REPRODUCTION IN THE NILE BOLTI,

TILAPIA NILOTICA L.

Sexual cycle of the male

BY

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I.—INTRODUCTION

In the present time, a great amount of data about the seasonal changes of the sexual glands in bony fishes has accumulated. The males of a num- *Gasterosteus aculeutus* (Craig-Bennett, 1931), *Fundulus heteroclitus* (Matthews, 1938), *Onchorhynchus nerka* (Weisel, 1943) etc. were investigated. On the whole, the progress of the process of spermatogenesis differs greatly. The most simple condition is the synchronous development of the sexual cells in a given wave of spermatogenesis. According to Kulayev (1944) the complication of the process of spermatogenesis and the character of the discharge of the sexual products was related to the unsynchronous entry of the primary spermatogonia into the period of reproduction. Besides, the unsynchronism of the process of spermatogenesis is comparatively widely spread in bony fishes (Kulayev 1944 ; Butskaya, 1955 ; Koppel, 1955). However, the unsynchronous ripening and discharge of sexual cells can be related not only to unsynchronism of the process of spermatogenesis but also to unsynchroronous progress of the wave of spermatogenesis in the different parts of the testis (Butskaya, 1955 ; Partlo, 1955).

In turn, the males - independent on the character of the spawning of the female - discharge their sperms not in a short period and once but in fractions. However, in the species whose females lay egg in a single group in the annual sexual cycle, the males discharge their sperms in a comparatively short period which may not be more than few days. In the fractional spawning condition, the males can participate in spawning for weeks or even months and in some instances during the whole year. On this account, Dryagin (1949) has characterized two types of males, viz., 1) those with short spawning and correspond to the females spawning a single group of eggs, and, 2) those which have a stretched spawning and correspond with portional spawning females.

II.—MATERIAL AND METHODS

Specimens of the Nile Bolti were collected monthly from the River Nile in the vicinity of Cairo near the Barrages. At capture the weight, standard and total lengths and the date were registered. After opening the abdominal cavity of males, the testes were separated and fixed immediately in aqueous Bouin. Paraffin embedding was carried out after dehydration and clearing. Sections ranging from 6—10 u in thickness were stained by adopting Heidenhain's iron alum haematoxylin or azan techniques. The gonad index was computed as the percentage weight of the gonad to that of the fish.

III.– GENERAL SHAPE OF TESTIS

The testis of *Tilapia nilotica* belongs to the radial type of Brock (1878). In this type the seminiferous lobules are radially disposed as they extend from the periphery of the testis towards its "centre". In a transverse section the testis is roughly triangular in shape, with acute angles and with the base pointing dorsally and there lie the sperm-duct and the spermatic vein and artery. In the early stages of activity of the testis and when the spermatogonia are the main components of the testicular tissue, the testis is nearly kidney-shaped but becoming triangular in the active condition of spermatogenesis.

The testis is covered externally by a wall, the tunica propria, which is distinguished into 2 layers. The external layer is in continuation with the peritoneum. This layer coats the testis and is made up of small elongated cells with central nuclei. This peritoneal layer is mostly undistinguishable from the underlying 2nd. layer of fibrous connective tissue which forms the greatest part of the thickness of the tunica propria.

IV.– MONTHLY PECULIARITIES OF TESTIS

November and December :

In these months the testis of *Tilapia nilotica* is reduced in size. The main mass of the testis is made up of spermatogonia which are grouped in nests made up of a varying number of the spermatogonia (Fig. 1) of varying size. The larger cells are about 10 u in diameter and lie in the outer region of the testis. These germ cells are faintly stained and the nucleus is spherical. The chromatin network varies in amount in the different spermatogonia. Thus, in some cells the chromatin material is well-differentiated and forms thick small spherules on the inner side of the nuclear wall. The nucleolus is small, spherical and shows a great affinity to stain. In most spermatogonia a single nucleolus is found in each cell, but rarely 2 nucleoli are differentiated. The nuclear membrane is well-differentiated. The interlobular connective tissue found in between the cells is comparatively thin. Mitotic division of spermatogonia is infrequent. Few spermatocytes, spermatids and spermatozoa are differentiated as well. These are darkly stained by Heidenhain's iron haematoxylin and lie towards the central region of the testis.

The wall of the testis is comparatively thin. The interlobular connective tissue is also thin and is thicker in the external part of the testis in between the apices of the lobules.

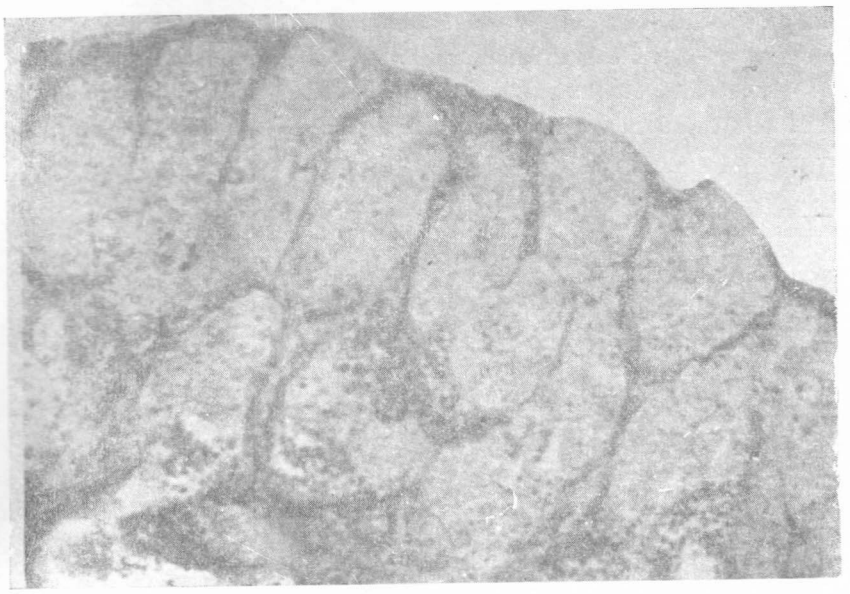

Fig. 1—Part of T. S. of testis (fish length 15 cme G. I. 0.06) in December; note rpermatogonia pseponderating (270 x)

January :

The testes examined in this month show varying condition. Thus, in the fishes that have a low gonad index, the germ cells detected in the testis were only spermatogonia. Thus, in a fish whose length is 14.2 cm. and gonad index 0.06, the spermatogonia are about 10 u in diameter. Nucleolus is spherical and lie mostly close to the nuclear membrane. The radial condition of the seminiferous lobules is hardly detectable. The medulla is formed mostly of connective tissue. The sperm duct is quite capacious and free from spermatozoa.

In another group of fishes, the testes show an active wave of spermatogenesis, but in varying degrees. Thus in some testes, besides the pesipheral about 5 u in diameter. They show greater affinity to stains than the sperspermatogonia, there are multitudes of primary spermatocytes which are matogonia. The chromosomes are scattered inside the nucleus which accordingly acquires a reticulate appearance. The nucleoli as well as the cell wall are not distinguished. Together with this active progress towards ripening, the radial condition of the seminiferous lobules becomes distinguished. The lobules are separated from one another by a thin layer of connective tissue. Considerably few spermatozoa are seen towards the centre of the testis.

In the fishes that have a gonad index of more than 0.15, the testis condition is more advanced than in the above-described group. The different stages of spermatogenetic wave were identifiable (Figs. 2 &3). The external part of the testis is occupied by the spermatogonia. Going, deeper the other stages, including spermatocytes, spermatids and spermatozoa, were seen as well forming nests and each is formed of a single stage. Cysts of spermatogonia are formed of a few cells (may be about four), but cysts of the remaining stages are made up of a greater number of cells. Besides, the spermatogonia forming nests in the medullar region of the testis are smaller than those lying near the periphery. Synaptic stages of primary spermatocytes are common. The secondary spermatocytes are smaller in size than the primary. Near the centre of the testis, the lumina of the lobules lead to he sperm duct and are distended with spermatozoa. The follicular epithelial cells are here easily identifiable and among them lie solitary spermatogonia which are about 10 u in diameter. The interlobular connective tissue layer is thicker than in the afore-mentioned conditions.

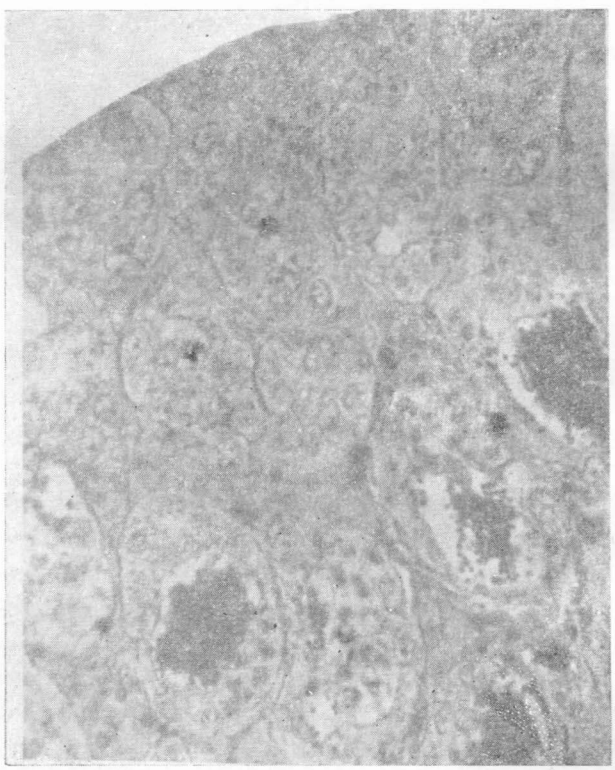

FIG. 2—Part of L.S. of testis of male 17.2 cm. long (G.I. 0.17) on 30 January; showing spermatogenesis with formation of spermatozoa (270 x).

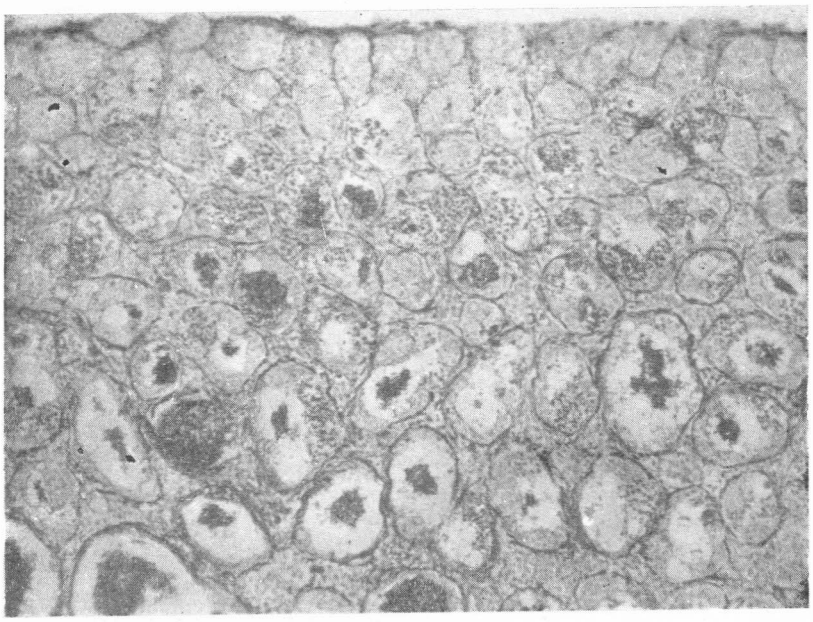

FIG. 3—Part of L.S. of testis of male1 6.8 cm. long (G.I. 0.16) on 30 January ; showing spermatogenesis (90 x).

February :

In February, males can generally be roughly divided into two groups in relation to the condition of their testes but, on the whole spermatogenesis has proceeded to a greater degree than in January. In the first group of fishes, whose gonad index is about 0.1, the testis is in an early stage of spermatogenesis, is closer in shape to a kidney than to a triangle, is differentiated into cortex and medulla, and is built up mainly of spermatogonia (Fig. 4). These germ cells show tendency for lobule formation and are about 8 u in diameter. The nucleus is spherical and its chromatin material is concentrated close to the nuclear wall. The nucleolus is spherical and mostly central in position. Primary and secondary spermatocytes and spermatids are few in number. The spermatozoa are also few and lie mainly towards the centre of the testis. The lumina of the seminiferous lobules are mostly undetectable, and some have a fair amount of spermatozoa and extend forwards to join the sperm duct. This duct, is, in cross section, somewhat elongated and has but few spermatozoa. The medulla is made up mainly of connective tissue.

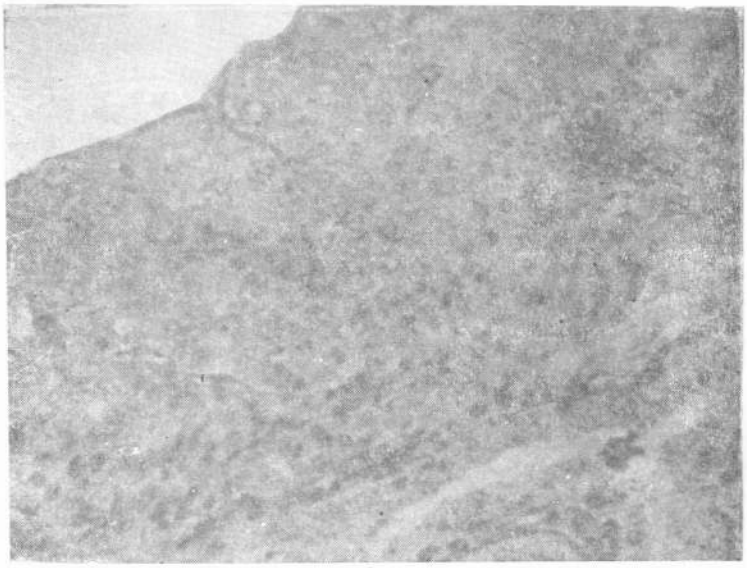

FIG. 4—Part of T.S. of testis of male 15.2 cm. long (G.I. 0.10) on 24 February ; showing spermatogonia mainly (270 x).

In the other group of fishes whose gonad index is about 0.18 or more, the spermatogenesis has proceeded to a greater degree than in the preceding stage or in the preceding month. The testis is nearly triangular and the cortex and medulla are differentiated through the concentration of spermatogonia in the former region while the latter is highly loaded with spermatozoa (Figs. 5). The degree of distention increases on passing towards the central region of the testis. The spermatogonia are comparatively small, about 7 u in diameter and show less chromatin than the afore-mentioned larger ones. Besides, the sperm duct has multitudes of spermatozoa and its lumen is in continuation with the lumina of the seminiferous lobules of the inner part of the testis. However, cysts of spermatocytes were uncommon and only those of spermatids are commonly detected.

March :

Spermatogenesis has proceeded forwards to a greater degree than in the preceding month and shows different states in the different testes.

In some testes, the different germ cells of the wave of spermatogenesis are identifiable. Besides, the spermatozoa are confined mostly to the inner half of the testis.

In some other testes, although an active spermatogenesis is in progress yet this is at a lower degree than in the preceding condition. Thus, in some testes, the main germ cells found, are the dividing primary spermatocytes and due to them the testis, regardless of the small peripheral spermatogonia as well as the interlobular connective tissue, is characteristically black. The spermatids and spermatozoa occur to a less degree than in the preceding condition. The sperm duct as well contains but few spermatozoa.

A comparable figure was also detected in some other testes but although the primary spermatocytes are the main germ cells present yet those former, are still in the period of synapsis (Fig. 6). On the whole, the lumina of the seminiferous lobules are detectable only in close vicinity of the sperm duct.

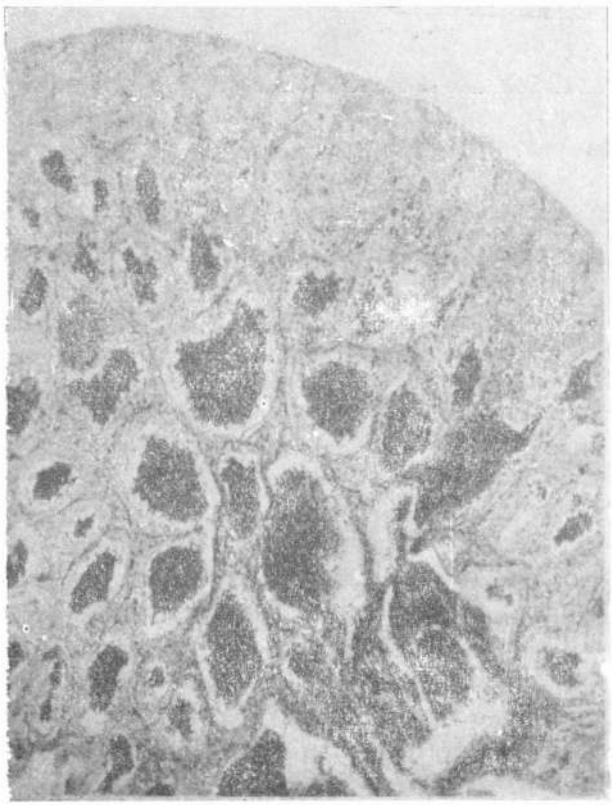

FIG. 5—Part of L.S. of testis of mae 16.2 cm. long (G.I. 0.18) on 24 ; February showin gacti spermatogenesis (90 x).

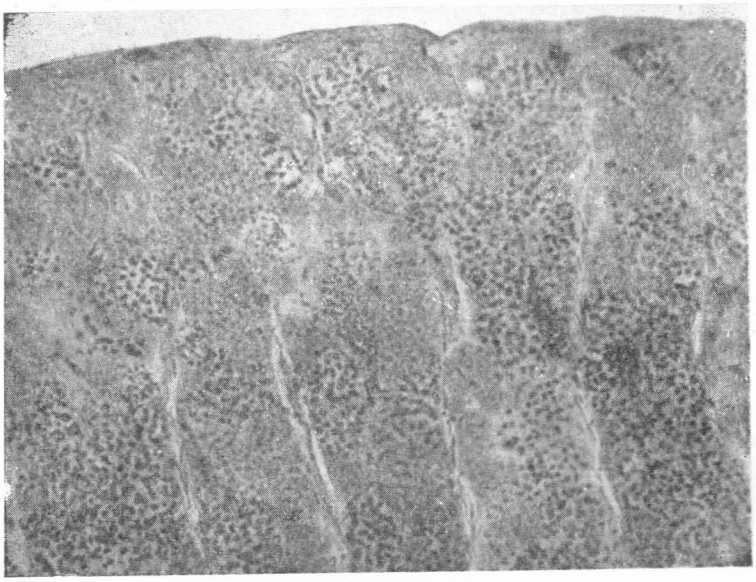

FIG. 6—Part of T.S. of testis of fish 28 cm. long (G.I. 0.27) on 29 March ; showing primary spermatocytes preponderating (150 x).

April :

As shown in the preceding month, the testes may show different degrees of the spermatogenesis. In the lower degree of maturation, the main mass is formed of primary spermatocytes. In such a condition the lumina of the seminiferous lobules are detected only in the inner part of the testis. Spermatids and spermatozoa are few. The sperm duct contains few spermatozoa.

In an advanced degree towards the maturation of the testis (Fig. 7) the whole series of cells of the spermatogenetic wave are common. The spermatogonia are small, mostly peripheral. Although the synaptic or post-synaptic stages of the primary spermatocytes may in some instances preponderate, yet the other stages including the secondary spermatocytes and spermatids are found in fair amounts. Apparently, the nests of primary spermatocytes lying in the metaphase stage are commoner in the outer region of the testis. This is expected as the spermatozoa are mostly confined to the inner part of the testis and here the lumina of the lobules are distinguished. In the different fishes, the lumina show varying degrees of distention with spermatozoa and on the whole they lead to the sperm duct.

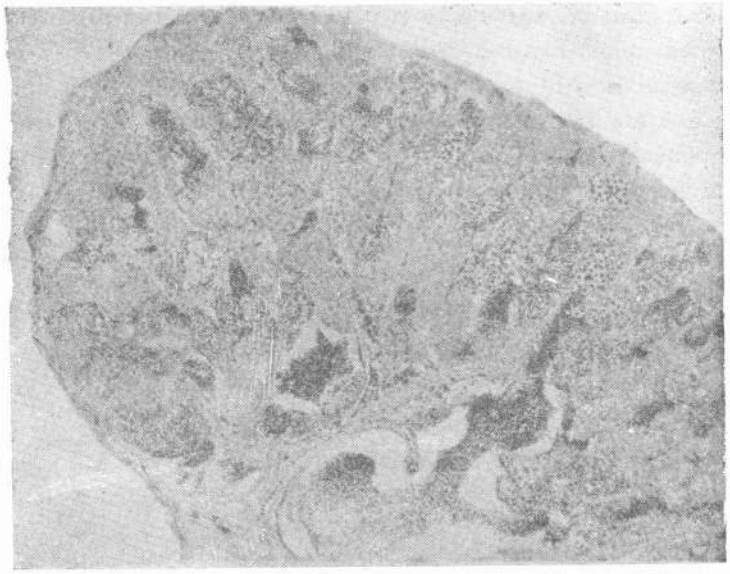

FIG. 7.—Part of T.R. of testis (male 15.1 cm. long, G.I. 0.29) on 15 April ; showing active spermatogenesis ; sperm duct has spermatozoa (90 x).

May :

The testes examined about the first of May showed varying degrees of spermatogenesis. Thus, in some testes the primary spermatocytes of the post-synapsis stage are common and form the main mass of the testis. However, in some lobules, the peripheralmost part of the lobules may be spermatogonia but by primary spermatocytes. The other cell stages of spermatogenesis may be present but to a lower degree. These include, the synapsis stage of primary spermatocytes, dividing primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa. These last are mostly confined to the central region of the testis. Such testes are as well characterized by thin interlobular connective tissue as well as the impossibility of defining the follicular cells. Besides, the lumen of the seminiferous lobules even towards the centre of the testis may be undistinguished. The sperm duct contains comparatively few spermatozoa.

In a more advanced condition the sperm duct contains a comparatively greater amount of spermatozoa. There is an active division of spermatogonia, primary and secondary spermatocytes. These groups of cells as well as spermatids and spermatozoa are detected along the whole thickness of the testis. Lumina of the seminiferous lobules are only detected towards

the centre of the testis but externally such lumina are undetectable. A comparable figure can still be seen yet the post-synaptic primary spermatocytes are common (Fig. 8). Still in some other testis, the lumina of the seminiferous lobules, mid-way between the centre and the periphery, are detectable but not so in the external region of the testis. In the former part, the primary and secondary spermatocytes, spermatids and spermatozoa form nests which are of varying thickness (Fig. 9). Faint amount of spermatozoa is seen in the sperm duct.

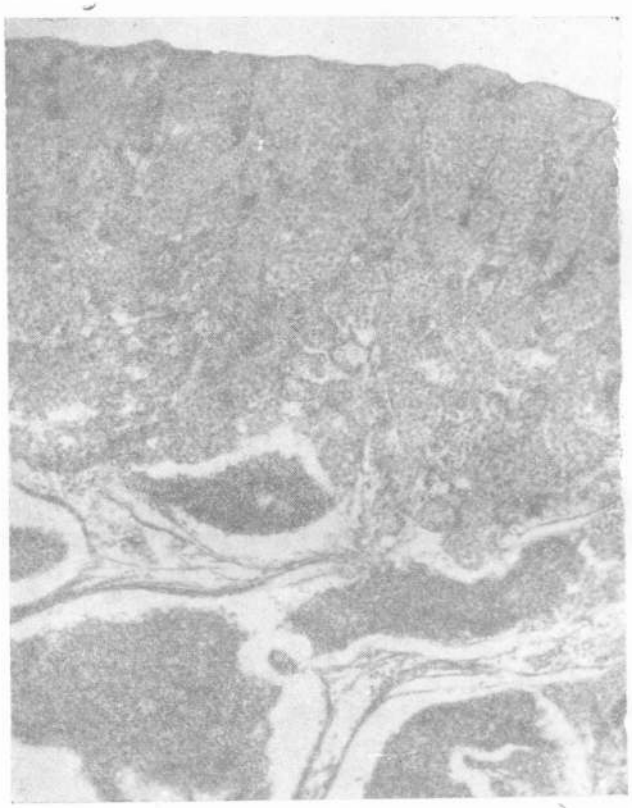

FIG. 8.—Part of T.S. of testis(male 13. 6 cm.long, G.I.0.23) on 1 May ; showing active spermatogensis, predominating post-synaptic 1*ry* spermatocytes (90x)

Towards the middle of May, the testes of the species under study may as well show varying conditions. Thus, in some individuals the central part of testis is composed mainly of connective tissue. The lumina of the seminiferous lobules are comparatively wide and quite clear even near the periphery of the testis. In such a plac the wall of the lobules is made up of

nests of primary and secondary spermatocytes, spermatids and spermatozoa. In such lobules, the spermatogonia are few and are mostly contiguous to the thick external tissul layer. Such spermatogonia are of comparatively large size. Their cytoplasmic layer is comparatively thick and nucleus forms about half the size of the speramtogonium. The cytoplasm is faintly stained. Thl sperm duct, on the whole, has few spermatozoa.

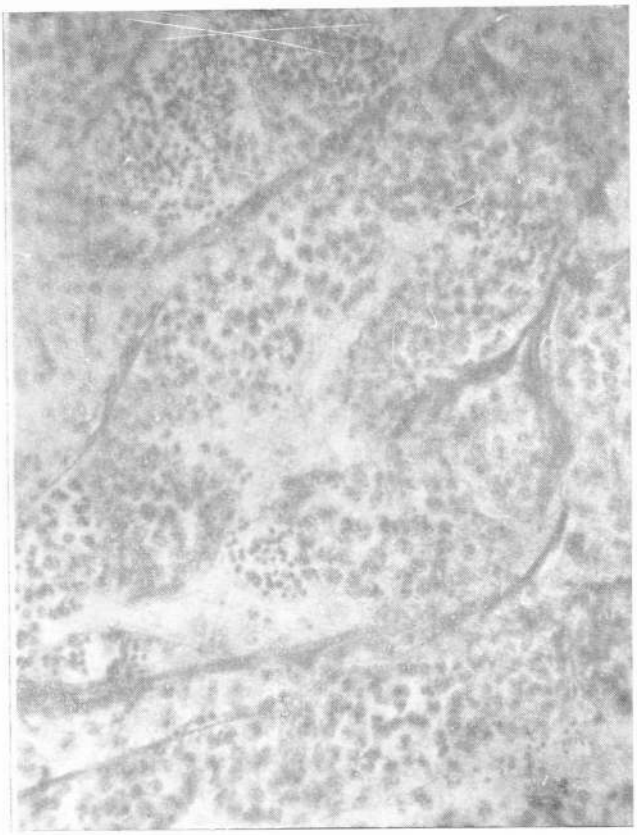

FIG. 9.—Part of T.S. of testis (fish 15.6 cm. long, G.I. 0.81) in May ; showing seminiferous lobule (270 x).

In still other forms, the lumina of the seminiferous lobules, which have considerable amount of spermatozoa, are seen only in about the inner third of the testis and lead to the sperm duct which also has fair amount of spermatozoa (Fig. 10). There is an active spermatogenetic wave.

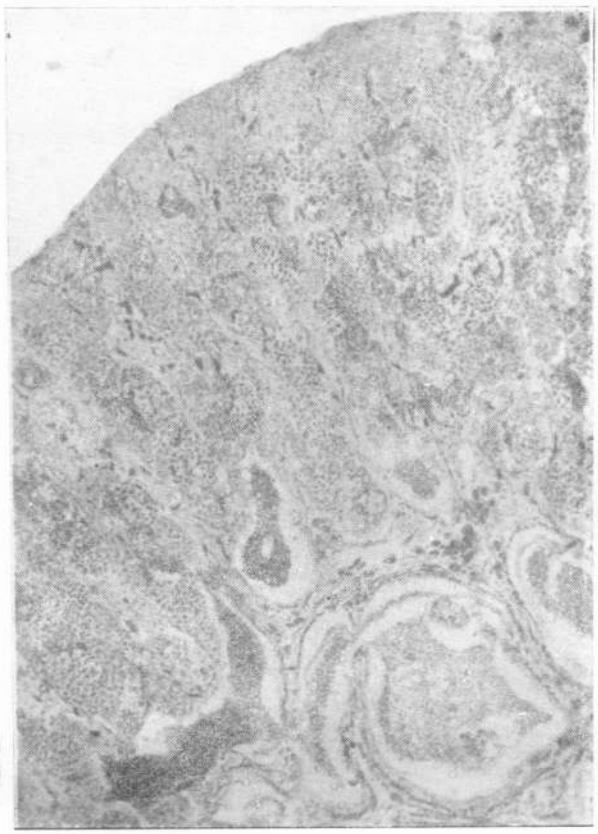

FIG. 10.—General view of part of T.S. testis (male 24.7 cm. long, G.I.0.12) in May, note lumina of seminiferous lobules detectable only towards centre and common primary spermatocytes (90 x).

June :

As in the preceding months, the testes examined in June show varying degrees of activity. Thus, in some testes the central region of connective tissue is not so thick (Fig. 11). The thickness of the testis is therefore occupied for the greater part by the seminiferous lobules, which have distinguishable lumina only in the inner part. The different stages of the spermatogenetic wave including the spermatocytes, spermatids and spermatozoa are distinguished along the length of the seminiferous lobules, although the 1 ry. spermatocytes are the most common. The spermatogonia are small, faintly stained and are as usual peripheral.

FIG. 11—Part of T.S. of testis(male 9.7cm.long, G.I. 0.27)on 10th June,primary spermatocytes predominating (90 x).

In some other testes, a comparable figure was observed, yet the central part of the testis has seminiferous lobules higly distended with spermatozoa. Such a character is again accompanied by the appearance of follicular epithelium in the wall of the lobules, besides an increase in the thickness of the interlobular connective tissue. The sperm duct was also distended with spermatozoa. Towards the periphery, the lumina of the seminiferous lobules are undetectable and the lobules are made up mainly of cysts which are for the greater part composed of primary spermatocytes and spermatozoa.

Still in other testes, the inner part of the testis, about half the length of its radius, is vacuolated and made up mainly of connective tissue. The seminiferous lobules which lie in the external half of the radius of the testis show an active wave of spermatogenesis, indicated by the appearance of nests of the different stages of spermatogenesis. These lobules reach the outermost region of the testis. Their lumina may be faintly noticeable or comparatively wide. Such a difference may be due to variation in the discharge of spermatozoa, being in the former less than in the latter.

July :

As shown in the preceding months, the testes may show different peculiarities. Thus in some fishes, the testis may be reduced in size and the vacuolization of the internal region of the testis is no longer detectable. The spermatogonia may be close to the peritoneal layer, a character which is accompanied by the thin tunica propria. The spermatogonia show active division, are small in size, the large ones being wanting. The primary spermatocytes form the commonest stage of spermatogenesis and they actively divide. The lumina of the seminiferous lobules as well as the interlobular connective tissue are only distinguished towards the central region of the testis (Fig. 12).

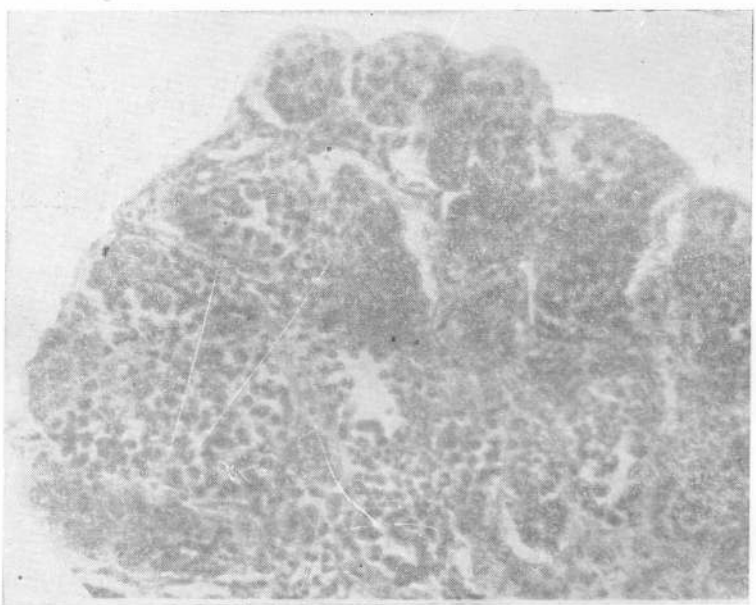

FIG. 12.—Part of T.S. of testis of male 14.1 cm. (G.I. 0.35) on 13th July, showing multitudes of primary spermatocytes (270 x).

A comparable figure was seen in still other testes but with some differences. Thus, the lobules of the inner 2/3 of the thickness of the testes are made up exclusively of spermatozoa notwithstanding the follicular epithelial cells as well as solitary spermatogonia lying at the periphery of the lobule, but towards the periphery of the testis, the lumina of the lobules become identifiable and nests of primary and secondary spermatocytes, spermatids and spermatozoa are identifiable. In such a region the spermatozoa are common, but in varying degrees in the different testes. This was found to

be related to the condition of the 1 ry. spermatocytes. When these cells are in a division stage after the synaptic stage, the sperms are more abundant than in the case when the primary spermatocytes are in the synaptic stage. The tunica propria is comparatively thick and some spermatogonia, about 8 u in diameter, are present. Some of these cells have regular or triangular nuclei and they show considerable affinity to stains.

Still in a third group of fishes, the testis is highly vacuolated, especially the inner half of the thickness of the wall of the testis. The lumen of the seminiferous lobules is wide and reaches almost to the periphery of the testis. These lobules have cysts of different stages of spermatogenesis but the peripheralmost cells are spermatogonia. The lumina of the sperm-duct and the seminiferous lobules have few spermatozoa.

August :

As formerly, the testes show varying degrees of activity. Thus, in the first place, some males have testes with an active wave of spermatogenesis. Thus, is such testes only a small part of the "central" region is vacuolated and the sperm duct is distended with spermatozoa. To the sperm duct lead the lumina of the internal region of the seminiferous lobules. These lumina are also distended with spermatozoa. The peripheral spermatogonia are somewhat small, about 6 - 8 u in diameter. The tunica propria is htick. In the external half of the testis, the primary and secondary spermatocytes, spermatids and sperms lie in nests and the lumina of the lobules are identifiable. The commonest cells are the primary spermatocytes. The interlobular connective tissue is somewhat thick even in the external part of the testis and tends to increase in thickness towards the centre.

In still some other males, the testes have apparently discharged a greater amount of spermatozoa. The inner region of the testis is vacuolated. The lumina of the seminiferous lobules are comparatively wide and reach nearly to the tunica propria. Along the whole length of the lobules, nests of different germ cells, excluding spermatogonia, are detected, and of these the primary spermatocytes are common, although in some specimens the secondary spermatocytes may be more common. Few spermatogonia lie in the apical zone of the lobules. The tunica propria is thick and the comparatively large spermatogonia are wanting. The interlobular connective tissue is thick and distended with interstitial cells. The sperm-duct has few spermatozoa. A figure comparable to the above-mentioned condition can further be observed in some other specimens, but in the external part of the testis, the lumina of the lobules are not so wide. Besides, it is possible to distinguish some small spermatogonia lying among the interstitial cells which are slightly larger (Fig. 13).

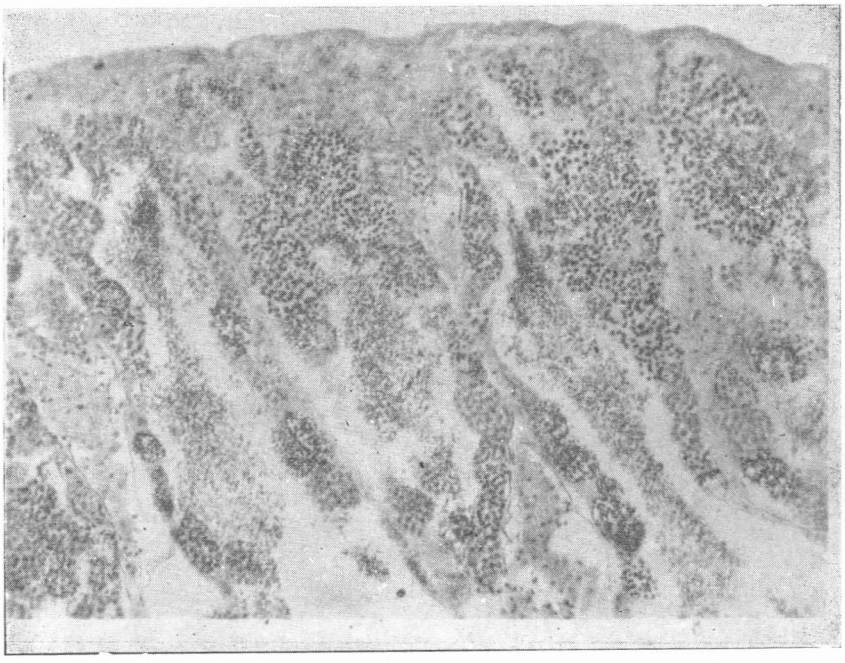

FIG. 13.—Part of T.S. of testis of female 13.1 cm. long, (G.I. 0.11) on 29 August ; showing thick tunica propria, lumina of seminiferous lobules and cysts of different spermatogenesis cells. (90 x).

Still in another group of fishes, the testes are reduced in size, particularly towards the end of August. Such testes appear microscopically depleted of vacuoles. The sperm-ducts contain few spermatozoa. The most characteristic feature is the presence of spermatogonia which are comparatively large, 8 u or more in diameter. Some spermatogonia have two nuclei. The nucleus is spherical and of considerable size and central in position. The chromatin material is specially concentrated close to the inner side of the nuclear membrane. The tunica propria is thin. The individuality of the lobules, due to the decrease in the thickness of the interlobular connective tissue, is distinguished with difficulty and the lumina are not clear. They are made up of cysts of primary and secondary spermatocytes, spermatids and spermatozoa and do not reach the external periphery of the testis but end some distance from it. This distance is occupied by the afore-mentioned spermatogonia.

September :

As usual the testes are of varying peculiarities. Thus, in the first place we describe some testes which have the seminiferous lobules extending for more than 2/3 of the radius of the testes. In such testes, the centre is only for a small part vacuolated and only near the sperm duct the lumina of the seminiferous lobules are identifiable. These lumina have spermatozoa and lead to the sperm duct. Towards the periphery, the lumina are not distinguished and the lobules are of nests of primary and secondary spermatocytes, spermatids and spermatozoa although the first may preponderate in number. At the periphery lie spermatogonia which are not so large in size (about 6—8 u diameter). The interlobular connective tissue and the tunica propria are thin.

In some other males the inner half of the radius of the testes is vacuolated. the external region is occupied by the seminiferous lobules. The lumina of the tunica propria are comparatively wide and nearly reach the testis. Such a region is occupied by spermatogonia of considerable size (more than 8 u in diameter)., The lobules are made up of cysts of different stages of spermatogenesis, although the spermatocytes, whether actually dividing or just in the post-synaptic stage, are common. In some testis, the apices of the lobules are occupied by smaller spermatogonia. The interlobular connective tissue is thick especially in between the apices of the seminiferous lobules (Fig. 14).

In another group of fishes, the testis shows an active wave of spermatogenesis. The lumina of the seminiferous lobules and the sperm-duct are full of spermatozoa. In the inner part of the testis, the lobules are made up mainly of spermatozoa and solitary spermatogonia.

In the outer half of the testes, although the lobules are distended with spermatozoa, so that their lumina are not detectable yet there are many nests of primary and secondary spermatocytes, spermatids and spermatozoa. The spermatogonia are as usual, confined to the peripheral region of the testis, and are considerable in size (about 7 u in diameter). Larger spermatogonial cells are comparatively few. The tunica propria is thin. The interlobular connective tissue even in the outer part of the testis and in-between the apices of the lobules is thin and hardly distinguished.

Still in another group of males, the testes are greatly reduced. In such a case, the radial peculiarities of testis are less distinguished than before. The lobules have nests of spermatocytes, spermatids and spermatozoa, although the primary spermatocytes may preponderate in number. The

lumina of the lobules are in most instances not identifiable, except in the central part near the sperm-duct and in some fishes. The spermatozoa are to some extent not considerable in amount. The spermatogonia are found in the different regions of the testes and may vary in size according to position and may in some testes form the greatest part of size of the testis. So, the large- sized ones which vary in diameter from 8 to 15 u are mainly confined to the external part of the testes. Such cells have a fair amount of chromatin and considerably large nucleolus. The tunica propria is thin.

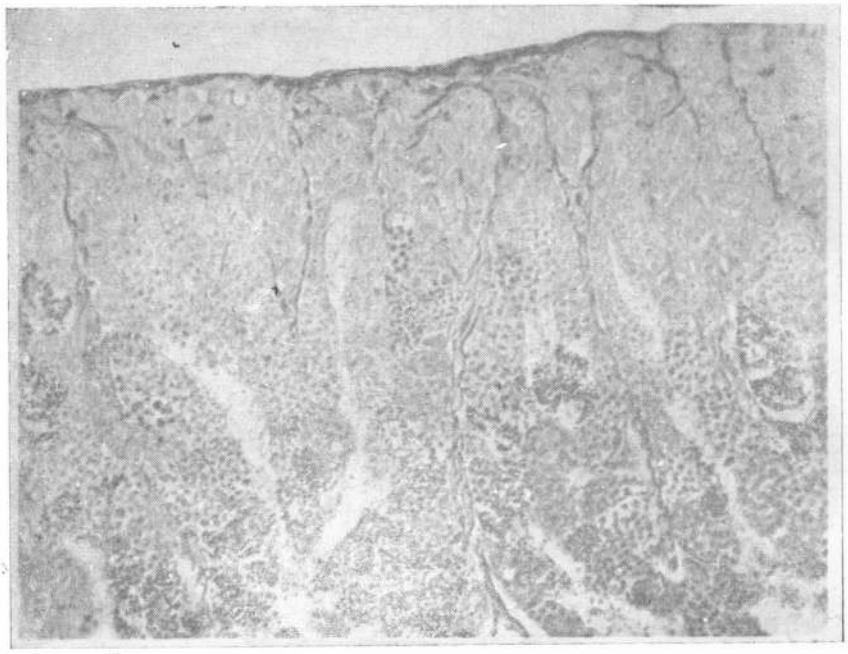

FIG. 14.—Part of T.S. of testis of male 14.9 cm. (G.I. 0.40) on 24 September ; showing thick tunica propria, lumina of seminiferous lobules reaching almost to periphery, and 1 *ry* spermatocytes common (150 x).

October :

During this month, still some testes are distended with the spermatozoa, especially in its first half. These spermatozoa completely block the sperm duct and the seminiferous lobules. Besides, the sperms, they have some nests of the different stages of the spermatogenesis wave and especially the secondary spermatocytes and spermatids, which vary in abundance in different testes, being sometimes few. Still the spermatogonia can be detected

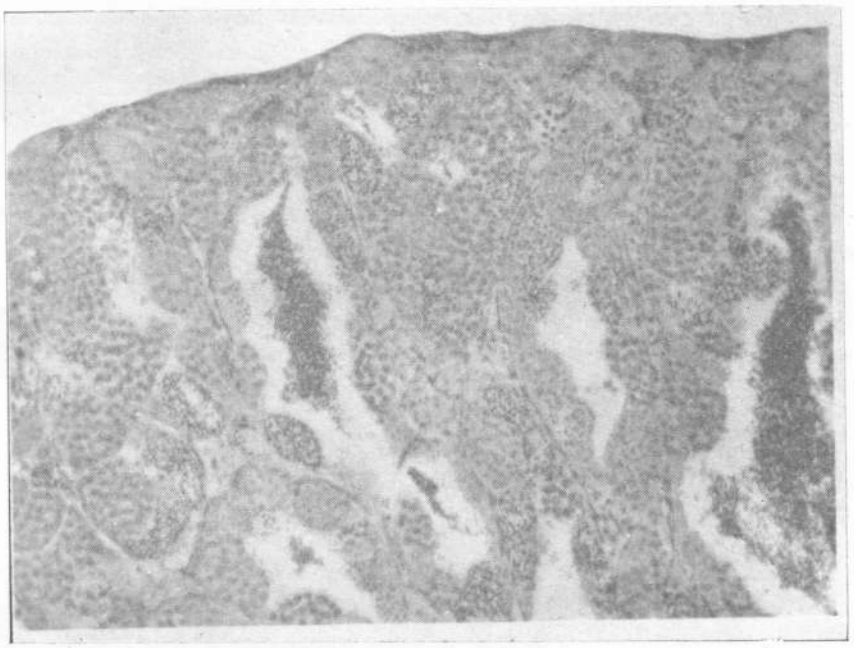

FIG. 15.—Part of T.S.of testis of male 21.5 cm.long(G.I. 0.27)on15 October; showing lumina of sieminiferous lobules reaching almost to periphery, cysts of spermatogonia, sperma tocytes, spermatids and spermatozoa; and thin connective tissue layer of tunica propria (150 x).

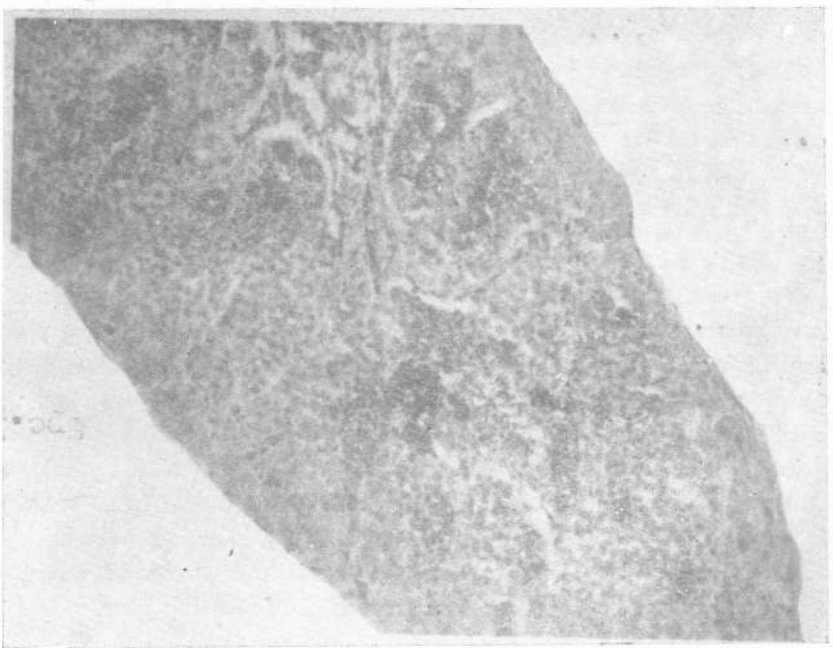

FIG. 16.—Part of T.S. of testis of male 11.5 cm. long(G.I. 0.31)on 7 October; showing reduced testis, undetectable radial character of seminiferous lobules and different germ cells (150 x).

and they are of two types, viz. the comparatively large type with conspicuous nucleolus and a smaller type with a small nucleolus. Interlobular connective tissue is thin but tends to become thicker towards the centre of the testis. The tunica propria is thin.

In some other testes, the lobules have multitudes of cysts of different cells including the primary and secondary spermatocytes, spermatids and spermatozoa (Fig. 15). The lumina of these lobules are wide, contain some sperms and pass almost to the periphery of the testis. The apical part of the lobules and the peripheral region of testis are occupied by spermatogonia of considerable size. The connective tissue layer of the tunica propria is thin. The sperm duct is distended with spermatozoa.

In October, some other testes are greatly reduced in size. The sperm-duct is narrow and contains few sperms. The radial character of the lobules is hardly detectable due to the faint development of interlobular connective tissue which can be detected only by oil immersion. Primary and secondary spermatocytes, spermatids and sperms were found to a low degree (Fig. 16). The connective tissue layer of the tunica propria is not detected and its place is occupied by spermatogonia which are of two types. Some are comparatively large, about 8 u diameter, with one large nucleous. Others are smaller and sometimes have two nucleoli.

V. DISCUSSION

The testis of *Tilapia nilotica* is of the radial type of Brock (1878). This type derives its name from the radial arrangement of the seminiferous lobules and, owing to the prevalence of this type in the percoid fishes, it is sometimes referred to as percoid. The testis is coated externally by the tunica propria which is differentiated into an outer peritoneal and inner connective tissue layers. In the internal region of the latter are differentiated smooth muscle fibres.

In *Tilapia nilotica* the peripheral region of the seminiferous lobules shows the presence of spermatogonial cells. Such a position of spermatogonia is also common in the radial testis and was described in many fishes *of Perca fluviatilis* (Kulayev, 1927), *Lepomis macrochirus* and *Huro salmoides* (James, 1946), *Lucioperca lucioperca* (Gerbilsky, 1947 ; Trusov, 1949), etc. However, Turner (1919) failed to detect spermatogonia in the periphery of the testis of *Perca flavescens* after spawning. Dealing with *Perca fluviatilis*, Kulayev (1927) found that in March, whence the current spermatogenetic wave came to an end, the spermatogonia showed active division. This condition was referred to as pre-spermatogenesis, due to its prevalence in advance of the future spermatogenetic wave of the following year.

In *T. nilotica*, the histological peculiarities of the testis show variation from one month to another and even in different individuals in one and the same month. However, the individual variation is not so well marked during November and December when the testes are composed mainly of spermatogonia, when spermatids and spermatozoa are few. In January and February some testes are composed mainly of spermatogonia, but in others the spermatogenesis has proceeded to a much greater degree so that the medullar region is distended with spermatozoa. In March, some testes exhibit the latter condition but some others are composed mainly of primary spermatocytes which may be actually dividing or in the synaptic stage and in such a case the lumina of the seminiferous lobules are only detected in the neighbourhood of the sperm duct. In April, although the primary spermatocytes are the main constituents of the testes yet he sperms are found in considerable amounts.

The testes may show different histological peculiarities whether in the same or different periods of May and this reveals a difference in the contribution of males in spawning. Besides, the difference in the gradual extension of the lumina of the seminiferous lobules, from the inner part of the testis towards its periphery, shows that the discharge of the sperms proceeds intermittently. Thus, although on the first of May the spermatozoa are found in all the testes yet some have preponderating postsynaptic stages of primary spermatocytes while in others the primary and secondary spermatocytes are less detected and this is accompanied by active division of spermatogonia. In such conditions the lumina of the seminiferous lobules may either be detected in the inner half of the testis or almost hardly detectable. In the middle of May, although some testes have the lumina detectable only in the inner half of testes, yet in some others these lumina reach almost the periphery of the testes.

During June through August the testes show different characters in the structure, magnitude of the different germ cells, path of the lumina of the seminiferous lobules, the thickness of the core of connective tissue and the distension of the sperm duct with spermatozoa. All these peculiarities may show a variation in the participation of males in the spawning period and are in adaptation to the long spawning season and the fractional spawning habit of the female.

In September although some testes show active spermatogenesis indicated by the presence of clusters of spermatozoa, others are reduced in size, have small amounts of spermatozoa and the radial peculiarities of the

seminiferous lobules are distinguished with difficulty or may be altogether indistinguishable. Such conditions were also detected in October although the reduction in size of the testis as well as the preponderance of the spermatogonia may increase throughout this month.

Furthermore, the peculiarity of spermatogenesis is related to the type of spawning whether shortened or extended. Besides, the discharge of sperms is in adaptation with the mono-or polyportional spawning peculiarity of the female. The phenomena connected with such differences may vary in different fishes. The three percoids, *Perca fluviatilis* (perch), *Luciopevca* (pike perch) and *Acerina cernua* (striped perch), are different, as the first two species have short spawning periods while the last has a long spawning period when the female participates by three portions in the spawning season. Butskaya (1959) concluded that the brevity of the spawning period in the first two species and its prolongation in the last species are not due to differences in the course of spermatogenesis but are due to differences in the peculiarities of the discharge of spermatozoa during the breeding season. In other words, the rapid discharge is ensured by dilution of the "mass" of spermatozoa by intensive secretion by the follicular epithelium of the vasa deferentia in the perch or by exudative process by the follicular epithelium of the seminiferous lobules in the pike perch. In the striped perch, there is a comparatively small amount of seminal fluid whereby the sperms are slightly diluted and are liberated slowly and this leads to a prolongation of the period of utilization of the sperms. On this account, the striped perch is different from some other fishes, similarly have as well a stretched spawning period such as *Abramis brama*, *Vimba*, Volga herring where besides the economy in the use of the spermatozoa additional portions of sperms are formed as well during the spawning period (Sakun and Butskaya, 1963).

During the spawning period, the testes of *T. nilotica* exhibit different peculiarities which are in adaptation with the stretched spawning period and with the fractional spawning character of the female. Thus, in one and the same period, the testes of different individuals show different spermatogenetic activities or conditions. Besides, additional amounts of sperms are always formed during the spawning period. Still in a third adaptive character, the discharge of spermatozoa from the seminiferous lobules proceeds gradually. Thus, in the first place, the sperms along the innermost part of the testis are first utilized and these are followed by those lying outer to them and so on. This is clearly revealed by the gradual ex-

tension of the lumina of the seminiferous lobules towards the periphery of the testes and the gradual continuity with the sperm duct. Apparently throughout the spawning period, the testis restores its distention by the different stages of spermatogenesis mostly by the peripheral reserve of spermatogonia. These germ cells have different peculiarities in the different testes and may sometimes be comparatively large, about 10 u in diameter or more. In turn, the nuclei of the above-mentioned large spermatogonia have the chromatin mostly concentrated near the nuclear membrane and are consequently comparable to the secondary spermatogonia of Kulayev (1929). These cells on multiplication become smaller and through such a process spermatogenesis proceeds with the continual formation of spermatozoa during the spawning season.

VI. SUMMARY

1. Testis is of radial or percoid type where seminiferous lobules acquire radial character.

2. Peripheral region of testis has always a reserve of spermatogonia responsible for following sexual cycle or in different periods of same cycle. During spawning season, some characteristic and large cells, up to 10 u in diameter, with chromatin nodes close to nuclear wall, may appear.

3. Wall of testis or tunica propria is formed of outer peritoneal and inner connective tissue layers.

4. Histological peculiarities of testis vary from one period to another and in different individuals in one and same period. Viable spermatozoa were found early in advance to breeding season.

5. In males, a) presence of testis in different conditions b) asynchronity in discharge of spermatozoa from seminiferous lobules, and c) additional spermatogenetic waves, are adaptations to elongated spawning season.

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