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HERMAPHRODITISM OF RHABDOSARGUS HAFFARA (TELEOSTEI: SPARIDAE) FROM SUEZ BAY, RED SEA

BY

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Key words: *Sparidae*, *Rhabdosargus haffara*, hermaphroditism, protandrous.

ABSTRACT

Rhabdosargus haffara is one of the most economically important fish in the Suez Bay. The present study is based on the examination of 398 fish specimens ranged in length from 9.4 to 21.0 cm in total length collected from Suez Bay and aimed to give information on the hermaphroditism and sex change in Rhabdosargus haffara. Histological sections for gonads were made. Five types of gonads were arbitrary classified according to the functional male or female cells into: Mf, mf, fm, Fm, and F. The present results showed that 76.88 % were hermaphrodites distributed as 58.0 % Mf, 4.77 % mf, 5.28 % fm and 8.79 % Fm while 23.12 % are exclusively female gonads. Frequency distribution analysis of different types of gonads by length classes and examination of histological sections suggested that R. haffara was a protandrous hermaphrodite. Gonads of exclusively female were found but no exclusively male gonads were detected.

INTRODUCTION

Hermaphroditism is common in fishes, members belonging to class Pisces exemplify an almost complete range of the various types of sexuality from synchronous hermaphroditism, protandrous and protogynous hermaphroditism, to gonochorism. Order perciformes includes four families *Centracanthidae, Labridae Serranidae*, and *Sparidae* in which either synchronous or consecutive hermaphroditism normally occurs, however there are some gonochoristic species (Yamamoto., 1969). This phenomenon was noticed in diferent species in the Family sparidae from different localities (EL-Maghraby *et al*., 1981; Hashem and Gassim 1981 and EL-Agamy 1989).

Cody and Bortone (1992) listed the different reproduction modes of some species of *Sparidae*, these modes are: protandry, protogyny, rudimentary, functional and gonochorism.

st abundant species of *Sparidae* in Suez Bay. AL-oraimi
biology of *R. haffara* in Suez Canal. EL-Boray (1997)
hermaphroditism of *R. haffara* in the first year of age in
was protandrous. Ibrahim (1999) reported the ecology
outhern Sinai Coasts. The behavior of this fish in Suez
mation of functional sex have not been studied. This
ised on this phenomenon by examining histological
of length frequencies.

ERIALS AND METHODS

21.0 cm (total length) were collected by line angling
from 19 May 1999 to 11 May 2000. Gonads were
and processed for transverse sections taken at 6 µm
The histological sections were examined to identify
in frequencies against the total length classes. The
otomicrograph for sections were taken to illustrate

RESULTS

ads

ssified after histological examination, according
into five categories: a functional testis with a
s with a previously function male but its fateful
l in a dominant state (mf), ovotestis where the
ate and the female portion start to be active
ries with a rudiment of a testicular area (Fm)
ar tissue (F).

assified five types of gonads are shown in
on of lengths 19, 20 and 21 cm, a small
l (F) gonads represent the length class
26.7%, respectively.

n relation to the length. This percentage
18 cm. The (mf) and (fm) are found only
n of (Fm) occurred in length class

*Table 1: Frequency distribution of the different types of gonads by length class of *Rhabdosargus haffara* in Suez Bay during the period from 19 May 1999 to 11 May 2000.

Length Class	Total No.	Mf	%	mf	%	fm	%	Fm	%	F	%
9	5	4	80.0							1	20
10	15	11	73.3							4	26.7
11	47	29	61.7	5	10.60	5	10.60	3	6.38	5	10.6
12	91	57	62.6	8	8.79	6	6.59	9	9.89	11	12.1
13	91	69	75.8	1	1.10	3	3.30	6	6.59	12	13.2
14	49	30	61.2	2	4.08	1	2.04	5	10.20	11	22.4
15	45	12	26.7	1	2.22	5	11.10	5	11.10	22	48.9
16	29	10	34.5	2	6.90	1	3.45	3	10.30	13	44.8
17	13	4	30.8					2	15.40	7	53.8
18	9	2	22.2					2	22.20	5	55.6
19	2	2	100.0								
20	1	1	100.0								
21	1									1	100
Total	398	231		19		21		35		92	
%		58.0		4.77		5.28		8.79		23.10	
r.		-0.9		-0.2		-0.1		0.92		0.81	

- r. (correlation coefficient.
- (Mf) a functional testis with a rudimentary ovarian area.
- (mf) ovotestis with a previously function male but its fateful is not known and the female portion still in a dominant state.
- (fm) ovotestis where the testis portion becomes in a dominant state and the femaleportion start to be active (increasing of oogonia division).
- (Fm)ovaries with a rudiment testicular area.
- (F) exclusively female without any testicular tissue.

According to the percentage of gonadal types and their correlation coefficient (r) with length classes, the (Mf) represented (58 %, r = - 0.9) and observed in all obtained length classes except 21 cm. The transition gonads (mf) and (fm) where the two areas of ovarian and testicular tissues of nearly equal developmental, occurred in similar range of length classes (11-16) cm and represented by the lowest percentage of occurrence (4.77 %, r = - 0.2) and (5.28, r = - 0.1) respectively.

The percentage of ovaries with a rudiment testicular cells (Fm) are corresponded to (8.79 %, r = 0.92) for length classes of 11 to 18 cm. The (F) gonads which are exclusively female, (without testicular tissue) are found through the all length classes except 19 and 20 cm due to the scarcity of samples, represented by (23.1 %, r = 0.81). The percentage of all forms of hermaphroditism (Mf, mf, fm and Fm) was 76.88 % while that of gonochoristic i.e. was 12.12 %.in *Rhabdosargus haffara*

III- Sex change process

Histological observations in the present study showed that *R. haffara* starts its life as exclusively female with a length of 9.6 cm (Fig. 1) and hermaphrodite gonads with functional male with a length of 9.8 cm (Fig. 2). After spawning season, a portion of the functional male gonads (Mf) are transformed into a functional female (Fm). According to the basis of change in the structure of the germinal elements, histological transformation of ovotestis male to ovotestis female was divided into 5 stages, these stages are:

(1) At the beginning the ovotestis with ripe male (Fig. 3), where the female cells are arrested on perinucleolus stage, evacuated some of its spermatozoa. Accordingly, the lobules shrinkage while the spermatic duct is still full of spermatozoa (Fig. 4).

(2) In the spent stage (Fig. 5) where the lobules and spermatic duct are empty of spermatozoa and smaller in size than that in the previous stage. The lumen of lobules is still obvious.

(3) The last gonads either function as male in the next spawning or transformed into functional female. In the first case, the spermatogonia are activated and lined the wall of lobules in addition to the presence of spermatids and residual of spermatozoa (Figs. 6 and 7). In the second case, the lobule lumens are closed and the spermatic duct coalesced with the wall of the ovary. Brownish pigment granules were founded in the male portion and the testicular cells lost its normal structure (Figs. 8 and 9). The female area becomes active and resumes its rounded shape. The oogonia divided and lined the wall of ovigerous lamellae (Fig. 10).

(4) The testicular cells degenerated in the center with increasing the clusters of brownish pigment granules, except the peripheral layer of spermatogonia (Fig. 11). The testicular size decreased while the ovarian size ncreased and ovigerous lamellae filled with perinucleolus and oogonia cells. 'he ovigerous lamellae reached to the ovarian cavity (Fig. 12).

(5) The testicular area either becomes atrophied and contains a very small numbers of degenerating spermatogonia (Fig. 13) or still has their spermatogonia cells in normal structure with the functional female (Figs. 14 and15).

DISCUSSION

Yamamoto (1969) cited that a number of teleost fishes are hermaphrodites. Atz (1964), among others, defined the types of hermaphroditism. An individual is hermaphroditic if it bears recognizable male and female tissues. If all, or nearly all, individuals possess both ovarian and testicular tissues, that species is hermaphroditic.

Analyzing the obtained results in this study showed that the smallest length classes (9 and 10 cm) present both gonochoristic female and hermaphrodite with functional male individuals. Therefore, *R. haffara* manifest two distinct forms in the beginning of its life a) protandrous hermaphroditism in the majority of individuals and b) in the minority of individuals, ovaries do not have any hermaphroditic structure.

The percentage of hermaphroditism in *Sparidae* differs from species to species and from different localities (Hashem and Gassim, 1981 and EL-Agamy, 1989). In the present study it was 76.88 %. While in *Acanthopagrus latus* and *Acanthopagrus cuvieri* were 5.8 and 5.7 %, respectively (Abu-Hakima, 1984); *Obalda melanura* was 12.4 % at the maximal percentage during the year (Asem, 1992); *Boops boops* was 16.5% (Gordo, 1995).

The positive correlation ($r = 0.81$) between length classes and the percentage of (F) indicating that the number of exclusively female increased with lengths. Similarly, the positive correlation ($r = 0.92$) between length classes and percentage of (Fm) indicated that the number of transformed fishes from (Mf) to (Fm) increased with length. (Mf) is negatively correlated with length classes ($r = -0.9$), indicating that the percentage of (Mf) decreased with increasing length. From the aforementioned statistical analysis in addition to the presence of hermaphrodite male in all lengths, it can be concluded that *R haffara* in the wild is a protandrous hermaphrodite in addition to presence of gonochoristic female gonads. The present results is supporting the previous finding reached by the author (1997) on *R. haffara* in fish farms while Ibrahim (1999) in Southern Sinai Coasts showed that *R. haffara* was a rudimentary type, *i.e.* the young fish possess an immature intersexual gonad but mature as either male or female fish, with no evidence of sex reversal". This is not observed in the present study.

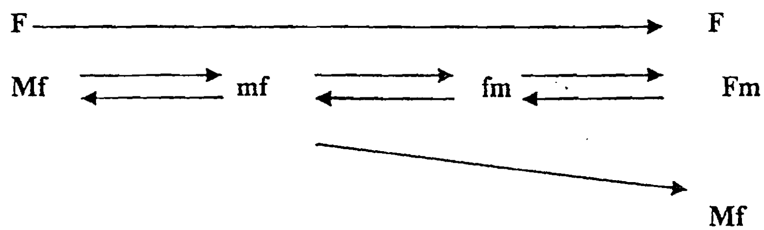
Overlaps in length classes of (Mf) and (Fm) in large lengths suggests that a portion of the (Mf) do not change sex. This finding agrees with that of Abu-Hakima (1984) in *Acanthopagrus latus* and *Acanthopagrus cuvieri* and Krug (1990) in protandrous *Pagellus bogaraveo*.

To establish protandrous hermaphroditism in the sparid fish, Michale and Perdichizzi (1994) cited that "different criteria have been used such as the prevalence of either testicular or ovarian tissue within the bisexual gonad (Lissia-Frau and Pala, 1968) or sexual dimorphism in the size of individuals (Fisher, 1983; Pollock, 1985). Sadovy and Shapiro (1987) pointed out that the strongest indicators of protandry are transitional individuals whose gonads contain degenerating testicular tissue and developing ovarian tissue". Histological sections of gonads in *R. haffara* after spawning season showed the presence of degenerating testicular tissue and developing ovarian tissue. This finding agrees with Micale and Perdichizzi (1994) in *Diplodus sargus* where they mentioned that the presence of degenerating testis beside advanced vitellogenic oocytes within the bisexual gonad, strongly suggests the occurrence of protandrous sex inversion. However Tobin *et al*., (1997) mentioned that histological examination and population structure do not provide direct evidence of a sex change process and they are replaced with the direct detection of sex change in individual fish.

Krug, 1990 classified the gonads of hermaphroditism according to the size of testicular and ovarian area in the ovotestis. In the present study, it was found that in some of the ovotestis gonad the testicular portion was smaller than that of ovarian portion but the fish functions as male (Fig. 6). Therefore, the relative size of each type of germinal tissue within the ovotestis is not a distinctive sign of sex inversion in *R. haffara*, however this result agreed with Kime *et al*., (1991).

Micale and Perdichizzi (1994) showed that two processes may occur in the spent testis: either spermatogonial mitosis starts again leading to complete spermatogenesis and subsequent emission of sperms, or the testicular tissue undergoes regressive changes leading to complete atrophy of the male portion of the gonad. In addition to the above observation in the inverting testis of *R. haffara* it was found that with the functional female portion, spermatogonia are either degenerating completely except few numbers of cells or staying as normal cells in structure but not function. This suggests that the non-degenerating spermatogonia may be reactive and the fish function as male again. Such assumption may explain the overlapping in length classes of Mf and Fm.

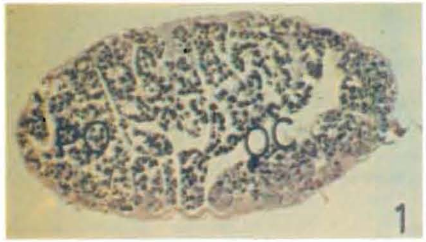
From the above observations and suggestion, the processes of transformation in *R. haffara* could be summarized in the following diagram;



In protandrous hermaphrodite, sparid fishes exclusively male without any ovarian tissue were found (Breaka, 1988; Krug, 1990; Cody and Bortone 1992; Gordo, 1995). In *R. haffara,* this structure is not found. Also in some species of *Sparidae* it is found that the cells of male or female gonads can be found in the opposite portion (Smale, 1988; Asem, 1992; and Gordo, 1995, Mahmoud 2002). This case is not also found in *R. haffara.*

There are many theories and hypothesis to hermaphroditism: Moe (1969) studying the grouper, *Epinephelus morio,* suggested that hermaphroditism and sex transition in the teleosts may occur in response to population pressure rather than changes in the environment. Yamamoto (1969) showed that sex reversal might be caused by sex hormone imbalances, in the female phase the female hormone might dominate the male hormone and in the male phase the reverse might be true. Warner (1975) suggested that the fish by spending only part of the mature life span as female and part as male might yield a higher expected reproductive potential when compared with non-hermaphrodites.

It could be concluded that *R. haffara* in the wild is a protandrous hermaphrodite. Not all ovotestis males transformed into ovotestis females. The transformed ovotestis female that has normal structure spermatogonia may be transformed again into ovotestis male. Exclusively male gonads were not found and the cells of male or female can not be found in the opposite portion. The phenomenon of hermaphroditism needs to be studied carefully to know its advantages and benefits.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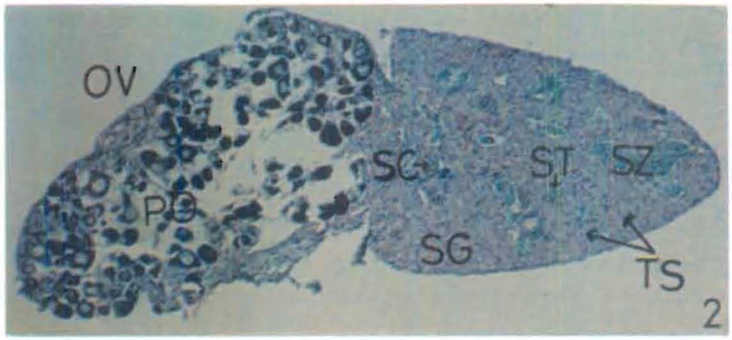
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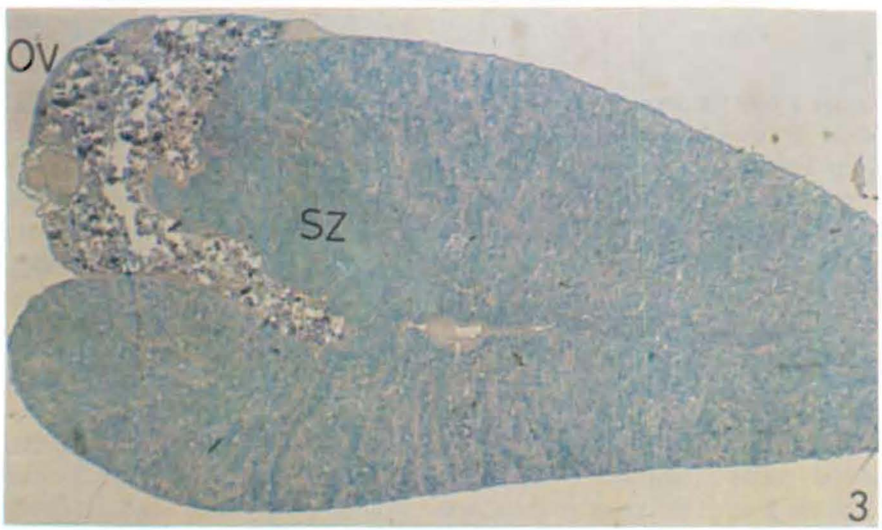
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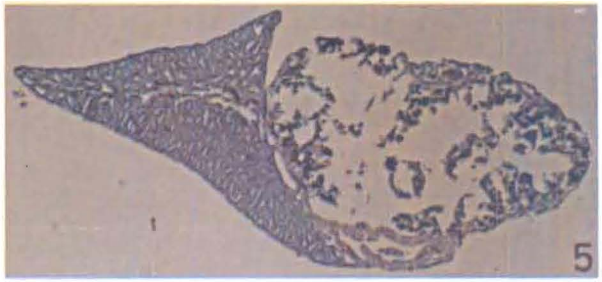
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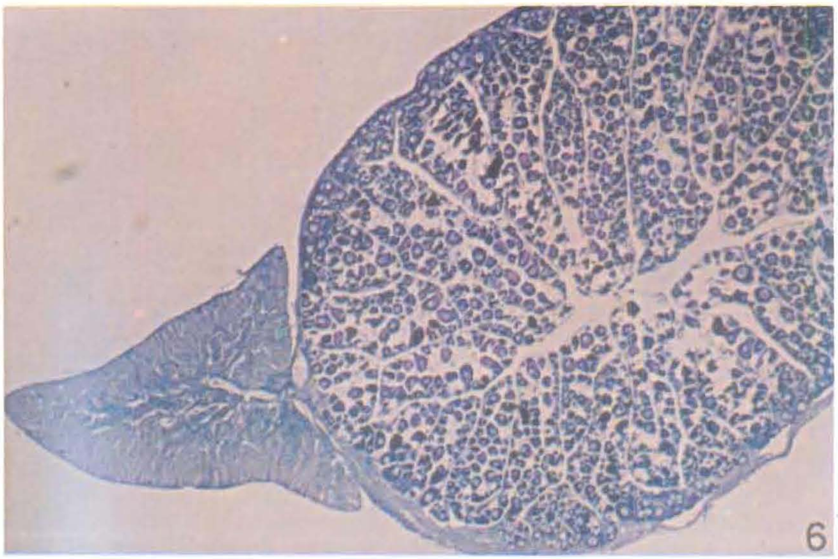
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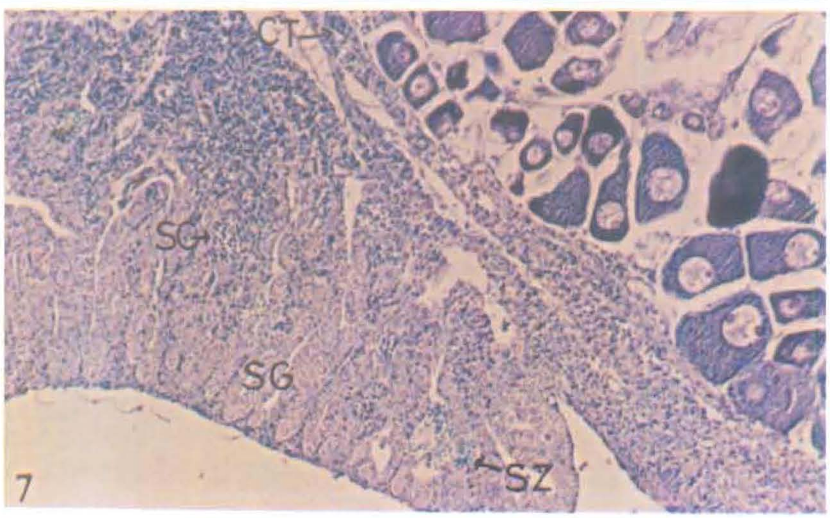
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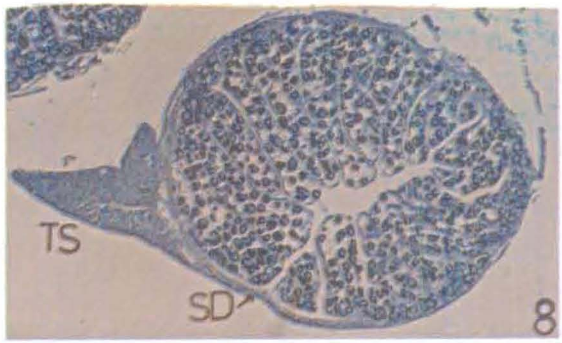
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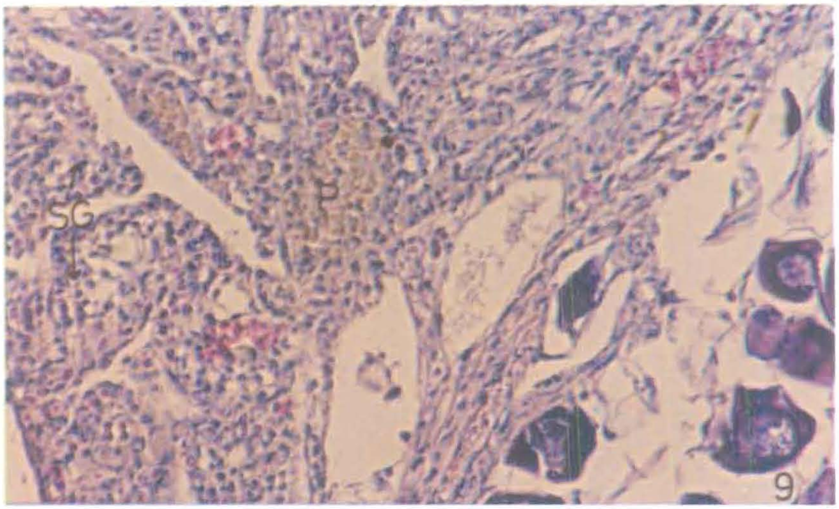
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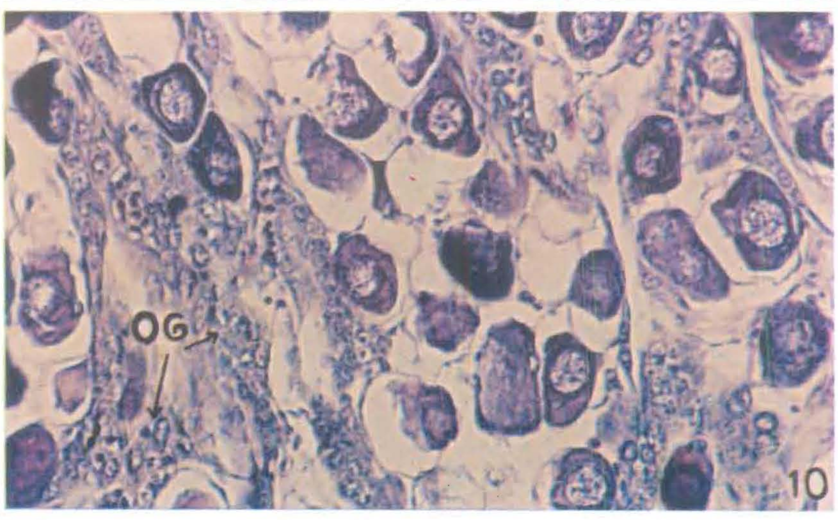
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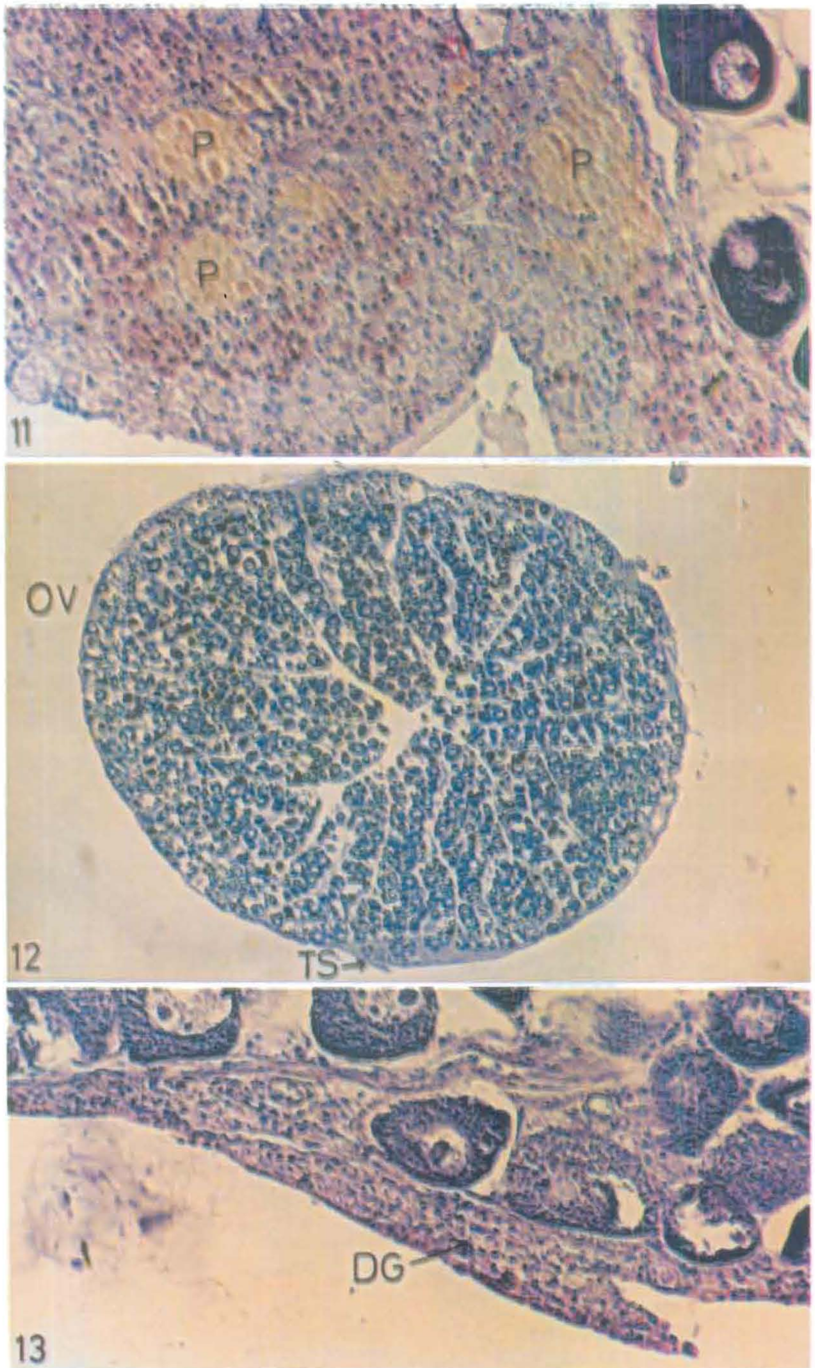
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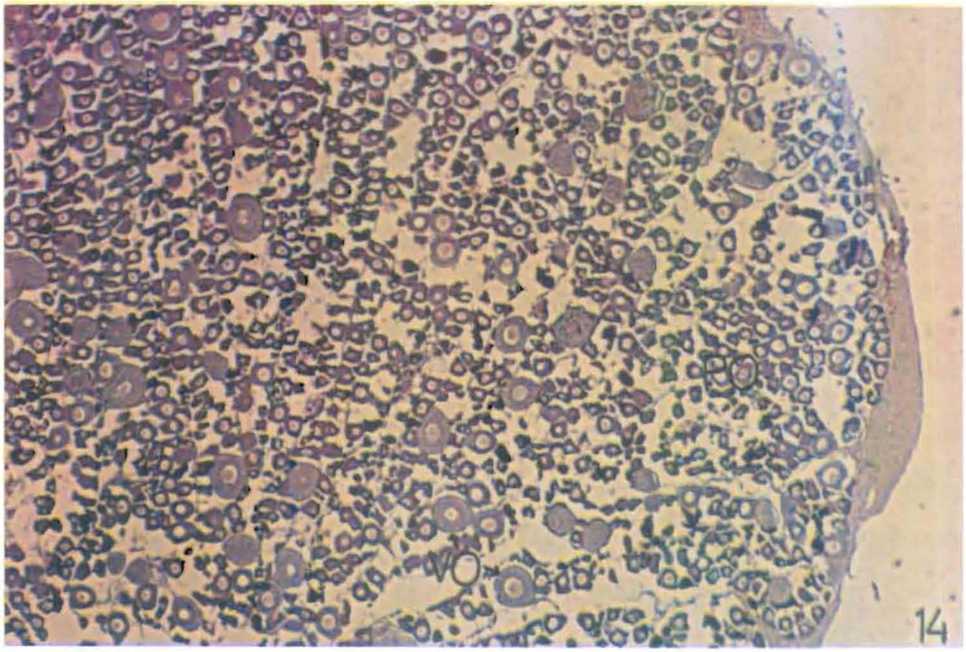
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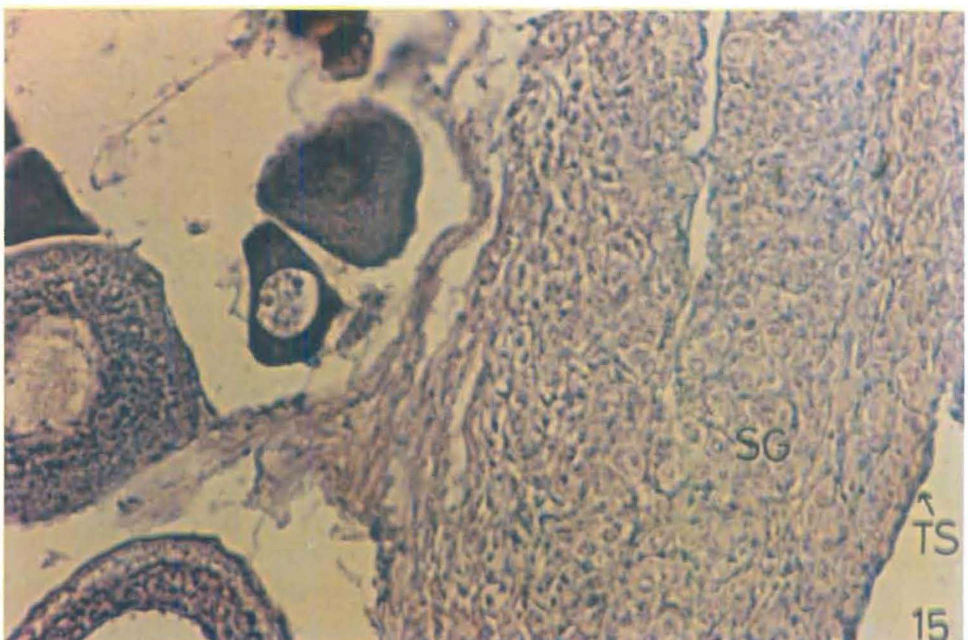
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LIST OF FIGURES

Fig 10: Enlargement of female lobe in fig (8) showing the activation of oogonia (OG) and increasing their number. X 250

Fig 11: An ovotestis of *Rhabdosargus haffara* showing the degenerating testis in a transitional phase. Many areas of degenerating cells in which masses of brownish pigment are found (P). The marginal spermatogonia are found in normal structure. X 250

Fig 12: An ovotestis of *Rhabdosargus haffara* showing the ovarian lobe (OV) and the testicular part (TS) is very small portion beside the wall of the female. X 25

Fig 13: Enlargement of fig (12) illustrates the degenerating testicular cells (DG). X 250

Fig 14: A functional female ovotestis of *Rhabdosargus haffara* showing the ovarian lobe contains perinucleolus oocytes (PO) and vacuolized oocytes (VO). The testicular area (arrow) is found as a band beside the ovarian wall. X 25

Fig 15: Enlargement of Fig (14) showing the presence of normal structure of spermatogonia (SG) in the male portion (TS). X 250

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