

# Three non-indigenous species of *Aoroides* (Crustacea: Amphipoda: Aoridae) from the French Atlantic coast

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*The amphipod genus Aoroides is reported for the first time in European marine waters. Specimens of Aoroides semicurvatus and Aoroides curvipes were collected in oyster reefs in Arcachon Bay between 2009 and 2014 and in Hossegor Lake in 2014 (SW France). Specimens of Aoroides longimerus were collected in 2013 and 2014 in subtidal slipper limpet beds and Zostera marina meadows in Arcachon Bay and in 2014 on floating pontoons in the Bay of Brest (W France). These species, native to Asia, may have been accidentally introduced in Arcachon Bay and Hossegor Lake with oyster transfers and in the Bay of Brest through both oyster transfers and shipping.*

**Keywords:** *Aoroides*, European marine waters, non-indigenous species, taxonomy

Submitted 19 March 2015; accepted 13 November 2015; first published online 21 December 2015

## INTRODUCTION

Aoridae (Crustacea: Amphipoda) are distributed all over the world from shallow estuarine to open marine habitats (Myers, 2009) and are grouped into 26 genera. In European waters, Aoridae are represented by nine genera (Horton & De Broyer, 2015): *Aora* Krøyer, 1845, *Arctolembos* Myers, 1979, *Autonoe* Bruzelius, 1859, *Bemlos* Shoemaker, 1935, *Chevreuxius* Bonnier, 1896, *Grandidierella* Coutière, 1904, *Lembos* Bate, 1857, *Microdeutopus* Costa, 1853, *Tethylembos* Myers, 1988. The genus *Aoroides* contains 18 valid species (Lowry, 2015) and is distributed only in the coastal regions of the Pacific Ocean (Barnard & Karaman, 1991; Ariyama, 2004; Myers, 2005, 2009). This paper reports on the first records of the genus *Aoroides* in European marine waters with the presence of three Asian species on the French Atlantic coasts: *A. longimerus* Ren & Zheng, 1996, *A. semicurvatus* Ariyama, 2004 and *A. curvipes* Ariyama, 2004. An identification key is provided for the three European species of the genus *Aoroides*.

## MATERIALS AND METHODS

### Study areas

The Bay of Brest (NW Brittany) is a 180 km<sup>2</sup> semi-enclosed shallow basin (Figure 1A) connected to shelf waters (Iroise

Sea) by a narrow (1.8 km wide) and deep (40 m) channel. Owing to strong tidal influence, the water masses are well-mixed (Le Pape *et al.*, 1996). In this bay, the main freshwater inputs (80%), due to the Elorn River in the northern part and to the Aulne River in the southern part, can influence salinity of surface seawater in localized areas. According to local hydrodynamic conditions, the Bay of Brest encompasses a mosaic of habitats from mud flats to coarse gravels and rocky substrata (Castric-Fey & Chassé, 1991; Grall & Glémarec, 1997). Important cupped oyster (*Crassostrea gigas* (Thunberg, 1793)) farms (110 ha) are located in the south-eastern part of the bay. Brest is one of the main hotspots of military, commercial and recreational shipping on the Atlantic coast of France. A total of 2250 berths are available, distributed between the marinas of Moulin-Blanc in the eastern part and Château in the western part (Figure 1A).

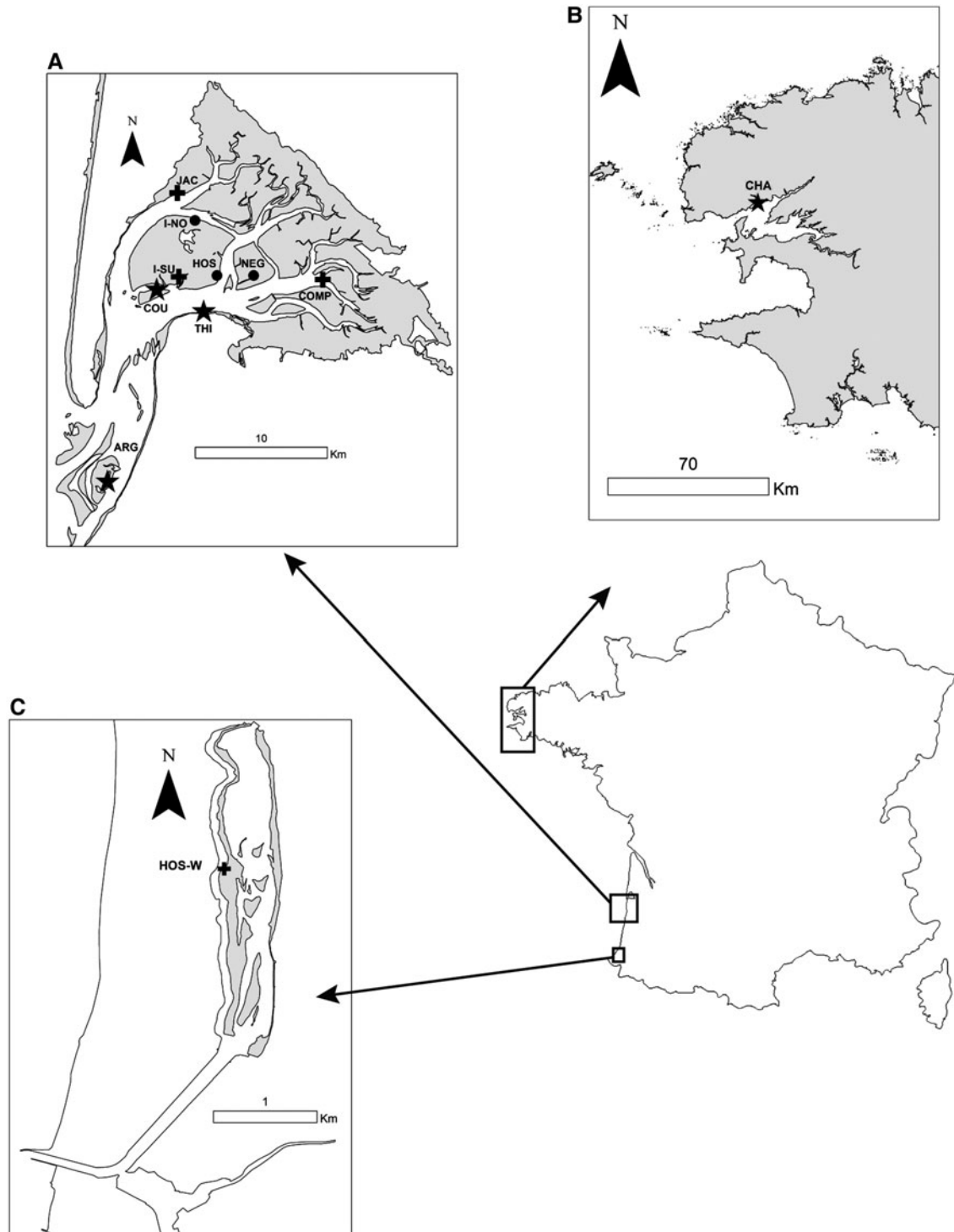
Arcachon Bay is a 180 km<sup>2</sup> macrotidal coastal lagoon situated on the south-western coast of France (Figure 1B). This lagoon communicates with the Atlantic Ocean by a narrow channel and receives freshwater inputs in its south-eastern part (Leyre River). It is characterized by large intertidal flats (115 km<sup>2</sup>), whose lower parts are used for cupped oyster farming (720 ha). In the inner lagoon, tidal channels represent 71 km<sup>2</sup>, with 1.02 km<sup>2</sup> occupied by eelgrass beds (*Zostera marina* Linnaeus, 1753) (Plus *et al.*, 2010). Arcachon Bay is surrounded by marinas and numerous seasonal moorings representing a total accommodation capacity of more than 7800 leisure boats (Alzieu, 2000).

Hossegor Lake (Figure 1C) is a small coastal lagoon (0.9 km<sup>2</sup>) communicating with the Atlantic Ocean by a very narrow channel and receiving fresh water by two small

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**Fig. 1.** Sampling stations of *Aoroides longimerus* Ren & Zheng, 1996 (black stars), *Aoroides semicurvatus* Ariyama, 2004 (black crosses) and both *A. semicurvatus* and *Aoroides curvipes* Ariyama, 2004 (black dots) in: (A) Arcachon Bay; (B) Bay of Brest; (C) Hossegor Lake (see code legend in Table 1).

rivers (Bourret and Boudigau Rivers) in its southern part. Hossegor Lake is also connected to Capbreton harbour. Intertidal flats represent 0.28 km<sup>2</sup> (Trut *et al.*, 2009), with the south-eastern part devoted to oyster farming.

**Material examined**

Specimens of *Aoroides* were collected from different stations and habitats in the Bay of Brest, Arcachon Bay and

Hossegor Lake from 2009 to 2014 (Figure 1, Table 1). In Arcachon Bay and Hossegor Lake, specimens were sampled during specific biodiversity surveys. In the Bay of Brest, the specimens were incidentally sampled as part of a study aiming at examining colonization patterns on hard substrates in three marinas in Brittany. Specimens were fixed in 4% formalin and some individuals stained with methyl green for further morphological examinations. Specimens were observed under a Nikon SMZ25 stereomicroscope and a

Nikon Eclipse E400 microscope, and photographed with a Nikon DS-Ri2 camera. Body length (BL) was measured with NIS-Elements Analysis software from anterior margin of head to posterior end of telson. Drawings were carried out from pictures using Inkscape software. Specimens examined in the scope of this study were deposited in collections of the Muséum National d'Histoire Naturelle, Paris (Table 1) and of Arcachon and Brest Marine Stations.

## RESULTS

### SYSTEMATICS

Order AMPHIPODA Latreille, 1816  
Suborder SENTICAUDATA Lowry & Myers, 2013  
Infraorder Corophiida Leach, 1814  
Parvorder Corophiida Leach, 1814  
Superfamily Aoroidea Stebbing, 1899

Family Aoridae Stebbing, 1899

Genus *Aoroidea* Walker, 1898

Type species: *Aoroidea columbiae* Walker, 1898

Specimens were identified as being members of the genus *Aoroidea*, a genus not previously reported in European waters. Three species of *Aoroidea* were sampled in three different sites between 2009 and 2014: *Aoroidea longimerus* (Figure 2A) in Bay of Brest and Arcachon Bay, *Aoroidea semicurvatus* (Figure 2B) in Arcachon Bay and Hossegor Lake and *Aoroidea curvipes* (Figure 2C) in Arcachon Bay.

### GENERIC DIAGNOSIS

According to Barnard & Karaman (1991), the genus *Aoroidea* is characterized by: article 3 of antenna 1 shorter than article 1; accessory flagellum absent; mandibular palp article 3 recto-linear (except for *A. palfreyensis* Myers, 2009 and *A. vitiosus* Myers, 1995 without mandibular palp); gnathopod 1 grossly

**Table 1.** Records of the *Aoroidea* species in Bay of Brest, Arcachon Bay and Hossegor Lake. Sites and stations: see Figure 1.

Species	Sites	Stations (code)	Date	Habitat	Tidal level (m)	Latitude	Longitude	N	MNHN deposition
<i>Aoroidea longimerus</i>	Brest	Château (CHA)	August 2014	Floating pontoons	-1 <sup>(a)</sup>	48°22'N	4°29'W	56	MNHN-IU-2013-9865 (3 individuals)
-	Arcachon	Courbey (COU)	July 2013	<i>Zostera</i> meadow	-2	44°40'N	1°12'W	1	
-	Arcachon	Thiers (THI)	June 2014	Slipper limpet bed	-5	44°39'N	1°10'W	3	
-	Arcachon	Thiers (THI)	July 2014	Slipper limpet bed	-5	44°39'N	1°10'W	3	MNHN-IU-2013-9866 (1 individual)
-	Arcachon	Arguin (ARG)	October 2014	Oyster reef	-0.1	44°34'N	1°14'W	1	
<i>Aoroidea curvipes</i>	Arcachon	Les Hosses (HOS)	October 2009	Oyster reef	+1	44°40'N	1°10'W	5	MNHN-IU-2013-9867 (3 individuals)
-	Arcachon	La Negue (NEG)	October 2014	Oyster reef	+1	44°41'N	1°12'W	1	
-	Arcachon	Ile Nord (I-NO)	November 2014	Oyster reef	+1	44°42'N	1°10'W	1	MNHN-IU-2013-9868 (1 individual)
<i>Aoroidea semicurvatus</i>	Arcachon	Les Hosses (HOS)	October 2009	Oyster reef	+1	44°40'N	1°10'W	46	MNHN-IU-2013-9869 (5 individuals)
-	Arcachon	Ile Sud (I-SU)	January 2013	Under oyster tile	+1	44°40'N	1°11'W	1	
-	Arcachon	Comprian (COMP)	June 2014	Oyster reef	+1	44°40'N	1°05'W	1	
-	Arcachon	Comprian (COMP)	November 2014	Oyster reef	+1	44°40'N	1°05'W	2	
-	Arcachon	Les Jacquets (JAC)	June 2014	Oyster reef	+1	44°40'N	1°05'W	6	
-	Arcachon	Les Jacquets (JAC)	July 2014	Oyster reef	+1	44°40'N	1°05'W	19	
-	Arcachon	Les Jacquets (JAC)	October 2014	Oyster reef	+1	44°40'N	1°05'W	54	MNHN-IU-2013-9870 (5 individuals)
-	Arcachon	La Negue (NEG)	October 2014	Oyster reef	+1	44°41'N	1°12'W	4	
-	Arcachon	Ile Nord (I-NO)	November 2014	Oyster reef	+1	44°42'N	1°10'W	13	
-	Hossegor	Hossegor Ouest (HOS-W)	July 2014	Oyster reef	+1	43°40'N	1°25'W	4	

N, number of males collected.

<sup>a</sup>For floating pontoons, specimens were found on substrates at a constant water depth of 1 m.



**Fig. 2.** Lateral views of (A) *Aoroides longimerus* Ren & Zheng, 1996: specimen from Brest, W France; (B) *Aoroides semicurvatus* Ariyama, 2004: specimen from Arcachon Bay, SW France; (C) *Aoroides curvipes* Ariyama, 2004: specimen from Arcachon Bay, SW France. Scale bars: 0.5 mm.

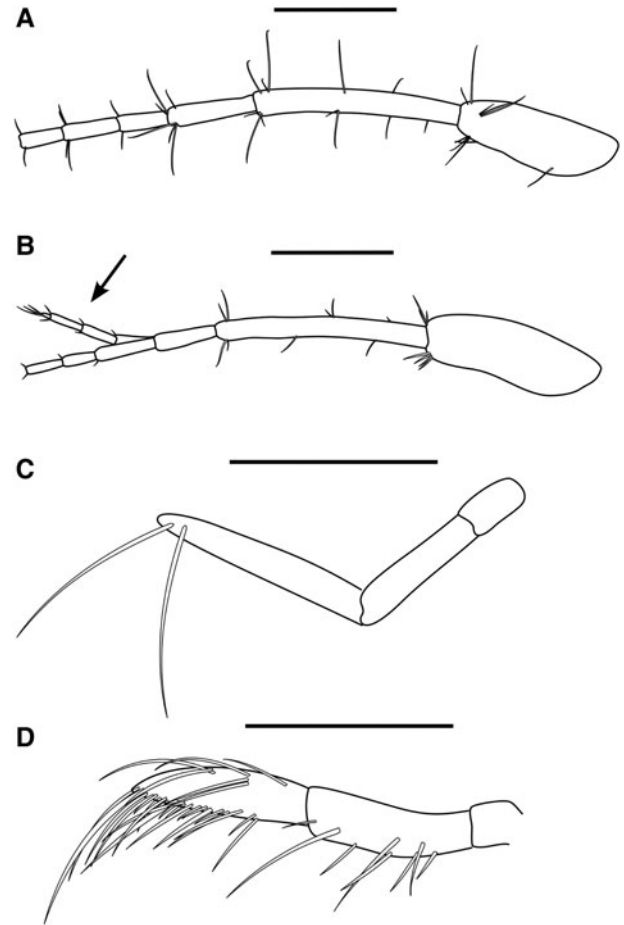
merochebate; gnathopod 2 not carpochebate; uropod 3 with 2 rami.

As the individuals of the family Aoridae are easily broken, specimens of *Aoroides* might be confused with *Aora* Krøyer, 1845, a common aorid genus in European waters. However, *Aoroides* can be easily separated from *Aora* by (1) the absence of the accessory flagellum and (2) the mandibular palp article 3 rectilinear (Barnard & Karaman, 1991) (Figure 3).

*Aoroides longimerus* Ren & Zheng, 1996

#### MATERIAL EXAMINED

North-east Atlantic Ocean: France: Arcachon Bay, Bay of Brest.



**Fig. 3.** Comparison of antenna 1 and mandibular palp in the genera *Aora* and *Aoroides*. (A) Antenna 1, lateral view of *Aoroides longimerus* Ren & Zheng, 1996; specimen from Bay of Brest, W France; (B) Antenna 1, lateral view of *Aora gracilis* with black arrow showing the accessory flagellum; specimen from Arcachon Bay, SW France; (C) Left mandibular palp, posterior view of *Aoroides longimerus*; specimen from Bay of Brest; (D) Left mandibular palp, posterior view of *Aora gracilis*; specimen from Arcachon Bay. Scale bars: (A), (B) 0.2 mm; (C), (D) 0.1 mm.

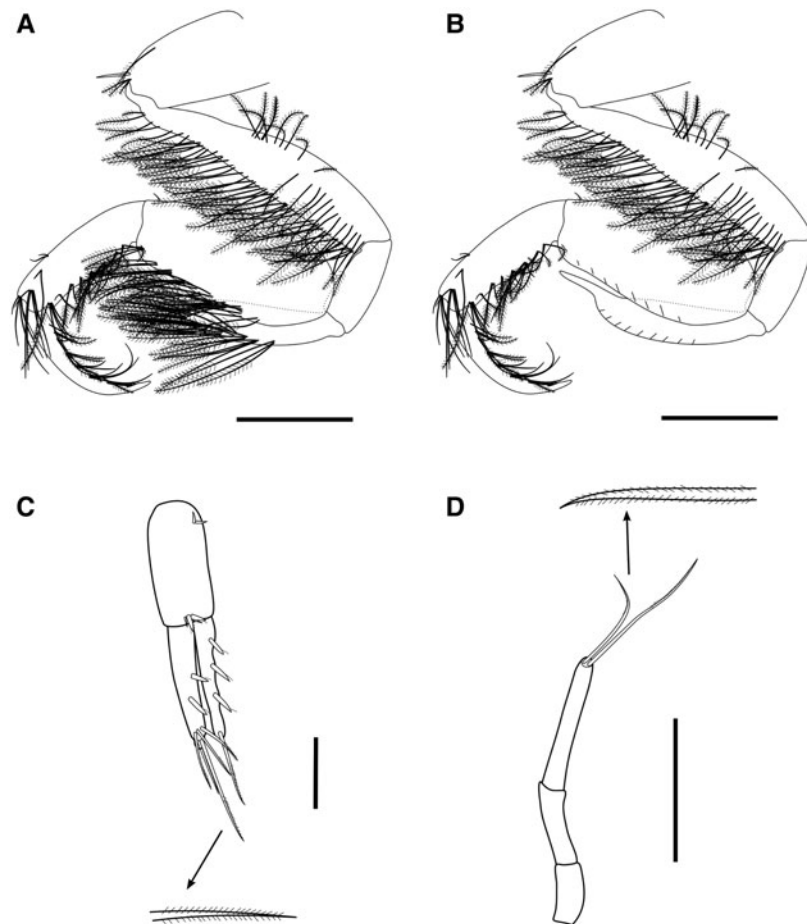
#### DESCRIPTION

Based on male, BL = 4.4 mm, Château marina (Brest), August 2014.

Antenna 1 accessory flagellum absent; mandibular palp article 3 with 2 distal setae (Figure 4D); coxa 1 with several plumose setae and one robust seta anteriorly; gnathopod 1 basis and carpus with many plumose setae (Figure 4A, B); palm of gnathopod 2 transverse; anterior margin of basis pereopods 3 and 4 with several simple setae; uropod 3 peduncle with 2 proximal and 4 distal sensory cuspidate setae (sensu Garm (2004): cuspidate setae with a sensory seta at its distal end), inner ramus with 3 dorsal sensory cuspidate setae, outer ramus with 2 dorsal and 1 distal sensory cuspidate setae (Figure 4C).

#### COLOURATION

Dorsal part of head, anterior and posterior margins of pereonite 1, posterior margins of pereonites 2–5 and 7 (sometimes 6), pleonites 1–3, uropodite 1, ventral parts of pleonites 1–3, ventral surface of coxa 1 brown or with dense brown dots (Figure 2A).



**Fig. 4.** *Aoroides longimerus* Ren & Zheng, 1996: specimen from Bay of Brest, W France (Body length = 4.4 mm): (A) left gnathopod 1, lateral view; (B) left gnathopod 1, setae of carpus and merus not all drawn, lateral view; (C) left uropod 3, dorsal view; (D) left mandibular palp, posterior view. Scale bars: (A), (B) 0.5 mm; (C), (D) 0.1 mm.

#### VARIABILITY

According to Ariyama's (2004) description, uropod 3 rami show a great variability with 1 to 3 dorsal sensory cuspidate setae on inner ramus and 1 to 3 dorsal sensory cuspidate setae on outer ramus.

#### REMARKS

Setae on distal part of uropod 3 rami and mandibular palp with short setules (difficult to see); this information is lacking for Japanese specimens (Ariyama, 2004).

#### HABITAT

This species occurs in different types of sublittoral habitats, frequently associated with biogenic structures, living among seaweeds and on the surface of sessile animals (ascidians, hydroids, bryozoans and sponges). Rarely, *A. longimerus* could be found under stones in intertidal areas (Ariyama, 2004). In this study, specimens were sampled on slipper limpet beds, oyster reefs and *Zostera marina* meadows (Arcachon) or associated with fouling communities dominated by mussels, ascidians and bryozoans under pontoons (Brest).

#### DISTRIBUTION

Japan, China (Ariyama, 2004), France: Bay of Brest, Arcachon Bay (this study).

#### *Aoroides semicurvatus* Ariyama, 2004

#### MATERIAL EXAMINED

North-east Atlantic Ocean: France: Arcachon Bay, Hossegor Lake.

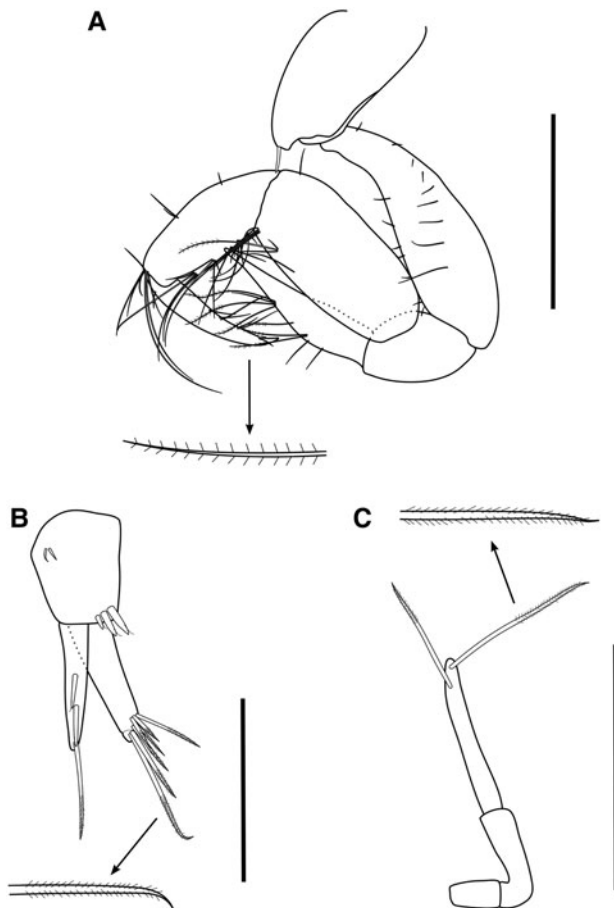
#### DESCRIPTION

Based on male, BL = 3.9 mm, Les Hosses (Arcachon), October 2009.

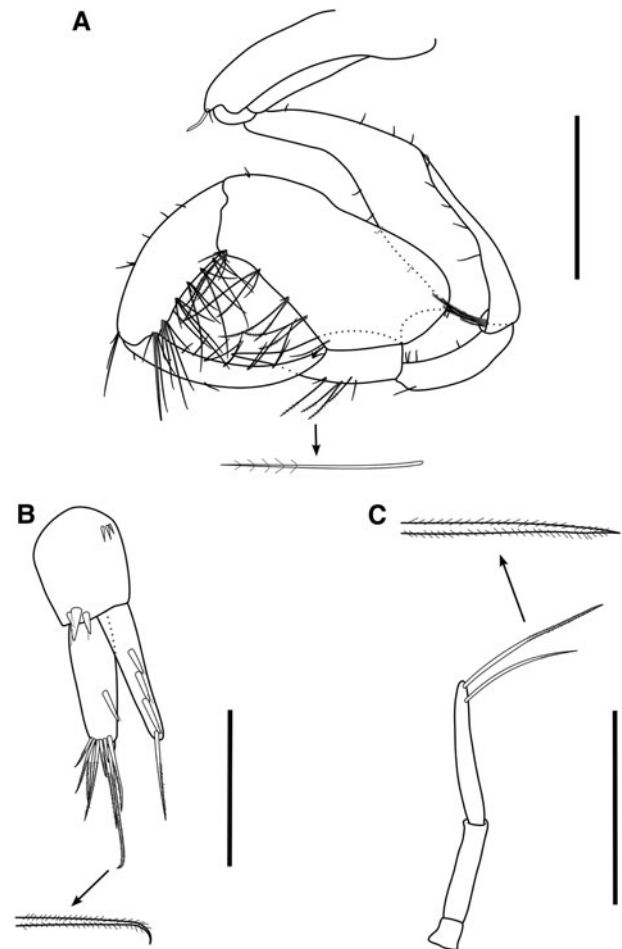
Antenna 1 accessory flagellum absent; mandibular palp article 3 with 2 distal setae (Figure 5C); coxa 1 with only one robust seta anteriorly; gnathopod 1 basis and carpus with few simple and fine plumose setae respectively (Figure 5A); palm of gnathopod 2 curved; anterior margin of basis pereopods 3 and 4 with several simple setae; uropod 3 peduncle with 2 proximal simple and 3 distal sensory cuspidate setae, inner ramus with 2 dorsal sensory cuspidate setae, outer ramus without dorsal setae and with 1 distal robust seta (Figure 5B).

#### COLOURATION

Posterior part of head, ventral surface of coxa 1, posterior and lower parts of pereonites 1–5, posterior part of pereonite 7, posterior and ventral parts of pleonite 1, ventral part of pleonite 2 brown (Figure 2B).



**Fig. 5.** *Aoroides semicurvatus* Ariyama, 2004: specimen from Arcachon Bay, SW France (Body length = 3.94 mm): (A) left gnathopod 1, arrow showing plumose seta, lateral view; (B) right uropod 3, dorsal view; (C) left mandibular palp article 3 with a detailed seta, posterior view. Scale bars: A: 0.5 mm; (B), (C) 0.2 mm.



**Fig. 6.** *Aoroides curvipes* Ariyama, 2004: specimen from Arcachon Bay, SW France (Body length = 4.1 mm): (A) left gnathopod 1, lateral view; (B) left uropod 3, dorsal view; (C) left mandibular palp article 3, posterior view. Scale bars: A: 0.5 mm; (B), (C) 0.2 mm.

#### VARIABILITY

Uropod 3 peduncle: distal end with 2 or 3 sensory cuspidate setae, inner ramus with 1 or 2 dorsal sensory cuspidate setae.

#### REMARKS

Ariyama (2004) described *A. semicurvatus* with mandibular palp article 3 with 7 marginal and one terminal setae and uropod 3 peduncle without proximal setae and with 2 distal robust setae. Arcachon specimens have only 2 subdistal setae on mandibular palp article 3 and 2 proximal simple and 3 distal sensory cuspidate setae on uropod 3 peduncle. After reexamination of *A. semicurvatus* specimens in the Osaka Museum of Natural History collections, mandibular palp article 3 shows a great variability with 2 to 12 setae (H. Ariyama, pers. comm.). Setae on gnathopod 1 carpus finely plumose, setae on distal part of uropod 3 rami and mandibular palp with short setules (difficult to see); this information is lacking for Japanese specimens.

#### HABITAT

This species is present in the lower intertidal zone, under stones, rarely among algae (Ariyama, 2004). In Arcachon Bay, specimens were typically associated with intertidal oyster reefs (this study).

#### DISTRIBUTION

Japan (Ariyama, 2004), France: Arcachon Bay, Hossegor Lake (this study).

*Aoroides curvipes* Ariyama, 2004

#### MATERIEL EXAMINED

North-east Atlantic Ocean: France: Arcachon Bay.

#### DESCRIPTION

Based on male, BL = 4.1 mm, Les Hosses (Arcachon), October 2009.

Antenna 1 accessory flagellum absent; mandibular palp article 3 with 2 distal setae (Figure 6C); coxa 1 with a robust and a simple setae anteriorly; gnathopod 1 basis with few simple setae, except a group of plumose setae in distal part, merus and carpus with few finely plumose setae (Figure 6A); palm of gnathopod 2 curved; anterior margin of basis pereopods 3 and 4 with several simple setae; uropod 3 peduncle with 3 proximal and 3 distal robust setae, inner ramus with 3 dorsal robust setae, outer ramus with 1 dorsal and 1 distal robust setae (Figure 6B).

#### COLOURATION

Dorsal part of head, whole pereonites 1–5, lower part of pereonite 7, dorsal and lower parts of pleonite 1, lower part of pleonites 2–3, coxae 1–5 brown (Figure 2C).

#### VARIABILITY

Uropod 3 peduncle: distal end with 3 or 4 robust sensory setae; coxa 1 with 1 robust sensory setae and with or without 1 simple setae.

#### REMARKS

Ariyama (2004) described *A. curvipes* with mandibular palp article 3 with 5 setae and uropod 3 peduncle with 1 proximal and 2 distal robust setae. Arcachon specimens have only 2 subdistal setae on mandibular palp article 3, and 3 proximal and 3 distal robust setae on uropod 3 peduncle. After examination of *A. curvipes* specimens in the Osaka Museum of Natural History collections, mandibular palp article 3 shows great variability with 3 to 9 setae. Uropod 3 peduncle also shows a great variability with 1 or 2 proximal setae and 1 to 3 distal setae (H. Ariyama, pers. comm.). Setae on distal part of uropod 3 rami and mandibular palp with short setules (difficult to see). French specimens were found in intertidal areas whereas Japan specimens were found in the subtidal.

#### HABITAT

This species was found in intertidal areas and typically associated with oyster reefs.

#### DISTRIBUTION

Japan (Ariyama, 2004), France: Arcachon Bay (this study).

#### DISCUSSION

In this study, we report the first records of the genus *Aoroides* in European waters, and assume that the three species recorded along the French Atlantic coast are non-indigenous. One of the species was unambiguously assigned to *A. longimerus* native to north-western Pacific and which has never been recorded elsewhere. The French specimens of the other two species differ from the Pacific species by very minor morphological details, mainly relative to the number of proximal setae on the uropod 3 peduncle: 2 setae (Atlantic) vs 0 (Pacific) and 3 setae (Atlantic) vs 1–2 (Pacific) in *A. semicurvatus* and *A. curvipes*, respectively. However, Japanese specimens also show a great variability in some characters (mandibular palp and uropod 3 ornamentations) (Ariyama, 2004 and H. Ariyama, pers. comm.). Molecular studies could be helpful for confirming the species identifications (see remarks in the Results section). Taxonomic and systematic issues are common issues in biological invasion studies and non-native surveys (Carlton, 2009). DNA-based studies, namely molecular barcoding (Comtet *et al.*, 2015), integrative taxonomy (e.g. Geoffroy *et al.*, 2012), phylogeography and phylogeny (e.g. Dijoux *et al.*, 2014) are efficient approaches to address this problem. Although some sequences are available (e.g. *A. columbiae*, Best & Stachowicz, 2013), no molecular barcodes are yet publicly available for the genus *Aoroides* but, regarding the European specimens, a first step could be reached by comparing specimens from Arcachon Bay and

Japan. This comparison would be valuable to confirm that the documented morphological differences are due to natural variability.

Repeated and numerous successful introductions of Asian species in Arcachon Bay have been well documented. Since the decimation of the Portuguese cupped oyster (*Crassostrea angulata* (Lamarck, 1819)) by a viral disease in the 1970s and the massive introduction of the Pacific cupped oyster *C. gigas* from Japan to sustain the local industry, several Asian species were recorded in the bay, including species with either indirect (*Arcuatula senhousia* (Benson in Cantor, 1842)) (Bachelet *et al.*, 2009) or direct development (*Paranthura japonica* Richardson, 1909, *Grandidierella japonica* Stephensen, 1938) (Lavesque *et al.*, 2013, 2014). Due to the presence of sandbanks at the entrance of Arcachon Bay, commercial shipping is absent and recreational boating restricted within the bay. Owing to the strong association of *Aoroides semicurvatus* and *A. curvipes* with oyster beds in the bay and the numerous introductions of non-native species with imports of *C. gigas* in European waters (Brenner *et al.*, 2014), we assume that these species were introduced accidentally through aquaculture. The configuration of Hossegor Lake also prevents the entrance of ships in the lake and strengthens the hypothesis that *A. semicurvatus* was introduced through oyster transfers, probably from other shellfish farming areas in France. Unlike these intertidal species, *A. longimerus* has been observed in diverse subtidal habitats in Arcachon Bay and under pontoons in the Bay of Brest. In these bays, oysters are massively cultivated and farming may have been the cause of its initial introduction, but its current distribution and common association with biogenic structures suggest more a complex establishment and subsequent spread, in the absence of a larval stage (Ruiz *et al.*, 2000; Clarke Murray *et al.*, 2014). Within Arcachon Bay, adults of *A. longimerus* may have dispersed away from oyster beds, through natural migration or transport as a fouling organism on the hull of recreational boats, and successfully established in seagrass meadows and slipper limpet beds. In the Bay of Brest, the species *A. longimerus* was incidentally sampled as part of a global study aiming at examining colonization patterns on hard substrates in three marinas in Brittany. It is noteworthy that *A. longimerus* was found living on the surface of fouling communities in a marina of Brest, as in its native range in Asia: these communities include several widespread native (*Mytilus* sp., *Ascidia aspersa* (Müller, 1776), *Ciona intestinalis* (formerly known as *C. intestinalis* type B; Brunetti *et al.* 2015) and non-indigenous (e.g. *Bugula neritina* (Linnaeus, 1758), *Watersipora subatra* (Ortmann, 1890), *C. robusta* (formerly known as *C. intestinalis* type A; Brunetti *et al.* 2015)) species reflecting a boat-shipping network connecting marinas at regional and international scales (Bishop *et al.*, 2014). In the Bay of Brest, *A. longimerus* has been recorded only in the Château marina, at least so far (present study and Le Garrec, unpublished data). In particular, conversely to other non-native taxa found in Château, it was absent from the surveys conducted in two other marinas in Northern Brittany (Leclerc & Viard, in preparation). As such, we may assume that the introduction of *A. longimerus* has occurred recently in the study area. With regards to the strong similarity of fouling communities across the English Channel marinas (Bishop *et al.*, 2014) and its ubiquitous habitat affinity, *A. longimerus* might further establish and spread in the region as has been

documented for other non-native invertebrates that first appeared on the coasts of Brittany (Bishop *et al.*, 2014), e.g. the tunicate *Asterocarpa humilis* (Heller, 1878) (Bishop *et al.*, 2013).

*Aoroides* species might be present in European waters for decades but misidentified by marine biologists for different reasons. The main one is that this genus is not listed in the taxonomic keys generally used for amphipod identification in European waters (Chevreux & Fage, 1925; Lincoln, 1979; Ruffo, 1982). Until now, this genus was only recorded from the North Pacific. Moreover, the specimens are very fragile (loss of gnathopods and antennae) during the sieving process and are thus difficult to identify. Since only males of Aoridae could be identified to species level, most specimens without gnathopods are frequently classified as 'Aoridae'. Finally, *Aoroides* species are present in particular habitats (oyster reefs, slipper limpet beds, fouling communities under pontoons) which are not usually sampled in benthic routine surveys using corers or grabs. These three species might be present in other locations in France and in Europe, particularly in shellfish farming areas and marinas. The transfer of *C. gigas* among regions has caused the introduction and spread of numerous alien species in northern Europe (Gouletquer *et al.*, 2002). Recreational boating has been only recently pointed as an important vector for both primary and secondary introductions for a diverse set of non-native taxa (Mineur *et al.*, 2008; Clarke Murray *et al.*, 2011; Ros *et al.*, 2013).

Identification key to adult males of *Aoroides* species from the French Atlantic coast (based on Ariyama's (2004) key):

1. Gnathopod 1 poorly setose. Intertidal species.....2  
— Gnathopod 1 densely setose. Subtidal species .....  
*A. longimerus* Ren & Zheng, 1996
2. Outer ramus of uropod 3 with 1–2 spines, inner ramus with 2–3 spines .....*A. curvipes* Ariyama, 2004  
— Outer ramus of uropod 3 marginally bare, inner ramus with 1–2 spines .....  
*A. semicurvatus* Ariyama, 2004

## ACKNOWLEDGEMENTS

The authors thank F. Prince and P. Dusoewoir, captain and crew member of RV 'Planula IV'. We also thank X. de Montaudouin, L. Pascal and S. Gasmi for their help in field sampling. We are very grateful to J.C. Sorbe for his help to confirm the genus *Aoroides*. The authors would like to thank F. Vandenbosch, W. Thomas, F. Noisette, T. Androuin, G. Schaal, L. M.-L. J. Noël and Div&Co members, especially J. Coudret, T. Broquet, S. Le Cam, C. Roby and T. Comtet for fieldwork assistance and help with sample processing throughout the JCL/FV Commun'touf project. We also thank two anonymous reviewers for helpful comments on the manuscript. Finally, the authors are very grateful to H. Ariyama for his help to confirm our identifications of *Aoroides* specimens and for his observations of specimens of *A. semicurvatus* and *A. curvipes* in the Osaka Museum of Natural History collections.

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