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Reproductive characteristics of the spotted weever (*Trachinus araneus*- Cuvier, 1829) and the greater weever (*Trachinus draco*- Linnaeus, 1758) from the western Egyptian Mediterranean coast

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ABSTRACT
536 *Trachinus araneus* and 460 *Trachinus draco* samples were collected monthly from August 2018 to August 2019 by the bottom trawl operated in the Western Egyptian Mediterranean coast. Some reproductive characteristics of both species such as sex ratio, gonado-somatic index (GSI), hepato-somatic index (HSI), spawning time, and length at first maturity were reported. Sex ratio analysis of male: female ratio was 1: 2.90 (x^2 = 122.56) for *T. araneus* and 1: 0.29 (x^2 =135.08) for *T. draco*. The gonado-somatic index (GSI) and hepato-somatic index (HSI) for the two species indicate that the spawning period occurred in autumn months. The Length at first sexual maturity (Lm_{50}) was 14.29± 0.38 cm for *T. araneus* and 14.60± 0.26 cm for *T. draco* with compatible ages 3.89 and 3.92 years, respectively. Moreover, the reproductive load ratios were 0.44 for *T. araneus* and 0.56 for *T. draco*.

INTRODUCTION

Weevers (Family Trachinidae) in the Mediterranean Sea are represented by two genius (Trachinus and Echiichthys), representing by four species: *Trachinus araneus*- Cuvier, 1829 (spotted weever), *Trachinus draco*- Linnaeus, 1758 (greater weever), *Trachinus radiatus*- Cuvier, 1829 (starry weever) and *Echiichthys vipra*- Cuvier, 1829 (lesser weever), **Bentivegna and Fiorito (1983)**; **Nelson *et al*. (2016)**. They are widely distributed venomous species in eastern Atlantic coastline, Mediterranean, Aegean and Black Seas **(Fischer *et al.*, 1987)**; found on the sandy and muddy bottoms **(Frosese and Pauly, 2007)**. In Egypt, weevers fish present mainly as bycatch in the bottom trawl fishing gear. Although they haven't economic value but they have a vital ecological role in the marine fauna biodiversity. There is no availability about this family reproductive aspects in Egypt but only **Abdallah (2002); Heneish and Rizkalla (2021)** studied its length- weight relationship and biometric characters, respectively. In other areas, **Ak and Genç (2013)** concerned with growth and reproductive traits of *T. draco* in the eastern coast of Black sea where **Hamed and Chakroun (2017)** focused on the reproductive biology of *T. radiates* in the Gulf of Tunis.

The present study based on the most dominant species in family trachinidae catch (*T. araneus* and *T. draco*) to study their reproductive aspects as sex ratio, gonado-somatic index, hepato-somatic index and length at first sexual maturity because of their vital ecological importance role in the marine biodiversity.

MATERIALS AND METHODS

Trachinidae fish samples were monthly collected from August 2018 to August 2019 by the bottom trawl operated in the Western coast of Egyptian Mediterranean Sea **(Fig. 1).** The samples transferred to the laboratory where we identified and separated to different species and sexes. Our study for the reproductive aspects based on 536 *T. araneus* and 460 *T. draco* samples. For each specimen the total length (TL) measured to the nearest 0.1 mm. The total weight (Tw), gonad weight (Gw), liver weight (Lw) measured to the nearest 0.01 g.

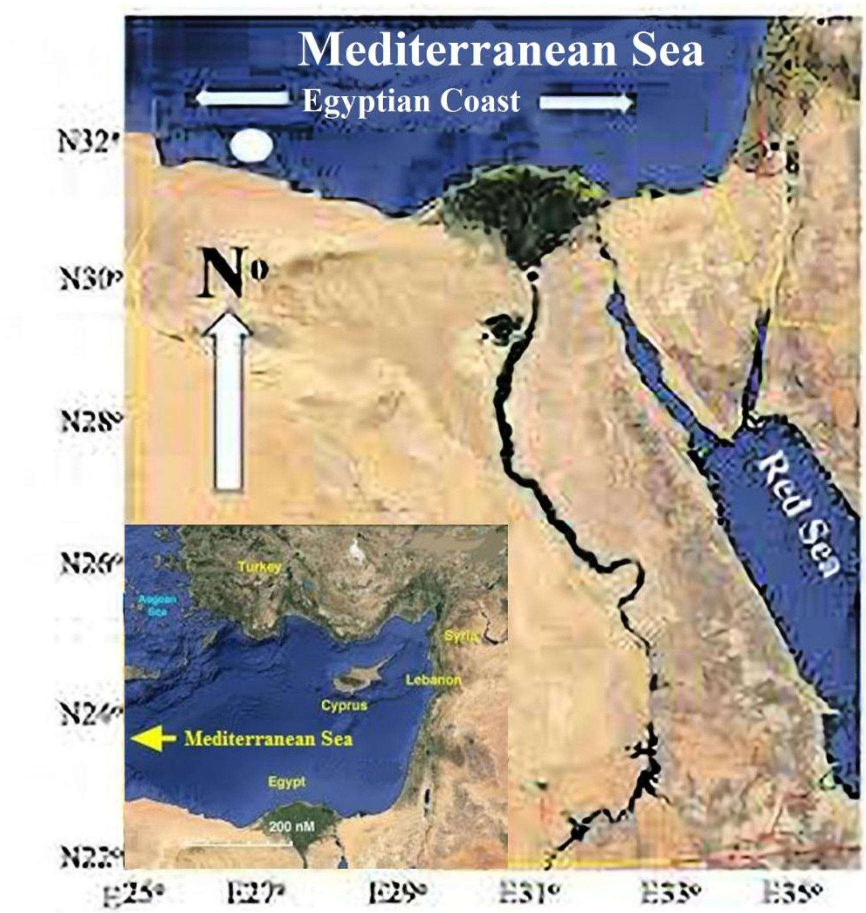

Fig. 1. Map of the study area, the Western Egyptian Mediterranean Sea.

Sex was determined by examination of gonad either by the visual assessment or under a binocular microscope. The sex ratio was calculated from the formula: Sex ratio (M:F) = Number of Females/Number of males. The Chi-square test at the 0.05

significance level was employed to find out the goodness of fit of the observed sex ratio to that of theoretical sex ratio of 1:1 (M:F). The following formula of **Wootton (1998)** was used for Chi-square test: $\chi^2 = [(F-E)^2/ E] + [(M-E)^2/ E]$ where χ^2 is the value of Chi-Square, F is the observed number of females, M is the observed number of males and E is the expected number of each sex (the hypothetical 1:1 ratio).

Spawning season was estimated based on the availability of gonad maturation during the study period and the monthly variation in the gonado-somatic index (GSI). Maturity stage was evaluated in different months, based on the scale described by **King (1982)** with some modifications. Maturity stages were classified into six stages, (I) Immature, (II) Developing/ Recovery, (III) Maturing, (IV) Ripe, (V) Running/ Spawning and (VI) Spent according to their development. The monthly gonado-somatic index was calculated according to **(Anderson and Gutreuter, 1983)** formula: (GSI= gonad weight/ total body weight)*****100. The hepato-somatic index monthly values fluctuations were followed by using **Bougis (1952)** formula: HSI= (liver weight/ gutted body weight)*****100.

The size at sexual maturity (L_{m50}) for each species, the percentage frequency of immature and mature fish during the period of gonad maturation was used to group the fish into 1 cm length group, then the maturity curves **(King, 1995)** were fitted to estimate the length at which 50% of the population become mature for the first time.

The reproductive load ratio was estimated as L_{m50}/ L_{max}, **(Longhurst and Pauly, 1987)**, where L_{max} = maximum length reached in the sample.

RESULTS

1. Sex ratio

The overall sex ratio M: F was 1: 2.90 for *T. araneus* and 1:0.29 for *T. draco*, which unlike the expected ratio (1:1), where x^2 = 122.56 in *T. araneus* and x^2 = 135.08 in *T. draco*. The Immature or juveniles sample that couldn't be distinguished as male or females were (10 samples) of *T. araneus* and (12 samples) of *T. draco* were excluded from the sex ratio investigation, **Table (1& 2).**

The length of *T. araneus* was ranged from 10.9 cm to 30.0 cm the total number of males represent (25.86%) and the females representing (74.14%), which indicates that the percentage of females are more dominant than the males percentage in all length groups except for lengths (14-14.9 and 29-29.9) cm. Where *T. draco* length was ranged from 11.8cm to 27.6cm the total number of males represent (77.23%) and the females representing (22.77%) which indicates that the percentage of males are more dominant than the females percentage in all length groups except in the large lengths from 25.0-27.9 cm.

Table 1. *T. araneus* collected from Western Egyptian Mediterranean coast sex ratio variation with length groups (cm).

Length group	Total Fish No.	Males		Females		Sex ratio M:F	χ^2
		No.	%	No.	%		
13- 13.9	5	2	40.00	3	60.00	1:1.5	0.2
14- 14.9	11	6	54.55	5	45.45	1: 0.83	0.09
15- 15.9	28	5	17.86	23	82.14	1: 4.60	11.57
16- 16.9	38	14	36.84	24	63.16	1: 1.71	2.63
17- 17.9	54	11	20.37	43	79.63	1: 3.91	18.96
18- 18.9	57	16	28.07	41	71.93	1: 2.56	10.96
19- 19.9	55	15	27.27	40	72.73	1: 2.67	11.36
20- 20.9	46	11	23.91	35	76.09	1: 3.18	12.52
21- 21.9	40	13	32.50	27	67.50	1: 2.08	4.90
22- 22.9	51	16	31.37	35	68.63	1: 2.19	7.08
23- 23.9	43	13	30.23	30	69.77	1: 2.31	6.72
24-24.9	28	6	21.43	22	78.57	1: 3.67	9.14
25- 25.9	22	3	13.64	19	86.36	1: 6.33	11.64
26- 26.9	16	1	6.25	15	93.75	1: 15	12.25
27- 27.9	13	1	7.69	12	92.31	1: 12	9.31
28- 28.9	14	2	14.29	12	85.71	1: 6	7.14
29- 29.9	2	1	50.00	1	50.00	1: 1	0.00
30- 30.9	3	1	33.33	2	66.67	1: 2	0.33
Total	**526**	**136**	**25.86**	**390**	**74.14**	**1: 2.90**	**122.65**

Table 2. *T. draco* collected from Western Egyptian Mediterranean coast sex ratio variation with length groups (cm).

Length group	Total Fish No.	Males		Females		Sex ratio M:F	χ^2
		No.	%	No.	%		
11-11.9	1	1	100	-	-	1:0	1
12-12.9	1	1	100	-	-	1:0	1
13- 13.9	3	2	66.67	1	33.33	1: 0.5	0.33
14- 14.9	23	17	73.91	6	26.09	1: 0.35	5.26
15- 15.9	28	24	85.71	4	14.29	1: 0.167	14.29
16- 16.9	25	20	80	5	20	1: 0.25	9
17- 17.9	51	41	80.39	10	19.61	1: 0.24	18.840
18- 18.9	84	66	78.57	18	21.43	1: 0.27	27.43
19- 19.9	89	69	77.53	20	22.47	1: 0.29	14.75
20- 20.9	55	37	67.27	18	32.73	1: 0.49	6.56
21- 21.9	35	27	77.14	8	22.86	1:0.30	10.31
22- 22.9	22	17	77.27	5	22.73	1: 0.14	6.54
23- 23.9	16	14	87.5	2	12.5	1: 0.22	9
24-24.9	11	9	81.82	2	18.18	1: 4.5	4.45
25- 25.9	2	1	50	1	50	1: 1	0
26- 26.9	1	-	-	1	100	0:1	1
27- 27.9	1	-	-	1	100	0:1	1
Total	**448**	**346**	**77.23**	**102**	**22.77**	**1: 0.29**	**135.08**

2. Spawning period

2.1. Gonado-somatic index (GSI)

GSI monthly variations of *T. araneus* **(Fig.2)** declared that the highest value of males and females was found in October (2.405 ± 0.349) and (4.008 ± 0.776) respectively, while the lowest value of GSI was observed in April for males (0.191±0.149) and females (0.485±0.692). The GSI started to increase slowly from May until reach its peak in October; the gradual increase indicates that *T. araneus* spawning activities takes place at the autumn.

The monthly variations in GSI of *T. draco* **(Fig. 2)** revealed that it reached its maximum value in September (1.030± 0.431 for males and 3.092± 0.832 for females), while minimum value were observed in May (0.161±0.092 in males and 0.317±0.232 in females). The GSI tend to increase from June until reach its peak in September that revealed that the spawning activity of *T. draco* occurred during the early autumn.

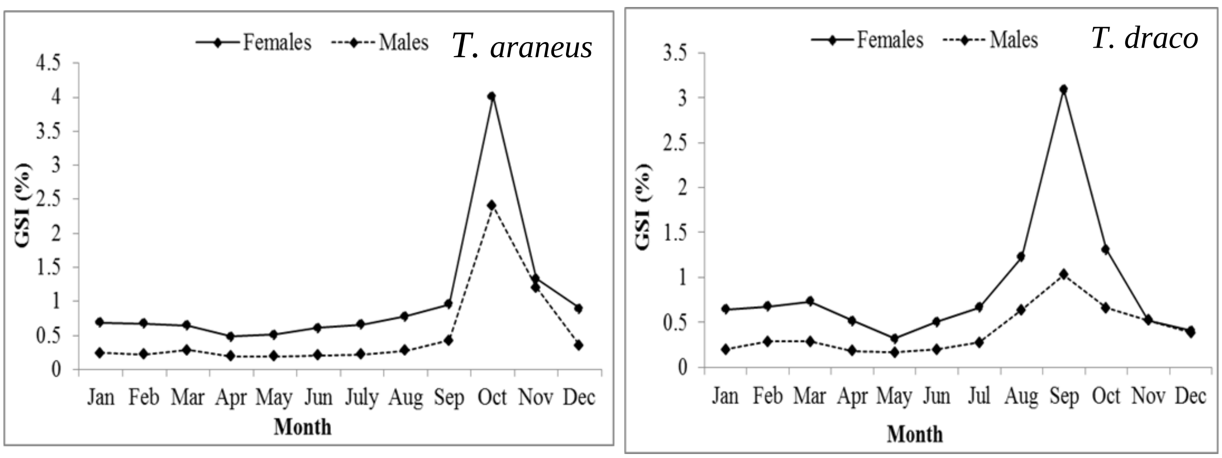

Fig. 2. Monthly variations in Gonado–Somatic Index (GSI) of *T. araneus* and *T. draco* collected from Western Egyptian Mediterranean coast.

2.2. Hepato-somatic index (HSI)

Hepato-somatic index (HSI) monthly fluctuations **(Fig. 3)** shows *T. araneus* HSI started to increase from April until reaching its highest value in September (males, 0.778±1.400; females, 2.884±2.999), while the lowest values were recorded in December for males (0.331±0.146) and for females (0.606 ±0.484). On the other hand, *T. draco* HIS was frequently fluctuated during different months with peak in August (males, 0.782±0.108; females, 1.202±0.426), and the minimum values were reported in December for males (0.333 ± 0.407) and (0.426 ±0.699) for females.

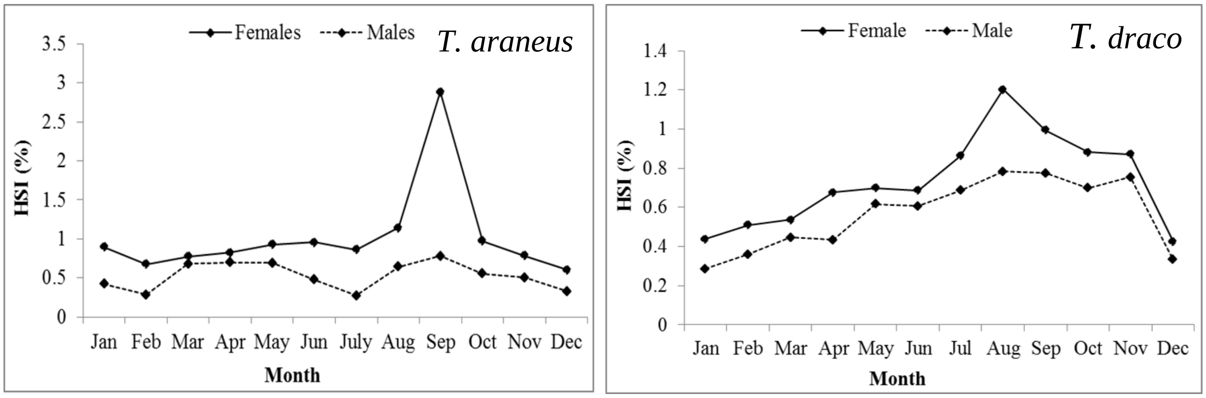

Fig. 3. Monthly variations in hepato-somatic Index (HSI) of *T. araneus* and *T. draco* collected from Western Egyptian Mediterranean coast.

3. Length at first sexual maturity (L_{m50})

Length at first sexual maturity (L_{m50}) of the total samples was estimated for *T. araneus* as 14.29±0.38 cm and 14.60± 0.26 cm for *T. draco* with corresponding ages 3.89 and 3.92 years, respectively, **(Fig. 4).** The reproductive load ratios were estimated as 0.44 for *T. araneus* and 0.56 for *T. draco.*

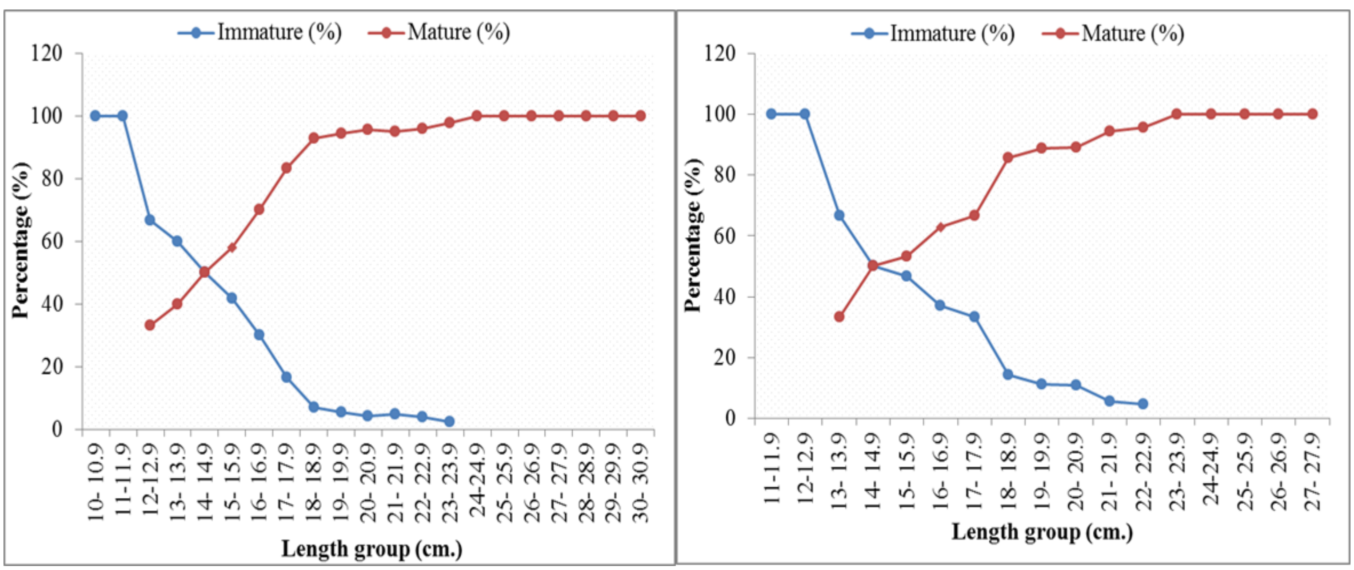

Fig. 4. Length at first sexual maturity (L_{m50}) of *T. araneus* and *T. draco* total samples collected from Western Egyptian Mediterranean coast.

DISCUSSION

Understanding the reproductive biology of a species is a central aspect of providing sound scientific advice for fisheries management. Reproductive biology plays an important role in determining productivity and therefore a population's resiliency to exploitation by fisheries or to perturbation caused by other human activities **(Morgan, 2008)**.

Reproductive tools as the Sex ratio, maturity, gonado-somatic index and the first sexual maturity are very important in the field of fisheries biology to determine the stock spawning biomass and the reproductive potential of a fish population. In the current study for *T. araneus* females almost were more dominated along the study in all length groups than males vice versa for *T. draco* males nearly were more dominated in all length groups and there was significantly different from the expected sex ratio 1:1. In case of *T. draco,* the favorability of males is in accordance with **Bagge (2004); Ak and Genç (2013); Hamed and chakroun-Marzouk (2015)** where it differ from **Kinacigil *et al.* (2008)** that stated their no significant different between the two sex.

The predominance of females may be related to the high catch ability for female than that in male, or due to the high mortality of males, as they are more vulnerable to the fishing gears, furthermore, in some species males disappear or migrant to guard eggs and juveniles in deep waters **(Chakroun and Ktari, 2006**; **Mendonca *et al.*, 2006; Cherif *et al.*., 2007**). **Pavlov *et al.* (2014**) stated that the variation in sex ratio could be attributed to the environmental condition where the better food availability resulted in increasing of females. **Conover and Voorhees** (**1990**) indicated that the differences of sex ratio of stock population tend to a balanced sex ratio through generations and the high temperature observed during the late spawning may cause most recruitment produced to become males.

Analysis of the gonado-somatic index (GSI) showed that the spawning period of the *T. araneus* was started in males and females from July to December with a peak in October where it started from June to November with a peak in September for males and females of *T. draco*. In the Black Sea, the sexual development of the *T. draco* occurred in the period between April and May and the spawning period was between June and August **Ak and Genç (2013).** At the same region of Black Sea **Dekhnik (1973), Satılmış (2001) and Ak (2009)** found the eggs of *T. draco* in July and August. Otherwise, the *T. draco* reproduction period is between April-September in the Aegean Sea **(Ak and Hoşsucu, 2001; Çoker 2003)**, May-August in the Marmara Sea **(Yüksek, 1993)** and from July to October off Erdemli, Mersin in the Mediterranean **(Ak, 2004).** The earlier induction of gonad development or faster gonad development may be attributed to the increasing of water temperature in the Aegean Sea starts earlier than it the Black Sea. **Bagge (2004)** reported that both males and females reach spawning condition in June - August, peaking in July.

T. araneus hepatosomatic index (HSI) highest values were between July and November with sudden decrease in December, where for *T. draco* hepato-somatic index (HSI) highest values were between June and November and fall sharply in December. **Hamed and Chakroun-Marzouk (2015, 2017)** revealed that the HSI highest values were observed at the same period from June to August for *T. draco* and *T. radiatus,* respectively. The HSI fluctuations classically observed in fishes as the result of the mobilization of the hepatic lipid reserves for the needs of reproduction.

Proper estimation of length at first sexual maturity (L_{m50}) is very useful for fish stock management as it has widely been considered as the minimum legal size (MLS) under which fish should not be caught. Length at first sexual maturity in the present study was 14.29cm for *T. araneus* and 14.60 for *T. draco*. **Kınacıgil *et al.* (2008)** reported that the *T. draco* length at first maturity in the Aegean Sea was 15.3 cm in males and 16.2 cm in females. In the Gulf of Tunis, the estimated length at first sexual maturity (L_{m50}) was 18.2 cm for *T. draco* (**Hamed and Chakroun-Marzouk, 2015),** while it was 24.5 cm for *T. radiatus* **(Hamed and Chakroun-Marzouk, 2017)**. The length at sexual maturity is strongly correlated with growth, maximum size and longevity of the species **(Froese and Binohlan, 2000)**. It also, may be affects by abundance, food availability in different season, temperature, and by other environmental factors in several localities **(King, 1995)**.

The observed value of the reproductive load was 0.44 for *T. araneus* and 0.56 for *T. draco*. The reproductive load generally lies in the range of 0.3-0.8 and 0.4-0.9 gather by **Froese and Binohlan (2000)**; **Trindade-Santos and Freire (2015)**, respectively. The reproductive load is usually tended to be small in large fishes and it is bigger in smaller size fishes **(Froese and Binohlan, 2000; Froese and Pauly, 2000)**. The result of the reproductive load in the present study is tending to be within the same range suggested by different authors.

CONCLUSION

The output of this study revealed that the spawning season of Trachinidea species under investigation takes places during autumn months. To achieve sustainable utilization, minimum fishing size should be limited to be at least L_{m50} = 15.0 cm for *T. araneus* and *T. draco* to protect the adult fish.

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