

Mediterranean Marine Science

Vol 5, No 2 (2004)



**Microcassiope minor (Dana, 1852): a description of
the first stage zoea (Crustacea: Decapoda:
Brachyura: Xanthidae)**

P.F. CLARK, M.A. DIONISIO, A.C. COSTA

doi: [10.12681/mms.200](https://doi.org/10.12681/mms.200)

To cite this article:

CLARK, P., DIONISIO, M., & COSTA, A. (2004). *Microcassiope minor* (Dana, 1852): a description of the first stage zoea (Crustacea: Decapoda: Brachyura: Xanthidae). *Mediterranean Marine Science*, 5(2), 23–34.
<https://doi.org/10.12681/mms.200>

***Microcassiope minor* (Dana, 1852): a description of the first stage zoea
(Crustacea: Decapoda: Brachyura: Xanthidae)**

P.F. CLARK¹, M.A. DIONISIO² & A.C. COSTA²

¹Department of Zoology, The Natural History Museum,
Cromwell Road, London SW7 5BD, England

e-mail: pfc@nhm.ac.uk

²Departamento de Biologia, Universidade dos Açores,
Rua Mãe de Deus, 9500 Ponta Delgada, Açores, Portugal

e-mail: ana_dionisio@iol.pt; costa@alf.uac.pt

Abstract

The first stage zoea of Microcassiope minor (Dana, 1852) is described, illustrated and compared with thirteen other known Xanthinae. This comparison suggests that M. minor is closely related to another Atlantic Ocean xanthid, Nanocassiope melanodactyla (A. Milne-Edwards, 1867). Such an affinity may indicate that the genus Nanocassiope Guinot, 1967) is not a homogenous taxon.

Keywords: *Microcassiope minor* (Dana, 1852); First stage zoeal description; Comparative morphology; Xanthinae.

Introduction

SERÈNE (1984:21, 172) listed 13 Xanthinae genera, but the larvae are only known for *Leptodius exaratus* (H. Milne Edwards, 1834) by AIKAWA (1929) as *Xantho exaratus* [ZI], CHHAPGAR (1956) [ZI], TUFAIL & HASHMI (1964) as *L. exeratus* [ZI-II], SABA (1976) [ZI-IV, Meg.], FIELDER *et al.* (1979) [ZI-IV, Meg.], TERADA (1980) [ZI-IV], AMIR (1989, publication not seen during this present study), SIDDIQUI & TIRMIZI (1998) [ZI-IV], KO & CLARK (2002) [ZI], and CLARK & PAULA

(2003) [ZI]; *Macromedaeus distinguendus* (de HAAN, 1835) by TERADA (1980) [ZI-IV]; *Nanocassiope granulipes* (SAKAI, 1939) by KO & CLARK (2002) [ZI-IV, Meg.]; *Nanocassiope melanodactyla* (A. Milne-Edwards, 1867) by DORNELAS *et al.* (2004) [ZI-IV, Meg.] and *Paraxanthias elegans* (Stimpson, 1858) by TERADA (1990) [ZI-IV]. *Xantho* is also assigned to this subfamily and the larvae of a number of species are known e.g. *Xantho incisus* Leach, 1814 by LÉBOUR (1928) [ZI-IV, Meg.], BOURDILLON-CASANOVA (1960) as *Xantho incisus granulicarpus* [ZI-IV],

and INGLE (1983) [ZI-IV, Meg.], (1991) [ZI-IV, Meg.]; *Xantho pilipes* A. Milne Edwards, 1867 by LÉBOUR (1928) as *Xantho hydrophilus* [ZI], INGLE (1992) [ZI] and PAULA & dos SANTOS (2001) [ZI-IV, Meg.], and *Xantho poressa* (Olivi, 1792) by GOURETT (1884) as *Xantho rivulosus* [ZI], BOURDILLON-CASANOVA (1960) [ZI], RODRIGUEZ & MARTIN (1997) [ZI-IV, Meg.], and KO & CLARK (2002) [ZI]. Other genera may also be referred to the Xanthinae for which the larval morphology is reported for *Cataleptodius floridius* (Gibbes, 1850) by KURATA (1970, publication not seen during this present study) as *Leptodius floridius* and INGLE (1987) [ZI]; *Cycloxanthops novemdentatus* (LOCKINGTON, 1877) by KNUDSEN (1960) [ZI-IV, Meg.]; *C. truncatus* (de HAAN, 1837) by HONG (1977) [ZI-IV, Meg.], SUZUKI (1979) [ZI-IV] and TERADA (1980) [ZI-IV] and *Pseudomedaeus agassizii* (A. Milne Edwards, 1880) by COSTLOW & BOOKHOUT (1968) as *Leptodius agassizii* [ZI-IV, Meg.].

According to MANNING & HOLTHUIS (1981) *Microcassiope minor* (Dana, 1852) lives inter-tidally down to a depth of ca. 220 m with a reported distribution from the Eastern Atlantic including the Açores, Madeira, the Cape Verde Islands, the Canary Islands, the Spanish Sahara, the Ivory Coast, Ghana, the Gulf of Guinea (Príncipe and São Tomé) to Annobon and Saint Helena. LEWINSOHN & HOLTHUIS (1964) provide records for the Eastern Mediterranean and Chace (1966) for the Western Atlantic (the Bahamas, Cuba, Curaçao and Islas Los Roques). CHACE (1966) recorded ovigerous crabs from Saint Helena in January and April and off West Africa during June (FOREST & GUINOT, 1966). Recently an ovigerous crab of *M. minor* was collected from São Miguel, Açores in August and the first stage zoeas were hatched in the laboratory. The purpose of this present study is to describe the morphology in detail and compare it with other known Xanthinae first stage zoeas in an attempt to establish the relationship of *M. minor* within this subfamily.

Materials and Methods

An ovigerous *Microcassiope minor* was collected by hand on the lower shore from Ponta Delgada, São Miguel, Açores, on 5 August 2002. The first stage zoeas hatched on 13 August 2002 and were fixed and preserved in 4% buffered formalin. Zoeas were dissected using a Wild M5 and an Olympus BH-2 microscope equipped with Nomarski interference contrast. Setal ambiguities were resolved using a Zeiss Axioskop differential interference contrast microscope. Appendages were mounted on slides in polyvinyl lactophenol and allowed to clear for 24 h. Cover slips were sealed with clear nail varnish and drawings were made with the aid of camera lucida. Five zoeal specimens were examined. The sequence of the zoeal descriptions is based on the malacostracan somite plan and described from anterior to posterior. Setal armature of appendages is described from proximal to distal segments and in order of endopod to exopod (CLARK *et al.*, 1998). The first stage zoea and the spent female are deposited in The Natural History Museum, London, registration number NHM 2002.2006. The first stage zoea is described and fully illustrated. The long plumose natatory setae of the first and second maxillipeds, and the long antennular aesthetascs, were drawn truncated. The approximate measurement of the antennal exopod (for its ratio with the protopod) was taken from the base to the tip excluding the terminal setae.

Description

Microcassiope minor (Dana, 1852)

Zoea I

Carapace (Figs 1a, b). Dorsal spine long, distally curved and spinulate and longer than rostral spine; rostral spine straight with prominent spines distally and equal in size to the antennal protopod; lateral spines present with spinulations on anterior margin;

anterodorsal setae absent; one pair of posterodorsal setae present; each ventral margin without setae; eyes sessile.

Antennule (Fig. 1c). Uniramous; endopod absent; exopod unsegmented with three long (two stout + one thinner) aesthetascs, one short, slender aesthetasc and one small seta, all terminal.

Antenna (Fig. 1d). Protopod equal in length to rostral spine and distally spinulate; with a minute protopodal spine; exopod ca.

17% length of protopod with one long subterminal seta and two terminal setae of unequal length.

Mandible. Mandibular palp absent.

Maxillule (Fig. 2a). Epipod absent, coxal endite with seven setae; basal endite with five setal processes; endopod two-segmented, proximal segment with one seta, distal segment with six (two subterminal + four terminal) setae; exopod seta absent.

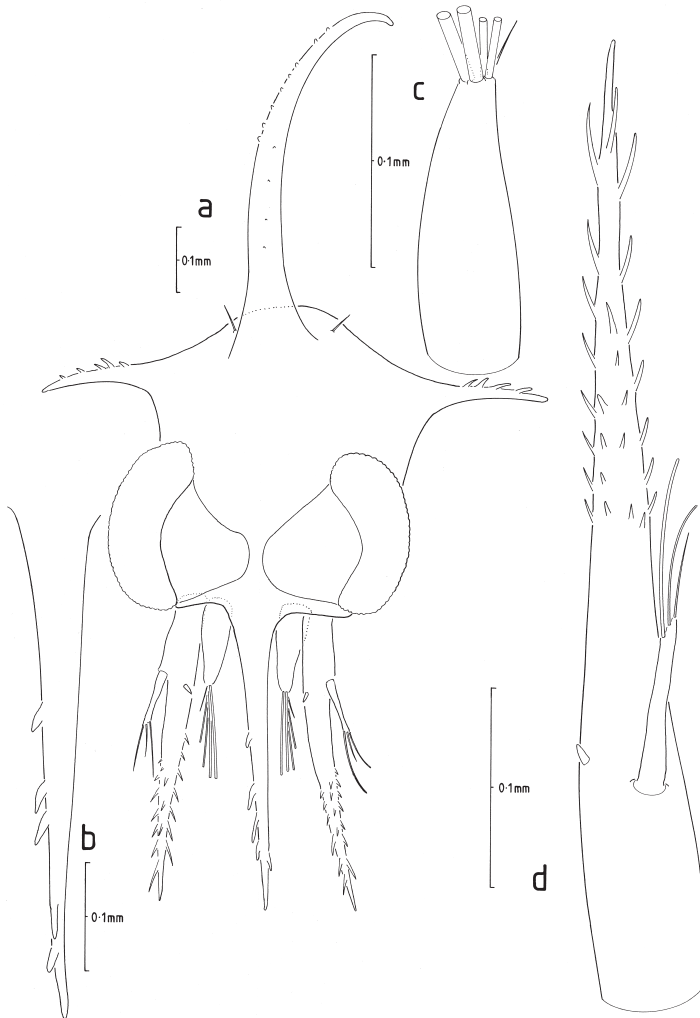


Fig. 1: *Microcassiope minor* (Dana, 1852) first stage zoea; a) anterior view of carapace; b) rostral spine; c) antennule; d) antenna.

Maxilla (Fig. 2b). Coxal endite bilobed with 4 + 4 setae; basal endite bilobed with 5 + 4 setae; endopod bilobed with 3 + 5 (two subterminal + three terminal) setae; exopod (scaphognathite) margin with four plumose setae plus distal stout plumose process.

First maxilliped (Fig. 3a). Coxa with 1 seta; basis with ten setae arranged 2, 2, 3, 3; endopod five-segmented with 3, 2, 1, 2, 5 (one subterminal + four terminal) setae

respectively; exopod two-segmented, distal segment with four terminal natatory plumose setae.

Second maxilliped (Fig. 3b). Coxa without seta; basis with four setae arranged 1, 1, 1, 1; endopod three-segmented, with 1, 1, 6 (three subterminal + three terminal) setae respectively; exopod two-segmented, distal segment with four terminal natatory plumose setae.

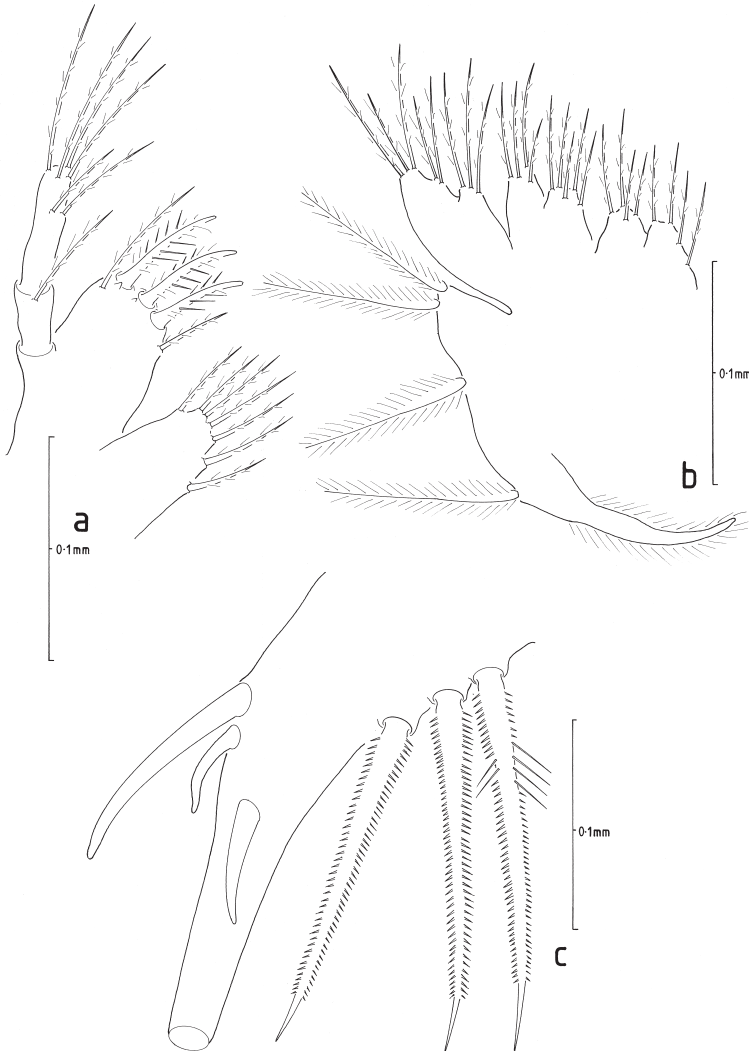


Fig. 2: *Microcassiope minor* (Dana, 1852) first stage zoea; a) maxillule; b) maxilla; c) telson.

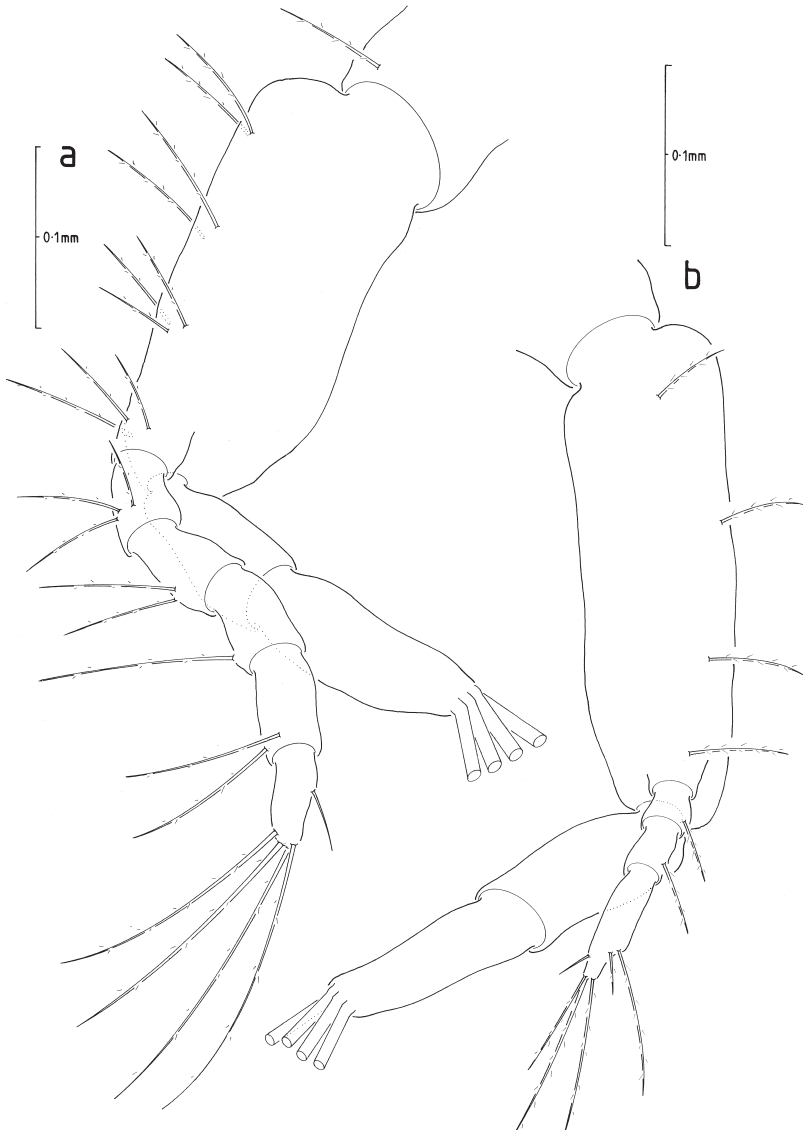


Fig. 3: *Microcassiope minor* (Dana, 1852) first stage zoea; a) first maxilliped; b) second maxilliped.

Third maxilliped. Absent.

Pereiopods. Absent.

Abdomen (Figs 4a, b). Five somites; somite 2 with a pair of lateral processes directed laterally; somite 3 with a pair of lateral processes directed posteriorly; somites 3-5 with posterolateral processes; somites 2-5 with

one pair of posterodorsal setae; pleopods absent.

Telson (Figs 4a, b; 2c). Each fork long and not spinulate, with two lateral spines (one stout and one smaller) and one dorsomedial spine; posterior margin with three pairs of stout spinulate setae.

Discussion

The first stage zoeas of nine genera and thirteen species which may have affinities within the Xanthinae MacLeay, 1838, are tabulated (Table 1) with respect to six larval characters. These are the antennal ratio of the exopod length to protopod length, the presence of the antennal endopod spine, the terminal setation

of the antennal exopod, the presence or absence of spinulation on the anterior margin of the lateral carapace spines, the setation of the distal endopod segment of the second maxilliped and the lateral armature of the telson. One character that appears to have been overlooked in the past by a number of Xanthidae (*sensu* SERÈNE, 1984) zoeal descriptions is the small endopod spine on the antenna (Fig. 1d) and this is probably due to

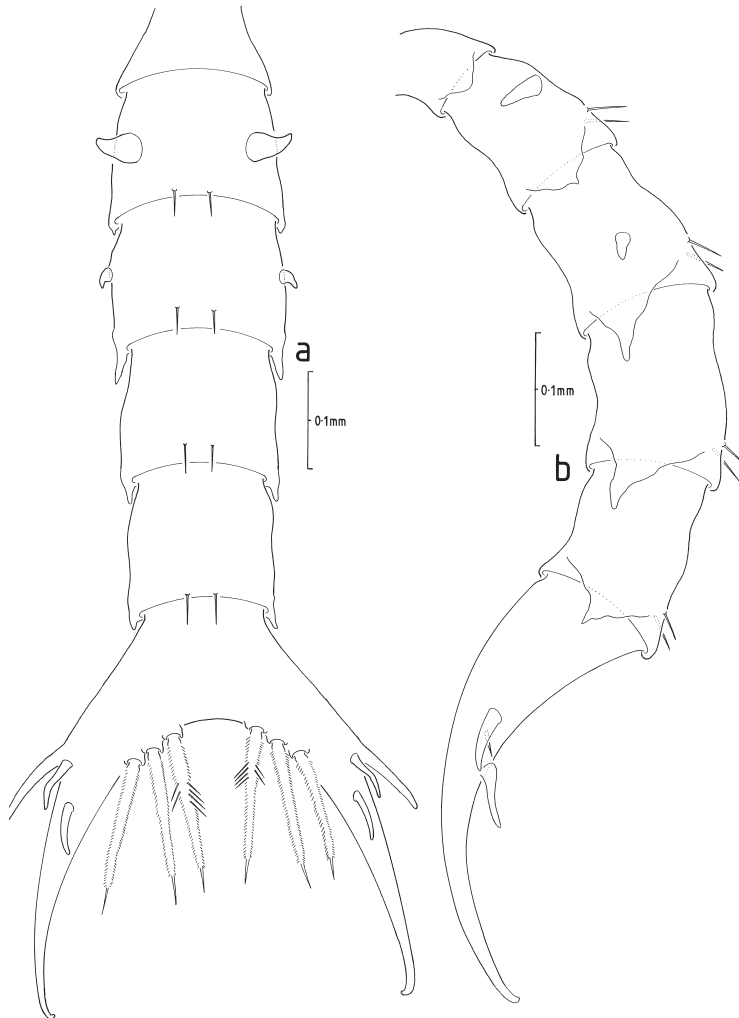


Fig. 4: *Microcassiope minor* (Dana, 1852) first stage zoea; a) dorsal view of abdomen; b) lateral view of abdomen.

Table 1

A comparison of first stage zoeal characters from some known Xanthinae descriptions. ? = character may require re-examination (continued)

Species	Antenna: ratio of exopod length to protopod length	Small antennal endopod spine	Terminal setation of the antennal exopod	Spinulation on anterior margin of lateral carapace spines	Setation of distal endopod segment of 2nd maxilliped	Lateral armature of the telson
<i>Microcassiope minor</i>	17% (this study: Fig. 1d)	present (this study: Fig. 1c)	3 (this study: Fig. 1d)	present (this study: Fig. 1a)	6 (this study: Fig. 3b)	1 spine + 1 smaller spine (this study: Figs 2c, 4a, b)
<i>Nanocassiope melanodactyla</i>	19% (Dornelas et al., 2004: Fig. 5A)	present (Dornelas et al., 2004: Fig. 5A)	3 (Dornelas et al., 2004: Fig. 5A)	present (Dornelas et al., 2004: Fig. 1A)	6 (Dornelas et al., 2004: Fig. 10A)	1 spine + 1 smaller spine (Dornelas et al., 2004: Figs 11A, 12A, 13A)
<i>Paraxanthias elegans</i>	26% (Terada, 1990: Fig. 3CI)	absent? (Terada, 1990: Fig. 3CI)	3 (Terada, 1990: Fig. 3CI)	absent (Terada, 1990: Fig. 3AI)	5? (Terada, 1990: Fig. 3GI)	1 spine + 1 seta (Terada, 1990: Fig. 3HI)
<i>Xantho poressa</i>	2.5% (Ko & Clark, 2002)	present (Ko & Clark, 2002)	2 (Rodriguez & Martin, 1997: Fig. 2F)	absent (Rodriguez & Martin, 1997: Fig. 1A)	6 (Rodriguez & Martin, 1997: Fig. 5H)	1 spine + 1 smaller spine (Rodriguez & Martin, 1997: Fig. 6A)
<i>Xantho incisus</i>	3% (Ko & Clark, 2002)	present (Ko & Clark, 2002)	2 (Ko & Clark, 2002)	absent (Ingle, 1983: Fig. 7a)	6 (Ko & Clark, 2002)	1 spine + 1 smaller spine (Ko & Clark, 2002)
<i>Xantho pilipes</i>	6% (Dornelas et al., 2004)	present (Dornelas et al., 2004)	2 (Paula & dos Santos, 2001: Fig. 1D)	absent (Paula & dos Santos, 2001: Fig. 1A, B)	5? (Paula & dos Santos, 2001: Fig. 1A, J)	1 spine + 1 smaller spine (Paula & dos Santos, 2001: Fig. 1A, J)
<i>Cycloaxanthops truncatus</i>	13% (Terada, 1980: Fig. 2B'1)	present (Terada, 1980: Fig. 2B'1)	2 (Terada, 1980: Fig. 2B'1)	absent (Terada, 1980: Fig. 1B'1)	5 (Terada, 1980: 138)	1 spine + 1 smaller spine (Terada, 1980: Fig. 3B1)
<i>Catantopodius floridanus</i>	10% (Ingle, 1987: Fig. 4c)	present (Ko & Clark, 2002)	2 (Ingle, 1987: Fig. 4c)	absent (Ingle, 1987: Fig. 4a)	5 (Ingle, 1987: Fig. 4g)	1 spine + 1 smaller spine (Ingle, 1987: Fig. 4h)
<i>Pseudomedaeus agassizii</i>	10% (Cositlow & Bookhout, 1968: Fig. 1D)	absent? (Cositlow & Bookhout, 1968: Fig. 1D)	2 (Cositlow & Bookhout, 1968: Fig. 1D)	absent (Cositlow & Bookhout, 1968: Fig. 1B)	5 (Cositlow & Bookhout, 1968: Fig. 1I)	1 spine + 1 smaller spine (Cositlow & Bookhout, 1968: Fig. 1B)
<i>Nanocassiope granulipes</i>	12% (Ko & Clark, 2002: Fig. 5a)	present (Ko & Clark, 2002: Fig. 5a,b)	1 (Ko & Clark, 2002: Fig. 5a,b)	absent (Ko & Clark, 2002: Fig. 1a)	5 (Ko & Clark, 2002: Fig. 9a)	1 spine + 1 seta (Ko & Clark, 2002: Figs 11a, 12a, 13a)

Table 1 (continued)

Species	Antenna: ratio of exopod length to protopod length	Small antennal endopod spine	Terminal setation of the antennal exopod	Spinulation on anterior margin of lateral carapace spines	Setation of distal endopod segment of 2nd maxilliped	Lateral armature of the telson
<i>Leptodius exaratus</i>	7% (Clark & Paula, 2003)	present (Clark & Paula, 2003)	1 (Clark & Paula, 2003)	absent (Clark & Paula, 2003)	5 (Clark & Paula, 2003)	1 spine + 1 small spine (Clark & Paula, 2003)
<i>Cycloxanthops novemdentatus</i>	11% (Knudsen, 1960: pl. 2 Fig. 3)	absent? (Knudsen, 1960: pl. 2 Fig. 3)	1 (Knudsen, 1960: pl. 2 Fig. 3)	present (Knudsen, 1960: pl. 2 Fig. 1)	5 (Knudsen, 1960: pl. 2 Fig. 1)	1 spine + 1 smaller spine (Knudsen, 1960: pl. 2 Fig. 2)
<i>Macromedacus distinguendus</i>	9% (Terada, 1980: Fig. 2 C'1)	absent? (Terada, 1980: Fig. 2 C'1)	1 (Terada, 1980: Fig. 2 C'1)	absent (Terada, 1980: Fig. C 1)	5 (Terada, 1980: Fig. 2 C''4)	1 spine + 1 seta (Terada, 1980: Fig. 2 C 1)

the use of an inadequate microscope. This small endopod spine may be a diagnostic zoal character of the family.

DORNELAS *et al.* (2004) suggested that *Nanocassiope* was not a homogenous taxon and could be divided into separate Atlantic and Indo-Pacific genera. They concluded that the larval study of another Indo-Pacific species would be needed to clarify further the generic status of *Nanocassiope*, and adult characters will also have to be reappraised. However, this present larval study appears to support their hypothesis because *Microcassiope minor*, with an Atlantic distribution, appears to show close affinities with *N. melanodactyla*. Four zoal characters (Table 1) distinguish these two Atlantic species from *N. granulipes* as described by KO & CLARK (2002) and include: the number of terminal setae on the antennal exopod (three versus one respectively), the number of setae on the distal endopod segment of the second maxilliped (six versus five respectively), the presence or absence of spinulation on the anterior margin of the lateral carapace spines and the lateral armature of the telson fork (one spine and one smaller spine versus one spine and one seta respectively). Zoal evidence seems to suggest that adult characters within *Nanocassiope* Guinot, 1967 will have to be reappraised.

Acknowledgements

The authors wish to thank Maria Thessalou-Legaki and the organising committee of the 8th Colloquium Crustacea Decapoda Mediterranea for an extremely successful meeting.

References

- AIKAWA, H., 1929. On larval forms of some Brachyura. Records of Oceanographic Works, Japan 2: 17–55.
- AMIR, N., 1989. Abundance and distribution of some brachyuran larvae (Decapoda, Crustacea) in the northern Arabian Sea, (M. Phil. Thesis), Institute

- of Marine Sciences University of Karachi. (not seen).
- BOURDILLON-CASANOVA, L., 1960. Le méroplancton du Golfe de Marseille: les larves de crustacés décapodes. *Recueil des Travaux de la Station Marine d'Endoume* 30: 1–286.
- CHACE, F. A., 1966. Decapod crustaceans from St. Helena Island, South Atlantic. *Proceedings of the U.S. National Museum* 118 (3535): 622–661.
- CLARK, P. F., CALAZANS, D. K. & W. POHLE, G., 1998. Accuracy and standardisation of brachyuran larval descriptions. *Invertebrate Reproduction and Development* 33: 127–144.
- CLARK, P. F. & PAULA, J., 2003. Descriptions of ten xanthoidean (Crustacea: Decapoda: Brachyura) first stage zoeas from Inhaca Island, Mozambique. *Raffles Bulletin of Zoology* 51: 323–378.
- CHHAPGAR, B. F., 1956. On the breeding habits and larval stages of some crabs of Bombay. *Records of the Indian Museum* 54: 33–52.
- COSTLOW, J. D. & BOOKHOUT, C. G., 1968. Larval development of the crab, *Leptodius agassizii* A. Milne Edwards in the laboratory (Brachyura, Xanthidae). *Crustaceana (Supplement)* 2: 203–213.
- DANA, J. D., 1852. *Conspectus Crustaceorum, &c.* *Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N. I. Crustacea Cancroidea*. *Proceedings of the Academy of Natural Sciences of Philadelphia* 6(no. III): 73–86. [meeting of May 1852]. [Reprint: *Crustacea Cancroidea & Corystoidea. Conspectus Crustaceorum, &c. Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N. including the Crustacea Cancroidea and Corystoidea*. *Proceedings of the Academy of Natural Sciences of Philadelphia* VI: 73–86].
- DORNELAS, M., CLARK, P. F., & PAULA, J., 2004. The larval development of *Nanocassiope melanodactyla* (A. Milne Edwards, 18670) (Crustacea: Decapoda: Brachyura). *Journal of Natural History* 38: 506–535.
- FIELDER, D. R., GREENWOOD, J. G., & JONES, M. M., 1979. Larval development of the crab *Leptodius exaratus* (Decapoda, Xanthidae), reared in the laboratory. *Proceedings of the Royal Society of Queensland* 90: 117–127.
- FOREST, J. & GUINOT, D., 1966. 16. Crustacés Décapodes: Brachyours. In *Campagne de la Calypso dans le Golfe de Guinée et aux Iles Principe, São Tomé et Annobon* (1956). *Annales de l'Institut Océanographique, Monaco* 44: 23–124.
- GIBBES, L. R., 1850. On the carcinological collections of the United States. *Proceedings of the American Association for the Advancement of Science* 3: 167–201.
- GOURETT, P., 1884. Considérations sur la faune pélagique du golfe de Marseille suivies d'une étude anatomique et zoologique de la spadella marioni espèce nouvelle de l'ordre des chaetognathes (Leuckart). *Annales du Muséum d'Histoire Naturelle du Marseille* 2 (II): 1–175.
- GUINOT, D., 1967. Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyours. II. Les anciens genres *Micropanope* Stimpson et *Medaeus* Dana. *Bulletin du Muséum National d'Histoire Naturelle, Paris. 2e série* 39: 345–374.
- DE HAAN, W., 1835. Crustacea. In v. Siebold, P. F., *Fauna Japonica, sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava imperium tenent, suscepto, annis 1823–1830 collegit, notis, observationibus et adumbrationibus illustravit P.F. de Siebold. Coniunctis studiis C.J. Temminck et H. Schlegel pro Vertebratis atque W. de Haan pro Invertebratis elaborata Regis auctoris edita*, (Leiden: Lugundi-Batavorum), *Decas II*, 25–64, pls 9–15, 17, C, D. [For dates see Sherborn & Jentink, 1895; Holthuis, 1953 and Holthuis & Sakai, 1970].
- DE HAAN, W., 1837. Crustacea. In v. Siebold, P. F., *Fauna Japonica, sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava imperium tenent, suscepto, annis 1823–1830 collegit, notis, observationibus et adumbrationibus illustravit P.F. de Siebold. Coniunctis studiis C.J. Temminck et H. Schlegel pro Vertebratis atque W. de Haan pro Invertebratis elaborata Regis auctoris edita*, (Leiden: Lugundi-Batavorum), *Decas III*, 65–72, pls 16, 18–24, E, F. [For dates see Sherborn & Jentink, 1895; Holthuis, 1953 and Holthuis & Sakai, 1970].
- HOLTHUIS, L. B., 1953. On the dates of publication of W. De Haan's volume on the Crustacea of P. F. Von Siebold's "Fauna Japonica". *Journal of the Society for the Bibliography of Natural History* 3: 36–47.
- HOLTHUIS, L. B. & SAKAI, T., 1970. Ph. F. Von Siebold and *Fauna Japonica*. A history of Early Japanese Zoology. Academic Press of Japan, Tokyo

- part I, 1–132, (in English), part II, 207–323 (in Japanese).
- HONG, S. Y., 1977. The larval stages of *Cycloxanthops truncatus* (De Haan) (Decapoda, Brachyura, Xanthidae) reared under the laboratory conditions. Publications of the Institute of Marine Science, National Fisheries University of Busan 10: 15–24.
- INGLE, R. W., 1983. A comparative study of the larval development of *Monodaeus couchi* (Couch), *Xantho incisus* (Leach) and *Pilumnus hirtellus* (Linnaeus) (Crustacea: Brachyura: Xanthidae). Journal of Natural History 17: 951–978.
- INGLE, R. W., 1987. The first zoea of three *Pachygrapsus* species and of *Catleptodius floridanus* (Gibbes) from Bermuda and Mediterranean (Crustacea: Decapoda: Brachyura), Bulletin of the British Museum (Natural History): Zoology 52: 31–41.
- INGLE, R. W., 1992. Larval Stages of Northeastern Atlantic Crabs. An illustrated Key. Natural History Museum Publications and Chapman & Hall.
- KO, H. S. & CLARK, P. F., 2002. The zoeal development of *Nanocassiope granulipes* (Sakai, 1939) (Crustacea: Decapoda: Brachyura: Xanthidae) described from laboratory reared material. Journal of Natural History 3: 1463–1488.
- KNUDSEN, J. W., 1960. Life cycle studies of the Brachyura of Western North America, IV. The life cycle of *Cycloxanthops novemdentatus* (Stimpson). Bulletin of the Southern California Academy of Sciences 59: 1–8.
- KURATA, H., 1970. Studies on the Life Histories of Decapod Crustacea of Georgia: Part III; Larvae of Decapod Crustacea of Georgia. Unpublished report. University of Georgia Marine Institute. Sapelo Island: 1–274 (not seen).
- LEACH, W. E., 1814. Crustaceology. In Brewster, D., (ed) The Edinburgh Encyclopedia; conducted by D. Brewster, (Edinburgh) 7(2): 385–437. [For dates of publication see Rathbun, 1897 and Sherborn, 1937]
- LEBOUR, M. V., 1928. The larval stages of the Plymouth Brachyura. Proceedings of the Zoological Society of London 1928: 473–560.
- LEWINSOHN, CH. & HOLTHUIS, L. B., 1964. New records of decapod Crustacea from the Mediterranean coast of Israel and the eastern Mediterranean. Zoologische Mededelingen, Leiden 40: 45–63.
- LOCKINGTON, W. N., 1877. Remarks on the Crustacea of the West Coast of North America, with a catalogue of the species in the Museum of California Academy of Sciences. Proceedings of the California Academy of Sciences 7: 94–108.
- MACLEAY, W. S., 1838. On the Brachyurous Decapod Crustacea. Brought from the Cape by Dr. Smith. Illustrations of the Zoology of South Africa; consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa, in the years 1834, 1835, and 1836; fitted out by "The Cape of Good Hope Association for Exploring Central Africa:" together with a summary of African Zoology, and an inquiry into the geographical ranges of species in that quarter of the globe, Published under the Authority of the Lords Commissioners of Her Majesty's Treasury, Invertebratae. In A. Smith. Smith, Elder and Co., London : 53–71.
- MANNING, R. B. & HOLTHUIS, L. B., 1981. West African crabs (Crustacea: Decapoda), Smithsonian Contributions to Zoology 306: 1–379.
- MILNE-EDWARDS, A., 1867. Description de quelques espèces nouvelles de crustacés brachyures. Annales de la Société Entomologique de France (Série 4) 7: 263–288.
- MILNE EDWARDS, H., 1834. Histoire Naturelle des Crustacés, Comprenant l'Anatomie, la Physiologie et la Classification de ces Animaux. Librairie de Roret, Paris.
- OLIVI, G., 1792. Zoologia Adriatica ossia Catalogo Ragionato degli Animali del Golfo e della Lagune di Venezia; Preceduto da una Dissertazione sulla Storia Fisica e Naturale del Golfo; e Accompagnato da Memorie, ed Osservazioni di Fisica, Storia Naturale ed Economia. Bassano: 1–334.
- PAULA, J. & SANTOS, A. DOS, 2001. Larval and early post-larval stages of the crab *Xantho pilipes* A. Milne-Edwards, 1867 (Crustacea, Decapoda, Xanthidae), reared under laboratory conditions. Invertebrate Reproduction and Development 38: 253–264.
- RATHBUN, M. J., 1897. A revision of the nomenclature of the Brachyura. Proceedings of the Biological Society of Washington 11: 153–167.
- RODRIGUEZ, A. & MARTIN, J. W., 1997. Larval development of the crab *Xantho poressa* (Decapoda: Xanthidae) reared in the laboratory. Journal of Crustacean Biology 17: 98–110.

- SABA, M., 1976. Studies on the larvae of crabs of the family Xanthidae. I On the larval development of *Leptodius exaratus*. Researches on Crustacea. 7: 57-67.
- SAKAI, T., 1939. Studies on the Crabs of Japan IV Brachygnatha, Brachyrhyncha. Yokendo, Tokio.
- SERÈNE, R., 1984. Crustacés décapodes brachyours de l'Océan Indien occidental et de la Mer Rouge, Xanthoidea: Xanthidae et Trapeziidae. Avec un addendum par Crosnier, A.: Carpiliidae et Menippidae. Faune Tropicale 24: 1-243.
- SHERBORN, C. D., 1937. Brewster's Edinburgh Encyclopaedia. Issued in 18 vols. From 18- to 1830. Journal of the Society for the Bibliography of Natural History 1: 112.
- SHERBORN, C. D. & JENTINK, J. A., 1895. On the dates of the Parts of Siebold's 'Fauna Japonica' and Giebel's 'Allgemeine Zoologie' (first edition). Proceedings of the Zoological Society of London 1895: 149-150.
- SIDDIQUI, F. A. & TIRMIZI, N. M., 1998. Morphology of the larval stages of *Leptodius exaratus* (H. Milne Edwards, 1834) (Brachyura, Xanthidae) reared under laboratory conditions. Pakistan Journal of Marine Sciences 7: 123-135.
- STIMPSON, W., 1858. Prodrromus Descriptionis Animalium Evertbratorum quae in Expeditione ad Oceanum Pacificum Septentrionalem a Republica Federata Missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit, Part IV, Crustacea Cancroidea et Corystoidea. Proceedings of the Academy of Natural Sciences of Philadelphia 10: 31-40. [reprint idem. pp. 29-37].
- SUZUKI, H., 1979. Studies on the larvae of two xanthid crabs, *Paramedaeus noelensis* (Ward) and *Cycloxanthops truncatus* (De Haan) (Crustacea, Brachyura, Xanthidae). Proceedings of the Japanese Society of Systematic Zoology 16: 35-52.
- TERADA, M., 1980. Zoea larvae of four crabs in the subfamily Xanthinae. Zoological Magazin, Tokyo 89: 138-148.
- TERADA, M., 1990. Zoal development of five species of xanthid crabs, reared in the laboratory. Researches on Crustacea 18: 23-47 (In Japanese).
- TUFAIL, H. & HASHMI, S. S., 1964. Early developmental stages of *Leptodius exaratus* (Milne Edwards). Pakistan Journal of Scientific and Industrial Research 7: 127-133.

