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`BRIEF COMMUNICATION

New records of larval stages of the eel cod genus *Muraenolepis* Günther 1880 (Gadiformes: Muraenolepididae) from the western Antarctic Peninsula

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RUNNING HEAD: LARVAL STAGES OF *MURAENOLEPIS*

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Three newly discovered larval specimens of the genus *Muraenolepis* collected from the waters of the western Antarctic Peninsula are described. Knowledge of their natural history is sparse and information about their early life history is based on only a few larval stages. Here, the available literature on larval eel cods is reviewed, and the specimens placed in context.

Key words: Bregmacerotidae; fish larvae; Gadiformes; Southern Ocean.

Muraenolepididae, eel cods, is a gadiform family that comprises eight species in two genera, including *Muraenolepis andriashevi* Balushkin & Prirodina 2005*, Muraenolepis evseenkoi* Balushkin & Prirodina 2010*, Muraenolepis kuderskii* Balushkin & Prirodina 2007*, Muraenolepis marmorata* Günther 1880*, Muraenolepis orangiensis* Vaillant 1888*, Muraenolepis pacifica* Prirodina & Balushkin 2007*, Muraenolepis trunovi* Balushkin & Prirodina 2006 and *Notomuraenobathys microcephalus* (Norman 1937); five of these have been described in the last 10 years (Balushkin & Prirodina, 2005, 2006, 2007; Prirodina & Balushkin, 2007; Balushkin & Prirodina, 2010*a*). *Muraenolepis microps* Lönnberg 1905 was synonymized with *M. marmorata* by Balushkin & Prirodina (2010*b*), although this was made with no detailed comment. These authors also placed *M. microcephalus* Norman 1937 in its own genus, *Notomuraenobathys* (Balushkin & Prirodina, 2010*b*), based on a greater number of vertebrae, differences in the cephalic sensory canals and body proportions (Balushkin & Prirodina, 2013).

The position of the family among Gadiformes is unclear, and has been proposed as closely related to Bregmacerotidae (Endo, 2002), or as the sister group of all other Gadiformes (Roa-Varon & Orti, 2009), based on morphological and molecular data, respectively. Balushkin & Prirodina (2005) proposed a basal position within the Gadiformes as well. Muraenolepidids are characterized by having two dorsal fins, of which the first consists of two rays; the long second dorsal fin is confluent with the caudal and anal fins. The filamentous pelvic fins, consisting of four to five rays, are in a jugular position. A mental barbel is present in all species, the gill

opening is restricted ventral to the pectoral fin, and a single lateral line is present only on the anterior half of the body. All members of the family are confined to the benthopelagic zone of the cold temperate waters of the southern hemisphere. Most of the species are associated with the Antarctic continental shelf, although some species (*e.g. M. orangiensis* and *M. pacifica*) are found outside the Antarctic shelf region (Gon & Heemstra, 1990; Prirodina & Balushkin, 2007). *Muraenolepis andriashevi* is even reported from the southern coast of Africa (Balushkin & Prirodina, 2005).

Due in part to their distribution in the Southern Ocean and their benthopelagic habitat, knowledge about their natural history is sparse and information about their early life history is based only on a few larval stages. Efremenko (1983), in a comprehensive work on larval fishes of the Southern Ocean, described an unknown number of larvae between 6.5 and 28.5 mm standard length (L_S) as *M. microps,* but illustrated only three individuals. North & White (1982) depicted a 16.6 mm total length (L_T) larva from the Scotia Sea that they assigned to *M. microps*, although they did not provide any characters supporting this identification; this description served as the basis for the most comprehensive identification key of Antarctic larval fishes (Kellermann, 1990). Fahay & Markle (1984) provided information based on a single juvenile (32.2 mm L_T) that they did not assign to a species. Here three newly discovered larval specimens of the genus *Muraenolepis* (Fig. 1) collected from the waters of the western Antarctic Peninsula are described and the information that is known of the larval stages of the genus is summarized.

The smallest larva (VIMS 33000) was 10.5 mm L_T [Fig. 1(a) and Table I], and was collected near Adelaide Island in January 2005 (Fig. 2). The bottom was 598 m at this sampling station and the larva was caught at 119 m depth. The larva is elongated and laterally compressed with a tapered caudal region [Fig. 1(a)]. A narrow fin fold surrounds the body (incomplete due to damage in the present specimen) and the only fin present at this stage is the pectoral fin, although fin rays are lacking. Compared to other gadiform larvae the gut is of moderate length and uncoiled. The pigmentation of the head is restricted to the posterior part of the head, the lower jaw and a line of pigment along the hyomandibular. A wide pigment band occurs dorsally along the gut and is heaviest posteriorly, near the anus. A mediolateral line of pigments extends from just posterior to the head to the caudal peduncle. In the post-anal portion of the body, this pigment extends into the epaxial and hypaxial musculature approximately between myomeres 31 to 52. The tip of the caudal peduncle area lacks pigmentation.

The next smallest larva (VIMS 21608) was 14.5 mm L_T [Fig. 1(b) and Table I)] and was collected off Anvers Island in January 2001, *c.* 30 km from the outer slope of the continental shelf (Fig. 2). The bottom depth was 335 m and the larva was caught at 120 m depth. The body shape of the larva is similar to the smaller stage. The base of the pectoral fin is slightly enlarged and stalk-like (although not as extreme as in macrourid larvae; Fahay & Markle, 1984). No fin rays are present in the pectoral fin at this stage. The anal fin lacks the most posterior fin rays (Table II), whereas the

second dorsal fin lacks the anterior and the most posterior fin rays. The overall pigmentation increases, but does not appear as dark as in the previous stage. The pigmentation of the posterior part of the head is increased overall and the pigmentation bands on the lower jaw and the lateral side of the head have become broader. The pigment along the dorsal surface of the gut has spread and is more evenly distributed than in the previous stage. The pigmentation on the body has increased anteriorly, although the pigment on the mediolateral side of the body appears darker. Dark lines of pigment are present posteriorly along the base of the dorsal and anal fins. The caudal peduncle area still lacks pigmentation.

The third and largest larva described here (VIMS 21106) measured 18.4 mm L_T [Fig. 1(c) and Table I] and was collected off Lavoisier Island in January 1999, *c.* 30 km from the outer slope of the continental shelf (Fig. 2). The bottom depth was 366 m and the larva was caught at 120 m depth. The dorsal profile of the head is concave in this specimen, whereas in the smaller larvae it appears convex. The pectoral fin still lacks fin rays, although its base is no longer stalked, as in the smaller larvae. The anal fin still appears to lack fin rays posteriorly, and the elongate second dorsal fin still lacks fin rays both anteriorly and posteriorly. Although pigmentation has increased, the overall colouration is even lighter than in the smaller specimens. The epaxial pigmentation has increased anteriorly, with just a small patch above the gut without pigment. The post-anal body pigmentation has spread posteriorly, although the caudal area remains free of pigment. The mediolateral line of

pigmentation and those at the base of the dorsal and anal fins are still more pronounced than the remaining body pigmentation.

The sequence of fin development is as follows: pectoral fin base, anal fin, second dorsal fin, pelvic fin, first dorsal fin and finally the caudal fin [the appearance of the first dorsal fin and caudal fin is based on Efremenko's (1983) drawing of a 20.5 mm L_T specimen]. The fin rays of the anal and second dorsal fins appear to develop from a centre far posterior, with fin rays being added bi-directionally. In the 14.5 mm L_T larva [Fig. 1(b)] the anal fin shows well-developed fin rays in the posterior half, but not at the posterior tip. In the 18.4 mm L_T larva [Fig. 1(c)] the dorsal fin lacks fin rays on the most posterior tip as well as the anterior most portion of the fin.

North & White (1982) illustrated a 16.6 mm L_T larva that they assigned to *M. microps* without any evidence. Efremenko (1983) described an ontogenetic growth series assigned to *M. microps* as well. Interestingly, Efremenko's (1983) larvae have a myomere count fewer than 70 [Table I; Leis & Carson-Ewart (2000) is followed here and myomere and vertebral counts considered interchangeable]; these are the lowest counts for any species known. Vertebral counts for *M. marmorata* (67 – 71) and *M. kuderski* (68 – 69) are close to Efremenko's (1983) meristics for *M. microps*; both are known from South Georgia (Scotia Sea), which is where Efremenko's (1983) larvae were collected. *Muraenolepis microps* is also known from the same area, but has a

slightly higher myomere count (70 – 74). The larva depicted by Fahay & Markle (1984) was collected off the northern tip of South Georgia by the British Antarctic Survey. The larva has a geographic and meristic overlap with *M. kuderskii* and *M. marmorata* (the very low number of pectoral fin rays in the larva is possibly because of the late development of the pectoral-fin rays, based on the present specimens). The myomere counts of the present larvae overlap with several species (Table II). Of these, *M. orangiensis* and *M. pacifica* do not occur in the same area from which the larvae were collected. The distribution of *M. evseenkoi* is on the continental shelf around mainland Antarctica, but not on the Peninsula. *Muraenolepis microps* and *M. marmorata* appear to have disjunct distributions, although this may be the result of irregular sampling and collections. It was not possible to identify the present three larvae to species level, although based on myomere (= vertebral) counts, there are three potential species: *M. evseenkoi*, *M. microps* or *M. marmorata* [the synonymy between the latter two proposed by Balushkin & Prirodina (2010*b*) should be more fully examined]. It is possible also to demonstrate that the larvae described prior to the present three specimens (North & White, 1982; Efremenko, 1983) cannot unambiguously be assigned to *M. microps*. Furthermore, the specimens described by Efremenko (1983) could be either *M. kuderskii* or *M. marmorata* based on the overlap of myomere counts.

Muraenolepid larvae are identified by a distinct combination of characters unique among gadiforms: two dorsal fins with 1-2 fin rays in the first dorsal fin, an

elongate body shape, confluent median fins and a late-forming jugular pelvic fin with 4-5 rays. Based on adult characters, muraenolepids have been proposed as basal Gadiformes or as a sister group and larvae do share several similar characters with other Gadiformes such as distinctive pigment patterns, myomeres > 50 and a pectoral fin base that is slightly to strongly pedunculate. Among the other gadiform suborders, muraenolepids have been proposed to be closely related to the gadoid family Bregmacerotidae (Endo, 2002). Larvae of *Bregmaceros* have a distinctive single dorsal fin ray similar to muraenolepids, but it is more anteriorly placed on the head. The median fins are almost confluent, except for a small notch on each side near the caudal fin and the pelvic fin is jugular. Bregmacerotids hatch at small sizes, however, and their larvae have short guts. Muraenolepid larvae also resemble some macrouroid larvae. Macrourid larvae have two dorsal fins, confluent tail (although much longer and tapered), and total myomeres >60 and stalked pectoral fins. Information on larvae of the family Moridae is limited, and the few specimens that are known can be confused with muraenolepid larvae. Morids, however, have two or three dorsal fins, one or two anal fins, and the first fin that forms is the pelvic fin (Fahay & Markle, 1984). This is in contrast to muraenolepids, which consistently have two dorsal fins and a single anal fin, and the pectoral fin is the first to appear in ontogeny. In addition, most morids have elongate pelvic fin rays (Fahay & Markle, 1984). Complete developmental series are needed for all of the Gadiformes (especially melanonids) before inferences can be drawn about phylogenetic relationships based on early life-history characters.

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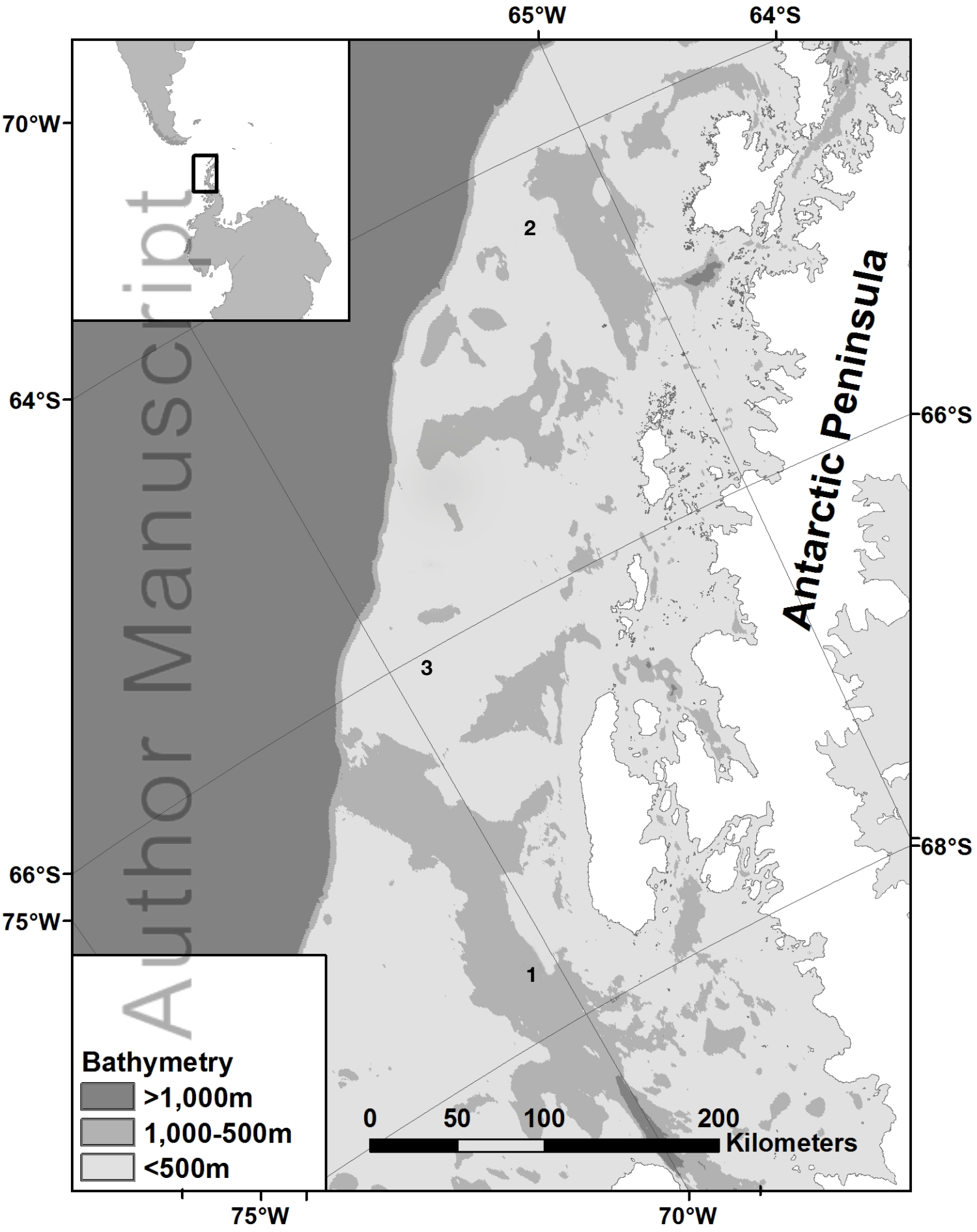

FIG. 1. *Muraenolepis* sp. (a) 10.5 mm total length (L_T; VIMS 33000), (b) 14.2 mm L_T (VIMS 21608) and (c) 18.4 mm L_T (VIMS 21106). Scale bars equal 2 mm. [type-setter: please change A to (a) etc on figure.]

FIG. 2. Locality data for the three *Muraenolepis* sp. larvae: 1, VIMS 33000 (10.5 mm total length, L_T, larva, collected at 67.6393°S, 70.2540°W); 2, VIMS 21608 (14.2 mm L_T, collected at 64.3406°S, 65.9661°W); 3, VIMS 21106 (18.4 mm L_T, collected at 65.6295°S, 68.8866°W).

Kilometers to km; leave key on figure.

TABLE I. Morphometric data of larval stages of *Muraenolepis*

Specimen or taxon	L_T (mm)	L_H, as % L_T	O, as % L_H	P_A, as % L_T	Source
Muraenolepis sp. VIMS 33000	10.5	22.8	41.7	51.4	1
Muraenolepis sp. VIMS 21608	14.5	22.1	37.2	46.2	1
Muraenolepis sp. VIMS 21106	18.4	22.3	39.0	46.2	1
M. microps (=*M. marmorata?*)	6.5 – 9.6	15.8 - 18.5	30.8 – 33.5	40.0 – 44.5	2
M. microps (=*M. marmorata?*)	16.5 – 22.0	18.2 – 21.5	26.5 – 28.5	43.5 – 46.5	2
M. microps (=*M. marmorata?*)	26.5 – 28.5	20.0 – 22.2	29.5 – 31.5	45.5 – 48.5	2

1, This study; 2, Efremenko (1983).

L_T, total length; L_H, head length; O, eye diameter; P_A, pre-anal length.

TABLE II. Meristics of all species and larval stages of *Muraenolepis*. Values in bold font indicate overlap of taxa from the literature and specimens described here

Species	V/M	D_1	D_2	A	P_1	P_2	Source
Muraenolepis sp. VIMS 33000	**70+**	-	**-**	**-**	-	-	1
Muraenolepis sp. VIMS 21608	**73+**	-	**-**	97 - 98	-	-	1
Muraenolepis sp. VIMS 21106	**70-74**	-	127 - 130	106 - 108	-	-	1
M. microps (=*M. marmorata?*) (6.5 – 9.6)	63 - 64	-	**-**	**-**	-	-	2
M. microps (=*M. marmorata?*) (16.5 – 22.0)	64 - 65	-	**-**	**-**	-	-	2
M. microps (=*M. marmorata?*) (26.5 – 28.5)	64 - 65	-	**-**	**-**	-	-	2
Muraenolepis sp. (32.5)	67 - 69	1 - 2	127 - 141	98 - 112	16 - 21	4	3
M. andriashevi	**72 - 73**	2	154 - 167	113 - 121	38 - 41	4	4, 5
M. evseenkoi	**70-73**	2	140-145	102-106	38-40	4	6
M. kuderskii	68-69	2	132-147	105-113	36-37	4	7
M. marmorata	**67-71**	2	128-147	89-108	?	5	8
M. microps (=*M. marmorata?*)	**70-74**	2	133-146	99-112	?	5	8
M. orangiensis	**74-76**	2	161-175	124-131	?	5	8
M. pacifica	**73-75**	2	171-184	126-133	36-39	4	9

M. trunovi	**73**	2	137	102		4	10
Notomuraenobathys microcephala	83-85	2	160-176	122-135	?	5	11

- ,Characters are not present at these stages; ?, meristic data are not known.

1, This study; 2, Efremenko (1983); 3, Fahay & Markle (1984); 4, Balushkin & Prirodina (2005); 5, Balushkin & Prirodina (2010*c*); 6, Balushkin & Prirodina (2010*a*); 7, Balushkin & Prirodina (2007); 8, Gon & Heemstra (1990); 9, Prirodina & Balushkin (2007); 10, Balushkin & Prirodina (2006); 11, Balushkin & Prirodina (2010*b*).

A, anal fin; D, dorsal fin; M, myomeres; P_1, pectoral fin; P_2, pelvic fin; V, vertebrae.