

PRESENCE OF *PENICULUS FISTULA FISTULA* AND *LEPEOPHTHEIRUS ACUTUS* FROM THE NORTH AEGEAN SEA, TURKEY

Ahmet Öktener and Dilek Türker

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Abstract: The parasitic copepod, *Peniculus fistula fistula* (Nordmann, 1832) is found on the caudal, ventral, pectoral, dorsal, anal, fins of garfish, *Belone belone* (Linnaeus, 1760), while *Lepeophtheirus acutus* (Heegaard, 1943) on the dorsal body surface of common guitarfish, *Rhinobatos rhinobatos* (Linnaeus, 1758) in the North Aegean Sea, Turkey on 2017. This study presents a new locality as Aegean Sea for *Lepeophtheirus acutus* (Heegaard, 1943) and a new host as garfish for *Peniculus fistula fistula* (Nordmann, 1832) in Turkey. This study confirms third report of *Peniculus fistula fistula* (Nordmann, 1832) in Turkey again.

Keywords: common guitarfish, garfish, *Lepeophtheirus acutus*, *Peniculus fistula fistula*, Turkey

Introduction:

The garfish, *Belone belone* (Linnaeus, 1760) (Beloniformes: Belonidae) is a fish species of important commercial value, distributed in Eastern Atlantic and Mediterranean Sea. It is carnivorous fish that feeds mainly on small fishes especially clupeids. It is pelagic-oceanic and oceanodromous fish (Froese and Pauly 2019).

Ten species of parasitic copepods (*Bomolochus bellones* Burmeister, 1833; *Bomolochus decapteri* Yamaguti, 1936; *Caligus belones* Krøyer, 1863; *Caligus elongatus* von Nordmann, 1832; *Caligus lacustris* Steenstrup and Lütken, 1861;

Caligus adanensis Özak, Sakarya and Boxshall, 2019; *Lepeophtheirus salmonis* Krøyer, 1837; *Lernaeolophus sultanus* Milne Edwards, 1840; *Metopocatacoteinus hirsutus* Hesse, 1871; *Nothobomolochus gibber* Shiino, 1957) from *Belone belone* have been listed by WoRMS Editorial Board (2019). In addition, Vidjak et al. (2008) reported *Peniculus fistula* ectoparasite on garfish in the Mediterranean Sea. *Bomolochus bellones* and *Caligus adanensis* was reported only for parasitic copepod fauna of garfish in Turkey (Öktener et al. 2015; Özak et al. 2019).

The common guitarfish, *Rhinobatos rhinobatos* (Linnaeus, 1758) (Rhinopristiformes: Rhinobatidae) is a

Ahmet Öktener:

Bandirma Sheep Research Station
Department of Fisheries
Çanakkele Street 7km, Bandirma
Balıkesir 10200, Turkey

e-mail (for all authors):
ahmetoktener@yahoo.com

Dilek Türker:

Faculty of Science
Department of Biology
University of Balıkesir
Campus of Çağış
Balıkesir 10145, Turkey

demersal elasmobranch fish species. It is carnivorous fish that feeds on benthic invertebrates, mainly crustaceans and small fishes; it occurs in Eastern Atlantic Ocean and Mediterranean Sea (Froese and Pauly 2019).

Two species of parasitic copepods (*Eudactylina rhinobati* Raibaut and Essafi, 1979; *Lepeophtheirus acutus* Heegaard, 1943) from the common guitarfish were listed by WoRMS Editorial Board (2019).

This study contributes new geographic distribution for *Lepeophtheirus acutus* and *Peniculus fistula fistula* and also confirms the occurrence of *Peniculus fistula fistula* in Turkish marine waters.

Materials and methods:

Thirteen specimens of garfish (32.5-46.5 cm in total length) were collected by fishing rod and 2 specimens of common guitarfish (95 and 97 cm in total length) by trammel net from the Edremit Bay (North Aegean Sea, Turkey) in 2014 and 2016. Specimens of copepods recovered from the hosts were fixed in 4% formaldehyde and preserved for long-term storage in 70% ethanol. They were cleared in lactic acid and their appendages were dissected out by using Wild M5, Leica M140 stereo microscope. Dissected parts were mounted on slides in glycerin-gelatine mounting medium. The photos were taken with the aid of Canon camera (EOS 1100D) connected to a microscope. The appendages were drawn with the aid of a camera lucida (Olympus BH-DA). All measurements are in millimeters. Scientific names, synonyms of the parasite and the host were checked through WoRMS Editorial Board (2019) and Froese and Pauly (2019). Identifications were done according to Boxshall (1986), Vidjak et al. (2008), Venmathi Maran et al. (2012), Moon and Choi (2014) for *Peniculus fistula* and Tang et al. (2013), Özak et al. (2018), Boxshall (2018) for *Lepeophtheirus acutus*.

Results and discussion:

Siphonostomatoida Burmeister, 1835
Caligidae Burmeister, 1835
Lepeophtheirus von Nordmann, 1832
Lepeophtheirus acutus Heegaard, 1943
(Figs. 1-7, Annexes)

Host: The common guitarfish, *Rhinobatos rhinobatos* (Linnaeus, 1758)

Infestation site: dorsal surface of body

Examined fish: 2

Infested fish: 2

Number of total parasite: 519 (449 female, 70 male)

Prevalence: 100%

Mean intensity: 260.5

Female morphology:

Cephalothoracic shield subcircular, longer 1.46 mm (1.39-1.53) than width 1.34 mm (1.28-1.4) and posterior margin of thoracic zone extending beyond posterior edges of lateral zone. Fourth pedigerous somite wider 0.29 mm (0.27-0.33) than length 0.16 mm (0.15-0.2) and distinctly separated from genital complex. Genital complex wider 0.77 mm (0.67-0.82) than length 0.68 (0.65-0.72), with slightly oblique of anterior margins and rounded posterolateral corners. Abdomen with 1-segmented, length 0.22 mm (0.18-0.26) is close to width 0.22 mm (0.19-0.25) and indistinctly separated from genital complex. Caudal ramus longer 0.054 mm (0.049-0.068) than wide 0.042 mm (0.033-0.048), with six plumose setae and row setules along distomedial margin. Egg sacs is 1.57 mm (1.46-1.71) long and 0.22 mm (0.22-0.24) wide. Antennule two-segmented; proximal segment longer than distal segment, bearing two posterodistal processes and 27 setae (25 plumose, two naked); distal segment slim, bearing 12 setae (two setae near posterodistal corner share a common base) and two aesthetascs. Antenna three-segmented, proximal segment bearing with spiniform process in posterior; middle segment with adhesion pad; distal segment produced strongly curved claw with seta

proximally and another seta in mid-section. Postantennal process slightly curved, with two setulose papillae in inner section of base and one setulose papilla in out of base. Mandible bearing 12 teeth in distomedial section. Maxillule composed of papilla bearing 3 unequal setae at dentiform process, anterior sclerite projects over base of dentiform process. Sternal furca with slightly divergent tines, apically rounded, shorter than box. Maxilliped three-segmented, proximal segment (corpus) and subchela consisting shaft and claw; proximal segment unarmed; claw with seta at base.

Male morphology:

Cephalothoracic shield subcircular, longer 0.93 mm (0.87-0.96) than width 0.81 mm (0.75-0.87). Fourth pedigerous somite wider 0.18 mm (0.16-0.19) than length 0.08 mm (0.069-0.099). Genital complex little wider 0.29 mm (0.27-0.31) than length 0.28 mm (0.25-0.31). Abdomen with 1-segmented, wider 0.15 mm (0.14-0.16) than long 0.13 mm (0.11-0.14). Caudal ramus longer 0.068 mm (0.059-0.074) than wide 0.05 mm (0.044-0.0588), with six plumose setae and row setules along distomedial margin. Antenna three-segmented, comprising coxa, basis and one-segmented endopod incorporating distal claw; coxa with corrugated adhesion pad on inner surface; basis with a large and a small corrugated pads; distal segment forming recurved claw and 2 unequal claw-like processes, plus 2 setae. Maxillule with corrugated pad and a small knob on dentiform process. Postural process elongated, with corrugated pad. Leg 5 with four plumose setae situated mid-laterally on genital complex. Leg 6 with one seta and two subequal, spiniform processes on distolateral corner.

Geographical Distribution:

Apamama Island, Gilbert Islands, western Pacific Ocean (Heegaard 1943); Tropicarium Hagenbeck in Germany, Burger's Zoo in the Netherlands (Kik et al. 2011); Okinawa-jima Island, Japan (Tang et al.

2013); Campeche, in the southern Gulf of Mexico (Rodriguez-Santiago et al. 2016); North-eastern Mediterranean waters between Tuzla and Karataş (Özak et al. 2018); Moreton Bay, Queensland, Australia (Boxshall 2018).

Hosts:

Taeniura lymma (Heegaard 1943); *Carcharhinus amblyrhynchos*, *Carcharhinus melanopterus*, *Triaenodon obesus*, *Pteroplatytrygon violacea*, *Glaucostegus typus*, *Stegostoma fasciatum* (Kik et al. 2011); *Rhincodon typus*, *Mobula alfredi* (Tang et al. 2013); *Aetobatus narinari* (Rodriguez-Santiago et al. 2016); *Aetobatus ocellatus* and *Maculabatis astra*, *Himantura cf. astra* (Boxshall 2018); *Rhinobatos rhinobatos*, *Aetomylaeus bovinus* (Özak et al. 2018).

Remarks:

Lepeophtheirus acutus is very closely similar to *Lepeophtheirus rhinobati*. The main point of difference is that "accessory processes on spines 2 and 3 on distal margin of exopod of leg 1 only just extending beyond apex of spine" in *Lepeophtheirus acutus* according to Özak et al. (2018). Although Özak et al. (2018) found female abdomen about 1.8 times longer than wide in *Lepeophtheirus acutus*, abdomen length is close the width in this study. Especially, the morphological extrimities of mouth-parts of specimens found in this study have been compared to the findings presented by Özak et al. (2018), Tang et al. (2013). The morphology of specimens collected in this study was consistent with these literatures concerning *Lepeophtheirus acutus*.

Siphonostomatoida Burmeister, 1835

Pennellidae Burmeister, 1835

Peniculus Nordmann, 1832

Peniculus fistula fistula Nordmann, 1832 (Fig. 8, Annexes)

Host: The garfish, *Belone belone* (Linnaeus, 1760)

Infestation site: fins

Examined fish: 30

Infested fish: 13

Number of total parasites: 17

Prevalence: 43.33%

Mean intensity: 1.3

Geographical Distribution:

Peniculus fistula is reported from Mediterranean, Atlantic and Indo-Pacific, Adriatic Sea (Vidjak et al. 2008) and also Sea of Marmara (Öktener and Şirin 2019).

Hosts:

Zeus faber (Nordmann 1832), *Pseudopercis semifasciata* (Claus 1868); *Lampris guttatus* (Brian 1898); *Atherina boyeri*, *Diplodus vulgaris* and *Zeus faber* (Brian 1906); *Diplodus annularis* (Brian 1917); *Girella nigricans* and *Hypsypops rubicundus* (MacGinitie 1937; Wilson 1935); *Mullus barbatus barbatus*, *Mullus surmuletus*, *Capros aper* and *Pagellus erythrinus* (Delamare Deboutteville and Nunes Ruivo 1951); *Trachurus trachurus* and *Trachurus picturatus* (Candeias 1955); *Pagellus bogaraveo* and *Pagellus erythrinus* (Gooding 1957); *Synagrops microlepis* (Capart 1959); *Pagellus erythrinus* (Larraneta 1964); *Lithognathus mormyrus* (Zuniga and Suau 1967); *Anisotremus scapularis*, *Cheilotrema saturnum*, *Medialuna californiensis*, *Micrometrus minimus*, *Brachyistius frenatus*, *Hypsurus caryi*, *Atherinops affinis*, *Embiotoca jacksoni*, *Rhacochilus toxotes*, *Rhacochilus vacca*, *Phanerodon furcatus*, *Trachurus symmetricus* and *Anisotremus davidsonii* (Hobson 1971); *Cymatogaster aggregata*, *Embiotoca jacksoni*, *Paralabrax clathratus*, *Paralabrax nebulifer*, *Phanerodon furcatus* and *Hypsurus caryi* (Love and Moser 1983); *Xenistius californiensis* (Sikkel 1985); *Liza richardsonii*, *Pagellus erythrinus* and *Scorpius lineolata* (Boxshall 1986); *Prolatilus jugularis* (Sepúlveda et al. 2004); *Pagrus*

(Ramdane and Trilles 2007); *Belone belone* (Vidjak et al. 2008); *Boops boops* (Zuniga and Suau 1967; Olmo et al. 2008); *Coryphaena hippurus* (Öktener 2008); *Pagellus bogaraveo* (Hermida et al. 2013a, 2013b); *Chromis notata* (Moon and Choi 2014); *Cheilotrema fasciatum*, *Chromis crusma*, *Girella laevifrons*, *Hemilutjanus macrophthalmus*, *Isacia conceptionis*, *Mugil cephalus*, *Odonthesthes regia*, *Prolatilus jugularis* (Castro-Romero et al. 2016), *Mullus surmuletus* (Öktener and Şirin 2019).

Remarks:

Examination of the parasite specimens showed that they were *Peniculus fistula fistula* Nordmann, 1832 (Pennellidae) according to the general drawings and descriptions such as the proportions of cephalothorax, neck, trunk, abdomen, egg sacs, mouth parts (antenna, maxilla, maxillule), the distance between legs given by Boxshall (1986), Vidjak et al. (2008), Venmathi Maran et al. (2012), Moon and Choi (2014).

Rezumat:

PREZENȚA SPECIILOR *PENICULUS FISTULA FISTULA* ȘI *LEPEOPHTHEIRUS ACUTUS* ÎN NORDUL MĂRII EGEE, TURCIA

Copepodul parazit *Peniculus fistula fistula* (Nordmann, 1832) a fost găsit în 2017 în Nordul Mării Egee, Turcia, pe zărgan, *Belone beone* (Linnaeus, 1760), în zonele caudală, ventrală, pectorală, dorsală, anală și aripioare, în timp ce *Lepeophtheirus acutus* (Heegaard, 1943) pe *Rhinobatos rhinobatos* (Linnaeus, 1758). Acest studiu prezintă o nouă locație pentru *Lepeophtheirus acutus* (Heegaard, 1943) în Marea Egee și zărganul ca gazdă nouă pentru *Peniculus fistula fistula* (Nordmann, 1832), în Turcia. Studiul confirmă a treia semnalare a lui *Peniculus fistula fistula* (Nordmann, 1832) în Turcia.

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Annexes:

Figure no. 1 *Lepeophtheirus acutus* (left: male; right: female)



Figure no. 2 *Lepeophtheirus acutus* ♀: a) antennule (0.12 mm); b) antenna and postantennal process (0.12 mm); c) mandible (0.20 mm); d) maxilla (0.13 mm); e) maxilliped (0.11 mm); f) maxillule (0.27 mm); g) caudal ramus (0.07 mm); h) sternal furca (0.12 mm)

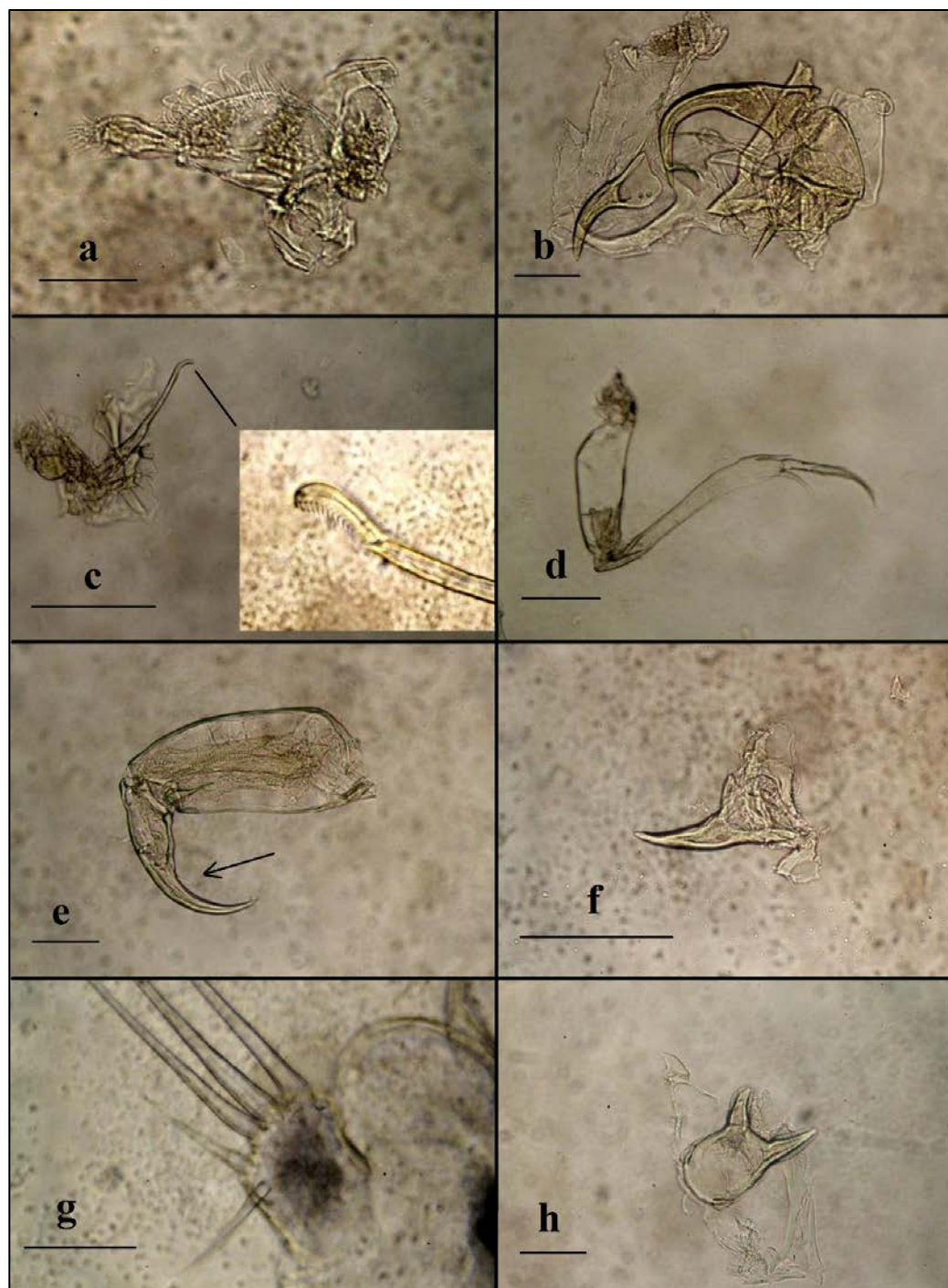


Figure no. 3 *Lepeophtheirus acutus* ♀: a) antennule (0.06 mm); b) antenna (0.06 mm); c) postantennal process (0.08 mm); d) maxillule (0.13 mm); e) sternal furca (0.12 mm); f) maxilliped (0.11 mm); g) maxilla (0.13 mm); h) caudal ramus (0.07 mm); i) fifth leg (0.03 mm)

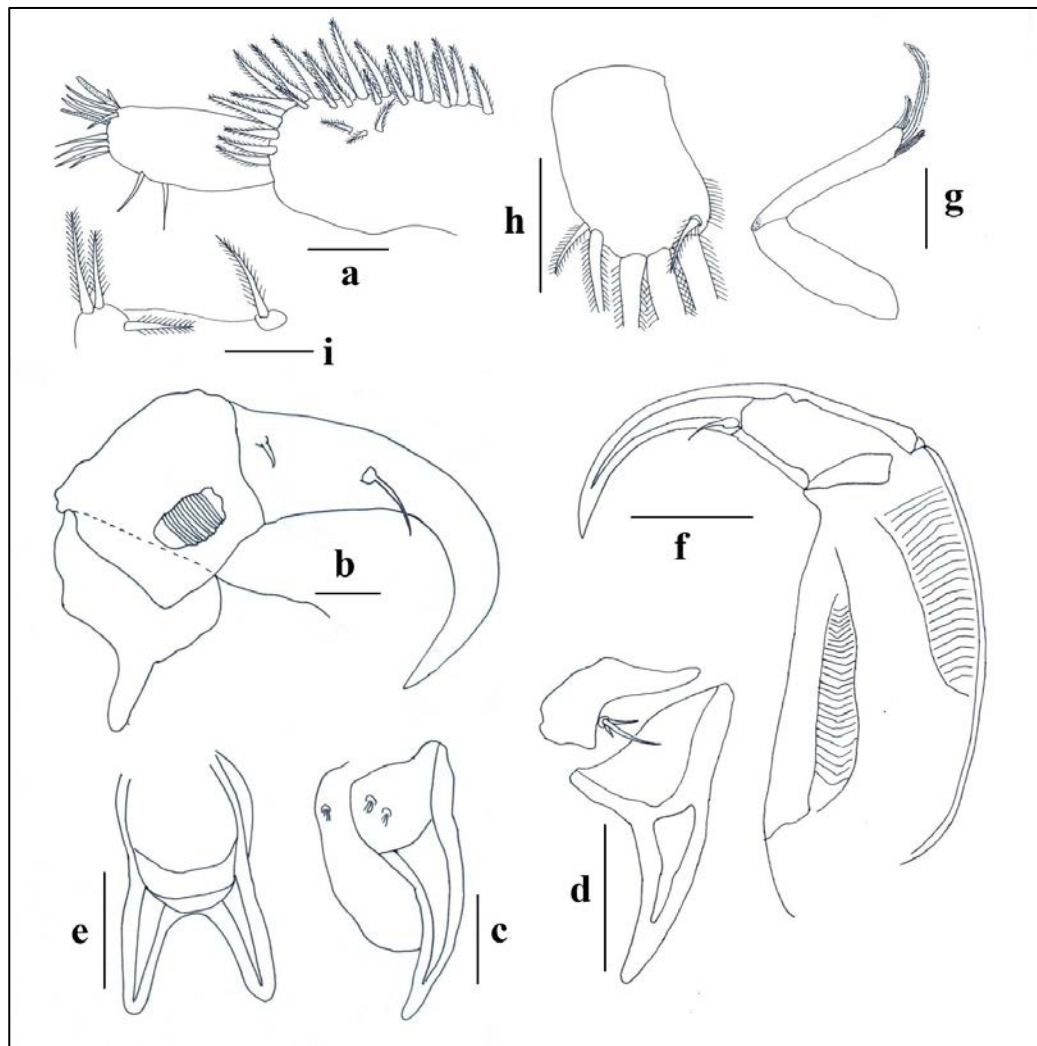


Figure no. 4 *Lepeophtheirus acutus* ♀: a) first leg (0.10 mm); b) exopod of first leg; c) second leg (0.07 mm); d) denticular ornamentation on outer margin of first endopodal segment of leg 2; e) fourth leg (0.11 mm); f) fifth leg (0.03 mm)

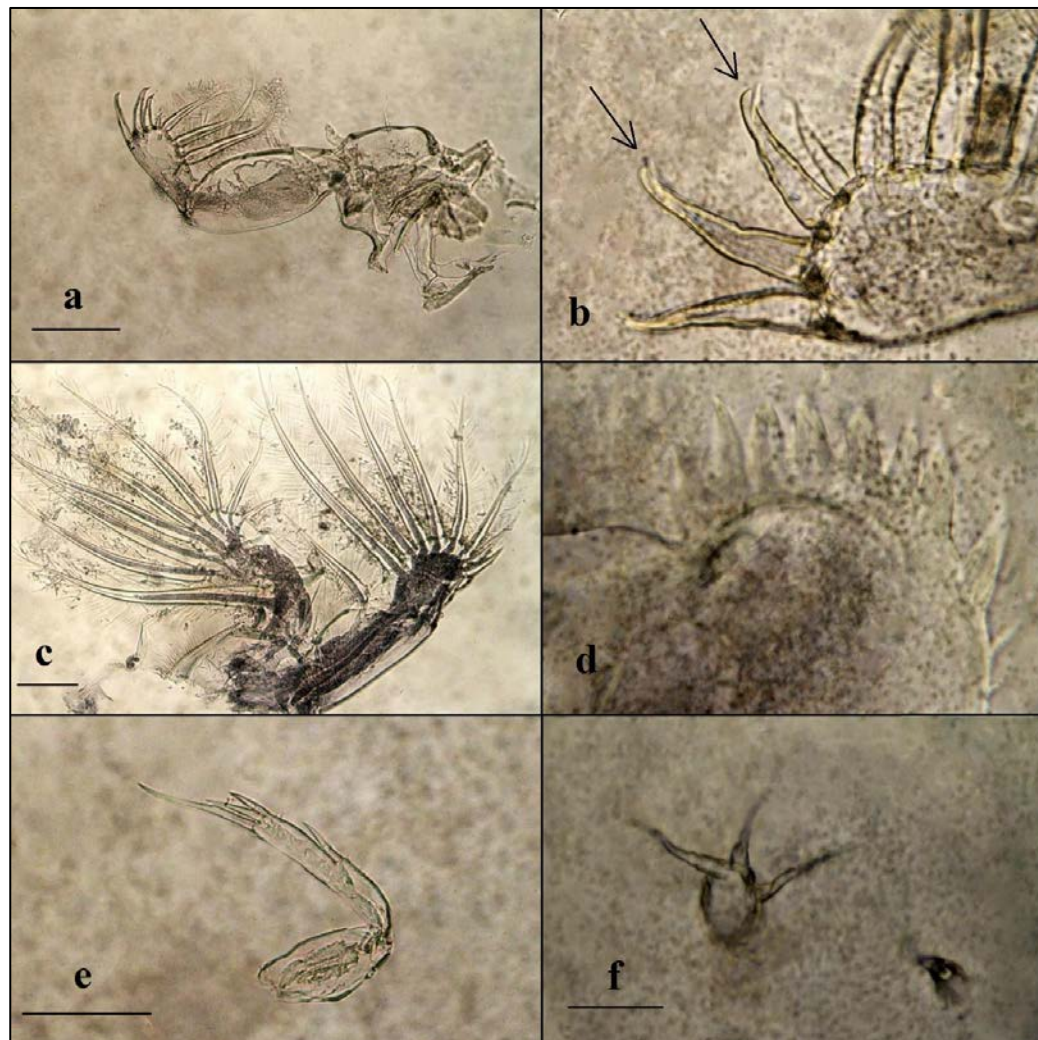


Figure no. 5 *Lepeophtheirus acutus* ♀: a) first leg (0.10 mm); b) second leg (0.07 mm); c) third leg (0.06 mm); e) fourth leg (0.07 mm); f) mandible (0.05 mm)

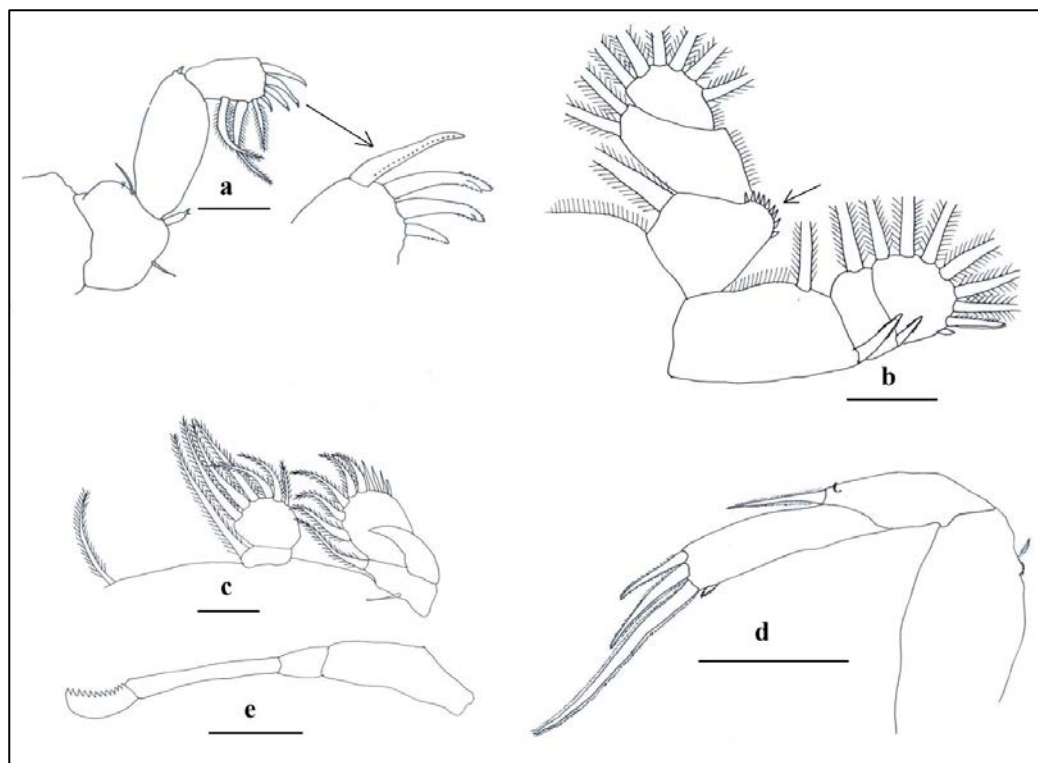


Figure no. 6 *Lepeophtheirus acutus* ♂: a) second antenna (0.10 mm); b) sternal furca (0.10 mm); c) maxillule (0.14 mm); d) fifth leg (0.15 mm)

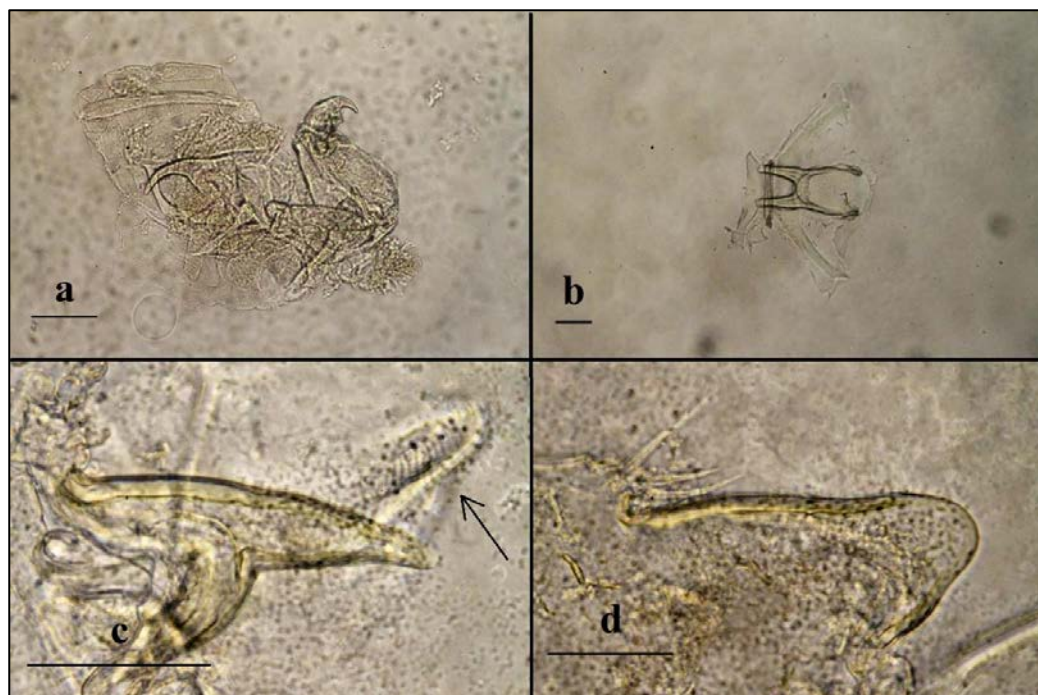


Figure no. 7 *Lepeophtheirus acutus* ♂: a) second antenna (0.05 mm); b) maxillule (0.14 mm); c) fifth leg (0.08 mm)

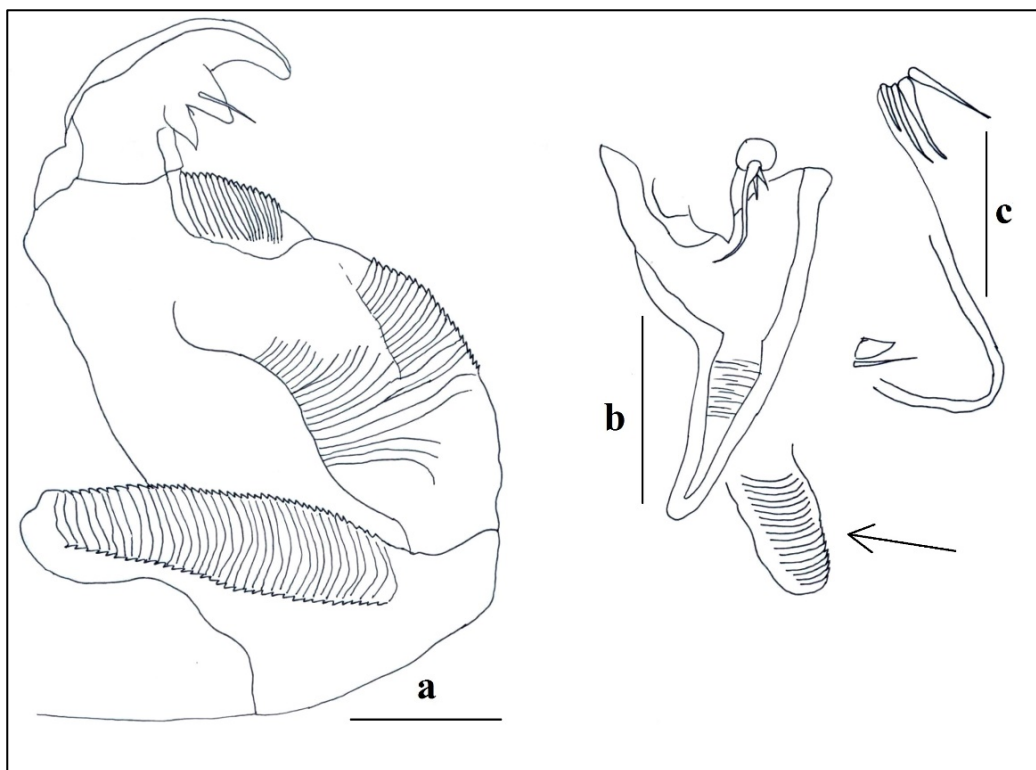


Figure no. 8 a) *Peniculus fistula fistula*; b, c, d) *Peniculus fistula fistula* on caudal fin of garfish; e, f) *Peniculus fistula fistula* on ventral fin of garfish

