Thalassia Salentina
Thalassia Sal. 41 (2019), 53-70
ISSN 0563-3745, e-ISSN 1591-0725
DOI 10.1285/i15910725v41p53
http: siba-ese.unisalento.it - © 2019 Università del Salento

LOUIS PAUL TAVERNE[1], LUIGI CAPASSO[2]

[1] Royal Institute of Natural Sciences of Belgium, Directorate Earth and History of Life, Vautierstreet, 29, B-1000 Brussels, Belgium. e-mail: louis.taverne@skynet.be
[2] Museo Universitario dell'Universitá "G. d'Annunzio" di Chieti-Pescara, Piazza Trento e Trieste, 1, I-661000 Chieti, Italy. e-mail: lcapasso@unich.it

OSTEOLOGY OF *CAVINICHTHYS PACHYLEPIS* GEN. AND SP. NOV. (TELEOSTEI, CROSSOGNATHIFORMES, PACHYRHIZODONTIDAE) FROM PIETRAROJA (LOWER CRETACEOUS, CAMPANIA, SOUTH ITALY)

SUMMARY

Cavinichthys pachylepis gen. and sp. nov., a fossil pachyrhizodontid fish from the marine Albian deposits (Lower Cretaceous) of Pietraroja (Campania, southern Italy), is described in details. The new genus differs from the other members of the family by the minute teeth ranged in wide patches on its jaws. The pterotic is devoid of posterior pointed process. The premaxilla is short and triangular in shape. The unique supramaxilla is narrow and extremely elongate. The first two infraorbitals are fused together, while the three large posterior infraorbitals are separated. The anterior extremity of the large supraorbital reaches the first infraorbital. There is no antorbital. The ventral branch of the preopercle is strongly reduced. The opercle is large and the subopercle small. The first preural centrum and the two ural centra are autogenous but reduced in size. The two ventral hypurals are fused together but not to the first ural centrum. The first uroneural has a broadened anterior extremity but is not forked. *Cavinichthys pachylepis* occupies a basal position in the phylogenetic tree of the Pachyrhizodontidae.

INTRODUCTION

The marine Albian fossil fish community of Pietraroja (province of Benevento, Campania, southern Italy) is one of the most important and various ichthyofauna ever discovered in the Lower Cretaceous deposits of Europe. The scientific study of those fossil fishes begun with the works of Costa (1853-1860, 1864) and was continued by D'Erasmo (1914-1915), who published

two exhaustive volumes on the subject. Capasso (2000, 2007) relates the detailed story of the geological and paleontological investigations in the region of Pietraroja, from their first mention in the 18th century to the present days. Freels (1975), Bravi (1996) and Signore (2004) give a good synthesis of our actual knowledge on the geology, the stratigraphy and the palaeoenvironment of Pietraroja.

The aim of our present paper is to describe the skeleton of a new genus of pachyrhizondontid fish from the Albian of Pietraroja and to comment on its relationships with the other members of the family Pachyrhizodontidae. This fossil fish is represented by only one large and perfectly preserved specimen.

Pachyrhizodontidae is one of the two families that constitute the extinct suborder Pachyrhizodontoidei, a lineage of primitive teleosts often ranged within the order Crossognathiformes (Taverne, 1989; Patterson, 1993; Arratia, 2008), a position that is however denied by a few ones (Cavin, 2001). Pachyrhizodontoidei are marine predators, with a fusiform body. They eat principally smaller fishes (Taverne, 1989: 103). Their size is highly variable, from a few centimetres to almost one meter in length. Their first occurrence dates back to the Upper Jurassic (Arratia and Schultze, 1999). They have a worldwide distribution during the Cretaceous (Taverne, 1989: figs 11-13). They disappear at the Cretaceous/Paleocene boundary, except one genus, *Platinx* Agassiz 1835, that survives in Europe till the Middle Eocene (Taverne, 1980).

MATERIAL AND METHODS

The specimen hereafter studied belongs to the Capasso collection (CLC) in Chieti (Italy). This collection is legally registered and was declared part of the Italian cultural heritage by a decree of the Ministero per I Beni e le Attività Culturali under the date of October 11th 1999, following the disposition of the Italian law of cultural heritage protection N° 1089/1939. The specimens of this collection were also subject to prescription in order of conservation and availability to the studies on the basis of the article 30 of the Italian law N° 42/2004. The Soprintendenza per I Beni Archeologici dell'Abruzzo-Chieti has authorized the authors to study this collection by two letters bearing the dates of May 5th, 2011 (ref.: MBAC-SBA-ABR PROT 0004537 05/05/ 2011 Cl. 34.25.01/2.1) and July 30th, 2014 (ref.: MBAC-SBA-ABR PROT 0005618 31/07/2014 Cl. 34.25.01/2.1).

The material was examined with a stereomicroscope Leica Wild M 8. The figures were drawn by the first author (L. T.). The photos were made by Mr. Luciano Lullo from the Universitá "G. d'Annunzio" di Chieti-Pescara.

SYSTEMATIC PALEONTOLOGY

Division Teleostei Müller, 184
Order Crossognathiformes Taverne, 1989
Suborder Pachyrhizodontoidei Forey, 1977
Family Pachyrhizodontidae Cope, 1872
Genus ***Cavinichthys*** gen. nov.

Type-species
Cavinichthys pachylepis gen. and sp. nov. (by monotypy)

Diagnosis
As for the species (monospecific genus).

Etymology
The generic name of the new fossil fish is given in honour of Dr. Lionel Cavin (Geneva) who greatly contributed to the comprehension of the phylogeny within pachyrhizontid fishes.

Species ***Cavinichthys pachylepis*** gen. and sp. nov.

Diagnosis
Large pachyrizodontid fish. Wide dermethmoid (= rostral) not fused with the ossified endochondral part of the mesethmoid. Plate-like nasal. Small parietal. Latero-parietal skull. Pterotic devoid of posterior acuminate process. Supraoccipital crest weakly developed. Small supratemporal. Orbital bones completely surrounding the orbit. No antorbital. Infraorbitals 1 and 2 fused. Wide infraorbitals 3, 4 and 5 reaching the anterior margin of the preopercle. Large triangular dermosphenotic. Long and broad supraorbital reaching the first infraorbital. Very small conical teeth ranged in patches on the vomer, premaxilla, maxilla and dentary. Only one narrow and elongate supramaxilla. Small autogenous retroarticular. Articulation between the lower jaw and the quadrate posterior to the orbit. Ventral branch of preopercle extremely shortened. Large opercle. Small subopercle. Seven branchiostegal rays. Cephalic ribs present. Origin of the ventral fins located at the level of the 31st vertebra. About 64 vertebrae (23 in the caudal region). Neural and haemal arches articulated on the corresponding centra. Lateral faces of the vertebrae ornamented with one or two horizontal crests. Epineurals only present in the abdominal region, the first ones fused to the neural arches, the last ones free. No epicentral. No epipleural. Dorsal fin with 15 rays and 13 pterygiophores. Dorsal fin origin located above the 25th vertebra. Anal fin with 10

rays and 7 pterygiophores. Anal fin origin located below the 49th vertebra. Preural vertebra 1 and ural vertebrae 1 and 2 small and autogenous. Neural spine of preural vertebra 3 slightly shortened. Neural spine of preural vertebra 2 strongly reduced and fused with the corresponding centrum. Hypurals 1 and 2 fused together but not with the first ural centrum. Only one epural. Three uroneurals, the first one with an enlarged and rounded anterior region. Caudal fin forked, with 19 principal rays. No true caudal scutes. Scales large, ovoid, thick and ornamented with alveoli and tubercles.

Etymology
From the Greek *pachys*, épais thick, and *lepis*, scale. The species name refers to the thickness of the scales of the new fossil fish.

Holotype
CLC I-123, a complete specimen (Fig. 1; Capasso, 2007: fig. 170A, B, C, D, erroneously presented as *Chanos leopoldi*). Total length: 82 cm.

Formation and locality
Marine Albian (Lower Cretaceous) plattenkalk of Pietraroja (province of Benevento, Campania, southern Italy).

Morphometric data (Fig. 1)
The morphometric data are given in percentage (%) of the standard length of the holotype (68 cm).

Length of the head (opercle included).....27.5 %
Depth of the head (in the occipital region).....21.3 %
Maximum depth of the body (just before the dorsal fin).....24.6 %
Prepelvic length.....57.4 %
Predorsal length.....50.4 %
Preanal length .....80.7 %
Depth of the caudal peduncle .....7.8 %
Length of the caudal fin lobes.....22.5 %

Osteology

The skull (Fig. 2, 3)

The dermic component (= dermethmoid, rostral) of the mesethmoid is a large ovoid bone. The endochondral region of the mesethmoid is also ossified but the dermethmoid is not fused with this internal part of the bone. The lateral ethmoid is well developed. The nasal is a small plate-like bone located along the most anterior region of the frontal. A part of

the vomer is visible. The bone bears a patch of very small conical teeth.

The frontals are narrow but extremely elongated. They form the greatest part of the skull roof. They reach the dermethmoid anteriorly and the supraoccipital posteriorly. The skull is latero-parietal. The parietal is a small and narrow bone lying along the posterior part of the frontal and the anterior part of the supraoccipital. The median crest of the supraoccipital is very short. The autosphenotic is entirely hidden under the dermosphenotic. The pterotic is devoid of pointed posterior process. The small epiotic is located just behind the parietal. A small broken plate-like supratemporal (= extrascapular, scale bone) is visible, just behind the epiotic and the supraoccipital. The posttemporal fossa, the supraorbital and the otic sensory canals are not visible.

The orbitosphenoid and the pleurosphenoid are well developed and clearly visible in the top of the orbit. There is no bony interorbital septum. The parasphenoid, the basisphenoid, the prootic, the exoccipital, the intercalar and the basioccipital are covered by the orbital bones and thus not visible.

The quadrate is more or less triangle-shaped, with a well developed articular head for the lower jaw. The posterior region of the ectopterygoid is visible but not the endopterygoid, the metapterygoid and the palatine.

The premaxilla, the maxilla and the dentary bear patches of very small conical teeth. A few teeth are a little longer than the others. The premaxilla is triangular in shape and devoid of well marked dorsal process. The maxilla is long and rather broad. There is only one very long, thin and anteriorly acuminate supramaxilla. The lower jaw is elongated. The articulation with the quadrate is positioned far behind the level of the orbital posterior margin. The angular forms the articular fossa for the quadrate. The inner face of the mandible is not accessible and we do not know if the articular was autogenous or fused to the angular. There is a small autogenous retroarticular. Some pores located in the anterior region of the dentary are the only visible traces of the mandibular sensory canal.

The orbital series is completely preserved. The orbital bones entirely surround the orbit. There is no antorbital. The first two infraorbitals are fused together. The three posterior infraorbitals are extremely enlarged and extend till the anterior margin of the preopercle. The dermosphenotic is triangular. The supraorbital is elongated, with a narrow posterior extremity in contact with the dermosphenotic and a broadened anterior region that reaches the first infraorbital. A sclerotic bony ring is present. The infraorbital sensory canal is not visible.

The preopercle has a long and narrow dorsal branch. The ventral region of the bone is broadened but the ventral branch is extremely short. The opercle is a large bone, deeper than long, with an upper region narrower than the lower one. The interopercle, if present, is not visible. Seven branchiostegal rays are preserved. The preopercular sensory canal is not visible.

The hyoideo-branchial skeleton (Fig. 2, 3)
The hyomandibula and the symplectic are completely hidden by the posterior infraorbitals and the preopercle. Small fragments of branchial bones and the urohyal (= parahyoid) are visible under the lower jaw. A series of sinuous branchial filaments are preserved just before the branchiostegal rays.

The girdles (Fig. 1-3, 7)
The pectoral girdle is not completely preserved. The postemporal is missing. The hypercleithrum (= supracleithrum) is partly visible behind the opercle. The upper part of the cleithrum is lost. The bone seems crescent-like. The preserved part of the pectoral fin contains 11 rays but the fin is not complete.

The pelvic bones are rod-like and extremely elongated. The ventral fins are long. Each fin contains 5 rays. The first one is segmented and pointed, the others segmented and branched. The origin of the ventral fins is located at the level of the 31st vertebra (this count includes six centra hidden by the opercle).

The axial skeleton (Fig. 1, 4, 7)
There are 58 vertebrae visible in the axial skeleton, including the two ural ones. However, the first centra, probably six, are covered and hidden by the opercle. The total number of vertebrae is thus about 64, with 23 in the caudal region. These vertebrae are deeper than long. Their lateral faces are generally ornamented with one or two horizontally oriented and well marked crests. The crests are thinner but more numerous on the last preural vertebrae. The neural and haemal arches are autogenous and simply articulated on the corresponding centra all along the vertebral axis. The neural and haemal spines are long, thin and obliquely oriented. The haemal arches are represented by paired haemapophyses (= parapophyses) in the abdominal region of the body. The exact number of ribs is not determinable. The ribs are long and narrow, except the last pairs that are strongly shortened. The two last abdominal vertebrae already bear short haemal spines that support the reduced ribs.

A few thin cephalic ribs are attached to the rear of the braincase. Only some fragments of supraneurals are visible but most of them are missing or covered by scales. Epineurals are only present in the abdominal region of the body. They are extremely elongated and curved. The first ones are fused to the neural arches and the last ones are free. No epicentral and no epipleural are visible.

The dorsal and anal fins (Fig. 5, 6)
The origin of the dorsal fin is located above the 25th vertebra (including the six ones hidden by the opercle) and thus well before the origin of the ventral fins. The dorsal fin contains 15 rays supported by 13 pterygiophores (= axonosts). The first four rays are short spines that progressively lengthen from the

first to the fourth one. The fifth ray is the first long one. From the fifth to the fifteenth, the rays are segmented and branched. They progressively decrease in length. The first axonost is composed of only one branch. The tip of the axonosts is enlarged. A mesonost is associated with each axonost. A few baseosts are also present at the basis of some rays.

The anal fin is located nearer to the tail than to the pelvic girdle, its origin being positioned at the level of the 49th vertebra (including the six ones hidden by the opercle).. There are 7 pterygiophores (= axonosts) supporting 10 rays. The first three rays are short spines. A beginning of segmentation is visible on the distal extremity of the anterior margin of the third spine. From the fourth to the tenth, the rays are segmented and branched. A mesonost is associated with each axonost. A few baseosts are visible.

The caudal endoskeleton and fin (Fig. 7-9)

The last five preural (PU1-5) and the two ural vertebrae (U1, 2) and their associated elements support the caudal fin. From PU5 to U2, the centra are progressively upturned. U1 and U2 are strongly reduced. All the neural and haemal pieces of the caudal complex are autogenous, except the neural arch of PU2 that is fused to the centrum.. PU4 bears the last complete neural spine. The neural spine of PU3 is slightly shortened and that of PU2 is slightly broadened but strongly shortened. It is possible that PU1 and U1 bear reduced neural arches completely hidden by the first two uroneurals. Such small neural arches on PU1 and U1 are present in some pachyrhizodontid fishes. The parhypural is articulated on PU1 and is slightly enlarged. There are three hypurals visible (HY1-3). The uppermost hypurals are hidden under the caudal rays. HY1 and HY2 are fused together and articulated on U1. A small hypural foramen is present in the most proximal region of this ventral hypural plate. The large HY3 is connected to U2. There are three uroneurals (UR1-3). UR1 has an enlarged but not forked anterior extremity and extends on the lateral face of PU1 and PU2. UR2 is shorter and reaches the rear of PU1. A small UR3 is present behind U2. One short, broad and rod-like epural (EP1) is located in the prolongation of the shortened neural spine of PU2.

There is a series of long and broad ossified ligaments above the last neural spines preceding the tail.

The caudal fin is forked, with the two lobes of the same length. There are 19 principal caudal rays, 11 dorsal and 9 ventral procurrent rays (= basal fulcra). The longest procurrent rays of each lobe are already segmented. The most external dorsal and ventral principal rays are segmented and pointed. The seventeen other principal rays are segmented and branched. The most dorsal and the most ventral last scales have an irregular shape that differs from the more ovoid preceding scales. They take the place of the caudal scutes generally present in the tail region of pachyrhizodontid fishes.

The squamation (Fig. 1, 5-8)
The scales are large, ovoid, deeper than long, extremely thick and ornamented with small alveoli and tubercles.

DISCUSSION

Cavinichthys pietrarojae* and *Caeus* (*"Chanos"*) *leopoldi
When *Cavinichthys pietrarojae* was figured for the first time (Capasso, 2007: fig. 170A), it was considered as a probable specimen of *Caeus* (*"Chanos"*) *leopoldi* Costa, 1860, another large teleost present in the Albian deposits of Pietraroja. This fossil chanid fish was re-studied recently (Taverne and Capasso, 2017), allowing now an accurate comparison with *Cavinichthys pietrarojae*.

Caeus leopoldi has a broad frontal, a preopercle with an elongate ventral branch, only 51 vertebrae, epicentrals and epipleurals, a dorsal fin with 12 rays and 11 pterygiophores, a first dorsal axonost divided in three branches, an anal fin with 6 rays and 4 pterygiophores, two epurals, two uroneurals, a complete neural spine on PU2, a shortened neural spine on PU1, HY1 and HY2 separated, HY2 fused to U1 and small cycloid scales with *circuli* and *radii*.

For all these characters, *Caeus leopoldi* completely differs from *Cavinichthys pietrarojae*. The two species clearly belong to two different genera.

***Cavinichthys pietrarojae* and the other large teleosts of Pietraroja**
D'Erasmo (1915) points out the presence of five other rather large teleosts in the ichthyofauna of Pietraroja, *Chirocentrites coroninii* Heckel, 1850, *Elopopsis* aff. *fenzii* Heckel, 1856, *Sauropsidium laevissimum* Costa, 1856, *Hypsospondylous bassanii* Gorjanovic-Kramberger, 1884 and *Hemieloposis gibbus* Gorjanovic-Kramberger, 1886. Unfortunately the description of their skull is not detailed and nothing is written about their caudal skeleton. However, a superficial comparison remains possible.

Chirocentrites coroninii belongs to the family Ichthyodectidae. Its small braincase, its short, broad and prognathous lower jaw, its large fang-like teeth, the shape of its body, the length of its axial skeleton, the proportions and the position of its dorsal and anal fins near the tail (Taverne, 2008a: figs 2, 3) completely differ from the same anatomical elements of *Cavinichthys pietrarojae*.

Elopopsis aff. *fenzii* has a more elongate and acuminate snout than *Cavinichthys pietrarojae*, a shorter supramaxilla, a preopercle with a well developed ventral branch and small individualized conical teeth not ranged in patch, (D'Erasmo, 1915: figs 26, 27, pl. 4, figs 1-4).

In *Sauropsidium laevissimum*, the articulation of the lower jaw and the quadrate is located at the level of the middle length of the orbit, the ventral

branch of the preopercle is well marked, the dorsal fin contains 24 rays, the anal fin 14 rays and the scales are small and delicate (ibid., 1915: pl. 3).

In *Hypsospondylous bassanii*, the lateral faces of the vertebrae are ornamented with numerous thin crests, epineurals and epipleurals are present in the caudal region of the body, the origin of the ventral fin is located before the origin of the dorsal fin, the posterior margin of the scales is pectinate and the caudal scutes have a elongate and acuminate exterior extremity (ibid., 1915; fig. 31a, b, pl. 5, fig. 3).

All the specimens of Pietraroja referred to *Hemieloposis gibbus* are incomplete and badly preserved (ibid., 1915: pl. 5: figs 1, 2,). The skull is not known. The number of vertebrae is thought to be of about 47-48. The dorsal and the ventral fins are opposite. The dorsal fin has no more than 10 rays.

These short comparisons are sufficient to show that *Cavinichthys pietrarojae* differ from those five fishes and can not be referred to one or another of them.

The relationships of *Cavinichthys* within Teleostei

Cavinichthys has a long maxilla that forms the greatest part of the oral margin of the upper jaw. The three posterior infraorbitals are wide bones with an important membranous component. The retroarticular is autogenous. The pelvic girdle is abdominal. The dorsal and anal fins are devoid of strong spines. The supraneurals are numerous. The first epineurals are fused to the neural arches. PU1, U1 and U2 are autogenous. There are three uroneurals. The caudal fin contains 19 principal rays. The scales are not ctenoid. All these characters indicate that the new Italian genus belongs to the primitive Teleostei.

Cavinichthys also exhibits a few specialized characters. The parietal is a small bone and the skull is latero-parietal. The antorbital is missing and the long supraorbital reaches the first infraorbital. There is only one elongated and anteriorly acuminate supramaxilla. The two ventral hypurals are fused together. The anterior extremity of the first uroneural is broadened and partly covers the lateral face of the vertebrae. Within primitive teleosts, only Pachyrhizodontidae share these specialized anatomical features. *Cavinichthys* obviously belongs to this family.

The relationships of *Cavinichthys* within Pachyrhizodontidae

Until now, the only real attempt to retrace the phylogeny within Pachyrhizodontoidei is the one of Cavin (2001: fig. 16) that also involves other primitive teleostean fishes.

One cranial and two caudal characters allow to precise the systematic position of *Cavinichthys* in Pachyrhizodontidae.

(1) Some members of the family share a specialized cranial feature, the

development of a posterior acuminate process on the pterotic (Cavin, 2001, character 3[1]). The concerned group includes the genera *Platinx* Agassiz, 1835, *Rhacolepis* Agassiz, 1841, *Elopopsis* Heckel, 1856, *Goulmimichtys* Cavin, 1995, *Nardopiscis* Taverne, 2008 and *Apricenapiscis* Taverne, 2013 (Forey, 1977: figs 12-14, 34; Taverne, 1980: fig. 1, 1994: fig. 3, 2008: figs 4, 5, 2013: figs 3, 5; Cavin, 2001: fig. 2). *Cavinichthys*, *Pachyrhizodus* Dixon, 1850, *Greenwoodella* Taverne & Ross, 1973 and *Aquilopiscis* Cumba & Murray, 2008 do not possess a posterior pointed process on the pterotic (Bartholomai, 1969: fig. 48; Forey, 1977: fig. 25; Taverne, 1991: fig. 2; Cumbaa and Murray, 2008: fig. 7).The situation is uncertain in *Tingitanichtys* Taverne, 1996, the most posterior part of the pterotic being unknown in this fish (Taverne, 1996: fig. 3).

(2) A few Pachyrhizodontidae exhibit another evolved feature. They have a forked anterior extremity on UR1 (Cavin, 2001; character 58[1]). The concerned genera are *Pachyrhizodus*, *Rhacolepis*, *Goulmimichthys* and *Aquilopiscis* (Nelson, 1973: fig. 8A; Forey, 1977: figs 24, 36; Taverne, 1987: fig. 4; Maisey, 1991: fig. p. 255; Cavin, 2001: fig. 11B; Cumbaa and Murray, 2008: fig. 10). *Cavinichthys* and the other pachyrhizodontid genera do not share this advanced character. They have a less specialized UR1, just broadened but not forked in its forepart. The caudal skeleton is unknown in *Greenwoodella*, *Nardopiscis* and *Apricenapiscis*.

(3) Most pachyrhizodontid fishes have still another specialized character. Their two ventral hypurals, eventually fused together, are fused to U1 (Cavin, 2001, character 64[1]). This pattern is present in *Pachyrhizodus*, *Rhacolepis*, *Platinx*, *Tingitanichthys* and *Goulmimichthys* (Nelson, 1973: fig. 8A; Forey, 1977: figs 24, 36; Taverne, 1980: fig. 6, 1987: figs 4, 5, 1996: fig. 5; Cavin, 2001: fig. 11B). In *Elopopsis* and *Aquilopiscis*, the ventral hypurals are articulated on the corresponding centrum but not fused with this vertebra (Taverne, 1994: fig. 6; Cumbaa and Murray, 2008: fig. 10). The oldest known pachyrhizodontoid fish dates back to the Upper Jurassic and was found in Chile. The two ventral hypurals are fused together but not with the last vertebrae (Arratia and Schultze, 1999: fig. 17). The situation is unknown in *Greenwoodella*, *Nardopiscis* and *Apricenapiscis*.

The characters discussed in points (1), (2) and (3) show that *Cavinichthys* occupies in the phylogeny of the family a plesiomorphic position in regard to *Platinx*, *Rhacolepis*, *Pachyrhizodus*, *Elopopsis*, *Tingitanichthys*, *Goulmimichthys*, *Nardopiscis*, *Apricenapiscis* and *Aquilopiscis*.

A phylogenetic comparison with *Greenwoodella* is not possible, this genus being only known by its skull (Taverne, 1991).

The generic validity of *Cavinichthys*

Cavinichthys is the only member of the family with minute teeth ranged in wide patches on the premaxilla, the maxilla and the dentary. Most other pachyrhizodontid fishes have small to middle-sized teeth on the jaws. Two genera exhibit edentulous jaws, *Greenwoodella* and *Nardopiscis* (Taverne, 1991: fig. 1, 2008b: figs 3, 6).

It is also to be noted that *Cavinichthys* has particularly thick and ornamented scales, is devoid of epipleurals and of true caudal scutes and exhibits a series of ossified ligaments in the tail region, four characters that also mark differences with the other members of the family.

All these features amply justify the peculiar generic status of the new Italian pachyrhizodontid fish.

ACKNOWLEDGMENTS

We greatly thank Dr. Silvano Agostini, Superintendant of the Soprintendenza per i Beni Archeologici dell'Abruzzo – Chieti, for allowing us to study the fossil fishes of the Capasso collection. We are grateful to M. Adriano Vandersypen, from the Royal Institute of Natural Sciences of Belgium, and to M. Luciano Lullo, from the University of Chieti, for their technical help. We are also indebted to the anonymous reviewers who have read and commented our text.

List of abbreviations used in text-figures

AN: angular; BR: fragments of branchial bones; BRSTG: branchiostegal rays; CLT: cleithrum; DETH: dermethmoid (= rostral, dermic component of the mesethmoid); DN: dentary; DSPH: dermosphenotic; ECPT: ectopterygoid; EP: epural; EPI: epiotic (= epioccipital); EPIN: epineural; FR: frontal; HCLT: hypercleithrum (= supracleithrum); HEM: haemal arch; HEMAP: haemapophysis (= parapophysis); HEMEP: haemal spine; HY 1 + 2: fused hypurals 1 and 2; HY 3: hypural 3; IORB 1 + 2: fused infraorbitals 1 and 2; IORB 3, 4, 5: infraorbitals 3, 4 and 5; LEP: fin ray (= lepidotrichia); LETH: lateral ethmoid; METH: ossified endochondral part of the mesethmoid; MX: maxilla; NP PU2: shortened neural spine of preural vertebra 2; NA: nasal; NEUR: neural arch; NEUREP: neural spine; OP: opercle; OSPH: orbitosphenoid; PA: parietal; PHY: parhypural; PMX: premaxilla; POP: preopercle; PSPH: pleurosphenoid (= pterosphenoid); PTE: pterotic; PU1-5: preural vertebrae 1 to 5; QU: quadrate; RART: retroarticular; RI: rib; c. RI: cephalic rib; SC: modified caudal scale; SCL: sclerotic bony ring; SMX: supramaxilla; SOC: supraoccipital; SOP: subopercle; SORB: supraorbital; ST: supratemporal (= extrascapular, scale bone); U1-2: ural vertebrae 1 and 2; UHY: urohyal (= parahyoid); UR 1-3: uroneurals 1 to 3; V: vertebral centrum; VO: vomer; br. fi.: branchial filaments; l.: left; oss. lig.: ossified ligaments; r.: right.

REFERENCES

Arratia G., 2008 - The varasichthyid and other crossognathiform fishes, and the break-up of Pangaea. *In*: Cavin L., Longbottom A., Richter M. (eds). *Fishes and the Break-up of Pangaea*. Geological Society, London, Special Publications **295**: 71-92.

Arratia G., Schultze H.-P., 1999 - Mesozoic fishes from Chile. *In*: Arratia G., Schultze H.-P. (eds). *Mesozoic Fishes 2 – Systematics and Fossil Record*. Verlag Dr. F. PFEIL, München: 565-593.

Bartholomai A., 1969 – The Lower Cretaceous elopoid fish *Pachyrhizodus marathonensis* (Etheridge Jr). *In*: Campbell K. S. W. (ed.), *Stratigraphy and Paleontology*. Australian National University Press, Canberra: 249-263.

Bravi S., 1996 - *Ricerche sui livelli ad ittioliti in facies di piattaforma carbonatica dell'Italia Meridionale*. Tesi di dottorato, Universita degli Studi di Napoli Federico II: 396 pp.

Capasso L., 2000 - Storia della Paleoittiologia Italiana. *Atti del Museo Civico di Storia Naturale di Trieste* **48**: 251-260.

Capasso L., 2007 - *Pietraroja pietre e memorie*. Ed. Paper's World, Teramo: 1-181.

Cavin L., 2001 - Osteology and phylogenetic relationships of the teleost *Goulmimichthys arambourgi* Cavin, 1995, from the Upper Cretaceous of Goulmima, Morocco. *Eclogae geologicae Helvetiae* **94**: 509-535.

Costa O. G., 1853-1860 - *Ittiologia fossile italiana. Opera da servire di supplemento alle ricerche su i pesci fossili di L. Agassiz*. Napoli: I-VIII + 1-67.

Costa O. G., 1864 - Paleontologia del regno di Napoli. Parte 3. *Atti dell'Academia Pontaniana* **8**: 1-196.

Cumbaa S. L., Murray A. M., 2008 – New Late Cretaceous pachyrhizodontid and enchodontoid fishes and associated ichthyofauna from the Northwest Territories, Canada. *In*: Arratia G., Schultze H.-P., Wilson M.V.H. (eds). *Mesozoic Fishes 4 – Homology and Phylogeny*. Verlag Dr. F. PFEIL, München: 229-256.

D'Erasmo G., 1914 - La fauna e l'età dei calcari a ittioliti di Pietraroia. Parte I. *Palaeontographica Italica, Memorie di Paleontologia*, Pisa **20**: 1-58.

D'Erasmo G., 1915 - La fauna e l'età dei calcari a ittioliti di Pietraroia. Parte II. *Palaeontographica Italica, Memorie di Paleontologia*, Pisa **21**: 59-111.

Forey P.L., 1977 - The osteology of *Notelops* Woodward, *Rhacolepis* Agassiz and *Pachyrhizodus* Dixon (Pisces: Teleostei). *Bulletin of the British Museum (Natural History), Geology* **28** (2): 123-204.

Freels D., 1975 - Plattenkalke Becken bei Pietraroja (Prov. Benevento, Sud Italien) als Vorussetzug einer fossillagerstätte Erbildung. *Neues Jahrbuch für Geologie und Paläontologie Abtleilung* **148**: 320-352.

Maisey J. G., 1991 - *Rhacolepis* Agassiz, 1841. Santana Fossils. An Illustrated Atlas, T. H. F. (ed.), Neptune City, U.S.A.: 248-257.

Nelson G. J., 1973 – Notes on the structure and relationships of certain Cretaceous and Eocene teleostean fishes. *American Museum Novitates* **2524**: 1-31.

Patterson C., 1993 - Osteichthyes: Teleostei. *In*: Benton, M. J. (ed.). *The Fossil Record 2*. Chapman & Hall, London: 621-656.

Signore M., 2004 - Sample excavations in Pietraroja (lower Cretaceous, Southern Italy) in 2001 and notes on the Pietraroja palaeoenvironment. *www. PalArch.nl, vertebrate paleontology* **2**(2): 13-21.

Taverne L., 1980 - Ostéologie et position systématique du genre *Platinx* (Pisces, Teleostei) de l'Eocène du Monte Bolca (Italie). *Académie Royale de Belgique*, *Bulletin de la Classe des Sciences*, 5e série **66** (11): 873-889.

Taverne L., 1987 – On the cranial and caudal osteology of the Cretaceous marine teleost *Pachyrhizodus* (Pachyrhizodontidae, Crossognathiformes). *Biologish Jaarboek Dodonaea* **55** (1): 136-145.

Taverne L., 1989 - *Crossognathus* Pictet, 1858 du Crétacé inférieur de l'Europe et systématique, paléozoogéographie et biologie des Crossognathiformes nov. ord. (Téléostéens) du Crétacé et du Tertiaire. *Palaeontographica*, Stuttgart, A **207** (1-3): 79-105.

Taverne L., 1991 – *Greenwoodella tockensis* Taverne and Ross, 1973 from the marine Lower Aptian (Töck) of Helgoland (West Germany), the oldest known pachyrhizodontid fish (Teleostei, Crossoganithiformes). *Geologisches Jahrbuch*, A **120**: 305-309.

Taverne L., 1994 - Ostéologie et affinités du Téléostéen crétacique *Elopopsis microdon* (Pisces, Crossognathiformes, Pachyrhizodontidae). *Biologish Jaarboek Dodonaea* **61** (1993): 172-192.

Taverne L., 1996 - Révision de *Tingitanichthys heterodon* (Arambourg, 1954) nov. gen. (Teleostei, Pachyrhizodontoidei) du Crétacé supérieur marin du Maroc. *Biologisch Jaarboek Dodonaea* **63** (1995): 133-151.

Taverne L., 2008a - Considerations about the Upper Cretaceous genus *Chirocentrites* and erection of the new genus *Heckelichthys* (Teleostei, Ichthyodectiformes). A new visit inside the ichthyodectid phylogeny. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Sciences de la Terre* **78**: 209-228.

Taverne L., 2008b. Les poissons crétacés de Nardò. 29°. *Nardopiscis cavini* gen. et sp. nov. (Teleostei, Crossognathiformes, Pachyrhizodontidae). *Bollettino del Museo Civico di Storia Naturale di Verona*, *Geologia Paleontologia Preistoria* **32**: 19-28.

Taverne L., 2013. Les poissons du Santonien (Crétacé supérieur) d'Apricena (Italie du Sud). 4°. *Apricenapiscis depotteri* gen. et sp. nov. (Teleostei, Crossognathiformes, Pachyrhizodontidae). *Bollettino del Museo Civico di Storia Naturale di Verona*, *Geologia Paleontologia Preistoria* **37**: 57-66.

Taverne L., Capasso L., 2017 – Osteology and relationships of *Caeus* (*«Chanos»*) *leopoldi* (Teleostei, Gonorynchiformes, Chanidae) from the marine Albian (Early Cretaceous) of Pietraroja (Campania, southern Italy). *Bollettino del Museo Civico di Storia Naturale di Verona, Geologia Paleontologia Preistoria* **41**: 3-19.

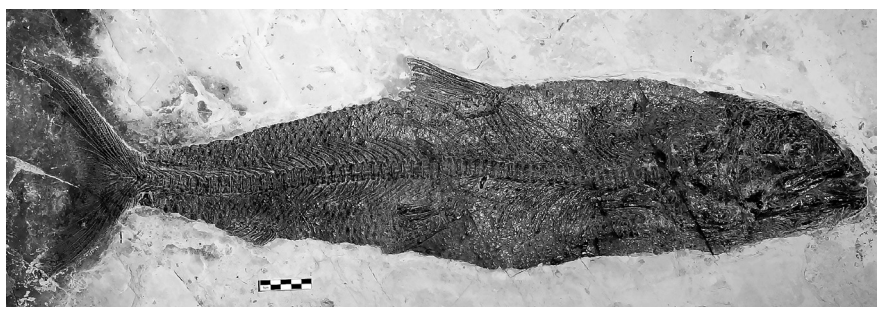

Fig. 1. *Cavinichthys pietrarojae* gen. and sp. nov. Holotype CLC I-123.

Fig. 2. *Cavinichthys pietrarojae* gen. and sp. nov. Head region of holotype CLC I-123.

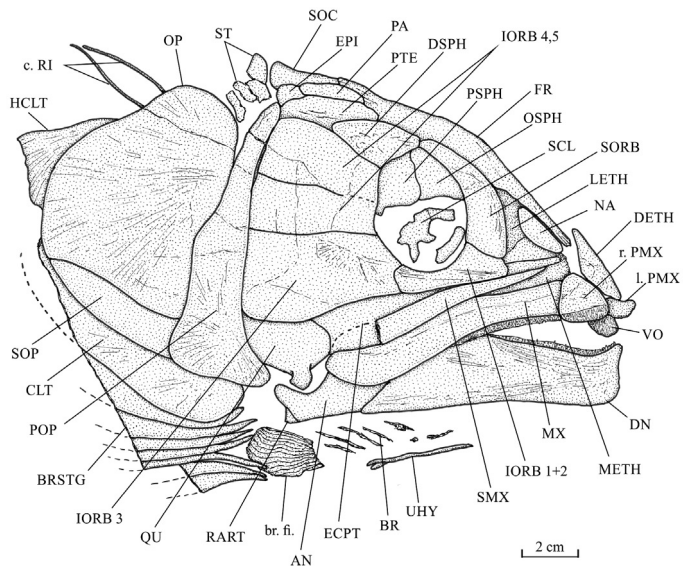

Fig. 3. *Cavinichthys pietrarojae* gen. and sp. nov. Skull and pectoral girdle of holotype CLC I-123.

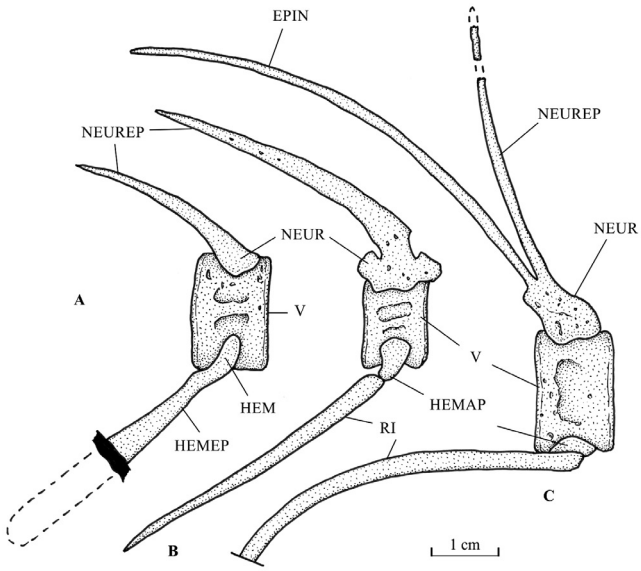

Fig. 4. *Cavinichthys pietrarojae* gen. and sp. nov. Holotype CLC I-123. (A) 44th vertebra (this number includes six vertebrae hidden under the opercle). (B) 34th vertebra. (C) 10th vertebra.

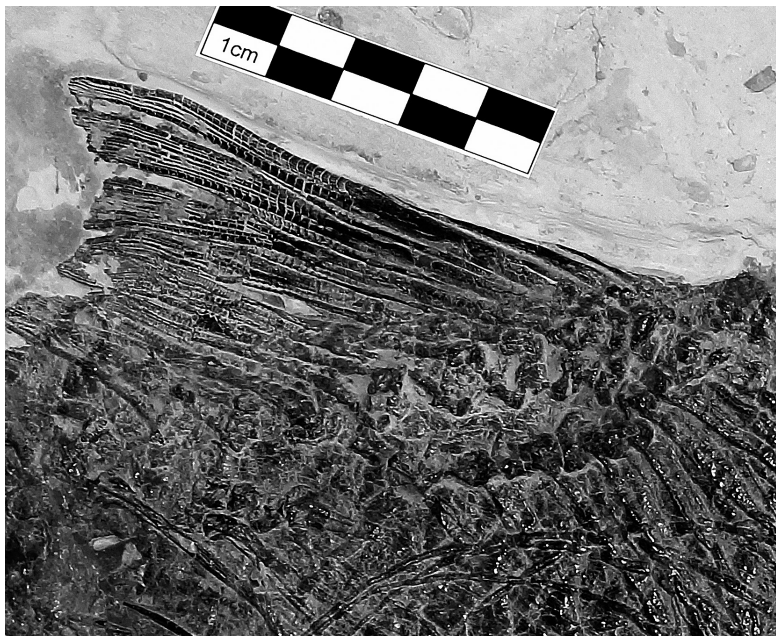

Fig. 5. *Cavinichthys pietrarojae* gen. and sp. nov. Dorsal fin of holotype CLC I-123.

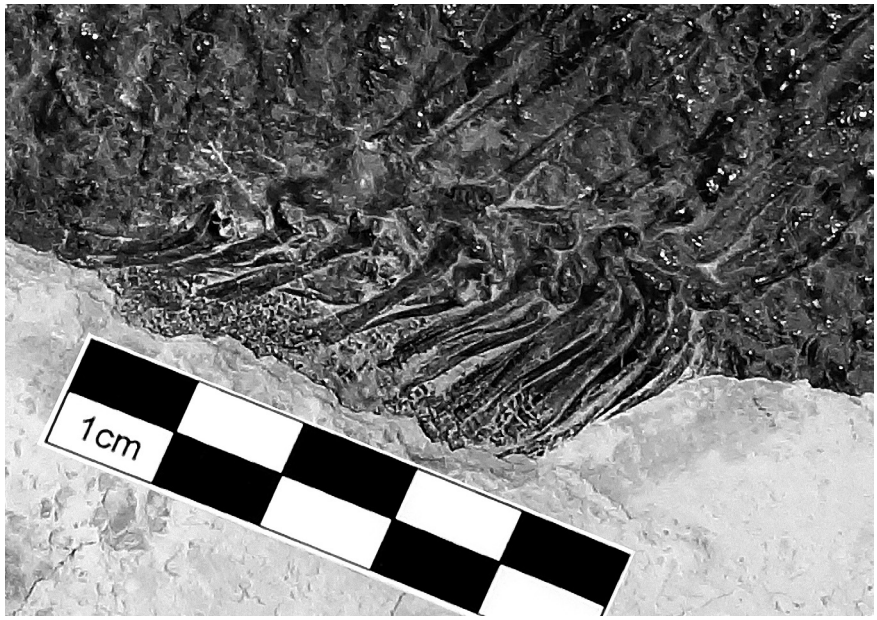

Fig. 6. *Cavinichthys pietrarojae* gen. and sp. nov. Anal fin of holotype CLC I-123.

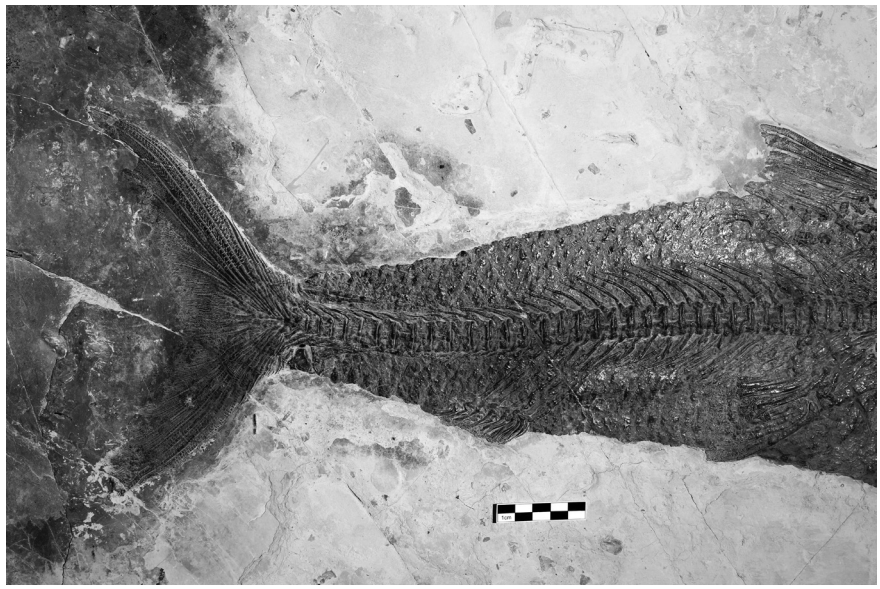

Fig. 7. *Cavinichthys pietrarojae* gen. and sp. nov. Holotype CLC I-123. Caudal region of the body.

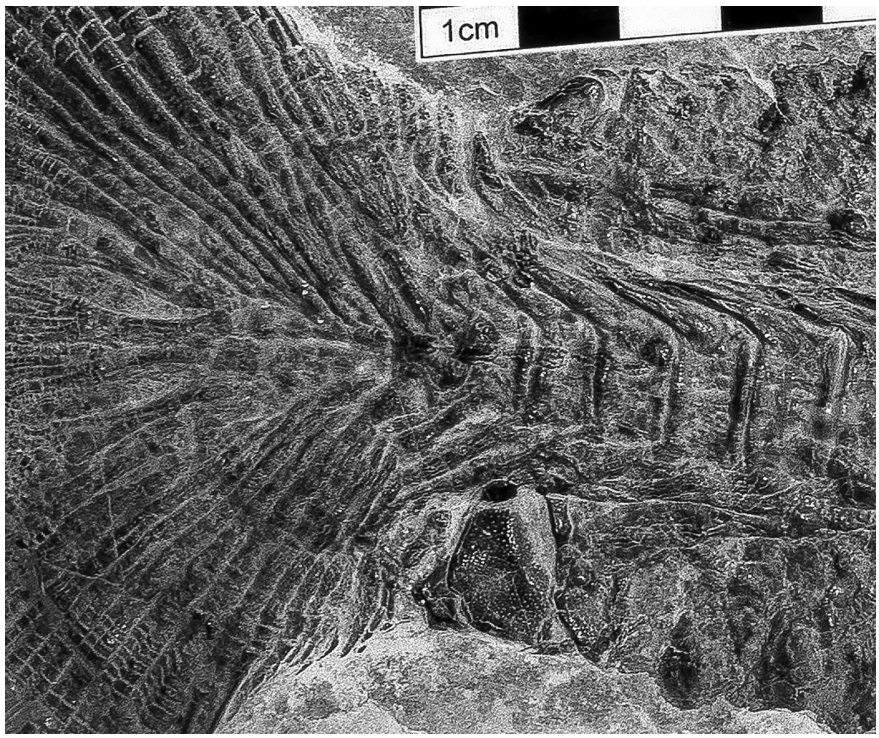

Fig. 8. *Cavinichthys pietrarojae* gen. and sp. nov. Tail region of holotype CLC I-123.

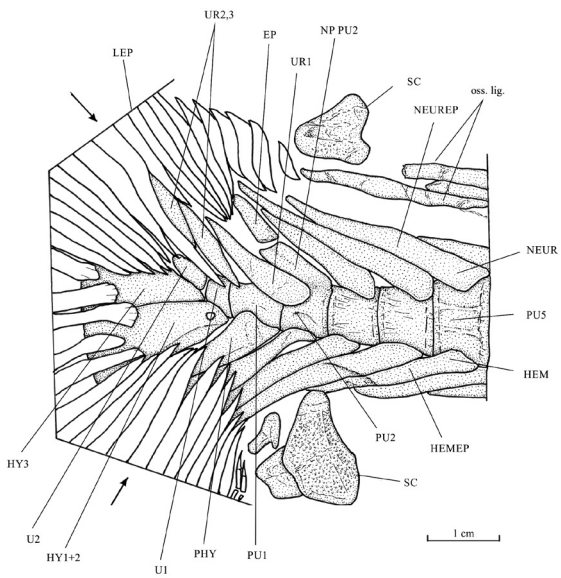

Fig. 9. *Cavinichthys pietrarojae* gen. and sp. nov. Caudal endoskeleton of holotype CLC I-123.