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RESEARCH ARTICLE

Additional Record of Rare Pilot Fish, *Naucrates ductor* (Linnaeus, 1758) with Some Biological Notes from the Northern Aegean Sea, Türkiye

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Rare species
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Abstract: In this study, four individuals of pilot fish *Naucrates ductor* which were accidentally caught by a commercial purse seiner in Edremit Bay (Aegean Sea) were investigated. The morphometric and meristic characteristics, sex, maturity stages, otoliths, age and stomach contents of the specimens were evaluated. This study contributes to the existing literature by providing additional records from specimens reported from the northernmost location reported so far as well as other biological information for the rarely observed pilotfish.

Anahtar kelimeler:

Naucrates doctor
Nadir tür
Gırgır balıkçılığı
Popülasyon
Edremit körfezi

Ege Denizi'nin Kuzeyinde Nadir Bulunan Malta Palamudunun *Naucrates ductor* (Linnaeus, 1758) Bazı Biyolojik Özellikleri ile Birlikte İlave Kaydı

Öz: Bu çalışmada Ege Denizi'nin Edremit Körfezi'nden gırgır balıkçılığı operasyonu ile tesadüfi olarak yakalanan 4 adet Malta palamudu *Naucrates ductor* incelenmiştir. Elde edilen bireylerin morfometrik ve meristik özellikleri, cinsiyet, olgunluk safhaları, otolit ölçümü, yaş ve mide içerikleri incelenmiştir. Nadir gözlemlenen türün en kuzeyden bireylerini değerlendirme imkânı sağlayan bu çalışma, ilave kayıtlar ve biyolojik notlar ile literatüre katkı sağlamaktadır.

Introduction

The pilotfish (*Naucrates ductor* (Linnaeus,1758)) (Carangidae) is an epi-pelagic fish species which is found in tropical and subtropical seas (Whitehead et al., 1986; Quigley, 2019). It is distributed in the Mediterranean; Corsini-Foka et al. (2015) and Ali-Basha et al. (2021) reported this species from Rhodes (Southwest Aegean Sea) and Syrian waters, respectively. Although Bilecenoğlu et al. (2014) stated that the pilot fish's distribution comprise all Türkiye Seas (Bilecenoğlu et al., 2014), none of these records accompanied any specimens. The pilot fish was considered as a rare fish species for Türkiye waters (Smith-Vaniz, 1986). Özgül (2015) identified 21 specimens from Kuşadası Bay when working on the species composition of fish aggregation devices and Akyol (2019) reported a single individual of pilot fish caught by a gillnet in Izmir Bay, Aegean Sea. Ichthyoplanktonic results suggested that pilot fish spawns around the Bodrum-Yalıkavak region, in the Southeastern Aegean Sea (Mater and Coker, 2002; Hoşsucu and Taylan, 2015).

Information on the pilot fish biology in the literature is also scarce. In terms of behavior, commensal relationship between pilot fish and large-size marine animals such as sharks, mobulid rays, bony fish and turtles (Massutí and Reñones, 1994; Vassilopoulou et al., 2004) as well as floating objects were reported (Massutí and Reñones, 1994; Reñones, et al., 1998). The pilot fish was caught as a by-catch in the Mediterranean using purse seine nets around floating objects (Reñones et al., 1999; Pipitone et al., 2000). With respect to foraging, the pilot fish feeds on jellyfish and drifting seaweed (Golani et al., 2006; Froese and Pauly, 2018). Members of Arthropoda, Annelida, Mollusca, Vertebrata and Tunicata species were reported in the stomach contents of the pilot fish (Pipitone et al., 2000; Vassilopoulou et al., 2004).

This study reports a new additional northernmost record of the pilot fish with some data on morphometric and biological characteristics. This information will help increase knowledge of pilot fish biology.

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Material and Methods

Four individuals of pilot fish were caught by a commercial purse seiner at a depth of nearly 100 meters, on 15th December, 2022 in Edremit Bay, Northern Aegean Sea, Türkiye (Coordinates: 39°25'584'' N - 26°14'351'' E) (Figure 1).

The specimens were transferred to the laboratory in a cooler. Individuals were identified based on Whitehead et al., (1986) and photographed. Some morphometric characteristics were measured and meristic characteristics were counted (Figure 2) and then compared with previous studies.

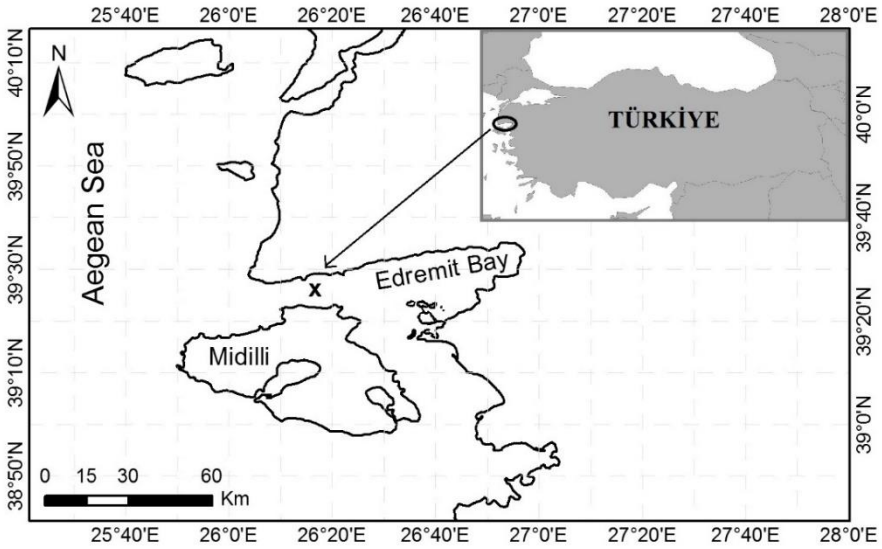

Figure 1. Map of sampling area (x showing the catch location of *N. ductor* on Edremit Bay)

Figure 2. Individuals of *N. ductor*

The morphometric measurements were performed to the nearest millimeter (mm) using a measuring board. The total body and gonads were recorded to the nearest 0.0001 gram (g). The length-weight relationship was estimated using the equation $W = a^* L^b$, where, W = total weight (g), L = total length (cm), a = intercept and b = regression coefficient (Ricker, 1975). Following log transformation, the constants a and b were estimated by least square linear regressions. Growth type was determined by the value "b" which reflects allometry of the growth and it was tested by t-test (Pauly,

1984) at the 0.05 significance level to verify the significant difference from the isometric growth (b = 3). The statistical significance level of the coefficient of determination (r^2) and 95% confidence intervals (95% CI) of b were also estimated (Zar, 1999).

Only 1 out of 4 otoliths were successfully recovered intact and therefore, otolith measurements were based on a single otolith. Age was estimated by interpreting the annual growth rings of the otolith according to Iglesias and Dery's (1981) method using an image analysis software (Q-capture). Readings were made by three independent researchers.

Sex and maturity stages were determined by macroscopic observation of gonads. The sexual maturity stages were determined according to the method described by Holden and Raitt (1975) as;

Stage I (Immature), ovary and testis about 1/3rd length of body cavity, ovaries pinkish, testis whitish.

Stage II (Maturing), ovary and testis about 1/2 length of body cavity.

Stage III (Ripening), ovary and testis is about 2/3rds length of body cavity.

Stage IV (Ripe), ovary and testis from 2/3rds to full length of body cavity, ovary orange-pink in colour with conspicuous superficial blood vessels, testis whitish-creamy, soft.

Stage V (Spent), ovary and testis shrunken to about 1/2 length of body cavity, ovary contain remnants, testis bloodshot and flabby.

The stomach was dissected, dried on blotting paper and all materials inside the stomach were sorted and identified (Fischer, 1973; Murduchay-Boltouski, 1969).

Results

Morphometric measurements, meristic counts, total body, gonad weights, and otolith measurements of the pilot fish were summarized and compared with previous studies in Table 1. The total length and weight was highly correlated (r^2:0.99) and the b value was found as 2.88 indicating a negative allometric growth.

Gonad weights for the 1st, 2nd, 3rd and 4th pilot fish were recorded as 1.1421 g, 0.7366 g, 3.3952 g and 0.3777 g, respectively. The 4th individual was determined as a male and the rest of the specimens were female. Only a single ripe gonad (4th stage) was found (3rd individual) covering more than 2/3 of the body cavity, having an orange color and surrounded by blood vessels (Figure 3a, 3b). The gonads of the remaining three individuals were immature (1st stage) with a tube-shaped, thin and transparent appearance (Figure 3c, 3d).

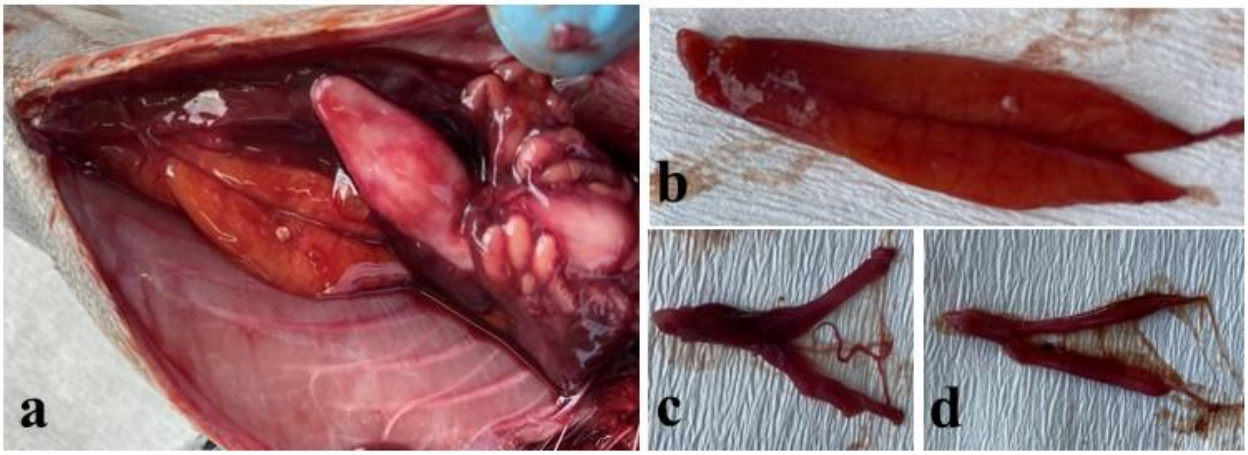

Figure 3. a) Dissected individual with gonads (3rd individual), **b)** 3rd individual with 4th stage gonad, **c)** Female with 1st stage gonad (1st individual), **d)** Male with 1st stage testis (4th individual)

The length, width and weight of the right otolith of 4th individual were measured as 0.944 mm, 1.699 mm, and 0.0001 g, respectively. The nucleus was clearly visible but there was no valid opaque zone on the otolith. Thus, the age was determined to be 0 due to the invisible annual age mark (Figure 4).

The stomachs of three individuals were empty. The stomach of 4th individual contained two prey items belonging to two different prey types. One of them was identified as a seaweed, with a length of 11 mm (Figure 5a) and the second item was identified as cuttlefish (*Sepia officinalis* Linnaeus, 1758) having a total length of 70 mm, and a mantle length of 45 mm (Figure 5b).

Table 1. Morphometric measurements, meristic counts, sex, maturity stages and otolith measurements recorded and compared with previous studies of *N. ductor*

N. ductor	**In this study**				**Akyol (2019)**	**Ali-Basha et al., (2021)**
	North Aegean Sea				**Aegean Sea**	**Syrian waters**
Fish numbers	**1st**	**2nd**	**3rd**	**4th**	**1st**	**1st**
Sex	Female	Female	Female	Male	-	-
Maturity stages	I	I	IV	I	-	-
Morphometric measurements (mm)						
Total length (TL)	346	324	311	276	275	300
Standart length	271	256	243	222	247	261
Fork length (FL)	312	292	281	251	224	267
Head length	71	66	64	56	58	61
Interorbital space	31	27	25	23	-	-
Predorsal length	117	98	96	87	84	118
Preanal length	185	166	165	136	134	163
Prepectoral length	78	71	65	57	62	66
Prepelvic length	8	82	81	68	-	-
Max. Body depth	67	63	55	47	-	65
Eye diameter	12	11	10	9	11	11
Preorbital length	23	22	21	19	18	34
Total weight	468.66	385.37	326.56	244.75	-	294.29
Gonad weight	1.1421	0.7366	3.3952	0.3777	-	-
Stomach weight	7.4452	5.142	4.9193	8.1304	-	-
Meristic counts						
Dorsal fin rays	IV+I+27	IV+I+27	IV+I+27	IV+I+27	IV+I+28	IV+I+27
Anal fin rays	II+16	II+16	II+16	II+16	III+15	II+ I+15
Pectoral fin rays	18	18	18	18	18	20
Caudal fin rays	12	12	12	12	-	-
Pelvic fin rays	I+5	I+5	I+5	I+5	I+5	I+5
Gillrakers	23	23	24	24	-	-
Linea lateralis scale	148	144	145	142	-	-
Operculum rays	8	8	8	8	-	-
Otolith measurements				**Right**		
Width (mm)	-	-	-	1.699	-	-
Length (mm)	-	-	-	0.944	-	-
Weight (g)	-	-	-	0.0001	-	-

Figure 4. Right sagittal otolith of 4th individual

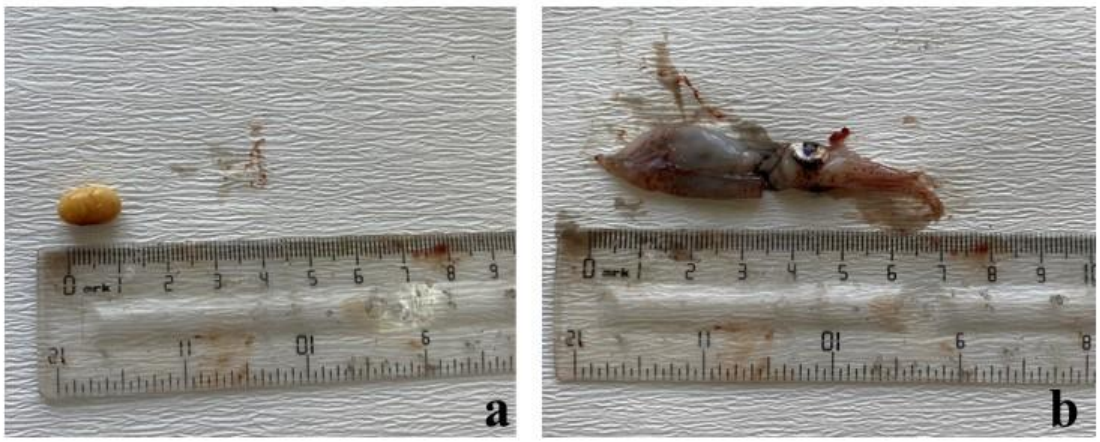

Figure 5. Stomach contents of 4th individual **a)** Seaweed, **b)** Cuttlefish

Discussion

Although considered as a common species in some areas such as the Indian Ocean (Eschmeyer, 1983), the pilot fish is a rarely seen fish species in the Mediterranean. Recent new records from the western Mediterranean to the Irish coasts and from the Syrian coasts to the Northeastern part of the Aegean Sea indicated a broad range distribution (Corsini-Foka et al., 2015; Quigley, 2019; Ali-Basha et al., 2021). However, large stocks of the pilot fish have not been reported.

Reñones et al. (1998) stated that sex determination of individuals below 10 cm FL was not possible. Individuals between 10 - 31.2 cm FL were sexed as 0 years old and the largest specimens were five month old. Vassilopoulou et al. (2014) reported that individuals between 18.9 - 30.5 cm were aged as 0. In the present study, all individuals were sexed and one female specimen had mature gonads but none of them reached the age of 1 year. Thus, the findings of this study support those of Reñones et al. (1998). Jardas (1996) reported that pilot fish reach sexual maturity at total length of approximately 25 cm. In the present study, the smallest individual with a 27.6 cm TL was found to be sexually mature. Vassilopoulou et al. (2014) stated that TL>250 mm was at stage III. This finding supports that of Jardas (1996). In the present study, however, gonads with more advanced stages were not observed in the larger 3rd individual due possibly to spawning. Reñones et al. (1998) stated that pilot fish spawning occurred in two different peaks in July and December. The ichthyoplankton results showed that pilot fish spawned in October in the Aegean Sea (Hossucu and Taylan, 2015; Mater and Coker, 2002) and between December to March around the Dardanelles Strait (Daban and Yüksek, 2017). Since all fish examined in the present

study were caught in December, the ichthyoplanktonic findings supported the possibility of earlier spawning.

Reñones et al. (1998) and Vassilopoulou et al. (2014) estimated the age of an individual with 31.2 cm TL as 0 years-old. These authors also stated that this species can reach 26.1 cm FL in four months. The findings in this study are in accordance with those of Reñones et al. (1998) and Vassilopoulou et al. (2014) and suggested a rapid growth during the first year.

The morphometric measurements and meristic counts of pilot fish and the comparative results in previous studies are shown in Table 1. Differences between studies may be related to the fish size and habitat.

Whitehead et al. (1986) and Cervigón (1993) reported pilot fish lengths of 35 cm and 40 cm TL, respectively, whereas the maximum length was reported as 70 cm TL (Edwards, 1990). In previous studies, total length measurements ranged between 4 -8 cm (Özgül, 2015) and 27.5 mm (Akyol, 2019) in İzmir Bay, Aegean Sea, between 21 -39 cm (mean: 30.3 cm) in the Irish coasts (Quigley, 2019), 28.7 cm in Adriatic coasts (Glamuzina et al., 2017), 30 cm TL in Syrian coasts (Ali-Basha, 2021), and between 15 - 31.2 cm fork length in the Mallorca coasts, western Mediterranean (Reñones et al., 1999). The length measurements of *N. ductor* from the Mediterranean Sea were relatively lower than those reported by Whitehead et al. (1986) and Cervigón (1993). Lower reported values may stem from foraging by dolphins or overfishing by purse seine fishing.

In the previous studies, members of Arthropoda, Annelida, Mollusca and Tunicata were found in the stomach contents of pilot fish (Reñones et al., 1998; Pipitone et al., 2000; Vassilopoulou et al., 2004; Glamuzina et al., 2017). Jellyfish and seaweeds were also reported as prey items for pilot fish (Golani et al., 2006; Froese and Pauly, 2018) along with *Octopus* sp. and *Onychoteuthis banksi* reported from pilot fish caught in Mallorca coasts (Reñones et al., 1998). Cuttlefish (*Sepia officinalis*), on the other hand, was reported for the first time as a prey item for the pilot fish.

With increasing sea water temperatures due to global climate change pilot fish can expand its distribution range in the near future to other regions such as the Marmara Sea and the Black Sea. FAD locations may prove successful sampling areas to study pilot fish biology for this rare species in the Mediterranean. Although ichthyoplankton and gonad findings indicate reproduction potential of pilot fish in the Aegean Sea, a better understanding of its rarity is required with respect to conservation efforts as rare species are more prone to overfishing

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Conflicts of Interest

The authors declare that there are no conflicts of interest or competing interests.

Author Contributions

Yusuf Şen: Designing of the study, writing-original draft preparation, submission, writing-review and editing, visualization. İsmail Burak Daban: Designing of the study, sorting into taxonomic groups, identification of species, data analysis, checking-original draft preparation. Ceyda Kalemli: Supported the laboratory study, checking-original draft preparation.

Ethics Approval

Ethics committee approval isn't required for this study.

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