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The first record of the eggs of black wing flyingfish *Hirundichthys rondeletii* (Valenciennes, 1846) in the Turkish nearshores of the Aegean Sea (Gümüldür)

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Abstract: *Hirundichthys rondeletii* is among the three flyingfish species showing distribution in the Turkish seas. However, the egg stages of Exocoetidae species found in the Turkish waters have not been documented. Flyingfish eggs were randomly obtained on 16 July 2016 on the coast of Gümüldür, at a depth of approximately 1 m from a sandy bottom. Samples were fixed in a 4% buffered formaldehyde solution. The eggs were described and illustrated. The diameters of spherical fish eggs were between 1.75 mm and 2.05 mm. They have bipolar filaments: a single filament on one pole and 28–33 filaments on the other pole. The maximum length of these filaments was 73 mm. Vitellus in the eggs was homogeneous and did not contain oil globules. The total egg number determined with the gravimetric method was 4319.91 ± 22. This is the first record of the eggs of black wing flyingfish *H. rondeletii* found in the Turkish waters.

Key words: Black wing flyingfish, Exocoetidae, fish egg, ichthyoplankton, Aegean Sea

Flyingfish belong to the family Exocoetidae and are generally characterized by their pectoral fins that are high on the sides, strikingly long, and always extending beyond the dorsal fin. Pelvic fins are abdominal in position and greatly enlarged in many species, which are called four-winged fish (Parin, 2002). Representatives of the family Exocoetidae are distributed in tropical and subtropical waters around the world (Oxenford et al., 1995; Monteiro et al., 1998; Parin, 2002; Savaliev et al., 2014). In addition to their commercial value, flyingfish are crucial components in the epipelagic food chain, where they are the preferred prey of predators such as *Coryphaena hippurus*, *Thunnus thynnus*, *Thunnus albacares*, *Tetrapturus albidus*, *Makaira nigricans*, and *Prionace glauca,* which are of high commercial value (Parin, 1968; Pinkas, 1971; Massutí et al., 1998; Araújo and Chellappa, 2002). Moreover, pelagic seabirds from the family Laridae are also known to feed on flyingfish (Hensley and Hensley, 1995). Exocoetidae species predominantly feed on copepods, followed by species from the zooplankton group including amphipods, chaetognaths, crustaceans, and fish larvae (Lewis et al., 1962; Van Noord et al., 2013).

Flyingfish species usually spawn in schools and deposit eggs on the bottom layers or floating objects (Casazza et al., 2005). Parents' preference to attach their eggs to floating objects, albeit being a demersal species, is thought to be due to the positive effect of the higher temperature of surface waters than that of bottom waters on egg development (Oxenford et al., 1995) and benefiting from the dynamic advantages of surface current while acting on the instinct to protect the eggs during their critical early life phase (Stevens et al., 2003).

Eggs of some flyingfish species (*Exocoetus*) do not contain filaments and have positive buoyancy, whereas all other species have long adhesive filaments on their eggs, which enable eggs to attach to the surrounding vegetation or floating objects, such as tree branches (Gillette and Ianelli, 1992). Filaments on *Hirundichthys* eggs have a bipolar arrangement (Collette et al., 1984).

Until today, members of the family Exocoetidae in the Turkish waters comprised three species, namely *Cheilopogon heterurus* (Rafinesque, 1810), *Hirundichthys rondeletii* (Valenciennes, 1846), and *Parexocoetus mento* (Valenciennes, 1846) (Bilecenoğlu et al., 2002, 2014; Mater et al., 2011). The main distribution area of *H. rondeletii* is the Mediterranean Sea (Parin and Belyanina, 2002). Occurrences of adult *H. rondeletii* species in the Turkish shores were recorded in the Sea of Marmara (Devedjian, 1915), the Aegean Sea (Geldiay, 1969), and the Mediterranean Sea (Gücü and Bingel, 1994) but encounters with the family Exocoetidae were not documented by other studies. This study is of great importance since it is the first record of an encounter with the eggs of Exocoetidae species in the Turkish seas.

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The eggs were randomly obtained from a floating branch (Figure 1) found at the coast of Gümüldür (38°3′41.54″N, 27°0′15.10″E) from a sandy bottom approximately 1 m deep on 16 July 2016 at 1500 hours. Samples were fixed in a 4% buffered formaldehyde solution. The eggs were examined in the laboratory with an Olympus SZ40 stereomicroscope. Identification of the eggs was performed in accordance with Kovalevskaya (1972), Watson (1996), and Cotten and Comyns (2006). The eggs were described and illustrated.

The number of the eggs were calculated with the gravimetric method. All eggs were weighed with an analytical balance at 0.0001 g sensitivity. To calculate the total egg number, subsamples of 1 g were collected and eggs in the subsamples were counted and proportioned to the general weight (Murua et al., 2003). The averages of egg measurements were, in general, given with their standard error (SE) values.

H. rondeletii eggs were obtained in July when the surface temperature was 26.02 °C (https://oceancolor.gsfc.nasa.gov); the prevailing wind was from the southwest and had a velocity of 11 knots/h (https://www.windguru.cz/archive.php).

The diameter of spherical fish eggs varied between 1.75 and 2.05 mm (n: 50) and their mean value was 1.92 ± 0.01 mm. They have bipolar filaments: a single filament on one pole and 28–33 filaments (30.5 ± 0.54) on the other pole (Figure 2). In most of the eggs, a conical structure was observed in the regions where their single filaments emerge. The maximum length of these filaments was 73 mm. Their vitelluses were quite large (1.09 ± 0.02 mm), homogeneous, and did not contain oil globules. There were a couple of punctate melanophores on the vitelluses of some embryos. The length of the embryos in the eggs varied between 2.50 mm and 2.95 mm and their mean value was 2.75 ± 0.04 mm.

The horizontal axis of their eye was longer than its vertical axis, oval (long diameter: 0.35 ± 0.005 mm; short diameter: 0.25 ± 0.003 mm), and had few punctate melanophores. The bodies of embryos were covered with regular lines of intense pigmentation, except for the parts near the occipital and urostyle. In this pigmentation, melanophores on the heads and bodies were stellate in shape and smaller towards the posterior region. Their tails covered more than half of their vitelluses and the ends of the tails were independent from the vitelluses.

A total of 4319.91 ± 22 eggs were determined on the branch found at the coast. Although the eggs mostly had developed embryos, there were few dead or unfertilized eggs.

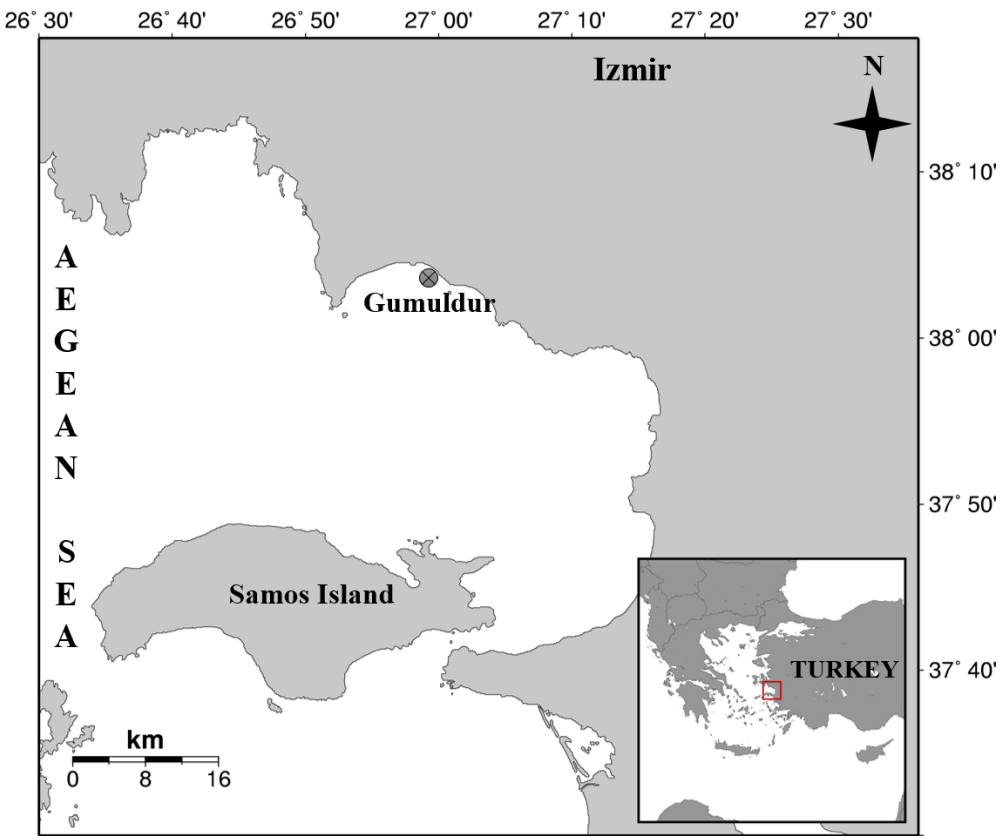

Figure 1. The map of the region where *Hirundichthys rondeletii* eggs were found.

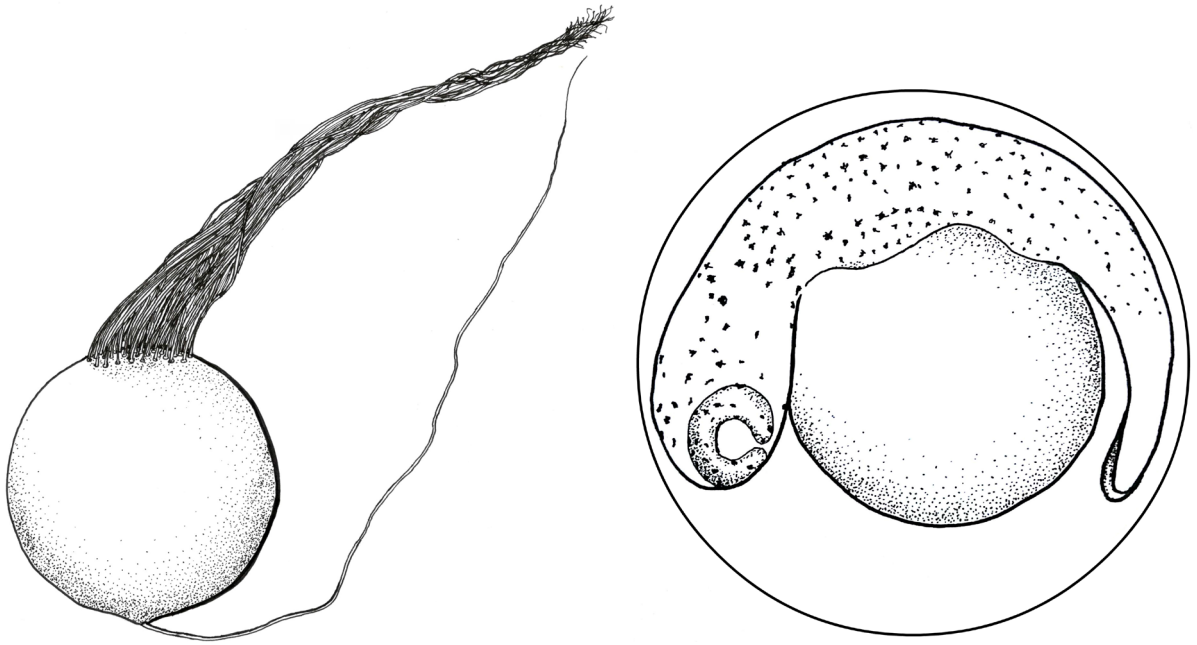

Figure 2. External and internal appearance of *Hirundichthys rondeletii* eggs (drawings by O Uygun).

D'Ancona (1931) reported that the diameters of the *H. rondeletii* eggs obtained from the Gulf of Napoli were between 1.4 mm and 1.5 mm and determined that the eggs had 40–45 long filaments, which were evenly distributed on the eggs per hemisphere and did not contain oil globules. Evidently, egg diameters and positions and numbers of the filaments reported in the present study do not comply with these reported in the other study. However, it was found that the diagnostic features of *H. rondeletii* eggs obtained in the present study and in various studies (Kovalevskaya, 1972; Cotten and Comyns, 2006; Guardia and Huamaní, 2013) had similarities with the *C. heterurus* eggs described in the monograph by D'Ancona (1931) in terms of shape, filament positions, and descriptions.

According to Cotten and Comyns (2006), diameters of the eggs of *H. rondeletii* species were between 1.9 and 2.2 mm, the eggs had bipolar filaments with one long filament on one pole and 25–30 filaments on the other pole, and they did not contain oil globules. According to Guardia and Huamaní (2013), in their study carried out on the southern shores of Peru, the diameter of the eggs was 1.8 ± 0.09 mm and the eggs had bipolar filaments, with one long filament on one pole and 25 ± 4.03 filaments on the other pole. The comparison of the properties of the eggs obtained in our study to the properties determined in other studies shows that our results were more similar to those of Cotten and Comyns (2006) and Guardia and Huamaní (2013).

No studies were found in the literature on the early life stages of *H. rondeletii* in the waters of Turkey. Mater and Çoker (2002) reported that they obtained *H. rondeletii* eggs in the Aegean Sea (Hoşsucu and Taylan, 2015) and carried out the identification based on the monograph by D'Ancona (1931). On the other hand, according to the studies of Kovalevskaya (1972), Cotten and Comyns (2006), and Guardia and Huamaní (2013), these eggs do not match the characteristics belonging to *H. rondeletii* eggs.

In the present study, the eggs of the species were obtained in summer (July). According to Parin (1986) these eggs are found in the Mediterranean Sea during summer; according to Kovalevskaya (1972), Watson (1996), Cotten and Comyns (2006), during the period from winter to spring; and according to Guardia and Huamaní (2013), during spring and summer.

The reproduction biology of this species has not been documented. However, in their study on *Hirundichthys affinis* (Günther, 1866), which is from the same genus as *H. rondeletii*, Oliveria et al. (2015) reported that *H. affinis* average absolute fecundity was 9092 ± 1153 (SD) and Araújo and Chellappa (2002) reported that they had an average absolute fecundity of 5400 eggs. As a result of the lack of studies on *H. rondeletii*, whether the eggs were deposited by a single fish or a group of fish is not known. Therefore, a comparative interpretation on their fecundity was not included in the present study.

This is the first record of the eggs of black wing flyingfish *H. rondeletii* found in the Turkish waters. According to the IUCN Red List, *H. rondeletii* in the Mediterranean Sea is

in the LC (Least Concern) group (Di Natale et al., 2011). However, with regard to its attractive appearance, its importance in the food chain, and the commercial value of its eggs, we can say that the protection of *H. rondeletii* is of great importance, which brings along the need for more detailed studies.

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