17) RAPID #
-409626

BORROWER
AUM

System Date/Time: 03/25/2004 09:03:29

CALL #: QH301 .A493
LOCATION: Washington State Owen

TYPE: Article
USER JOURNAL TITLE: European archives of biology
OCLC JOURNAL TITLE: European archives of biology
NTE CATALOG TITLE: European archives of biology.
ARTICLE TITLE: : REPRODUCTIVE BIOLOGY OF THE WHITE PIAU SCHIZODON-KNERII STEINDACHNER 1875 ANOSTOMIDAE FROM A RESERVOIR IN SOUTHEAST BRAZIL.
VOLUME: 101
NO: 3
YEAR: 1990(1990)
COPYRIGHT: CCL
PAGES: 331
ISSN: 0777-0553
OCLC #: 20335057
VERIFIED:

PATRON: Godinho,Alexandre
PATRON ID: 0
PATRON PHONE:
PATRON DEPT: Natural Resources Conservation
PATRON STATUS: DoctoralCandidate
PATRON FAX:
PATRON ADDRESS:
PATRON E-MAIL:
PATRON NOTES:

RAPID *LENDING STATISTICS*

REQUEST TYPE:
_____ (**L**)oan
_____ (**P**)hotocopy
_____ (**U**)nfilled

CHARGES: **0**

EXPOSURES: _____

DATE COMPLETE: _____

UNFILLED REASON: _____

SENT OUT VIA:
_____ (**C**)ourier
_____ (**A**)riel
_____ Federal E(**X**)press
_____ (**M**)ail
_____ (**F**)ax
_____ (**O**)ther

IA-GARCIA *et al.*

gment persists beyond O'Rahilly's

VLEDGEMENTS

ı Shashok for translating the original

ERENCES

bation and its relation to the thoracic paries, as
ınd abnormalities in the human subject. *J. Anat.*

COSTEA. — Deux cas de lobe azygos associé à un
be supérieur droit. Considérations chirurgicales.
-589 (1969).
u poumon. Le lobe supérieur du poumon gauche.
4 (1900).
nes congénitas del aparato respiratorio. *Rev Esp.*

Tuberculose du Lobe Azygos. Bibliothèque de
Paris (1933).
R. — The development of the vena cava inferior
83 (1925).
R. — Introduction a l'étude des stades embryon-
nat. **65/189** : 141-208 (1981).
I 5th ed. Editorial Científico-Médica. Barcelona

aine. Vol. III Fasc. II Masson et Cie. Edit. Paris.

ón Humano de 29 mm. con Lóbulo Acigos. *Arch.*

y lobe of the vena azygos. *J. Anat. and Physiol.*

micae de vena azyga duplicii aliisque hujus venae
ocietatis Reg. Scient. **8** : 14-18 (1778).

lorfológicas

Eur. Arch. Biol. (Bruxelles) **101** : 331-344 (1990)

REPRODUCTIVE BIOLOGY OF THE WHITE-PIAU, Schizodon knerii (Steindachner, 1875) (Anostomidae) *FROM A RESERVOIR IN SOUTHEAST BRAZIL*

BY

R. M. A. FERREIRA and H. P. GODINHO.

(Department of Morphology, Institute of Biological Sciences, Federal University of Minas Gerais, 30270 Belo Horizonte, MG, Brazil)

(Received August 28, 1989; revised and accepted December 12, 1989)

SUMMARY — *White-piau* (Schizodon knerii), *one of the most important fish in commercial catches at Três Marias reservoir in the San Francisco river, has its reproductive biology been under investigation for the first time. Ovaries and testes of the white-piau are of the cystoovarian and lobular types, respectively. The reproductive period of this species extends from October to April similarly to that of most species of Southeast Brazil. This period coincides with the rainy season, high water temperature and long daylength. Females are in better "condition" when outside the reproductive period. The amount of fat accumulated within abdominal cavity follows the cyclic variation in the reservoir water level. The white-piau is a fractional spawner, has adhesive eggs and spawning occurs within reservoir waters. Females were induced to spawn in captivity with crude carp pituitary extract.*

Key words : Teleost fish, Schizodon knerii, reproductive biology, artificial spwaning, Três Marias Reservoir, tropical reservoir.

INTRODUCTION

The growing demand on hydrolectric power in Brazil has been matched with the construction of large hydroelectric reservoirs (<1,000 Km² of impounded area). Três Marias reservoir at the San Francisco river (Fig. 1), the oldest among these, was built in the early 60' and only recently has its fishery resources been under

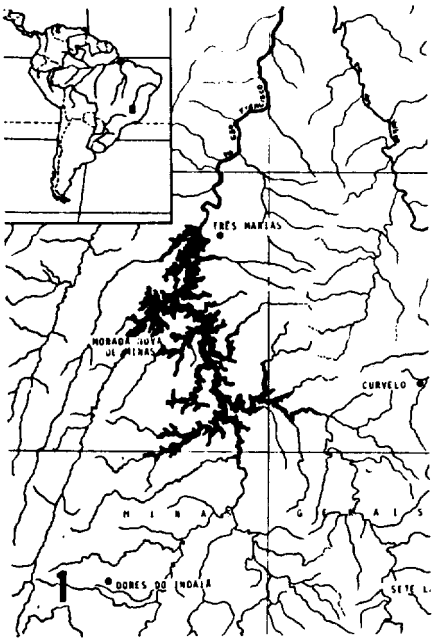


FIG. 1. Três Marias reservoir (insert = general location) in the San Francisco River at the state of Minas Gerais, Brazil (18 - 20 °S, 44 - 46 °W).

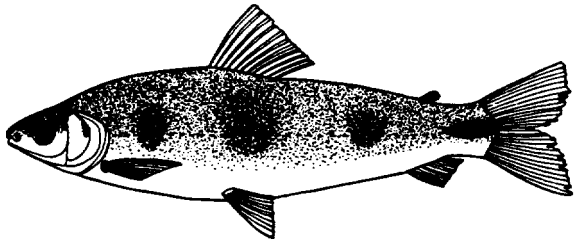


FIG. 2. Schematic drawing of the white-piau (*Schizodon knerii*).

evaluation. Commercial fishery at Três Marias is performed by approximately 150 fishermen. Gill nets are the fishing gear used. Annual production is estimated to be around 400 metric tons and the white-piau (*Schizodon knerii* Steindachner, 1875) being one of its most important species (SATO & OSÓRIO, 1987).

Anostomidae fish, to which belongs the white-piau, are herbivorous and found in large rivers (BRITSKI *et alii*, 1984). White-piau

feeds mainly on macrophytes, algae and s
RES, 1984). The largest white-piaus capt
ches during 1981-1986 had 35 cm, standa
weight, whereas commercial fish weighe
pers. com.).

The reproduction cycle of this fish a
reported, to our knowledge, for the firs
propagation of this species is also give

MATERIAL AND MET

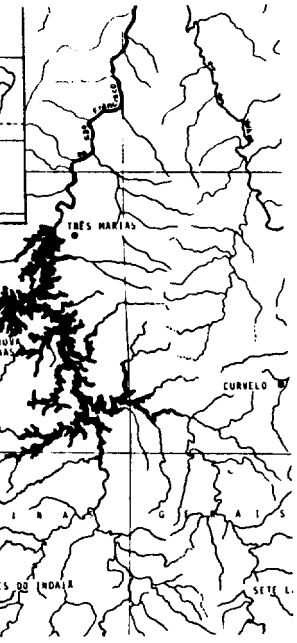
The fish were captured from May, 19
gill nets placed in the water in late after
early morning of the next day. 1,201 f
greater than 13.6 cm (males) and 14.7

The following parameters were obtain
the period of May, 1982 to June 1983 (19
body weight (BW), standard length (SL)
reproductive cycle (SRC), weight of one
(LW) and abdominal fat weight (AFW).
resting; 2A = initial maturation; 2B =
= mature; 4A = partially spawned; 4B
SRC were : 1 = non-reproduction (tot
reproduction (2A = in maturation/matu
Gonad fragments were fixed in Bouin
studies which included microscopic eva
estimation of the relative frequency of the
tion (SOM). The latter was obtained thro
mula (1946) modified by AMANN (1962)

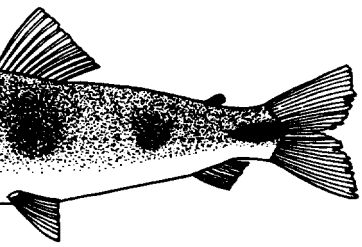
The fish (363 females, 434 males) capt
ly, 1983 to October, 1984 had their BW
macroscopically) obtained.

The following indexes were then calcula
index) = GW × 200/BW, HSI (hepatos
100/BW, AFI (abdominal fat index) =
(condition factor) = BW × 100/SL³.

Three females and three males were in
crude carp pituitary extract according to
in WOYNAROVICH & HORVÁTH (1980). T



= general location) in the San Francisco River at the
20 °S, 44 - 46 °W).



hite-piau (*Schizodon knerii*).

hery at Três Marias is performed by ap-
Gill nets are the fishing gear used. An-
d to be around 400 metric tons and the
rii Steindachner, 1875) being one of its
ATO & OSÓRIO, 1987).
hich belongs the white-piau, are her-
rivers (BRITSKI *et alii*, 1984). White-piau

feeds mainly on macrophytes, algae and sediment (BOTELHO & TORRES, 1984). The largest white-piaus captured in experimental catches during 1981-1986 had 35 cm, standard length, and 1 Kg, body weight, whereas commercial fish weighed circa 0.2-0.3 Kg (SATO, pers. com.).

The reproduction cycle of this fish at Três Marias reservoir is reported, to our knowledge, for the first time. Data on artificial propagation of this species is also given.

MATERIAL AND METHODS

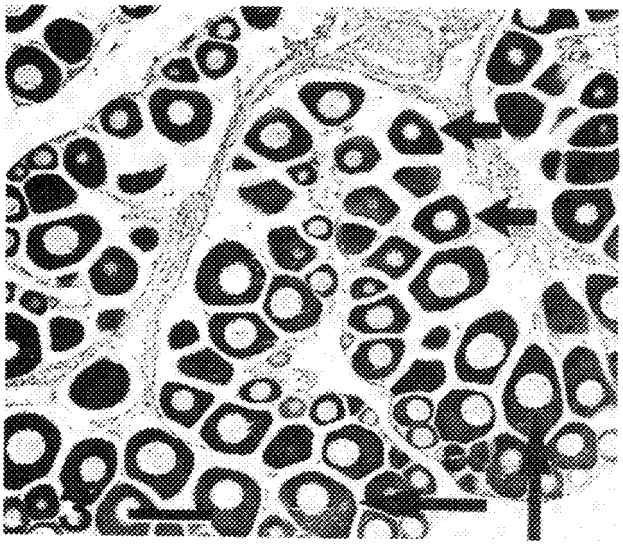
The fish were captured from May, 1982 to October, 1984 with gill nets placed in the water in late afternoon and removed in the early morning of the next day. 1,201 fish with standard length greater than 13.6 cm (males) and 14.7 (females) were used.

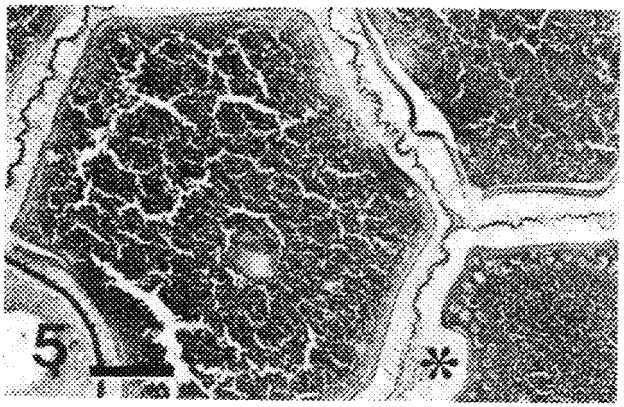
The following parameters were obtained from fish captured in the period of May, 1982 to June 1983 (197 females and 207 males) : body weight (BW), standard length (SL), sex (M,F), stages of the reproductive cycle (SRC), weight of one gonad (GW), liver weight (LW) and abdominal fat weight (AFW). Female SRC were : 1 = resting; 2A = initial maturation; 2B = advanced maturation; 3 = mature; 4A = partially spawned; 4B = totally spawned. Male SRC were : 1 = non-reproduction (totally spent/resting); 2 = reproduction (2A = in maturation/mature; 2B = partially spent). Gonad fragments were fixed in Bouin's liquid for histological studies which included microscopic evaluation of the SRC and estimation of the relative frequency of the stages of oocyte maturation (SOM). The latter was obtained through ABERCROMBIE's formula (1946) modified by AMANN (1962).

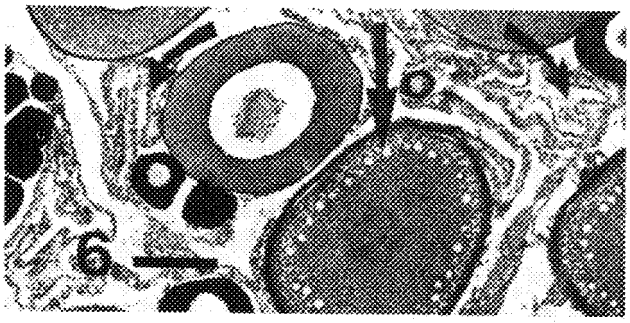
The fish (363 females, 434 males) captured in the period of July, 1983 to October, 1984 had their BW, SL, S and SRC (only macroscopically) obtained.

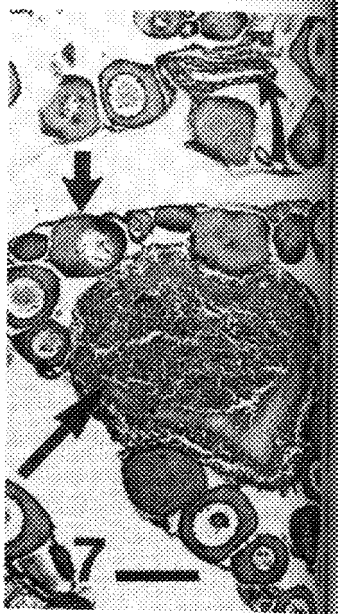
The following indexes were then calculated : GSI (gonadosomatic index) = GW × 200/BW, HSI (hepatosomatic index) = LW × 100/BW, AFI (abdominal fat index) = AFW × 100/BW and K (condition factor) = BW × $100/SL^3$.

Three females and three males were induced to reproduce with crude carp pituitary extract according to the technique described in WOYNAROVICH & HORVÁTH (1980). This work was performed









at the Fishery Station of Três Marias
State of Minas Gerais, in December,

The regression analysis and the othe
the present paper were performed acc

Results and Disc

White-piau (Fig. 2) presents a pair of
solateral portion of the coelomatic cavi
vesicle. The ovaries are of the cystovari
the testes are of the lobular type (Billa
papila they unite to each other to for
Macroscopic changes in size and color
ing the reproductive cycle.

The histological organization of the
of other Brazilian characiform fish (An
Bazzoli, 1985; Tavares, 1986). The se
white-piau contain cysts inside which al
in the same stage of development. Cysts
along the whole length of the seminifero
the testis of this fish belongs to the « un
type » of Grier *et al.* (1980) and Grier
constitute the wall of these cysts (Grier,
at the final stage of spermiogenesis an
in the lumen of the seminiferous tubules
Sherestha & Khanna, 1976).

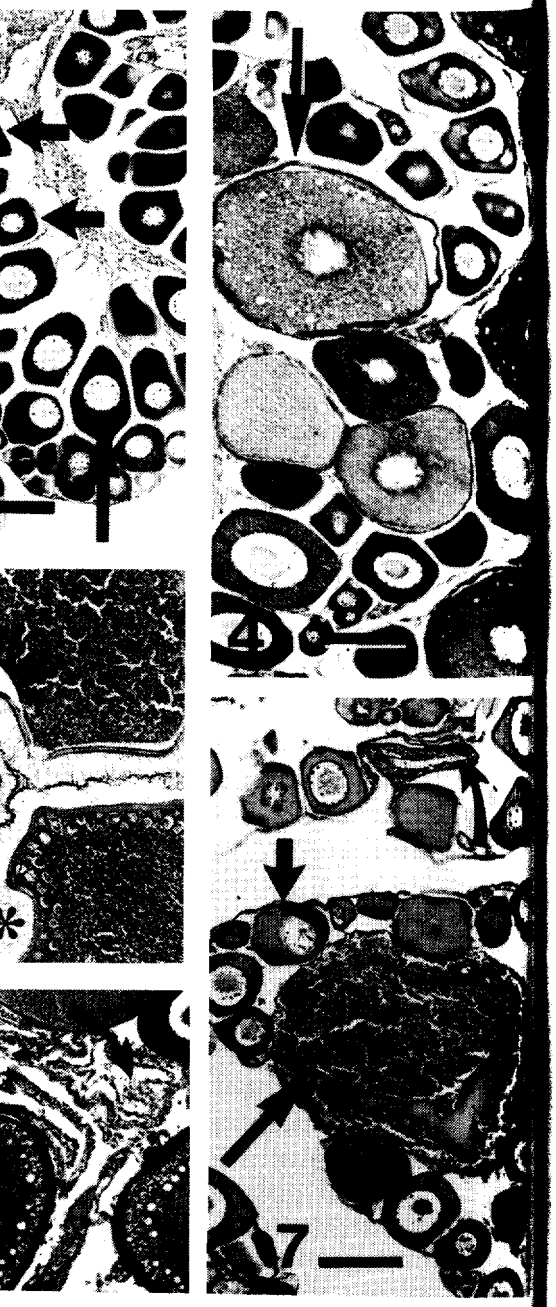
Table 1 and 2 and Figures 3 to 11 pres
characteristics of females and males duri

The log transformed data on lengh
females and males, respectively, are give

$$\ln BW = -4{,}147 + 3.078$$

$$\ln BW = -3{,}692 + 2.9$$

Figs. 3 to 7 depict histological sections of white-piau ov
ductive cycle (paraffin embedded, 7 μm thick, haematox
Fig. 3. Resting stage; short arrows = type 1 oocyte;
Fig. 4. Initial maturation stage; arrow = type 3 ooc
Fig. 5. Advanced maturation stage; large type 4 oocy
prismatic follicular cells.
Fig. 6. Partially spent stage; straight arrow = type 3 oo
Fig. 7. Totally spent stage; short arrow = type 1 ooc
long arrow = type 4 oocyte in reabsorption.



at the Fishery Station of Três Marias (CODEVASF), Três Marias, State of Minas Gerais, in December, 1985.

The regression analysis and the other statistical calculations of the present paper were performed accordingly to RICKER (1975).

RESULTS AND DISCUSSION

White-piau (Fig. 2) presents a pair of gonads situated in the dorsolateral portion of the coelomatic cavity, ventrally to the gaseous vesicle. The ovaries are of the cystovarian type (HOAR, 1969), and the testes are of the lobular type (BILLARD, 1986). Near the genital papila they unite to each other to form a single excretory duct. Macroscopic changes in size and color of the gonads are seen during the reproductive cycle.

The histological organization of the gonads are similar to that of other Brazilian characiform fish (ANDRADE & GODINHO, 1983; BAZZOLI, 1985; TAVARES, 1986). The seminiferous tubules of the white-piau contain cysts inside which all the gametogenic cells are in the same stage of development. Cysts of spermatogonia are seen along the whole length of the seminiferous tubules. For this reason the testis of this fish belongs to the « unrestricted spermatogonial type » of GRIER *et al.* (1980) and GRIER (1981). Sertoli cells which constitute the wall of these cysts (GRIER, 1976; GRIER, 1981) disrupt at the final stage of spermiogenesis and release the spermatozoa in the lumen of the seminiferous tubules (RUBY & MCMILLAN, 1975; SHERESTHA & KHANNA, 1976).

Table 1 and 2 and Figures 3 to 11 present the main reproductive characteristics of females and males during the reproductive cycle.

The log transformed data on lenght/weight relationship for females and males, respectively, are given in the formulae below :

$$\ln BW = -4{,}147 + 3.078 \ln SL, \text{ and}$$

$$\ln BW = -3{,}692 + 2.923 \ln SL$$

FIGS. 3 to 7 depict histological sections of white-piau ovaries at different stages of the reproductive cycle (paraffin embedded, 7 μm thick, haematoxylin-eosin stained, bar = 100 μm) :

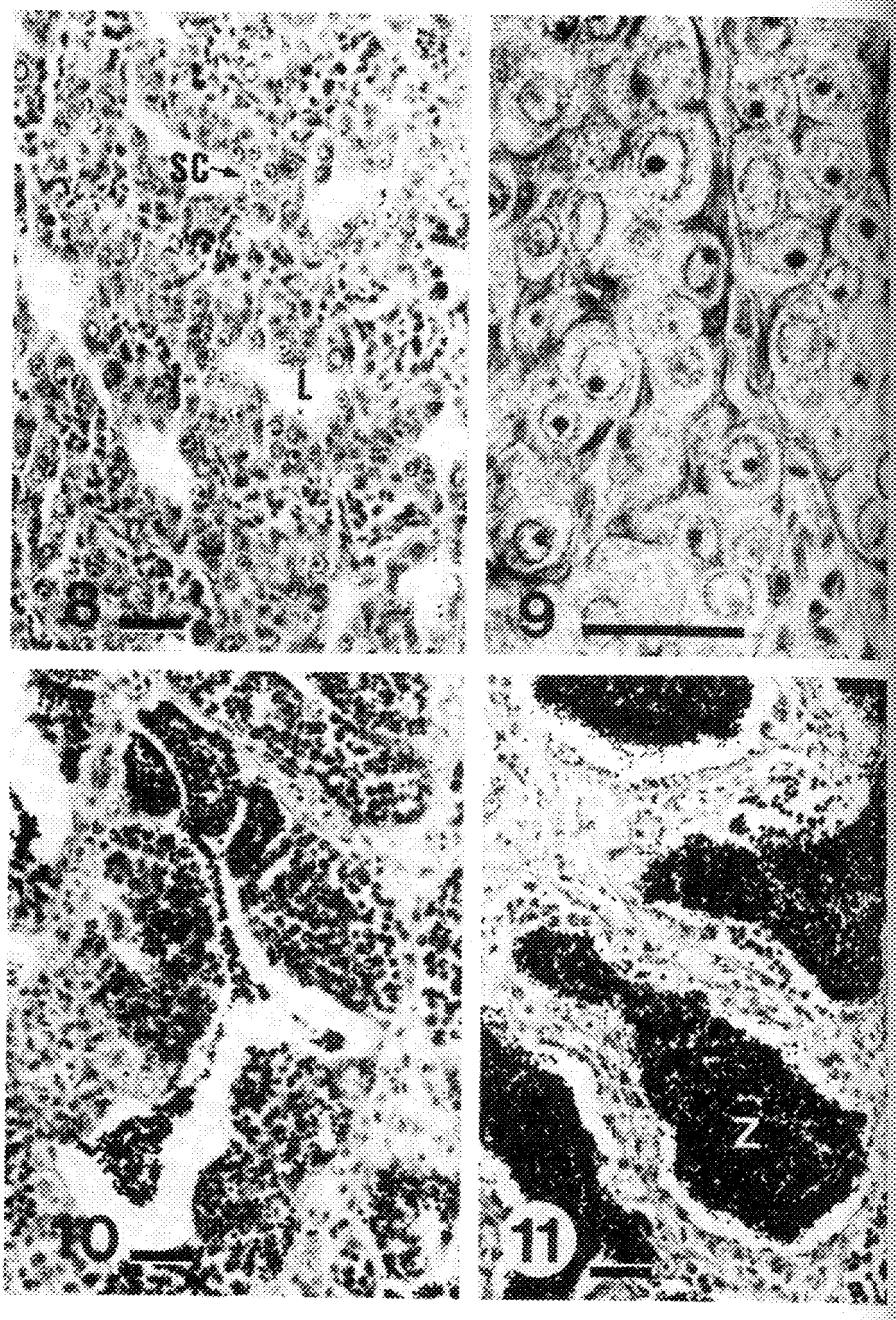
FIG. 3. Resting stage; short arrows = type 1 oocyte; long arrows = type 2 oocyte.

FIG. 4. Initial maturation stage; arrow = type 3 oocyte.

FIG. 5. Advanced maturation stage; large type 4 oocyte at the center; asterisks = highly prismatic follicular cells.

FIG. 6. Partially spent stage; straight arrow = type 3 oocyte; bent arrows = empty follicles.

FIG. 7. Totally spent stage; short arrow = type 1 oocyte; bent arrow = empty follicle; long arrow = type 4 oocyte in reabsorption.



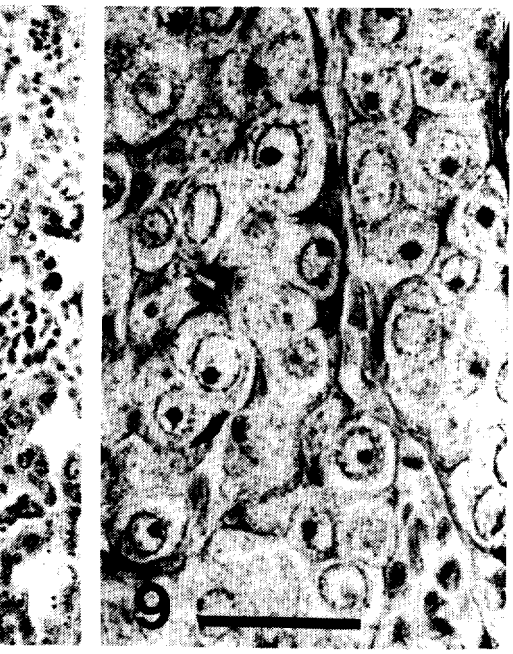
Isometrically growth (LE CREN, 19
white-piau since the regression coeffic
mulae) is close to 3. SATO & BARBIER
similar results, have considered it to

Fig. 12 shows the relative frequency
stages of maturation during the reproc
oocytes (previtellogenic) predominate i
tive cycle. Type 3 oocytes (in vitelloge
at initial maturation and in those parti
(complete vitellogenesis) are seen at the
tion and also in process of reabsorptic
Only about 10% of the previtell
vitellogenesis within one reproductive c
extruded. The oocyte dynamics in the wh
synchronous pattern which is the most co
(WALLACE & SELMAN, 1981).

Data on K, GSI and HSI of females at
tive cycle are in Fig. 13. Females are i
CREN, 1951) when outside the reprodu
of GSI and HSI were found at the stag
and partially spent. This finding sugges
ed as an indicator of the reproduction
from man made reservoirs (RAHMAN & M
et al., 1984). Variations of these parar
pressive (Fig. 14).

Fig. 15 shows monthly AFI's of femal
higher monthly AFI values occurre
September. Thereafter they gradually
values in January-February to raise aga
This variation follows behind that of
Submerged littoral macrophytes durin
ing period possibly are transformed int

FIGS. 8 to 11 are light photomicrographs of white-p
reproductive cycle (paraffin embedded, 7 μm thick,
FIG. 8. Non-reproduction stage; totally spent testis;
open; luminal spermatoza are absent; SC = cysts o
FIG. 9. Non-reproduction stage; resting testis showing
of seminiferous tubules is collapsed; 1088 ×.
FIG. 10. Reproduction stage; maturing testis; wall of
various stages of spermatogenesis; 425 ×.
FIG. 11. Reproduction stage; mature testis; lumina
spermatozoa (Z); 425 ×.



Isometrically growth (LE CREN, 1951) may be ascribed to the white-piau since the regression coefficient (b value in above formulae) is close to 3. SATO & BARBIERI (1983), although relating similar results, have considered it to be of the allometric type.

Fig. 12 shows the relative frequency (%) of oocytes at different stages of maturation during the reproductive cycle. Type 1 and 2 oocytes (previtellogenic) predominate in all stages of the reproductive cycle. Type 3 oocytes (in vitellogenesis) are present in ovaries at initial maturation and in those partially spent. Type 4 oocytes (complete vitellogenesis) are seen at the stage of advanced maturation and also in process of reabsorption in ovaries totally spent. Only about 10% of the previtellogenic oocytes complete vitellogenesis within one reproductive cycle and may eventually be extruded. The oocyte dynamics in the white-piau follows the group-synchronous pattern which is the most common type among teleosts (WALLACE & SELMAN, 1981).

Data on K, GSI and HSI of females at each stage of the reproductive cycle are in Fig. 13. Females are in better « condition » (LE CREN, 1951) when outside the reproductive period. Peak values of GSI and HSI were found at the stages of advanced maturation and partially spent. This finding suggests that the GSI may be used as an indicator of the reproduction period as in other teleosts from man made reservoirs (RAHMAN & MOGHRABY, 1984; TÓMASSON *et al.*, 1984). Variations of these parameters in males were inexpressive (Fig. 14).

Fig. 15 shows monthly AFI's of females and males. In both sexes, higher monthly AFI values occurred in the period of July-September. Thereafter they gradually diminished to reach lowest values in January-February to raise again in the following months. This variation follows behind that of the reservoir water level. Submerged littoral macrophytes during the reservoir water raising period possibly are transformed into feeding resources for the

FIGS. 8 to 11 are light photomicrographs of white-piau testis at different stages of the reproductive cycle (paraffin embedded, 7 μm thick, haematoxylin-eosin stained).

FIG. 8. Non-reproduction stage; totally spent testis; lumen (L) of seminiferous tubules is open; luminal spermatoza are absent; SC = cysts of spermatogonia; 425 ×.

FIG. 9. Non-reproduction stage; resting testis showing only cysts of spermatogonia; lumen of seminiferous tubules is collapsed; 1088 ×.

FIG. 10. Reproduction stage; maturing testis; wall of seminferous tubules shows cysts at various stages of spermatogenesis; 425 ×.

FIG. 11. Reproduction stage; mature testis; lumina of seminiferous tubules packed with spermatozoa (Z); 425 ×.

TABLE 1. Reproductive characteristics of white-piau females from Três Marias reservoir during the reproductive cycle.

Stage	Characteristics
Resting (FIG. 3)	Thin, flattened and translucid ovaries, containing types 1 and 2 oocytes. Type 1 oocyte : 57.3 ± 26.7 μm in diameter; homogeneous and basophyl cytoplasm; vesiculous nucleus with peripheral nucleoli. Type 2 oocyte : 109.5 ± 38 μm in diameter; cytoplasm is granular with vitellinic nucleus; nucleus is similar to that of type 1 oocyte; thin zona pelucida; squamous follicular cells.
Intial maturation (FIG. 4)	Size of ovaries is increased; gray oocytes are observed with naked eyes; type 1, 2 and 3 oocytes are present. Type 3 oocyte : 284.5 ± 69.2 μm in diameter, vitellinic vesicles at the cytoplasm periphery, central nucleus with smaller number of nucleoli; zona pelucida becomes evident; cubic follicular cells; thin theca.
Advanced maturation (FIG. 5)	Ovaries are pale green in colour and greatly increased in size; type 1, 2, 3 and 4 oocytes are present. Type 4 oocyte : 545.4 ± 97.4 μm in diameter; cytoplasm is filled with vitellinic globules; nucleus is excentric in some oocytes, high prismatic follicular cells; thick zona pelucida; theca well evident.
Mature	Final maturation of oocytes occurs at this stage; fish at this stage were not identified due to the methods used in the presente work.
Partially spent (FIG. 6)	Ovaries are reduced in size, with hemorrhagic areas; type 1, 2, 3 and 4 oocytes are present intermingled with empty follicles.
Totally spent (FIG. 7)	Ovaries are flaccid, opaque, with hemorrhagic areas; type 1 and 2 oocytes are present; remaining type 4 oocytes are in reabsorption process; empty follicles present.

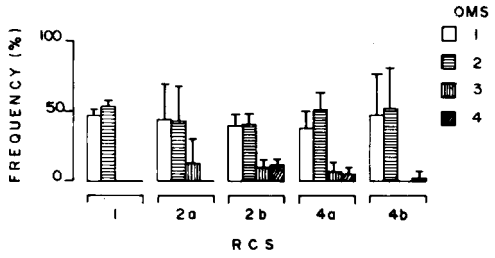


FIG. 12. Relative frequency (%) of the different oocyte maturation stage (OMS) at each stage of the reproductive cycle (RCS) of white-piau from Três Marias reservoir.

white-piau. The importance of this ecosystem on white-piau feeding strategy has been emphasized by ESTEVES & SATO (1986). Probably, such water level fluctuation along the year may play a more important role in the variation of the abdominal fat content than the stage of the reproductive cycle.

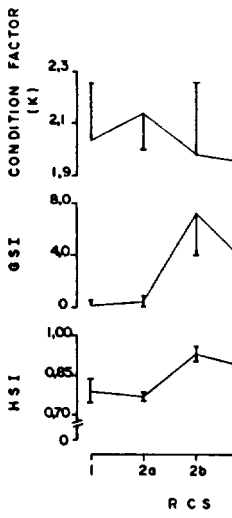


FIG. 13. Condition factor (K), gonadosomatic index (G
at each stage of the reproductive cycle (RCS) of wh
reservoir.

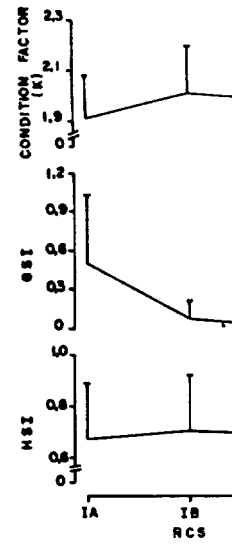
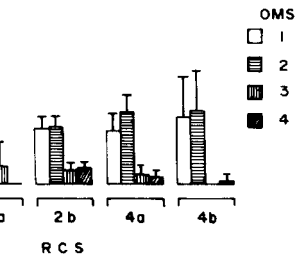


FIG. 14. Condition factor (K), gonadosomatic index (G
at each stage of the reproductive cycle (RCS) of white-pi

of white-piau females from Três Marias reservoir

Characteristics
ned and translucid ovaries, containing types 1 and Type 1 oocyte : 57.3 ± 26.7 μm in diameter; us and basophyl cytoplasm; vesiculous nucleus with ucleoli. Type 2 oocyte : 109.5 ± 38 μm in diameter; granular with vitellinic nucleus; nucleus is similar pe 1 oocyte; thin zona pelucida; squamous follicular
ies is increased; gray oocytes are observed with nak- 1, 2 and 3 oocytes are present. Type 3 oocyte : 284.5 in diameter, vitellinic vesicles at the cytoplasm entral nucleus with smaller number of nucleoli; zona comes evident; cubic follicular cells; thin theca.
pale green in colour and greatly increased in size; and 4 oocytes are present. Type 4 oocyte : 545.4 ± iameter; cytoplasm is filled with vitellinic globules; centric in some oocytes, high prismatic follicular cells; pelucida; theca well evident.
tion of oocytes occurs at this stage; fish at this stage ntified due to the methods used in the presente work.
reduced in size, with hemorrhagic areas; type 1, 2, ytes are present intermingled with empty follicles.
flaccid, opaque, with hemorrhagic areas; type 1 and e present; remaining type 4 oocytes are in reabsorp- ; empty follicles present.



e different oocyte maturation stage (OMS) at each of white-piau from Três Marias reservoir.

of this ecosystem on white-piau feeding d by ESTEVES & SATO (1986). Probably, along the year may play a more im- of the abdominal fat content than the ycle.

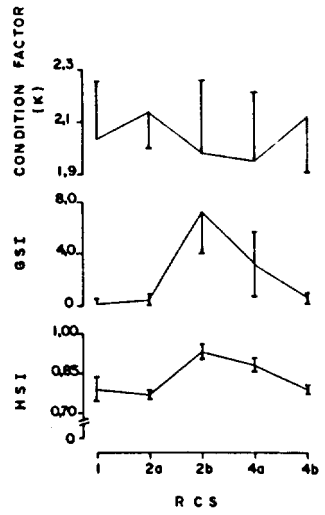


FIG. 13. Condition factor (K), gonadosomatic index (GSI) and hepatosomatic index (HSI) at each stage of the reproductive cycle (RCS) of white-piau females from Três Marias reservoir.

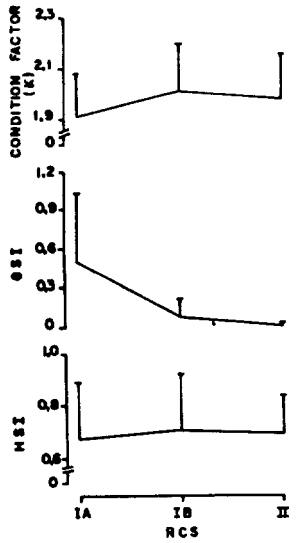


FIG. 14. Condition factor (K), gonadosomatic index (GSI) and hepatosomatic index (HSI) at each stage of the reproductive cycle (RCS) of white-piau males from Três Marias reservoir.

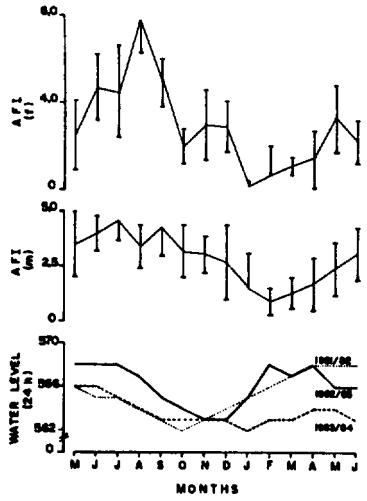


FIG. 15. Monthly abdominal fat index (AFI) of females (f) and males (m) of white-piau and Três Marias reservoir historical water level.

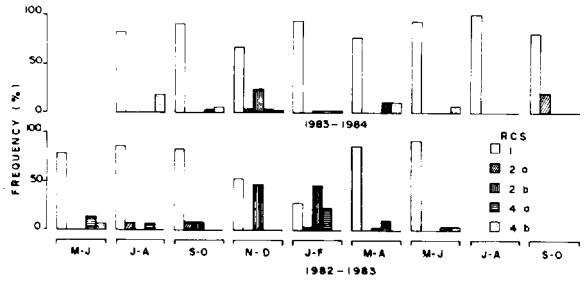


FIG. 16. Bimonthly relative frequency (%) of female reproductive cycle stages (RCS) of white-piau from Três Marias reservoir from 1982 to 1984.

The reproductive period of the white-piau extends from October to April (Figs. 16, 17). The cyclic reproductive pattern of fish from Três Marias reservoir (GODINHO, 1984; BAZZOLI, 1985; TAVARES, 1986; TELES, 1989; present paper) tends to follow that found in the fish from the rest of Southeast Brazil. They usually reproduce during the rainy season, when the water temperature and daylength are at their highest values in the year (Fig. 18). Capture of white-piaus in all stages of the reproductive cycle and their alevins (pers. obs.) gives support to GODINHO (1984) who mention the reproduction of this species within Três Marias waters. However, the exact site of spawning and its reproductive behaviour remain unknown.

TABLE 2. Reproductive characteristics of white-piau r ing the reproductive cycle.

Stage	Cl
Non-reproduction (FIGS. 8, 9)	Testes totally spent (FIG. 8 reduced in size, flacid, wi matogonia and residual seminiferous tubules may l and translucid containing tubules lumina are empty
Reproduction (FIGS. 10, 11)	Testes in maturation (FIG. 1 were classified as in reprod and whittish; cysts of all spe are present in the lumen of amounts. Fish with mature pressure; it has only cysts seminiferous tubules are pa tially spent show hemorrhag are seen; lumen of seminifer of spermatozoa.

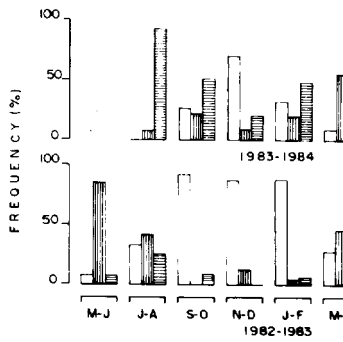
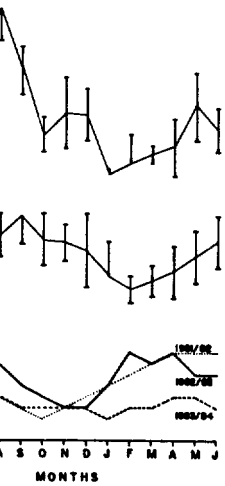


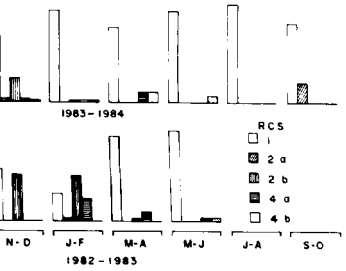
FIG. 17. Bimonthly relative frequency (%) of male repr piau from Três Marias reservoir from 1982 to 1984.

The presence of type 3 and 4 oocyte follicles and the egg adhesiveness at sp present paper) suggest that white-piau

All three white-piau females used i sucessfully induced to spawn with crude injection of same extract in the males oocytes measured, at extrusion, 956 ±



(AFI) of females (f) and males (m) of white-piau
ater level.



(%) of female reproductive cycle stages (RCS) of
r from 1982 to 1984.

f the white-piau extends from October
yclic reproductive pattern of fish from
INHO, 1984; BAZZOLI, 1985; TAVARES,
paper) tends to follow that found in
theast Brazil. They usually reproduce
n the water temperature and daylength
the year (Fig. 18). Capture of white-
oductive cycle and their alevins (pers.
HO (1984) who mention the reproduc-
ês Marias waters. However, the exact
oductive behaviour remain unknown.

TABLE 2. Reproductive characteristics of white-piau males from Três Marias reservoir during the reproductive cycle.

Stage	Characteristics
Non-reproduction (FIGS. 8, 9)	Testes totally spent (FIG. 8) or resting (FIG. 9). The former are reduced in size, flacid, with hemorrhagic areas; cysts of spermatogonia and residual spermatozoa in the lumen of the seminiferous tubules may be seen. Resting testes are thin shaped and translucid containing only spermatogial cysts; seminiferous tubules lumina are empty and collapsed.
Reproduction (FIGS. 10, 11)	Testes in maturation (FIG. 10), mature (FIG. 11) or partially spent were classified as in reproduction. Testes in maturation are thick and whittish; cysts of all spermatogenic cells are seen; spermatozoa are present in the lumen of the seminiferous tubules in variable amounts. Fish with mature testes expel semen under abdominal pressure; it has only cysts of spermatogonia and the lumen of seminiferous tubules are packed with spermatozoa. Testes partially spent show hemorrhagic areas; only cysts of spermatogonia are seen; lumen of seminiferous tubules contains reduced amount of spermatozoa.

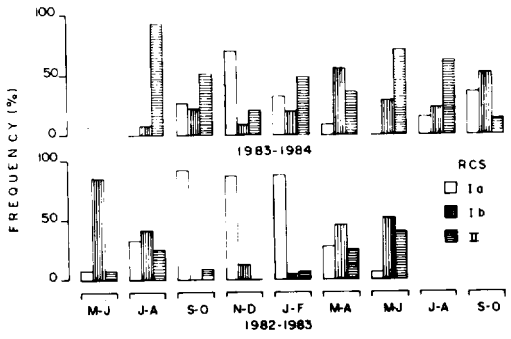


FIG. 17. Bimonthly relative frequency (%) of male reproductive cycle stages (RCS) of white-piau from Três Marias reservoir from 1982 to 1984.

The presence of type 3 and 4 oocytes coincidently with empty follicles and the egg adhesiveness at spawning (SATO *et al.*, 1985; present paper) suggest that white-piau is a fractional spawner.

All three white-piau females used in the present paper were sucessfully induced to spawn with crude carp pituitary extract. The injection of same extract in the males helped to milt them. The oocytes measured, at extrusion, 956 ± 55μm and, after hydration,

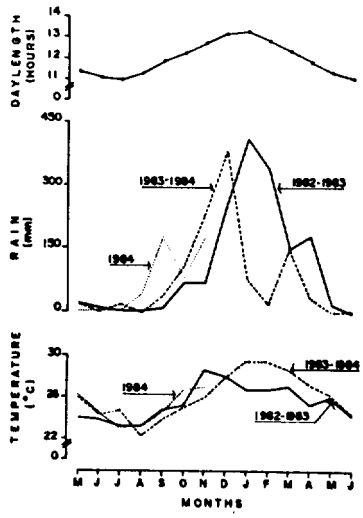


FIG. 18. Monthly daylength (hours), rain (mm) and Três Marias reservoir historical water temperature (°C).

1222 ± 69 μm. The number of oocyte.g^{-1} of ova was 1898 ± 77. Extrusion was performed at 212 degree-hours and hatching occured at 497 degree-hours, the water temperature being 23.5 - 24.5 °C. Shrub (*Cupressus* sp) stems were placed into the incubators to serve as egg substrate. Data on degree-hours at extrusion and hatching, oocyte size and its strong adhesiveness correspond to those obtained by SATO *et al.* (1985).

ACKNOWLEGMENTS

The author are grateful to the staff of Três Marias Fisheries Station (Codevasf) for the field help during the course of the work. Thanks are also due to the Brazilian CNPq for its partial support.

REFERENCES

ABERCROMBIE, M. — Estimation of nuclear populations from microtome sections. *Anat. Rec.* **94** : 238-248 (1946).

AMANN, R. P. — Reproductive capacity of dairy bulls. III. The effect of ejaculation frequency, unilateral vasectomy, and age on spermatogenesis. *Am. J. Anat.*, **110** : 49-68 (1962).

ANDRADE, D. R. and H. P. GODINHO — Annual ma
teleost fish *Leporinus silvestrii* (Boulenger, 19
(1983).

BAZZOLI, N. — Biologia reprodutiva do peixe-cachorr
1874) (Characidae, Acestrohynchinae) da repre
MG. Master Thesis, Federal University of Minas

BILLARD, R. — Spermatogenesis and spermatology
Nut. Dévelop., **26** (4) : 877-920 (1986).

BOTELHO, P. M. A. and G. TORRES — Estudo do regin
knerii Steindachner, 1875 (Cypriniformes, Ano
Proc. XI Brazil. Congr. Zool., Belém., p. 25

BRITSKI, H. A., Y. SATO and A. B. S. ROSA — *Manu
de Três Marias (com chaves de identificacão
cisco)*. Câmara dos Deputados/CODEVASF, Br

ESTEVES, F. A. and Y. SATO — Importância da ve
tação dos peixes da represa de Três Marias. V Re
p. 55 (abstract) (1986).

GODINHO, H. P. — Reprodução dos peixes da repres
Horizonte), **10** (110) : 29-34 (1984).

GRIER, H. J. — Sperm development in the teleost
419-431 (1976).

GRIER, H. J. — Cellular organization of the testis
Zool., **21** : 345-357 (1981).

GRIER, H. J., J. R. LINTON., J. F. LEATHERLAND
evidence for two different testicular types in teleo
(1980).

HOAR, W. S. Reproduction. In : W. S. HOAR and
Academic Press, London. v. 3, 1-72 (1969).

LE CREN, E. D. — The length-weight relationship a
condition in the perch (*Perca fluviatilis*). *J. A*

RAHMAN, A. A. and A. I. MOGHRABY — Breeding
in Jebel Aulia reservoir, Sudan. *Hydrobiologi*

RICKER, W. E. — *Computation and interpretation
tions.* Ottawa, Bulletin 191, Department of Fi

RUBY, S. M. and D. B. MCMILLAN — The interstiti
of stickleback. *J. Morphol.*, **145** : 295-318 (19

SHERESTHA, T. K. and S. S. KHANNA— Histology
a hill-stream fish, *Schizothorax plagiostomus.*
749-761 (1976).

SATO, Y. and G. BARBIERI — Crescimento de *Schizo*
Anostomidae) na represa de Três Marias, MG. P
São Carlos, p. 201-221 (1983).

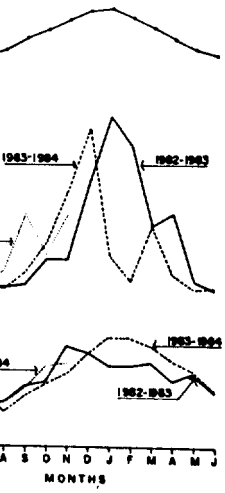
SATO, Y., E. L. CARDOSO and S. A. CAPUCHINHO —
(*Schizodon knerii*) da bacia do São Francisco (no
Minas Gerais, Belo Horizonte, p. 2-3 (abstrac

SATO, Y. and F. M. F. OSÓRIO — A pesca profiss
em 1986. V Ann. Meet. Aquacul. Minas Gera

TAVARES, E. F. — Biologia reprodutiva do piau-gordu
Anostomidae) da represa de Três Marias, rio São
University of Minas Gerais, Belo Horizonte (

TELES, M. E. D. — Biologia reprodutiva da piram
1874 (Pisces, Characidae) de represa de Três M
Thesis, Federal University of Minas Gerais, B

TÓMASSON, T., J. A. CAMBRY and P. B. N. JACKSON -
fishes (Cyprinidae) in a man-made lake, Orang
112 : 179-195 (1984).



ain (mm) and Três Marias reservoir historical water

of oocyte.g^{-1} of ova was 1898 ± 77. 212 degree-hours and hatching occured ıter temperature being 23.5 - 24.5 °C. were placed into the incubators to serve egree-hours at extrusion and hatching, nesiveness correspond to those obtained

NOWLEGMENTS

the staff of Três Marias Fisheries Sta- d help during the course of the work. Brazilian CNPq for its partial support.

REFERENCES

uclear populations from microtome sections. *Anat.*

acity of dairy bulls. III. The effect of ejaculation and age on spermatogenesis. *Am. J. Anat.*, **110** :

ANDRADE, D. R. and H. P. GODINHO — Annual male reproductive cycle of the Brazilian teleost fish *Leporinus silvestrii* (Boulenger, 1902). *Arch. Biol. (Bruxelles)*, **94** : 1-14 (1983).

BAZZOLI, N. — Biologia reprodutiva do peixe-cachorro *Acestrorhychus lacustris* (REINHARDT, 1874) (Characidae, Acestrohynchinae) da represa de Três Marias, rio São Francisco, MG. Master Thesis, Federal University of Minas Gerais, Belo Horizonte, Brazil (1985),

BILLARD, R. — Spermatogenesis and spermatology of some teleost fish species. *Reprod. Nut. Dévelop.*, **26** (4) : 877-920 (1986).

BOTELHO, P. M. A. and G. TORRES — Estudo do regime alimentar do piau-branco, *Schizodon knerii* Steindachner, 1875 (Cypriniformes, Anostomidae), da represa de Três Marias. Proc. XI Brazil. Congr. Zool., Belém., p. 255-256 (1984).

BRITSKI, H. A., Y. SATO and A. B. S. ROSA — *Manual de identificacão de peixes da região de Três Marias (com chaves de identificacão para os peixes da bacia do São Francisco)*. Câmara dos Deputados/CODEVASF, Brasília, 143, (1984).

ESTEVES, F. A. and Y. SATO — Importância da vegetação terrestre marginal na alimentação dos peixes da represa de Três Marias. V Regional Seminar on Ecology, São Carlos, p. 55 (abstract) (1986).

GODINHO, H. P. — Reprodução dos peixes da represa de Três Marias. *Inf. Agropec.* (Belo Horizonte), **10** (110) : 29-34 (1984).

GRIER, H. J. — Sperm development in the teleost *Oryzias latipes*. *Cell Tiss. Res.*, **168** : 419-431 (1976).

GRIER, H. J. — Cellular organization of the testis and spermatogenesis in fishes. *Amer. Zool.*, **21** : 345-357 (1981).

GRIER, H. J., J. R. LINTON., J. F. LEATHERLAND and V. L. DE VLAMING — Structural evidence for two different testicular types in teleost fishes. *Amer. J. Anat.*, **159** : 331-345 (1980).

HOAR, W. S. Reproduction. In : W. S. HOAR and D. J. RANDALL — *Fish physiology*. Academic Press, London. v. 3, 1-72 (1969).

LE CREN, E. D. — The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol.* **2092** : 201-219 (1951).

RAHMAN, A. A. and A. I. MOGHRABY — Breeding of *Barbus bynni* (Pisces, Cyprindae) in Jebel Aulia reservoir, Sudan. *Hydrobiologia*, **110** : 319-325 (1984).

RICKER, W. E. — *Computation and interpretation of biological statistics of fish populations*. Ottawa, Bulletin 191, Department of Fisheries and Oceans (1975).

RUBY, S. M. and D. B. MCMILLAN — The interstitial origin of germinal cells in the testis of stickleback. *J. Morphol.*, **145** : 295-318 (1975).

SHERESTHA, T. K. and S. S. KHANNA— Histology and seasonal changes in the testes of a hill-stream fish, *Schizothorax plagiostomus*. *Z. Mikrosk. anat. Forsch.*, **90** (45) : 749-761 (1976).

SATO, Y. and G. BARBIERI — Crescimento de *Schizodon knerii* Steindachner, 1875 (Pisces, Anostomidae) na represa de Três Marias, MG. Proc. III Regional Seminar on Ecology, São Carlos, p. 201-221 (1983).

SATO, Y., E. L. CARDOSO and S. A. CAPUCHINHO — Reprodução induzida de piau-branco (*Schizodon knerii*) da bacia do São Francisco (nota preliminar). IV Ann. Meet. Aquacul. Minas Gerais, Belo Horizonte, p. 2-3 (abstract) (1985).

SATO, Y. and F. M. F. OSÓRIO — A pesca profissional na região de Três Marias, MG, em 1986. V Ann. Meet. Aquacul. Minas Gerais, Belo Horizonte, p. 91-92 (1987).

TAVARES, E. F. — Biologia reprodutiva do piau-gordura *Leporinus piau* Fowler, 1941 (Pisces, Anostomidae) da represa de Três Marias, rio São Francisco, MG. Master Thesis, Federal University of Minas Gerais, Belo Horizonte (Brazil) (1986).

TELES, M. E. D. — Biologia reprodutiva da pirambeba *Serrasalmus brandtii* Reinhardt, 1874 (Pisces, Characidae) de represa de Três Marias, rio São Francisco, MG. Master Thesis, Federal University of Minas Gerais, Belo Horizonte (Brazil) (1989).

TÓMASSON, T., J. A. CAMBRY and P. B. N. JACKSON — Reproductive biology of four riverine fishes (Cyprinidae) in a man-made lake, Orange river, South Africa. *Hydrobiologia*, **112** : 179-195 (1984).

WALLACE, R. A. and K. SELMAN — Cellular and dynamic aspects of oocyte growth in teleosts. *Amer. Zool.*, **21** : 325-343 (1981).
WOYNAROVICH, E. and L. HORVÁTH — *The artificial propagation of warmwater finfiches - a manual extension.* FAD Fish. Tech. Pap., (201)(1980).

H. P. GODINHO, PhD
Laboratório de Ictiologia, ICB/UFMG
30, 270 Belo Horizonte, MG
Brasil

Eur. Arch. Biol. (Bruxelles) **101** : 345-358 (1990)

EFFECTS OF VASECTOM EPIDIDYMIS AND SEMI THE LABORATO

BY

P. SINGH and C. J.

(Department of Zoology, Banaras Hindu Uni

(Received October 5, 1989; revised and a

SUMMARY — *The changes induced l teral (UV) vasectomy in the testis, epi of laboratory mice belonging to the F bed. Marked degenerative changes we rous tubules during the first two m However, by four to six months post-v ry of spermatogenic activity was evide ve changes were observed only in the tes vas; the contralateral testis exhibited j Leydig cells presented normal morph No significant difference was found in RNA and protein in the testis in oper with the controls. Vasectomy induced gical changes in the caput and cauda the degenerative changes were confine ral to the occluded vas, while the contr ted normal appearance. Concentration and fructose in the seminal vesicle rem mized mice. The results suggest that in reversible suppression of spermatogene the endocrine functions of the testis.*

Key words : Testis, epididymis, se mouse.

INTRODUCTIO

Even though vasectomy has gained w of male contraception, there are still