of the scale (TAVERNE, 1977: fig. 3).

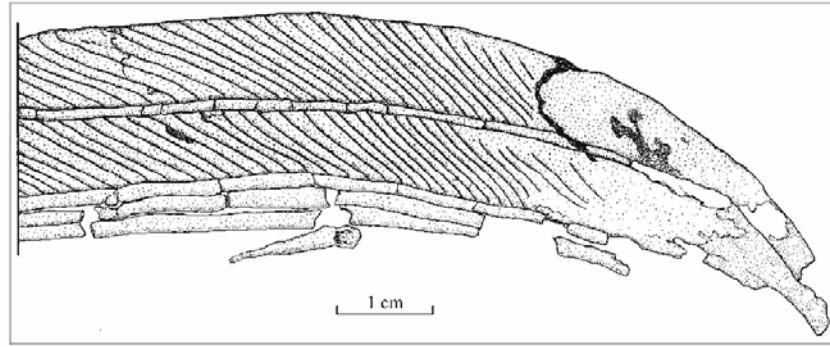


Figure 6: Basal part of the first long dorsal ray of *Dixonanogmius birmanicus* (TAVERNE, 1977), holotype BGRHB Nr Kc 65. The two halves of the ray are dissociated due to the fossilisation, one half being located just before the other.

DISCUSSION

Within the fossil and Recent actinopterygian fish world, only two teleost genera exhibit the same highly specialized fin ray morphology than that of the Burmese fish, *Tselfatia* ARAMBOURG, 1943 and *Dixonanogmius* TAVERNE, 2000 (Fig. 7A, B). Both fishes are closely allied and belong to the Plethodidae (TAVERNE, 2000a, b), a family included in the order Tselfatiiformes (= Bananogmiiformes). The concerned strange fin ray is the first long one of the dorsal and anal fins of *Tselfatia* and *Dixonanogmius*, the dorsal ray being much longer than the anal one. The pseudo-fringing fulcra of that fin ray are rather broad in *Tselfatia* (Fig. 7B) but, on the contrary, very narrow in *Dixonanogmius* (Fig. 7A), as in the Burmese fossil fish. We can thus confidently refer the fossil fish “*Neopachycormus*” *birmanicus* to the genus *Dixonanogmius*. Seeing that the preserved ray of the Burmese fish is extremely long, we can conclude that it belongs to the dorsal fin and not the anal fin.

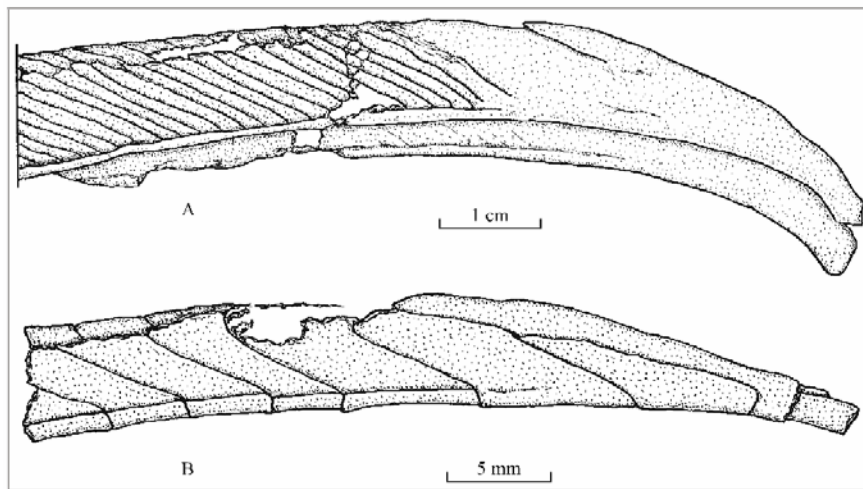


Figure 7: (A) Basal part of the first long dorsal ray of *Dixonanogmius* sp., specimen KUV 463, Trego County, Kansas, U.S.A., Niobrara Formation. (B) Basal part of the first long dorsal ray of *Tselfatia formosa* (ARAMBOURG, 1943), specimen MCSNV IG 37540, Cinto Euganeo, Italy, Turonian.

The genus *Tselfatia* contains only one species, *Tselfatia formosa* ARAMBOURG, 1943, that is known from the Cenomanian-Turonian in Morocco, Italy, Germany, Croatia, U.S.A. and Mexico (ARAMBOURG, 1943, 1954; SORBINI, 1976; BARDACK & TELLER-MARSHALL, 1980; TAVERNE, 1974, 1983, 2000a; BIZZARINI & COCCIONI, 1990; MAISCH & LEHMANN, 2000; GONZÁLEZ-RODRIGUEZ, 2013).

Dixonanogmius is the oldest member of the Plethodidae. It appears in the Albian of England with the species *Dixonanogmius oblongus* (DIXON, 1850) that is also present in the Cenomanian of this country and is the type-species of the genus (DIXON, 1850; WOODWARD, 1899; TAVERNE, 2000b). A second species, *Dixonanogmius dalmatius* (BARDACK & TELLER-MARSHALL, 1980) comes from the Cenomanian-

Turonian of Croatia (BARDACK & TELLER-MARSHALL, 1980; TAVERNE, 2000b). The genus also exists in the Santonian-Campanian of North America (TAVERNE, 2000b). The *Tselfatia* sp. recorded in the Turonian of the Mexcala Formation, Mexico, very probably belongs to the genus *Dixonanogmius* and not to the genus *Tselfatia*, as its pseudo-fringing fulcra are narrow (ALVARADO-ORTEGA *et al.*, 2006: fig. 4C).

The Tselfatiiformes (Fig. 8), nicknamed “banana-fishes” by the English-speaking paleontologists, are one of the major lineages within Teleostei during the Cretaceous. They are big fishes sometimes reaching one meter in length. The order is subdivided in three families, the Eoplethodidae with one monospecific genus, the Plethodidae (= Tselfatiidae, Bananogmiidae, Niobrariidae, Thryptodontidae) with eighteen genera and twenty-eight species, and the Protobramidae with three genera and four species (TAVERNE & GAYET, 2004, 2005; CAVIN & FOREY, 2008). Their first occurrence dates back to the Albian and their last one to the Campanian. They are recorded in North, Central and South America, in Europe, North Africa and Near East.

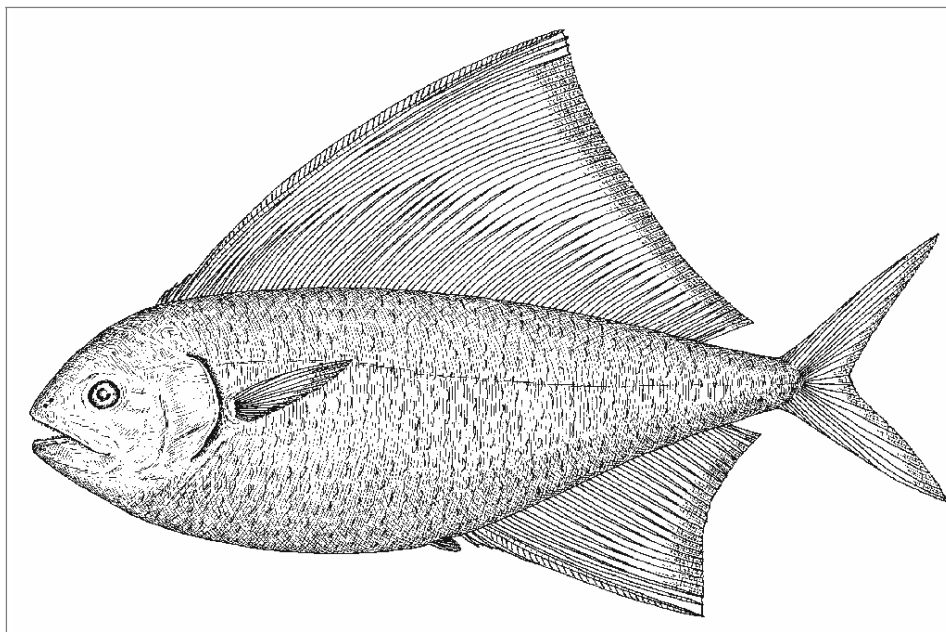


Figure 8: Reconstruction of the plethodid fish *Tselfatia formosa* (ARAMBOURG, 1943).

The cleithrum of the Burmese fish, with its short but broad dorsal limb and its elongate ventral limb (Fig. 3), perfectly correspond to the shape of the same bone in *Tselfatia formosa* and *Dixonanogmius dalmatius* (ARAMBOURG, 1954: fig. 66; BARDACK & TELLER-MARSHALL, 1980: fig. 4; TAVERNE, 1983: fig. 2; MAISCH & LEHMANN, 2000: fig. 3) and some other Plethodidae.

However, the Asian *Dixonanogmius* differs from the English *D. oblongus* and from the Croatian *D. dalmatius* by at least one character, the shape of its preopercle. These species exhibit numerous long and well marked secondary tubules on the lower part of the preopercular sensory canal. But, in the Burmese fish, the dorsal limb of the preopercle is broad and triangle-shaped (Fig. 3 A), while this dorsal limb is elongate and extremely narrow in *D. oblongus* and *D. dalmatius* (Fig. 3 B, C). We propose to maintain the specific name *birmanicus* for the Burmese *Dixonanogmius*.

Plethodidae and the entire order Tselfatiiformes were unknown in central and eastern Asian Cretaceous deposits. Until now, the most eastern occurrence for the order was represented by the family Protobramidae from the marine Cenomanian of Lebanon (TAVERNE & GAYET, 2004, 2005). The Cenomanian *Dixonanogmius birmanicus* from Burma is thus the first record of a tselfatiiform fish in the Far East.

The presence of *Dixonanogmius* in the marine Cenomanian of eastern Asia has another consequence. The first and oldest occurrences of the genus are located in the European realm of the Mesogea during Albian and Cenomanian-Turonian times. In North America, *Dixonanogmius* firstly appears in the Turonian of Mexico and later in the Santonian-Campanian of the U.S.A. Until now, such a paleogeographic and chronological distribution of the genus was explained by a Cenomanian-Turonian westward dispersal from the European region of the Mesogea to the North American Interior Sea via the Central Proto-Atlantic Ocean and the Caribbean Sea (TAVERNE & GAYET, 2005). Another hypothesis is presently possible. From now on, we can envisage a Cenomanian eastward travel of *Dixonanogmius* from the eastern Asian realm of the Mesogea to the North American Internal Sea through the Pacific Ocean and the strait that separated South and North America during the Cretaceous.

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