

On some reproductive aspects of  
the Sky Emperor, *Lethrinus*  
*mahsena* (Pieces) in the Sudanese  
Red Sea

Adil S. O. Abu Degoon<sup>(1)</sup> and Sayed M. Ali<sup>(2)</sup>

**Abstract:**

A total of 344 *Lethrinus mahsena* specimens were collected from Port Sudan fish market during October 2003- November 2004 to study some aspects of reproduction. It has been found that the sky emperor in particular and other emperors in general dominated the Sudanese catch especially during the summer season.

Females become sexually mature at a mean total length of  $29.6 \pm 2.6$  cm and at an age of 2+ to 3+ years. This is attained in males at  $33.5 \pm 1.7$  cm and age of 3+ to 4+ years. From the findings, females seemed to reach first maturity at a size and age earlier than males. The absolute fecundity was significantly ( $p < 0.05$ ) related to total length, age, body weight, gonadal weight but insignificantly ( $p > 0.05$ ) related to egg diameters.

Breeding seems to occur throughout the year with a main peak in January. Sequential protogynous hermaphroditism has been observed to occur in *L. mahsena* at age 4+ to 5+ years. Histological studies on gonads suggested the occurrence of secondary males.

**Introduction:**

*Lethrinus mahsena* (sky emperor), known in Sudan as Shaour-Kadeed, is considered to be an excellent and popular food fish in

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(1) Dept. of Environment and Natural Resources, Faculty of Applied Sciences, Red Sea University, Port Sudan, Sudan, e-mail: abudegoon@yahoo.com.

(2) Ministry of Sciences and Technology, Fisheries Research Center, Alshajara Research Station, Khartoum, Sudan.

most areas of the Red Sea and is abundant throughout the year (Reed, 1964). Moreover, it is a game and a highly commercial fish (Carpenter and Allen, 1989). It is the most important species caught from the waters of Mauritius and contributes some of 90% of the total catch (Soondron et al., 1998). Its distribution ranges a round (28°N-25°S) and extends from the Red Sea via, East Africa to Srilanka. It is mainly caught with hand lines, traps and trawls (Smith, 1986) as it dwells in coatal waters to about 50 to 100 m depth (Carpenter and Allen, 1989 and De Bruin et al., 1995).

According to (Vine, 1986 and Bouhleb, 1988) it is a harmless fish.

The present work on *L. mahsena* is meant to avail baseline data on some reproductive aspects of this popular fish.

### Materials and methods:

A total of 344 specimens of *L. mahsena* were collected on bimonthly basis from Port Sudan fish market from October 2003 to November 2004. The total length was measured to the nearest 0.1 cm and a total weight to the nearest gm, the sex and gonadal weight were recorded. Maturity stages and age of first maturity were determined according to (Soondron et al., 1998) and Alreeki (2001). Ovaries were fixed in Gilson's fluid, egg diameter was measured following (Cheesbrough, 1951 and Abdel Razig, 1987). Fecundity and condition factor followed (Abdel Razig, 1987). Fecundity determination was based on the volume method and was calculated as :

$$AF = \frac{TBV \times NES}{SV}$$

Where:

AF= absolute fecundity, TBV=Total beaker volume, NES= Number of eggs in the sample volume, SV=Sample volume.

Fulton's condition factor (K), was calculated through the formula:

$$K = \frac{W \times 100}{L^3}$$

Where:

K=Condition factor, W=Total body weight in gm, L=Total body length in cm.

Histological studies followed (Le Cren, 1951). Microphotography of histological sections was by Leitz Dialax 20

microscope fitted with MPS 11 Camera. Regression analysis relating fecundity to different measurements was performed.

## Results:

### Gonadal development and stage of maturation:

Observations showed that *L. mahsena* passes through five stages of gonadal maturation in its life cycle. These are, stage I (immature), stage II (maturing or ripening), stage III (mature), stage IV (spawning) and stage V (spent).

Size and Age at first maturity ( $L_m 50$ ,  $t_m$ ):

The length at first maturity ( $L_m 50$ ) which is the length, at which 50% of all fish at that length attain maturity, was attained in females at a mean total length of  $29.6 \pm 2.6$  cm and ( $t_m$ ) was at 2+ to 3+ years old. This is attained in males at  $33.5 \pm 1.7$  cm and 3+ to 4+ years. Consequently, it appeared that females of *L. mahsena* attain first maturity earlier in size and age than males (1)

Table (1): Age, mean length and percentage of mature fish used to determine length and age at first maturity ( $L_m 50$ ,  $t_m$ ) for *L. mahsena* in the Sudanese Red Sea coast.

Age (year)	Females			Males		
	Mean Length (cm)	No.	% of Mature fish	Mean length (cm)	No.	% of mature fish
0+	0	0	0	0	0	0
1+	23	8	9	23.9	7	17
2+	27.7	12	22	27.3	1	20
3+	31.5	47	74	32.3	4	29
4+	34.5	13	89	34.7	25	90
5+	36.7	6	96	36.4	2	100
6+	38	4	100	41	2	100

### Breeding season and condition factor:

Mature *L. mahsena* occurs throughout the year with one main peak in January. This is in a harmony with the well being of the fish as its Fulton's condition factor is greater than 1 ( $K > 1$ ) Fig. (1).

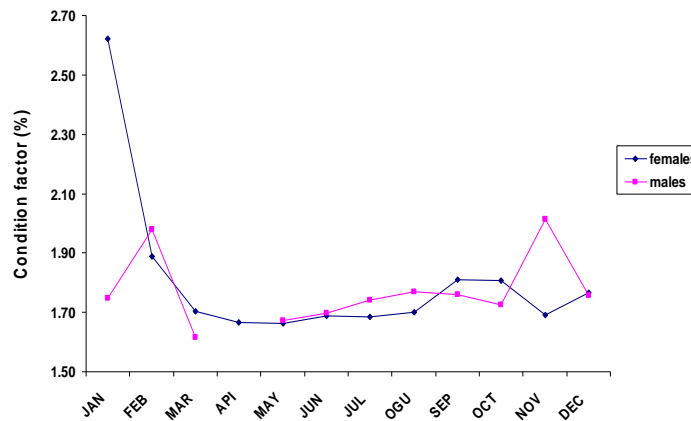


Fig (1): Monthly condition factor (k) for *lethrinus mahsena* in the Red Sea. Data for April is missing

Most mature ova had spherical shape Fig. (2). The diameter of ova ranged between 318.2-456.3 micron Table (2). The absolute fecundity ranged from 226667-1646667 eggs per mature female Table (2).

Table (2): Range variations in fecundity and egg diameter against age, body length, body and gonad weight for *L. mahsena* in the Sudanese Red Sea coast.

Age (year)	TL (cm)	Tw(g)	GW (g)	Egg. Dim (μ)	AF
2+	27.5-28	355-440	9.58-9.16	366.6-435.7	463333-533333
3+	29.5-32.6-	405-660	20.98-12.99	382.3-356.8	480333-866667
4+	33-35.5	575-800	7.86-24.86	336.8-456.3	393333-766667
5+	35-36.8	755-920	8.92-13.96	333.6-415.3	226667-620000
6+	37-39.8	950-1100	18.08-34.45	318.2-353.3	716667-763333
7+	44	1475	13.95	329.1	1646667
8+	47	1600	44.05	345.4	1063333

Key: TL=Total length, TW=total body weight, GW=gonad weight, Egg. Dim=egg diameter, AF=absolute fecundity.

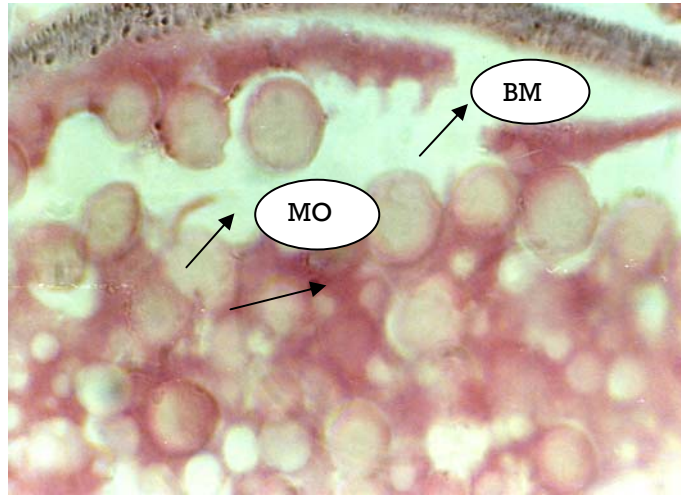


Fig (2): T. S. in ovary of a prespawning female, containing mature ova (MO) having a spherical shape, Basement membrane (BM) H&E (X 1568).

The regression of absolute fecundity against length, weight, age and gonad weight Table (3) was significant ( $p < 0.05$ ) and insignificant for absolute fecundity against egg-diameter ( $p > 0.05$ ).

Table (3): Statistics of Fecundity Regression against Length, Age, Weight, Gonad weight and Egg- diameter for *L. mahsena*.

Parameter	Regression equation	Significance of Regression	Correlation Coefficient (r)
Total length	$F = -890299 + 42109L$	$p < 0.05$	0.58
Age	$F = 38419 + 123579A$	$p < 0.05$	0.56
Total weight	$F = 75537 + 643.92Tw$	$p < 0.05$	0.61
Gonads weight	$F = 295574 + 16101Gw$	$p < 0.05$	0.46
Egg-diameter	$F = 892454 - 1010.4 Ed$	$p > 0.05$	0.17

### Hermaphroditism and sex - ratio:

Histological studies made on the testes showed a mode of secondary males (having transformed from ovaries, Fig. (3)). In some instances, this is very clear as the majority of the gonad was testicular tissues and the ovarian tissues were scattered in small patches Fig. (4).

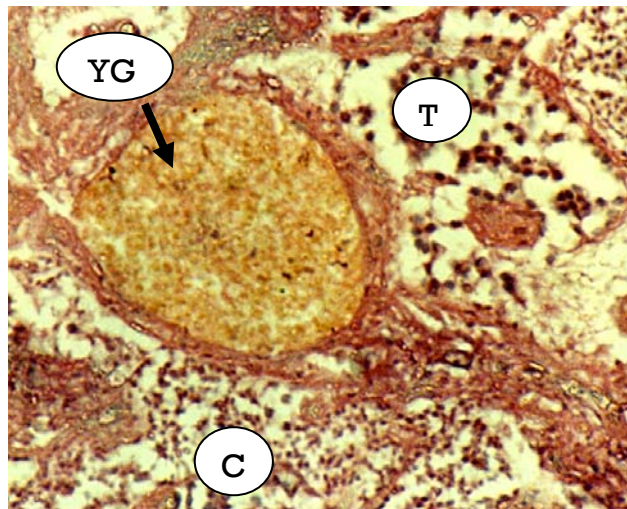


Fig (3): T.S. in a testis of a hermaphrodite, *L. mahsena* . A yolk globule (YG) surrounded by spermatids (T) and spermatocytes (C). H&E(X392).

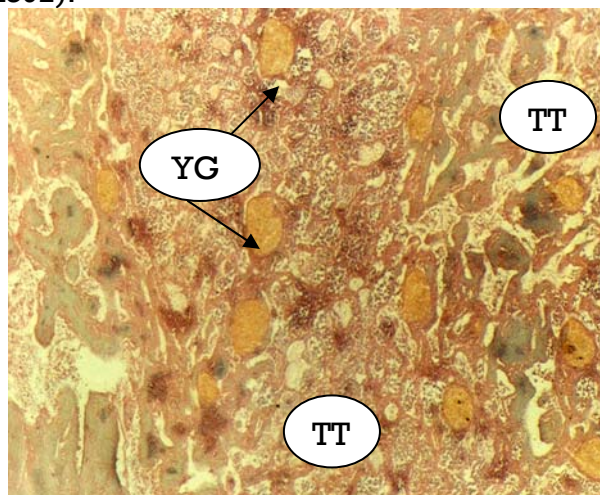


Fig (4): T.S. in a hermaphrodite gonad of *Lethrinus mahsena*. Testicular tissues (TT), yolk globules (YG).H&E (X63).

Females outnumber males in ages from 0+ to 3+ years. The opposite holds true in ages from 4+ to 7+ years Table (4). The overall sex ratio was 1:1.7 in favour of females. Sex reversal (sequential protogynous hermaphroditism) was found to occur at ages 4+ and 5+ years Table (4). The percentage numbers of males, females, hermaphrodites and undetermined sex was 57.3%, 43.6%, 5.5% and 2.6%, respectively.

Table (4): Percentage of sex ratio at different age groups used to determine age of sex reversal in *L. mahsena* in the Red Sea.

Age (year)	Femles	males	Hermaphrodites	Undetermined sex
+0	71.4	28.6	0	0
+1	50	38.9	0	11.1
+2	66.7	28.2	2.3	4.8
+3	67.6	28.2	4.2	0
+4*	34	53	12.8	0
+5*	42.1	57.9	31.6	0
+6	29.4	47.1	23.5	0
+7	20	80	0	0

N. B: \* = Age of sex reversal.

### Discussion:

Females of *L. mahsena* became sexually mature ( $L_m$  50) at a mean total length of  $29.6 \pm 2.6$  cm long, age ( $t_m$ ) 2+ to 3+ years. This is attained in males at  $33.5 \pm 1.7$  cm long and age ( $t_m$ ) 3+ to 4+ years. In the same species from Jeddah, (Hashim and Shakour, 1981) reported an  $L_m$  50 of 20 and a  $t_m$  of 3, (Soondron et al., 1998) reported from Mauritius an  $L_m$  50 of 19.1 and a  $t_m$  of 3.5 (Table (5)).

Table (5): Length and age at first maturity ( $L_m50$ ,  $t_m$ ) obtained from the present study compared with those of previous studies.

$L_m50$ (cm)	$t_m$ (year)	Reference	Locality	Year
29.6 (♀)	2.5	Present Study	Sudanese Red Sea waters	2005
33.5 (♂)	3.5	Present Study	Sudanese Red Sea waters	2005
20	3	<i>Hashim &amp; Shakour</i>	Jeddah Region, Red Sea	1981
19.1	3.5	<i>Soondron et. al.</i>	Sayde Malha bank, Mauritius	1998
-	6.5	Eli	Unknown	1999

Most fishes reproduce continually throughout their lifetime but spawn only once and die shortly thereafter (Everyharh *et al.*, 1975 and Lagler, 1956). Spawning of Lethrinids is thought to be after dark in areas near a reef, either in lagoon or on the outer edge of a reef (Johnnes, 1981). It occurs in large aggregations while swimming in circles near the surface or at the bottom of reef slopes (Carpenter and Allen, 1989).

Breeding season varies widely among Lethrinids, but it is generally throughout the year with peaks occurring at different seasons. (Toor, 1964) reported that the red spot emperor, *L. Lentjan*, spawns mostly from December to February and from June to August in India. (Loubens, 1980) reported that the spawning was from September and December in New Caledonia and in Saudi Arabia between April and May (Kedidi, 1984). In Sayade Malha bank spawning for *L. mahsena* spawns from December to January and from May to June (Soondron *et al.*, 1998) suggesting 2 peaks of spawning activity.

In the present study, mature gonads were found throughout the year, which indicates the prolonged spawning season for the sky emperor. This is in a harmony with a previous study on the same

species, by (Soondron *et al.*, 1998). On the other hand, the condition factor ( $K > 1$ ) suggested the goodness of growth. This also agrees with the study of (Tony and Paul, 1982). These results are in accordance with those of (Carpenter and Allen, 1989), (Froese, 1994 and Soondron *et al.*, 1998).

In Perciformes, hermaphroditism occurs naturally and in high frequency (Leonard, 2002). Synchronous hermaphrodites were reported in a number of species including *Diplodus sargus*, *Diplodus vulgaris*, and *Oblada melanura* (Hoar and Randal, 1969 and El-Maghraby *et al.*, 1981). In sequential hermaphrodites, both male and female reproductive organs may be present, but only one is active and viable at any given time (Leonard, 2002).

In the most common type of sex reversal, females mature, reproduce, and then become males and changing sex can take as little as 4 days (Shapiro, 1994). Females often outnumber males, so males get a good rate of return on their mating efforts (Shapiro, 1994). Only the largest female and male reproduce but if this female dies or leaves, her mate becomes a female and the largest juvenile fish in the group becomes a fully functional male (Shapiro, 1994). Some fish such as *Paragobiodon echinocephalus*, *Cirrhilichthys aureus*, and *Trimma okinawae* can change sex several times (Sunobe, 1993). According to (Bertrand, 1986), *L. mahsena* at Sayade Malha bank was observed to be protogynous hermaphrodite, with sex reversal occurring when this fish is 5 to 6 years old. A considerable overlapping in size distribution occurs between males and females of *Lethrinus* species, which suggests that sexual transformation occurs over a wide size range (Young and Martin, 1982).

Histological studies done by (Young and Martin, 1982) on testes show typical secondary males (having transformed from an ovary) characteristics and no evidence has been found to support occurrence of primary males (testes form without going through an ovary stage).

(EL-Serafy *et al.*, 1988) found that absolute fecundity of *Lutjanus lineolatus* increases with increase in total length, total weight and age. This confirms the findings of (Bagenal, 1973, Mann and Morse, 1981, Kandler and Pirwitz, 1957 and Hassan, 1995). According to (Toor, 1964), fecundity for the Red spot emperor was estimated at 12000–77000 eggs spawned per female per year, while for *L.*

*mahsena* it was estimated between 26700 and 166200 eggs per mature female (Carpenter and Allen, 1989) which is by far below the range of 226667-1646667 eggs reported during this study. This difference is probably due to differences in habitat.

Reproduction indicates developing gonads throughout the year, probably resulting from intermittent shedding of the products. Females reach first maturity before males at earlier ages and smaller sizes.

Phenomenon of sex reversal is confined and it was found at ages 4+ and 5+ years.

Further investigations on sex reversal should be based on samples reared in ponds or floating cages and on histological investigations of the reproductive system.

### References:

- [1] Abdel Razig, H. A. (1987). Fishery Biology (Arabic version). Basra University Press, Iraq. Pp. 279.
- [2] Alreeki, A. M. (2001). Biology of *Acanthopagrus latus* (Houtuyn, 1782) in Iraqi Marine waters. Thesis, M.Sc. College of Agriculture, University of Basra, 70 pp.
- [3] Bagenal, A. (1973): In Hassan, A. Jastina. (1995). Fecundity of *Limanda limanda* in Oxwich Bay, South Wales, and U.K: In J. King Abdulaziz University, Jeddah, Suadia Arabia. 6: (69-77).
- [4] Bertrand, J. (1986). Pour une evaluation des ressources en capita/dame berri (*Lethrinus mahsena*) des bancs de Saya de Malha. Rapport du goupe de travail. Ifremer/Albion Fisheries Research Centre (Mauritius), 23-25 Juillet 1985:39 pp.
- [5] Bouhleb, M. (1988). Poissons de Djibouti. Placerville (California, USA): RDA international, Inc. pp. 416
- [6] Carpenter, K. E. and G. R. Allen. (1989). FAO Species Catalogue. Vol. 9. Emperor Fishes and large-eye breams of the world (family Lethrinidae). An annotated and illustrated catalogue of lethrinid species known to date. FAO Species Synop. No. 125 (9): (118).
- [7] Cheesbrough, M. (1987). Medical Laboratory Manual for Tropical Countries, vol. 1, 2nd edition. P 4:10-4:11. Holly court, Jordan Hill, Oxford, U. K.
- [8] De Bruin, G. H. P, Russell, B. C. and Bogusch, A. (1995). FAO species identification field guide for fishery purposes. Marine fishery resources of Srilanka. Rome, FAO, pp.400.
- [9] Eli, A. (1999). Growth parameters, food items and spawning of *Lethrinus mahsena*. [www/ htm.fish base.org](http://www/htm.fishbase.org).

- [10] El-Maghraby, A. M, Botros G. A., Hashim M. T. and Wassif F. A. (1981). Hermaphroditism in three sparid fish, *Diplodus sargus* L., *Diplodus vulgaris*, G., and *Oblada melanura*, L. From the Egyptian Mediterranean waters. Bull. inst. Oceanogr. 7 (3): 378-385 p.
- [11] EL-Serafy, S. S, EL-Zahaby A. S., and EL-Darawani M. A. (1988). On the biology of *Lutjanus lineolatus* (Bloch) in the Gulf of Suez: Length-weight relationship, relative condition factor and fecundity: In Bulletin of the National Institute of Oceanog. and Fish.: 14: (2). Faculty of Science, University of Zagazic. Egypt. 114-122 p.
- [12] Everyharh, W, Eipper, A. W and Youngs, W. D (1975). Principles of fishery Science. Cornel University Press. New York.
- [13] Frose, (1994). Fecundity, depth of occurrence and growth parameters of *Lethrinus mahsena*. [www/ htm.fishbase.org](http://www/htm.fishbase.org).
- [14] Hashim, M. T. and Shakour A. A. (1981). Age determination and growth studies of *Lethrinus mahsena* and *Lethrinus xanthochilus*. Jeddah, J. Mar. Res, 1:11-20
- [15] Hassan, A. (1995). Fecundity of *Limanda limanda* in Oxwich Bay, South Wales, and U. K: In J. of King Abdel-aziz University, Jeddah, Saudi Arabia. 6: (69-77).
- [16] Hoar, W. S and Randal D. J., (1969). Fish physiology. Vol III. Academic press, pp. 485.
- [17] Johnnes, O. M (1981): In Carpenter, K. E. and G. R. Allen. (1989). FAO Species Catalogue. Vol.9. Emperor Fishes and large-eye breams of the world (family Lethrinidae). An annotated and illustrated catalogue of lethrinid species known to date. FAO Species Synop. No. 125 (9):118p.
- [18] Kandler, M and O Pirwitz (1957): In Hassan, A. (1995). Fecundity of *Limanda limanda* in Oxwich Bay, South Wales, and U. K: In Journal of King Abdulaziz University, Jeddah, Suadia Arabia. vol. 6:69-77p.
- [19] Kedidi, S. M (1984). Biology and Stock Assessment of the Red Spot Emperor, *Lethrinus lentjan* from waters adjacent to Tuwwal, Saudi Arabia. Project for development of fisheries in Areas of the Red Sea and Gulf of Aden, RAB/81/002/15. pp. 21.
- [20] Lagler, K. F (1956). Fresh water fishery biology. W. M. C. Brown Co. publ, Iowa. pp. 123.
- [21] Le Cren, E. D. (1951). The length-weight relationship and seasonal cycle in gonadal weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol, 20:201-219.

- [22] Leonard, (2002). Hermaphroditism. [www.reefscape.net/articles/2002/.html](http://www.reefscape.net/articles/2002/.html).
- [23] Loubens, D (1980): In Stock Assessment of the Red Spot Emperor, *Lethrinus lentjan* from areas adjacent to Suakin and Muhammad Qol (Sudan), Kedidi, S. M (1984). Survey conducted during 1982-1984. FAO, Rome, Italy. RAB/83/023/07. pp. 27.
- [24] Mann, K and M Morse (1981): In Hassan, A. Jastina. (1995). Fecundity of *Limanda limanda* in Oxwich Bay, South Wales, and U. K: In Journal of King Abdulaziz University, Jeddah, Suadia Arabia. vol. 6:69-77p.
- [25] Reed, W. (1964). Red Sea fisheries of Sudan, Ministry published by Game and Fisheries Section, Ministry of Animal Resources, Sudan Government, Pp. 116.
- [26] Shapiro, (1994). Un covering the wild ways of fish: In fishy sex. [www/.html](http://www/.html).
- [27] Smith, M. M., (1986). Lethrinidae 595-600: In S Smith, M. M. and P. C. Heemstra (eds.) Smiths' Sea Fishes. J. L. B. Smith Institute of Ichthyology, Grahamstown. pp 1047.
- [28] Soondron, S, Venkatasami A., and Mamode A., (1998). Some results of the study on sexual maturity of *Lethrinus mahsena* from Sayade Malha Bank. Albion Fisheries Research Center, Mauritius.
- [29] Sunobe, (1993). Uncovering the wild ways of fish: In Tina Adler, 1995. Fishy sex. [www/html](http://www/html).
- [30] Tony, J and Paul, J (1982). Fisheries Ecology, American edition. Univ. of Leicester, pp. 414.
- [31] Toor, A (1964): In Stock Assessment of the Red Spot Emperor, *Lethrinus lentjan* from areas adjacent to Suakin and Muhammad Qol (Sudan), Kedidi, S. M (1984). Survey conducted during 1982-1984. FAO, Rome, Italy. RAB/83/023/07. pp. 27.
- [32] Vine, P. (1986). Red Sea Safety. London, pp. 144.
- [33] Young, E and Martin D. (1982): In Carpenter, K. E. and G. R. Allen. (1989). FAO Species Catalogue. Vol. 9. Emperor Fishes and large-eye breams of the world (family Lethrinidae). An annotated and illustrated catalogue of lethrinid species known to date. FAO Species Synop. No. 125 (9):118p.