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Short note

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Two marine parasitic crustaceans new to the Belgian fauna

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Marine parasites comprise various groups of animals, including crustaceans (copepods, isopods), ecto- and- endoparasitic flukes (platyhelminthes), round worms (nematodes), Bryozoa, bivalves and even Cnidaria [1].

Since many commercial fish species and populations are parasitized (e.g., [2]), with often a severe impact on fitness and health, knowledge on parasites is of considerable ecological and economic importance [3]. In addition, organisms from lower trophic levels that form the base of the food chain, can be subject to parasites (e.g., [4]). In Belgium efforts have been taken to assess patterns and prevalence of parasites on whiting and dab during the years 1996–2011 [5], and to quantify parasites originating from marine dredge spoil disposal sites [6]. Otherwise, parasites have only been reported occasionally or as a side-product of a survey (e.g., [7]).

Two marine parasites; *Progebiophilus euxinicus* (Popov, 1929) (isopoda: Bopyridae) and *Caligus brevicaudatus* A. Scott, 1901 (Siphonostomatoida: Caligidae) are here recorded for the first time in Belgian waters [8]. On a global scale, both species are reported infrequently and often without details on collection date and location. Moreover, the environmental parameters of these species remain hitherto unknown (i.e., depth, temperature, salinity). In this paper, we link the collected specimens to a wide range of parameters (Appendix 1), including pigment and nutrient concentrations of water, and measurements on conductivity, temperature, and depth. These new species records bring the list of known occurrences of parasitic crustaceans for Belgium to 11 species of parasitic Isopoda and 14 species of parasitic Copepoda [9] (Table 1).

The Belgian part of the North Sea (BPNS) covers an area of approximately 3447 km² and is part of the Southern Bight of the North Sea. The BPNS is unique in the way it is characterized by sand banks: Flemish banks, Zealand banks, Hinder banks and Coastal banks. Currents in the BPNS are dominated by semi-diurnal tides ranging from 3 m (neap tide) to 4.5m (spring tide) [10]. River plumes of the Scheldt, Rijn, Seine and Maas reduce the salinity in the BPNS [11].

TABLE 1

Species of parasitic Isopoda and Caligidae known from Belgium (based on [7, 9, 31]) with reference to the aphiaID in the World Register of Marine Species [32]. *Caligus rapax* Milne Edwards, 1840 was recorded from the BPNS by [31], but is here omitted based on [33].

Species	AphiaID
Isopoda	
Progebiophilus euxinicus (Popov, 1929)	118233
Pseudione hyndmanni (Bate & Westwood, 1868)	118240
Prodajus ostendensis Gilson, 1909	148638
Pleurocrypta porcellanaelongicornis Hesse, 1876	593521
Nerocila orbignyi (Guérin-Méneville, 1832)	118911
Hemiarthrus abdominalis (Krøyer, 1840)	118217
Gnathia oxyuraea (Lilljeborg, 1855)	118995
Ceratothoa oestroides (Risso, 1816)	118871
Athelges paguri (Rathke, 1843)	118196
Portunion kossmanni (Giard & Bonnier, 1886)	148668
Ione thoracica (Montagu, 1808)	118218
Siphonostomatoida	
Caligus brevicaudatus A. Scott, 1901	135746
Caligus curtus O.F. Müller, 1785	135749
Caligus elongatus von Nordmann, 1832	135754
Caligus diaphanus von Nordmann, 1832	135751
Eudactylina acuta Van Beneden, 1853	135806
Haemobaphes ambiguus Scott T., 1900	135987
Kroyeria lineata Van Beneden, 1853	135834
Tripaphylus musteli (Van Beneden, 1851)	136011
Pseudocharopinus malleus (Rudolphi *in* Nordmann, 1832)	135876
Lernaeocera minuta (Scott T., 1900)	135995
Lernaeocera lusci (Bassett-Smith, 1896)	135994
Lernaeocera branchialis (Linnaeus, 1767)	135993
Lernaeenicus sprattae (Sowerby, 1806)	135991
Lepeophtheirus pectoralis (Müller O.F., 1776)	135779

First record of *Progebiophilus euxinicus*

On 26th October 2016, at 51.30934 N, 2.852588 E, one fished specimen of the mud-shrimp *Upogebia deltaura* was infested with the parasite *Progebiophilus euxinicus* [8] (Fig. 1). Two individual parasites, an adult male and an adult female with full brood sac, were recovered from the branchial cavity. These specimens are stored in 70% ethanol in the Marine Station Ostend (MSO), Flanders Marine Institute, Ostend, Belgium. All details on this record are available online [8], and accessible through EurOBIS (http://www.iobis.org/mapper/) and EMODnet biology portal (http://www.emodnet-biology.eu/portal/#).

Progebiophilus euxinicus is a highly modified epicaridean isopod, parasitic in the branchial cavity of mud-shrimps *Upogebia stellata* (Montagu, 1808), *U. deltaura* (Leach, 1815) and *U. pusilla* (Petagna, 1792) (all Decapoda: Thalassinidea) (Appendix 2). From the coast of Denmark and the Netherlands, *Upogebia* species are considered amongst the most important food sources for plaice *Pleuronectes*

platessa Linnaeus, 1758 [12]. The parasite has been previously found in the branchial cavity of *U. stellata*, taken from the gut of plaice *P. platessa* [13]. Occasionally, *Upogebia* can be seen in large numbers (Ranson, ILVO, pers. comm.).

Upogebia has a specific ecology, living permanently in a relatively easy system of passages in the sediment [14]. In this stable environment, *Upogebia* serves as an important host for a variety of parasites, including Bryozoa (*Triticella flava* Dalyell, 1848), Bivalvia (*Lepton squamosum* (Montagu, 1803), *Hemilepton nitidum* (Turton, 1822)) and other isopods (*Gyge branchialis* Cornalia & Panceri, 1861). *Gyge branchialis,* is known to have a strong negative impact on the fitness of mud-shrimps, including their reproductive success [4]. Since *Gyge* and *Progebiophilus* can be found simultaneously on the same mud-shrimp *Upogebia* and both are morphologically very similar [15], it is quite possible that *Progebiophilus* may have similar effects on its host but this has not yet been determined. Larval *Progebiophilus* enter the host at an early life stage of the host, and both develop together. So far, no adult individual parasites, have been found outside of the gill chamber [16, 17].

Figure 1. – Infested *Upogebia deltaura,* the left gill chamber conspicuously swollen by the two parasites inside.

BOURDON [15] distinguishes *Progebiophilus* and *Gyge* as follows: females of *Progebiophilus* have biramous and elongated, pointed pleopods (Fig. 2A–B), while pleopods are uniramous and rounded in females of *Gyge*; the males of *Progebiophilus* have large and distinctive pleopods (Fig. 2A, C), while they are small and indistinct in the males of *Gyge*. All life stages of both *Progebiophilus* and *Gyge* are depicted and described in detail by BOURDON [15]. Males and females of *P. euxinicus* differ markedly in size: the female reaches lengths up to 10–12 mm whilst the male reaches lengths up to 2.75–4.5mm [15] (Fig. 2A). The female is asymmetrically rounded; with one flat and one markedly protruding body side. The male is elongated and segmented, resembling typical isopods, and often resides within a cavity of the female body.

Both *G. branchialis* and *P. euxinicus* have been reported from the Friese Front, the Netherlands [18] and were to be expected in the BPNS. No other observations in the North Sea have been published or are known to be communicated, so the species is considered a rare occurrence in the North Sea (Fig. 3). Eight of the twelve known records originate from Mediterranean and Atlantic waters (Fig. 3). Due to the limited records in literature it is difficult to assess the temporal distribution. Three records ([13, 18, 19]) include collection dates and indicate *Progebiophilus* can be collected all year round.

First record of *Caligus brevicaudatus*

On 29th August 2013, near 51.43319N, 2.80777E, a tub gurnard (*Chelidonichthys lucerna*) was fished that hosted four female *Caligus brevicaudatus* (Fig. 4) [8]. Two specimens were dissected for species identification: all legs (Fig. 5A–D), mouthparts, antennae and antennules were dissected and studied. Two specimens remain intact and stained. Three specimens are stored in 70% ethanol as part of the LifeWatch sample library in the MSO, Flanders Marine Institute, Ostend, Belgium. All details on this

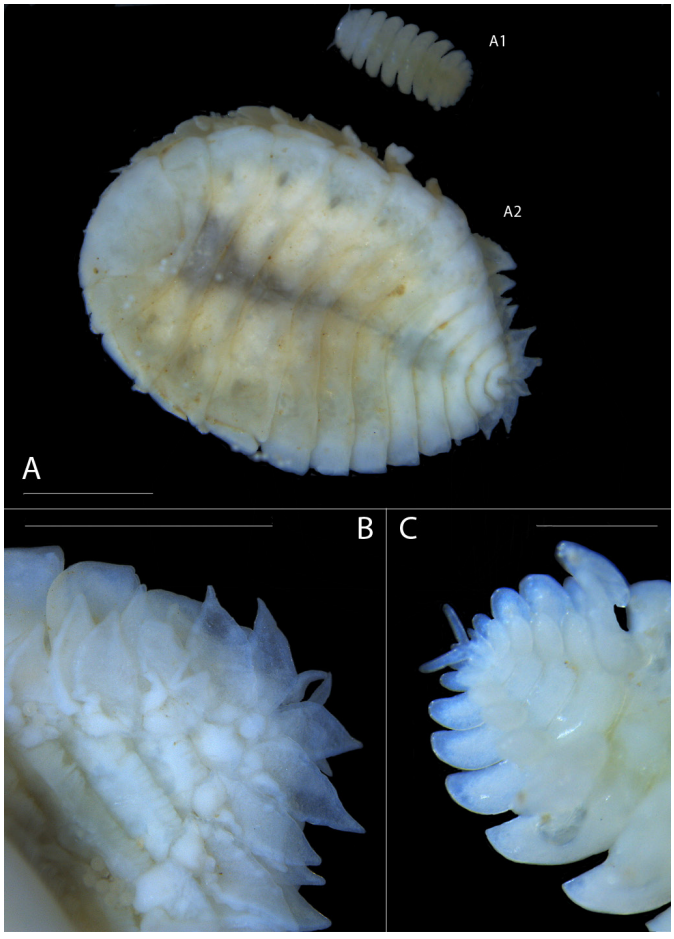

Figure 2. – Male (A1) and female (A2) of *Progebiophilus euxinicus* (Popov, 1927). Female, ventral view of pleopodes and uropods (B). Male, ventral view of pleopodes and uropods (C). Scale bars: A–B = 0.25 mm; C = 0.05 mm.

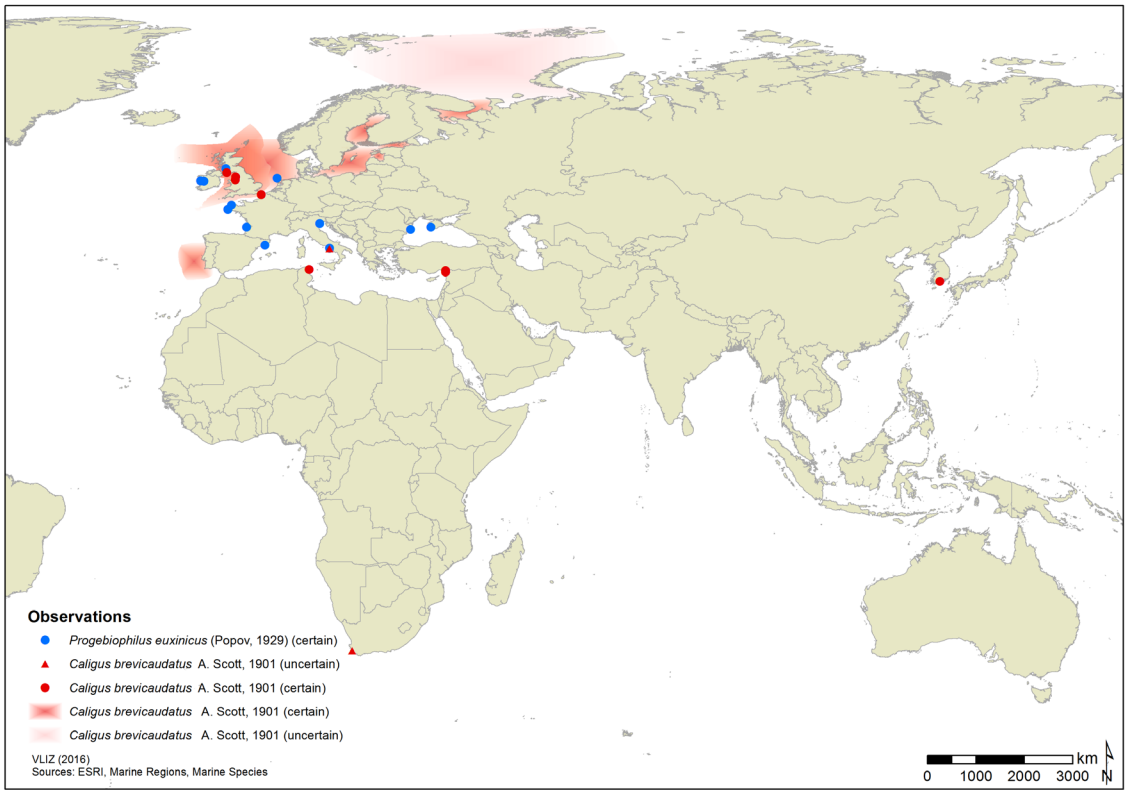

Figure 3. – Known distribution of *Caligus brevicaudatus* (red) and *Progebiophilus euxinicus* (blue), based on [13, 15, 18-20, 24-29]. If no point location is known, the wider sea region is coloured according to MarineRegions [30].

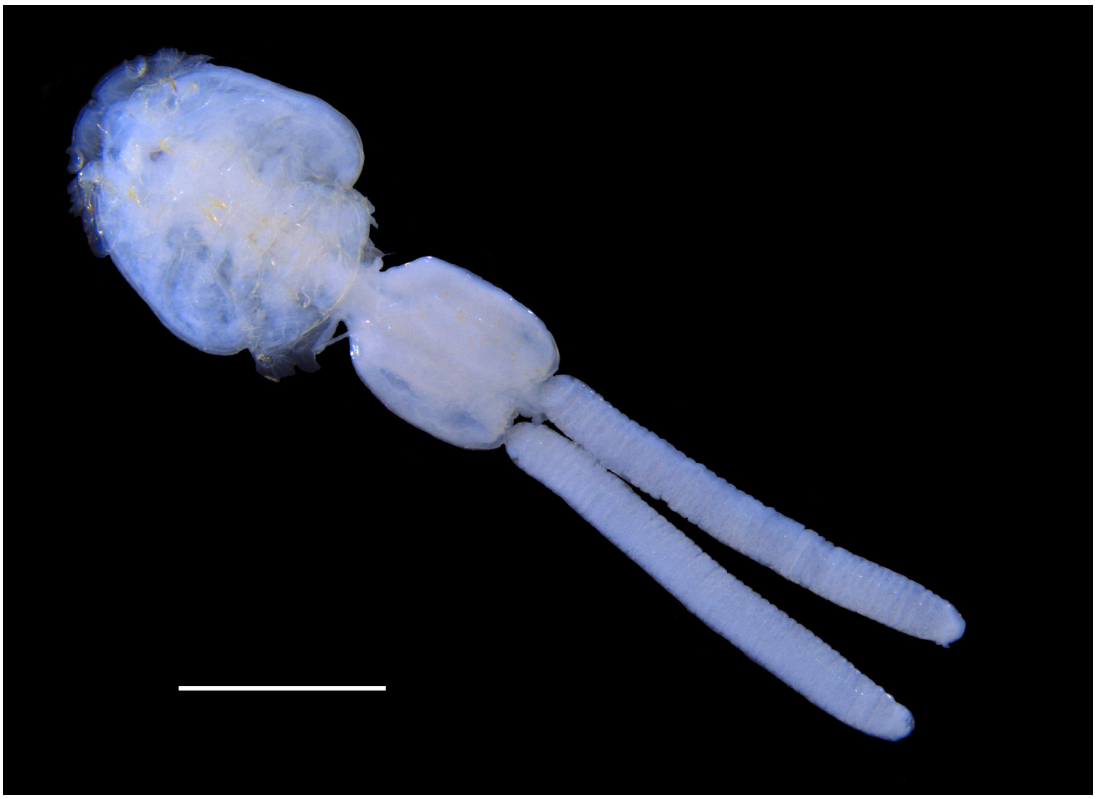

Figure 4. – Female of *Caligus brevicaudatus,* dorsal. Scale bar: 1cm

record are available online [8], and accessible through EurOBIS (http://www.iobis.org/mapper/) and EMODnet biology portal (http://www.emodnet-biology.eu/portal/#).

Caligus brevicaudatus is an ectoparasitic copepod, known to parasitize several species of *Chelidonichthys* and *Eutrigla* (gurnard), including *C. capensis* (Cuvier, 1829), *C. lucerna* (Linnaeus, 1758) and *E. gurnardus* (Linnaeus, 1758) [2, 20]. Besides gurnards, also several flatfish species have been reported as hosts: *Paralichthys olivaceus* (Temminck & Schlegel, 1846), *Pegusa lascaris* (Risso, 1810), *Solea senegalensis* Kaup, 1858, *Solea solea* (Linnaeus, 1758) [21, 22]. An overview on host-parasite relationships is given in Appendix 2. Similar species of ectoparasitic copepods, e.g., *Lepeophtheirus salmonis* (Krøyer, 1837) are known to be able to kill the host [23]. However, no such reports are known for *Caligus brevicaudatus*.

Identification of parasitic copepods is challenging and often involves dissection of legs, antennae and mouthparts. KABATA [2] provides a recent synopsis covering all British species of parasitic copepods on fish enabling researchers to key out the several genera and species around the British Isles. For the BPNS and the wider region of the North Sea, additional literature should be used.

Remarkably, males of *C. brevicaudatus* were only described in 2016 [20]. Females are scarce [2, 20] and were thoroughly redescribed in 2016 [20]. Records are known from Wimereux, France [24] and from the Western Wadden Sea and the Netherlands [25], and therefore, the species was expected to occur in the BPNS. The current distribution of *C. brevicaudatus* is enigmatic and few reliable records exist (Fig. 3). No exact collection dates were found in literature.

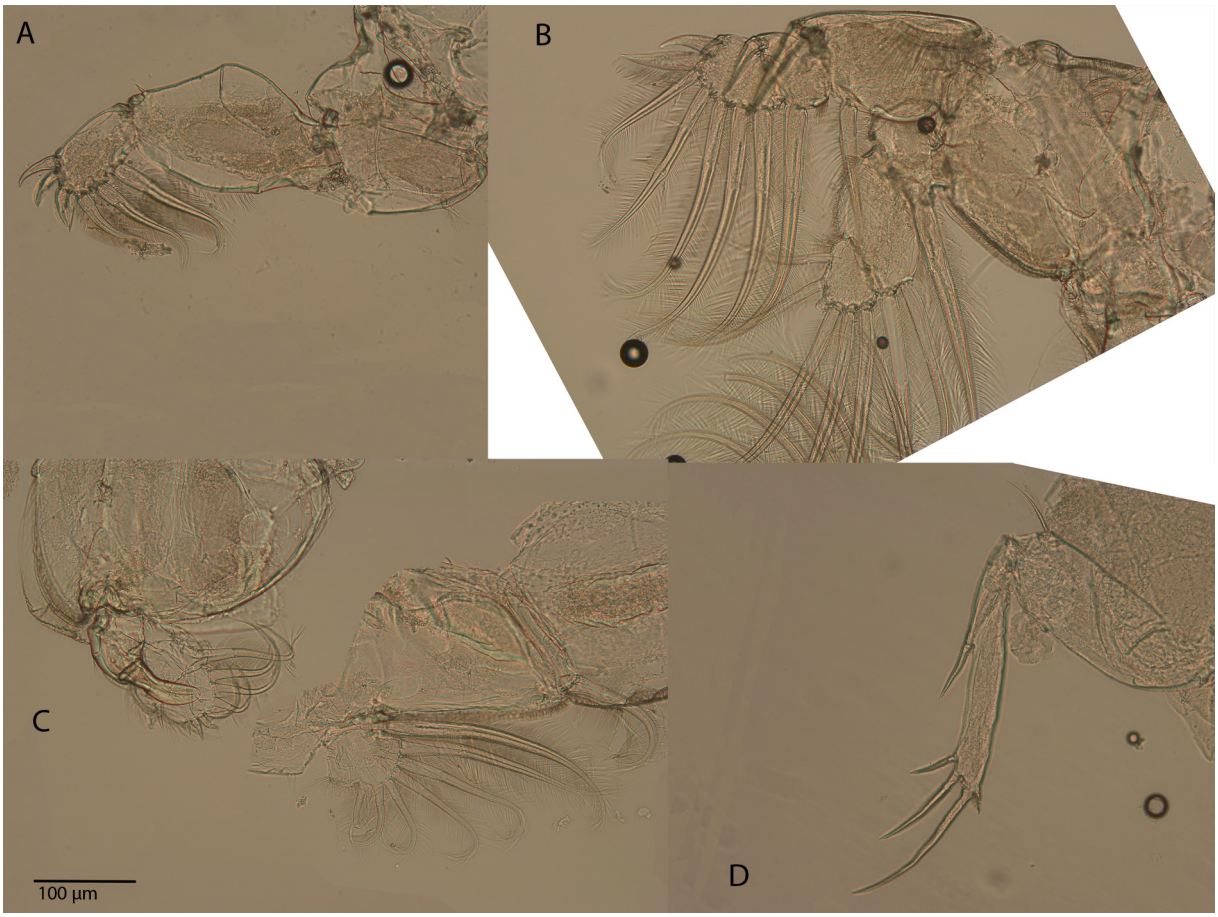

Figure 5. – Female of *Caligus brevicaudatus*. Legs 1 (A), 2 (B), 3 (dissected, C) and 4 (D).

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Appendix 1

Metadata associated with the sample [37].

Parameter	Value (26/10/2016)	Value (29/8/2013)	Unit
Secchi > Secchi Depth	80	440	cm
Pigments > Chlorophyll c3	0	0	µg/l
Pigments > Chlorophyll c2	0.226	0.500	µg/l
Pigments > Chlorophyllide a	0	0	µg/l
Pigments > Pheophorbide a	0	0	µg/l
Pigments > Peridinin	0	0.196	µg/l
Pigments > 19But-Fucoxanthin	0	0	µg/l
Pigments > Fucoxanthin	1.151	2.286	µg/l
Pigments > Neoxanthin	0	0	µg/l
Pigments > Prasinoxanthin	0	0	µg/l
Pigments > 19Hex-Fucoxanthin	0	0	µg/l
Pigments > Diadinoxanthin	0.099	0.285	µg/l
Pigments > Antheraxanthin	0	0	µg/l
Pigments > Alloxanthin	0.077	0.148	µg/l
Pigments > Diatoxanthin	0	0.018	µg/l
Pigments > Zeaxanthin	0.013	0	µg/l
Pigments > Chlorophyll b	0.057	0	µg/l
Pigments > Chlorophyll a	2.841	5.468	µg/l
Pigments > Pheophytin a	0	0.040	µg/l
Pigments > Beta_Carotene	0.065	0.135	µg/l
Nutrients > Ammonium NH4	3.750	24.478	µmol N_NH4/L
Nutrients > Nitrite NO2	1.340	0.143	µmol N_NO2/L
Nutrients > Nitrate NO3	13.170	?	µmol N_NO3/L
Nutrients > Nitrate Nitrite	14.510	3.242	µmol N_NO3-NO2/L
Nutrients > Phosphate PO4	1.040	0.404	µmol P_PO4/L
Nutrients > Silicate SiO4	13.950	2.793	µmol Si_SiO4/L
SPM > SPM	30.000	2.100	mg/l
CTD > Pressure	3.106	3.026	db
CTD > Temperature	13.080	19.677	°C
CTD > Conductivity	38217.000	45591.000	mS/cm
OBS 3+	8.945	3.292	NTU
Oxigen	7.660	6.239	mg/L
CTD > Density	1024.318	1023.605	kg/m³
CTD > Salinity	32.322	33.355	PSU
CTD > Sound Velocity	1497.340	1518.780	m/s
MaximumDepth			m

Appendix 2

Host relationships of *P. euxinicus* and *C. brevicaudatus*.

	Host	Reference
P. euxinicus	*Upogebia stellata* (Montagu, 1808)	[19] (from left branchial chamber), [13, 34]
	Upogebia pusilla (Petagna, 1792)	[19] (from left branchial chamber), [13, 34, 35]
	Upogebia deltaura (Leach, 1816)	[18] (from right branchial chamber), [15, 36]
C. brevicaudatus	*Eutrigla gurnardus* (Linnaeus, 1758)	[20, 27]
	Chelidonichthys lucerna (Linnaeus, 1758)	[20, 25]
	Paralichthys olivaceus (Temminck & Schlegel, 1846)	[21]
	Pegusa lascaris (Risso, 1810)	[23]
	Solea senegalensis Kaup, 1858	[22]
	Solea solea (Linnaeus, 1758)	[22]
	Chelidonichthys capensis (Cuvier, 1829)	[20]
	Chelidonichthys obscurus (Walbaum, 1792)	[20]