



- RESEARCH ARTICLE -

Age, growth parameters and food composition of Invasive Red Lionfish (*Pterois volitans* L., 1758) in İskenderun Bay

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Abstract

Age, growth parameters and food of *Pterois volitans* (Linnaeus, 1758) Red lionfish were studied. A total of 254 lion fishes (*P. volitans* and *Pterois miles*) were collected from commercial drift net, angling fisheries and diving with hand net southern coast of the İskenderun Bay between March 2018 and March 2019. 29.53% of sample was *P. volitans*. Age was determined by reading whole sagittal otoliths. Fish ranged from 14.2 to 35.3 cm in total length, which corresponded to fish between 1 to 7 years old. The sex ratio (1:1.07) was biased toward males ($P < 0.05$). The length–weight relationships were $W = 0,0042 \times L^{3.3514}$ ($R^2 = 0,92$) and $W = 0,0108 \times L^{3.0423}$ ($R^2 = 0,94$) for females and males, respectively. Growth parameters were estimated using the standard von Bertalanffy growth model ($K = 0.1507$, 64, $L_{\infty} = 47.58$ cm and $t_0 = -2.0506$ for combined sexes. The diet was composed of fishes and crustaceans.

Keywords:

Pterois volitans, Age, Growth, İskenderun Bay

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Introduction

Invasive species are a major threat to global biodiversity for ecosystem health (Carlton and Geller 1993; Ruiz et al. 1997). *P. volitans* and *P. miles* *P. volitans* has been reported as the most documented invader among aquatic organisms (Hixon ve ark., 2016; Azzurro ve ark., 2017; Bilge ve ark., 2016. The opening of the Suez Canal in 1869 was the most important factor leading to an increase in the inflow of Indo-Pacific invasive species into the Mediterranean. With the opening of this channel, alien species began to enter the Mediterranean intensively and in time, the entry of these alien species was described as invasion (Öztürk and Turan, 2012). Studies on lion fish have increased steadily over the last 10 years and are generally related to their geographical distribution (Dağhan and Demirhan, 2020 inpress). *P. volitans* in the Gulf of İskenderun for the first time the

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presence of Gürlek et al. (2016). Lion fish should be expected to spread throughout the Gulf of Iskenderun in 5-10 years and affect biodiversity (Dağhan and Demirhan, 2020 inpress).

The purpose of the study is to determine age, growth of *P. volitans* in İskenderun Bay.

Material and Methods

A total of 75 lionfish specimens were obtained from commercial drift net, pole spears and hand net while SCUBA diving or snorkeling from Southern coast of shallow waters of İskenderun Bay. Total lengths to the nearest 1 mm and wet weights to the nearest 0.1 g were recorded for all fish. Lionfish were sexed via macroscopic examination of their gonads, and sagittal otoliths were removed from the fish and cleaned with alcohol, stored with glycerin oil in U shape plate. Age determination was performed using a stereoscopic zoom microscope (Olympus SZX16) under reflected light against a black background. Stomachs are dissected from fish in the field and preserved in formalin. The relationships between wet weights and total lengths was determined by fitting a power function to the relevant data. Age and length data were used to model growth by estimating parameters in von Bertalanffy growth equations (von Bertalanffy, L. 1957; Bagenal, 1978; Avsar, 2005).

Results

Fish ranged from 14.2 to 35.3 cm in total length, which corresponded to fish between 1 to 7 years old (Figure 1). The sex ratio (1:1.07) was biased toward males ($P < 0.05$). The length–weight relationships were for combined data from juveniles, males and females were related to total lengths $W = 0,0042 \times L^{3.3514}$ ($R^2 = 0,92$) and $W = 0,0108 \times L^{3.0423}$ ($R^2 = 0,94$) for females and males, respectively (Figure 2a and b).. Growth parameters were estimated $K = 0.1507$, 64 , $L_{\infty} = 47.58$ cm and to -2.0506 for combined sexes using the standard von Bertalanffy growth model (Figure 3). The prey taxa found in the greatest proportion of sampled lionfish stomachs (excluding empty stomachs) were unidentified (i.e. digested) teleosts (65% of sampled stomachs), followed by crustacea (35% of stomachs).

Figure 1. Length frequency of *P. volitans*

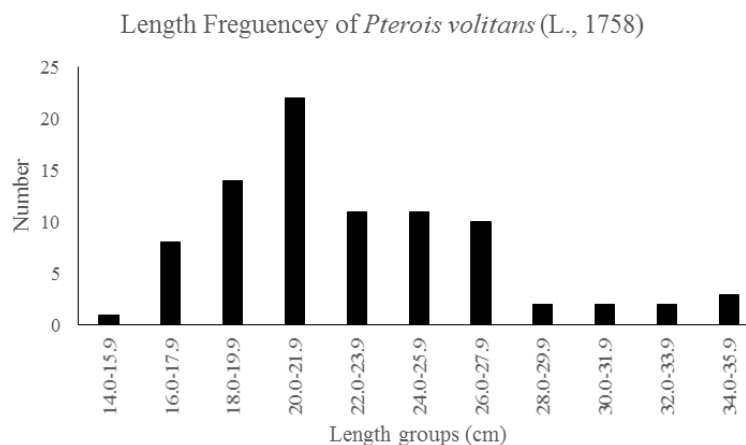


Figure 1. Length frequency of *P. volitans*

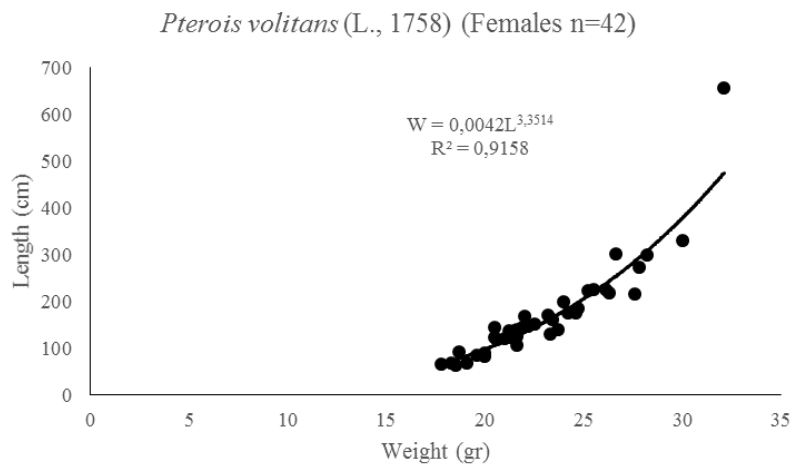


Figure 2. Length-Weight relationship of *P. volitans* females

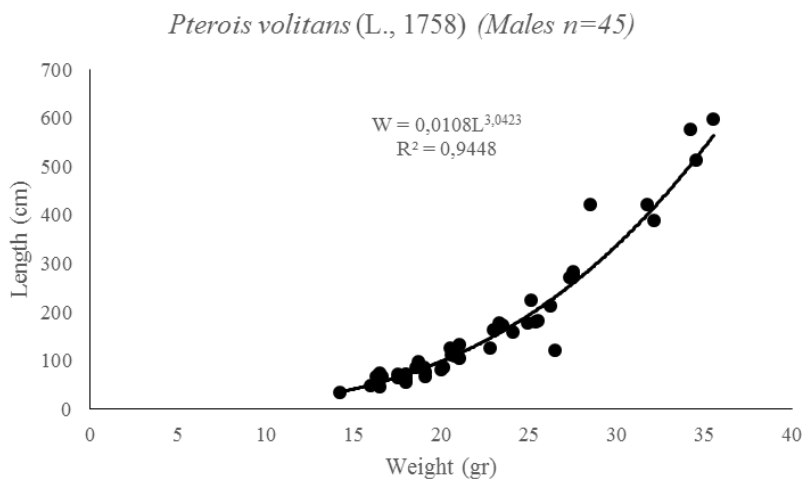


Figure 3. Length-Weight relationship of *P. volitans* males

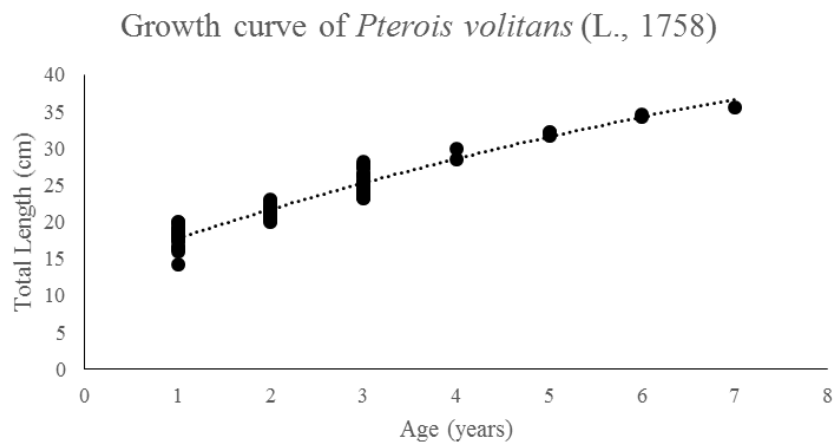


Figure 4. Growth curve of *P. volitans*

Discussion

First of all, the situation that attracts attention in the studies with lion fish is the handling of the species. In most studies, two species were evaluated together as *P. volitans/miles* complex, while in some studies two species were identified as *Pterois* spp. Additionally, in species discriminated studies, *P. miles* has been studied in few studies and *P. volitans* has been studied mostly (Dağhan and Demirhan, 2020 inpress). The primary reason that the studies are mostly related to *P. volitans* is that the species was carried out in the West Atlantic where proportionally it is very abundant (Morris ve ark., 2008). In addition, researchers may have overlooked a small number of *P. miles* because of the complexity and difficulty of species discrimination (Kochzius et al., 2003; Hamner, 2005), and may have evaluated two species together in this region (Dağhan and Demirhan, 2020 inpress). Turan et al. (2020 inpress) reported the presence of *P. miles* and *P. volitans* in the Mediterranean, and the DNA Barcodes of the species for the definitive differentiation of these two species.

Allometric growth obtained in the present study is similar to the values reported by other researchers (Tablo 1). “b” value of males is very close to 3 called isometric growth. Actually, the difference between males and females may be due to the fact that the species has mature gonads that are constantly mature due to its reproductive strategy throughout the year and the nutritional habit that it can starve for a long time. The fact that the female individuals obtained in the study were above the height of reaching sexual maturity reported in the literature and that the stomach content was generally empty support this situation.

In the present study, larger asymptotic length value and lower growth coefficient value were found other researchers reported (Tablo 2). Differences between populations of the same species in different ecosystems are expected (Pusack et al., 2016). The reason for the low growth coefficient may be that the Mediterranean is less nutritionally inefficient than the other regions reported in the literature. It is expected that the species with lower growth coefficient will reach a larger asymptomatic length value (Gubiani et al., 2011). However, sampling methods have an impact on the results obtained. Selective methods are used in the sampling of lion fish, and therefore the sample may not adequately reflect the population.

Table 1. Length-weight relationships of *P. volitans* (re-edited from Dağhan and Demirhan, 2020)

Reference	Species	Region	a	b	R ²
Recent study	<i>P. volitans</i> (males)	NE Mediterranean	0,0108	3,0423	0,94
Recent study	<i>P. volitans</i> (females)	NE Mediterranean	0,0042	3,3514	0,92
Recent study	<i>P. volitans</i> (all)	NE Mediterranean	0,0089	3,1116	0,92
Edwards et al., (2014)	<i>Pterois</i> spp.	Western Atlantik	0.000003	3,2400	0,97
Barbour et al., (2011)	<i>P. volitans</i> ve <i>P. miles</i>	Western Atlantik	0,00003	2,8900	-
Sandel et al. (2015)	<i>P. volitans</i> ve <i>P. miles</i>	Western Atlantik	0,0235	2,8100	-
Chin et al., (2016)	<i>P. volitans</i> ve <i>P. miles</i>	Western Atlantik	2,8000	2,8500	0,87

V-Derbez and Fitzgerald (2016)	<i>P. volitans ve P. miles</i>	Western Atlantik	0,3200	3,2300	0,98
Fogg et al., (2013)	<i>P. volitans</i>	Western Atlantik	0,1400	3,4300	0,99
Dahl and Patterson (2014)	<i>P. volitans</i>	Western Atlantik	0,2100	3,3400	0,98
P-Chan and A-Perera (2014)	<i>P. volitans</i>	Western Atlantik	0.104	3.30	0.98
Toledo-Hernández (2014)	<i>P. volitans</i>	Western Atlantik	0,0800	3,1100	0,96
Rodriguez et al., (2015)	<i>P. volitans</i>	Western Atlantik	0,0110	3,3300	0,97
Itza et al., (2016)-2012	<i>P. volitans</i>	Western Atlantik	0.0041	3.25	0.97
Itza et al., (2016)-2013	<i>P. volitans</i>	Western Atlantik	0.0049	3.19	0.98
Cobián-Rojas et al., (2016)	<i>P. volitans</i>	Western Atlantik	0.012	3.01	-
Sabido-Itza et al., (2016)	<i>P. volitans</i>	Western Atlantik	0,5200	3,1800	0,99
A-Perera and Q-Puerto (2016)	<i>P. volitans</i>	Western Atlantik	0,2900	3,3000	0,95

Table 2. Von Bertalanffy growth parameters of *P. volitans* (re-edited from Dağhan and Demirhan, 2020)

Reference	Species	Region	Ages	L_{∞}	K	t_0
Recent study	<i>P. volitans</i>	NE Mediterranean	0-7	47,58	0,15	-2,05
Edwards et al., (2014)	<i>Pterois spp.</i>	Western Atlantik	0-5	34,90	0.42	-1,01
Barbour et al., (2011)	<i>P. volitans ve P. miles</i>	Western Atlantik	0-8	42,52	0,47	-0,50
Swenarton (2016)	<i>P. volitans ve P. miles</i>	Western Atlantik	0-3	44,80	0,62	0,00
Johnson ve Swenarton (2016)	<i>P. volitans ve P. miles</i>	Western Atlantik	0-3,5	44,80	0,47	0,00
Eddy et al., (2019)	<i>P. volitans ve P. miles</i>	Western Atlantik	0-9	38,10	0,77	-0,42
Farquhar, (2016)	<i>P. volitans</i>	Atlantik Caroline	0-6	42.5	0.32	0.85
Farquhar, (2016)	<i>P. volitans</i>	Atlantik Bonaire	0-5	38.7	0,39	0,048
Rodriguez et al., (2015)	<i>P. volitans</i>	Western Atlantik	0-2,5	42,00	0,88	-0,107
Fogg et al., (2015)	<i>P. volitans</i>	Western Atlantik	0-4,5	40,00	0,56	-0,21

Pusack et al., (2016)	<i>P. volitans</i>	Pasifik	0-8	22,50	1,62	-0,07
Pusack et al., (2016)	<i>P. volitans</i>	Atlantik	0-8	32,2	1,48	-0,07

The lion fish floating egg masses can be transported by currents to long distances (Hare and Whitfield, 2003; Morris and Whitfield, 2009; Ahrenholz and Morris, 2010; Morris et al., 2011). The larvae, which are planktonic in 25-40 days, can be carried by currents (Hare ve Whitfield, 2003; Morris ve Whitfield, 2009; Ahrenholz ve Morris, 2010). This breeding strategy is the reason that the species passes through the Suez Canal to the Mediterranean Sea (Morris et al., 2011). Probably, the larvae passing through the Mediterranean Sea and reaching the shallow waters could not increase their populations due to the predation pressure and the larvae reaching the deeper regions could increase their populations due to the lower predation pressure. The lion fish, which increased its population in deeper water, started to spread in shallow water in time. This may be the reason for the rapid spread of *P. miles*, other species of Pterois in the region, 20 years after 1991 (Golani and Sonin, 1992), when it was first observed in the Mediterranean, as it was first observed in the Atlantic in 1985 (Semmens et al., 2004) and was not observed for a period of 15 years and then increased and expanded in intensity (Schofield, 2009). The species discussed in this study is probably to have a similar story. The 7 age values obtained in the present study indicate that *P. volitans*, which was first detected in 2016 (Gürlek et al., 2016; Turan ve ark., 2017) has been in the Gulf of İskenderun since 2012. As it is known, lion fish spread to mesopotic depth (Nuttall et al., 2014; Goodbody-Gringley et al., 2019).

There are two species of lion fish in the Mediterranean: *P. volitans* and *P. miles* (Golani ve Sonin, 1992; Turan ve ark., 2014; Gürlek ve ark., 2016). *P. miles*, one of the lion species, is more invasive than *P. volitans* (Australian Bureau of Rural Sciences, 2008; Azzurro ve ark., 2017; Bilge ve ark., 2016), while *P. volitans* is more common than *P. miles* (Morris ve ark., 2008). As in the Mid-West Atlantic, the spread from lagoons (Jud et al., 2011) to mesophotic depth (Nuttall et al., 2014; Goodbody-Gringley et al., 2019) or even very shallow longos (Barbour et al., 2010; Biggs and Olden 2011; Claydon et al., 2012; Pimiento et al., 2015) should be expected to become widespread throughout the Iskenderun Gulf in 5-10 years and affect biodiversity if it does not encounter ecological resistance. Additionally, it is possible that other species (*P. antennata* Bloch, 1787; *P. brevipectoralis* Mandritsa, 2002; *P. mombasea* Smith, 1957; *P. andover* Allen and Erdman 2008; *P. paucispinula* Matsunuma and Motomura 2014; *P. sphex* Jordan and Evermann 1903) will enter the Mediterranean with first priority two species (*P. cincta* Rüppel 1838 and *P. radiate* Cuvier 1829) still present in the Red Sea and one species (*P. russelii* Bennett 1831) in Persian Gulf.

It is known that lion fish are not dominant in the Indian Ocean and Pacific because of the balance in the natural ecosystem. Green and Co'te' (2009) and Pusack et al. (2016) suggest that volitans grow faster in the Atlantic than in the Pacific, where they may reach a larger population level and larger average asymptotic length than natural populations in the invading region. Albins and Hixon (2008) that lion fish infested in the region of natural species in the inventory reduces the participation by 80%, Green et al. (2012) reported that they reduce natural biomass by 65%. Over the last 2 year. *P. volitans* and *P. miles* has rapidly become established in the Southern coastal waters of İskenderun Bay. Management strategies have to be developed to control of this invasive

species for protecting of biodiversity ecosystems, and to society and health, which translate directly into threats to the economy. Management and control strategies are implemented with lion fish in various regions in the Atlantic (Morris et al., 2009; Morris ve Withfield, 2009; Sealey et al., 2009; Ritterman, 2016). It is seen that the fishing pressures applied in these regions (Morris ve ark., 2011; Barbour ve ark., (2011) do not provide the expected benefit. Barbour et al. (2011) reported that the population of lion fish can only be controlled when kept under constant high fishing pressure, but this requires high cost and is not likely to eliminate the species with this effort. The researcher stated that this application may yield small scale results.

Consequently, region-specific control and management strategy with lion fish should be developed; ⁽¹⁾ selective and over fishing pressure should be established on lion fish (by supporting spearfishing in shallow waters, pot fishing methods (Demirhan et al., 1998) or other methods like underwater robots should be developed in deeper waters by special licensed fishermen), ⁽²⁾ fishing pressure over the other species should be reduced, ⁽³⁾ public awareness should be raised, ⁽⁴⁾ consumption should be encouraged, ⁽⁵⁾ regular monitoring studies of the species should be established and supported.

Conflict of Interest: No potential conflict of interest was reported by the authors.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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