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LOUIS TAVERNE[1], LUIGI CAPASSO[2]

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

ITALOPHIOPSIS DERASMOI GEN. AND SP. NOV. (IONOSCOPIFORMES, ITALOPHIOPSIDAE FAM. NOV.) FROM THE CRETACEOUS OF PIETRAROJA (ITALY)

SUMMARY

The skeleton of *Italophiopsis derasmoi* gen. and sp. nov., an ionoscopiform fish (Halecomorphi) from the marine Albian of Pietraroja (Campania, southern Italy), is studied in details. The new Italian genus has parietals and dermopterotics of approximately the same length, unornamented infraorbitals and diplospondylous vertebrae in the caudal region, three features characterizing Ophiopsidae. *Italophiopsis* also exhibits crests and fossae on the first abdominal vertebrae and thin ovoid and slightly ornamented scales, two characters that are absent in Ophiopsidae but announce the lateral fossae of the vertebrae and the thin ovoid amioid-like scales present in Ionoscopidae. *Italophiopsis* probably has around 20 supraneurals between the head and the dorsal fin, a number found in Ionoscopidae but differing from that of Ophiopsidae. Such a situation does not allow the inclusion *Italophiopsis* in one of these two families. The new family Italophiopsidae is erected and considered as intermediate between Ophiopsidae and Ionoscopidae.

INTRODUCTION

The marine Albian fossil fishes of Pietraroja (Benevento Province, Campania, southern Italy) constitute one of the richest Early Cretaceous ichthyofaunas in the world. These fishes are known since the 18th century and were principally studied by Costa (1853-1860; 1864) and D'Erasmo (1914; 1915).

Ionoscopus petrarojae Costa, 1853 is one of the numerous fossil fishes from the Early Cretaceous strata of Pietraroja. It was the subject of a recent revision (Taverne and Capasso, 2016). Until now, *I. petrarojae* was the only member of the Ionoscopiformes recorded in the ichthyofauna of Pietraroja.

The aim of our present paper is to describe a second fish from those deposits that also belongs to this order.

Ionoscopiformes are a lineage of Mesozoic halecomorph fishes that contains about a dozen of genera. They are divided in two families, Ionoscopidae and Ophiopsidae. A third family, Oshuniidae, erected for *Oshunia* Wenz and Kellner, 1986 from the Early Cretaceous of Brazil (Grande and Bemis, 1998), is now synonymised with the Ionoscopidae. Most Ionoscopiformes are marine fishes. Only one species, *Congophiopsis lepersonnei* (De Saint-Seine, 1950) from the Middle Jurassic of the Democratic Republic of Congo, is of freshwater origin (Taverne, 2015).

Robustichthys Xu *et al.*, 2014 and *Panxianichthys* Xu and Shen, 2015 from the Anisian (Middle Triasisc) of China are considered as the oldest occurrence of the order by some (Xu *et al.*, 2014; Xu and Shen, 2015). Others disagree. They consider *Robustichthys* as a stem-group Ginglymodi and *Panxianichthys* as a member of a new halecomorph order, the Panxianichthyiformes, that represents the sister group of a lineage containing Amiiformes and Ionoscopiformes (Sun *et al.*, 2017). *Archaeosemionotus* Deecke, 1889 from the Ladinian (Late Triassic) of northern Italy is the oldest ionoscopiform fish recorded in Europe (López-Arbarello *et al.*, 2014). *Ionoscopus petrarojae* from the Albian (Early Cretaceous) of southern Italy and the new genus hereafter described represent the youngest occurrence of the order.

MATERIAL AND METHODS

The specimen hereafter studied belongs to the Luigi Capasso collection (CLC) in Chieti (Abruzzo, Italy). The material was studied with a stereomicroscope Leica Wild M 8. The drawings for the figures were made by the first author and the photos by the Mr. Luciano Lullo from the Universita "G. d'Annunzio" di Chieti-Pescara.

The Capasso collection is legally registered 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 1089/39. 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).

SYSTEMATIC PALEONTOLOGY

Subclass Actinopterygii Klein, 1885

Series Neopterygii Regan, 1923
Division Holostei Müller, 1845
Subdivision Halecomorphi Cope, 1871
Order Ionoscopiformes Grande and Bemis, 1998
Family Italophiopsidae fam. nov.

Diagnosis
The same as the genus (monogeneric family)

Genus ***Italophiopsis*** gen. nov.

Diagnosis
The same as the species (by monospecificity).

Etymology
The new generic name refer to Italy and to the ionoscopiform genus *Ophiopsis*.

Species ***Italophiopsis derasmoi*** gen. and sp. nov.

Diagnosis
Small ionoscopiform fish characterized by the following unique combination of features. Parietal approximately equal in length to the dermopterotic. Large dermosphenotic incorporated in the skull roof and completely covering the autosphenotic. Basioccipital posteriorly protruding. Sigma-shaped autopalatine. Entopterygoid bearing a few acuminate teeth. Quadrate and symplectic rod-like. Toothed jaw with strong conical teeth. Maxilla outpacing the level of the orbit and reaching the preopercle. Posterior margin of maxilla slightly concave. One long and narrow supramaxilla. Enlarged articular. Autogenous retroarticular. Five unornamented infraorbitals, with the third one greatly enlarged. Two supraorbitals. Two well developed postorbitals (= suborbitals). Elongate crescent-like preopercle. Small gular plate. Hyoid bar long, narrow, bearing 16 long and thin branchiostegal rays. 61 vertebral segments, with a total of 84 centra. 38 monospondylous abdominal vertebrae. 23 diplospondylous caudal vertebrae. Crests and fossae present on the first abdominal vertebrae. Around 20 supraneurals. Dorsal fin elongate with around 25 rays. Origin of the dorsal fin located at the level of the 19th vertebra and anterior to the origin of ventral fins. Centra of the caudal endoskeleton ossified. Last neural spine associated to the 77th centrum (a precentrum). Small uroneural-like elements visible above last centra. 6 long and thin epurals. Caudal fin supported by 14 long and slightly broadened hypaxial elements. Thin, more or less ovoid scales, slightly ornamented with feebly marked tubercles.

Etymology
The new specific name is given in honour of Geremia D'Erasmo (1887-1962), one of the most famous Italian paleontologist of the 20th century and the principal scientist having studied the fossil fish fauna of Pietraroja (cf. Capasso, 2000; 2007).

Holotype
CLC I-218. A complete specimen seen from its left side and preserved partly in bones partly in imprints (Fig. 1, 2). Total length: 102 mm. Standard length: 82 mm.

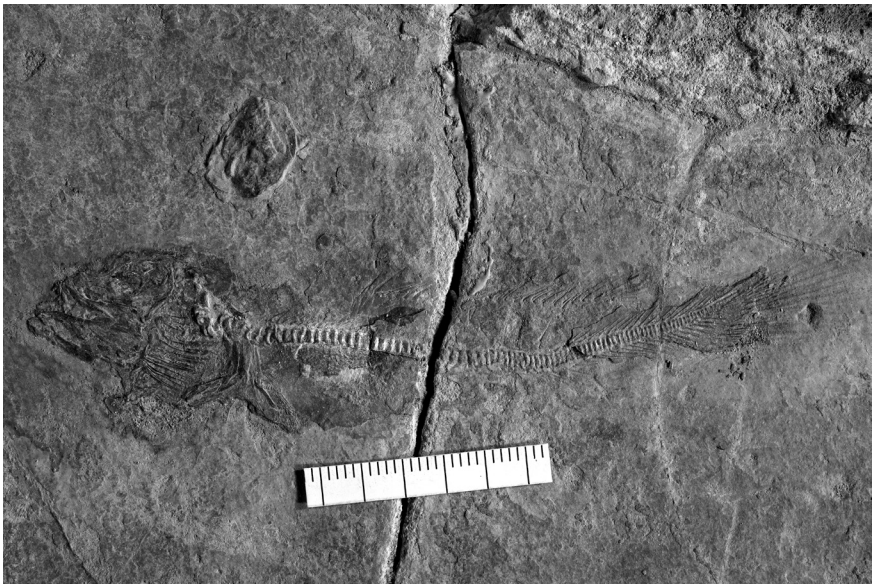

Fig. 1. *Italophiopsis derasmoi* gen. and sp. nov. Holotype CLC I-218. Scale in mm.

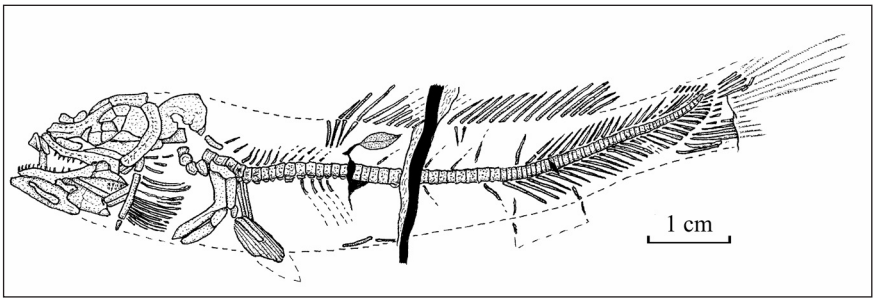

Fig. 2. *Italophiopsis derasmoi* gen. and sp. nov. Reconstruction of holotype CLC I-218.

Formation and locality
Limestones of Pietraroja, marine Albian (Early Cretaceous), around the village of Pietraroja, province of Benevento, Campania, southern Italy.

Morphometric data
The morphometric data are given in percentage (%) of the standard length (82 mm) of the holotype.
Head length (opercle included) .....32.0 %
Head depth .....21.3 %
Maximum body depth (between the head and the dorsal fin).....21.8 %
Length of the pectoral fin.....9.8 %
Predorsal length.....48.4 %
Length of the dorsal fin basis .....38.2 %
Preanal length around .....71 %
Caudal peduncle depth .....9.8 %

Osteology

The skull (Fig. 3, 4)

The skull is preserved in bones for a large part and in imprints for a small part. The cranial bones are moderately thick and devoid of ornamentation.

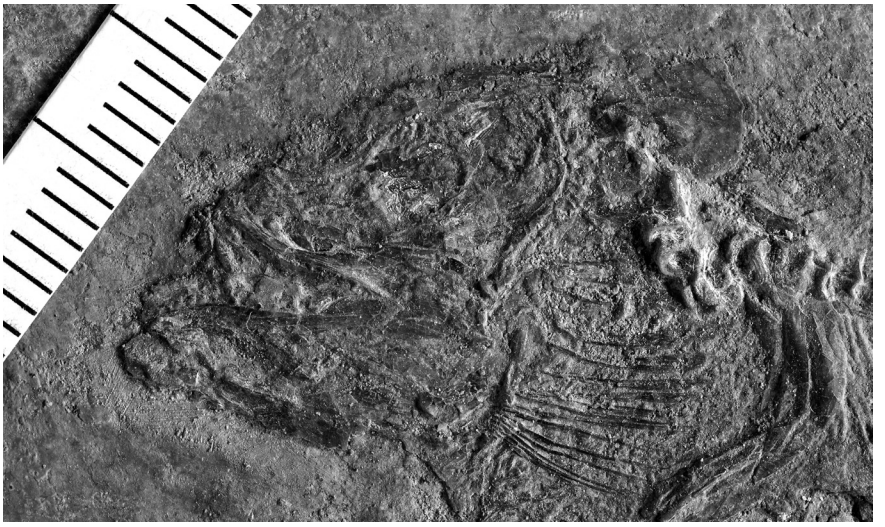

Fig. 3. *Italophiopsis derasmoi* gen. and sp. nov. Head region of holotype CLC I-218. Scale in mm.

No part of the endocranium is apparent, except a large protruding basioccipital that is visible under the opercle.
The median dermethmoid (= rostral) occurs at the anterior border of the skull roof. The bone is well developed and triangular in shape, with its two posterior corners forming a small point. The rostral sensory commissure crosses the dermethmoid from one corner to the other and is not open by pores. The lateral ethmoids and the nasals are not preserved. The upper face of the vomer is visible between the dermethmoid and the left maxilla.

The skull roof is seen in dorsal view. It exhibits the usual sand-glass shape, with a broad preorbital region, a strong narrowing of the frontals at the level of the orbit and an important broadening of the postorbital region. The parietals meet on the mid-line (medioparietal skull). They are elongate but their posterior parts are covered by the displaced infraorbitals and postorbitals. Only the right dermopterotic is preserved but its most posterior portion is lost due to the fossilization. The anterior margin of the dermopterotic is slightly posterior to the anterior margin of the parietal. The dermosphenotic is in-

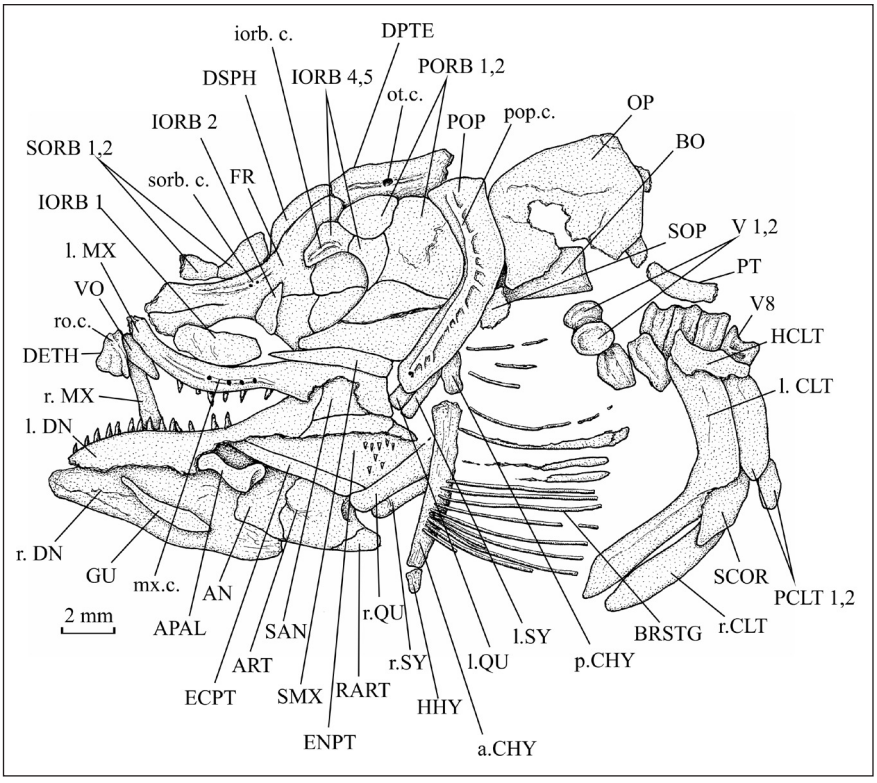

Fig. 4. *Italophiopsis derasmoi* gen. and sp. nov. Skull and pectoral girdle of holotype CLC I-218.

corporated in the skull roof and is sutured to the lateral border of the frontal, just before the dermopterotic. This dermosphenotic is a long bone that completely covers the autosphenotic. No innerorbital flange is visible. This process probably is bent under the bone because of a taphonomic event. The supraorbital sensory canal and the otic sensory canal are visible respectively on the right frontal and the right dermopterotic.
The orbitosphenoid, the pterosphenoids, the basisphenoid and the parasphenoid are hidden under the skull roof.

The palatine arch is almost completely preserved. The autopalatine is massive, short and more or less sigma-shaped. The ectopterygoid is long and narrow. The wide triangular entopterygoid bears a few small conical teeth on its posterior part. The metapterygoid is not visible. The quadrate is a strong rod-like bone. A smaller rod-like symplectic lies along the quadrate. Both the quadrate and the symplectic articulate on the lower jaw.

The jaws are elongate and toothed. The teeth are strong, conical and acuminate. The articulation of the mandible with the quadrate is located much posterior to the level of the orbit. The premaxilla is not preserved. The long and curved maxilla bears a maxillary sensory canal that is opens by a series of small pores. The posterior margin of the maxilla is very slightly concave. There is one long and narrow supramaxilla. The mandible contains a large dentary, an angular, a small surangular forming the coronoid process, a massive articular and an autogenous retroarticular.

The two right supraorbitals are visible along the external border of the frontal. The antorbital is not preserved and we do not know if it reached the orbital margin or not. The first infraorbital is wide and longer than deep. The second infraorbital is dorsally displaced by the fossilization. It is a small triangular bone, with a broad anterior margin and an acuminate posterior region. Such a shape gives a space for the anterior region of the supramaxilla that lies under the second infraorbital. The posterior orbital bones were displaced on the skull roof during the fossilization. The third infraorbital is by far the largest of the series. The fourth and the fifth infraorbitals are smaller. The infraorbitals are not ornamented. As already written, the dermosphenotic is a part of the skull roof. There are two postorbitals (= suborbitals), a small dorsal one and a much wider ventral element. The orbital sensory canal is visible on the fifth infraorbital.

The preopercle is crescent-like and a little broader at is dorsal margin than ventrally. The preopercular sensory canal is well marked. It bears a series of very short secondary tubules. The opercle is more or less rounded and of moderate size. The anterior dorsal corner of the suborpercle is the only preserved part of this bone. The interopercle is lost, due to the fossilization. There is a small gular plate well visible between the left and the right dentaries.

The hyomandibula is not visible. The elongate and narrow hyoid bar con-

tains three thin bones, a small hypohyal, a long anterior ceratohyal and a short posterior ceratohyal. Sixteen long and thin branchiostegal rays are attached on the two ceratohyals.

The girdles (Fig. 3, 4)

Only parts of the posttemporal and of the hypercleithrum (= supracleithrum) are preserved. The cleithrum is divided in two well-developed branches of approximately the same length, one dorsal and one ventral. There are two postcleithra, a dorsal one as high as the upper branch of the cleithrum and a smaller lower one. The distal part of the pectoral fin is lost and the precise number of pectoral rays is unknown. The first pectoral ray is broader than the other rays. No fringing fulcra are visible.

Fragments of the pelvic girdle are present at the level of the 24th to the 28th vertebrae. The pelvic bones are short and narrow. The origin of the ventral fins is a little posterior to that of the dorsal fin. The number of ventral fin rays is unknown.

The axial skeleton (Fig. 1, 2, 5)

The axial skeleton contains 61 vertebral segments, with a total of 84 centra. This count includes two vertebral segments that are missing after the 28th vertebrae, due to a break in the substratum. The first 38 vertebrae are monospondylous. The posterior 23 vertebral segments contain diplospondylous vertebrae, with a precentrum and a postcentrum for each segment, except the last caudal vertebrae that seem again monospondylous with one haemal piece attached to each centrum. The neural and haemal arches and spines are autogenous all along the vertebral axis. In the abdominal region, the haemal arches are formed by paired small haemapophyses (= parapophyses). In the diplospondylous region of the vertebral axis, the neural arches are located above the precentra and the haemal arches below the postcentra. The lateral sides of the first monospondylous vertebrae are ornamented with crests and feebly marked fossae. The following vertebrae only bear some small pits on their lateral faces. This ornamentation progressively disappears on the centra of the diplospondylous region.

A few ribs are preserved. The first ones are robust and rectilinear. The first rib seems associated with the sixth vertebra. The total number of ribs is unknown.

The last supraneural is the only one preserved. It is a thin rod-like bone located just before the first dorsal pterygiophore, at the level of 19th vertebra. If there was one supraneural per vertebral segment, as normally, we can estimate that the total number of supraneurals was around twenty.

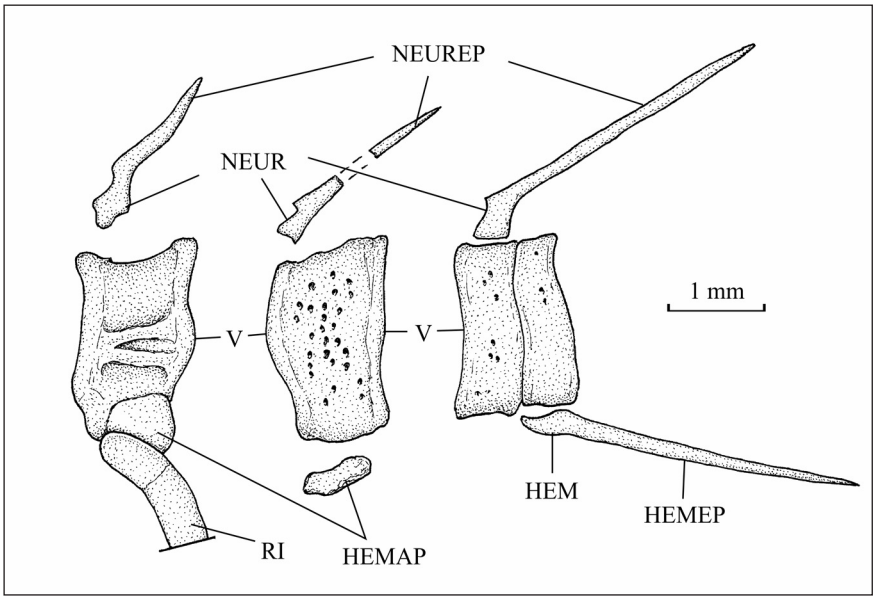

Fig. 5. *Italophiopsis derasmoi* gen. and sp. nov. Holotype CLC I-218. (A) Ninth vertebra (monospondylous). (B) Fourteenth vertebra (monospondylous) . (C) Forty-fifth vertebral segment, with two short centra, the fifty-first and the fifty-second ones (diplospondyly).

The dorsal and anal fin (Fig. 6)

The dorsal fin is elongate and 23 rays are visible. But the total number of rays probably is 25. Indeed, at least two elements are missing between the ninth and the tenth preserved rays, due to a break in the slab. All these rays are unsegmented and unbranched. Neither basal fulcra nor fringing fulcra are present but this absence perhaps is due to an artefact of fossilisation. A few pterygiophores are preserved at the level of the first rays. The origin of the dorsal fin is located at the level of the 19th vertebra and is thus anterior to that of the ventral fins.

Small fragments of anal rays and pterygiophores are visible under the 40th and the 45th vertebral segments.

The caudal endoskeleton and fin (Fig. 7, 8)

All the centra of the caudal endoskeleton are ossified. The last centrum is conical and longer than the preceding ones. The neural spines of the tail region are elongate, thin and very obliquely oriented. The last true neural spine is associated to the 77th centrum (a precentrum). Small fragments of uroneural-like pieces are visible above the last three centra. The proximal parts of 6

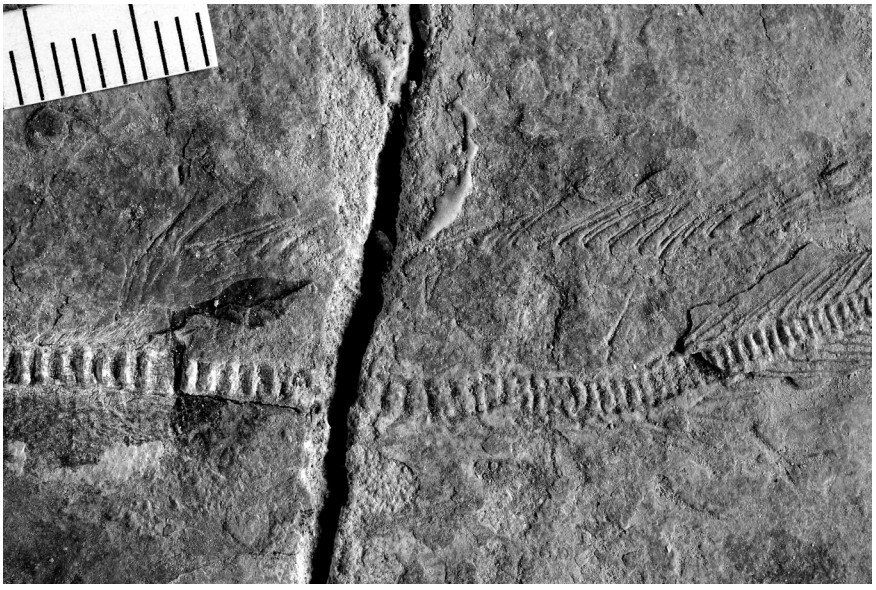

Fig. 6. *Italophiopsis derasmoi* gen. and sp. nov. Middle region of holotype CLC I-218, showing the dorsal fin. Scale in mm.

Fig. 7. *Italophiopsis derasmoi* gen. and sp. nov. Tail region of holotype CLC I-218. Scale in mm.

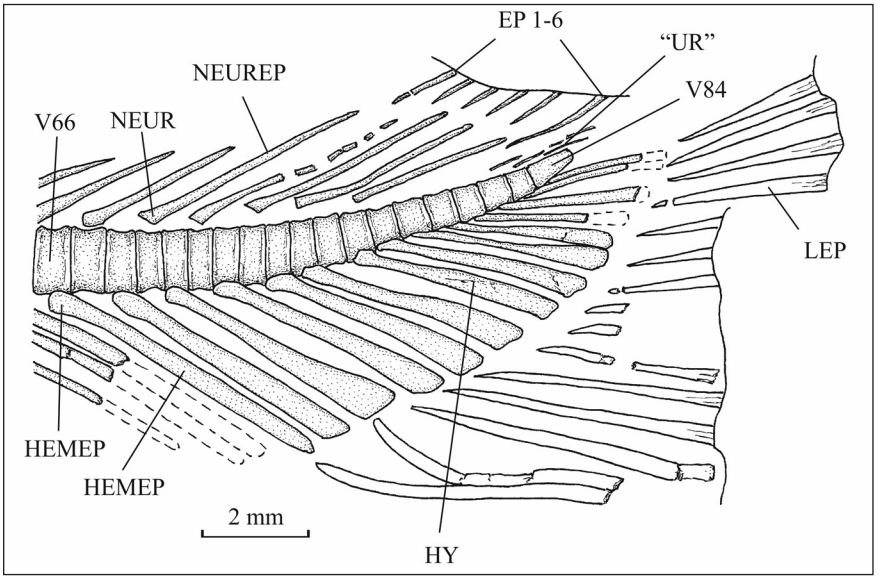

Fig. 8. *Italophiopsis derasmoi* gen. and sp. nov. Caudal skeleton of holotype CLC I-218.

long and thin epurals are preserved. The caudal fin is supported by 14 long and slightly broadened hypaxial elements. It is not possible to determine the exact positions of the parhypural and of the first hypural in this series. From the 77th centrum to the 84th centrum, each vertebral component bears a hypaxial element. These last eight centra seem thus monospondylous again.

Only the proximal region of the caudal fin is preserved. There are 15 rays. Neither basal nor fringing fulcra are visible.

The squamation (Fig. 9)

The scales are not preserved and the axial skeleton is thus visible. We can conclude from this loss that these scales were rather thin. However, a few imprints of scales are visible in some rare places, for instance below the dorsal fin. They are not rhomboid but more or less ovoid and slightly ornamented with feebly marked tubercles.

DISCUSSION

Italophiopsis within Halecomorphi

Within Halecomorphi, the order Ionoscopiformes is characterized by a few peculiar osteological features, such as a sensory canal on the maxilla, elon-

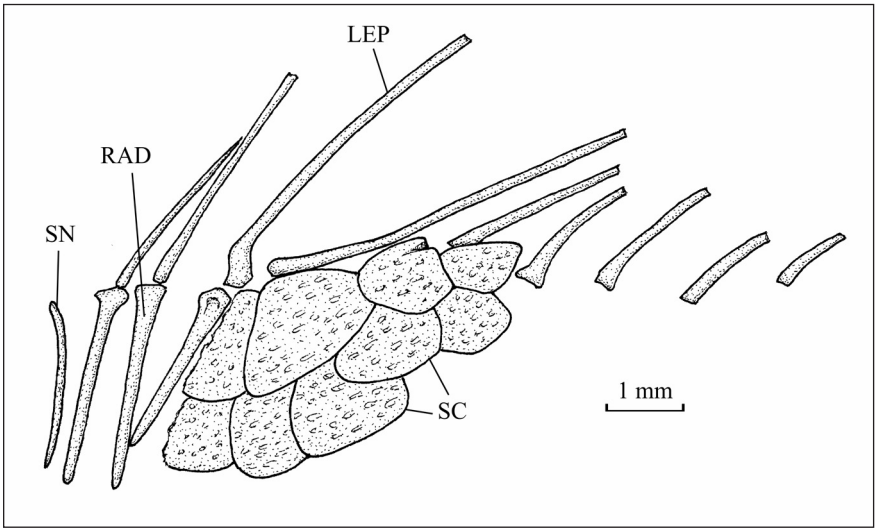

Fig. 9. *Italophiopsis derasmoi* gen. and sp. nov. Holotype CLC I-218. Some scales (imprints) at the level of the dorsal fin origin.

gate parietals, a sand-glass in shape skull roof, with a narrowing at the orbital level and a broadening in the preorbital and postorbital regions, a crescent-shaped preopercle, a dermosphenotic included in the skull roof and bearing an innerorbital flange that links this bone with the upper posterior infraorbital.

Italophiopsis shares all these characters, except the innerorbital flange on the dermosphenotic. But, as already written, this flange probably is hidden under the bone in the concerned specimen, due to a *post mortem* crushing of the skull during the fossilization. We can thus confidently conclude that *Italophiopsis* belongs to the Ionoscopiformes.

Italophiopsis within Ionoscopiformes

The two ionoscopiform families differ by several characters. For instance, Ionoscopidae have the dermopterotic extending before the level of the anterior margin of the parietal, some infraorbitals decorated with ridges and pits, monospondylous vertebrae, centra ornamented with lateral fossae, 15 or more supraneurals and thin subrectangular or ovoid amioid-like scales. On the contrary, Ophiopsidae exhibit parietals and dermopterotics of the same length, unornamented infraorbitals, diplospondylous vertebrae in the caudal region, unornamented centra, less than 15 supraneurals and thick rhomboid scales.

Theoretically and until now, with these well marked differences, it was easy to range each ionoscopiform genus in its own family.
However, the situation of *Italophiopsis* is more complicated as this fossil fish exhibits a mixing of features present in both families. Indeed, the new Italian genus has (1) parietals and dermopterotics of approximately the same length, (2) unornamented infraorbitals, (3) diplospondylous vertebrae in the caudal region, (4) crests and fossae on the first abdominal vertebrae, (5) probably around 20 supraneurals and (6) thin ovoid and slightly ornamented scales. Characters (1), (2) and (3) are shared by Ophiopsidae but not by Ionoscopidae. Chatacters (4) and (6) are absent in Ophiopsidae and announce the fossae present on the lateral faces of the vertebrae in Ionoscopidae and their thin ovoid amioid-like scales Character (5) is typical of Ionoscopidae.

The new Italian ionoscopiform genus keeps thus some features characterizing Ophiopsidae but also possesses some anatomical traits linked with Ionoscopidae. In these conditions, it is not possible to include *Italophiopsis* neither in Ophiopsidae nor in Ionoscopidae. It is why we propose the erection of the new family Italophiopsidae for the new genus *Italophiopsis*, this family being intermediate between Ophiopsidae and Ionoscopidae.

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List of abbreviations used in the text-figures

AN: angular; ART: articular; APAL: autopalatine; BO: basioccipital; BRSTG: branchiostegal ray; a. CHY: anterior ceratohyal; p. CHY: posterior ceratohyal; CLT: cleithrum; DETH: dermethmoid (= rostral); DN: dentary; DPTE: dermopterotic; DSPH: dermosphenotic; ECPT: ectopterygoid; ENPT: entopterygoid; EP 1-6: epurals 1 to 6; FR: frontal; GU: gular plate; HCLT: hypercleithrum (= supracleithrum); HEM: haemal arch; HEMAP: haemapophysis (= parapophysis); HEMEP: haemal spine; HY: hypural; IORB 1-5: infraorbitals 1 to 5; LEP:

fin ray (= lepidotrichia); MX: maxilla; NEUR: neural arch; NEUREP: neural spine; NP PU3: neural spine of preural vertebra 3; OP: opercle; PA: parietal; PCLT 1, 2: postcleithra 1 and 2; POP: preopercle; PORB 1, 2: postorbitals (= suborbitals) 1 and 2; PT: posttemporal; QU: quadrate; RAD: pterygiophores (= radials); RART: retroarticular; RI: rib; SAN: surangular; SC: scale; SMX: supramaxilla; SN: supraneural; SOP: subopercle; SORB 1-2: supraorbitals 1 and 2; SY: symplectic; U 1, 12: ural vertebrae 1 and 12; UD 1, 2: urodermals 1 and 2; "UR": uraneural-like neural arches; V: vertebral centrum; V 1-8: monospondylous vertebrae 1 to 8; V 66: 66th centrum (= postcentrum); V 84: last centrum; VO: vomer; fr. fu.: fringing fulcra; iorb. c.: infraorbital sensory canal; l.: left; mx. c.: maxillary sensory canal; pop. c.: preopercular sensory canal; ot. c.: otic sensory canal; r.: right; ro. c.: rostral sensory commissure; sorb. c.: supraorbital sensory canal.

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