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FINDING OF *PSEUDOBACCIGER HARENGULAE* (DIGENEA, FAUSTULIDAE) IN THE MEDITERRANEAN HORSE MACKEREL, *TRACHURUS MEDITERRANEUS* (ACTINOPTERYGII, CARANGIDAE), FROM THE GULF OF ODESSA, BLACK SEA, UKRAINE

Bohdan Hulak[1,2], Yuriy Kvach[3,4]

[1]*Odessa Center of Southern Scientific Research Institute of Marine Fisheries and Oceanography, vul. Mechnykova, 132, Odesa, 65028 Ukraine*
[2]*Department of Hydrobiology and General Ecology, Odessa I. I. Mechnikov National University, vul. Dvorianska, 2, Odesa, 65082 Ukraine*
[3]*Institute of Vertebrate Biology, Academy of Science of the Czech Republic, v. v. i., Květná / 8, 60365 Brno, Czech Republic;*
E-mail: yuriy.kvach@gmail.com
[4]*Institute of Marine Biology, NAS of Ukraine, vul. Pushkinska, 37 Odesa, 65011 Ukraine*

Finding of *Pseudobacciger harengulae* (Digenea, Faustulidae) in the Mediterranean Horse Mackerel, *Trachurus mediterraneus* (Actinopterygii, Carangidae), from the Gulf of Odessa, Black Sea, Ukraine. Hulak, B., Kvach, Y. — *Pseudobacciger harengulae* (Yamaguti, 1938) is a parasite of herrings (Actinopterygii, Clupeidae) in both Atlantic and Pacific oceans. We record this parasite from the gut of *Trachurus mediterraneus* (Steindachner, 1868) (Actinopterygii, Carangidae) from the Gulf of Odessa, Black Sea, Ukraine. A description and images of the specimens are provided. This is the first record of *P. harengulae* in a carangid fish, and the second record of accidental infestation of *T. mediterraneus* with faustulid flukes in the Black Sea.
Key words: Black Sea, Digenea, *Pseudobacciger*, *Trachurus*, new records, new host.

Introduction

At present time, a total of 13 faustulid fluke genera (Digenea, Faustulidae) comprising 81 species, are known to parasitise marine and brackish water fish (Bray, 2008; Cribb & Gibson, 2010). In Atlantic waters, nine species in six genera are described (Bray et al., 2016), while only four species from two genera are known from the Mediterranean Sea (Pérez-del-Olmo et al., 2016). Six species of faustulids are described from the Black Sea fishes, namely *Bacciger bacciger* (Rudolphi, 1819), *B. grandispinatus* Naidenova, 1970, *B. israelensis* Fischthal, 1980, *B. minutus* Gaevskaja & Naidenova, 1996, *Pronoprymna ventricosa* (Rudolphi, 1819), and *Pseudobacciger harengulae* (Yamaguti, 1938) (Naidenova, 1974; Dimitrov & Bray, 1994; Gaevskaya & Naidenova, 1996; Dimitrov et al., 1999; Bray, 2008).

Two species of horse mackerels (Actynopterygii, Carangidae), the Atlantic horse mackerel, *Trachurus trachurus* Linnaeus, 1758, and the Mediterranean horse mackerel, *Trachurus mediterraneus* Steindachner, 1868 (=*Trachurus mediterraneus ponticus* Aleev, 1956), are known from the Black Sea (Yankova et al., 2014). The Mediterranean horse mackerel (*T. mediterraneus*) is widespread and commercially important fish species in the Black Sea region and adjacent waters (Turan, 2004). Also, it is a common species in the North-Western Black Sea, including the Gulf of Odessa (Vinogradov & Khutornoy, 2013).

The parasite fauna of the Mediterranean horse mackerel in Europe consists of one species of Apicomplexa, four species of myxozoans, five Monogenea, 26 Digenea, seven Cestoda, two Acanthocephala, 10 Nematoda, and five Crustacea (Costa et al., 2017). Twenty-six digenean species are known in this host in the Black Sea (Gaevskaya, 2012; Kornyychuk et al., 2016; Costa et al., 2017, and references herein). However, the data about the parasites of the Mediterranean horse mackerel in the Gulf of Odessa are absent. The aim of our study was to confirm the presence of digeneans in the Mediterranean horse mackerel (*T. mediterraneus*) in the Gulf of Odessa, Ukraine, and to clarify their taxonomic status.

Material and methods

The fish sampling was carried out by angling in June 2015 in the Gulf of Odessa (46.408675 N, 30.762139 E), Black Sea, from seawalls and piers, at depth of ~1.5 m. Seven individuals of Mediterranean horse mackerels were caught. The live fish were immediately placed in aerated buckets with the water from the sampling locality, then transported to the laboratory of the Institute of Marine Biology where they were held in an aerated aquarium.

The fish were dissected within 48 hrs. as recommended by Kvach et al. (2016). The digeneans were isolated from the gut, washed in saline and fixed with hot 4% formalin (Cribb & Bray, 2010). The preserved digenean samples were stained with iron acetic carmine and mounted in Canada balsam (Georgiev et al., 1986).

Six specimens were studied for morphology and identification to the species level. The slides were examined under a Olympus BX50 light microscope equipped with phase contrast, differential interference contrast and the Olympus MicroImage™ Digital Image Analysis software (Olympus Optical Co.). All measurements were provided using ImageJ on Ubuntu. The length and width of the body, suckers, pharynx, testes, ovary, vitellarium and eggs were measured in μm. The species identification was provided in accordance with the description of Dimitrov et al. (1999).

Results

One of the seven fish sampled was infected with six specimens of *Pseudobacciger harengulae* (Yamaguti, 1938), sited in central part of the intestine. Only one of the flukes was adult, while five were pre-adult, but with formed reproductive organs. We provide the brief description of the specimens found.

Pseudobacciger harengulae (Yamaguti, 1938) (fig. 1)

Host: *Trachurus mediterraneus* (Steindachner, 1868).
Site of infection: intestine.
Locality: Gulf of Odessa, North-Western Black Sea.

Body oval (table 1; see fig. 1, A–B). Tegument covered with spines. Oral sucker globular, ventrally subterminal, its posterior part hiding prepharynx and anterior part of pharynx, slightly smaller than ventral sucker. Ventral sucker slightly transversely elongate, almost entirely embedded in body. Gland-cells not observed.

Prepharynx not visible; pharynx oval. Oesophagus short, usually of same length as pharynx, or slightly longer. Caecal bifurcation anterior to ventral sucker. Caeca tubular, arcuate, posterior regions slightly widened, partly overlapping testes, reaching to posterior margin of testes or beyond. Excretory pore terminal; excretory vesicle V-shaped.

Genital pore median, between ventral sucker and intestinal bifurcation. Genital atrium not clearly seen but apparently short. Testes dorso-lateral, symmetrically located at mid-body level. Cirrus-sac absent, pars prostatica and prostatic cells not observed. Seminal vesicle voluminous, bipartite (see fig. 1, C), parts in tandem, anterior part larger than posterior, oval or round, located at level of ventral sucker, posterior part also oval or round,

Table 1. Morphometric parameters of *Pseudobacciger harengulae* ex *Trachurus mediterraneus* from the Gulf of Odessa, Black Sea

Morphometric parameters, μm	Adult (n = 1)	Pre-adults (n = 5)
Body length	263	216 (196–243)
Body width	198	136 (114–175)
Oral sucker	40 × 45	39 (38–45) × 39 (34–44)
Ventral sucker	51 × 60	39 (37–42) × 39 (37–41)
Sucker ratio	1 : 1.3 × 1 : 1.5	1 : 1 × 1 : 1 (1 : 1–1.1)
Pharynx	25 × 25	24 (19–29) × 23 (22–23)
Testes	35 × 35	34 (23–41) × 26 (20–36)
Ovary	47 × 49	30 (31–50) × 21 (23–32)
Vitellarium	59 × 38	42 (32–47) × 26 (21–30)
Eggs	22 (19–24) × 12 (10–15)	–

Note. All parameters present as mean (minimum–maximum), "–" — data are absent.

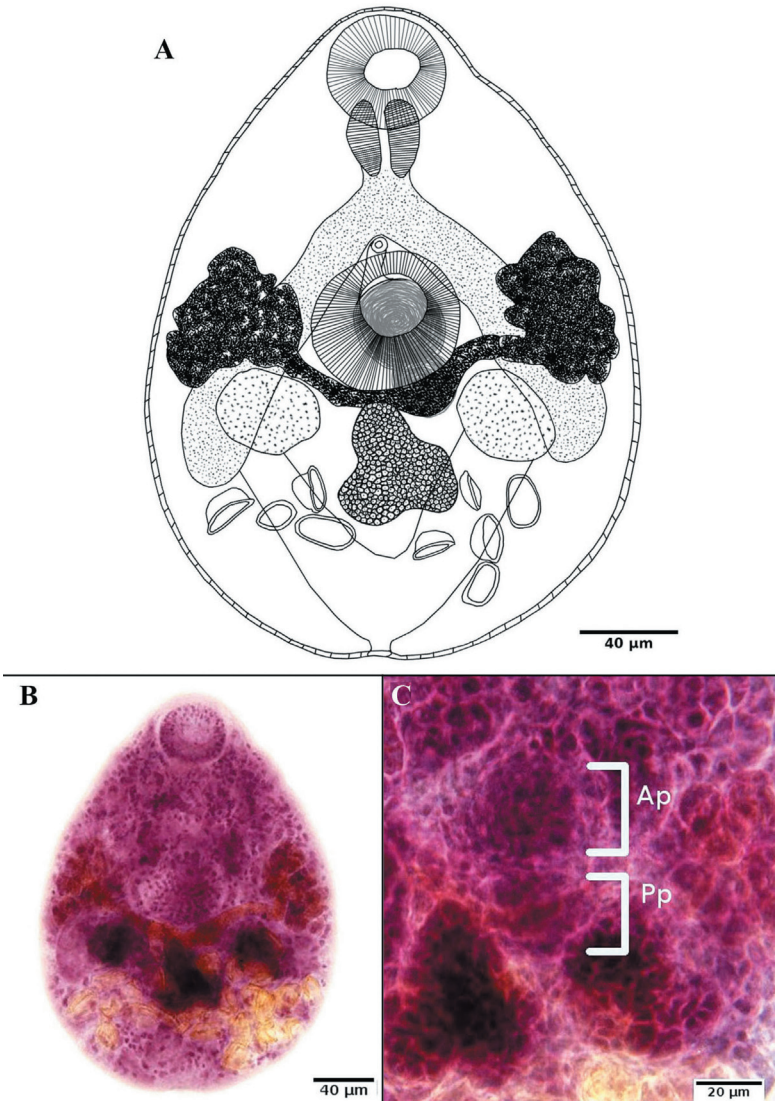

Fig. 1. *Pseudobacciger harengulae* ex *T. mediterraneus* from the Gulf of Odessa, Black Sea. A — total view of adult (drawing); B — photograph of adult; C — seminal vesicle: Ap — anterior part, Pp — posterior part.

at level of posterior margin of ventral sucker or extending beyond. Ovary 3-lobed, between testes, slightly larger or equal to testes in size, partly post-testicular. Seminal receptacle ventral or ventro-lateral to ovary on either side, almost as large as posterior part of seminal vesicle. Vitellarium follicular, in two lateral, compact clusters located marginally at level of ventral sucker. Uterus in hindbody. Eggs oval, thick-shelled.

Discussion

The present study is the first record of *Pseudobacciger harengulae* in the Mediterranean horse mackerel (*T. mediterraneus*), and also, this is the first report of this species in the Gulf of Odessa of the Black Sea.

Morphologically, our specimens are most similar to *P. harengulae* from the European anchovy (*Engraulis encrasicholus* L., 1758) from the Bulgarian coast of the Black Sea described by Dimitrov et al. (1999). Gland-cells were observed in the anterior part of the body in the Bulgarian specimens but not in our specimens. This confirms the observation that the gland-cells cannot be observed in some cases, as was described for specimens collected from the Atlantic herring (*Clupea harengus* L., 1758) in the North Sea off Norway (Rahimian & Thulin, 2003). In addition, the testes in our specimens are smaller, than in all previously described ones (see Dimitrov et al., 1999; Rahimian & Thulin, 2003, and references herein). On the other hand, high variability of this character has been already recorded by previous authors.

Pseudobacciger harengulae, known mainly as a parasite of herrings (Actinopterygii, Clupeidae), was first described from the Japanese sardinella (*Sardinella zunasi* (Bleeker, 1854)) (Yamaguti, 1938). It has also been recorded from the same host in off Korea (Chun et al., 1981; Kim & Chun, 1984). It is known from the dotted gizzard shad (*Konosirus punctatus* (Temminck & Schlegel, 1846)) from Far-Eastern Asian coasts (Chun et al., 1981; Kim & Chun, 1984). In the Atlantic waters, it is known from the Atlantic herring from the North Sea (Rahimian & Thulin, 2003), and from the European pilchard (*Sardina pilchardus* (Walbaum, 1792)) and the round sardinella (*Sardinella aurita* (Valenciennes, 1847)) from the Eastern Atlantic (Gaevskaya, 1996). Except the clupeid fish it was recorded from a sparid, the bogue (*Boops boops* L., 1758) in the Atlantic (Parukhin, 1976), and in a pomacanthid, the black-striped angelfish *Genicanthus lamarck* (Lacepède, 1802) off Japan (Machida & Uchida, 2001). Our finding of *P. harengulae* from the carangid fish confirms the possibility that this parasite is able to infect fish from several families. It should be noted, however, that Sun et al. (2014), in describing a new species from a pomacanthid, cast doubt on the identity of Machida & Uchida's worms.

In the Black Sea *P. harengulae* was first reported in the European anchovy (*E. encrasicholus*) and the European sprat (*Sprattus sprattus* L., 1758) from the Bulgarian coasts (Dimitrov et al., 1999), and also from the round sardinella from the Crimean coasts (Gaevskaya & Korniychuk, 1999). We provide the third finding of this parasite in the Black Sea. So, taking into account the absence of reports before 1999, it is plausible that this parasite is a new component of the Black Sea fauna.

The life cycle of this parasite in unknown in Europe. In the Far-Eastern Asian waters the parthenogenetic stages of *P. harengulae* develop in the Gould's razor shell (*Solen strictus* Gould, 1861) (Mollusca, Solenidae), also in several species of Venus clams (Mollusca, Veneridae), i. e. *Laternula rostrata* (Sowerby, 1839), *Meretrix lusoria* (Röding, 1798), *Ruditapes philippinarum* (Adams & Reeve, 1850), and metacercariae are in the ridgetail prawn (*Palaemon carinicauda* Holthuis, 1950) (Malacostraca, Palaemonidae) (Kim & Chun, 1984). In the Black Sea, the Atlantic venerid species, the baby clam (*Chamelea gallina* (L., 1758)) is one of the most abundant components of the coastal ecosystems in the Gulf of Odessa (Vorobyova & Synyogub, 2014). Two species of palaemonid prawns, *Palaemon adspersus* Rathke, 1837 and *Palaemon elegans* Rathke, 1837, are also common species in the coastal

waters of this water body (Varigin, 2014). *Palaemon elegans* is one of the dietary items of the European anchovy and the Mediterranean horse mackerel in the Black Sea (Snigirov, 2015), therefore it is possible that this species of prawn is a source of metacercariae.

We consider that the infestation of the Mediterranean horse mackerel with *P. harengulae* is accidental. Among faustulid flukes, only *Bacciger bacciger* (Rudolphi, 1819) is known from the Mediterranean horse mackerel (Gaevskaya & Naidenova, 1996). That record is also considered a case of accidental infestation, as *B. bacciger* occurs mostly in *Atherina* spp. (Actinopterygii, Atherinidae) (Palombi, 1934).

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