Syst Parasitol (2019) 96:207–232
https://doi.org/10.1007/s11230-019-09841-3

The re-discovery of *Caligus lichiae* Brian, 1906 (Copepoda: Caligidae) parasitic on two carangid fishes in the Mediterranean Sea, and the recognition of *Caligus aesopus* Wilson C. B., 1921 as a junior subjective synonym

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Received: 18 September 2018 / Accepted: 1 January 2019 / Published online: 11 February 2019

Abstract The caligid copepod *Caligus lichiae* Brian, 1906 is redescribed based on new material collected from the type-host, *Lichia amia* (Linnaeus), and from a second carangid, *Seriola dumerili* (Risso), both caught in the Gulf of Iskenderun, Turkey. Key diagnostic characters of both sexes are reported, supported by drawings and scanning electron microscopy images. Despite the commercial importance of its type-host, *L. amia*, *C. lichiae* has not been reported since its original description. After detailed comparison with recent descriptions of *Caligus aesopus* Wilson C. B., 1921, commonly found on *S. dumerili*, we recognise these two species as conspecific and propose to relegate *C. aesopus* Wilson C. B., 1921 to a junior subjective synonym of *C. lichiae* Brian, 1906. *Caligus lichiae* is a member of the *C. confusus* group of species and an identification key to species in this group is provided.

This article is part of the Topical Collection Arthropoda.

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Introduction

The Carangidae Rafinesque is a commercially important and diverse family of marine fishes which includes the jacks, trevallies (crevalles), amberjacks, pompanos, scads, kingfish, pilotfish and runners. Carangids commonly serve as hosts to parasitic copepods particularly to species belonging to the genus *Caligus* O. F. Müller, 1785 (Caligidae). To our knowledge, 47 species of *Caligus* (18.4% of the 266 valid species in the genus) have been reported from carangid fishes (Table 1). In the Mediterranean, the Carangidae is represented by 20 species (Froese & Pauly, 2018) but only six have been reported as hosts of parasitic copepods (Table 2). Globally, 26.6% of carangid species are known to be infected by species of *Caligus* (Table 1), so it is surprising that only leerfish *Lichia amia* (Linnaeus) among the 20 carangids known from the Mediterranean has been recorded as host to a *Caligus*. *Lichia amia* is the type-host of *C. lichiae* Brian, 1906 and the type-localities were given by Brian (1906) as Genoa and the Island of Elba (Italy), but *C. lichiae* has never been reported since its original discovery.

In this study, we present the redescription of *C. lichiae* based on newly collected material from the gill

Table 1 Fishes of the family Carangidae Rafinesque, 1815 and species of the genus *Caligus* O.F.Müller, 1785 reported globally

Genera of the family Carangidae	Fish species	Species of *Caligus*	Reference
Alectis Rafinesque, 1815	*Alectis alexandrina* (Geoffroy Saint-Hilaire, 1817)	*C. vexator* Heller, 1865	Oldewage & van As (1989)
	Alectis indica (Rüppell, 1830)	*C. constrictus* Heller, 1865	Pillai (1967)
Alepes Swainson, 1839	*Alepes djedaba* (Forsskål,1775)	*C. confusus* Pillai, 1961	Kensley & Grindley (1973); Song & Chen (1976); Oldewage & van As (1989); Dippenaar (2005);
		C. bicycletus Heegaard, 1945 (syn. *C. djedabae* Rangnekar, 1956)	Pillai (1967)
		C. productus Dana, 1852	Ho & Lin (2004)
Atropus Oken, 1817	NR	NR	
Atule Jordan & Jordan, 1922	NR	NR	
Campogramma Regan, 1903	NR	NR	
Carangoides Bleeker, 1851	*Carangoides armatus* (Rüppell, 1830)	*C. rotundigenitalis* Yü, 1933	Ho & Lin (2004)
	Carangoides bartholomaei (Cuvier, 1833)	*C. chorinemi* Krøyer, 1863	Cressey (1991)
		C. robustus Bassett-Smith, 1898	Cressey (1991)
	Carangoides equula (Temminck & Schlegel, 1844)	*C. equulae* Ho & Lin, 2003	Ho & Lin (2004)
	Carangoides fulvoguttatus (Forsskål, 1775)	*C. fortis* Kabata, 1965	Kabata (1965)
	Carangoides malabaricus (Bloch & Schneider, 1801)	*C. constrictus* Heller, 1865	Pillai (1967)
Caranx Lacépède, 1801	*Caranx caballus* Günther, 1868	*C. aesopus* Wilson C.B., 1921	ND
		C. confusus Pillai, 1961	ND
		C. hoplognathi Yamaguti & Yamasu, 1959	ND
		C. latigenitalis Shiino, 1954	ND
		C. robustus Bassett-Smith, 1898	ND
		C. serratus Shiino, 1965	Morales-Serna et al. (2013)
	Caranx caninus Günther, 1867	*C. aesopus* Wilson C.B., 1921	ND
		C. chorinemi Krøyer, 1863	ND
		C. confusus Pillai, 1961	ND
		C. hoplognathi Yamaguti & Yamasu, 1959	ND
		C. longipedis Bassett-Smith, 1898	ND
		C. robustus Bassett-Smith, 1898	ND
		C. serratus Shiino, 1965	Morales-Serna et al. (2013)

Table 1 continued

Genera of the family Carangidae	Fish species	Species of *Caligus*	Reference
	Caranx crysos (Mitchill, 1815)	*C. chorinemi* Krøyer, 1863	Cressey (1991)
		C. longipedis Bassett-Smith, 1898	Cressey (1991)
		C. robustus Bassett-Smith, 1898	Cressey (1991)
		C. tenax Heller, 1865	Pillai (1967)
	Caranx hippos (Linnaeus, 1766)	*C. chorinemi* Krøyer, 1863	Pearse (1952); Cressey (1991)
		C. constrictus Heller, 1865	Rangnekar (1956); Lagarde (1991)
		C. longipedis Bassett-Smith, 1898	Cressey (1991)
		C. praetextus Bere, 1936	Causey (1953)
		C. robustus Bassett-Smith, 1898	Cressey (1991)
		C. tenax Heller, 1865	Marques (1965); Pillai (1967); Lagarde (1991)
	Caranx ignobilis (Forsskål, 1775)	*C. confusus* Pillai, 1961	Pillai (1967); Ho & Lin (2004)
		C. fortis Kabata, 1965	Ho & Lin (2007)
		C. inanis Ho & Lin, 2007	Ho & Lin (2007)
		C. pagrosomi Yamaguti, 1939	Ho & Lin (2003)
		C. robustus Bassett-Smith, 1898	Pillai (1963; 1967)
		C. zylanica Hameed & Pillai, 1986	Hameed & Pillai (1986)
	Caranx melampygus Cuvier, 1833	*C. confusus* Pillai, 1961	Lewis (1968); Rohde (1980); Ho & Lin (2004)
		C. coryphaenae Steenstrup & Lütken, 1861	Lewis (1968)
		C. laticaudus Shiino, 1960	Ho & Lin (2004)
		C. longipedis Bassett-Smith, 1898	Lewis (1967); Cressey (1991)
		C. platurus Kirtisinghe, 1964	Kirtisinghe (1964); Pillai (1967)
		C. robustus Bassett-Smith, 1898	Pillai (1963); Kirtisinghe (1964); Pillai(1967)
		C. rotundigenitalis Yü, 1933	Ho & Lin (2004)
	Caranx rhonchus Geoffroy Saint-Hilaire, 1817	*C. dakari* Van Beneden, 1892	Capart (1959); Oldewage & van As (1989); Dippenaar (2005)
	Caranx sexfasciatus Quoy & Gaimard, 1825	*C. chiastos* Lin & Ho, 2003	Lin & Ho (2003); Ho & Lin (2004)
		C. confusus Pillai, 1961	Grobler et al. (2003); Ho & Lin (2004); Dippenaar (2005)

Table 1 continued

Genera of the family Carangidae	Fish species	Species of *Caligus*	Reference
		C. nengai Rangnekar, Rangnekar & Murti, 1953	Ho & Lin (2004)
		C. robustus Bassett-Smith, 1898	Cressey (1991); Ho & Lin (2007)
		C. rotundigenitalis Yü, 1933	Ho & Lin (2004)
	Caranx sp.	*C. brevicaudus* Pillai,1963	Pillai (1963)
Chloroscombrus Girard, 1858	NR	NR	
Decapterus Bleeker, 1851	*Decapterus kurroides* Bleeker, 1855	*C. kanagurta* Pillai, 1961	Ho & Lin (2004)
		C. jawahari Hameed & Adamkutty, 1985	Ho & Lin (2004)
Elagatis Bennett, 1840	*Elagatis bipinnulata* (Quoy & Gaimard, 1825)	*C. confusus* Pillai, 1961	Ho & Lin (2004)
		C. productus Dana, 1852	Ho & Lin (2004)
Gnathanodon Bleeker, 1850	*Gnathanodon speciosus* (Forsskål, 1775)	*C. longipedis* Bassett-Smith, 1898	Venmathi Maran et al. (2009)
		C. rotundigenitalis Yü, 1933	Rangnekar (1959); Pillai (1967)
Hemicaranx Bleeker, 1862	NR	NR	
Lichia Cuvier, 1816	*Lichia amia* (Linnaeus, 1758)	*C. dakari* Van Beneden, 1892	Boxshall & El-Rashidy (2009)
		C. lichiae Brian, 1906	Brian (1906); Raibaut et al. (1998)
Megalaspis Bleeker, 1851	*Megalaspis cordyla* (Linnaeus, 1758)	*C. calotomi* Shiino, 1954	Lin & Ho (2007)
		C. cordyla Pillai, 1963	Pillai (1963; 1967); Rohde (1980); Ho & Lin (2004)
		C. longipedis Bassett-Smith, 1898	Ho & Lin (2004)
		C. schlegeli (Ho & Lin, 2003)	Ho & Lin (2003)
Naucrates Rafinesque, 1810	NR	NR	
Oligoplites Gill, 1863	*Oligoplites palometa* (Cuvier, 1832)	*C. bonito* Wilson C.B., 1905	Takemoto & Luque (2002)
		C. robustus Bassett-Smith, 1898	Takemoto & Luque (2002)
		C. rufimaculatus Wilson C.B.,1905	Takemoto & Luque (2002)
	Oligoplites saliens (Bloch, 1793)	*C. robustus* Bassett-Smith, 1898	Takemoto & Luque (2002)
		C. rufimaculatus Wilson C.B., 1905	Takemoto & Luque (2002)
	Oligoplites saurus (Bloch & Schneider, 1801)	*C. robustus* Bassett-Smith, 1898	Takemoto & Luque (2002)
Pantolabus Whitley, 1931	NR	NR	
Parastromateus Bleeker, 1864	NR	NR	
Parona Berg, 1895	NR	NR	
Pseudocaranx Bleeker, 1863	*Pseudocaranx dentex* (Bloch & Schneider, 1801)	*C. kurochkini* Kazachenko,1975	Kazachenko (1975)
		C. longipedis Bassett-Smith, 1898	Johnson et al. (2004)

Table 1 continued

Genera of the family Carangidae	Fish species	Species of *Caligus*	Reference
Scomberoides Lacépède, 1801	*Scomberoides commersonnianus* Lacépède, 1801	*C. rotundigenitalis* Yü, 1933	Ho & Lin (2004)
	Scomberoides tala (Cuvier, 1832)	*C. epinepheli* Yamaguti, 1936	Pillai (1963); Pillai (1967)
Selar Bleeker, 1851	NR	NR	
Selaroides Bleeker, 1851	*Selaroides leptolepis* (Cuvier, 1833)	*C. confusus* Pillai, 1961	Hirunraks et al. (1977)
Selene Lacépède, 1802	*Selene setapinnis* (Mitchill, 1815)	*C. longipedis* Bassett-Smith, 1898	Cordeiro & Luque (2004)
		C. robustus Bassett-Smith, 1898	Cordeiro & Luque (2004)
	Selene vomer (Linnaeus, 1758)	*C. longipedis* Bassett-Smith, 1898	Cressey (1991)
Seriola Cuvier, 1816	*Seriola dumerili* (Risso, 1810)	*C. aesopus* Wilson C.B., 1921	Lin & Ho (2007)
		C. confusus Pillai, 1961	Ho & Lin (2004)
	Seriola lalandi Valenciennes, 1833	*C. aesopus* Wilson C.B., 1921	Hewitt (1963); Hewitt & Hine (1972); Kensley & Grindley (1973); Fernandez & Villalba (1986); Sharp et al. (2003); Dippenaar (2005)
		C. lalandei Barnard, 1948	Baeza-Kuroki & Castro-Romero (1982); Oldewage & van As (1989); Ho et al. (2001); Sharp et al. (2003); Johnson et al. (2004); Dippenaar (2005)
		C. lunatus Wilson C.B., 1924	Oldewage & van As (1989); Dippenaar (2005)
	Seriola peruana Steindachner, 1881	*C. aesopus* Wilson C.B., 1921	Wilson (1921); Kensley & Grindley (1973)
	Seriola quinqueradiata Temminck & Schlegel, 1845	*C. lalandei* Barnard, 1948	Ho et al. (2001)
		C. seriolae Yamaguti, 1936	Yamaguti (1936)
		C. spinosus Yamaguti, 1939	Johnson et al. (2004)
	Seriola rivoliana Valenciennes, 1833	*C. tenax* Heller, 1865	Lagarde (1991)
Seriolina Wakiya, 1924	NR	NR	
Trachinotus Lacépède, 1801	*Trachinotus blochii* (Lacépède, 1801)	*C. epidemicus* Hewitt, 1971	Johnson et al. (2004)
		C. cossacki Basset-Smith, 1898	Pillai (1967)
		C. orientalis Gusev, 1951	Johnson et al. (2004)
		C. pagrosomi Yamaguti, 1939	Ho & Lin (2003)
		C. punctatus Shiino, 1955	Johnson et al. (2004)

Table 1 continued

Genera of the family Carangidae	Fish species	Species of *Caligus*	Reference
	Trachinotus botla (Shaw, 1803)	*C. diaphanus* von Nordmann, 1832	Oldewage & van As (1989); Dippenaar (2005)
	Trachinotus carolinus (Linnaeus, 1766)	*C. mutabilis* Wilson C.B., 1905	Causey (1955); Cressey (1991)
	Trachinotus ovatus (Linnaeus, 1758)	*C. mutabilis* Wilson C.B., 1905	Luque & Cezar (2004)
Trachurus Rafinesque, 1810	*Trachurus symmetricus* (Ayres, 1855)	*C. pelamydis* Krøyer, 1863	Shiino (1965)
	Trachurus trachurus (Linnaeus, 1758)	*C. diaphanus* von Nordmann, 1832	MacKenzie et al. (2004)
		C. dakari Van Beneden, 1892 (syn. *C. mauritanicus* Brian, 1924)	Oldewage & van As (1989); Dippenaar (2005)
		C. elongatus von Nordmann, 1832	MacKenzie et al. (2004); Dippenaar (2005)
		C. haemulonis Krøyer, 1863 (syn. *C. mauritanicus minuscula* Brian, 1924);	Capart (1959)
		C. pelamydis Krøyer, 1863	Boxshall (1974); Rohde (1980); Palm et al. (1999); MacKenzie et al. (2004)
Ulua Jordan & Snyder, 1908	NR	NR	
Uraspis Bleeker, 1855	NR	NR	

Abbreviation: NR, no record; ND, not documented

Table 2 Carangid fishes of the Mediterranean and their parasitic copepods

Fish species	Copepod species
Alectis alexandrina (Geoffroy Saint-Hilaire, 1817)	NR
Alepes djedaba (Forsskål, 1775)	NR
Campogramma glaycos (Lacépède, 1801)	*Lernanthropinus trachuri* (Brian, 1903)
Caranx crysos (Mitchill, 1815)	NR
Caranx hippos (Linnaeus, 1766)	NR
Caranx rhonchus Geoffroy Saint-Hilaire, 1817	NR
Decapterus macarellus (Cuvier, 1833)	NR
Decapterus punctatus (Cuvier, 1829)	NR
Decapterus russelli (Rüppell, 1830)	NR
Elagatis bipinnulata (Quoy & Gaimard, 1825)	NR
Lichia amia (Linnaeus, 1758)	*Bomolochus unicirrus* Brian, 1902
	Caligus lichiae Brian, 1906
	Colobomatus lichiae (Richiardi, 1880)
	Lernaeenicus gracilis (Heller, 1865)
	Lernanthropus gisleri van Beneden, 1852
	Nemesis lamna Risso, 1826
	Eobrachiella elegans (Richiardi, 1880)
Naucrates ductor (Linnaeus, 1758)	*Pennella filosa* (Linnaeus, 1758)
Pseudocaranx dentex (Bloch & Schneider, 1801)	*Lernaeolophus sultanus* (Milne Edwards, 1840)
Seriola carpenteri Mather, 1971	NR
Seriola dumerili (Risso, 1810)	*Colobomatus lichiae* (Richiardi, 1880)
	Lepeophtheirus sp.
	Lernanthropus micropterygis Richiardi, 1884
	Eobrachiella elegans (Richiardi, 1880)
Seriola fasciata (Bloch, 1793)	NR
Trachinotus ovatus (Linnaeus, 1758)	NR
Trachurus mediterraneus (Steindachner, 1868)	NR
Trachurus picturatus (Bowdich, 1825)	NR
Trachurus trachurus (Linnaeus, 1758)	*Lernanthropinus trachuri* (Brian, 1903)

Abbreviation: NR, no record

cavity of *L. amia* and also from the mouth cavity and gill filaments of *Seriola dumerili* (Risso), both caught in the Gulf of Iskenderun, Turkey. Attempts were made to locate the type-material of *C. lichiae*. The location of the type-material of *C. lichiae* is given as unknown by Parker et al. (1968), but the material reported as *C. curtus* (Müller, 1785) by Brian (1898), which is effectively the type-material of *C. lichiae*, is listed as deposited in the collections of the Museo di Zoologia e Anatomia Comparata della Royale Università di Genova by Margolis et al. (1975: 8). Brian (1906: 36) stated "In my preceding publications I have wrongly referred to (*Caligus curtus*) some specimens of *Caligus* removed from *Lichia amia* Linnaeus specimens that here, later, I considered as a new species and described with the name of *C. lichiae*.". Our attempts to locate this material were unsuccessful. However, Brian's (1906) description is reasonably detailed and reveals many clues as to the identity of his species. The newly collected material of *Caligus* from these two Mediterranean carangids (*L. amia* and *S. dumerili*), was identified by reference to the original description of *C. lichiae* by Brian (1906).

The second host recorded here, *S. dumerili,* is also known as host of *C. aesopus* Wilson C. B., 1921 and *C. confusus* Pillai, 1961 (see Ho & Lin, 2001; Choe & Kim, 2010; Walter & Boxshall, 2018). *Caligus aesopus* was originally described by Wilson (1921)

based on the material collected from "probably *Seriola peruana*" from the Juan Fernandez Islands in the East Pacific. Recent redescriptions of *C. aesopus* were presented in Ho & Lin (2004), Choe & Kim (2010), and Boxshall (2018). In addition, Boxshall (2018) established a new species group within the genus *Caligus*, namely the *C. confusus*-group which comprises 20 species including *C. lichiae* and *C. aesopus*. These species are: *C. abigailae* Boxshall, 2018; *C. aesopus*; *C. alepicolus* Boxshall, 2018; *C. bicycletus* Heegaard, 1945; *C. brevicaudus* Pillai, 1963; *C. chorinemi* Krøyer, 1863; *C. confusus*; *C. cordyla* Pillai, 1963; *C. equulae* Ho & Lin, 2003; *C. kurochkini* Kazachenko, 1975; *C. lichiae*; *C. lunatus* Wilson C. B., 1924; *C. parapetalopsis* Hameed & Pillai, 1973; *C. platurus* Kirtisinghe, 1964; *C. randalli* Lewis, 1964; *C. seriolicolus* Boxshall, 2018; *C. spinosus* Yamaguti, 1939; *C. tenax* Heller, 1865; and *C. zylanica* Hameed & Pillai, 1986. *Caligus regalis* was erroneously listed by Boxshall (2018) as a member of the *C. confusus*-group. It does not exhibit the diagnostic features of the *C. confusus*-group, and according to Cressey & Cressey (1980), it is a close relative of *C. coryphaenae*. All members of the *C. confusus*-group are characterised by a suite of character states including: (i) antenna with typically spatulate posterior process on proximal segment; (ii) postantennal process with small accessory tine; (iii) maxillule with accessory tine on posterior maxillulary process; (iv) leg 3 with raised cuticular rib (often with bifid tip) and circular array of large denticles on apron; (v) first exopodal segment of leg 3 with large, recurved, hook-like outer margin spine; (vi) leg 4 with 3-segmented exopod armed with I, I, III spines. A further four species, *C. clavatus* Kirtisinghe, 1964, *C. fortis* Kabata, 1965, *C. inopinatus* Kabata, 1994 and *C. isonyx* Steenstrup & Lütken, 1861, share most but not all of these diagnostic features (Boxshall, 2018) and can be considered as affiliated to the group. The newly collected material of *C. lichiae* was compared with these species, as well as with all species in and affiliated with the *C. confusus* group, and a key to species is provided.

Materials and methods

Specimens of *Caligus lichiae* Brian, 1906 were collected from the gill cavity of the leerfish, *Lichia amia* (Linnaeus) and from the mouth cavity and gill filaments of the greater amberjack, *Seriola dumerili* (Risso) caught in north-eastern Mediterranean waters off the Turkish coast. Fishes were caught by rod and line, and were examined for presence of parasitic copepods. Copepods removed from infected fish were immediately preserved in 70% ethanol. Specimens were cleared in lactic acid for 2 h prior to examination using a Nikon SMZ 800N dissecting microscope and an Olympus BX51 compound microscope. Specimens were mounted as temporary preparations in a drop of lactic acid in the well of a cavity slide. Measurements were made using an ocular micrometer and drawings were made with the aid of a drawing tube. All measurements are given in millimetres unless otherwise stated, and are presented as the range followed by the mean in parentheses. The scientific and common names of fishes follow Froese & Pauly (2018) and the morphological terminology for the copepods follows Boxshall (1990) and Huys & Boxshall (1991). The protocols for preparing crustaceans for scanning electron microscopy (SEM) outlined by Felgenhauer (1987) were followed. Ethanol-fixed specimens were hydrated to distilled water and post-fixed in 1–2% osmium tetroxide (OsO_4) in buffer for 2 h, washed in distilled water, dehydrated through graded acetone series, critical point dried using liquid carbon dioxide as the exchange medium, mounted on aluminum stubs, and sputter-coated with platinum. Coated specimens were examined on a Zeiss Supra 55 (FE-SEM, Germany) field emission scanning electron microscope at 1–3 kV.

Family Caligidae Burmeister, 1835
Genus *Caligus* O.F. Müller, 1785

Caligus lichiae Brian, 1906

Host: *Lichia amia* (Linnaeus) (n = 1; total body length 52 cm; caught on 12.viii.2016); *Seriola dumerili* (Risso) (n = 19; total body length range 43–57 cm; caught on 16.viii.2016).
Locality: North-eastern Mediterranean waters off Yumurtalık, Gulf of Iskenderun, Turkey; depth range: 50–60 m.
Prevalence: 57.89% (11 fish infected out of 19 examined *S. dumerili*);
Voucher material: A total of 17 specimens: 1 ovigerous female (CUMAP-COP/2017-4) collected from the

gill cavity of *L. amia*, 7 ovigerous females (CUMAP-COP/2017-5) and 9 males (CUMAP-COP/2017-6) collected from the mouth cavity and gill filaments of *S. dumerili*; fixed in ethanol and stored in the collections of the Aquatic Parasitology Museum at the Faculty of Fisheries, University of Çukurova, Adana-Turkey. Three voucher specimens: 2 female and 1 male (NHMUK 2018.191-193) were also deposited in the collections of the Natural History Museum London.

Description (Figs. 1–10)

Adult female [Based on 8 specimens). Body caligiform, comprising cephalothorax incorporating first to third pedigerous somites, free fourth pedigerous somite, genital complex and 1-segmented abdomen (Fig. 1A). Body length 4.2–6.1 (5.8, n = 8) excluding caudal setae. Dorsal cephalothoracic shield circular, slightly wider than long, 1.9–2.7 × 2.0–2.9 (2.5 × 2.6), length of cephalothorax about 43% of total body length, posterior end of lateral zones slightly angular. Thoracic zone of shield 0.09–1.09 × 1.3–1.41 (1.05 × 1.38), comprising *c.*42% of cephalothorax length, and with concave postero-lateral margin around deeply incised posterior sinus (Figs. 1A, 2A), surrounded with prominent membrane (Fig. 2B, C). Fourth pedigerous somite fused with genital complex, wider than long, 0.49–0.6 × 0.71–0.81 (0.55 × 0.77). Genital complex (Fig. 1A) longer than wide, 1.69–1.83 × 1.31–1.44 (1.77 × 1.38); with rounded anterior corners, slightly convex sides and with lobate posterolateral corners ornamented with patch of spinules (Fig. 2D, E); mid-half of postero-ventral margin of genital complex comprising 2 adjacent flaps (Fig. 1A) covering egg sac attachment area; outer flap larger than inner. Abdomen (Fig. 1A) 1-segmented; longer than wide 0.88–0.97 × 0.57–0.66 (0.94 × 0.61), posterior third of abdomen narrower than anterior part, entire abdomen about 55% of length of genital complex. Combined length of genital complex and abdomen (excluding caudal rami) approximately 1.05 times longer than cephalothorax, and about 46% of total body length. Caudal ramus wider than long, 0.03–0.07 × 0.09–0.13 (0.05 × 0.11), armed with 6 pinnate setae, length of caudal ramus about 5% of length of abdomen.

Antennule (Figs. 1B, 3A) 2-segmented; proximal segment bearing 27 setae; slender distal segment with 11 naked setae plus two aesthetascs; distal segment elongate, about 1.6 times longer than proximal segment. Antenna (Figs. 1C, 3A) uniramous, 3-segmented; proximal segment small and with small, rounded posterior process; middle segment subrectangular, armed with small adhesion pad on dorsal surface; distal segment forming long, weakly curved claw; bearing large, spine-like seta proximally (Figs. 1C, 3A, B) and slender distal seta (Figs. 1C,3A). Postantennal process (Figs. 1D,3C) weakly curved, ornamented with 2 multisensillate papillae; similar papilla with 2 sensillae located on body surface adjacent to process. Proximal part bearing additional small, subtriangular inner process. Convex anterior margin of postantennal process with rounded protrusion.

Maxillule (Figs. 1E, 3D) comprising anterior papilla bearing 3 unequal setae; subcircular process present on adjacent anterior sclerite and projecting over base of process; and posterior blunt tipped dentiform process bearing shorter, medial tine. Mouth tube (Figs. 1F, 3D) with convex lateral margins, enclosing paired mandibles, each armed with 12 teeth distally.

Maxilla (Fig. 1G) 2-segmented, brachiform; proximal segment (lacertus) unarmed; slender distal segment (brachium) bearing long subterminal hyaline membrane (flabellum) on outer margin plus short canna and long, curved calamus ornamented with spirally arranged strips of serrated membrane (Fig. 4A, B). Maxilliped (Figs. 1H, 4C) comprising robust proximal segment (corpus) bearing subtriangular, tapering myxal process (Fig. 4C, white arrow) slightly directed to proximal part of corpus, dorsal surface of corpus ornamented with patches of corrugated pads distally (Fig. 4C arrowheads, D, E), and distal subchela representing fused endopodal segments plus claw; subchela armed with small seta at base of claw (Fig. 1H). Sternal furca (Figs. 5A, 6A) with small box and slightly divergent tines with rounded tips; tines with large marginal flanges (Fig. 6B).

Swimming leg 1 (Fig. 6C) biramous, with 2-segmented exopod and unsegmented vestigial endopod. Sympod (Fig. 5B) armed with lateral plumose seta and inner seta. Ventral surface of sympod ornamented with patch of spinules (Fig. 6D, inset) and bearing small, blunt dentiform process close to intercoxal sclerite (Figs. 5B6D arrow). Endopod (Fig. 5B) relatively long, unsegmented and carrying two fused minute

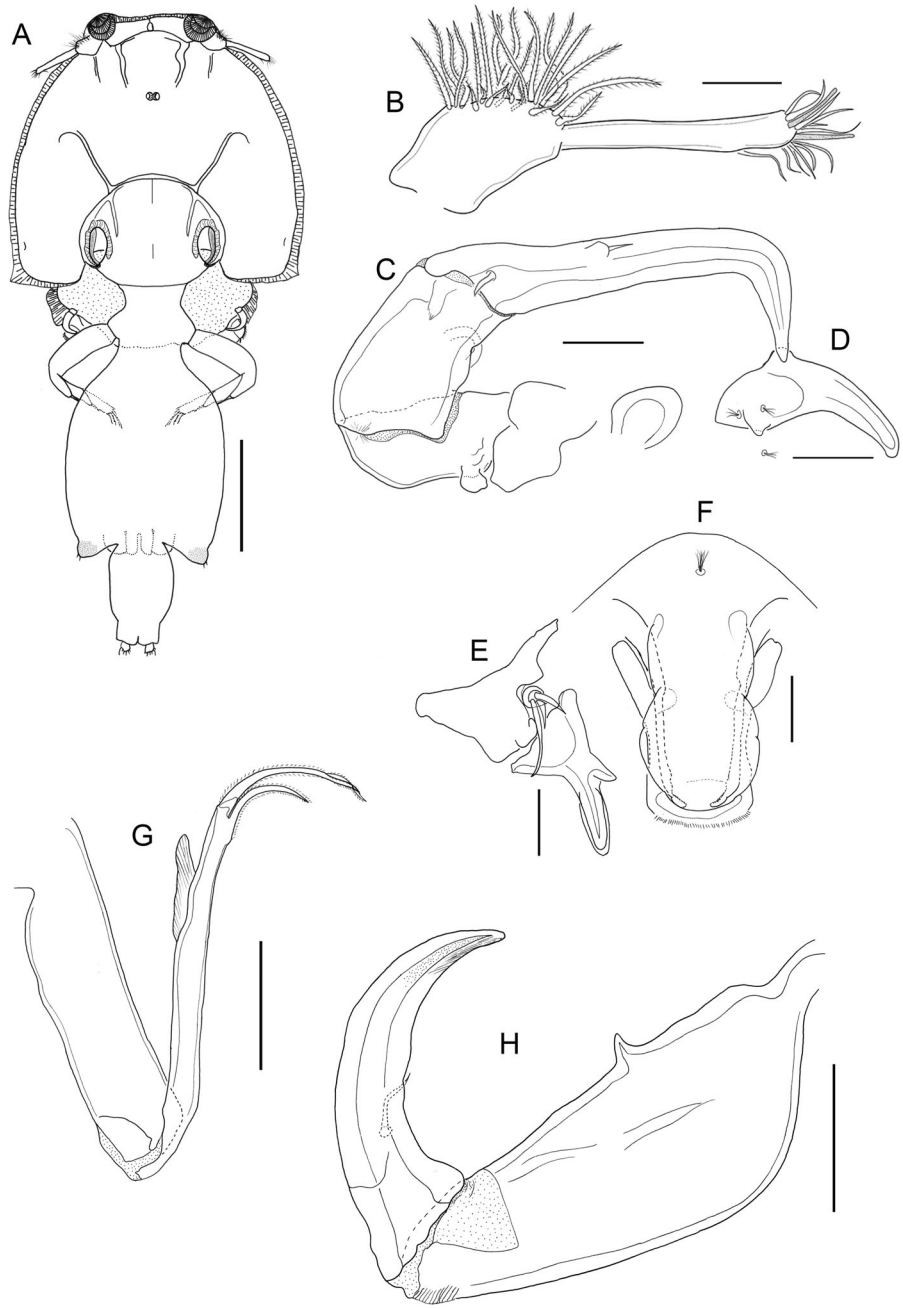

Fig. 1 *Caligus lichiae* Brian, 1906. Female. A, Habitus, dorsal view; B, Antennule; C, Antenna; D, Postantennal process; E, Maxillule; F, Mouth tube and mandible; G, Maxilla; H, Maxilliped. *Scale-bars*: A, 1 mm; B, 50 μm; C–F, 100 μm; G, H, 200 μm

elements apically. First exopodal segment ornamented with row of setules along free posterior margin and bearing small, triangular pecten-like process plus small spinule at outer distal corner (Fig. 5C). Distal exopodal segment (Fig. 5C) with 4 terminal elements; outermost element (spine 1) finely serrated along inner margin and with pecten at base; middle 2 elements (spines 2 and 3) unequally long, with fine serrations along inner margin; each with accessory process and pecten at base; short, digitiform projection present at

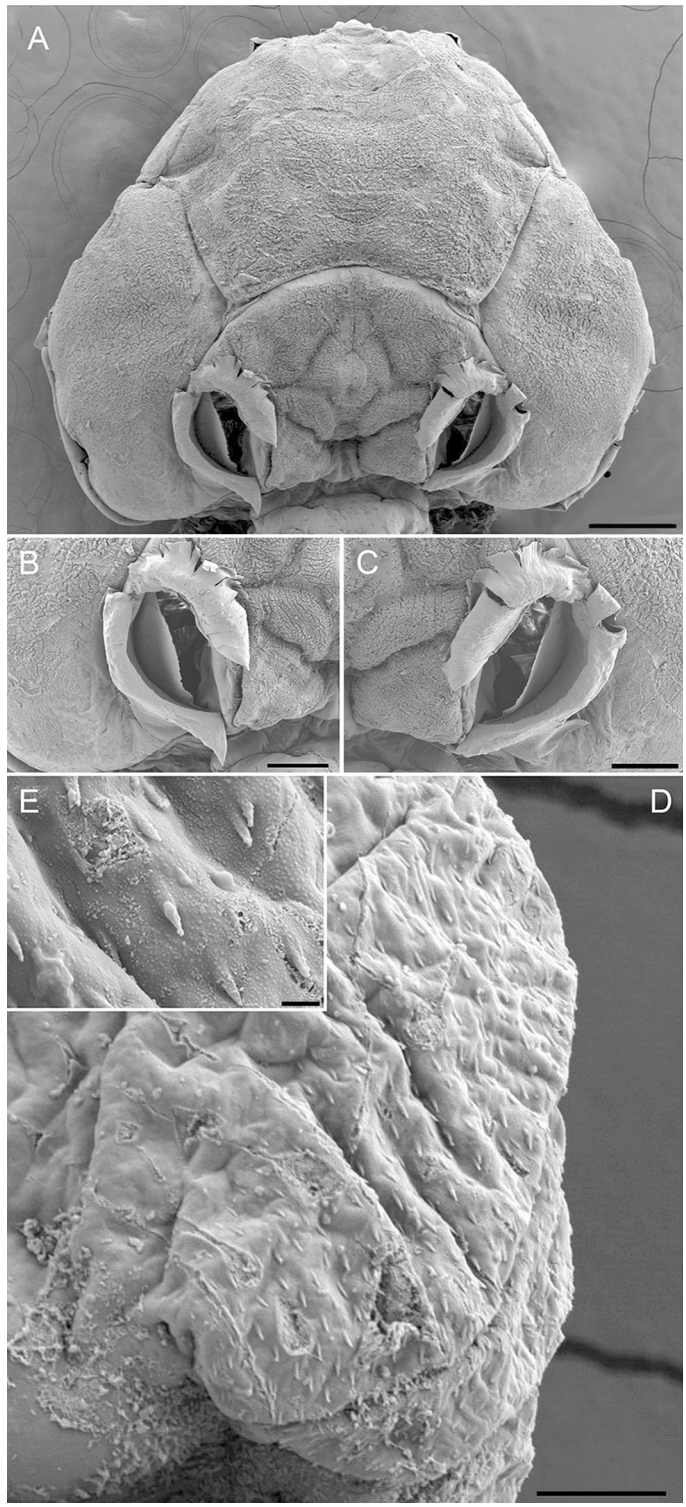

Fig. 2 *Caligus lichiae* Brian, 1906. Female. A, Dorsal cephalothoracic shield; B, Left posterior sinus; C, Right posterior sinus; D, Patch of spinules on posterolateral corner of genital complex; E, Spinules on posterolateral corner (closer view). *Scale-bars*: A, 30 μm; B, C, 50 μm; D, 5 μm; E, 0.5 μm

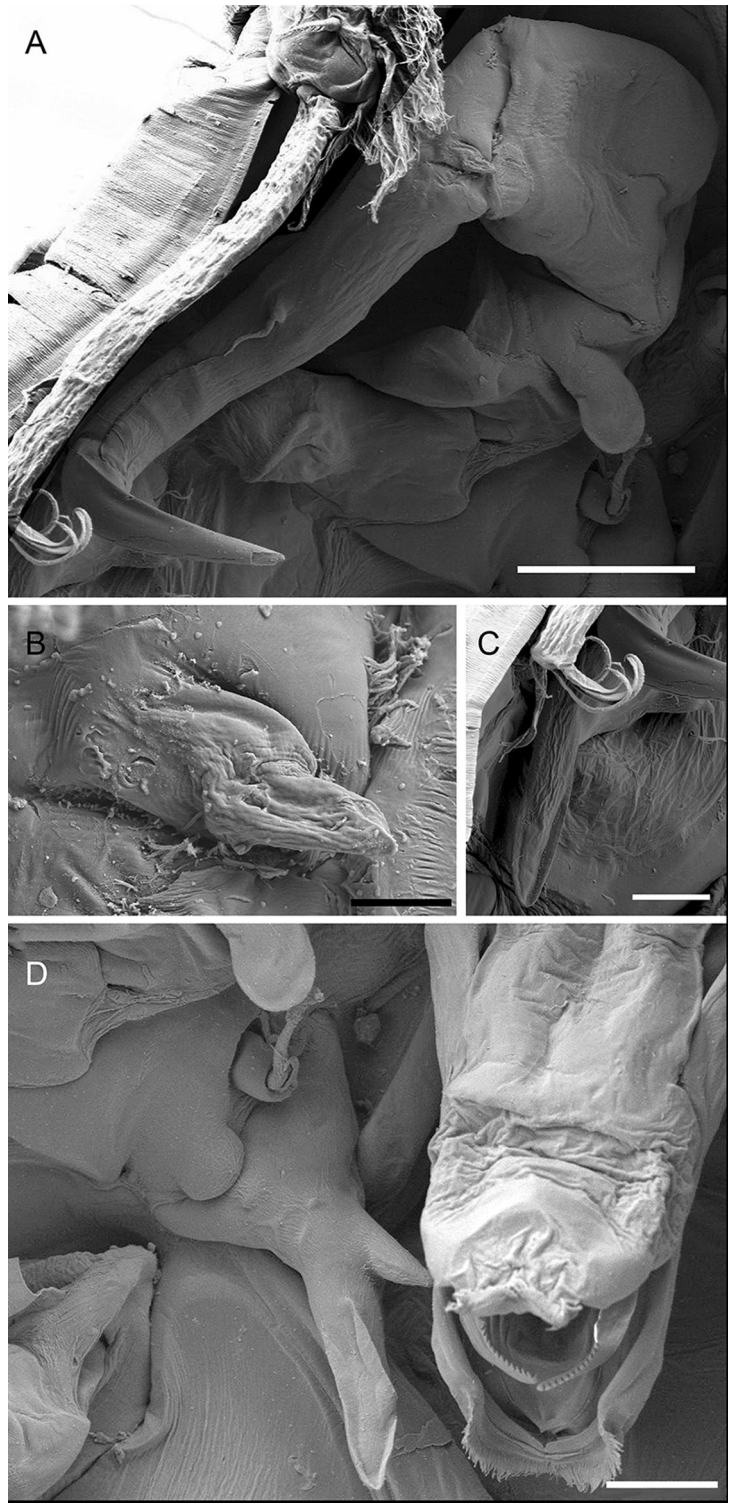

Fig. 3 *Caligus lichiae* Brian, 1906. Female. A, Antennule and antenna; B, Spine-like proximal seta on antenna; C, Postantennal process; D, Maxillule and mouth tube. *Scale-bars*: A, 50 μm; B, 5 μm; C, 20 μm; D, 25 μm

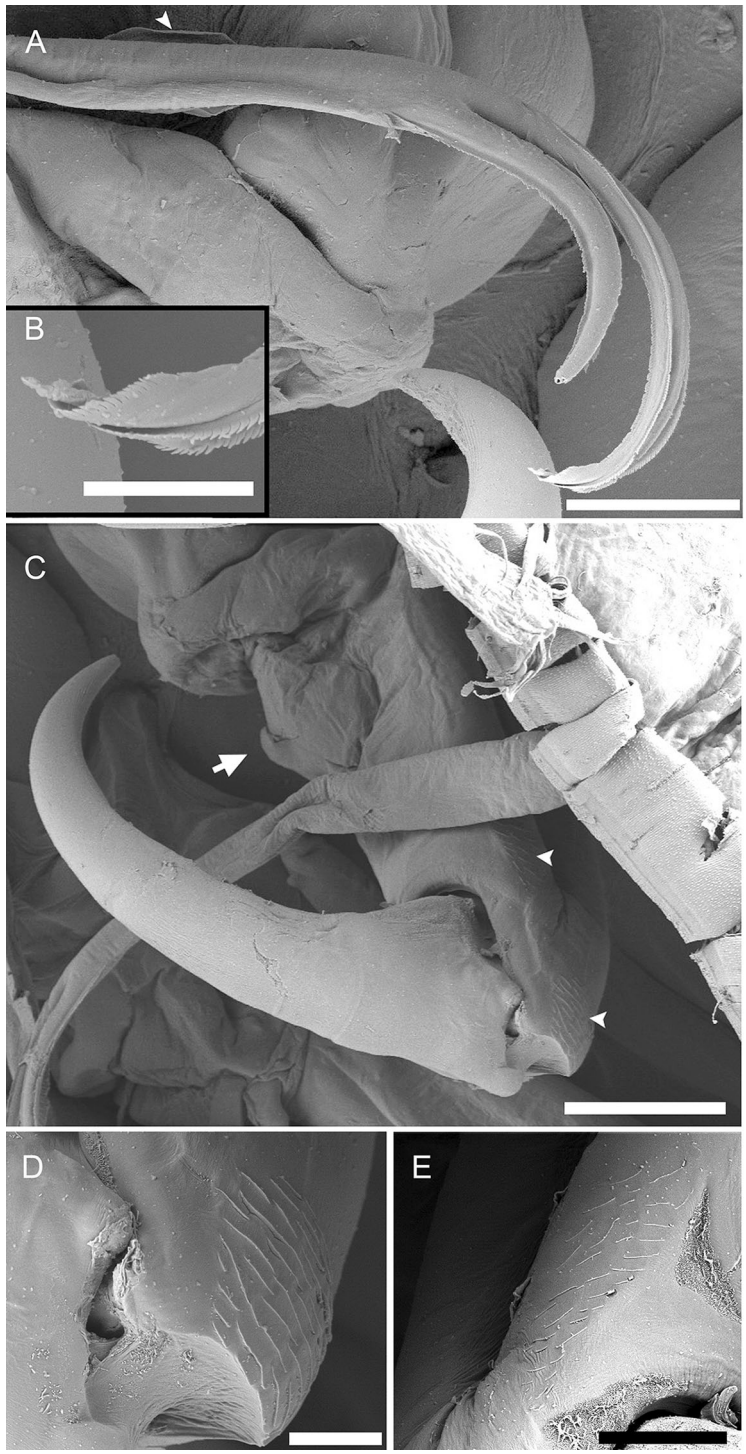

Fig. 4 *Caligus lichiae* Brian, 1906. Female. A, Flabellum (arrowhead) and tip of maxilla; B, Spirally twisted membrane on tip of calamus of maxilla; C, Posteriorly-directed myxal process (arrow) and patches of corrugations (arrowheads) on maxilliped; D, Outer distal patch of corrugations on dorsal surface of maxilliped corpus; E, Inner medio-distal patch of corrugations on dorsal surface of maxilliped corpus. *Scale-bars*: A, 30 μm; B–D, 10 μm; C, 50 μm; E, 20 μm

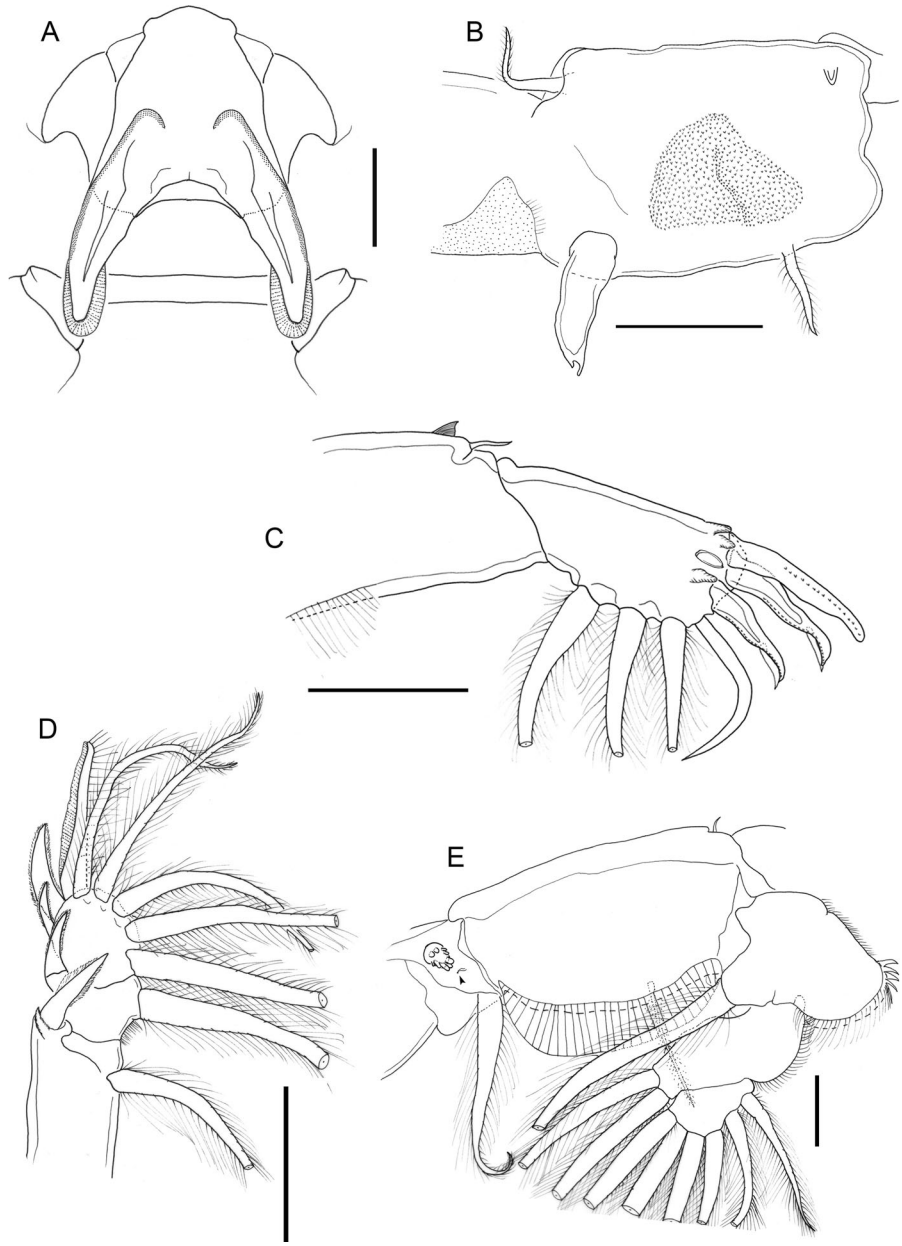

Fig. 5 *Caligus lichiae* Brian, 1906. Female. A, Sternal furca; B, Ventral surface of sympod ornamented with patch of spinules and blunt dentiform process close to intercoxal sclerite; C, Pecten-like process near small spinule at outer distal corner of first exopodal segment and distal exopodal segment of leg 1; D, Exopodal segments of leg 2; E, Ventral surface of coxa of leg 2 ornamented with patch of large spinules near two sensillae (arrowhead) and endopod of leg 2. *Scale-bars*: A–C, E, 100 μm; D, 200 μm

base of middle 2 spines (Fig. 6E arrow); innermost element (seta 4) simple, longer than other three spines (Fig. 5C). Free posterior margin of distal exopodal segment bearing three plumose setae (Fig. 5C).

Leg 2 biramous with 3-segmented rami. First two exopodal segments (Figs. 5D, 7A) with pinnate seta on inner margin and long oblique spine at outer distal corner, reflexed over surface of segment. Third exopodal segment with 3 outer spines, and 5 pinnate setae (Figs. 5D, 7A). Ventral surface of coxa ornamented with patch of large spinules and two sensillae (Figs. 5E, 7A arrow, 7B). Endopod (Fig. 5E)

3-segmented; first endopodal segment distinctly expanded laterally (Fig. 7A), carrying setules on proximal part and spinules on distal part of outer margin, plus inner pinnate seta; second endopodal segment with 2 pinnate setae and ornamented with dense spinules on outer margin; third segment with 6 pinnate setae.

Leg 3 with coxa and basis fused with intercoxal sclerite to form flattened apron-like sympod, ornamented with extended strips of hyaline membrane along lateral and free posterior margins (Fig. 8A, B), with rows of spinules on mid-ventral surface (Fig. 8A); with patch of large sclerotised, knobs (n = 14–19) located on raised cuticular swelling (Fig. 7C arrows, D) on inner ventral surface. Longitudinal ridge marking plane of fusion of protopod and intercoxal sclerite extending from anterior to posterior, and forming raised rib-like outgrowth with angled spatulate tip (Fig. 7C arrowheads). Exopod (Fig. 8B) 3-segmented, with large, recurved outer spine; large hyaline flap present along concave margin of spine. Second exopodal segment with outer spine and inner plumose seta. Third segment with 3 outer spines and 4 short pinnate setae. Endopod 2-segmented; first segment forming flap-like velum closing off space between rami, and armed with with long inner pinnate seta; second with 6 pinnate setae, ornamented with rows of long setules along outer margin.

Leg 4 uniramous with 3-segmented exopod (Fig. 8C, 9A); first segment with 1 distal spine about extending just over 80% of distance along margin of second exopodal segment; second segment with 1 distal spine extending beyond base of outermost spine on distal margin of third exopodal segment; third segment with 3 apical spines along oblique distal margin, inner spine longest, outer spine slightly shorter than middle spine, each spine surrounded with hyaline membrane, and with pecten at base.

Spine (Roman numerals) and seta (Arabic numerals) formula of legs 1–4 as follows:

	Exopod	Endopod
P1	I-0; III, 1, 3	vestigial
P2	I-1; I-1; II, I, 5	0-1; 0-2; 6
P3	I-0; I-1; III, 4	0-1; 6
P4	I-0; I, III	absent

Leg 5 (Fig. 8D) located at posterolateral corner of genital complex, represented by 2 papillae; anterior (outer protopodal) papilla bearing single plumose seta; posterior (exopodal) papilla bearing 3 plumose setae.

Adult male [Based on four specimens]. Body 3.21–3.63 (3.41 mm, n = 9) long excluding caudal setae. Dorsal cephalothoracic shield slightly wider than long, 1.62–1.91 × 1.68–1.96 (1.82 × 1.89), excluding marginal membranes (Fig. 10A). Free thoracic zone of shield wider than long, 0.75–0.9 × 0.09–1.1 (0.86 × 1.03); about 47% length of cephalothorax. Fourth pedigerous somite wider than long 0.25–0.42 × 0.4–0.51 (0.37 × 0.46), indistinctly divided from genital complex. Genital complex subtriangular; 0.46–0.74 × 0.38–0.6 (0.68 × 0.51), with narrow anterior part and slightly convex lateral margins; posterolateral corners ornamented with patch of spinules (Figs. 9B, 10A). Length of genital complex about 37% of cephalothorax. Abdomen (Fig. 10A) 1-segmented; subrectangular, longer than wide, 0.33–0.54 × 0.27–0.42 (0.48 × 0.37); entire abdomen about 71% of length of genital complex; combined length of entire abdomen and genital complex about 64% of cephalothorax length. Caudal ramus slightly longer than wide, 0.06–0.16 × 0.05–0.13 (0.1 × 0.08), armed with 6 pinnate setae; about 21% of abdomen length. Antenna (Figs. 9C, 10B) 3-segmented; proximal segment with 2 corrugated adhesion pads; middle segment largest, with corrugated pads on medial surface; distal segment of antenna forming strongly curved, striated claw (Fig. 10C arrowhead), armed with 2 slender basal setae. Postantennal process (Fig. 10C) more acutely curved than that of female, carrying 2 papillae each bisensillate; similar bisensillate papilla located on body surface adjacent to process: proximal part bearing small, subtriangular inner process: convex margin of postantennal process with rounded protrusion. Maxillule (Figs. 9D, 10D) with dense corrugated pad, medial tine and small knob distally on posterior process (Fig. 9D): anterior papilla with 3 unequal setae as in female. Sternal furca (Fig. 10E) with square box and more divergent tines than that of female, tines extending slightly beyond anterior margin of intercoxal sclerite of leg 1. Maxilliped (Fig. 10F) with massive corpus carrying 3 conspicuous triangular process along myxal margin plus laterally-directed process located proximally on posterior surface;

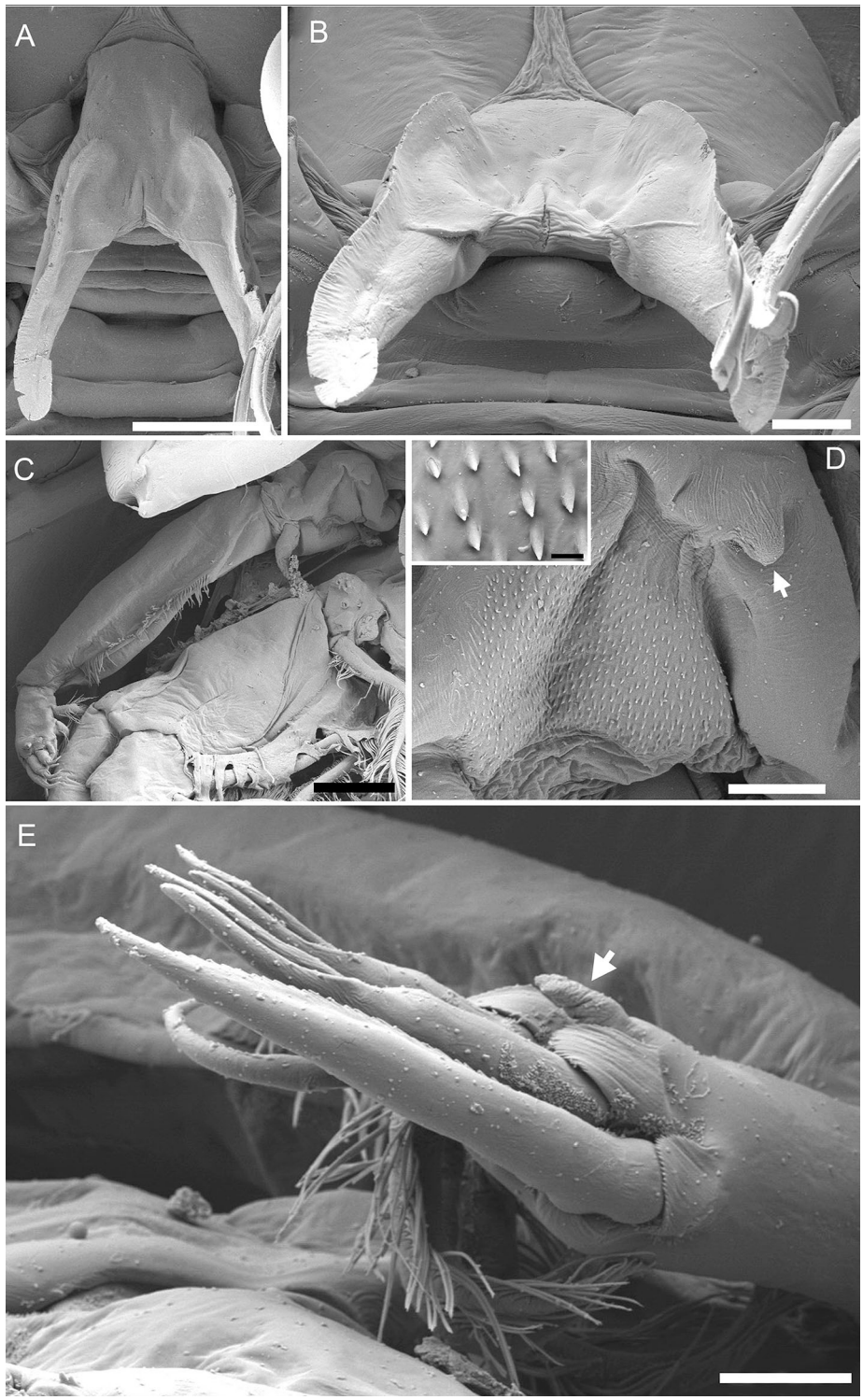

Fig. 6 *Caligus lichiae* Brian, 1906. Female. A, Sternal furca; B, Flange surrounding tines of sternal furca; C, Swimming leg 1; D, Ventral surface of sympod bearing a blunt dentiform process (arrow) and patch of spinules (inset, closer view of spinules); E, Terminal elements and digitiform projection on distal exopodal segment of leg 1. *Scale-bars*: A, C, 50 μm; B, 15 μm; D, E, 10 μm; D, inset, 1 μm

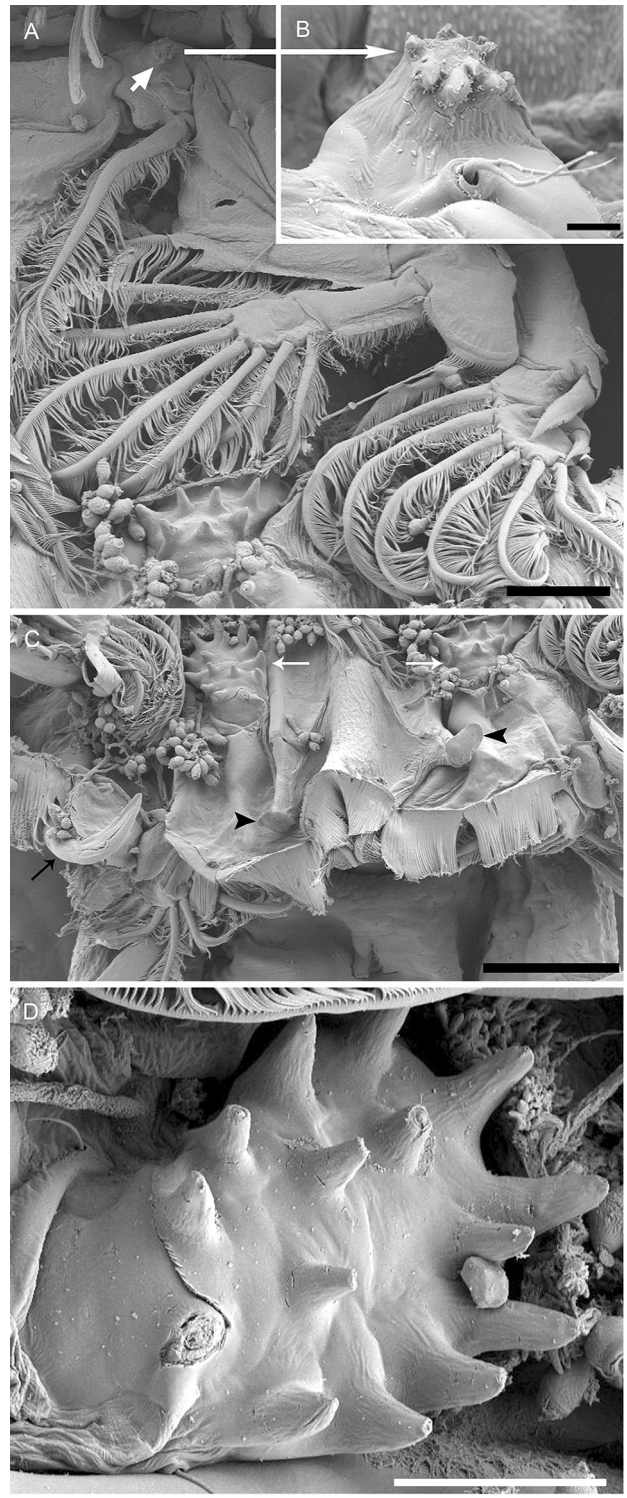

Fig. 7 *Caligus lichiae* Brian, 1906. Female. A, General view of leg 2 and patch of large spinules (arrow); B, Sensillae near raised patch of large spinules on coxa of leg 2; C, Paired patches of large, sclerotised knobs (arrows) located on raised cuticular swelling on inner ventral surface of leg 3 apron and rib-like outgrowth (arrowheads) with angled spatulate tip; D, Detail of patch of large, sclerotised knobs on raised cuticular swelling. *Scale-bars*: A, 50 μm; B, 5 μm; C, 100 μm; D, 30 μm

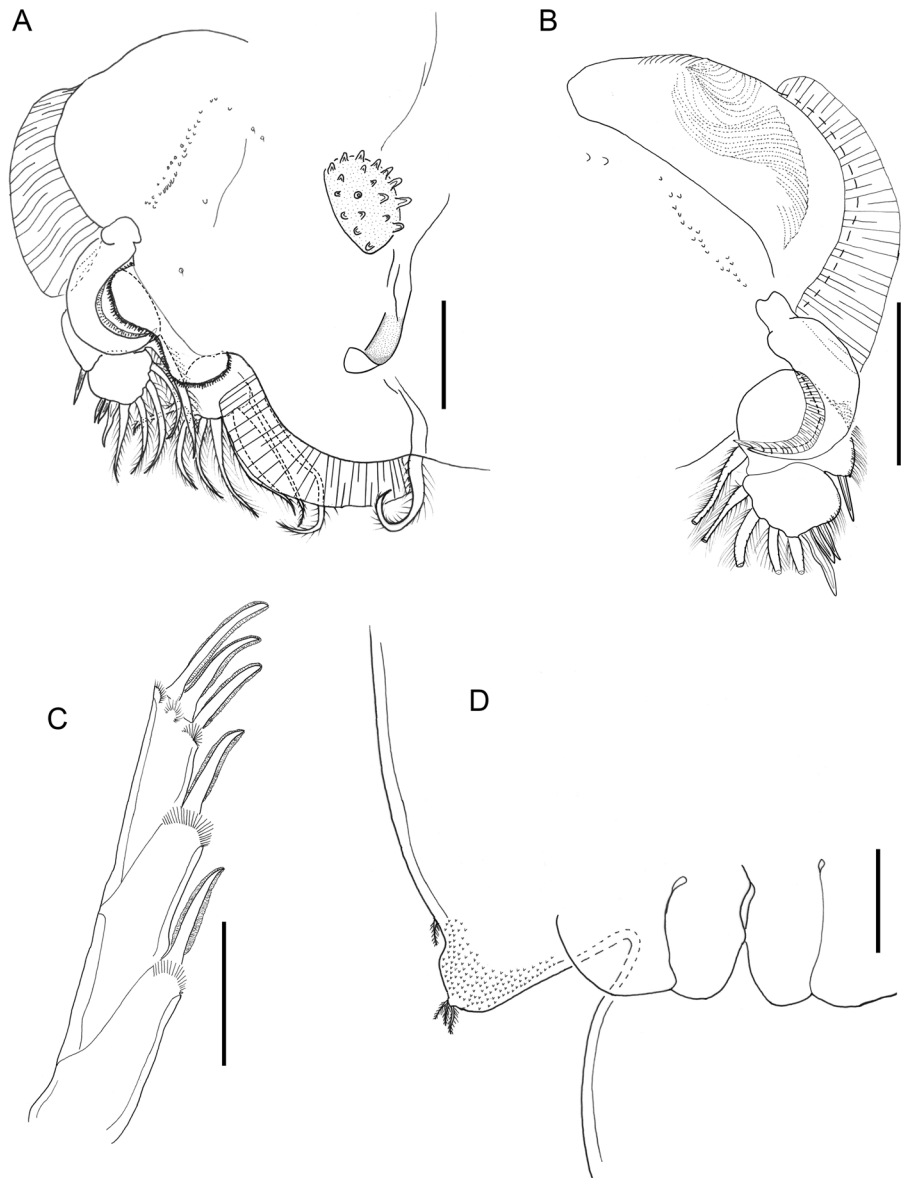

Fig. 8 *Caligus lichiae* Brian, 1906. Female. A, Leg 3; B, Exopod of leg 3; C, Spines on exopodal segments of leg 4; D, Leg 5. *Scale-bars*: A–D, 200 μm

subchela armed with long seta at base of claw; claw ornamented with minute spinules distally. Legs 1–4 as in female. Leg 5 (Fig. 10G) comprising 2 papillae located on posterolateral margins of genital complex, outer (protopodal) papilla with 1 seta, inner (exopodal) papilla with 3 plumose setae. Leg 6 (Fig. 10G) represented by single papilla carrying 3 pinnate setae; inner seta longest.

Remarks

Caligus lichiae was described over a century ago by Brian (1906) but has not been recorded since, even though its host, *L. amia* is distributed along the eastern Atlantic seaboard from the Bay of Biscay in the north to South Africa in the south, including the whole Mediterranean Basin through to the western Black Sea, and round into the Western Indian Ocean as far as

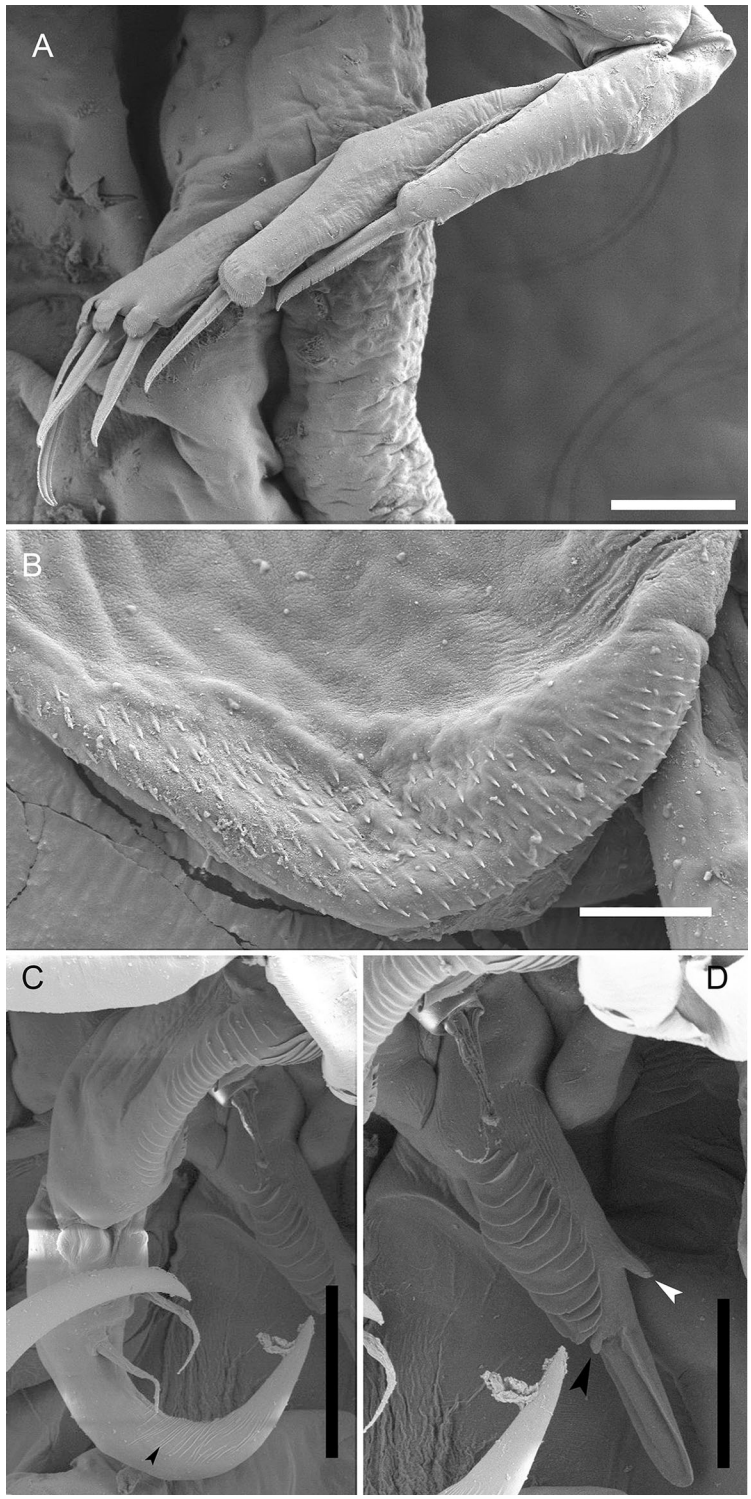

Fig. 9 *Caligus lichiae* Brian, 1906. A, Female, exopod of leg 4; B, Male, patch of spinules on posterolateral corner of genital complex; C, Male, claw of antenna ornamented with longitudinal ridges (arrowhead); D, Male, maxillule bearing corrugated pad, small medial tine (white arrowhead) and small knob (black arrowhead). *Scale-bars*: A, 50; B, 5 μm; C, 30 μm; D, 20 μm

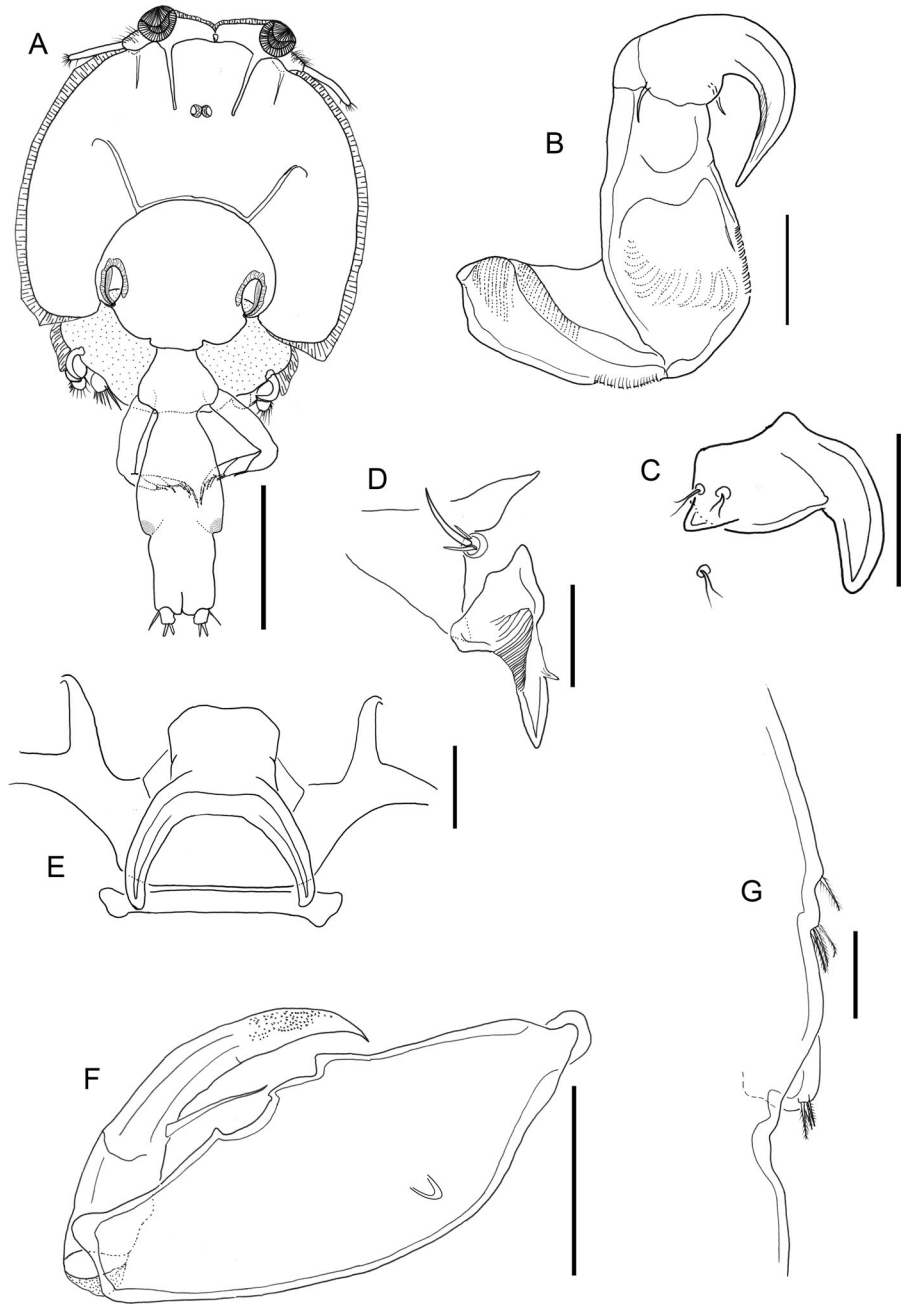

Fig. 10 *Caligus lichiae* Brian, 1906. Male. A, Habitus, dorsal view; B, Antenna; C, Postantennal process; D, Maxillule; E, Sternal furca *in situ*; F, Maxilliped; G, Legs 5 and 6. *Scale-bars*: A, 1 mm; B–E, G, 100 μm; F, 200 μm

the Bay of Maputo in Mozambique (Froese & Pauly, 2018). This suggests that *C. lichiae* is either extremely rare or has been confused with another species. The collection of the new female specimen from the type-host and the discovery that it was identical with the material from *S. dumerili* caught at the same locality, led us to explore the possibility of confusion with another species.

Seriola dumerili is known to be a common host of *Caligus aesopus* which was originally described by

Wilson (1921) based on eleven females collected from a large scombrid (probably *Seriola peruana* Steindachner, as mentioned by Wilson) from off Juan Fernandez (Masatierra), Chile. However, the original description was limited and included illustrations of female habitus, antenna, sternal furca, and legs 1, 3 and 4 only. Eighteen years later, Yamaguti (1939) described *C. spinosus* Yamaguti, 1939, from Japanese yellowtail, *Seriola quinqueradiata* Temminck & Schlegel which closely resembles *C. aesopus*. The similarity between these two species of *Caligus* has caused confusion resulting in numerous misidentifications. Recent detailed redescriptions of *C. aesopus* and *C. spinosus* (Choe & Kim, 2010) revealed that material previously identified as *C. spinosus* from Japanese waters by Shiino (1960), was in fact *C. aesopus*. In addition, Indian reports of *C. spinosus* (Pillai, 1963; Prabha & Pillai, 1983) were also re-identified as *C. aesopus*, whereas the other reports of *C. aesopus* from Chile, New Zealand, South Africa, Taiwan and Korea were correctly identified (Hewitt, 1963; Fernandez & Villalba 1986; Grobler, 2004; Ho & Lin, 2007; Lin & Ho, 2007; Choe & Kim, 2010).

Caligus spinosus was relegated to synonymy with *C. aesopus* by Fernandez & Villalba (1986) and this was followed by Lin & Ho (2007). However, this synonymy was rejected by Choe & Kim (2010) who treated the two species as distinct and valid. During the period from 1986 to 2007, while these two species were regarded as synonyms, records of *C. spinosus* and/or *C. aesopus* that are unaccompanied by a description, might refer to either species.

The general body morphology and the key diagnostic characters of the newly collected Mediterranean specimens from both *L. amia* and *S. dumerili* are in accord with those of the recently redescribed material of *C. aesopus* from Taiwan and Korea (Lin & Ho, 2007; Choe & Kim, 2010). In particular, the small, blunt process (Figs. 5B, 6D), described as "small tubercle" by Choe & Kim (2010), on ventral surface of the sympod of leg 1 and the presence of large sclerotised knobs located on a raised cuticular swelling (Fig. 7C arrows, D) on inner ventral surface of the apron of leg 3 are the two major key diagnostic characters of female *C. aesopus* which we observed in our material. In addition, the male maxilliped has a laterally-directed process located proximally on the posterior surface of the corpus, a feature present in *C. aesopus* and in our Turkish material.

The discovery of this *Caligus* on the type-host of *C. lichiae* now raises the question of whether *C. lichiae* and *C. aesopus* are synonymous. Unfortunately, the only description available for *C. lichiae* is the original (Brian, 1906) which was relatively detailed for the early 20th Century, but lacks the detail we would expect from a modern description. Brian's description reveals that *C. lichiae* exhibits all the features of a member of the *C. confusus*-group, as enumerated by Boxshall (2018) including: the presence of accessory processes on the postantennal process and posterior process of the maxillule, the elongate endopod of leg 1, the presence of accessory processes on spines 2 and 3 of leg 1, the strongly recurved spine on the first exopodal segment of leg 3 plus the raised rib and rosette of strong denticles on the apron of the same leg, and finally, the 3 segmented exopod of leg 4 armed with 1, 1, III spines. No member of the *C. confusus*-group other than *C. lichiae* has ever been reported from the Mediterranean.

Distinguishing between species of *Caligus* typically involves detailed comparisons of, for example, the relative lengths of setal elements. Unfortunately, we consider that Brian's description does not provide accurate information on such a fine scale: for example, it shows the middle spine of the three distal spines on the apical segment of leg 4 as the longest. We know of no species of *Caligus* where the middle spine is the longest. Similarly, it shows all three posterior margin setae on the distal exopodal segment of leg 1 as similar in length, but the outermost seta is always shorter than the other two. Another inaccuracy evident in Brian's depiction is the male abdomen, which he shows as having a deeply incised anal somite, which is not a feature of any member of the Caligidae. Brian (1906) shows the male maxilliped as possessing processes on the myxal surface plus a laterally-directed process proximally on the posterior surface of the corpus. This proximal process is a distinctive characteristic and is shared only with *C. aesopus*. A small rounded knob is present in a similar position in the male of *C. spinosus* (see Choe & Kim, 2010) but it is relatively inconspicuous. *Caligus randalli* has a similar laterally-directed process on the female maxilliped but the male is unknown. These species can be distinguished using the key provided below. On the basis of the generally very close correspondence between the description of *C. lichiae* by Brian (1906) and the redescription of *C. aesopus* by Choe & Kim (2010) and the possession of

the characteristic posterior surface process on the male maxilliped, we propose to relegate *C. aesopus* to a junior subjective synonym of *C. lichiae*.

Minor differences observed on the presently reported *C. lichiae* are as follows: the corpus of the male maxilliped has three triangular processes along the myxal margin (Fig. 10F) whereas four are shown in Lin & Ho (2007) and in Choe & Kim (2010). However, the triangular shapes of the three myxal processes in the Turkish material are all very similar to those illustrated by Lin & Ho (2007; figure 3c). The fourth process is minute and located proximally on the myxal margin but it was not present in our material. The Korean material has four rounded (*vs* triangular) processes on the myxal surface of the corpus of the male maxilliped (Choe & Kim, 2010; figure 6f). In the Turkish material, the male maxillule has a tiny knob on posterior end of the corrugated pad on the posterior process (Fig. 9D, black arrowhead): this has not been noted in previous descriptions, but may have been overlooked. Finally, the raised array of denticles on the ventral surface of the apron of leg 3 comprised 14–19 denticles in the Turkish material, compared to 10 in the material from Taiwan (Lin & Ho, 2007) and 11 to 14 in the material from Korea (Choe & Kim, 2010). We regard these fine-scale differences as representing geographical variation.

The core species and the four affiliated members of the *C. confusus*-group can be identified with the aid of the following key:

1a Posterolateral corners of female genital complex produced into paired expansions enclosing, laterally, proximal half of abdomen; abdomen about 1.7 times longer than broad, and with markedly convex lateral margins ……..…… *C. alepicolus* Boxshall, 2018

1b These characters not combined ……...… 2

2a Posterolateral corners of female genital complex produced into paired lobes extending about to middle of abdomen or beyond; first abdominal somite laterally expanded and with rounded posterolateral lobes extending along sides of much narrower anal somite ..…….……...… 3

2b Posterolateral corners of female genital complex rounded or with slight posterolateral lobes, not reaching middle of abdomen …… 4

3a Genital complex much narrower than dorsal cephalothoracic shield; posterolateral lobes on genital complex subtriangular, tapering towards tip …… *C. seriolicolus* Boxshall, 2018

3b Genital complex about as wide as dorsal cephalothoracic shield; posterolateral lobes on genital complex flattened and with broadly rounded tip …… …… *C. parapetalopsis* Hameed & Pillai, 1973

4a Anterior quarter of genital complex forming narrow waist-like region; abdomen dorso-ventrally flattened, more than 75% width of genital complex …… …… *C. kurochkini* Kazachenko, 1975

4b These characters not combined ……..…… 5

5a Abdomen distinctly 2-segmented, anterior somite dorsoventrally flattened and 79% of width of genital complex, anal somite narrow …… *C. constrictus* Heller, 1865

5b Abdomen 1-segmented or comprising 2 somites of similar width ……...… 6

6a Abdomen wider than long or with length:width ratio about equal …… 7

6b Abdomen distinctly longer than wide …… 13

7a Genital complex about 1.36 times wider than long; width about equal to width of dorsal cephalothoracic shield …… …… *C. bicycletus* Heegaard, 1945

7b Genital complex varying from longer than wide to just (less than 1.1 times) wider than long; genital complex distinctly narrower than dorsal cephalothoracic shield …… 8

8a Genital complex with short waist-like region anteriorly, and with small rounded posterolateral lobes; abdomen about as long as wide; posterior process of maxillule trifid …… …….. *C. confusus* Pillai, 1961

8b These characters not combined; maxillule simple or bifid …….. 9

9a Abdomen extremely short, about one tenth length of genital complex …… …… *C. equulae* Ho & Lin, 2003

9b Length of abdomen between 20–70% length of genital complex …… 10

10a Abdomen broad (about as long as wide) and about 70% length of genital complex …… …… *C. fortis* Kabata, 1965

10b Abdomen wider than long and comprising less than 40% of genital complex …… 11

11a Dorsal cephalothoracic shield 1.2 to 1.5 times wider than genital complex; genital complex

wider than long or about as long as wide; abdomen less than half width of genital complex ……... 12

11b Dorsal cephalothoracic shield about 2.0 times wider than genital complex; genital complex about 1.2–1.3 times longer than wide; abdomen more than half width of genital complex …… *C. brevicaudus* Pillai, 1963

12a Genital complex wider than long; abdomen unsegmented with evenly convex lateral margins; postantennal process simple …… …… *C. platurus* Kirtisinghe, 1964

12b Genital complex about as long as wide; abdomen indistinctly subdivided and widest anteriorly at junction with genital complex; postantennal process bifid …… …… *C. zylanica* Hameed & Pillai, 1986

13a Abdomen more than 3 times longer than wide and almost as long as genital complex; postantennal process and maxillule simple …… …… *C. clavatus* Kirtisinghe, 1964

13b These characters not combined …… 14

14a Abdomen about 70% of length of genital complex …… 15

14b Abdomen at most 50% of length of genital complex …… 17

15a Abdomen slender with parallel sides, more than 2.5 times longer than wide …… …….. *C. chorinemi* Krøyer, 1863

15b Abdomen with convex or tapering lateral margins, less than 2 times longer than wide …… 16

16a Abdomen with evenly convex lateral margins, about 1.6 times longer than wide …… ……. *C. randalli* Lewis, A. G., 1964

16b Abdomen widest anteriorly at junction with genital complex tapering back towards anal somite; about 1.75 times longer than maximum width …… *C. isonyx* Steenstrup & Lütken, 1861/ *C. lunatus* Wilson C. B., 1924

17a Genital complex bottle-shaped, narrow anteriorly and increasing in width posteriorly; posterolateral corners of complex rounded …… 18

17b Genital complex with parallel to slightly convex lateral margins; posterolateral corner of complex angular or slightly flared …… 19

18a Abdomen about 1.5 times longer than wide and about 35% length of genital complex …… …… *C. inopinatus* Kabata, 1994

18b Abdomen about 2 times longer than wide and about 45% length of genital complex …… …….. *C. abigailae* Boxshall, 2018

19a Genital complex about 2.7 times longer than abdomen; abdomen about 1.1 times longer than wide …… *C. cordyla* Pillai, 1963

19b Genital complex at most 2.2 times longer than abdomen; abdomen about 1.3–1.5 times longer than wide ……... 20

20a Abdomen with evenly convex lateral margins showing no trace of segmentation …… ……... *C. spinosus* Yamaguti, 1939

20b Abdomen with broad anterior part and narrow posterior part …… 21

21a Posterolateral corners of genital complex projecting laterally; female maxilliped with small myxal process …… *C. lichiae* Brian, 1906

21b Posterolateral corners of genital complex rounded, not projecting laterally; myxal surface of female maxilliped lacking process …… …….. *C. tenax* Heller, 1865

Caligus isonyx and *C. lunatus* are very similar in body proportions of the female and cannot be readily separated on the evidence available. It is possible that they are synonymous and this problem will be addressed elsewhere.

Acknowledgements We would also like to thank Associate Professor Dr Kasım Ocakoglu, former head of the Advanced Technologies Research & Application Center (MEITAM) of the University of Mersin, Turkey, and Professor Süphan Karaytuğ and Ms Seher Kuru from Mersin University for their administrative and technical support during the SEM.

Funding This research was funded by the Çukurova University academic research projects unit (Project No. FBA-2017-7490)

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving animals were in accordance with the ethical standards of the institution or practice at which the studies were conducted.

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