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RESEARCH ARTICLE

Lionfish distribution in the eastern Mediterranean coast of Turkey

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Abstract

This study presents the results of the interviews with the fishermen, sightings records in the newspapers and electronic social networks and the details of eight sampled individuals of the lionfish, *Pterois* sp. in the eastern Mediterranean coast of Turkey. It is evident that the lionfish has established in the eastern Mediterranean coast of Turkey. However, there is still a lack of information about its abundance. The total length (TL) of the eight individuals was 8.5-29.3 cm and the wet-weight 7.09-398.77 g, that were sampled in nine SCUBA dives at 10-15 m depths between 20.01.2017 and 10.02.2017 in Kemer, Antalya. One of the large specimens was a male (29.3 cm TL) and the other was a female (28.6 cm TL) and the rest were juveniles. The stomachs of four individuals were empty; however, identifiable parts of *Mullus surmuletus*, an individual of Gobiidae sp., unidentifiable parts of a Teleost fish and an undistinguished content were found in the stomachs of the other four individuals. A total of twenty sightings were recorded in the newspapers and electronic social networks in the eastern Mediterranean coast of Turkey between 15.07.2014 and 17.01.2017, apart from the scientific records, and fifteen of them were evidenced by photo and video. The interviews showed that lionfish was not well-known by the fishermen around the Gulf of Iskenderun yet. The public perception about the lionfish is highly variable in Turkey, and this may affect our understanding of the rate of invasion.

Keywords: Invasive alien species, interview, sighting records, sampling, eradication

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The lionfishes are one of the most invasive species in the world (Morris *et al*. 2009; Schofield 2010; Johnston and Purkis 2014; Poursanidis 2015). After twenty-two years of its first record from the Israeli coast (Golani and Sonin 1992), the Indo-Pacific lionfish, *Pterois miles* (Bennett, 1828) was reported from Lebanon, Cyprus, Turkey, Greece and Tunisia (Bariche *et al*. 2013; Turan *et al*. 2014; Crocetta *et al*. 2015; Iglésias and Frotté 2015; Oray *et al*. 2015;

Turan and Öztürk 2015; Dailianis *et al*. 2016; Jimenez *et al*. 2016; Kletou *et al*. 2016; Mytilineou *et al*. 2016) (Figure 1).

Figure 1. The locations of the records of the lionfish in the Mediterranean Sea: 1. Golani and Sonin (1992), 2. Bariche *et al.* (2013), 3. Turan *et al*. (2014), 4. Oray *et al*. (2015), 5. Iglésias and Frotté (2015), 6. Turan and Öztürk (2015), 7. Crocetta *et al*. (2015), 8. Mytilineou *et al*. (2016), 9 and 10. Dailianis *et al*. (2016), 11. this study, Kemer- Antalya, Turkey (location of the eight specimens sampled)

Pterois volitans (Linnaeus, 1758) was also reported for the first time in the Mediterranean Sea, from the Gulf of Iskenderun, Turkey (Gurlek *et al*. 2016). Although the morphological details have been given in the studies; following the recommendations that the positive identification can only be achieved via genetic analysis (Schultz 1986; Kochzius *et al*. 2003; Morris *et al*. 2009), we referred all specimens as "lionfish" in this document.

Local ecological knowledge is a fast and effective way to collect data about natural systems and monitoring biodiversity issues (Anadon *et al*. 2009; Azzurro *et al*. 2011). This method can also provide significant information on the status and distribution of recent invader lionfishes in the Mediterranean (Azzurro and Bariche 2017) and enable managers to take quick precautions. Thus, in this study, we collected data about the status of a recent invader, lionfish, throughout the Mediterranean coasts of Turkey from local communities and social media stream.

Materials and Methods

Interview with fishermen

To evaluate the distribution of lionfish in the Gulfs of Iskenderun and Mersin, interviews were conducted in nine fishery ports in the northeastern coast of the

Mediterranean, Camlibel and Karaduvar in Mersin, Karatas and Yumurtalik in Adana, Dortyol, Payas, Iskenderun, Arsuz and Konacik in Hatay (Figure 1) on 24 and 25 January 2017. The questions were directed to fishermen having at least five years of experience at sea. In interviews, we showed several lionfish photographs to the fishermen, before we directed the question "Have you ever seen this fish?". If the answer was negative, we only asked personal information such as experience at sea, purpose of fishing activity (professional or recreational) and types of fishing gears used. If the fishermen recognized lionfish, we preceded interview with the questions below:

1. "When did you first encounter this fish?"
2. "How do you call this fish?"
3. "Which equipment did you use to catch this fish?"
4. "What was the depth and bottom structure where you encountered in?"
5. "What was the maximum number of lionfish daily encountered?"
6. "What was the average and maximum length of lionfishes encountered?"

Interviewees were also inquired about the abundance of lionfish. We offered an ordinal scale in which 1: once until now, 2: several times until now, 3: once in 2 or 3 catches, 4: regularly present in all catches, 5: regularly present and abundant in all catches.

In order to test hypotheses, frequency tables were prepared with the answers in categorical and ordinal variables. Then the effects of fishery port and fishing gear were analyzed by using Chi-square tests. Continuous variables were analyzed with Kruskal-Wallis tests. All statistical analyses and visualizations were conducted in R 3.3 statistical language (R Core Team 2016).

Sightings reported in newspaper & electronic social network

The news in newspapers and the sightings reported in the electronic social networks by free divers, SCUBA divers, spear fishermen, artisanal and recreational fishermen were followed and checked for the distribution and the public opinion about the lionfish.

Sampling

In order to control the data obtained from sighting, eight SCUBA dives were conducted by two divers and eight specimens were sampled by spearfishing between 20.01.2017 and 10.02.2017 in Kemer, Antalya. The sea-water temperature was 14.9-16.0 °C. Special permission was taken from the Ministry of Food, Agriculture and Livestock to use spears with SCUBA equipment. The specimens were preserved in 8% formalin and transferred to the laboratory. They were measured (Total Length, TL) to the nearest 0.1 cm and weighed (Wet

Weight, WW: ±0.01 g). Three of the individuals were checked for the stomach content and sex.

Results

Interview with the fishermen

A total of 93 fishermen were visited during the study. Only seven of them were recreational while the others were professional. The average experience of fishermen interviewed was 24.13 ±1.44 (SD) years at sea. A total of 29 (31%) fishermen reported to encounter lionfish. Following local names were reported: "Aslan Balığı (lionfish)" (33%), "İskorpit (local name of scorpionfish)" (17%), "Zehirli Balık (venomous fish)" (11%), "Pisi Balığı" (11%), "Tragonya (local name of *Trachinus* sp.)" (11%), "Naylon (local name of *Sargocentron rubru*m)" (11%) and "Sokan (local name of *Siganu*s sp.)" (6%).

Encounter rates were significantly different among ports (chi-squared = 114.01, df = 8, $p < 0.001$). Maximum encounter rate was 67% in Konacik fishery port in the southeastern coast of Iskenderun. The encounter rates of the ports located around the northwestern coasts of the Gulf (Yumurtalik, Dortyol, Payas) were significantly lower than those of the rest of the study domain (Kruskal-Wallis chi-squared = 5.40, df = 1, $p< 0.05$). Figure 2 shows the spatial variation of encounter rates of lionfish.

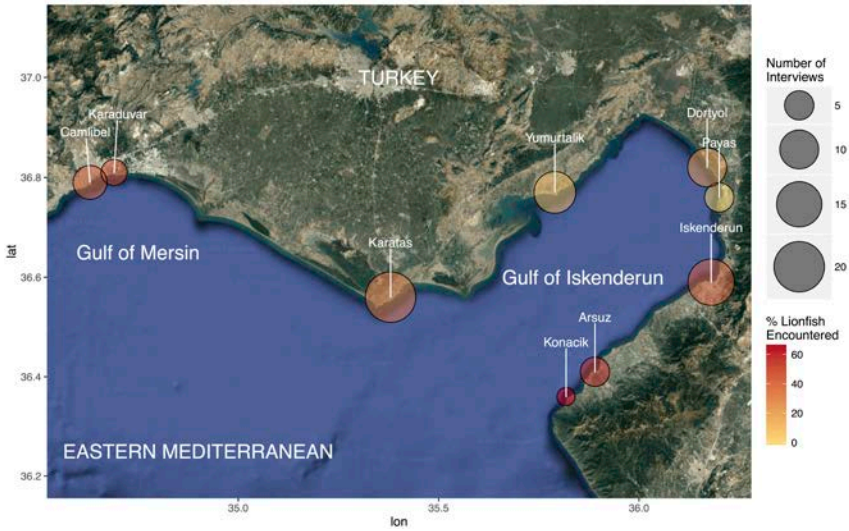

Figure 2. Spatial variation of encounter rates of lionfish around the Gulfs of Mersin and İskenderun based on the interviews with the fishermen

The encounter rates also significantly varied among fishing gears (chi-squared = 58.96, df = 6, p<0.001). Encounter rate was the highest in bottom trawls with 67%, followed by nets and seines with 39 and 33%, respectively. Longlines followed them with 25% and spear guns with 17%. Anglers had the lowest rate with 11% (Figure 3).

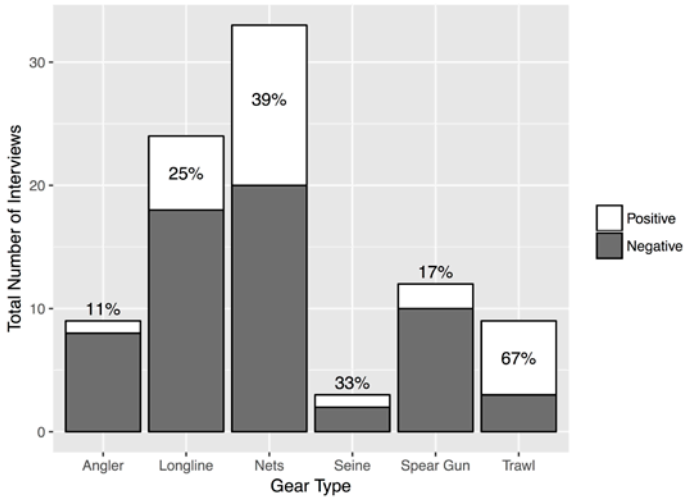

Figure 3. Encounter rates of lionfish by gear types

Rocky substratum was the mostly reported bottom type with 56% of positive interviews, followed by sandy and muddy bottoms with 32%. In the 12% of positive interviews, fishermen reported both substratum types. The reported depth varied in a wide range from 5m to 200m. The median value of depth in ordinal scale was in the second category, which was from 10 to 50 m. This category included the 42% of positive interviews and followed by the third category which was from 50 to 100 m with 27%. First (0 to 10 m) and fourth (>100 m) categories had the rates 19% and 12%, respectively.

Most of the fishermen with positive interviews reported that they encountered lionfish only once (46%) or several times (39%). A few fishermen reported that lionfish were regularly present in catches (11%) or abundant (4%). The reported abundance did not significantly change by fishing gears (chi-squared= 8.75, df= 15, p= 0.89) and ports (chi-squared= 19.96, df= 15, p= 0.17).

Best day-catch ranged between 1 and 52 individuals with a median value of 2 (1-6 interquartile range) individuals. Although, it was not significant (Kruskal-Wallis chi-squared= 5.38, df = 5, p= 0.37), the high values were usually reported by trawlers. The variation among fishery ports was also not found to be significant (Kruskal-Wallis chi-squared= 5.36, df= 5, p= 0.37).

The reported length ranged between 8 and 50 cm. The median length was 20 cm (15-25cm interquartile range). Neither average length (Kruskal-Wallis chi-squared= 3.02, df= 5, p= 0.70) nor maximum length (Kruskal-Wallis chi-squared= 3.31, df = 4, p= 0.51) significantly varied among fishing gears. The ports did also not affect the average length (Kruskal-Wallis chi-squared= 3.59, df= 7, p= 0.83) and maximum length values (Kruskal-Wallis chi-squared= 3.61, df= 5, p= 0.61).

Sightings reported in newspapers & electronic social network

A total of 20 sightings were recorded in the eastern Mediterranean coast of Turkey between 15.07.2014 and 17.01.2017, apart from the scientific records (Figure 4, Table 1), and 15 of them were evidenced by photo and video (Figure 5). Fourteen of them were reported in the Province of Antalya, three in Mersin, two in Hatay and one in Muğla. Nine of the sightings were recorded by SCUBA divers, six by free divers and spear fishermen, two by recreational and artisanal fishermen, two by the academicians, and two by the citizens who informed TUDAV.

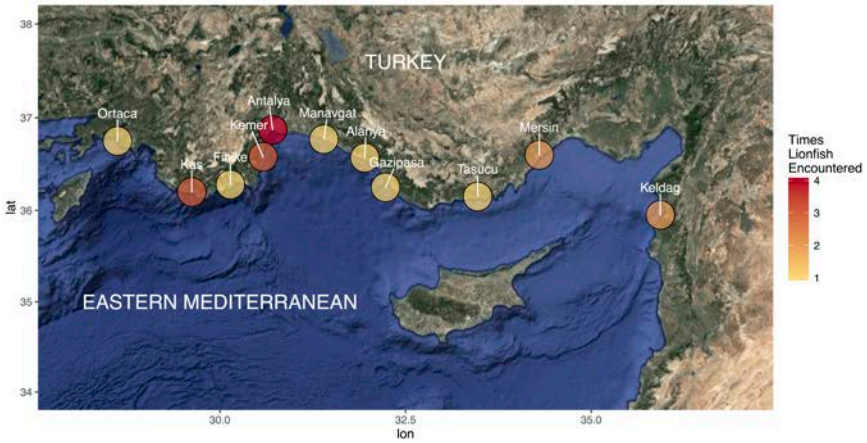

Figure 4. The number of sightings of the lionfish in the Mediterranean coast of Turkey reported via newspapers, electronic social networks and citizen science

As a result of the general evaluation of the public opinion, there is a wide variety of perception of the lionfish in Turkey that could be summarized as below:

Positive comments

1) A new source of income as an aquarium fish.
2) A new icon for the SCUBA diving tourism; very interesting fish to show the tourists.

3) Predator of the pufferfish to reduce their numbers.
4) Pufferfishes could not be eaten; it is another invasive exotic fish but at least we can eat it.
5) A new taste in the kitchen.

Negative comments

1) There were already very few fish left after the pufferfish invasion; now together with the effects of the lionfish, fisheries will come to an end.
2) Dangerous to handle because of its venomous spines.
3) Fisheries of this species is very difficult, it is not common in the catches of hooks and nets; so special and extra effort should be spent to reduce their numbers.
4) To create a demand for the lionfish as a food, the supply should be regular; however due to the difficulties of fishing, the fishermen seem to not prefer to deal with the fish.

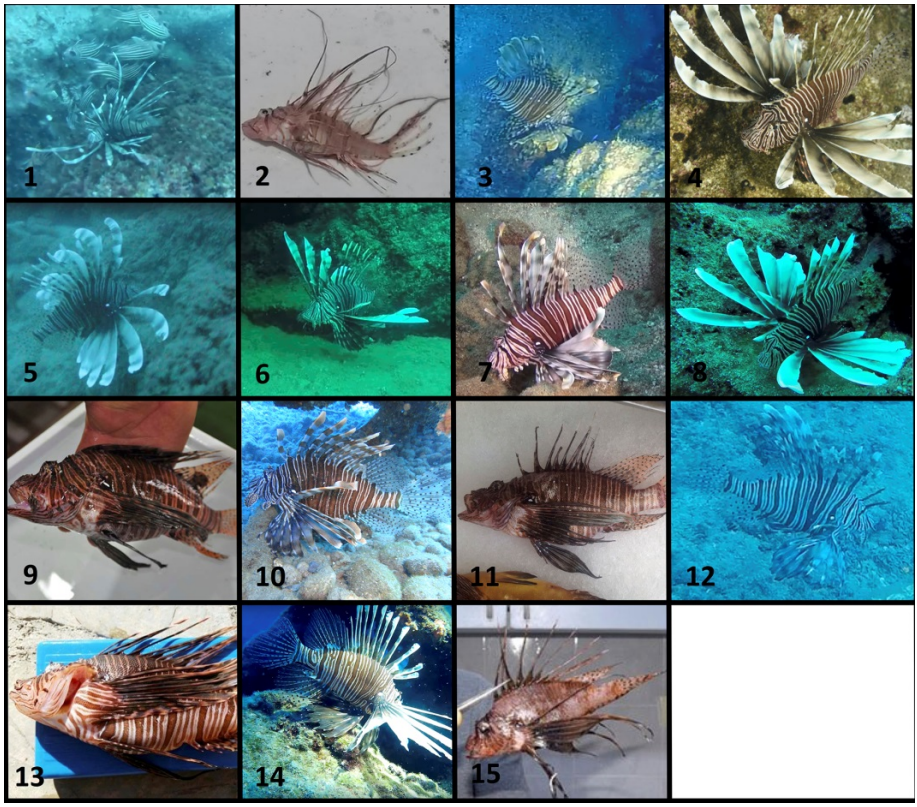

Figure 5. Pictures of the lionfish from the sightings in the Mediterranean coast of Turkey. Numbers refer to those in Table 1.

Table 1. Sightings of the lionfish from the Mediterranean coast of Turkey reported via newspapers, electronic social networks and citizen science. Picture no refers to the numbers in Figure 5. (Location* AN: Antalya)

No	Date	Location*	Name of the observer	Information of the observer	Source	Photo no
1	15.07.2014	Keldağ, Hatay	Freelife Dalış	SCUBA diving center	https://www.youtube.com/watch?v=YErZ3oVk6oc	1
2	25.12.2014	Finike, AN	Dansc_07	Free diver/Spearfishing	http://www.zipkinci.com/	-
3	20.03.2015	Gulf of Mersin	A.E. Kıdeyş	Academician	http://www.7deniz.net/haber/23059/mersinde-yakalandi-cok-zehirli.html	2
4	06.07.2015	Alanya,AN	N. Oğuz	Free diver/Spearfishing	http://www.zipkinci.com/	-
5	08.07.2015	Örnekköy, Antalya	comandante mako	Free diver/Spearfishing	http://www.zipkinci.com/	-
6	16.07.2015	Kaş, Antalya	Ö. Moğol	SCUBA diver	http://haberkibris.com/akdeniz-tropik-aslan-baligi-kayniyor-2015-07-16.html	-
7	21.07.2015	Antalya	O.K.Özcan	Free diver/ Spearfishing	https://www.youtube.com/watch?v=5N_GFbfSZuc	3
8	27.07.2015	Kaş, AN	M. Draman	SCUBA diver	https://www.dragoman-turkey.com/tr/blog/kizildenizden-goc/	4
9	28.07.2015	Ayaş, Mersin	E. Uçkan	Free diver/ Spearfishing	http://www.zipkinci.com/	-
10	17.10.2015	Fener/Lara, AN	İ. Alemdar	SCUBA diver	https://www.facebook.com/permalink.php?story_fbid=1063490773684354&id=1020491071317658	5
11	17.11.2015	Antalya	T. İşleyen	Free diver/ Spearfishing	https://www.youtube.com/watch?v=gtsixN6668o	6
12	20.12.2015	Samandağ, Hatay	BeylikdüzüSSK	SCUBA diving center	https://www.youtube.com/watch?v=KRlEGVwjyCI	7
13	29.12.2015	Kaş, AN	B. Şimşek	SCUBA diver	https://www.youtube.com/watch?v=GXmPQaVajyU	8
14	27.06.2016	Gazipaşa, AN	Y. Tatlısoy	Artisanal fisherman	http://www.milliyet.com.tr/gazipasa-da-zehirli-aslan-baligi-gundem-2269549/	9
15	Summer2016	Kemer, AN	T. Ayer	SCUBA diver	Reported and send photo to TUDAV (citizen science)	10
16	06.08.2016	Manavgat, AN	B. Koçkaya	Lawyer	Reported and send photo to TUDAV(citizen science)	11
17	17.10.2016	Üçadalar, AN	M. E. Eyuboglu	SCUBA diver	https://www.youtube.com/watch?v=Bg95NHDyEDk	12
18	03.11.2016	Muğla, Ortaca	U. Türk	Recreational fisherman	http://www.34volt.com/ortaca-da-zehirli-aslan-baligi-yakalandi-haberi-467173/	13
19	14.11.2016	Üçadalar, AN	M.E. Eyuboglu	SCUBA diver	https://www.youtube.com/watch?v=jKqCvZWbAms	14
20	17.01.2017	Taşucu Anamur	D. Ayas	Academician	http://www.virahaber.com/turkiye-denizlerinde-aslan-baligi-tehdidi-43457h.htm	15

Sampled individuals

Eight individuals of lionfish, *Pterois* sp. (Figure 6) were sampled in nine SCUBA dives at the depths between 10 m and 15 m, and between the dates of

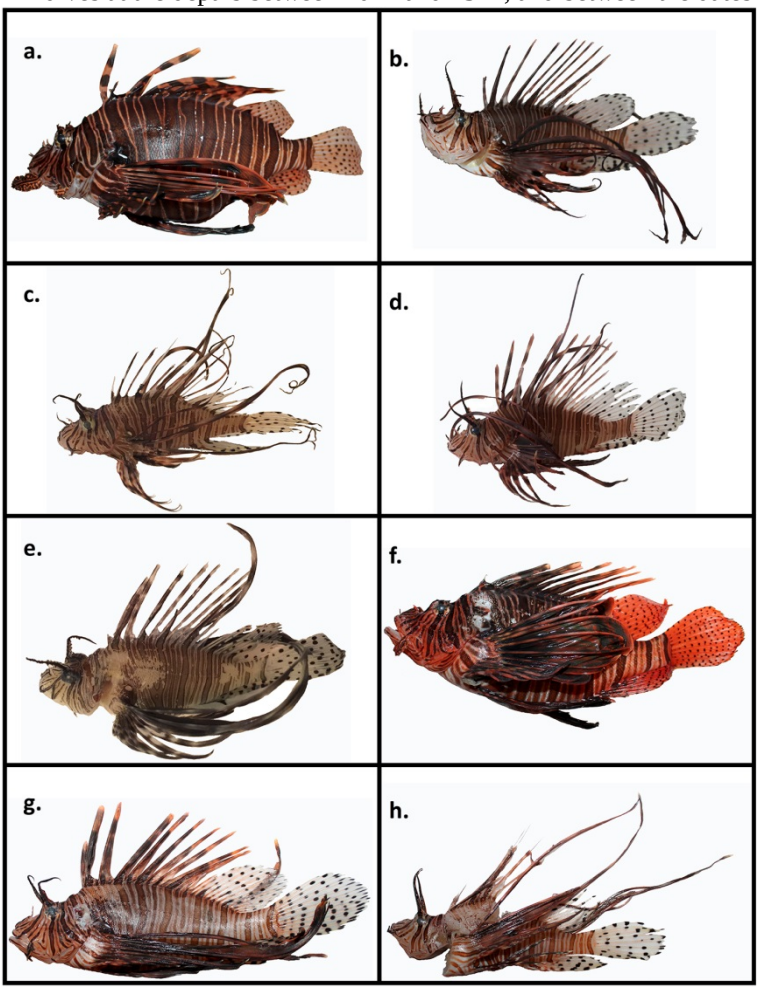

Figure 6. Lionfish individuals sampled in Kemer, Antalya; a) TL= 28.6 cm, WW= 398.77 g, D: XIII+10, A: III+7; b) TL= 11. 4 cm, WW= 14.47 g, D: XIII+10, A: III+7; c) TL= 9.2 cm, WW= 6.61 g, D: XIII+10, A: III+6; d) TL= 12.7 cm, WW= 20.75 g, D: XIII+10, A: III+6; e) TL= 13.4 cm, WW= 29.4 g, D: XIII+10, A: III+7; f) TL= 28.7 cm, WW= 395.08 g, D: XIII+11, A: III+7; g) TL= 16.7 cm, WW= 54.48 g, D: XIII+11, A: III+7; h) TL= 10.1 cm, WW= 8.45 g, D: XIII+10, A: III+6.

20.01.2017 and 10.02.2017 in Kemer, Antalya. The bottom time of the dives was approximately 45 min and the visibility was very low, approximately 1-2 m. The dives were conducted in the same localities that the fish were observed

by the divers during summer. The individuals seem not to change their localities in winter. They prefer the areas where the sandy and rocky habitats meet.

The total length (TL) of the eight individuals varied between 8.5 and 29.3 cm, and the wet-weight between 7.09 and 398.77 g. One of the large specimens was a male (29.3 cm TL) and the other was a female (28.6 cm TL) and the rest were juveniles. The gonads of one female individual were in the post-spawning stage. The specimens were checked for stomach contents. The stomachs of four individuals were empty. There were identifiable parts of *Mullus surmuletus* in the stomach of the specimen with 29.3 cm TL and the weight of the stomach was 1.29 g. An individual of Gobiidae sp. with 1.7 cm TL was found in the stomach of the specimen with 11.3 cm TL and the weight of the stomach was 0.14 g. There were unidentifiable parts of a Teleost fish in the stomach of the specimen with 8.5 cm TL with a stomach weight of 0.03 g. An undistinguished content was also found in the stomach of the specimen with 13.4 cm TL.

Discussion

Frazer *et al*. (2012) and Morris *et al*. (2009) summarized the impacts of the lionfish in the non-native ecosystems as: a) predation on a wide range of native organisms up to its 2.5- 6% of body weight per day, b) occupation of the key-habitats especially for juveniles, c) increase in the algal dominance with the reduced abundance of herbivore fish, d) predation on and competition with the commercial and endangered fish that may alter the fisheries and income, e) human envenomation; and stated the importance of the management approaches and measures. They describe the decreasing size frequency after targeted removals resulting smaller individuals that also consume less prey. Also, Arias-Gonzales *et al*. (2011) reveal that lionfish may have remarkable direct and indirect effects on food web in terms of predation and competition.

Although it is considered that an invasion is unlikely in the Mediterranean than for the Atlantic because of the results revealing low connectivity between areas which is potential for the invasion of lionfish. One of the greatest potential area was predicted as the Gulf of İskenderun, Turkey besides France, in terms of densities of settled lionfish and its larvae (Johnston and Purkis 2014). The prediction of Johnston and Purkis (2014) did not cover the Gulf of Antalya; however, Poursanidis (2015) reported high probability of distribution in the whole Mediterranean coast of Turkey. According to the results of this study, it is evident that the lionfish has established in the eastern Mediterranean coast of Turkey. However, there is still a lack of information about its abundance.

According to Kimball *et al*. (2004), lionfish stops feeding when the temperature is 16.1°C, but their ability to withstand prolonged fasting is very high for periods of over 12 weeks without mortality (Fishelson 1997). However, the stomach contents of the four individuals sampled from 14.9-16.0°C sea-water

revealed that the fish continues feeding in this low temperatures, and it is obvious that lionfish successfully overwinters in the eastern Mediterranean coasts of Turkey.

A wide range of organisms are reported as prey for lionfish (Green *et al*. 2011; Valdez-Moreno *et al*. 2012; Côté *et al*. 2013) and from the stomach contents of the sampled fish, it can be understood that the mullids and the gobiids are the preys of the lionfish in the Mediterranean Sea. However, the information on its diet in the Mediterranean is very scarce and urges immediate broad investigation.

Due to their high site fidelity and stationary behaviour after larval settlement (Kimball *et al*. 2004 and the references therein), the lionfish were observed in the same locations in winter as they were in summer. Sea-water temperature along the Mediterranean coast of Turkey during winter may provide suitable habitat for lionfish survival; however, decreasing temperatures below 10°C in the central Aegean Sea will likely to create a barrier for their northern expansion.

Lionfish were reported to reproduce every 2-4 days year-round with a fecundity of 1800–41945 oocytes. Female lionfish matured at 189–190 mm total length when they are 1+ years old (Edwards *et al*. 2014; Gardner *et al*. 2015; Johnson and Swenarton 2016). The specimens with 29.3 cm and 28.6 cm TL corresponds to an age of 2+ according to Edwards *et al*. (2014) and Johnson and Swenarton (2016) which is compatible to the date of the first record of the species in the region.

The interviews showed that lionfish was not well-known by professional fishermen around the Gulf of Iskenderun yet. Only 31% of interviewed fishermen could recognize this species. However, the answers given about the local names, distribution, habitat, depth and fishing gears clearly referred that it was confused with other species in the same area. Only 33% of the positive interviews, fishermen actually knew the local name as "Aslan Balığı" (lionfish). The other answers (İskorpit, Naylon, Zehirli Balık) were the local names mostly used for other Scorpaeniform fishes distributed in the area. Moreover, lionfish inhabits in rocky habitats (Froese and Pauly 2016), but nearly half of the consultees reported that they encountered the fish in sandy bottoms. Besides, the highest encounter rate was detected among the trawlers. Therefore, more effort is required to create public awareness especially among professional fishermen.

The public perception about the lionfish is highly variable in Turkey, and this may affect our understanding of the rate of invasion. Due to the risk of the envenomation and difficulties to catch, people could possibly avoid the fish. While the fish is not so common and cannot be baited, trapped or trawled; catching the fish will probably cost more than its sales value. It is, therefore,

very important to create public awareness to convince people that while hunting, trading, or cooking the lionfish, they are actually helping the native ecosystem. As the recognition increase, the fish could be a part of the fisheries industry like the other invasive alien species, *Saurida undosquamis* (Richardson, 1848) in the Mediterranean Sea.

Acknowledgement

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Türkiye'nin Doğu Akdeniz kıyılarında aslan balığının dağılımı

Öz

Bu çalışma aslan balıkları ile ilgili olarak balıkçılarla yapılan anket sonuçlarını, gazetelerdeki ve elektronik sosyal ağlardaki gözlem kayıtlarını ve Türkiye'nin Doğu Akdeniz kıyılarından örneklenen sekiz aslan balığı bireyinin ayrıntılarını sunmaktadır. Çalışmanın sonuçlarına göre, aslan balığının Türkiye'nin Doğu Akdeniz kıyılarında yerleştiği açıktır. Bununla birlikte, hâlâ bolluğu hakkında bilgi eksikliği vardır. 20.01.2017 ve 10.02.2017 tarihleri arasında Kemer, Antalya'da, 10-15 m derinliklerinde gerçekleştirilen dokuz SCUBA dalışında örneklenen sekiz bireyin toplam uzunlukları (TL) 8,5 cm ile 29,3 cm arasında ve ağırlıkları 7,09 g ile 398,77 g arasında değişmektedir. Büyük bireylerden biri erkek (29,3 cm TL) diğeri dişi (28,6 cm TL) ve diğer altı birey juvenildir. Balıkların mide içeriği kontrol edilmiştir. Dördünün midesi boştur. Diğer dört bireyin midelerinde *Mullus surmuletus* parçaları, bir Gobiidae türü, tanımlanamayan bir Teleost balık parçaları ve belirlenemeyen bir içerik tespit edilmiştir. Bilimsel yayınlar dışında, gazete ve sosyal medyada 15.07.2014 ile 17.01.2017 tarihleri arasında Türkiye'nin doğu Akdeniz kıyılarında toplam yirmi adet aslan balığı gözlem kaydı belirlenmiştir ve bunların on beşi fotoğraf ve video ile kanıtlanmıştır. Gerçekleştirilen anketler sonucunda aslan balığının henüz İskenderun Körfezi çevresindeki profesyonel balıkçılar tarafından iyi bilinmediği anlaşılmıştır. Aslan balığı ile ilgili halkın algısı Türkiye'de oldukça değişkendir ve bu durum istila oranını etkileyebilir.

Anahtar Kelimeler: Yabancı istilacı türler, anket, gözlem kayıtları, örnekleme, mücadele

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