

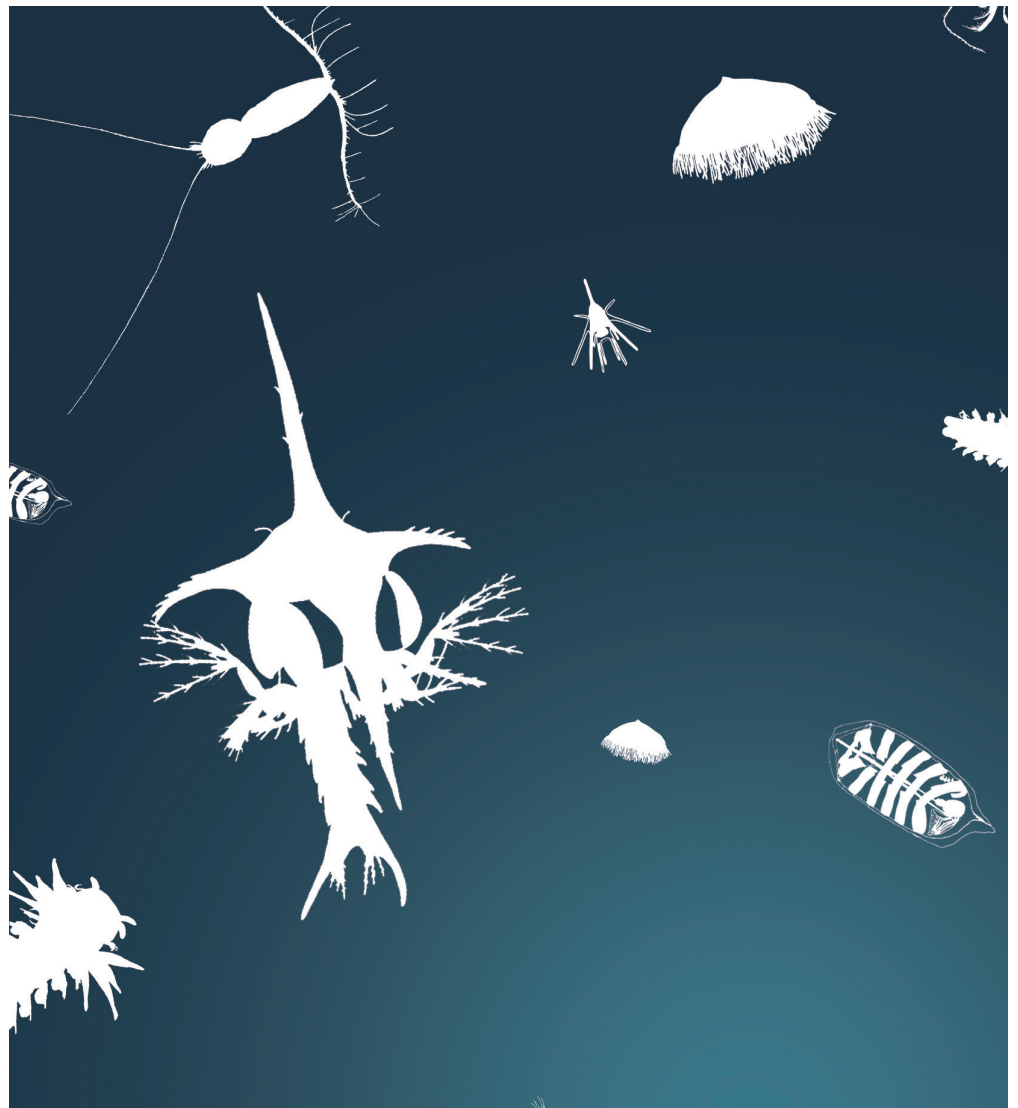
Varunidae H. Milne-Edwards, 1853, and Ocypodidae Rafinesque, 1815

Jose A. Cuesta and Juan Ignacio González-Gordillo

Leaflet No. 190 | April 2020

ICES IDENTIFICATION
LEAFLETS FOR PLANKTON

FICHES D'IDENTIFICATION
DU ZOOPLANCTON



International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Series editor: Antonina dos Santos and Lidia Yebra
Prepared under the auspices of the ICES Working Group on Zooplankton Ecology (WGZE)
This leaflet has undergone a formal external peer-review process

Recommended format for purpose of citation:

Cuesta, J. A., and González-Gordillo, J. I. 2020. Varunidae H. Milne-Edwards, 1853, and Ocypodidae Rafinesque, 1815. ICES Identification Leaflets for Plankton No. 190. 19 pp.
<http://doi.org/10.17895/ices.pub.5995>

The material in this report may be reused for non-commercial purposes using the recommended citation. ICES may only grant usage rights of information, data, images, graphs, etc. of which it has ownership. For other third-party material cited in this report, you must contact the original copyright holder for permission. For citation of datasets or use of data to be included in other databases, please refer to the latest ICES data policy on the ICES website. All extracts must be acknowledged. For other reproduction requests please contact the General Secretary.

This document is the product of an expert group under the auspices of the International Council for the Exploration of the Sea and does not necessarily represent the view of the Council.

Cover Image: Inês M. Dias and Lígia F. de Sousa for ICES ID Plankton Leaflets

<http://doi.org/10.17895/ices.pub.5995>

ISBN number: 978-87-7482-246-2

ISSN number: 2707-675X | © 2020 International Council for the Exploration of the Sea

Contents

1	Summary	1
2	Introduction	1
3	Distribution	2
4	Number and general morphology of larval stages	5
	Larval diagnostic features for Varunidae.....	5
	Larval diagnostic features for Ocypodidae	6
	Selected references	6
5	Taxonomic key	7
	Zoal stages	7
	Megalopa stage	8
6	Figures	9
7	Links to further information	11
	WoRMS.....	11
	Molecular information	11
8	Terminology	13
9	References	14
10	Author contact details	19

Decapoda

Infraorder:	Brachyura
Section:	Eubrachyura
Subsection:	Thoracotremata
Families:	Varunidae H. Milne-Edwards, 1853, and Ocypodidae Rafinesque, 1815

Author: Jose A. Cuesta and Juan Ignacio González-Gordillo

1 Summary

Varunids and ocypodids are Thoracotremata crabs inhabiting tropical and temperate seas worldwide. The adult forms are mainly semi-terrestrial (e.g. *Ocypode*, *Leptuca*, *Minuca*) and intertidal (e.g. *Hemigrapsus*, *Cyclograpsus*, *Gaetice*), although there are also some catadromous species (e.g. *Eriocheir*). Larval development is always linked to the sea. Varunidae comprises 160 species, and larval stages are known for 38 of them. For Ocypodidae, data exists on larval stages for 27 out of the 138 described species. In both groups, a combination of larval features exists that allows distinction at a familial level. This leaflet presents the known larval stages of the 11 species, 6 varunids and 5 ocypodids, distributed in ICES area: *Asthenognathus atlanticus*, *Brachynotus atlanticus*, *B. sexdentatus*, *Eriocheir sinensis*, *Hemigrapsus sanguineus*, *H. takanoi*, *Leptuca pugilator*, *Minuca minax*, *M. pugnax*, *Afruca tangeri*, and *Ocypode quadrata*. The leaflet includes a key to identify zoea and megalopa stages of these species, with some exceptions where no accurate morphological characters are present which would allow clear distinction.

2 Introduction

Families Varunidae and Ocypodidae belong to the brachyuran subsection Thoracotremata Guinot, 1977. Varunidae was considered a subfamily, Varuninae, of the former family Grapsidae MacLeay, 1838. However, after the works of Schubart *et al.* (2000, 2002), it was elevated to family level based on larval morphology and molecular data. Later, Ng *et al.* (2008) placed Asthenognathinae in Varunidae after it was removed from Pinnotheridae De Haan, 1833, based on larval morphology, molecular data, and re-examination of adult morphology.

Regarding Ocypodidae, Shih *et al.* (2016) recently made a systematic review of the family based on molecular data, and considered three subfamilies: Gelasiminae, Ocypodinae, and Ucidinae. Moreover, they proposed a new arrangement of genera, recognizing *Afruca* as a valid genus.

Listed below are the species belonging to the families Varunidae and Ocypodidae, which are currently recorded in ICES area. The taxonomic status is according to WoRMS (2019):

Order Decapoda

Family Varunidae H. Milne Edwards, 1853

Subfamily Asthenognathinae Stimpson, 1858

Asthenognathus atlanticus Monod, 1933

Subfamily Varuninae H. Milne Edwards, 1853

Brachynotus atlanticus Forest, 1957

Brachynotus sexdentatus (Risso, 1827)

Eriocheir sinensis H. Milne Edwards, 1853

Hemigrapsus sanguineus (De Haan, 1835)

Hemigrapsus takanoi Asakura and Watanabe, 2005

Family Ocypodidae Rafinesque, 1815

Subfamily Gelasiminae Miers, 1886

Leptuca pugilator (Bosc, 1802)

Minuca minax (LeConté, 1855)

Minuca pugnax (Smith, 1870)

Subfamily Ocypodinae Rafinesque, 1815

Afruca tangeri (Eydoux, 1835)

Ocypode quadrata (Fabricius, 1787)

Please note that the previous European records of the invasive crab *Hemigrapsus penicillatus* (see Noël *et al.* 1997; Gollasch 1999; and others) have been reassigned to the sibling species *H. takanoi*, according to Geburzi *et al.* (2015).

3 Distribution

Asthenognathus atlanticus Adult habitat: muddy fine sand to mud; on echinoids and commensal with polychaetes (Manning and Holthuis, 1981); from the intertidal zone down to 210 m depth (Glémarec and Hily, 1979; d'Udekem d'Acoz, 1999).

ICES area distribution: English Channel, Bay of Biscay and Galicia (d'Udekem d'Acoz, 1999; Jourde *et al.*, 2012).

Worldwide distribution: Northeast Atlantic to Angola (Manning and Holthuis, 1981); Mediterranean – Alboran Sea, Banyuls-sur-Mer (d'Udekem d'Acoz, 1999), and Algeria (Glémarec and Hily, 1979; Grimes *et al.*, 2016).

Brachynotus atlanticus Adult habitat: sandy substrata with pebbles; intertidal rocky shores.

ICES area distribution: Gulf of Cadiz (González-Gordillo *et al.*, 1990).

Worldwide distribution: Northeast Atlantic to Morocco, Sahrawi Republic,

and Mauritania (Forest, 1957; d'Udekem d'Acoz, 1999); Mediterranean – Alboran Sea (García-Raso, 1984).

*Brachynotus
sexdentatus*

Adult habitat: muddy and sandy bottoms with pebbles; from intertidal zone to 10 m (Ateş, 1999).

ICES area distribution: Bay of Biscay (Nöel *et al.*, 1997), Gulf of Cadiz (González-Gordillo *et al.*, 1990), and Swansea (UK; Naylor, 1957), but extinct in the UK, according to Clark (1986).

Worldwide distribution: Northeast Atlantic; Mediterranean – Alboran Sea and Spanish Mediterranean coast (Marco-Herrero *et al.*, 2015), Adriatic, Ionian and Aegean Seas, and the coast of Israel and Egypt; Black Sea (d'Udekem d'Acoz, 1999).

*Eriocheir
sinensis*

Adult habitat: catadromous species – juvenile and adult stages live in estuaries and upstream of rivers. Females migrate to brackish waters for reproduction, and larval development takes place in the sea. Megalopae return to estuaries.

ICES area distribution: species has been introduced to ICES area. It can be found along the coasts of the English Channel, North Sea, and Baltic Sea (d'Udekem d'Acoz, 1999), Seine and the Gironde estuaries in France (Vincent, 1996; Herborg *et al.*, 2003), Tagus river in Portugal (Cabral and Costa, 1999), and Miño and Guadalquivir rivers in Spain (Ferdinand-Martinez and Carrera, 2003; Cuesta *et al.*, 2006).

Worldwide distribution: native to the east coast of China, from Hong Kong to North Korea (Hymanson *et al.*, 1999). Invasive species in North America, in St Lawrence River and Ontario, Canada (Poore, 2004; de Lafontaine, 2005), San Francisco Bay (Rudnick *et al.*, 2003, 2005), Chesapeake Bay (Ruiz *et al.*, 2006), Lake Erie (Nepszy and Leach, 1973), and Hudson River (Schmidt *et al.*, 2009). In Asia it has been found in the Tazeh Bekandeh River in northern Iran (Robbins *et al.*, 2006), Lake Ladoga in Russia (Panov, 2006), and Shatt Al-Basrah Canal in Iraq (Clark *et al.*, 2006).

*Hemigrapsus
sanguineus*

Adult habitat: intertidal coastal and estuarine habitats, exposed rocky shores, sand and gravel substrata, commonly occupying habitats with high hydrodynamics (Dauvin *et al.*, 2009).

ICES area distribution: species has been introduced to ICES area. It can be found along the coastline from the English Channel to the North Sea (Epifanio, 2013). Other intermediate locations are listed in Dauvin *et al.* (2009).

Worldwide distribution: native to Japan, Korean Peninsula, Taiwan, and China. Invasive species from Maine to North Carolina (NW Atlantic), English Channel to the North Sea (NE Atlantic; Epifanio, 2013); and Croatia (Mediterranean; Schubart, 2003).

*Hemigrapsus
takanoi*

Adult habitat: intertidal and subtidal substrata of gravel, sand, oyster beds, and under boulders and rocks; commonly occupying habitats with low hydrodynamics (Dauvin *et al.*, 2009; Miyajima and Wada, 2017).

ICES area distribution: species has been introduced to ICES area; from

Laredo (Spain; Noël, 1997) to the western Baltic Sea (Geburzi *et al.*, 2015), including the south coast of England (Ashelby *et al.*, 2017). Invasive species in France, The Netherlands, Belgium, and the UK (Wood *et al.*, 2015).

Worldwide distribution: native to inner bays and estuaries of East Asia from the coast of the Russian Far East (Marin, 2013) to the Korean Peninsula (Lee *et al.*, 2013) and Japan (Asakura and Watanabe, 2005).

Leptuca pugilator

Adult habitat: sandy and muddy beaches bordering marshes, along banks of tidal creeks, and in marshes with *Salicornia* (Williams, 1984).

ICES area distribution: USA – Cape Cod to North Carolina (Williams, 1984).

Worldwide distribution: western Atlantic, from Cape Cod to Pensacola (Florida), in The Bahamas, and in Santo Domingo (Crane, 1975; Williams, 1984).

Minuca minax

Adult habitat: muddy substrata of marshes, and sandy mud with phanerogams and high organic content (Gray, 1942; Kerwin, 1971).

ICES area distribution: USA – Cape Cod to North Carolina (Williams 1984).

Worldwide distribution: western Atlantic, to Matagorda (Texas; Williams, 1984).

Minuca pugnax

Adult habitat: muddy marsh environments.

ICES area distribution: USA, Provincetown (Massachusetts) to Hampton (New Hampshire; Johnson, 2014).

Worldwide distribution: Northwest Atlantic, to Florida (Johnson, 2014).

Afruca tangeri

Adult habitat: intertidal to 5 m; soft habitats with muddy or sandy-muddy substrata and high organic content, sometimes partially covered by the cordgrass *Spartina maritima* or *Salicornia*.

ICES area distribution: restricted to Gulf of Cadiz (Zariquiey Álvarez, 1968; González-Gordillo *et al.*, 1990) and Mira estuary (southwestern Portugal; Lourenço *et al.*, 2000).

Worldwide distribution: eastern Atlantic, to southern Angola (Manning and Holthuis, 1981), the archipelagoes of São Tomé and Príncipe (Forest and Guinot, 1966), and Cape Verde (Monod, 1956).

Ocypode quadrata

Adult habitat: supralittoral, along the ocean and harbour sandy beaches.

ICES area distribution: USA, from Rhode Island to North Carolina (Williams, 1984).

Worldwide distribution: western Atlantic coast, Massachusetts to Rio Grande do Sul (Brazil), including the Bermudas, Jamaica and Fernando de Noronha archipelago (Brazil; Williams, 1984).

4 Number and general morphology of larval stages

The larval development of crabs of the Varunidae and Ocypodidae families comprises two consecutive phases: zoea and megalopa (decapodid), like that of almost all Brachyura. Zoeal stages are characterized by a globose carapace with conspicuous dorsal and rostral spines, maxillipeds with long distal setae that are used for swimming, and a pleon with 5–6 segments that ends in a fork-shaped telson. Both Varunidae and Ocypodidae comprise 5 zoeal stages (ZI–ZV) in their life cycle. The first three stages lack pleopods and carry 4, 6, and 8 distal natatory setae on the exopod of the first and second maxillipeds, respectively. The fourth stage shows uniramous (buds) pleopods and 10 natatory setae on the exopod of the first and second maxillipeds (although some ocypodids can show only 8–9 setae). The last zoeal stage (ZV) shows well developed biramous pleopod buds and 10–13 natatory setae (generally 12 setae) on the first and second maxillipeds. Megalopae of both families have a morphology similar to juvenile crabs, with a depressed carapace, 5 well developed pereopod pairs (first chelate) and the pleon provided with pleopods that allow them to move in the water column. Species of both families only present one stage of megalopa before the metamorphosis to juvenile.

Larval diagnostic features for Varunidae

Characteristics of the zoeal stages:

- i) Presence of dorsal, rostral, and lateral spines on the carapace.
- ii) Antennal exopod well developed with medial setae, generally similar in size or longer than protopod.
- iii) Maxillule with setation pattern 1, 5 on the endopod.
- iv) Maxilla with setation pattern 2 + 2 on the endopod, and zoea I with 4 + 1 marginal setae on the exopod (scaphognatite).
- v) Maxilliped I basis with 2 + 2 + 3 + 3 setae, zoea I with 2, 2, 1, 2, 5 setae on the endopod.
- vi) Maxilliped II basis with 1 + 1 + 1 + 1 setae, and 0, 1, 6 setae on the endopod.
- vii) Pleon without lateral expansions or distolateral processes on pleonite 5.
- viii) Telson furcated with median notch, and furcal rami unarmed.
- ix) Dorsolateral knobs on pleonites 2, 2, and 3 or 2–4.

Characteristics of the megalopa stage:

- i) Antennular endopod present.
- ii) Antenna with 10 segments.
- iii) Mandibular palp setation: 0, 5–13.
- iv) Scaphognatite with 39–90 marginal setae.
- v) Epipod present in the second maxilliped.
- vi) Pleopods with 3 cincinnuli.
- vii) Uropod setation: 1, 8–13.

Larval diagnostic features for Ocypodidae

Characteristics of the zoeal stages:

- i) Presence of dorsal and rostral spines on the carapace. Lateral spines can be absent or present. Dorsal spine smaller than the height of the carapace (although not conspicuous in *Afruca tangeri*, according to Rodríguez and Jones, 1993) and distinctly curved backwards.
- ii) Antennal exopod well developed with terminal setae, not reaching the end of protopod.
- iii) Maxillule with setation pattern 0, 4 on the endopod.
- iv) Maxilla with setation pattern 1 + 2 on the endopod, and zoea I with 4 + 1 marginal setae on the exopod (scaphognatite).
- v) Maxilliped I basis with 2 + 2 + 3 + 2–3 setae, zoea I with 2, 2, 1, 2, 5 setae on the endopod.
- vi) Maxilliped II basis with 1 + 1 + 1 + 1 setae and 0, 0, 5 setae on the endopod.
- vii) Pleon with or without lateral expansions and distolateral processes on pleonite 5.
- viii) Dorsolateral knobs on pleonites 2 and 3.
- ix) Telson furcated with median notch. Furcal rami with or without dorsal and lateral spines.

Characteristics of the megalopa stage:

- i) Antennular endopod present.
- ii) Antenna with 10 segments.
- iii) Mandibular palp setation: 0, 0, 7 (*A. tangeri*) or 2, 18 (*O. quadrata*).
- iv) Scaphognatite with 60–70 marginal setae.
- v) Epipod present in the second maxilliped.
- vi) Uropod setation: 1, 12 (*A. tangeri*) or 6, 26 (*O. quadrata*).

Selected references

- *Asthenognathus atlanticus*: under previous scientific name *Tritodynamia atlantica*; Bocquet (1965), partial description of larval stages (ZI–ZV + M) reared in the laboratory.
- *Brachynotus atlanticus*: Rodríguez *et al.* (1992), complete description of larval stages (ZI–ZV + M) reared in the laboratory.
- *Brachynotus sexdentatus*: Cuesta *et al.* (2000), complete description of larval stages (ZI–ZV + M) reared in the laboratory.
- *Eriocheir sinensis*: Kim and Hwang (1995), complete description of larval stages (ZI–ZV + M) reared in the laboratory; Kamanli *et al.* (2018), complete description of larval stages (ZI–ZV + M) reared in the laboratory.
- *Hemigrapsus sanguineus*: Hwang *et al.* (1993), complete description of larval stages (ZI–ZV + M) reared in the laboratory.

- *Hemigrapsus takanoi*: Landeira *et al.* (2019), complete description of larval stages (ZI–ZV + M) reared in the laboratory.
- *Afruca tangeri*: under previous scientific name *Uca tangeri*; Rodríguez and Jones (1993), complete description of larval stages (ZI–ZV + M) reared in the laboratory; Spivak and Cuesta (2009), larval description of the extra-stage ZVI, reared in the laboratory.
- *Leptuca pugilator*: under previous scientific name *Gelasimus pugilator*; Hyman (1920), description of larval stages (ZI–ZII) reared in the laboratory; ZIII–ZV and megalopa described from planktonic specimens.
- *Minuca minax*: under previous scientific name *Gelasimus minax*; Hyman (1920), description of larval stages (ZI–ZII) reared in the laboratory; ZIII–ZV and megalopa described from planktonic specimens.
- *Minuca pugnax*: under previous scientific name *Gelasimus pugnax*; Hyman (1920), description of larval stages (ZI–ZII) reared in the laboratory; ZIII–ZV and megalopa described from planktonic specimens.
- *Ocypode quadrata*: Díaz and Costlow (1972), complete description of larval stages (ZI–ZV + M) reared in the laboratory.

5 Taxonomic key

Zoal stages

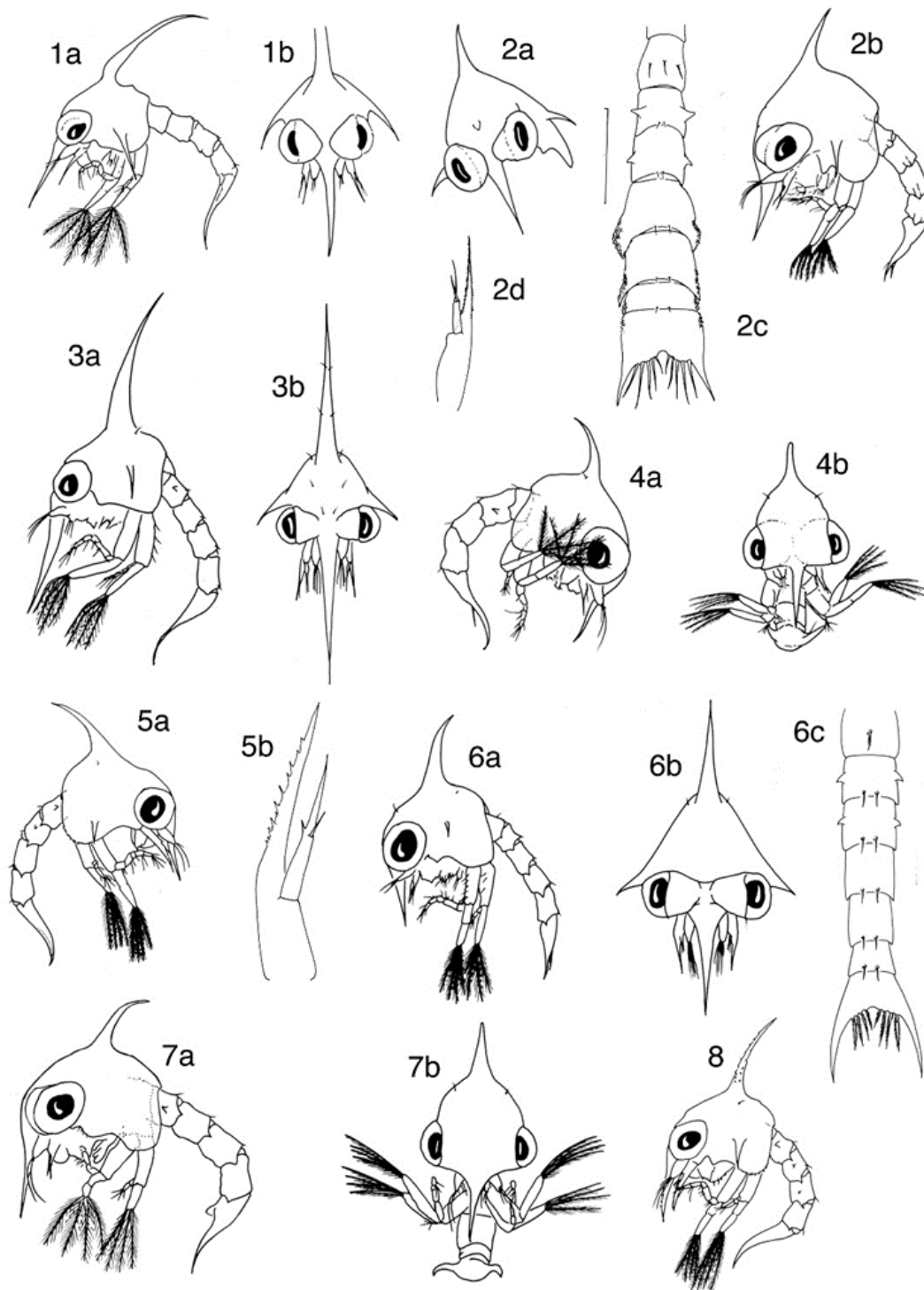
1. Antennal exopod short, smaller than half of the protopod, with terminal setae (Figure 2d)..... 2
 Antennal exopod well developed, longer than half of the protopod, with medial setae (Figure 5b)..... 4
2. Carapace lateral spines absent (Figure 7a)..... *Leptuca pugilator, Minuca pugnax, Minuca minax**
 Carapace lateral spines present (Figure 2a, 6b)..... 3
3. Pleonite 4 laterally expanded, telson furcae not longer than telson plate (Figure 2c)..... *Ocypode quadrata*
 Pleonite 4 not expanded laterally, telson furcae longer than telson plate (Figure 6c)..... *Afruca tangeri*
4. Dorsolateral knobs present on pleonite 2 (Figure 3a)..... *Brachynotus atlanticus*
 Dorsolateral knobs present on other pleonites..... 5
5. Dorsolateral knobs present on other pleonites 2-4 (Figure 8)..... *Eriocheir sinensis*
 Dorsolateral knobs present on pleonites 2-3 (Figure 1a, 5a)..... 6
6. Carapace dorsal spine longer than rostral spine and recurved (Figure 1a).....
 *Asthenognathus atlanticus*
 Carapace dorsal spine not longer than rostral spine, straight or slightly recurved..... 7
7. Carapace dorsal spine straight and twice longer than carapace height
 *Brachynotus sexdentatus*

Carapace dorsal spine slightly curved and slightly longer than carapace height..... *Hemigrapsus sanguineus, H. takanoi***

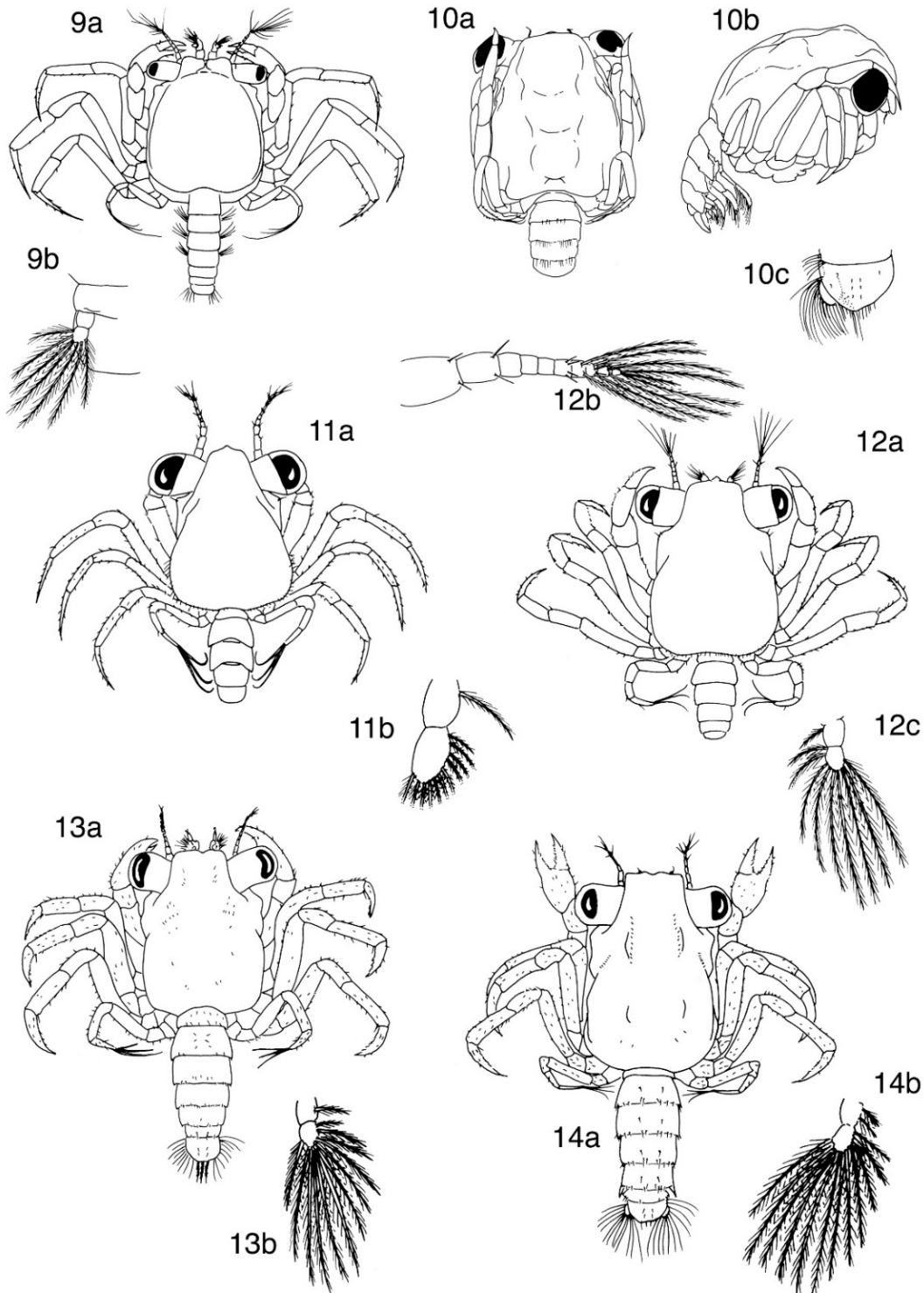
Megalopa stage

1. Uropod basal segment without setae (Figure 9b)..... *Asthenognathus atlanticus*
Uropod basal segment with setae (Figure 10c, 11a, 14b)..... 2
2. Uropod basal segment with 2 or more setae..... 3
Uropod basal segment with 1 seta (Figure 11a)..... 4
3. Uropod basal segment with 2 setae (Figure 14b)..... *Eriocheir sinensis*
Uropod basal segment with 6 setae (Figure 10c)..... *Ocypode quadrata*
4. Setae of antennal flagellum segment 5 long and overlapping setae of terminal segment (Figure 12b)..... 5
Setae of antennal flagellum segment 5 long but no overlapping setae of terminal segment..... *Afruca tangeri*
5. Uropod distal segment with 9 setae (Figure 12c)..... 6
Uropod distal segment with 10-12 setae (Figure 13b)..... 7
6. Mandibular palp setation: 0, 0, 8..... *Brachynotus atlanticus*
Mandibular palp setation: 0, 0, 9..... *Brachynotus sexdentatus*
7. Uropod distal segment with 10 setae..... *Hemigrapsus takanoi*
Uropod distal segment with 11-12 setae (Figure 13b)..... *Hemigrapsus sanguineus**

6 Figures



Figures 1–8. General morphology of Varunidae and Ocypodidae zoeal larval stages 1. *Asthenognathus atlanticus*, 1a. lateral view (ZI), 1b. frontal view (ZI); 2. *Ocypode quadrata*, 2a. frontal view (ZI), 2b. lateral view (ZI), 2c. pleon (ZIII), 2d. antenna (ZI); 3. *Brachynotus atlanticus*, 3a. lateral view (ZI), 3b. frontal view (ZIII); 4. *Minuca minax*, 4a. lateral view (ZI), 4b. frontal view (ZI); 5. *Hemigrapsus sanguineus*, 5a. lateral view (ZI), 5b. antenna (ZI); 6. *Afruca tangeri*, 6a. lateral view (ZI), 6b. frontal view (ZII), 6c. pleon (ZIII); 7. *Leptuca pugilator*, 7a. lateral view (ZI), 7b. frontal view (ZI); 8. *Eriocheir sinensis*, lateral view (ZI). All figures redrawn from: 1. Bocquet (1965) as *Tritodynamia atlantica*; 2. Díaz and Costlow (1972); 3. Rodríguez et al. (1992); 4. Hyman (1920) as *Gelasimus minax*; 5. Hwang et al. (1993); 6. Rodríguez and Jones (1993) as *Uca tangeri*; 7. Hyman (1920) as *Gelasimus pugilator*; 8. Kim and Hwang (1995). Drawings not to scale.



Figures 9–14. General morphology of Varunidae and Ocypodidae megalopa larval stage: 9. *Asthenognathus atlanticus*, 9a. dorsal view, 9b. right uropod; 10. *Ocypode quadrata*, 10a. dorsal view, 10b. lateral view, 10c. left uropod and telson; 11. *Afruca tangeri*, 11a. dorsal view, 11b. uropod; 12. *Brachynotus atlanticus*, 12a. dorsal view, 12b. antenna, 12c. uropod; 13. *Hemigrapsus sanguineus*, 13a. dorsal view, 13b. uropod; 14. *Eriocheir sinensis*, 14a. dorsal view, 14b. uropod. All figures redrawn from: 9. Bocquet (1965) as *Tritodynamia atlantica*; 10. Díaz and Costlow (1972); 11. Rodríguez and Jones (1993) as *Uca tangeri*; 12. Rodríguez *et al.* (1992); 13. Hwang *et al.* (1993); 14. Kim and Hwang (1995). Drawings not to scale.

7 Links to further information

WoRMS

<i>Asthenognathus atlanticus</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=107468
<i>Brachynotus atlanticus</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=107447
<i>Brachynotus sexdentatus</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=107450
<i>Eriocheir sinensis</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=107451
<i>Hemigrapsus sanguineus</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=158417
<i>Hemigrapsus takanoi</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=389288
<i>Afruca tangeri</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=955160
<i>Leptuca pugilator</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=955239
<i>Minuca minax</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=955266
<i>Minuca pugnax</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=955270
<i>Ocypode quadrata</i>	http://www.marinespecies.org/aphia.php?p=taxdetails&id=158432

Molecular information

Selected 16S and COI DNA barcode sequences of the species from the families Varunidae and Ocypodidae present in ICES area. In the cases where several sequences existed for the same species, links are presented for all sequences, and for selected 16S and COI DNA barcode sequences. The selection was performed based on the following criteria when several sequences existed for the same species: (i) most recent and/or longest sequence, (ii) the sequence included in previous phylogenetic studies, and (iii) testing by BLAST. All 16S and COI DNA barcode sequences are adopted from Genbank and were tested by BLAST.

<i>Asthenognathus atlanticus</i>	https://www.ncbi.nlm.nih.gov/nuccore/241993774
<i>Brachynotus atlanticus</i>	https://www.ncbi.nlm.nih.gov/nuccore/27524884
<i>Brachynotus sexdentatus</i>	https://www.ncbi.nlm.nih.gov/nuccore/?term=txid135464[Organism:noexp]
16S sequence	https://www.ncbi.nlm.nih.gov/nuccore/AJ278832
<i>Eriocheir sinensis</i>	https://www.ncbi.nlm.nih.gov/nuccore/?term=txid95602[Organism:noexp]

- 16S sequence <https://www.ncbi.nlm.nih.gov/nuccore/AF105243>
- COI sequence <https://www.ncbi.nlm.nih.gov/nuccore/MG935182>
- Hemigrapsus sanguineus* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid40176\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid40176[Organism:noexp])
- 16S sequence <https://www.ncbi.nlm.nih.gov/nuccore/GU731425>
- COI sequences <https://www.ncbi.nlm.nih.gov/nuccore/KX579065>
<https://www.ncbi.nlm.nih.gov/nuccore/KX579066>
- Hemigrapsus takanoi* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid764359\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid764359[Organism:noexp])
- 16S sequence <https://www.ncbi.nlm.nih.gov/nuccore/AJ278835>
- COI sequence <https://www.ncbi.nlm.nih.gov/nuccore/KT209537>
- Afruca tangeri* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53281\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53281[Organism:noexp])
- 16S sequence <https://www.ncbi.nlm.nih.gov/nuccore/AB813666>
- COI sequence <https://www.ncbi.nlm.nih.gov/nuccore/LC150399>
- Leptuca pugilator* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid6772\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid6772[Organism:noexp])
- 16S sequences <https://www.ncbi.nlm.nih.gov/nuccore/Z79659>
<https://www.ncbi.nlm.nih.gov/nuccore/Z79660>
<https://www.ncbi.nlm.nih.gov/nuccore/Z79661>
<https://www.ncbi.nlm.nih.gov/nuccore/Z79662>
- COI sequence <https://www.ncbi.nlm.nih.gov/nuccore/MK308325>
- Minuca minax* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid504420\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid504420[Organism:noexp])
- 16S sequence <https://www.ncbi.nlm.nih.gov/nuccore/LC150350>
- COI sequences FJ693516-693560 (sequence code range)
- Minuca pugnax* [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53306\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53306[Organism:noexp])
- 16S sequences <https://www.ncbi.nlm.nih.gov/nuccore/LC087924>

<https://www.ncbi.nlm.nih.gov/nuccore/LC087925>

COI sequences <https://www.ncbi.nlm.nih.gov/nuccore/LC087954>

<https://www.ncbi.nlm.nih.gov/nuccore/LC087955>

Ocypode quadrata [https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53310\[Organism:noexp\]](https://www.ncbi.nlm.nih.gov/nuccore/?term=txid53310[Organism:noexp])

16S sequences MG805665-805798 (sequence code range)

COI sequences KY568729-568760 (sequence code range)

8 Terminology

The explanation of the terminology has been taken, with modifications, from Ingle (1992), Martin *et al.* (2014), and Clark and Cuesta (2015). Terminology descriptions are modified according to brachyuran larval morphology.

- Antenna** Second pair of cephalic appendages, involved in sensory perception. Antennae can be absent. When present, it can be formed by a protopod, endopod, and exopod (not always) with different degree of development (according to larval stage and taxonomical position).
- Antennule** First pair of cephalic appendages, involved in chemosensory perception. In zoeal stages, it is a uniramous biflagellated appendage that presents a primary flagellum (bearing aesthetascs and setae) and an accessory flagellum (can be absent in the first stages and appears as a bud in subsequent stages). In the megalopa larval stage, it includes a basal segmented peduncle. The primary flagellum is annulated and the accessory flagellum (when present) bears setae.
- Basis** Second segment of the larval appendages. Endites are present in the maxillar basis.
- Carapace** Layer covering cephalon and thorax of zoea and megalopa larvae. Rostral, dorsal, and lateral spines can be present in zoea.
- Coxa** First segment of the larval appendages. Endites are present in the maxillar coxa.
- Endite** Lobes in the basis and coxa of the maxilla, bearing setae and/or spines.
- Mandible** Third pair of cephalic appendages, involved in the mastication of food. Mandibles are present from the first zoeal stage with two main functions: incisor and molar. An endopod palp bud appears in the last zoeal stages. In the megalopa stage, the endopod palp is segmented with setation, and the incisor and molar portions of the mandible can no longer be distinguished.
- Maxilla** Fifth pair of cephalic appendages, belonging to the mouthparts, and involved in feeding. It consists of a protopod (with coxal and basal endites), an endopod (unsegmented, but it can be bilobed), and an exopod (scaphognathite).
- Maxilliped** Three pairs of thoracic appendages. In the zoeal phase, the first two pairs are used for swimming, while the third pair is only present as a bud in the last stages. In the megalopa stage, all three pairs are mouthparts.

- Maxillule** The fourth pair of cephalic appendages, belonging to the mouthparts involved in feeding. It consists of a protopod (with coxal and basal endites), an endopod (segmented), and an exopod (absent in first zoea, present as a plumose seta in subsequent stages, and well developed and segmented in the megalopa).
- Megalopa** Last larval stage, characterized by the utilization of the pleopods for motility (swimming activity). It is a transitional stage between the planktonic zoeal phase and the benthonic juvenile stages. The pereopods are developed and functional, and are primarily used to catch or capture prey items, instead of motility.
- Pereopod** Thoracic appendages. In the first zoeal stages pereopods are absent. In the last stages they are present as non-functional buds with the first pair bilobed (= chelipeds). Pereopods are well developed and functional in the megalopa stage, although not involved in motility.
- Pleon** Third body tagma composed of 5/6 segments, called pleonites, and a terminal portion called telson.
- Pleonite** Segment of the pleon. The first zoea stages possess 5 pleonites. The sixth pleonite can be present in the last larval stages, and is generally well developed in the megalopa phase, although in some species it is always absent. Pleonites II–V bear pleopod buds (non-functional) throughout the zoea phase, and are also present in the pleonite VI (functional) in the megalopa.
- Pleopod** Pleonal natatory appendages. Present as non-functional buds on pleonites II–V or VI during the zoea phase, and functional on pleonites II–VI in the megalopa phase. Pleopods of pleonites II–V are biramous, formed by a protopod (without setation), an exopod with a variable number of long natatory setae, and a small endopod with a variable number of cincinnuli (hocked setae). Cincinnuli are used to link the pair of pleopods of the same pleonite, allowing synchronical swimming. The fifth pair of pleopods on the sixth pleonite, called uropods, are uniramous (endopod absent), and setation can be present in the protopod and exopod (natatory setae).
- Telson** Terminal portion of the pleon. Different morphologies can be observed in the zoea phase depending on the taxonomical position. In the megalopa phase, the morphology is similar in all species, a plate-like quadrangle with the posterior margin rounded (with a concave or convex shape).
- Zoea** First larval phase, with a variable number of stages (1–8). It is characterized by motility (swimming activity), using mouthpart appendages (maxillipeds). In the last stages, pereopods and pleopods appear as non-functional buds with different degree of development.

9 References

- Bi, H., and Benfield, M. 2006. Egg production rates and stage-specific development times of *Clausocalanus furcatus* (Copepoda, Calanoida) in the northern Gulf of Mexico. *Journal of Plankton Research*, 28: 1199–1216. <https://doi.org/10.1093/plankt/fbl050>
- Asakura, A., Watanabe, S. 2005. *Hemigrapsus takanoi*, new species, a sibling species of the common Japanese intertidal crab *H. penicillatus* (Decapoda: Brachyura: Grapsoidea). *Journal of Crustacean Biology*, 25: 279–292. <https://doi.org/10.1651/C-2514>

- Ashelby, C. W., Sewell, J., Rostron, J., Shrubsole, R., Child, T., Clark, P. F. 2017. Evidence for the invasion and successful establishment of *Hemigrapsus takanoi* Asakura & Watanabe, 2005 (Crustacea: Decapoda: Varunidae) in Great Britain. *Crustaceana*, 90: 695–708. <https://doi.org/10.1163/15685403-00003692>
- Ateş, A. S. 1999. *Liocarcinus depurator* (Linnaeus, 1758) and *Brachynotus sexdentatus* (Risso, 1827) (Decapoda, Brachyura), two new records for the Turkish Black Sea fauna. *Turkish Journal of Zoology*, 23(2): 115–118.
- Bocquet, C. 1965. Stades larvaires et juveniles de *Tritodynamia atlantica* (Th Monod) (= *Asthenognathus atlanticus* Th. Monod) et position systématique de ce crabe. *Cahiers de Biologie Marine*, 6: 407–418. [https://doi.org/10.1016/0011-7471\(64\)90205-0](https://doi.org/10.1016/0011-7471(64)90205-0)
- Cabral, H. N., Costa, M. J. 1999. On the occurrence of the chinese mitten crab, *Eriocheir sinensis*, in Portugal (Decapoda, Brachyura). *Crustaceana*, 72: 55–58. <https://doi.org/10.1163/156854099502853>
- Clark, P. F. 1986. North East Atlantic crabs, an atlas of distribution. Marine Conservation Society, Ross-on-Wye (1986), 252 pp.
- Clark, P. F., Abdul-Sahib, I. M., Al-Asaki, M. S. 2006. The first record of *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) from the Basrah area of southern Iraq. *Aquatic Invasions*, 1: 51–54. <https://doi.org/10.3391/ai.2006.1.2.1>
- Crane, J. 1975. Fiddler crabs of the world, Ocypodidae: Genus *Uca*. Princeton University Press, New Jersey, 424 pp.
- Cuesta, J. A., Schubart, C. D., Rodríguez, A. 2000. Larval development of *Brachynotus sexdentatus* (Risso, 1827) (Decapoda, Brachyura) reared under laboratory conditions, with notes on larval characters of the Varunidae. *Invertebrate Reproduction and Development*, 38(3): 207–223. <https://doi.org/10.1080/07924259.2000.9652456>
- Cuesta, J. A., González-Ortegón, E., Rodríguez, A., Baldó, F., Vilas, C., Drake, P. 2006. The decapod crustacean community of the Guadalquivir Estuary (SW Spain): seasonal and interyear changes in community structure. *Hydrobiologia*, 557: 85–95. https://doi.org/10.1007/1-4020-4756-8_11
- Dauvin, J. C., Rius, A. T., Ruellet, T. 2009. Recent expansion of two invasive crabs species *Hemigrapsus sanguineus* (de Haan, 1835) and *H. takanoi* Asakura and Watanabe 2005 along the Opal Coast, France. *Aquatic Invasions*, 4(3): 451–465. <https://doi.org/10.3391/ai.2009.4.3.3>
- Diaz, H., Costlow, J. D. 1972. Larval development of *Ocypode quadrata* (Brachyura: Crustacea) under laboratory conditions. *Marine Biology*, 15(2): 120–131. <https://doi.org/10.1007/bf00353640>
- Epifanio, C. E. 2013. Invasion biology of the asian shore crab *Hemigrapsus sanguineus*: a review. *Journal of Experimental Marine Biology and Ecology*, 441: 33–49. <https://doi.org/10.1016/j.jembe.2013.01.010>
- Ferdinand-Martinez, M. A., Carrera, A. G. 2003. Estatus de las poblaciones de cangrejos de río exóticos, *Procambarus clarkii*, *Pacifastacus leniusculus*, y *Eriocheir sinensis*, en el Noreste de la península Iberica, In Capdevila-Arguelles, L., Zilletti, B., Perez Hidalgo N (eds), Contribuciones al conocimiento de las especies exóticas invasoras-1. Ed. by L. Capdevila-Arguelles, B. Zilletti, N. Perez Hidalgo. Grupo Especies Invasoras Serie Técnica, León, Spain, pp 220–221.

- Forest, J. 1957. Mise au point sur les *Brachynotus* de Méditerranée et d'Afrique Occidentale: *Brachynotus sexdentatus* Risso et *Brachynotus Atlanticus* nov. sp. Bulletin de l'Institut Français de l'Afrique Noire (IFAN), Ser. A 19(2): 501–510. <https://doi.org/10.1038/180616a0>
- Forest, J., Guinot, D. 1966. Campagne de la «Calypso» dans le Golfe de Guinée et aux îles Principe, São Tomé et Annobon (1956). 16. Crustacés décapodes brachyours, In Résultats scientifiques des campagnes de la «Calypso», fasc. 7. Annales de l'Institut océanographique de Monaco, 44: 23-124. <https://doi.org/10.5962/bhl.title.65730>
- García-Raso, J. E. 1984. Brachyura of the Coast of Southern Spain. Spixiana, 7(2): 105–113.
- Geburzi, J., Graumann, G., Köhnk, S., Brandis, D. 2015. First Record of the Asian Crab *Hemigrapsus takanoi* Asakura & Watanabe, 2005 (Decapoda, Brachyura, Varunidae) in the Baltic Sea. Bioinvasions Records, 4(2): 103–107. <https://doi.org/10.3391/bir.2015.4.2.06>
- Glémarec, M., Hily, C. 1979. Nouvelles données sur la répartition de *Tritodynamea atlantica* Balls, 1922. Cahiers de Biologie Marine, 20: 499-505.
- Gollasch, S. 1999. The Asian decapod *Hemigrapsus penicillatus* (de Haan, 1835) (Grapsidae, Decapoda) introduced in European waters: status quo and future perspective. Helgoländer Meeresuntersuchungen, 52: 359–366. <http://dx.doi.org/10.1007/BF02908909>
- González-Gordillo, J. I., Cuesta, J. A., Pablos, F. 1990. Adiciones al conocimiento de los crustáceos decápodos de las zonas mediolitoral e infralitoral de las costas suratlánticas andaluzas (suroeste España). I Brachyura. Cahiers de Biologie Marine, 31: 417–429.
- Gray, E. H. 1942. Ecological and life history aspects of the red-jointed fiddler crab, *Uca minax* (LeConte), region of Solomons Island, Maryland. Chesapeake Biological Laboratory Publication, 51: 3–20.
- Grimes, S., Bakalem, A., Dauvin, J.C. 2016. Annotated checklist of marine Algerian Crustacean Decapods. Mediterranean Marine Science, 17(2): 384–395. <http://dx.doi.org/10.12681/mms.1420>
- Herborg, L. M., Rushton, S. P., Clare, A. S., Bentley, M. G. 2003. Spread of the Chinese mitten crab (*Eriocheir sinensis*, H. Milne Edwards) in Continental Europe: analysis of a historical data set. Hydrobiologia, 503: 21–28. https://doi.org/10.1007/978-94-017-2276-6_3
- Hwang, S. G., Lee, C., Kim, C. H. 1993. Complete larval development of *Hemigrapsus sanguineus* (Decapoda, Brachyura, Grapsidae) reared in laboratory. The Korean Journal of Systematic Zoology, 9(2): 69–86.
- Hyman, O. W. 1920. The development of *Gelasimus* after hatching. Journal of Morphology, 33: 485–501.
- Hymanson, Z., Wang, J., Sasaki, T. 1999. Lessons from the home of the Chinese mitten crab. Interagency Ecological Program Newsletter, 12: 25–32.
- Johnson, D.S. 2014. Fiddler on the roof: A northern range extension for the marsh fiddler crab *Uca pugnax*. Journal of Crustacean Biology, 34: 671-673. <https://doi.org/10.1163/1937240x-00002268>
- Jourde, J., Alizier, S., Dancie, C., Dauvin, J. C., Desroy, N., Dubut, S., Gentil, F., Grall, J., Hanin, C., Lanshere, J., Thiébaud, E. 2012. First and repeated records of the tropical-temperate crab *Asthenognathus atlanticus* Monod, 1932 (Decapoda: Brachyura) in the eastern part of the Bay of Seine (Eastern English Channel, France). Cahiers de Biologie Marine, 53(4): 525–532.

- Kamanli, S. A., Morritt, D., Ball, A. D., Goral, T. Clark, P. F. 2018. Re-description of chinese mitten crab *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Grapsoidea: Varunidae) zoeal development using confocal laser scanning microscopy. *Zootaxa*, 4507(1): 1–67. <https://doi.org/10.11646/zootaxa.4507.1.1>
- Kerwin, J. A. 1971. Distribution of the fiddler crab (*Uca minax*) in relation to marsh plants within a Virginia estuary. *Chesapeake Science*, 12: 180–183. <https://doi.org/10.2307/1350779>
- Kim, C. H., Hwang, S. G. 1995. The complete larval development of the mitten crab *Eriocheir sinensis* H. Milne Edwards, 1835 (Decapoda, Brachyura, Grapsidae) reared in the laboratory and a key to the known zoeae of the Varuninae. *Crustaceana*, 68(7): 793–812. <https://doi.org/10.1163/156854095x00953>
- Lafontaine, Y. de. 2005. First record of the chinese mitten crab (*Eriocheir sinensis*) in the St. Lawrence River, Canada. *Journal of Great Lakes Research*, 31: 367–370. [https://doi.org/10.1016/S0380-1330\(05\)70267-7](https://doi.org/10.1016/S0380-1330(05)70267-7)
- Ladeira, J. M., Cuesta, J. A., Tanaka, Y. 2019. Larval development of the brush-clawed shore crab *Hemigrapsus takanoi* Asakura & Watanabe, 2005 (Decapoda, Brachyura, Varunidae). *Journal of the Marine Biological Association of the United Kingdom*, 99(5): 1153–1164. <https://doi.org/10.1017/S002531541900002X>
- Lee, S., Lee, S-K., Rho, H. S., Kim, W. 2013. New report of the varunid crabs, *Hemigrapsus takanoi* and *Sestrostoma toriumii* (Crustacea: Decapoda: Varunidae) from Korea. *Animal Systematics, Evolution and Diversity*, 29: 152–159. <http://dx.doi.org/10.5635/ASED.2013.29.2.152>
- Lourenço, R., Paula, J., Henriques, M. 2000. Estimating the size of *Uca tangeri* (Crustacea: Ocypodidae) without massive crab capture. *Scientia Marina*, 64(4): 437–439. <http://dx.doi.org/10.3989/scimar.2000.64n4437>
- Manning, R. B, Holthuis, L. B. 1981. West african brachyuran crabs (Crustacea: Decapoda). *Smithsonian Contributions to Zoology*, 306: 1–379. <https://doi.org/10.5479/si.00810282.306>
- Marco-Herrero, E., Abelló, P., Drake, P., García-Raso, J. E., González-Gordillo, J. I., Guerao, G., Palero, F., Cuesta, J. A. 2015. Annotated checklist of brachyuran crabs (Crustacea: Decapoda) of the Iberian Peninsula (SW Europe). *Scientia Marina*, 79(2): 243–256. <https://doi.org/10.3989/scimar.04161.27a>
- Marin, I. N. 2013. New data on the distribution of hairy-clawed shore crabs of the genus *Hemigrapsus* (Decapoda: Varunidae) along the Russian mainland coast of the Sea of Japan. *Russian Journal of Marine Science*, 39: 301–305. <https://doi.org/10.1134/s106307401304007x>
- Miyajima, A., Wada, K. 2017. Relationships between life history traits and sexual dimorphisms in two varunid crabs, *Hemigrapsus takanoi* Asakura & Watanabe, 2005 and *H. sinensis* Rathbun, 1931 (Brachyura: Varunidae). *Journal of Crustacean Biology*, 37: 21–28. <https://doi.org/10.1093/jcbiol/ruw011>
- Monod, Th. 1956. Hippidea et Brachyura ouest-africains. *Memoires de l'Institut francais d'Afrique noire*, 45: 1-647.
- Naylor, E. 1957. Introduction of a grapsoid crab, *Brachynotus sexdentatus* (Risso), into British Waters. *Nature*, 180: 616–617. <https://doi.org/10.1038/180616a0>

- Nepszy, S. J., Leach, H. J. 1973. First records of the Chinese mitten crab, *Eriocheir sinensis* (Crustacea: Brachyura) from North America. *Journal of the Fisheries Research Board of Canada*, 30: 1909–1910. <https://doi.org/10.1139/f73-310>
- Ng, P. K. L., Guinot, D., Davie, P. J. F. 2008. *Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world*. *Raffles Bulletin of Zoology*, 17: 1–286.
- Noël, P., Tardy, E., d'Udekem d'Acoz, C. 1997. Will the crab *Hemigrapsus penicillatus* invade the coasts of Europe? *Comptes Rendus de l'Académie des Sciences. Série 3, Science de la vie*, 320: 741–745. [https://doi.org/10.1016/s0764-4469\(97\)84823-8](https://doi.org/10.1016/s0764-4469(97)84823-8)
- Panov, V. E. 2006. First record of the chinese mitten crab, *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) from Lake Ladoga, Russia. *Aquatic Invasions*, 1: 28–31. <https://doi.org/10.3391/ai.2006.1.1.6>
- Poore, G. C. B. 2004. *Marine decapod Crustacea of Southern Australia: A guide to Identification*. CSIRO Publishing, Collingwood, pp. ix + 574 pp.
- Robbins, R. S., Sakari, M., Nezami, S., Clark, P. F. 2006. The occurrence of *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) from the Caspian Sea region, Iran. *Aquatic Invasions*, 1: 32–34. <https://doi.org/10.3391/ai.2006.1.1.7>
- Rodríguez, A., González-Gordillo, J. I., Cuesta, J. A. 1992. Larval stages of *Brachynotus atlanticus* Forest, 1957 (Crustacea, Decapoda, Grapsidae) reared under laboratory conditions. *Journal of Plankton Research*, 14(6): 867–883. <https://doi.org/10.1093/plankt/14.6.867>
- Rodríguez, A., Jones, D. A. 1993. Larval development of *Uca tangeri* (Eydoux, 1835) (Crustacea, Decapoda, Ocypodidae) reared in the laboratory. *Journal of Crustacean Biology*, 13(2): 309–321. <https://doi.org/10.1163/193724093x00093>
- Rudnick, D. A., Hieb, K., Grimmer, K. F., Resh, V. H. 2003. Patterns and processes of biological invasion: The Chinese mitten crab in San Francisco Bay. *Basic and Applied Ecology*, 4: 249–262. <https://doi.org/10.1078/1439-1791-00152>
- Rudnick, D. A., Veldhuizen, T., Tullis, R., Culver, C., Hieb, K., Tsukimura, B. 2005. A life history model for the San Francisco Estuary population of the Chinese mitten crab, *Eriocheir sinensis* (Decapoda: Grapsoidea). *Biological Invasions*, 7: 333–350. <https://doi.org/10.1007/s10530-004-2286-y>
- Ruiz, G. M., Fegley, L., Fofonoff, P., Cheng, Y., Lemaitre, R. 2006. First records of *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) for Chesapeake Bay and the mid-Atlantic coast of North America. *Aquatic Invasions*, 1: 137–142. <https://doi.org/10.3391/ai.2006.1.3.7>
- Schmidt, R. E., Daniels, R. A., Swift, E. L., Shadis, I. B. 2009. Inferences on the biology of juvenile Chinese mitten crab (*Eriocheir sinensis*) from exuviae in a Hudson River tributary, New York, USA. *Aquatic Invasions*, 4: 613–617. <https://doi.org/10.3391/ai.2009.4.4.7>
- Schubart, C. D., Cuesta, J. A., Diesel, R., Felder, D. L. 2000. Molecular phylogeny, taxonomy, and evolution of non-marine lineages within the American Grapsoidea (Crustacea: Brachyura). *Molecular Phylogenetic & Evolution*, 15: 179–190. <https://doi.org/10.1006/mpev.1999.0754>
- Schubart, C. D., Cuesta, J. A., Felder, D. L. 2002. Glyptograpsidae, a new brachyuran family from Central America: larval and adult morphology, and a molecular phylogeny of the Grapsoidea. *Journal of Crustacean Biology*, 22: 28–44. [https://doi.org/10.1651/0278-0372\(2002\)022\[0028:ganbff\]2.0.co;2](https://doi.org/10.1651/0278-0372(2002)022[0028:ganbff]2.0.co;2)

- Schubart, C. D. 2003. The East Asian shore crab *Hemigrapsus sanguineus* (Brachyura: Varunidae) in the Mediterranean Sea: an independent human-mediated introduction. *Scientia Marina*, 67: 195-200. <https://doi.org/10.3989/scimar.2003.67n2195>
- Shih, H. T., Ng, P. K. L., Davie, P. J. F., Schubart, C. D., Türkay, M., Naderloo, R., Jones, D., Liu, M. Y. 2016. Systematics of the family Ocypodidae Rafinesque, 1815 (Crustacea: Brachyura), based on phylogenetic relationships, with a reorganization of subfamily rankings and a review of the taxonomic status of *Uca* Leach, 1814, *sensu lato* and its subgenera. *Raffles Bulletin of Zoology*, 64: 139-175.
- Spivak, E., Cuesta, J. A. 2009. The effect of salinity on larval development of *Uca tangeri* (Eydoux, 1835) (Brachyura: Ocypodidae) and new findings of the zoeal morphology. *Scientia Marina*, 73: 297-305. <https://doi.org/10.3989/scimar.2009.73n2297>
- Udekem d'Acoz C. d'. 1999. Inventaire et distribution des crustacés décapodes de l'Atlantique nord-oriental, de la Méditerranée et des eaux continentales adjacentes au nord de 25°N. Muséum National d'Histoire Naturelle, Paris (Collection Patrimoines Naturels, 40). 383 pp. [https://doi.org/10.1016/s0990-7440\(02\)01163-4](https://doi.org/10.1016/s0990-7440(02)01163-4)
- Vincent, T. 1996. Le crabe chinois *Eriocheir sinensis* H. Milne-Edwards 1854 (Crustacea, Brachyura) en Seine-Maritime, France. *Annales de l'Institut Oceanographique*, 72: 155-171. <https://doi.org/10.1051/kmae:1959003>
- Williams, A. B. 1984. Shrimps, lobsters, and crabs of the Atlantic coast of the Eastern United States, Maine to Florida. Smithsonian Institution Press, Washington, D.C. 550 pp. <https://doi.org/10.2307/1310137>
- Wood, C. A., Bishop, J. D. D., Davies, C. J., Delduca, E. L., Hatton, J. C., Herbert, R. J. H., Clark, P. F. 2015. *Hemigrapsus takanoi* Asakura and Watanabe, 2005 (Crustacea: Decapoda: Brachyura: Grapsoidea): First records of the brush-clawed shore crab from Great Britain. *BioInvasions Records*, 4: 109-113. <https://doi.org/10.3391/bir.2015.4.2.07>
- WoRMS Editorial Board (2019). World Register of Marine Species. Available from <http://www.marinespecies.org> at VLIZ. Accessed 2019-12-16. <https://doi.org/10.14284/170>
- Zariquiey Álvarez, R. 1968. Crustáceos decápodos ibéricos. *Investigación Pesquera*, 32: 1-510.

10 Author contact details

Jose A. Cuesta
Instituto de Ciencias Marinas de Andalucía (ICMAN-CSIC)
Consejo Superior de Investigaciones Científicas
Avda. República Saharaui, 2
11510 Puerto Real (Cádiz), Spain
e-mail: jose.cuesta@icman.csic.es

Juan Ignacio González-Gordillo
Instituto Universitario de Investigación Marina (INMAR)
Universidad de Cádiz
Avda. República Saharaui, s/n
11510 Puerto real (Cádiz), Spain
e-mail: nacho.gonzalez@uca.es