Anobothrus amourouxi sp. nov., a new species of Ampharetidae (Polychaeta) from the Capbreton Canyon (Bay of Biscay, NE Atlantic Ocean)

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ANOBOTHRUS AMOUROUXI SP. NOV., A NEW SPECIES OF AMPHARETIDAE (POLYCHAETA) FROM THE CAPBRETON CANYON (BAY OF BISCAY, NE ATLANTIC OCEAN)

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ABSTRACT

A new species of Ampharetidae, *Anobothrus amourouxi* sp. nov., has been identified from bathyal depths of the Capbreton Canyon, Bay of Biscay (NE Atlantic Ocean). This new species is characterized by inner branchiae with transversal ciliated ridges, notochaetae from modified eighth thoracic unciniger with hirsute tips, uncini from thoracic unciniger with 6–7 teeth in lateral view arranged in two vertical rows in frontal view, fused segments II+III with paleae from SII and reduced notopodia without chaetae from SIII. An identification key for all hitherto described species of the genus *Anobothrus* is provided.

Keywords: Polychaeta, Ampharetidae, *Anobothrus*, taxonomy, new species, Bay of Biscay, Capbreton Canyon

1 INTRODUCTION

Members of the Family Ampharetidae (Annelida: Polychaeta) are widely distributed from intertidal to abyssal depths and are common in deep-sea environments like plains, hot vents or cold seeps (Böggemann, 2009; Reuscher *et al.*, 2009; Aguirrezabalaga & Parapar, 2014). According to Jirkov (2011), this family includes more than 200 valid species distributed in two subfamilies: Ampharetinae Malmgren, 1866 and Melinnae Chamberlin, 1919. The taxonomy of ampharetids is complex and recently the number of genera was proposed to be strongly reduced from 90 to 24 (Jirkov, 2011). The genus *Anobothrus* is one of the most speciose with 18 species currently considered valid, 10 of them described between 2008 and 2014 (Jirkov, 2008; Schüller, 2008; Reuscher *et al.*, 2009; Imajima *et al.*, 2013; Schüller & Jirkov, 2013).

The first studies concerning the deep-sea macrofauna of the Bay of Biscay started in the 19th century and several expeditions were conducted in the 1970s (Laubier, 1985). Since the 1990s, several new species of Polychaeta have been described in the Capbreton Canyon following new oceanographic cruises from 1987 to 1990 (San Martín *et al.*, 1996; Nuñez *et al.*, 2000; Aguirrezabalaga *et al.*, 2001, 2002; Aguirrezabalaga & Ceberio, 2003, 2005a, 2005b, 2006; Aguirrezabalaga & Carrera-Parra, 2006; Aguirrezabalaga & Gil, 2009; Aguirrezabalaga & Parapar, 2014). The Capbreton Canyon is situated in the southeast of the Bay of Biscay, beginning at 250 m from the coastline, in front of Hossegor city. It extends through 300 km before ending on the abyssal plain at 3500 m depth (Gaudin *et al.*, 2006; Mazières *et al.*, 2014). Currently disconnected from the Adour River, the canyon continues to be affected by its plume during 20% of the year (Petus *et al.*, 2014). The Capbreton Canyon separates the northern Aquitanian shelf from the narrower southern Cantabrian platform (Pascual *et al.*, 2004).

The main purpose of the BIOMIN project was to study the *in situ* impact of the biological diversity on the mineralization of the organic matter at the water-sediment interface. This study took place close to three river mouths: Rhône River (Gulf of Lions, Mediterranean Sea), Gironde Estuary and Adour River (Bay of Biscay, Atlantic Ocean). During this project a new species of *Anobothrus* was discovered in the

Capbreton Canyon. The present paper provides the description of this species as well as a key for world-wide hitherto described species of this genus.

2 MATERIALS AND METHODS

The third cruise of the BIOMIN project (BIOMIN-3) took place on board of the RV *Côtes de la Manche* in July 2012 in the Capbreton Canyon. Macrofauna was sampled at 5 stations situated between 108 to 735 m depth and between 18 and 52 km off the Adour River (**Figure 1**). At each station, samples were collected using a Hamon grab (3 replicates of 0.25 m²) and an Oktopus® GmbH MC 6 multicorer (9 replicates of 0.007 m²).

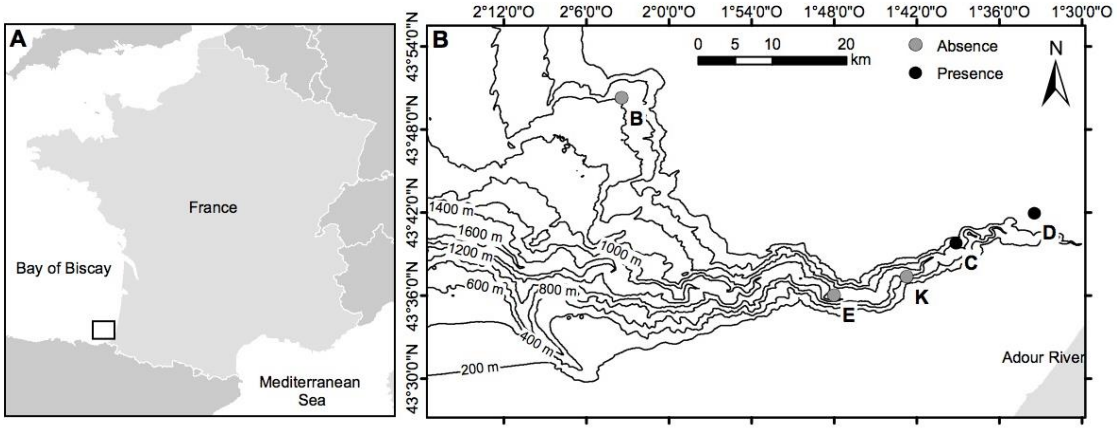

Figure 1. BIOMIN-3 cruise sampling stations in the Capbreton Canyon showing those with presence (black circles) and absence (grey circles) of Anobothrus amourouxi sp. nov.

Samples were sieved through a 1 mm mesh and the remaining fraction was immediately fixed in 5% buffered formalin. Back to the laboratory, organisms were sorted, identified to the lowest taxonomic level (in most cases to the species level) and counted.

Specimens of the new *Anobothrus* species were examined under a Nikon SMZ 1500 stereomicroscope and a Nikon Eclipse E400 microscope, and photographed with a Nikon DS-Fi 2 camera. Some specimens were figured with a

Wacom Intuos 5 tablet and Adobe Illustrator software. Length and width were measured with the NIS Elements Analysis software. Specimen used for examination with Scanning Electron Microscopy (SEM) was prepared by critical point drying, covered with gold and examined and photographed at the Servicios de Apoio á Investigación-SAI (Universidade da Coruña-UDC, Spain).

Type specimens were deposited in the Muséum National d'Histoire Naturelle (MNHN) (Paris, France) and Museo Nacional de Ciencias Naturales (MNCN) (Madrid, Spain). Additional non-type specimens were deposited in the Arcachon Marine Station.

Abbreviations used in the text: S = segment; TS = thoracic segment; TC = thoracic chaetiger; TU = thoracic unciniger; AU = abdominal unciniger.

3 RESULTS

SYSTEMATICS

Family AMPHARETIDAE Malmgren, 1866

Subfamily AMPHARETINAE Malmgren, 1866

Genus *Anobothrus* Levinsen, 1884

Type species: *Ampharete gracilis* Malmgren, 1866

Synonyms: *Anobothrella* Hartman, 1967: 155–156; *Melythasides* Desbruyères, 1978: 232–235; *Sosanides* Hartmann-Schröder, 1965: 243–246.

GENERIC DIAGNOSIS (EMENDED)

Prostomium trilobed, *Ampharete*-type, without glandular ridges. Buccal tentacles papillated or smooth. SII and SIII fused. Three to four pairs of branchiae (smooth or with transversal ciliated ridges or papillated), 3 pairs forming transversal

row with or without gap arising from fused SII+III to SIV and the fourth pair, if present, situated behind this row, arising from SV. Notochaetae in fused SII+III originating from SII or SIII, or both. If present, notochaetae originating from SII varying in size from regular size to strongly enlarged (paleae). If present, notochaetae originating from SIII varying from reduced to regular size. If present, a pair of nephridrial papillae is situated in SIV behind innermost pair of branchiae or behind some anterior notopodia. Sixteen to seventeen TS. Thirteen to fifteen TC starting at SIII-IV. Eleven or twelve TU starting at SVI. Notopodial cirri absent. Circular whitish band in TU1, TU2 or TU3. Fourth-, fifth- or sixth-to-last thoracic unciniger with one or combined modifications: elevated notopodia and/or modified notochaeta and/or dorsal ridge. First two AU of thoracic type. Number of AU generally constant for each species. Abdominal rudimentary notopodia absent.

REMARKS

This emended generic diagnosis combines the emended diagnosis proposed by Schüller & Jirkov (2013) and Imajima *et al.* (2013) which in turn combine previous proposals by Jirkov (2008) and Reuscher *et al*. (2009). Here we add the presence of transversal ciliated ridges on branchiae as an additional morphological character in the genus which should be taken into account in species descriptions.

Anobothrus amourouxi sp. nov.

(**Figures 2–4**)

TYPE MATERIAL

Holotype: MNHN-1561, incomplete specimen (broken at 9th AU), one branchial filament lacking and two filaments deciduous, 2.57 mm long and 1.02 mm wide, station C1-INCUB (multicorer) (43°39'48"N, 01°39'09"W), 364 m depth, 7 July 2012.

Paratypes: MNHN-1562, complete specimen, all branchiae missing, 12.5 mm long and 1.5 mm wide, station C4-MFC (multicorer) (43°39'48"N, 01°39'09"W), 364 m depth, 16 July 2012; MNHN-1563, four specimens (two complete), 10.3–13.9 mm long and 1.1–1.3 mm wide, all without branchiae, two specimens with oocytes in body cavity, station D (1 specimen collected with Hamon grab, 3 specimens with multicorer) (43°42'00"N, 01°33'27"W), 108 m depth, 7 and 12 July 2012; MNCN-16.01/16069, complete specimen , three branchial filaments lacking, 6.63 mm long and 0.63 mm wide, station C1-INCUB (multicorer) (43°39'48"N, 01°39'09"W), 364 m depth, 7 July 2012; MNCN-16.01/16070, 2 branchiae in a STUB for SEM of the paratype MNCN-16.01/16069; MNCN-16.01/16071, complete specimen in SEM stub (broken at 2nd AU), all branchiae missing, 8.6 mm long and 1.0 mm wide, station C1-BIOIR (multicorer) (43°39'48"N, 01°39'09"W), 364 m depth, 7 July 2012.

ADDITIONAL MATERIAL

Six specimens (one complete, 12.5 mm long and 1.5 mm wide), all without branchiae, one specimen with ventral groove, station C (1 specimen collected with Hamon grab, 5 specimens with multicorer) (43°39'48"N, 01°39'09"W), 364 m depth, 7, 12 and 16 July 2012.

DIAGNOSIS

Inner branchiae with transversal ciliated ridges, other ones smooth. Only modified TU8 provided notochaetae with hirsute tips. Uncini from TU1 with 6–7 teeth

in lateral view arranged in two vertical rows in frontal view. Uncini from AU3 with 4–5 teeth in lateral view arranged in three vertical rows in frontal view. SII+III fused with paleae from SII but with reduced notopodia without chaetae from SIII. 15 TC, 12 TU and 12 AU.

DESCRIPTION (BASED ON HOLOTYPE AND PARATYPES)

Prostomium trilobed and anteriorly rounded, *Ampharete*-type, without eye-spots. Buccal tentacles apparently smooth (**Figure 3B**).

Four pairs of long, gradually tapering, cirriform branchiae (**Figures 2A, D**). No gap between groups of branchiae. First three pairs of branchiophores arranged in a transversal line (inner, middle and outer pairs), forming a high fold, originating from fused SII+III. Fourth pair situated behind between inner and middle pairs, originating from SV (**Figure 2D**). Diameter of all branchiophores approximately equal. Middle and outer pairs of branchiae with branchiostyles longer and thicker than inner and posterior pairs (**Figure 2C**). Outer pair longer than remaining ones (**Figure 2B**). Middle, outer and fourth pairs of branchiae with smooth branchiostyles. Branchiostyles of inner pair of branchiae with tufts of cilia arranged in rows forming transversal ciliated ridges (visible in stereomicroscope) along the whole ventral side of the branchiostyle (**Figures 4C, D**). All branchiostyles presenting minuscule ciliated buttons (visible only under SEM) along their entire surface (**Figures 4E, F**). Right branchiostyle of inner pair thicker and longer than the left one. Fourth (posterior) pair of branchiae with thinnest and shortest branchiostyle.

One pair of nephridial papillae, not separated by gap, situated behind the base of innermost pair of branchiae (**Figure 2D**). Additional pairs of nephridial papillae present behind notopodia of TU1 and TU2 (visible under SEM, **Figure 3D**).

Fused SII+III with 12–16 gradually tapering paleae, longer and larger than the best-developed notochaetae (**Figures 2A, D; 3A**) from SII. The longest paleae surpassing the prostomium in lateral view. Fused SII+III (**Figures 2A; 3A**) with reduced notopodia, rounded in shape, hardly visible under the stereomicroscope, located behind the paleae, without chaetae, presenting a row of pores (**Figure 3C**)

from SIII. From SIV (TC2) notopodia well developed with rounded to elongate lobes and well developed notochaetae. Seventeen TS and 15 TC. Twelve TU. TU3 with an anterior whitish band (**Figure 2A**). Fifth-to-last TU (TC11, TU8) with slightly elevated notopodia connected by a pronounced dorsal ridge (**Figures 2A; 3E, F**), sometimes as high as notopodial lobe (*Anobothrus*-type).

Abdomen with 12 AU. Neuropodia of first two abdominal uncinigers (AU1–2) of thoracic type (tori instead of pinnules; **Figure 2A**). Neuropodial lobe forming pinnules from AU3 to posterior end. Rudimentary notopodia and neuropodial cirri absent.

Notochaetae bilimbate. First two thoracic chaetigers (SIV–V; TC1–2) with 3-4 short notochaetae; subsequent chaetigers with 5 long and 4 short notochaetae. Notochaeta longer than notopodial lobe in TU. Notochaetae from modified TU8 with hirsute tips (**Figures 2F; 4A**). TU1 with 38–48 uncini, pectinate, with 6–7 teeth in lateral view, arranged in two vertical rows in frontal view (**Figures 2G; 4B**). AU3 with 25–35 uncini, situated in marginal position of neuropodial pinnule, pectinate, with 4–5 teeth in lateral view (**Figure 2H**), arranged in three vertical rows in frontal view.

Pygidium with terminal anus, without lateral papillae but with 3–5 dorsal minute folds (**Figure 2E**).

REMARKS

Anobothrus amourouxi sp. nov. is similar to *A. antarctica* Monro, 1939, *A. glandularis* (Hartmann-Schröder, 1965), *A. mironovi* Jirkov, 2008, *A. paleaodiscus* Schüller & Jirkov, 2013 and *A. patersoni* Jirkov, 2008 because they share the following characters: presence of paleae in fused SII+III from SII, four pairs of branchiae, circular band at TU3, 12 TU, modified fifth-to-last TU (TU8) and 12 AU. These species can be separated into two groups based on the presence or absence of notochaetae with hirsute tips at TU8: Group 1: *A. paleaodiscus*, *A. patersoni* and *A. mironovi* with smooth tips, and Group 2: *A. amourouxi* sp. nov., *A. antarctica* and *A. glandularis* with notochaetae with hirsute tips (but only in TU8). However, *A. amourouxi* sp. nov. and *A. antarctica* differ from *A. glandularis* for having both 15 TC and ciliated or papillated branchiae instead of 14 TC and smooth branchiae.

Moreover, *A. antarctica* differs from *A. amourouxi* sp. nov. by presenting all branchiostyles papillated, from sparse to densely papillated (shaggy), while *A. amourouxi* sp. nov. presents only the inner pair provided with transversal ciliated ridges. Furthermore, *A. antarctica* has uncini from TU1 with 4–5 teeth, a large pair of nephridial papillae, and fused SII+III provided with notochaetae from SIII, while *A. amourouxi* sp. nov. has uncini from TU1 with 6–7 teeth, two groups of nephridial papillae, fused SII+III with reduced notopodia and without notochaetae from SIII. Indeed, in *A. amourouxi* sp. nov. the reduced notopodia from SIII at fused SII-III presents a row of pores instead of chaetae, a character also observed by Aguirrezabalaga & Parapar (2014: their figure 7E). These pores might be related to chaetae formation.

Although Imajima *et al.* (2013) suggested that the presence of transversal ciliated ridges on branchiae were related to the size of specimens, this could not be verified in *A. amourouxi* sp. nov. because the two biggest specimens (mature) lost their branchiae. However, no variation linked to age was observed for the other characters described here.

The *Anobothrus* species reported in the Northeast Atlantic waters are *A. gracilis* (Malmgren, 1866) and *A. patersoni* Jirkov, 2008. *A. gracilis* is a species described from Swedish coasts and has a wide distribution in the Arctic Ocean, North Atlantic Ocean (Iceland to Swedish West coast), and Northwest Pacific Ocean (Jirkov, 2008, 2011; Parapar *et al.*, 2014). *A. patersoni* is an exclusively abyssal species (3260-8292 m depth) described from North Pacific (Japan) but recorded also in the North Atlantic (Jirkov, 2008). In the Capbreton Canyon, Rallo *et al.* (1993) found a single specimen of *A. gracilis* between 358–410 m, and two incomplete specimens of *Anobothrus* aff. *gracilis* were also reported by Aguirrezabalaga & Parapar (2014), between 624–652 m depth. These records should be taken with caution as incomplete specimens may induce wrong identifications. These specimens might belong to *A. amourouxi* sp. nov. because *A. gracilis* share with the new species the possession of 15 TC, fused SII+III with reduced TC without notochaetae from SIII, 12 TU and circular band in TU3.

ETYMOLOGY

This species is dedicated to Dr. Jean-Michel Amouroux (Laboratoire Arago, Observatoire Océanologique de Banyuls-sur-Mer, France) for his friendship and many contributions to French benthic research.

DISTRIBUTION

Specimens of the new species were collected in the Capbreton Canyon muddy bottoms, between 108 and 364 m depth. In the same area Rallo *et al.* (1993) and Aguirrezabalaga & Parapar (2014) reported *Anobothrus gracilis* at 358–410 m depth and *Anobothrus* aff. *gracilis* at 624–652 m depth, respectively.

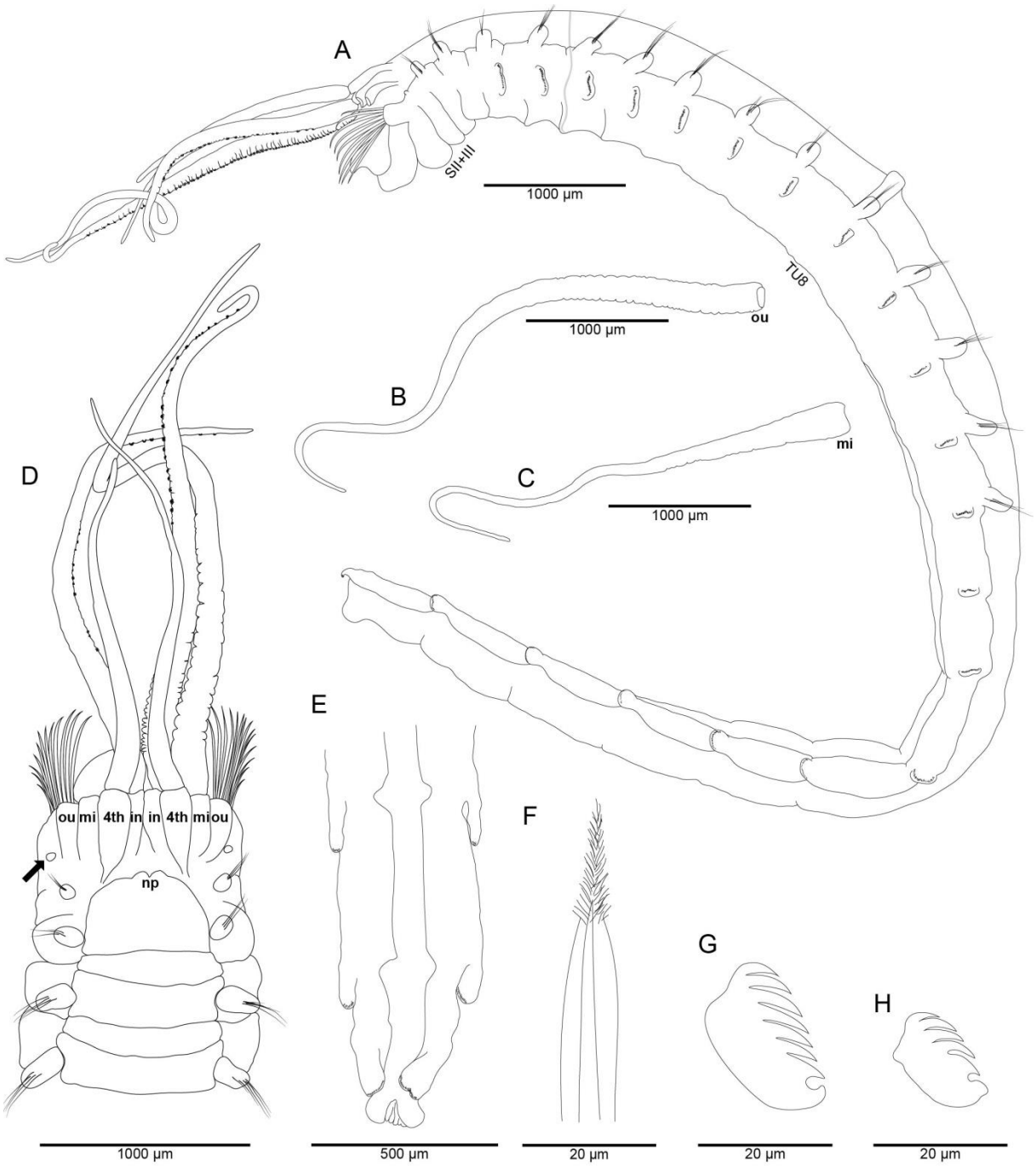

Figure 2. *Anobothrus amourouxi* sp. nov., holotype (MNHN-1561): (A) lateral view, specimen incomplete, showing fused SII+III; (B) deciduous branchia from outer (ou) pair; (C) deciduous branchia from middle (mi) pair; (D) anterior region, dorsal view, indicating reduced notopodia at fused segments II+III (arrow), nephridial papillae (np) and pairs of branchiae: (in) inner, (mi) middle, (ou) outer and (4th) fourth pair. Paratype (MNHN-1562): (E) pygidium, ventral view; (F) hirsute tips of notochaeta from modified eighth thoracic chaetiger (TU8). Paratype (MNHN-1563): (G) uncinus from first thoracic uncinigers (TU1), lateral view; (H) uncinus from third abdominal unciniger (AU3), lateral view.

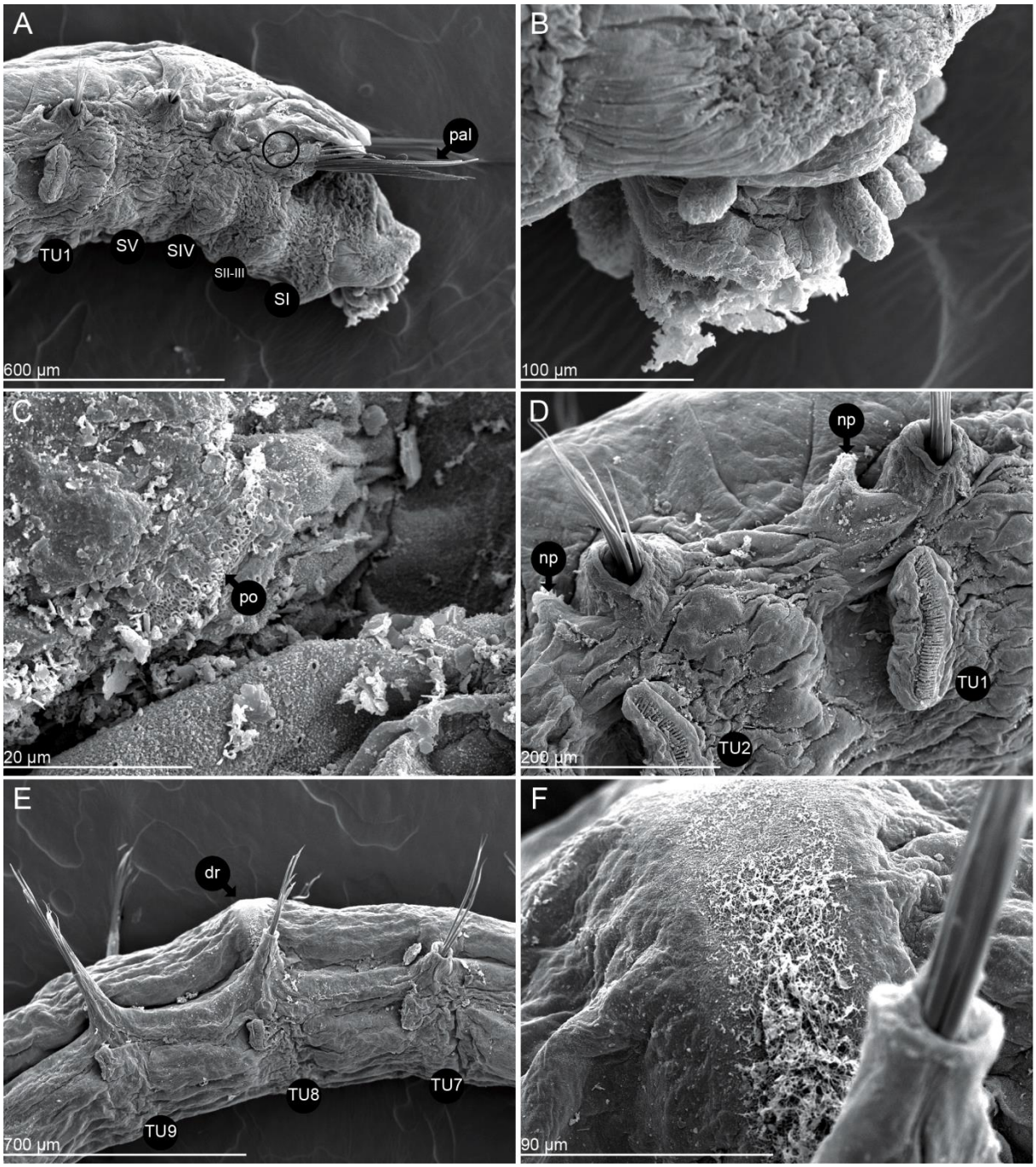

Figure 3. ***Anobothrus amourouxi*** **sp. nov., paratype (MNCN-16.01/16071): (A) anterior end, right lateral view, showing first five thoracic segments (SI–SV), and first thoracic unciniger (TU1); reduced notopodia (encircled) at fused segments II+III behind the paleae (pal); (B) detail of prostomium and buccal tentacles, lateral view; (C) notopodia of fused segments II+III showing a row of pores (po); (D) TU1 and TU2 showing position of nephridial pores (np); (E) TU8 showing a transversal dorsal ridge (dr); (F) detail of dorsal ridge at TU8.**

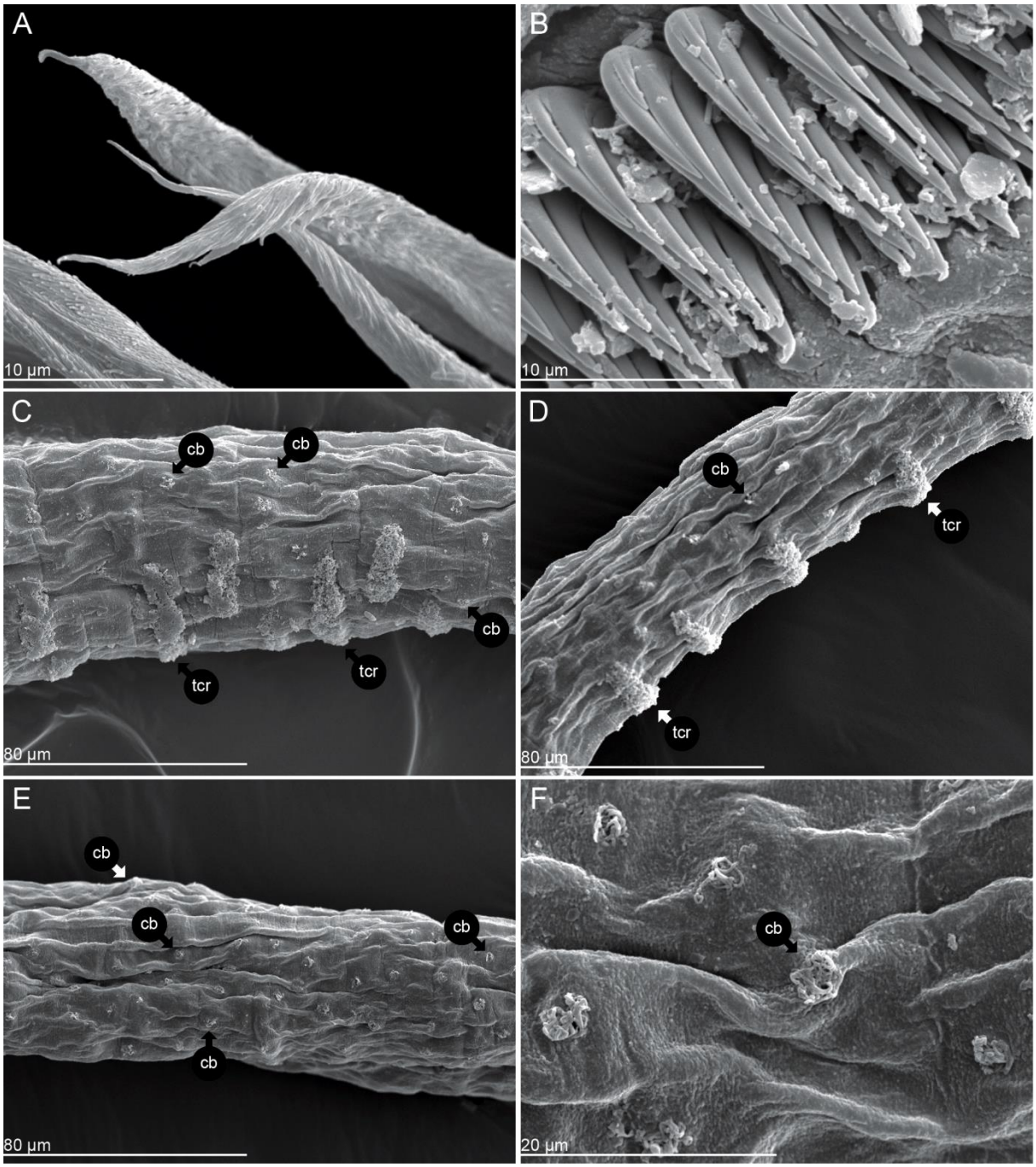

Figure 4. ***Anobothrus amourouxi*** **sp. nov., paratype (MNCN-16.01/16071): (A) hirsute tips of T8 modified notochaetae; (B) thoracic uncini, upper-frontal view. Paratype (MNCN-16.01/16070): (C-D) basal and median zones of inner ciliated branchia showing the transversal ciliated ridges (tcr) and ciliated buttons (cb); (E-F) median and distal zones of smooth branchiae showing the ciliated buttons (cb).**

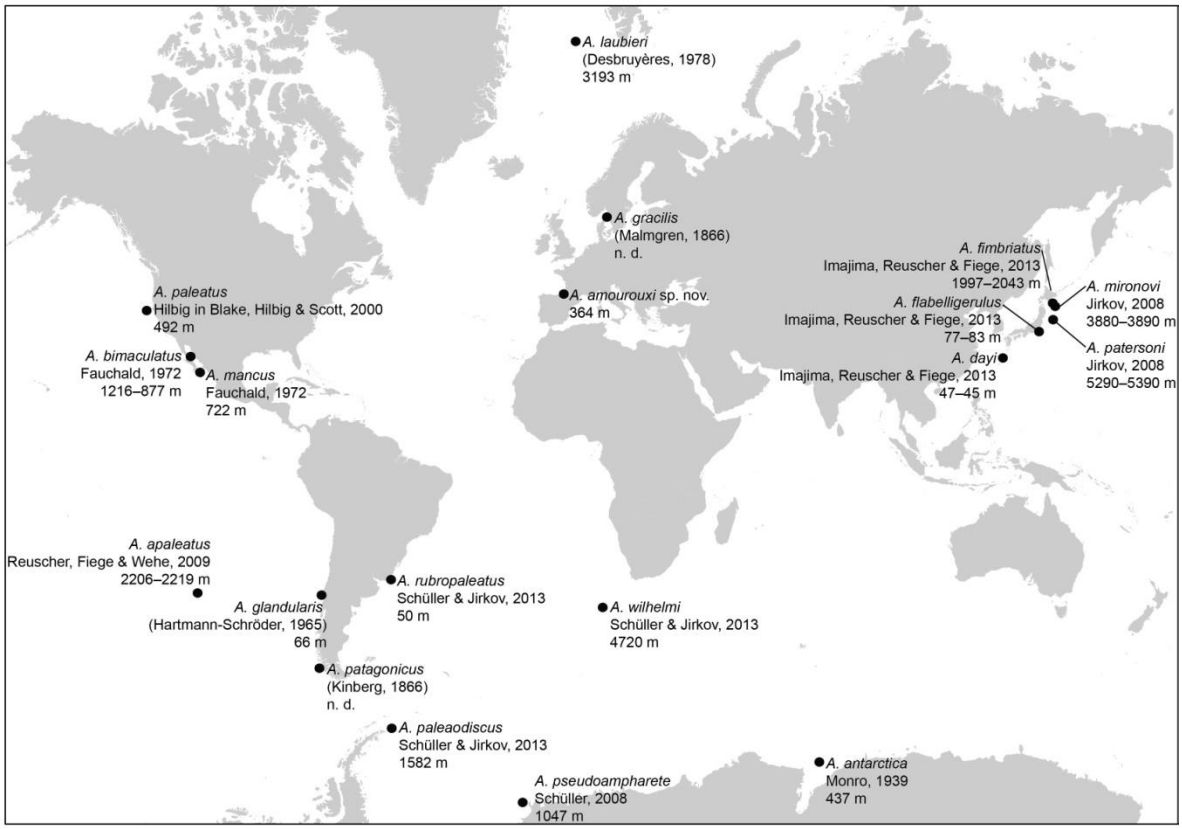

Fig. 5. World map showing location and depth of type locality of each currently considered valid species of *Anobothrus*.

KEY FOR IDENTIFICATION OF THE SPECIES OF THE GENUS *ANOBOTHRUS* IN THE WORLD

The following key accounts for the 18 species currently considered valid (Read, 2014) plus the new species here proposed. Described species are well distributed in the world ocean, but mainly concentrated in the southern hemisphere, NE Atlantic, Pacific coasts of North America and Japan. Nevertheless gaps still persist in the NW Atlantic, Indo-Malay Philippines archipelago and the coasts of Africa and Australia (**Figure 5**).

Five species were previously included in the genus *Anobothrus* but are currently considered invalid or excluded from this genus and thus excluded from the following key. *Anobothrus nasuta* (Ehlers, 1887), originally described in the genus *Amphicteis,* is supposed to belong to another genus (Jirkov, 2008; Schüller & Jirkov, 2013). *Anobothrus occidentalis* Hartman, 1969 and *Anobothrus trilobatus* Hartman, 1969 were re-examined by Hilbig (2000) and are presently considered as belonging to the

genera *Sosanne* and *Eclysippe*, respectively. Finally, *Anobothrus nataliae* Jirkov, 2008 and *Anobothrus wakatakamaruae* Imajima, 2009 are considered junior synonyms of *Anobothrus paleatus* (Imajima *et al.*, 2013).

1. No paleae.....2

- Paleae present.....3

2. Modified notopodia with hirsute tips notochaetae.....*A. fimbriatus*

- All notopodia without hirsute tips notochaetae .....*A. apaleatus*

3. 3 pairs of branchiae.....4

- 4 pairs of branchiae.....6

4. Modified notopodia on TU8 5

- Modified notopodia on TU9 ..... *A. flabelligerulus*

5. Notochaetae present on fused segments II- III, prostomium *Ampharete*-type, branchiae forming transversal line .....*A. laubieri*

- Notochaetae absent on fused segments II-III, prostomium conical, wide gap between groups of branchiae.....*A. dayi*

6. Modified notopodia on TU6 ..... *A. bimaculatus*

- Modified notopodia on TU7 ..... *A. mancus*

- Modified notopodia on TU8 7

- Modified notopodia on TU9 ..... *A. paleatus*

7. Circular band on TU1 ..... *A. patagonicus*

- Circular band on TU2 (modified notochaetae without hirsute tips) 8

- Circular band on TU3 9

8. Paleae colourless, fine, with base slimmer than (or equal to) most developed notochaetae, outer pairs of branchiae distinctly narrower than inner, 12–13 AU .. ……..*A. wilhelmi*

- Paleae reddish, stout, with base stouter than most developed notochaetae, branchiae with almost the same diameter, 13 AU ..... *A. rubropaleatus*

9. Modified notopodia without notochaetae with hirsute tips 10

- Only the modified notopodia with notochaetae with hirsute tips 11

- All notopodia with notochaetae with hirsute tips ..... *A. gracilis*

10. 3 teeth on uncini from TU1 (lateral view), paleae abruptly tapering to delicate tip ……*A. pseudoampharete*

- 8–9 teeth on uncini from TU1 (lateral view), diameter of all branchiophores more or less equal, less than 10 paleae, very conspicuous stout and long paleae ..... ……*A. paleaodiscus*

- 5 teeth on uncini from TU1 (lateral view), fourth pair of branchiophores two times slimmer and shorter than others reduced and their branchiostyles many times shorter than others, paleae longer than best-developed notochaeta, gradually tapering.....*A. patersoni*

- 5 teeth on uncini from TU1 (lateral view), inner and middle pairs of branchiophores shorter and slimmer than others .....*A. mironovi*

11. 6 teeth on uncini from TU1 (lateral view), surface of branchiostyle smooth, thoracic arrangement (fused SII-III with paleae from SII and without notochaetae from SIII).....*A. glandularis*

- 4–5 teeth on uncini from TU1 (lateral view), surface of all branchiostyles papillated, thoracic arrangement (fused SII-III with paleae from SII and notochaetae from SIII).....*A. antarctica*

- 6–7 teeth on uncini from TU1 (lateral view), surface of inner pair of branchiostyle with transversal ciliated ridges, thoracic arrangement (fused SII-III with paleae from SII and with reduced notopodia without notochaetae from SIII) .....*A. amourouxi* sp. nov.

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