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REPRODUCTIVE BIOLOGY OF Trigla lucerna AND Trigloporus lastoviza IN THE EGYPTIAN MEDITERRANEAN WATERS

BY

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ABSTRACT

Study of reproductive biology of gurnards ***Trigla lucerna***, Linnaeus 1758 and ***Trigloporus lastoviza*** (Brünnich 1768) are based on specimens caught by bottom trawlers operating in the Egyptian Mediterranean waters, off Alexandria during the period extending from October 1996 to September 1997. The results are summarized as follows:

1- Sex ratio (Males: Females) was 1: 1.28 for ***T. lucerna*** and 1: 1.01 for ***T. lastoviza***.

2- Size at first sexual maturity was 15.6 cm for males & 17 cm for females of ***T. lucerna*** and 14.5 cm for males & 15.3 cm for females of ***T. lastoviza***.

3- Spawning season extended from December to April for both ***T. lucerna*** and ***T. lastoviza***.

4- Ova diameter distribution revealed that both of ***T. lucerna and T. lastoviza*** are fractional spawners.

5- The average fecundity estimates of ***T. lucerna*** ranged from 7078 to 121700 eggs for the size range 16-30 cm while for ***T. lastoviza***, it varied between 3462 and 26640 eggs for the size range 15-24 cm.

INTRODUCTION

Gurnards or searobins are marine demersal fishes, found in tropical and temperate seas. Yellow gurnard, ***Trigla lucerna***, Linnaeus 1758 and rock gurnard, ***Trigloporus lastoviza*** (Brünnich 1768) are the only most commercially important species of the family Triglidae in the Egyptian Mediterranean waters, off Alexandria (Faltas, 1996; Faltas & Abdallah, 1997).

The reproductive biology of gurnards has been studied in the Mediterranean Sea by Bini (1969) in Italian waters; Kartas (1970, c.f. Papaconstantinou, 1983): Mouneime (1970, c.f. Papaconstantinou, 1983); Baron (1985) in French waters and Papaconstantinou (1983) in the Greek waters.

The present study was undertaken to investigate the reproductive aspects (sex ratio, maturation, length at first sexual maturity, spawning season, egg diameter and fecundity) of these gurnards mainly to fill up the lack in the knowledge aiming to be help in its management.

MATERIALS AND METHODS

The study was carried out on triglids ***T. lucerna*** & ***T. lastoviza*** captured by bottom trawlers operating in the Egyptian Mediterranean waters off Alexandria. A total of 264 & 207 specimens were randomly sampled for ***T. lucerna*** and T. ***lastoviza*** respectively during the period from October 1996 to September 1997.

In the laboratory, total length and gutted weight were recorded to the nearest millimeter and 0.1-gram respectively. Sex and maturity stages were determined macroscopically. Gonads and liver were weighed at accuracy of 0.01-gram.

Maturity stages of the gonads were detected according to the following scale: stage I (Immature stage), stage II (Maturing stage), stage III (Nearly ripe stage), stage IV (Ripe stage); stage V (Spawning stage) and stage VI (Spent stage).

Samples of gonads were preserved in 4% formalin for fecundity and ova diameter studies. Gonado-somatic and hepato-somatic indices were estimated as the percentage of gonads and liver weights respectively to gutted weight.

Absolute fecundity was estimated as the number of mature ova that are likely to be spawned using ripe ovaries of higher gonado-somatic index by the method of Batts (1972). Ova diameters were measured using an eye piece micrometer at 40X magnification and all measurements were then converted to millimeters.

RESULTS

Sex ratio

The overall ratio of males to females was 1:1.28 for ***T. lucerna*** and 1:1.01 for ***T. lastoviza*** (Table 1). Statistical analysis using Chi-square test (X^2) is significant for the former species ($P<0.05$) and insignificant for the latter species ($P>0.05$). For ***T. lucerna***, females were predominated over males in spring (1:1.5) and summer (1:1.83) but the reverse was true in autumn (1:0.91) and winter (1:0.87) while for ***T. lastoviza***. sex ratio was favor of females in all seasons (1:1.14-1.40) except for spring (1:0.63). X^2 analysis showed insignificant seasonal variation ($P>0.05$) for all seasons of the two species except in summer for ***T. lucerna*** ($P<0.01$).

Table (1): Seasonal sex ratio of both *T. lucerna* and *T. Lastoviza* in the Egyptian Mediterranean

Season	*T. lucerna*			
	No. of Males	No. of Females	Sex ratio	Chi-square
Autumn	32	29	1:0.91	0.15
Winter	30	26	1:0.87	0.29
Spring	18	27	1:1.50	1.8
Summer	36	66	1:1.83	8.82**
Total	116	148	1:1.28	3.88*
Season	***T. lastoviza***			
	No. of Males	No. of Females	Sex ratio	Chi-square
Autumn	15	21	1:1.40	1:1.40
Winter	26	33	1:1.27	0.83
Spring	40	25	1:0.63	3.46
Summer	22	25	1:1.14	0.19
Total	103	104	1:1.01	0.01

*Significant at 0.05
** Significant at 0.01

In the older populations of both species, females were more numerous since fishes $\geq$ 25 cm & > 20 cm were all females in ***T. lucerna*** & ***T. lastoviza*** respectively.

Length at first sexual maturity:

According to Pitt (1970) the length at which 50% of a fish population reaches sexual maturity (L_{50}) is considered to be the length of the onset sexual maturity. For this study, fishes with immature (stage I) gonads are regarded as immature, and those with maturing (stage II), nearly ripe (stage III), ripe (stage IV) or spawning (stage V) gonads are designated as mature individuals. Figure (1) which refers to ***T. lucerna*** shows that all females with total length less than 14 cm, and males less than 12 cm, are collectively immature. Larger fish show an increase in the frequency of mature specimens, and all females longer than 18 cm and males longer than 17 cm are fully mature. It is also clear that L_{50} for females and males of that species takes place at a total length of 17 and 15.6 cm, respectively.

In case of ***T. lastoviza*** it is clear that females with total length less than 12 cm and males less than 11 cm are totally immature while all females and males longer than 18cm are fully mature. Length at first sexual maturity is attained at 15.3 and 14.5 cm for females and males respectively (Fig. 2).

Monthly distribution of maturity stages:

The monthly percent frequency of the various maturity stages (except for stage I) are estimated and represented in Figures 3,4,5 & 6.

As represented in these Figures, it is obvious that individuals of the maturing stage for females & males of ***T. lucerna*** are represented through the periods from May to December and from June to November, respectively. The maturing females and males ***T. lastoviza*** are detectable through the period from June to December.

For both ***T. lucerna*** and ***T. lastoviza***, females and males of the nearly ripe gonads are detected only during November and December.

Ripe (stage IV) and spawning (stage V) females and males of both T. ***lucerna*** and ***T. lastoviza*** are detected through the period from December to April. They compose the majority of the detected specimens through that period except in April when the majority of females of ***T. lucerna*** are in spent stage.

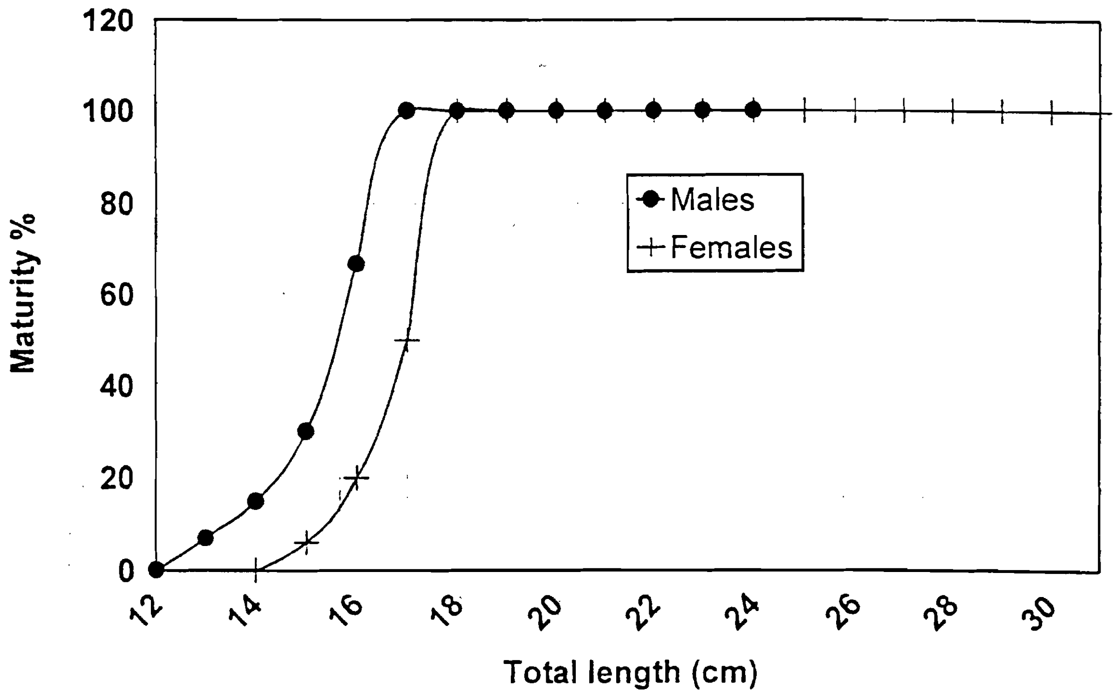

Fig.(1): Length at first sexual maturity for males and females *T. lucerna.*

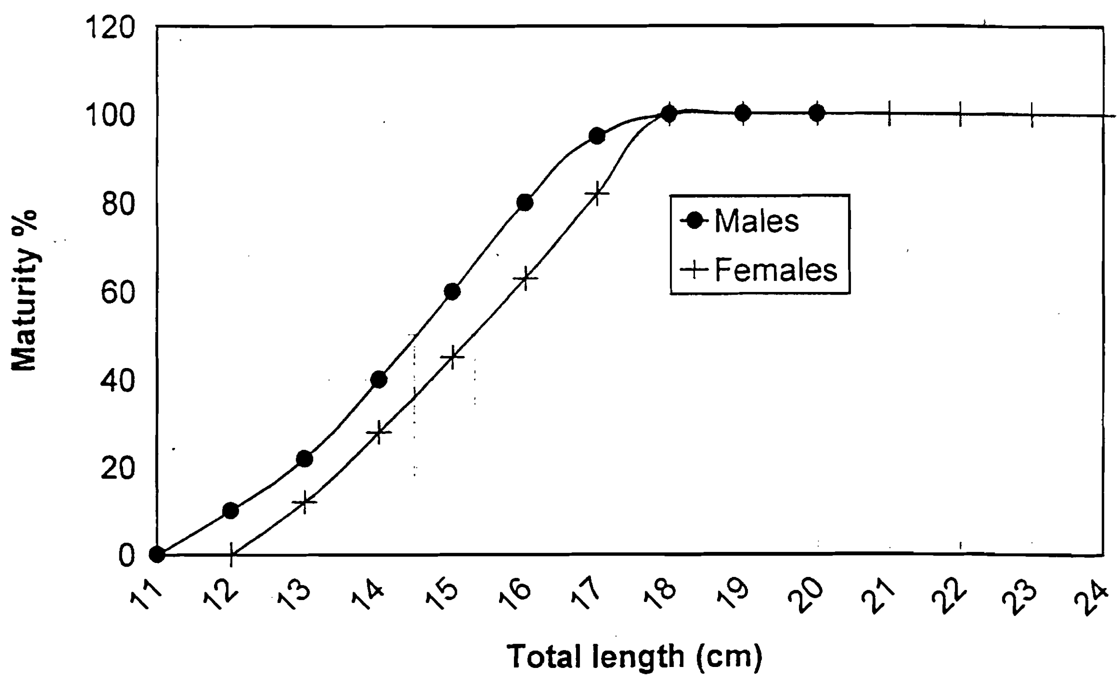

Fig. (2): Length at first sexual maturity for males and females *T. lastoviza.*

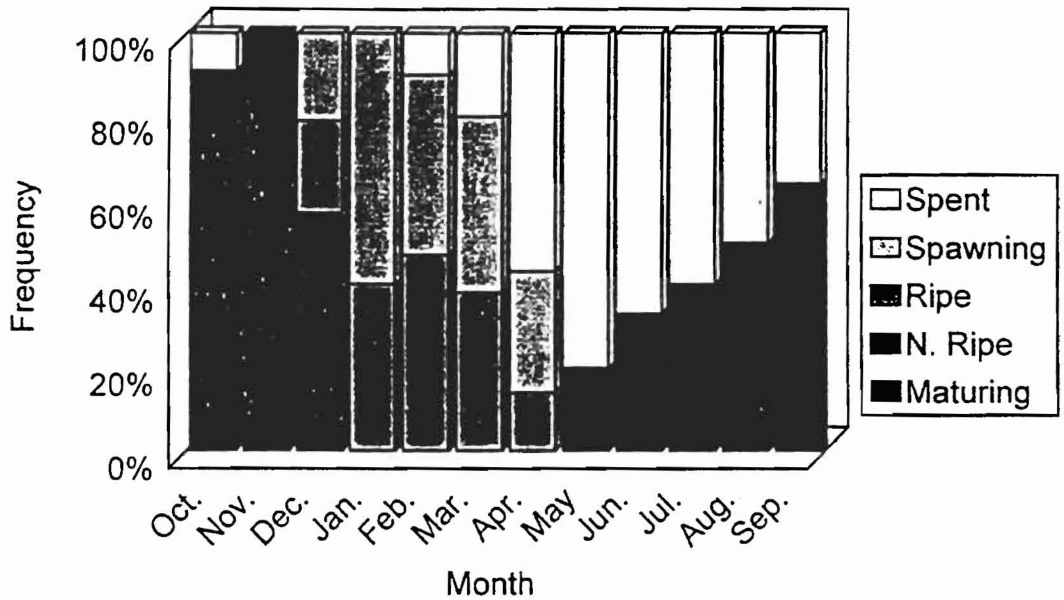

Fig. (3): Monthly distribution of maturity stages for females *T. lucerna*.

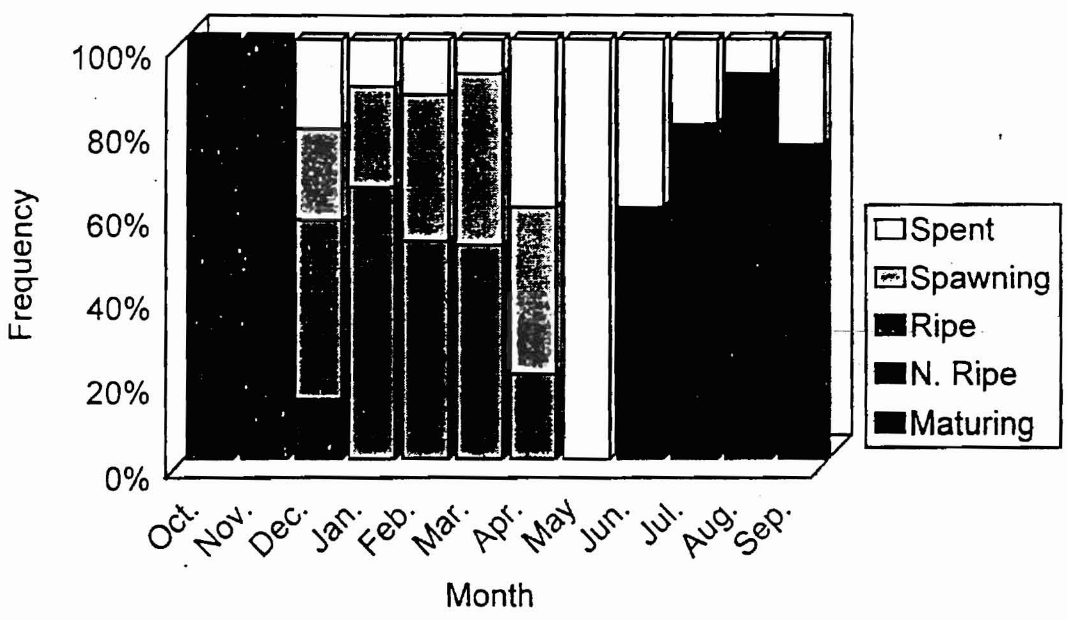

Fig. (4): Monthly distribution of maturity stages for males *T. lucerna*.

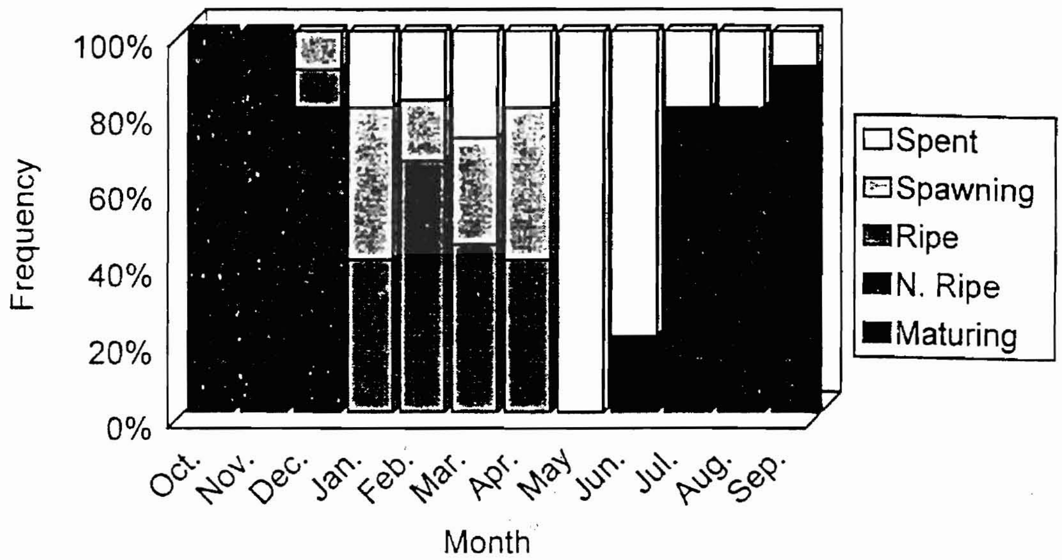

Fig. (5): Monthly distribution of maturity stages for females *T. lastoviza.*

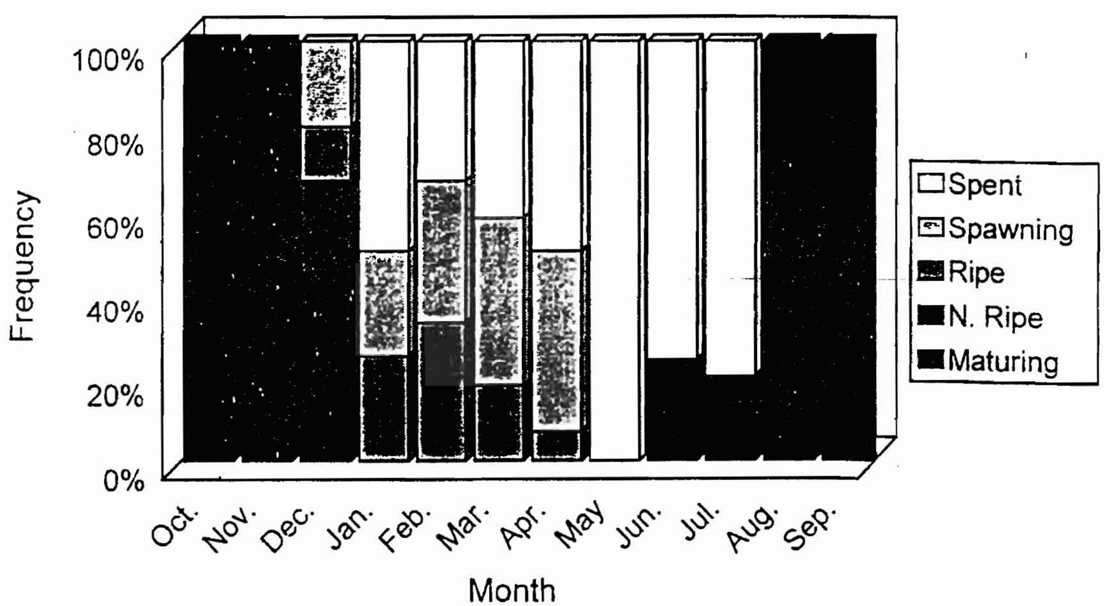

Fig. (6): Monthly distribution of maturity stages for males *T. lastoviza.*

Spent stages of females *T. lucerna* are observed through the period from February to October, while that of males are detected during the period from December to September. Spent stages of females and males *T. lastoviza* are detected through the periods from January to September and from January to July, respectively.

Gonado-somatic index (G.S.I.):

It is clear in Figures (7&8) that the increase of G.S.I. in December for both females and males of the two species indicate the beginning of the breeding season. These G.S.I. values are increased progressively to reach maximum values in January & February for *T. lucerna* and in January & March in the case of *T. lastoviza*. These months with high values of the G.S.I., represent the optimum time of spawning. Further, slight decrease can be noticed through the next months indicating the end of the spawning season by the beginning of May for both species.

Hepato-somatic index (H.S.I.):

Hepato-somatic index (H.S.I.) of *T. lucerna* and *T. lastoviza* are shown in Figures, 9 & 10. For both species, H.S.I. of females was almost higher than for males. However indices of both sexes showed more or less similar trend for *T. lastoviza* but they have different pattern for *T. lucerna*. Marked increases in liver size of females occur during the breeding season for both species in contrast to males, which show larger indices after the breeding season.

Egg diameter:

The percent frequency of ova diameter by 0.1 mm increments is calculated and graphically represented in Figures (11 & 12). The results indicate that the ripe female of both *T. lucerna* and *T. lastoviza* has three batches of ova. The first one includes eggs with a diameter ranging from 0.1 mm to less than 0.4 mm. These are immature eggs that represent the oocyte stock. This batch is represented in all the ovaries examined during the spawning season. The frequency percent of immature egg batches decreases throughout the spawning season. This decrease is accompanied with an increase in the frequency percent of the more advanced egg batches (Figures 11-B & 12-B). This immature egg batch increases again to dominate in the ovaries of spawning stage (Figures 11-C & 12-C).

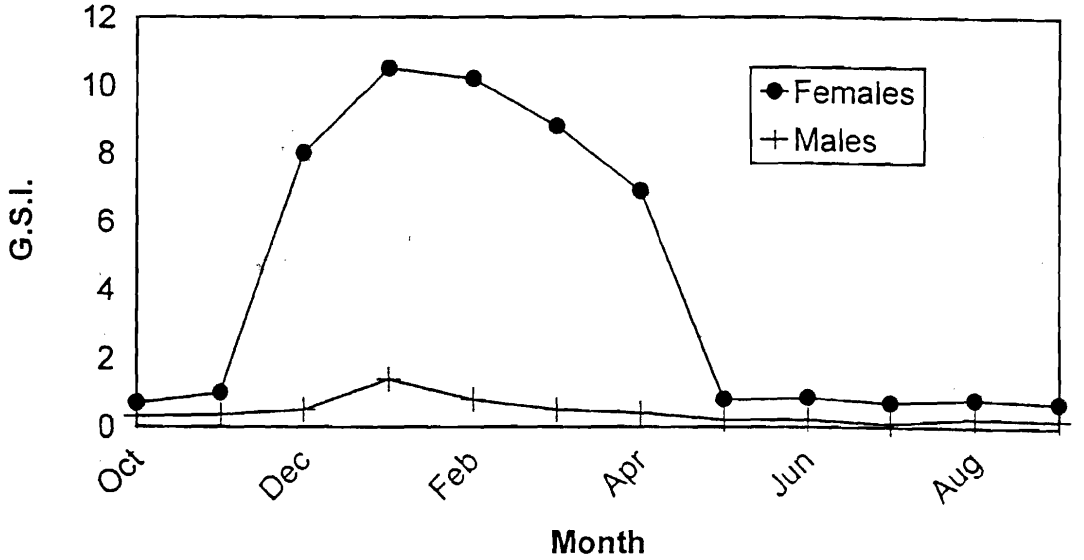

Fig. (7): Monthly variation in gonado-somatic index of females and males *T. lucerna*.

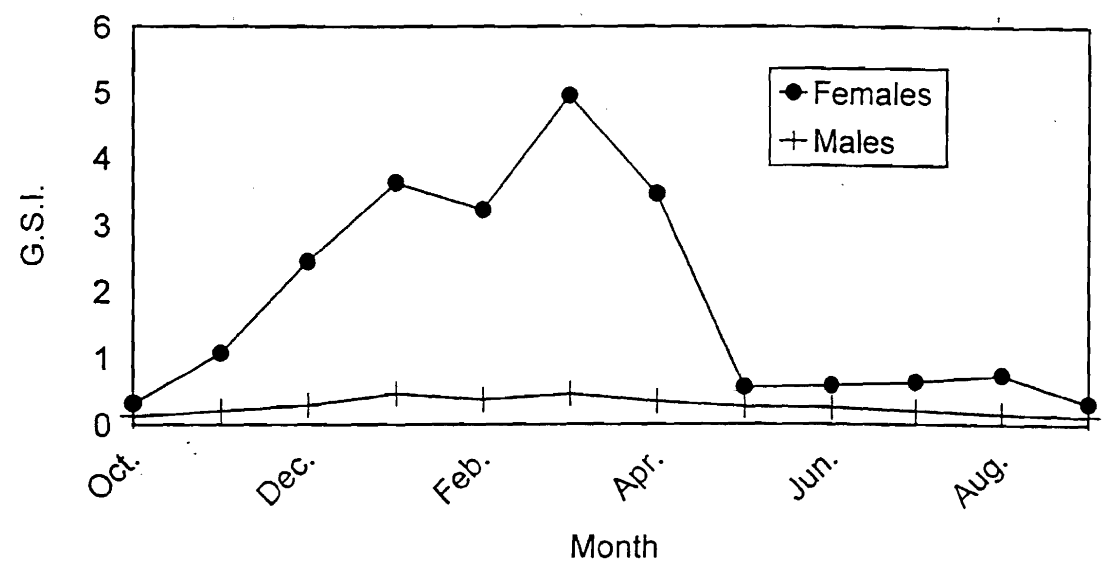

Fig. (8): Monthly variation in Gonado-somatic index of females and males *T. lastoviza*.

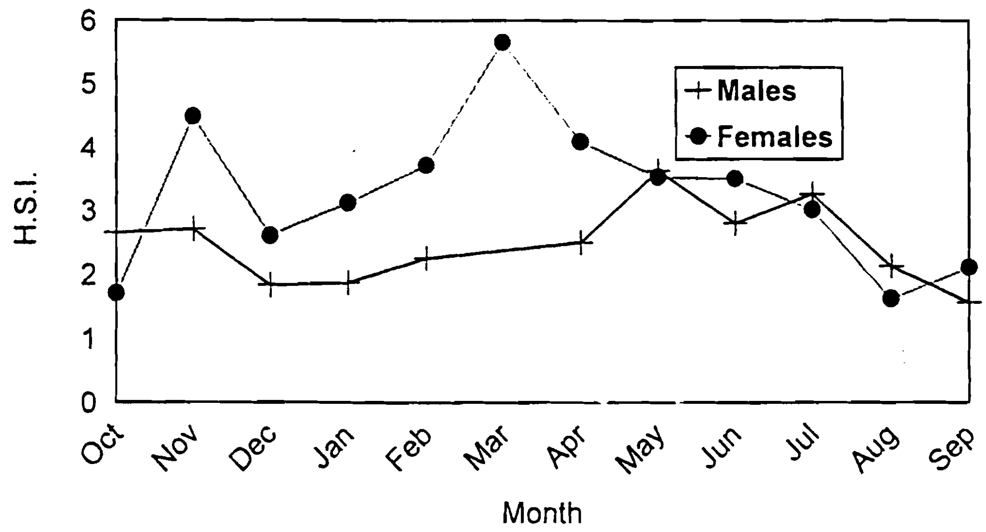

Fig. (9): Monthly variation in hepato-somatic index of males and females *T. lucerna*.

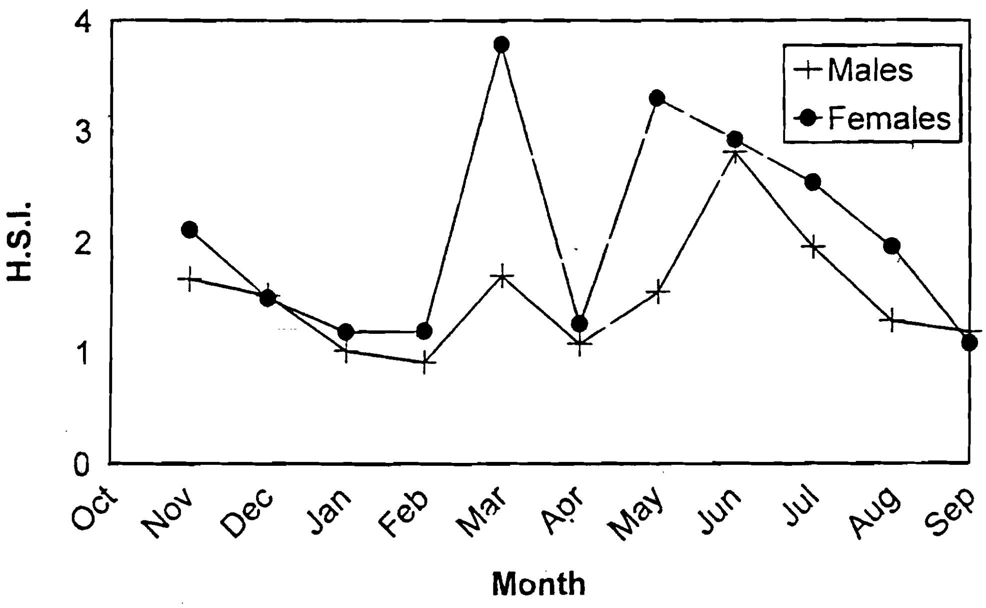

Fig. (10): Monthly variation in hepato-somatic index of males and females *T. lastoviza*.

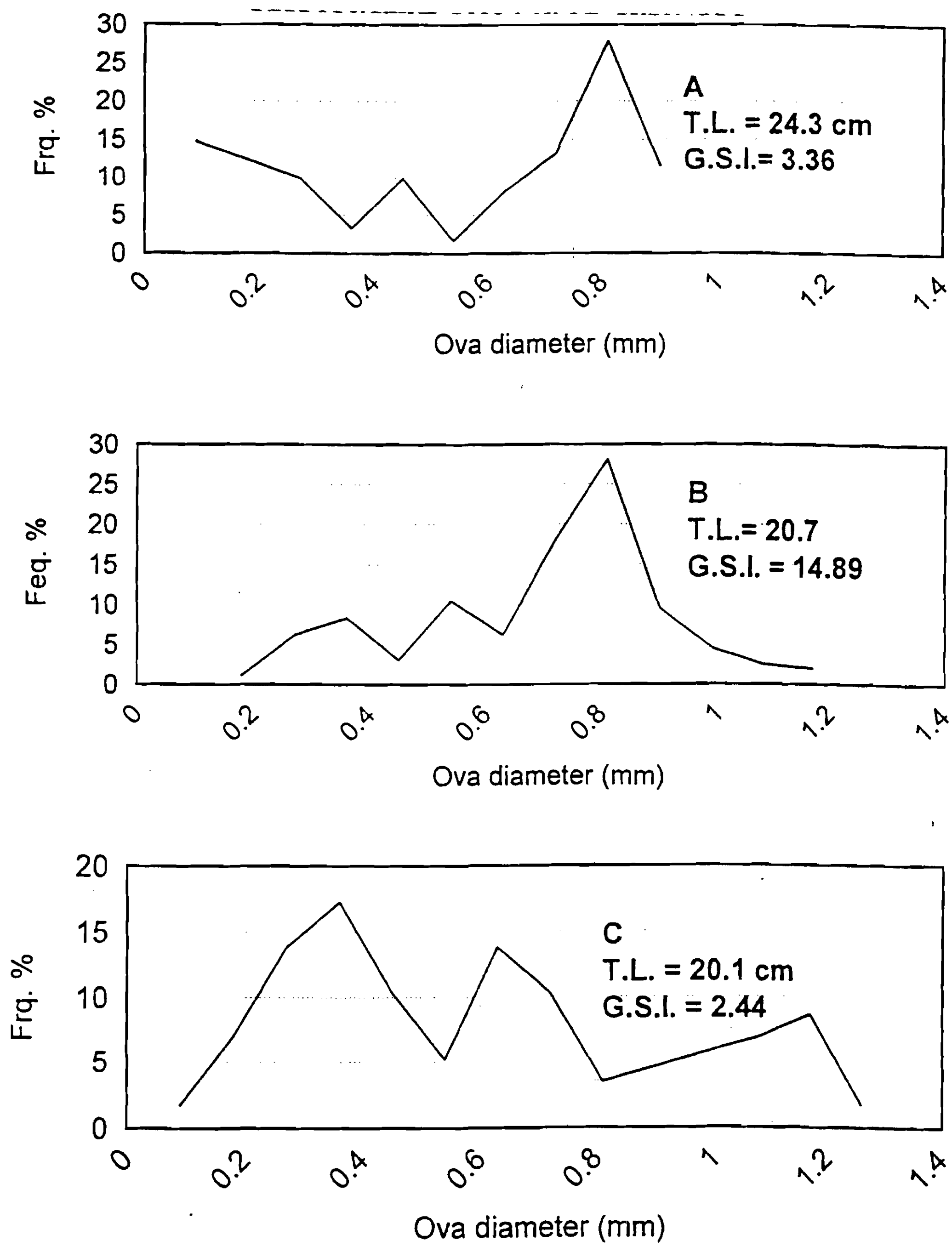

Fig. (11): Frequency distribution of ova diameter in the ovary (A: nearly ripe; B: ripe and C: spawning) of *T. lucerna* during the spawning season.

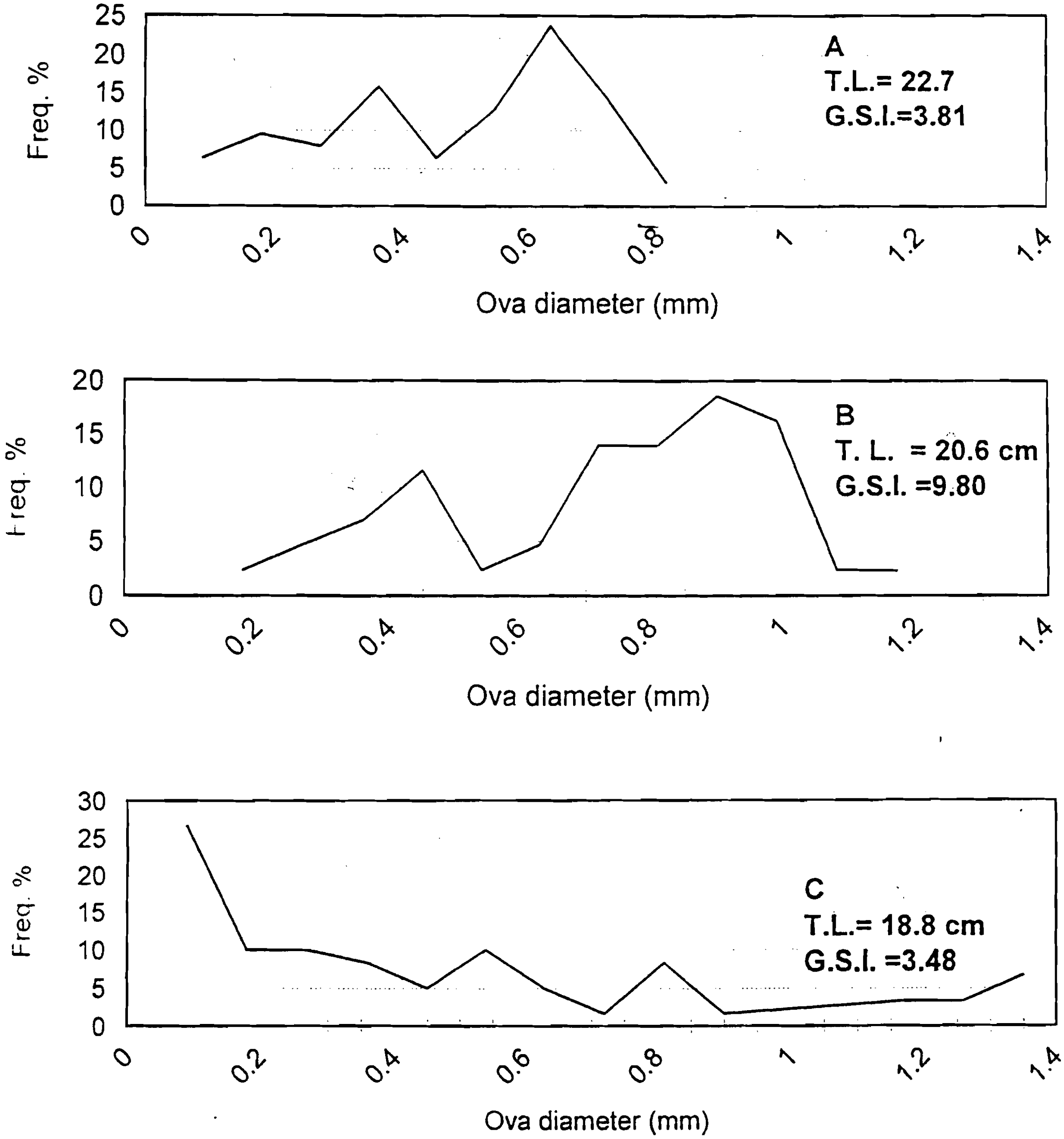

Fig. (12): Frequency distribution of ova diameter in the ovary (A: nearly ripe; B: ripe and C: spawning) **of *T. lastoviza* during the spawsning season.**

The second batch includes the yellow. yolky eggs with a diameter ranging from 0.4 to less than 0.8 mm while the third one includes the transparent, yolky eggs of diameter ranging from 0.8 mm to 1.3 mm in case of ***T. lucerna*** and to 1.4 mm in case of ***T. lastoviza***. It can be inferred that ***T. lucerna*** and T. ***lastoviza*** are fractional spawners.

Fecundity:

Absolute fecundity estimation in this study is based on counting the yolky and transparent ripe eggs in the ovaries of ripe females during the spawning season.

Fecundity-total length relationship:

Tables (2 & 3) show the log total length (L)-log absolute fecundity (F) relationship for both ***T. lucerna*** and ***T. lastoviza***. This relation can be represented by the following equations:

Log F = -0.733 + 4.045 Log L (r = 0.931) **for *T. lucerna*.**
Log F = -1.966 + 4.736 Log L (r = 0.938) **for *T. lastoviza*.**

Table (2): Total length-Absolute fecundity relationship for *T. lucerna*.

Mid. T.L. Cm	Observed Absolute Fecundity			Calculated Absolute Fecundity
	Min.	Max.	Average	
16.5	1695	12461	7078.0	15549.7
17.5	13622	23771	18696.5	19728.3
18.5	24867	34465	29666.0	24700.7
19.5	35503	44608	40055.5	30562.6
20.5	45595	54254	49924.5	37414.9
21.5	55193	63449	59321.0	45364.2
22.5	64345	72233	68289.0	54522.8
23.5	73090	80642	76866.0	65008.4
24.5	81463	88706	85084.5	76944.4
25.5	89494	96452	92973.0	90459.7
26.5	97210	103905	100557.5	105688.9
27.5	104635	111086	107860.5	122772.4
28.5	111790	118014	114902.0	141855.9
29.5	118693	124706	121699.5	163091.0

Table (3): Total length-Absolute fecundity relationship for *T. lastoviza*

Mid T.L. cm	Observed Absolute Fecundity			Calculated Absolute Fecundity
	Min.	Max.	Average	
15.5	1844	5079	3461.8	4692.6
16.5	5427	8465	6946.4	6309.6
17.5	8793	11656	10224.9	8337.4
18.5	11966	14674	13320.5	10847.4
19.5	14967	17537	16252.4	13918.9
20.5	17815	20259	19037.2	17638.7
21.5	20524	22853	21688.9	22101.8
22.5	23106	25332	24219.6	27411.7
23.5	25574	27705	26639.9	33680.4

Fecundity-gutted weight relationship:

The results concerning the relationship of fecundity (F) to fish gutted weight (W) are given in Tables (4 & 5). The resultant equations can be expressed in the following forms:

F = 8306.368 + 639.3842 W (r = 0.999) for ***T. lucerna***.

F = -1890.9849 + 251.5075 W (r = 0.999) for ***T. lastoviza***.

Table (4): Gutted weight-Absolute fecundity relationship for *T. lucerna*.

Mean Gutted weight	Observed Absolute Fecundity			Calculated Absolute Fecundity
	Min.	Max.	Average	
54.95	40275	46605	43147.5	43440.5
64.95	46669	52999	49236.3	49834.4
74.95	53063	59393	56325.2	56228.2
84.95	59457	65787	62424.0	62622.1
94.95	65851	72181	69513.8	69015.9
104.95	72245	78575	75602.7	75409.7
114.95	78639	84969	81701.5	81803.6

Table (5): Gutted weight-Absolute fecundity relationship for *T. lastoviza*

Mean Gutted weight	Observed Absolute Fecundity			Calculated Absolute Fecundity
	Min.	Max.	Average	
24.95	3139	5629	4124.1	4384.1
34.95	5654	8144	6349.2	6899.2
44.95	8169	10659	9567.2	9414.3
54.95	10684	13174	11123.3	11929.4
64.95	13199	15689	14465.4	14444.4
74.95	15714	18204	16557.5	16959.5
84.95	18229	20719	19678.5	19474.6

DISCUSSION

Gurnards are demersal fishes moving on the sea bed supported by the free end of pectoral fins and their reproduction is entirely accomplished by the release of pelagic eggs of medium size (Breder & Rosen, 1966). Ova and first developmental stages of gurnards are pelagic, transported by the currents (Papaconstantinou, 1983).

Sex ratio does not significantly differ from parity for ***T. lastoviza*** in the present study which is in agreement with the same species in Greek seas (Papaconstantinou, 1983) and Douarnenez Bay, France (Baron, 1985). On the other hand, sex ratio of ***T. lucerna*** significantly differs from 1:1 in favor of females. This goes parallel with the same species in Moroccan waters (Collignon, 1968) and in contrast to ***T. lucerna*** from Greek seas (Papaconstantinou, 1983) & and Douarnenez Bay (Baron, 1985). The deviation from the parity may be attributed to the shorter life span of males which is associated with their earlier attainment of sexual maturity (Hashem, 1981). Conover & Kynard (1981) showed the possibility of temperature effect on sex ratio of developing embryos. However, differences in sex ratio were observed in relation to size where the percentages of males in several fish species exhibited a distinct tendency to decrease with the increase of size (Hashem, 1981; Faltas, 1993; Allam, 1995). In the present investigation, females predominated the older populations since fishes ≥ 25 cm T.L. (19.8 cm F.L.) & > 20 cm T.L. (16.2 cm F.L.) were all females in ***T. lucerna*** & ***T. lastoviza*** respectively. Similar results were reported for ***T. lucerna*** (> 36 cm T.L.) in Moroccan Mediterranean (Collignon, 1968) and (>28-30 cm F.L.) in Greek seas (Papaconstantinou, 1983). The variation of sex ratio could be explained by differential mortality rates in sex (Solomon ***et. al.***, 1984) resulting in disappearance of males from the population at an earlier time than females.

For many fish species, males attain their sexual maturity at smaller sizes than females (Hoar, 1957). In the present study the size at which ***T. lucerna*** attains its sexual maturity is 17 cm T.L. for females & 15.6 cm T.L. for males and the corresponding ones of ***T. lastoviza*** are 15.3 cm T.L. for females & 14.5 cm T.L. for males. These values are markedly smaller than those given by Baron (1985) who suggested 40.1 cm T.L. for females & 35.5 cm. T.L. for males in ***T. lucerna*** and 29.6 cm T.L. for females & 28.6 cm T.L. for males in ***T. lastoviza*** in Douarnenez Bay. This can be due to that the average size of maturation is directly related to the population density and ecological conditions particularly temperature, which stimulate sexual maturation (Nikolsky, 1963; Kashiwagi ***et. al.***, 1987).

Hepato-somatic index (H.S.I.) for females of gurnards is almost higher than for males. This is in agreement with Roberts (1978) who related that such increase in females H.S.I. may be due to the increase in the activities of the sexual hormones. Marked increases in liver size of females occur during the breeding season in contrast to males, which show larger indices after breeding season. Ellis ***et. al.*** (1978) declared that the enlargement of the liver results from the physiological changes occurred in spawning. Baron (1985) pointed out that the liver organ is limited as a reserve organ for triglids in Douarnenez Bay since most reserves are stored among muscle fibers showing the importance of the mesentery as a reserve organ and the weak contribution of the liver in this function. The difference in H.S.I. pattern for both sexes in ***T. lucerna*** indicates that hepatic metabolism is not the same for both sexes.

Ova diameter investigations in the present work indicate that the ripe ovaries of these species contain two size groups of yolked ova together with a size group of smaller transparent yolkless ova. This indicates that the mature fish discharges its ova in batches during prolonged spawning period i.e., they are fractional spawners (Hickling & Rutenberg, 1936). This finding is in agreement with Baron (1985) for the same species in Douarnenez Bay and Nikolsky (1963) who stated that fractional and prolonged spawning are mainly characteristic of tropical and subtropical fish species.

In the present study, the agreement between the observed and calculated values of absolute fecundity for both ***T. lucerna*** & ***T. lastoviza***, indicates the fitness of the derived equations governing the relationship of the absolute fecundity to both total body length and gutted weight of the fish. In addition, the study indicates that the absolute fecundity increases with the size of fish. This observation agrees with that obtained by many other investigators including El-Maghraby ***et al.*** (1982) in ***Diplodus vulgaris***, Deniel (1984) in Teleosteens pleuronectiformes, and Zaki ***et al.*** (1995) in ***Mugil seheli***.

In the present study, according to the gonado-somatic index values and direct observation of gonad maturity of ***T. lucerna*** & ***T. lastoviza***, revealed that the spawning of these species took place during the same period extending from

December to April. Also, Baron (1985) found that ***T. lastoviza*** has the same spawning time *of* ***T. lucerna***. The spawning time of ***T. lucerna*** under study is only similar to that given by Fischer ***et al.*** (1987) for the same species in the Mediterranean while different findings have been reported for both species in different localities (Table 6) since the spawning period varies with latitudes. Further, Serena ***et. al.*** (1998) reported that there is a clear shift for reproductive processes timing of ***T. lucerna*** between the Mediterranean and North Atlantic waters. These differences in spawning season may reflect different temperature regimes among these areas (Kashiwagi ***et al.***. 1987).

Table (6): Spawning period of *T. lucerna* & *T. lastoviza* in different localities of the Mediterranean as reported by various authors.

Author	Locality	Spawning period
T. lucerna		
Marinaro, 1968	Mediterranean waters	Spring
Collignon, 1968	Moroccan waters	Dec. - July
Mouneimne, 1970*	Northern France	Feb. - May
Tortenese, 1975*	Mediterranean, France	Spring
Baron, 1985	Doumenez Bay, France	Apr. – Sep.
Hureau, 1986	Mediterranean	May - July
Fischer ***et. al.***, 1987	Mediterranean	Dec. – Apr.
T. lastoviza		
Dieuzeide ***et. al.***, 1955	W. Mediterranean	Summer
Bini, 1969	W. Mediterranean	Summer
Kartas, 1970*	W. Mediterranean	Summer
Tortenese, 1975*	Mediterranean France	Summer
Baron, 1985	Doumenez Bay, France	Mar. / Apr. to summer
Hureau, 1986	Mediterranean	Mid. summer (Jun. – Aug.)
Fischer ***et. al.***, 1987	Mediterranean	Spring & summer

*** Cited from Papaconstantinou (1983).**

REFERENCES

Allam, S. M., 1996. Reproductive biology of pelagic carangid fishes ***Trachinotus ovatus*** from the Mediterranean Sea. J. Egypt. Ger. Soc. Zool., Vertebrate Zoology, 19(B): 45-57.

Baron, J., 1985. Les triglids (Teleosteens, Scorpaeniformes) de la baie Douarnenez, 1- La Reproduction de ***Eutrigla gurnardus***, ***Trigla lucerna***, ***Trigloporus lastoviza*** et ***Aspitrigla cuculus***. Cybium, 9 (3): 255-281.

Batts, B. S., 1972. Sexual maturity, fecundity and sex ratio of the skipjack tuna, ***Katsuwonus pelamis*** (Linnaeus) in North Carolina waters. Trans. Amer. Fish. Soc., 101(4): 626-637.

Bini, G. 1969. Atlante dei pesci della coste italiane. Mondo Sommerso, 7, 200 pp.

Breder. C. M. and Rosen, D. E., 1966. Modes of reproduction in fishes. Amer. Mus. Nat. History Press., New York, 941 pp.

Collignon J., 1968. Les Trigles des eaux marocaines. Generalites. L'espece ***Trigla hirundo***. Bull. Inst. Peches Marit. Maroc, 16:3-33.

Conover, D. O. and Kynard, B. E., 1981. Environmental sex determination: Interaction of temperature and genotype in a fish. Science., 213: 577-579.

Deniel, C., 1984. La reproduction des poissons plats (Teleosteens pleuronectiformes) en baie de Douarnenez. II. Cycle sexual et fecundite de Soleidae: ***Solea vulgaris***, ***Solea lascaris***, ***Buglossidium luteum***. Et ***Microchirum variegatus***. Chaiers de biologiew marine. 25: 257-285.

Dieuzeide, R., Nouvella, P. and Rolland, J., 1955. Catalogue de poissons des cotes algeriennes. Bull. St. Aquic. Peche cestigloine, Nouvelle Ser. (6): 7-384.

Ellis, A. E., Roberts, R. J. and Tytler, P., 1978. The anatomy and physiology of teleosts. IN: Fish pathology (Ed.: Roberts, R. J.). Bailliere Tindall, London.: 13-54.

El-Maghraby, A. M., Botros, G. A.. Hashem, M. T. and Wassef, E. A., 1982. Maturation, spawning and fecundity of two sparid fish ***Diplodus sargus***, L. and ***Diplodus vulgaris*** Geoff. In the Egyptian Mediterranean waters. Bull. Inst. Oceanogr. & Fish. ARE, 8 (2): 51-67.

Faltas, S. N., 1993. Studies on the fishery biology of lizardfish (family: Synodontidae) in the Egyptian Mediterranean waters. Ph.D. Thesis, Fac. Sci., Alex. Univ., 305 pp.

Faltas, S. N., 1996. Food and feeding habits of gurnards, ***Trigla lucerna*** Linnaeus, 1758 and ***Trigloporus lastoviza*** (Brunnich, 1768) in the Egyptian Mediterranean waters. Bull. Nat. Inst. Oceanogr. & Fish., ARE, 22: 167-179.

Faltas, S. N. and Abdallah, M., 1997. Growth, mortality and relative yield per recruit of two triglid species from the Egyptian Mediterranean, off Alexandria. Bull. Nat. Inst. Oceanogr. & Fish., ARE, 23: 473-484.

Fischer, W., Bauchot, M. L. et Schneider, M., (redacteurs), 1987. FAO identification des especes pour les besoins de la peche (Revision). Mediterranee et mer Noire. Zone de peche 37. Rome, 1 & 2, 1530 pp.

Hashem, M. T., 1981. The breeding biology of ***Bagrus bayad***. Bull. Inst. Oceanogr. & Fish., ARE, 7(3): 416-428.

Hickling, C. F. and Rutenberg, E., 1936. The ovary as an indicator of the spawning period in fishes. J. Mar. Biol. Assoc. U. K., 21: 311-317.

Hoar, H. E., 1957. The gonads and reproduction. IN: The physiology of fishes (Ed.: Brown, M. E.). Acad. Press, New York, 1.

Hureau, J. C., 1986. Triglidae. IN: Fishes of the North Atlantic and the Mediterranean (Eds: Whitehead, P. J. P.; Bauchot, M. L.; Hureau, J. C.; Nielsen, J. & Tortonese, E.). UNESCO, Paris, 2: 1230-1238.

Kashiwagi, M., Sakaki, H., Takahashi, T. and Iwai, T., 1987. A relationship between egg size and hatching rate in Japanese whiting ***Sillago japonica***. Nippon Suisan Gakkaishi, 53(12): 2105-2110.

Marinaro J. Y., 1968. Contribution a'l'etude des oeufs et larves pélgique de poissons méditerranéens. II. Les premiers stades de development de ***Trigla obscura***. Pelagos, 8: 59-67.

Nikolsky, G. V., 1963. The ecology of fishes. Acad. Press., London & New York, 352 pp.

Papaconstantinou, C., 1983. Observations on the ecology of gurnards (Pisces Triglidae) of the Greek seas. Cybium, 7 (4): 71-88.

Pitt, T. K., 1970. Distribution, abundance and spawning of yellowtail flounder, ***Limanda ferruginea***, in the New Foundland area of the NorthWest Atlantic. J. Fish. Res. Bd. Canada, 27(12): 2261-2271.

Roberts, R. J., 1978. The pathophysiology of teleosts. IN: Fish pathology (Ed.: Roberts, R. J.). Bailliere Tindall, London: 55-91.

Serena, F.; Voliani, A. and Auteri, R., 1998. Nursery areas and some biological information of tub gurnards (***Trigla lucerna***, Linnaeus1758) off Tuscany coast (Italy). Rapp. Comm., int. Mer. Medit., 35: 482-483.

Solomon, G.; Matsushita, K.; Shimizu, M. and Nose, Y., 1984. The reproduction and condition factor of rose bitterling in Shin Tone River. Bull. Jap. Soc. Sci. Fish., 50(7): 1095-1103.

Zaki, M. I., El-Gharabawy, M. M., Salem, S. B., El-Shorbagy, I. K. and El-Boray, K. F., 1995. Reproductive biology of ***Mugil seheli*** in Suez Bay. J. Egypt. Ger. Soc. Zool., 16 (B): 307-327.