

Rapid Communication**First record of *Monocorophium uenoi* (Stephenson, 1932) (Crustacea: Amphipoda: Corophiidae) in the Bay of Biscay, French Atlantic coast**Benoit Gouillieux^{1,*} and Cécile Massé²¹Université de Bordeaux, Station Marine d'Arcachon, 2 rue du Professeur Jolyet, 33120 Arcachon, France²UMS 2006 AFB-MNHN-CNRS Patrimoine Naturel, Station Marine d'Arcachon, 2 rue du Professeur Jolyet, 33120 Arcachon, FranceAuthor e-mails: benoit.gouillieux@hotmail.fr (BG), cecile.masse@mnhn.fr (CM)

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OPEN ACCESS**Abstract**

The non-indigenous amphipod *Monocorophium uenoi* was recorded for the first time on the French Atlantic coast. This species has been collected in Arcachon Bay and Bidasoa Estuary as early as 2007, probably introduced with non-native oysters. A summary on its morphological characters and its current distribution is done, and an updated identification key to *Monocorophium* species for European waters is provided.

Key words: non-indigenous species, Peracarida, Corophiini, Arcachon Bay, Bidasoa Estuary, Pacific oyster

Introduction

The genus *Monocorophium* Bousfield and Hoover, 1997 is represented by 4 species in European waters: *M. acherusicum* (Costa, 1853), *M. insidiosum* (Crawford, 1937), *M. sextonae* (Crawford, 1937) and *M. uenoi* (Stephenson, 1932) (Lincoln 1979; Bousfield and Hoover 1997; Faasse 2014). These species are native from European waters, except *M. uenoi* native from Japan, and *M. sextonae* which may have a South-West Pacific origin for some authors (Gouilletquer et al. 2002). *M. uenoi* was recorded in The Netherlands in 2013 (Faasse 2014) – the first report from European waters. The present paper deals with *M. uenoi* record from the French Atlantic coast, which precedes the previous record.

Materials and methods*Study area* (Figure 1)

Arcachon Bay is a 180 km² macrotidal coastal lagoon, connected to the Atlantic Ocean by a narrow channel and receives freshwater from Leyre River. The lagoon is characterized by large intertidal flats (115 km²) (Plus et al. 2010). Farms rearing the Pacific oyster *Magallana gigas* (Thunberg, 1793) occupy the deeper intertidal. Between 2007 and 2017, water temperature

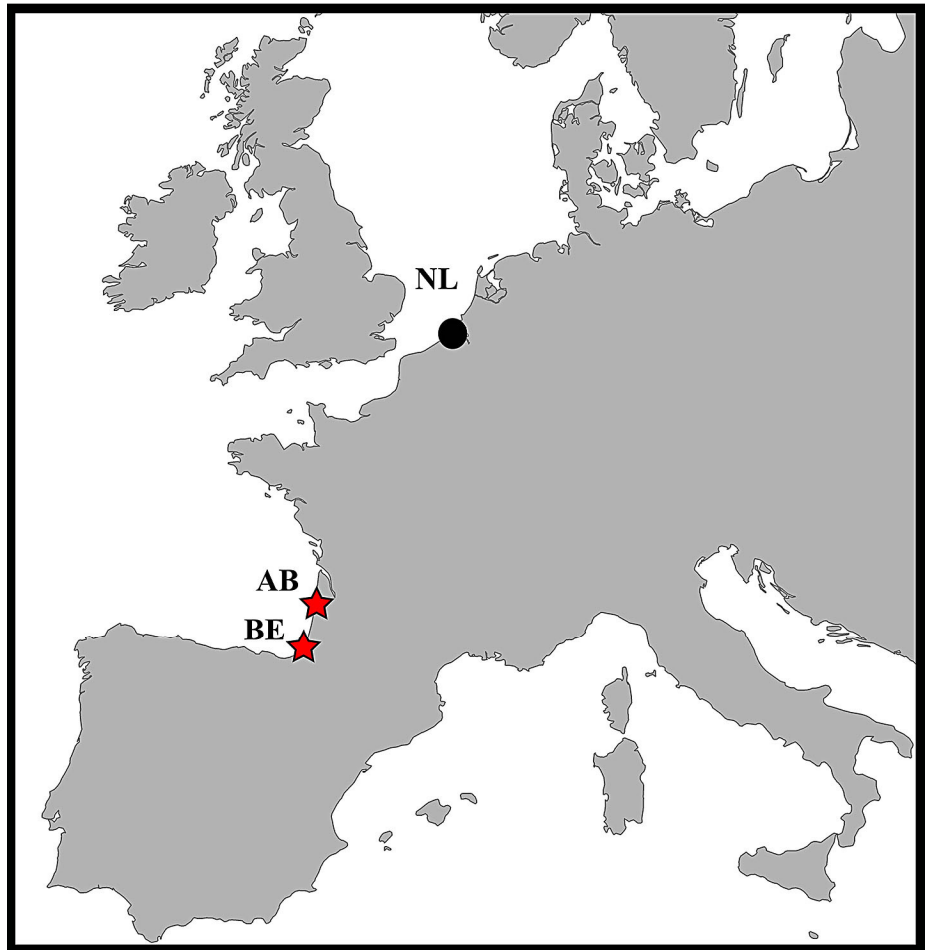


Figure 1. Locations in Europe with records of *Monocorophium uenoi*. NL: The Netherlands. AB: Arcachon Bay. BE: Bidasoa Estuary. Black spot: Faasse 2014. Red stars: present study.

ranged from 4 to 25 °C and salinity ranged from 21 to 36 with an average of 16 ± 4 °C and 33 ± 2 (mean \pm SD) respectively.

Bidasoa Estuary represents the border between France and Spain in the South East of the Bay of Biscay. It is a short estuary with some feral oyster reefs. No shellfish or commercial port are present. Water temperature ranged from 12 to 22 °C and salinity ranged from 13 to 35 ppt with an average of 17 ± 4 °C and 31 ± 5 (mean \pm SD) respectively.

Environmental data (temperature and salinity) for both Arcachon Bay and Bidasoa Estuary were provided by the SOMLIT (Service d'Observation en Milieu Littoral, a French coastal monitoring network: <http://somlit.epoc.u-bordeaux1.fr/fr/>).

Material examined

Monocorophium uenoi was collected during benthic surveys, in Arcachon Bay and Bidasoa Estuary (Figure 1, Table 1). Specimens were examined with a Nikon SMZ 1500 stereomicroscope and a Nikon Eclipse E400 microscope with up to 112,5 and 400x magnifications (and transmitted light) respectively. Body length (BL) was measured with NIS-Elements

Table 1. Sampling details. N = number of specimens of *Monocorophium uenoi* collected in Pacific oyster reef.

| Site | Station | Latitude | Longitude | Date | N | MNHN depository |
|-----------------|----------------------|-----------|-----------|--------------------|------|-------------------------------------|
| Arcachon Bay | Les Hosses | 44.666667 | -1.166667 | May 2007–June 2008 | 135* | MNHN-IU-2016-3430 (25 specimens) |
| – | Jacquet | 44.666667 | -1.083333 | July 2014 | 26 | |
| – | Arguin | 44.583333 | -1.233333 | December 2017 | 6 | |
| – | La Nègue | 44.666667 | -1.133333 | September 2015 | 1 | |
| – | Ile aux oiseaux Nord | 44.683333 | -1.166667 | September 2015 | 20 | MNHN-IU-2016-3429 (5 specimens) |
| Bidasoa Estuary | Station nautique | 43.366667 | -1.766667 | October 2015 | 50 | MNHN-IU-2016-3428 (20 specimens) |

* Specimens collected during Salvo (2010) thesis.

Analysis software from the anterior margin of head to the posterior end of telson. For Scanning Electron Microscope (SEM) studies, specimens were dehydrated in a graded ethanol series, critical point dried, sputter coated with gold and examined with a Hitachi TM3030Plus scanning electron microscope. Some specimens were deposited in the Muséum National d'Histoire Naturelle (MNHN, Paris) (Table 1).

Results

Out of 238 specimens of *Monocorophium uenoi* collected, 72% were females, including ovigerous individuals, and 28% were males. Both in Arcachon Bay and Bidasoa Estuary, specimens were all collected in oyster reefs (*Magallana gigas*) between May 2007 and December 2017 (see Table 1).

Diagnose of male Monocorophium uenoi from Arcachon Bay (SW France) (Figure 2)

Rostrum short, projecting slightly beyond lateral head lobes. Antenna 1 peduncle article 1 without lateral and with 3 ventral robust setae, without ventromedial process. Antenna 2 peduncle article 3 without robust seta; article 4 with 1 ventromedial robust seta and distoventral bidentate tooth; article 5 without robust seta, with 1 proximoventral and 1 distomedial process. Gnathopod 1 dactylus longer than palmar margin. Gnathopod 2 dactylus with 3 ventral teeth (tip of dactylus not counted as tooth). Urosome segment 1–3 fused. Uropod 1 inserted mainly laterally from lateral notches; peduncle with 1 distomedial robust seta. Uropod 2 inner ramus outer margin bare. Telson with 3 proximolateral setae and with 2 row of 4 robust setae tooth-like on the dorsodistal depression.

Female

Sexually dimorphic characters based on adult females, Arcachon Bay (SW France), (Figure 3A–C).

Rostrum shorter, not exceeding lateral head lobes. Antenna 1 peduncle article 1 with 1 lateral robust seta. Antenna 2 peduncle article 3 with 1 pair of robust setae; article 4 with row of 3 single robust setae, without

distoventral tooth; article 5 without proximoventral process and with 1 ventromedial robust seta.

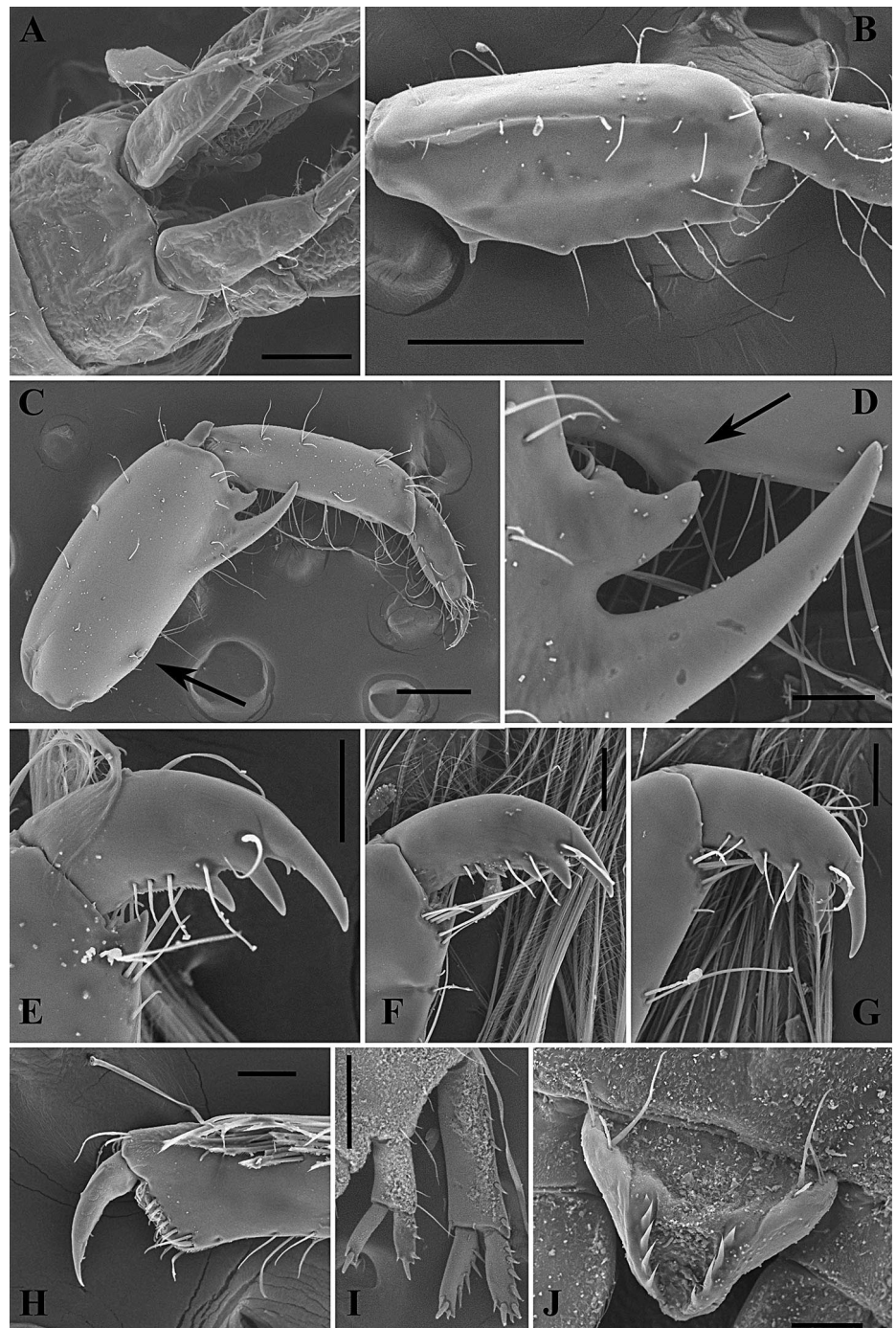


Figure 2. *Monocorophium uenoi* (Stephensen, 1932), males specimens from Jacquet, Arcachon Bay, July 2014. A) Head and antenna dorsal view; B) antenna 1 article 1 mesial view; C) antenna 2 mesial view with article 4 proximal ventromedial robust seta (black arrow); D) antenna 2 article 4 distoventral teeth and article 5 proximal ventral process (black arrow); E–G) gnathopod 2 distal part of propodus and dactylus showing variability in dactylus teeth; H) gnathopod 1 distal part of propodus and dactylus; I) uropod 1 and 2 dorsal view; J) telson dorsal view. Scale bars: A–C, I: 0.2 mm; D–H, J: 0.05 mm. Photomicrographs by B. Gouillieux.

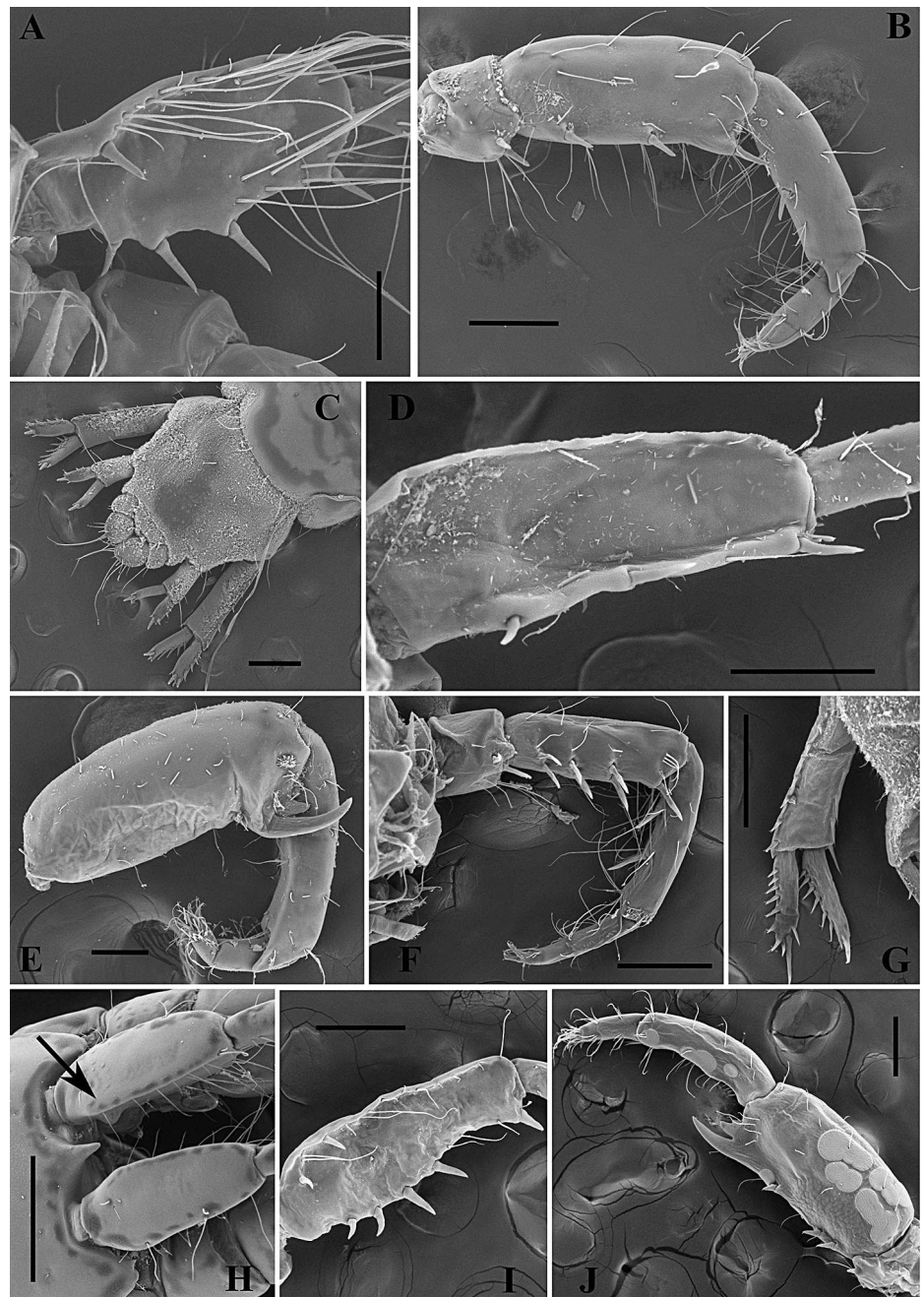


Figure 3. *Monocorophium uenoi* (Stephensen, 1932), females specimens from Jacquet, Arcachon Bay, July 2014; A) antenna 1 article 1 mesial view; B) antenna 2 mesial view; C) urosome dorsal view. *Monocorophium acherusicum* (Costa, 1853), specimens from Arcachon Bay; D) male antenna 1 article 1 mesial view; E) male antenna 2 mesial view; F) female antenna 2 mesial view; G) uropod 1 dorsal view. *Monocorophium insidiosum* (Crawford, 1937), male specimens from Bidasoa Estuary; H) head and antenna dorsal view showing medial process on antenna 1 article 1 (black arrow). *Monocorophium sextonae* (Crawford, 1937), male specimen from Arcachon Bay; I) antenna 1 article 1 mesial view; J) antenna 2 mesial view. Scale bars: A, D: 0.1 mm; B, C, E–J: 0.2 mm. Photomicrographs by B. Gouillieux.

Variability

Based on 60 specimens from Arcachon Bay and Bidasoa Estuary (BL range: 1.7–6.2 mm).

Antenna 1 peduncle article 1 with 0–2 (7%) or 3–4 (93%) ventral robust setae. Antenna 2 peduncle article 4 with (80%) or without (20%) ventromedial

robust setae. Gnathopod 2 dactylus with 2 (13%) or 3 (74%) teeth, or with no left/right symmetry (13%), third tooth sometimes difficult to see (Figure 2F). Number of robust setae on antenna 1 peduncle article 1 or number of gnathopod 2 dactylus teeth not significantly correlated to body length (Spearman, $\rho = 0.22$; p-value = 0.1)

Discussion

Description of Monocorophium uenoi

Monocorophium uenoi present specimens correspond to Stephenson (1932) and subsequent descriptions except for: (1) female antenna 1 article 1 with 1 medial robust seta (*versus* 4 or 5 for Nagata 1960); (2) female antenna 2 article 3 with 2 robust setae (*versus* 3 for Barnard 1952); (3) male antenna 2 peduncle article 5 with proximoventral process (*versus* without for Stephenson 1932 and Nagata 1960; with or without for Barnard 1952); (4) gnathopod 2 dactylus with 2 or 3 posterior teeth (*versus* 3 or 4 for Faasse 2014); (5) telson with 3 proximolateral setae and with 2 row of 4 robust setae tooth-like on the dorsodistal depression (*versus* 1 pair of proximolateral setae and 2 row of 3 robust setae tooth-like for Stephenson 1932).

Bousfield and Hoover (1997) published a revision of Corophiidae from Pacific coast of North America with description of new genus and new species. In their *Monocorophium* key, some updating is required. According to Stephenson (1932), Barnard (1952), Faasse (2014) and to our own observations, *M. uenoi* present gnathopod 1 dactylus longer than palmar margin but not always significantly; gnathopod 2 dactylus with 2 to 4 posterior teeth; urosome with distinct lateral notch and uropod 1 not specially ventrally inserted. Thus, we propose to modify Bousfield and Hoover (1997) key as follows:

3. Rostrum (male) weak, not projecting beyond lateral head lobes; uropod 2, inner ramus, outer margin spines.....4
 Rostrum (male) strong, projecting beyond lateral head lobes; uropod 2, inner ramus, outer margin bare6

And

6. Male rostrum short, projecting slightly beyond lateral head lobes; Female antenna 2 article 4 with row of single robust setae and uropod 2 outer ramus with outer marginal robust setae..... *M. uenoi*
 Male rostrum long, tip projecting distinctly beyond lateral head lobes; female article 4 with pairs robust setae (if row of single robust setae, then uropod 2 outer ramus with outer margin bare).....7

Ecology

As in The Netherlands (Faasse 2014), *M. uenoi* in Arcachon Bay and Bidasoa Estuary was recorded from intertidal Pacific oyster reefs. In Japan, Chile, and the USA (California, Rhode Island), it was mainly recorded in subtidal areas of shallow water bays to 18 m. Occasionally, it was encountered in estuaries, tidal-pools or associated with algae, and described as a tube-dwelling preferring sandy habitats and *Zostera* meadows (Stephensen 1932; Barnard 1952, 1964, 1969; Nagata 1966; Barnard and Reish 1959; Reish and Barnard 1967; Gonzalez 1991; Aikins and Kikuchi 2001, 2002; Kanaya et al. 2015). The species tolerates wide range of environmental parameters, including temperature and salinity (Matsumasa and Kurihara, 1988; present study).

Introduction history and vector

Monocorophium uenoi native range extends from Russian waters to Korea and China (Gurjanova 1951; Kim and Lee 2008; Lowry 2000; Ren 2012). The first introduction was recorded from 1946 in Newport Bay, California, U.S.A. (Carlon 1979, in Faasse 2014). Its distribution expanded from Monterey Bay (Barnard 1966), south to Chile (Gonzalez 1991), and the Gulf of Mexico (Escobar-Briones et al. 2002). In 2013, it was recorded in The Netherlands (Faasse 2014). The records of specimens in Arcachon Bay already in 2007 (Table 1) confirms Faasse's (2014) suggestion that the Netherlands population originated "... from a European area where it has been introduced from the Pacific unnoticed". It has been amply established that the importation and transfer of non-native oysters resulted in the introduction of numerous non-native species (Bachelet et al. 2009; Lavesque et al. 2013; Gouillieux 2017). Arcachon Bay is one of the principal oyster culture sites in France. With its older and more spatially widespread populations of *M. uenoi*, Arcachon Bay may serve as a "seed bank" for its secondary spread, by transfer of shellfish or shellfish farm equipment, or, as in the case of Bidasoa Estuary, possibly in fouling of recreational vessels.

Identification key to adult of *Monocorophium* species (ERMS area)

Modified from Faasse (2014)

1. Antenna 2 article 4 with ventrodiscal tooth (males) (Figure 2C–D) 2
 - Antenna 2 article 4 without ventrodiscal tooth (females) (Figure 3B) 5
2. Uropod 1 peduncle inner margin with only 1 distal robust seta (Figure 2I) 3
 - Uropod 1 peduncle inner margin with at least 3 robust setae (Figure 3G) 4
3. Antenna 1 article 1 without medial process (Figure 2A); Gnathopod 2 dactylus with 2 to 4 teeth (Figure 2E–G) *M. uenoi*

- Antenna 1 article 1 with medial process (Figure 3H); Gnathopod 2 dactylus with 3 or 4 teeth (as Figure 2F–G)..... *M. insidiosum*
- 4. Antenna 1 article 1 with maximum of 3 robust setae (Figure 3D); Antenna 2 article 4 without robust setae, article 5 with process (rarely with small proximal robust seta) (Figure 3E); Gnathopod 2 dactylus with 2 or 3 teeth (as Figure 2E–G)..... *M. acherusicum*
- Antenna 1 article 1 with at least 4 robust setae (Figure 3I); Antenna 2 article 4 with 2 or 3 robust setae, article 5 without proximal and distal process (Figure 3J); Gnathopod 2 dactylus with 2 teeth (as Figure 2E) *M. sextonae*
- 5. Antenna 2 article 4 with row of single robust setae (Figure 3B) 6
- Antenna 2 article 4 with row of paired robust setae (Figure 3F) 7
- 6. Uropod 1 peduncle inner margin with only 1 distal robust seta (Figure 3C).. *M. uenoi*
- Uropod 1 peduncle inner margin with at least 3 robust setae (Figure 3G) *M. sextonae*
- 7. Uropod 1 peduncle inner margin with at least 3 robust setae (Figure 3G); Gnathopod 2 dactylus with 2 or 3 teeth (as Figure 2E–G) *M. acherusicum*
- Uropod 1 peduncle inner margin with only 1 distal robust seta (as Figure 3C); Gnathopod 2 dactylus with 3 or 4 teeth (as Figure 2F–G) *M. insidiosum*

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