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CALIGUS MINIMUS (COPEPODA: CALIGIDAE) PARASITIC ON THE
GILLS OF A REMORA *ECHENEIS NAUCRATES* ATTACHED TO A SEABASS
DICENTRARCHUS LABRAX IN KÖYCEĞİZ-DALYAN LAGOON LAKE,
AEGEAN SEA, TURKEY

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ABSTRACT

The paper describes a parasitic copepod Caligus minimus found on the gill rakers of a remora Echeneis naucrates attached to a seabass Dicentrarchus labrax in the brackish Köyceğiz-Dalyan Lagoon Lake on the shore of the South Aegean Sea, Turkey. Morphological characters of the female copepod are provided and illustrated. The occurrence of this parasitic copepod species on a remora host and the association between this remora species and seabass in a brackish lagoon constitute new records. The present study elevates to four the Caligus species found on E. naucrates so far. We suggest two mutually non-exclusive scenarios for the occurrence of E. naucrates on D. labrax in brackish environments.

Key words: Caligidae, fish parasite, remora-seabass association, Turkey

CALIGUS MINIMUS (COPEPODA: CALIGIDAE) PARASSITA SULLE BRANCHIE DI UNA
REMORA *ECHENEIS NAUCRATES* ATTACCATA A UNA SPIGOLA *DICENTRARCHUS*
LABRAX NEL LAGO LAGUNARE KÖYCEĞİZ-DALYAN, MAR EGEO, TURCHIA

SINTESI

L'articolo descrive un copepode parassita Caligus minimus trovato sui rastrelli branchiali di una remora Echeneis naucrates attaccata ad una spigola Dicentrarchus labrax nel lago salmastro Köyceğiz-Dalyan Lagoon sulla riva dell'Egeo meridionale, in Turchia. I caratteri morfologici del copepode femmina sono forniti e illustrati. L'occorrenza di questa specie di copepode parassita su un ospite remora e l'associazione tra questa remora e la spigola in una laguna salmastra rappresentano dati nuovi. Il presente studio eleva a quattro le specie di Caligus trovate finora su E. naucrates. Gli autori suggeriscono due scenari reciprocamente non esclusivi per la presenza di E. naucrates su D. labrax in ambienti salmastri.

Parole chiave: Caligidae, parassita dei pesci, associazione remora-spigola, Turchia

INTRODUCTION

Research on gill parasites in remoras (Echeneidae) is scarce. A remarkable example of it is the study of the complex relationship between a monogenean (*Dionchus* sp.), a shark (*Carcharhinus limbatus* (Müller & Henle, 1839)), and a remora (*Echeneis naucrates* Linnaeus, 1758) (Figure 3 in Bullard *et al.*, 2000). So far there have been very few records of caligid copepods on *E. naucrates* (e.g., Wilson, 1905; Causey, 1953; Cressey, 1991), none of them *Caligus minimus* Otto, 1821. We report herein on a *C. minimus* attached to the gills of the slender sharksucker *Echeneis naucrates* and the association between this remora species and the European seabass *Dicentrarchus labrax* (Linnaeus, 1758) in a brackish lagoon of the South Aegean Sea, Turkey.

Caligus minimus is a widespread oioxenous species, i.e., it has a wide range of hosts (Öktener & Trilles, 2009; Boualleg *et al.*, 2011; Tanrıkul & Perçin, 2012; Hafir-Mansouri *et al.*, 2017). It is found on gills, mouth, or body surface of the hosts, and is able to live in brackish waters (Fonsêca *et al.*, 2000; Tanrıkul & Perçin, 2012; Yalım *et al.*, 2014). *Echeneis naucrates* is cosmopolitan and may live free-swimming or attached to a variety of fish hosts, including sharks, rays, bony fishes, sea turtles, dolphins, and whales (Strasburg, 1964; O'Toole, 2002; Brunnschweiler & Sazima, 2008, 2010; Santos & Sazima, 2008), and is able to live in brackish waters (Akyol & Balık, 2007; Santos & Sazima, 2008; Marletta & Lombardo 2020). *Dicentrarchus labrax* inhabits the Eastern Atlantic and the Mediterranean (Freyhof & Kotellat, 2008), is eurythermic (5–28 °C) and euryhaline (3‰ to full strength seawater), which allows it to dwell in coastal inshore waters, estuaries, and in brackish water (Bagni, 2005).

MATERIAL AND METHODS

A specimen of *Echeneis naucrates* attached to a *Dicentrarchus labrax* was caught in a fish trap in the Köyceğiz-Dalyan Lagoon (36.824967 N, 28.632510 E, 0 m a.s.l., 5 m depth) on the shores of the South Aegean Sea during parasitological surveys conducted by the first author in 2019. Parasites were removed from the gill rakers of the sharksucker, fixed in 4% formaldehyde and preserved in 70% ethanol. The copepod specimens were cleared in pure lactic acid for a minimum of 24 h and later dissected under a Wild M5, Leica M140 stereo-microscope. Photos were taken with the aid of a Canon camera (EOS 1100D) connected to the microscope. Measurements were recorded in millimetres. The appendages were measured using a micrometric programme (Pro-way). Identification and terminology follows Kabata (1979) and Öktener *et al.* (2017).

RESULTS

Subclass Copepoda Milne Edwards, 1840
Order Siphonostomatoidea Thorell, 1859

Family Caligidae O.F. Müller, 1785

Caligus minimus Otto, 1821 (Figs. 1–3, Tab. 1)

Female morphology (Fig. 1): Body length 3.014 mm; width 1.335 mm. Cephalothorax longer than wide. Fourth pediger a little longer than wide. Genital complex longer than wide. First abdominal segment longer than wide. Caudal ramus longer than wide. Exopod of first leg with two middle setae carrying narrow flanges at apices. Antennule (Fig. 2a) two-segmented; distal segment longer than proximal, distal segment bearing 12 setae and 1 subterminal seta on ventral margin, the proximal segment armed with 23 plumose setae. Antenna (Fig. 2b) 3-segmented; first segment features small; second segment nearly quadrangular; third segment long, distally strongly bent curved claw; subchela with a small seta. Postantennal process (Fig. 2b) smaller than antenna. Postantennal process slightly curved, carrying 3 papillae, each with 3 sensillae. Mandible (Fig. 2c) tip with 12 teeth. Maxillule (Fig. 2d) bearing a papilla with 3 unequal setae. Maxilla (Fig. 2e) two-segmented; proximal segment large and unarmed; slender distal segment with hyaline membrane on outer margin and tipped distally with 2 unequal processes. Maxilliped (Figs. 2f, g) proximal segment (corpus) the largest; distal two segments fused to form a claw carrying a small seta at base of claw. Tines of sternal furca (Fig. 2h) slightly curved inward. Caudal rami (Fig. 2i) with 3 long and 3 short setae. Shapes from first leg to fourth leg presented in Figs. 3a–3d, the formula from first leg to fourth leg in Tab. 1.



Fig. 1: *Caligus minimus* ♀ **habitus** (scale 1 mm) found fastened to gill filaments of *Echeneis naucrates* attached to *Dicentrarchus labrax* host (Photo: A. Öktener).

Sl. 1: *Caligus minimus* ♀ (merilo 1 mm) na škvrnih filamentih prilepa *Echeneis naucrates*, pritrjenega na brancina (*Dicentrarchus labrax*) (Foto: A. Öktener).

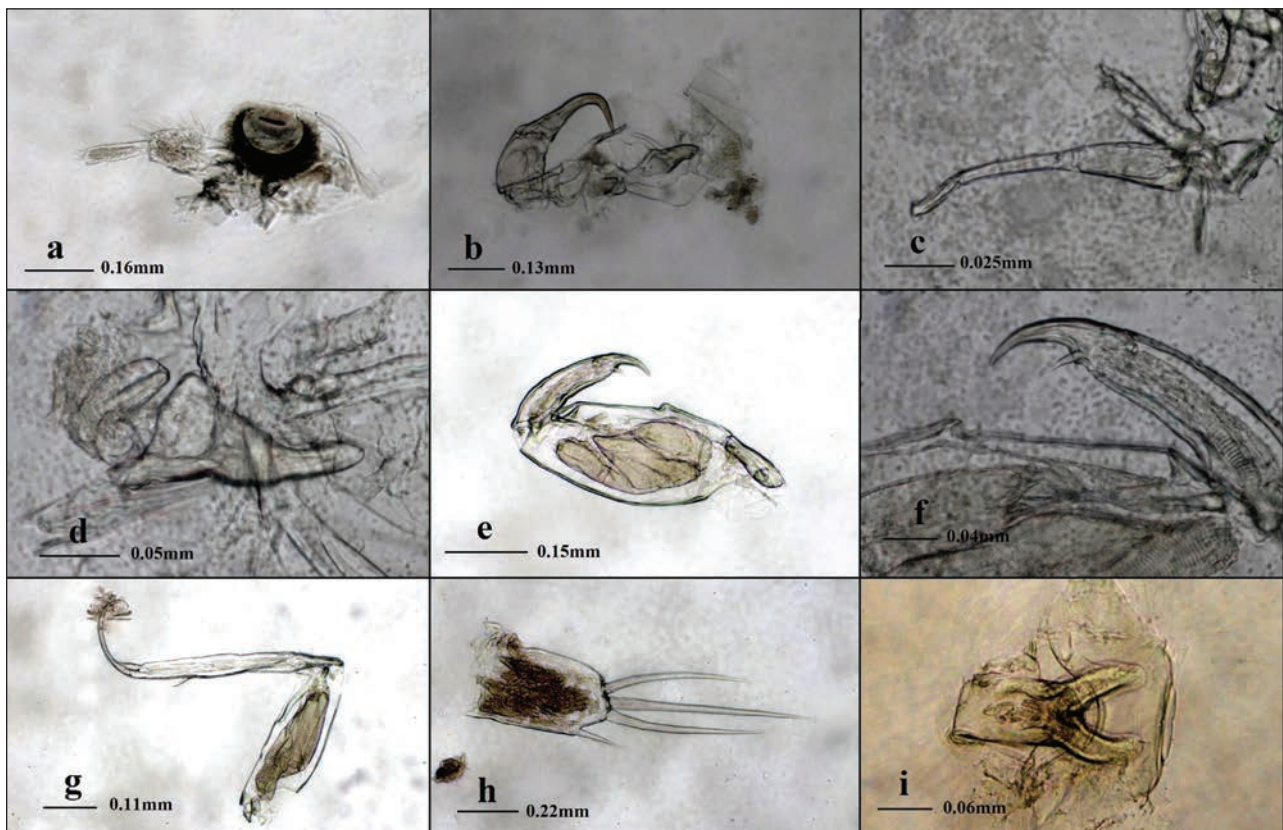


Fig. 2: *Caligus minimus* ♀ a) antennule, b) antenna and postantennal process, c) mandible, d) maxillule, e) maxilla, f) maxilliped, g) distal of maxilliped, h) sternal furca, i) caudal ramus (Photo: A. Öktener).

Sl. 2: *Caligus minimus* ♀ a) antenula, b) antenna in postantenski izrastek, c) mandibula, d) maksilula, e) maksila, f) maksiliped, g) distalni del maksilipeda, h) sternalna vilica, i) repni izrastek (Foto: A. Öktener).

The sharksucker *Echeneis naucrates* was about 30 cm total length (TL) with a slim brownish grey body, dark pectoral, pelvic, and caudal fins, and a barely visible darker stripe running from head to tail. The cephalic disk was about 6 cm long (20% of TL). The slim body, the colour, and the relative size of the cephalic disk are diagnostic of this remora species. Its stomach contents revealed no parasites. Its host, a sea bream *Dicentrarchus labrax*, measured about 60 cm TL and was sluggish, with wounds and intense mucus covering its body surface. We were unable to collect the sharksucker and the seabass, and we did not examine the seabass for parasites.

DISCUSSION

Our record of *C. minimus* raises to four the species of siphonostomatoid copepods found parasitising *Echeneis naucrates*. Previously, *Caligus praetextus* Bere, 1936 (Caligidae), *Tuxophorus caligodes* Wilson, 1908 (Tuxophoridae), and *Margolisius* cf. *abditus* (Lernaeopodidae) were reported from this remora species (Wilson, 1908; Cressey, 1991; Justine, 2010). *Margolisius abditus* Benz, Kabata & Bullard, 2000 was reported to have been found

on the gill lamellae of another remora species, *Remora remora* (Linnaeus) (Benz et al., 2000).

Fifteen species of parasitic copepods, including *C. minimus*, have been recorded for *Dicentrarchus labrax* (WoRMS, 2020). Incidentally, *D. labrax* is a new host for *E. naucrates* (O'Toole, 2002; Brunnenschweiler & Sazima, 2008, 2010). This remora species is uncommon in the Mediterranean and may occur in brackish lagoons (Akyol

Tab. 1: *Caligus minimus* ♀ setal and spinal formula from first to fourth leg.

Tab. 1: *Caligus minimus* ♀: formula ščetin in trnov od prve do četrte okončine.

Legs	Endopod	Exopod
First leg (Fig. 3a)	vestigial	I-0; IV-3
Second leg (Fig. 3b)	1-0; 2-0; 6-0	I-1; I-1; III-5
Third leg (Fig. 3c)	1-0; 6-0	I-0; I-1; III-4
Fourth leg (Fig. 3c)	absent	I-0; I, II

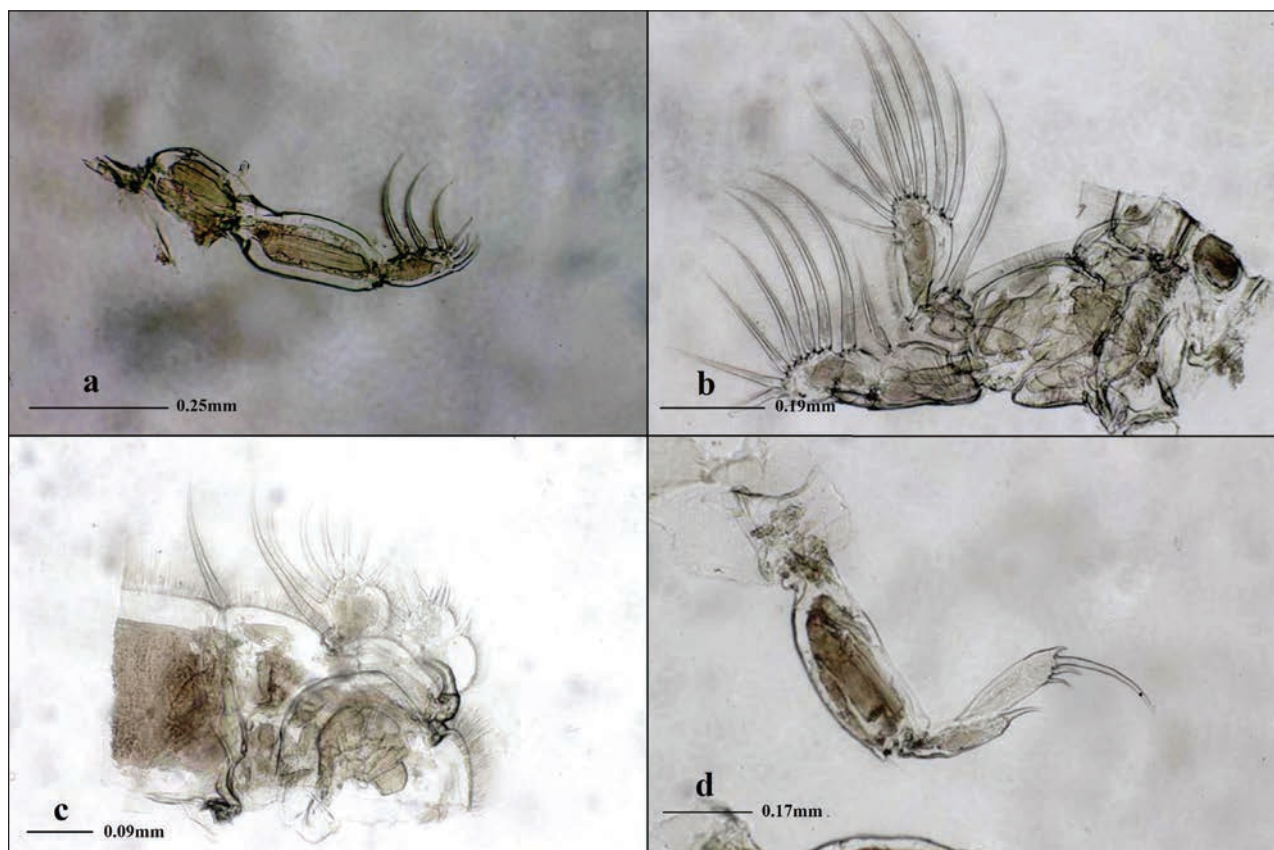


Fig. 3: *Caligus minimus* ♀ **a)** first leg, **b)** second leg, **c)** third leg, **d)** fourth leg (Photo A. Öktener).

Sl. 3: *Caligus minimus* ♀: **a)** prva okončina, **b)** druga okončina, **c)** tretja okončina, **d)** četrta okončina (Foto: A. Öktener).

& Balık, 2007; Marletta & Lombardo 2020). Thus, the occurrence of *C. minimus*, *E. naucrates*, and *D. labrax* in the brackish Köyceğiz-Dalyan Lagoon Lake matches the knowledge about salinity tolerance of all three organisms (Bagni, 2005; Akyol & Balık, 2007; Fonsêca *et al.*, 2010; Kyne, 2015; Marletta & Lombardo 2020). The wounds observed on the body of *D. labrax* could be due to infestation by *C. minimus* (Noor El-Deen *et al.*, 2013) or some other parasite, but we were unable to confirm this hypothesis.

We suggest that the presence of *C. minimus* on *E. naucrates* attached to *D. labrax* can be explained by two scenarios, which are not mutually exclusive: 1) the caligid fastened to the sharksucker when it fed on the parasites and the diseased or dead tissue of the seabass host; 2) the sharksucker swam freely in the lagoon without a host and picked up the caligid when it attached to the seabass. Our scenarios are supported by the biology of *E. naucrates*, as this remora lives free-swimming or attached to a host, from which it picks parasites and dead tissue, changing hosts from time to time (Strasburg, 1964; Cressey & Lachner,

1970; Brunschweiler & Sazima, 2008, 2010). Additionally, remoras may pick up parasites from a host and then transfer them to another host, as postulated by Bullard *et al.* (2000), which strengthens our suggestions above.

CONCLUSIONS

Our finding of the caligid copepod *C. minimus* on the gills of the slender sharksucker *E. naucrates* raises to four the *Caligus* species recorded on this remora species to date. The association of *E. naucrates* with the seabass *D. labrax* in a brackish lagoon is a new record for the Mediterranean Sea.

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CALIGUS MINIMUS (COPEPODA: CALIGIDAE), ZAJEDAVEC NA ŠKRGAH PRILEPA (*ECHENEIS NAUCRATES*), PRITRJENEGA NA BRANCINA (*DICENTRARCHUS LABRAX*) V LAGUNI KÖYCEĞİZ-DALYAN V EGEJSKEM MORJU, TURČIJA

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POVZETEK

Avtorja poročata o najdbi zajedavskega raka ceponožca vrste *Caligus minimus*, najdenega na škržnih ščetinah prilepa *Echeneis naucrates*, ki je bil pritrjen na brancina *Dicentrarchus labrax* iz brakične lagune Köyceğiz-Dalyan v južnem Egejskem morju (Turčija). Podajata morfološke znake samice raka ceponožca in slikovno gradivo. Pojavljanje zajedavskega ceponožca na prilepu in zajedanje slednjega na brancinu predstavlja nove podatke o teh odnosih. S pričujočimi podatki se je število zajedavskih vrst iz rodu *Caligus*, ki zajedajo prilepe, povečalo na 4. Nadalje avtorja razpravljata o pojavljanju prilepa na brancinu v brakičnem okolju na podlagi dveh scenarijih, ki se ne izključujeta.

Ključne besede: Caligidae, ribji zajedavec, združba prilep-brancin, Turčija

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