Seasonal Histology and Histochemistry of the Adenohypophysis of Nile Tilapia (*Oreochromis niloticus*)

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**Abstract**

In the present research, the histology and histochemistry of the adenohypophysis of Nile tilapia were done on 96 sexually mature Nile tilapia fish of both sexes collected monthly from the River Nile at Giza over the period from September 2009 to August 2010. The pituitary gland of both sexually mature male and female Nile tilapia was identically similar during the spring, summer and autumn seasons (breeding seasons). The pituitary gland revealed two well distinguished areas, the adenohypophysis and the neurohypophysis. The adenohypophysis showed three histologically distinct regions: rostral pars distalis, proximal pars distalis, and pars intermedia with no clear demarcation between them. The adenohypophysis was differentiated into two main cellular groups; the chromophobes and chromophils. The chromophils were differentiated into seven types of cells arranged in mosaic appearance; the acidophils (lactotrops and somatotrops); the basophiles (corticotrops, thyrotrops and gonadotrops); and the amphiphils (melanotrops and somatolactotrops). In between the adenohypophyseal cells few cavities either empty or partially filled with an amorphous, non-cellular colloid-like material were present. All parts of the adenohypophysis were penetrated by branching strands of neurohypophyseal tissue, which were coarser and extensive in the pars intermedia. During winter (non-breeding season), the adenohypophyseal glandular cells were smaller, less in field occupation and less in the intensity of their staining reactions.

**Key words**

Nile tilapia, the pituitary gland, the adenohypophysis.
Adenohypophysis of Nile Tilapia

**Introduction**

Nile tilapia belongs to genus Oreochromis. This species is naturally distributed in the Nile River as well as most parts of African Rivers and lakes. *Oreochromis niloticus* is gonochoristic, which each individual possessing a single sexual phenotype. Nile tilapia is characterized by extended spawning seasons, maturity at small size and a fast growth rate. (Peterson et al., 2004). *Oreochromis niloticus* is locally known as “Nile Bolti” or “Nile tilapia” and is so far one of the most important cultured species as food fish in Egypt either in pond culture or via other methods of fish farming (Mousa and Mousa, 1999a). The organization of the teleostean pituitary gland has been the subject of reviews (Ball and Baker, 1969; Sage and Bern, 1971; Schreibman et al., 1973) and Holmes and Ball, 1974). The study of the histology of the pituitary gland of the different teleost fish attracts the attention of several investigators such as Yoakim (1971) in *Synodontus schall*; Mousa (1998) in Nile tilapia (*Oreochromis niloticus*); Mousa and Mousa (1998) in mullet (*Mugil cephalus*); Mousa and Mousa (1999a) in Nile tilapia (*Oreochromis niloticus*) and Gaber (2000) in *Bagrus docmac* and *Bagrus bayad*. As far as we are aware, there are few references dealing with the season-generated changes in the histology and histochemistry of the adenohypophysis of Nile tilapia (*Oreochromis niloticus*) (Mousa and Mousa, 1999a). The principle objectives of the present investigation was to study the seasonal activity of the adenohypophysis to provide a clear information which could be useful for both scientists and who concerning with aquaculture development.

**Materials and Methods**

Specimens of Nile tilapia (*Oreochromis niloticus*) were collected monthly at the same time of the day from the River Nile at Giza. A total of 96 sexually mature Nile tilapia fish of both sexes were collected over the period from September 2009 to August 2010. Fish were transported alive to the central lab. of Cytology and Histology department, faculty of Veterinary Medicine Cairo University. The pituitary glands were removed immediately after decapitation and fixed in formol-sublimte and neutral buffered formalin for about 24hs., also Bouin’s fluid, Susa, Zenker’s formol and Bouin-holland sublimte were used for 12hs. After proper time of fixation for each fixative the samples were dehydrated, embedded in paraplast and following that 5-6 μm. sections were cut in sagittal plane.
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The following staining procedures were adopted for general histological examination.

1. Harris haematoxylin and eosin (H&E) for general histological examination.


3. Weighert’s elastic stain for demonstration of elastic fibers.

4. Gomori’s reticuline method for demonstration of reticular fibers.

The aforementioned fixatives and staining, methods were used as outlined by Drury and Wallington (1980).

The pituitary gland was specially stained for identification of the different cell types on the basis of their chemical constituents, by the following methods:

1. Aldehyde fuchsin - Orange G – Light green (AF-OG-LG) for demonstration of thyrotrops, gonadotrops, somatotrops (Halmi, 1952).


3. Peracetic acid- Alcian blue PH 0.2- Periodic acid schiff -Orange G (PA- AB - PAS – OG) for demonstration of thyrotrops, somatotrops, gonadotrops and lactotrops (Heath, 1965).

4. Aldehyde thionin- Periodic acid schiff - Orange G (Ath-PAS-OG) for demonstration of thyrotrops, gonadotrops, corticotrops and melanotrops (Ezrin and Murray, 1963).

5. Azocarmine-Aniline blue- Orange G (Heidenhain’s azan modification) for demonstration of somatotrops and lactotrops (Bancroft and Stevens, 1982).

6. Combined stain for fish pituitary (Performic acid - Alcian blue - Periodic acid schiff - Orange G-Acid fuchsin) for demonstration of lactotrops, corticotrops, melanotrops, somatotrops, gonadotrops and thyrotrops (Jafri, 1979).

7. Lead haematoxyline - Periodic acid schiff (PbH – PAS) for demonstration of corticotrops, melanotrops, somatolactotrops and gonadotrops (Bancroft and Stevens, 1982).

Results

In the present research, the histology and histochemistry of the adenohypophysis of Nile tilapia (Oreochromis niloticus) were described in
detail during the spring, summer and autumn seasons of the year (from March to November) to establish a standard against which the subsequent season of the year (winter) would be compared. The structure of the pituitary gland of both sexually mature male and female Nile tilapia (*Oreochromis niloticus*) was identically similar throughout the year. The pituitary gland of Nile tilapia (*Oreochromis niloticus*) revealed two well distinguished areas, the adenohypophysis and the neurohypophysis. The adenohypophysis was covered by a thin fibrous delicate capsule of fine collagenous, elastic, and few reticular fibers. The capsule was richly supplied with subcapsular blood vessels (Fig. 1). The supporting tissue was formed of reticular net. The adenohypophysis of the Nile tilapia (*Oreochromis niloticus*) revealed three histologically distinct regions: rostral pars distalis (RPD), proximal pars distalis (PPD), and Pars intermedia (PI) (Fig. 2). There was no clear demarcation between the three regions. The cells forming the adenohypophysis were arranged in cords and clumps or cell clusters (Fig. 3). Few cavities of variable sizes were observed, their lumina were either empty or filled with an amorphous, non-cellular colloid-like materials stained with orange G and azocarmine (Fig. 4). The cells of the epithelial compo-

ponent of the adenohypophysis were differentiated into two main groups; the chromophobes lack specific granules and hence showed only a faint cytoplasmic staining reaction. On the other hand, the chromophils were differentiated into acidophils, basophils and amphiphils. The acidophils (lactotrops and somatotrops) had a strong preference for acid dyes; the basophils (corticotrops, thyrotrops and gonadotrops) had a strong preference for basic dyes and the amphiphils (melanotrops and somatolactotrops) stained with both acid and basic dyes. There was a large number of blood sinusoids, which were highly engorged with blood distinguished along the whole adenohypophysis. All parts of the adenohypophysis were penetrated by branching strands of neurohypophyseal tissue. There was a more extensive interdigation between the neurohypophyseal tissue and pars intermedia (PI) (Fig. 5). The neurohypophysis was composed of a mesh work of axonal non-myelinated nerve fibers and neuroglial cells (Fig.10). Large blood sinusoids engorged with blood were present. Moreover, neurosecretory colloid droplets were evident.

**Lactotrops:** lactotrops or ("prolacin") cells formed the major component in the rostral pars distalis. Lactotrops were separated from the
neurohypophysis by the layer of corticotrops cells. Islets of lactotrops were detected in the proximal pars distalis, and isolated cells appeared subcapsular in the pars intermedia (Fig. 6). Lactotrops were usually large, generally round or oval cells, with granulated cytoplasm, and had a large, eccentric nucleus. Lactotrops were not grouped into follicles. They were positive to orange G (Figs. 7).

**Corticotrops:** corticotrops were arranged into cords and islets in the rostral pars distalis, bordering the neurohypophysis, and in the junction between the rostral pars distalis and proximal pars distalis. Furthermore, isolated cells were found dispersed deep in the proximal pars distalis. Corticotrops were angular or polygonal in shape with round eccentric vesicular nuclei with prominent nucleoli. The cytoplasm of corticotrops possessed a strong affinity to light green. Moreover, they stained grey with lead haematoxyline. Some of the corticotrops appeared degranulated (Fig. 8).

**Somatotrops:** Somatotrops were arranged into highly convoluted multicellular layers of cords arranged in long chain bordering the neurohypophyseal tissue which penetrated the proximal pars distalis, dispersed among gonadotrops, dispersed also in the proximal pars distalis bordering pars intermedia and in the pars intermedia between the melanotrops and somatolactotrops bordering the neurohypophysis. Somatotrops were round, columnar or ovoid cells of variable sizes. Somatotrops had an eccentric, large vesicular nucleus with distinct one or two nucleoli. Somatotrops had azocarmineophilic affinity (Fig. 9), acid fuchsin and orange G positive.

**Gonadotrops:** they form the main bulk of cells of the adenohypophysis during spring, summer and autumn seasons. Gonadotrops were located throughout the adenohypophysis, with the largest population occurred in the proximal pars distalis and along its junction with the pars intermedia (Fig.10). Isolated cells were also observed intermingled with other cells of rostral pars distalis and proximal pars distalis. These cells showed cytoplasmic protrusions shortly extending between the somatotrops (Fig.11). During these season, gonadotrops were numerous and larger in size than other cell types. Their cytoplasm showed different stages of granulation, degranulation and vacuolation. Some cells appeared nearly empty (Fig. 12). Gonadotrops were angular, oval or polygonal in shape. Their nuclei were vesicular, contained many nucleoli. Gonadotrops were basophilic cells gave intense periodic acid schiff positive reaction. Go-
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Thyrotrops: Thyrotrops were located in the proximal pars distalis (Fig. 13). Thyrotrops scattered in small islets in between the somatotrops in the proximal pars distalis near the neurohypophysis. Isolated thyrotrops were present among other cells of the proximal pars distalis, and along the periphery of the pars intermedia among the gonadotrops. Thyrotrops were small, angular, and irregular or polygonally shaped cells, each contained distinct fine cytoplasmic granules and round vesicular nucleus, with 1-2 nucleoli placed at one end of the cell. The thyrotrops were relatively fewer and smaller than gonadotrops and possessed cytoplasmic processes. These cells showed the same histochemical staining affinities as gonadotrops but their staining affinity was weaker.

Melanotrops: Melanotrops, the amphiphilic cells, were the predominant cell type mainly restricted to the pars intermedia, forming clusters and small groups of cells in the central parts of the pars intermedia (PI), lying further away from the neural tissue (Fig.14). Melanotrops were observed in the dorsal proximal pars distalis among the gonadotrops. Melanotrops were lead haematoxyline positive (PbH + cells). Melanotrops stained bluish with aniline blue. Melanotrops were larger, columnar cells with basal nucleus and a supranuclear mass of stainable secretory granules. Melanotrops showed great staining affinity to orange G and light green (Fig. 15).

Somatolactotrops: The somatolactotrops were amphiphilic cells formed a discontinuous layer bordering the neurohypophysis, or away from the neurohypophysis dispersed between melanotrops. Somatolactotrops were small sized cells, with oval or roundish shape. The nucleus was clear, round, oval or deeply indented. The somatolactotrops were modestly reacted to periodic acid–schiff (PAS + cells) (Fig.16). The somatolactotrops produce pale blue color when stained with aldehyde fuchsin. They were positively stained with the acidic dye azocarmine (Fig. 17).

Winter season (from December to February):

Lactotrops: Few cells showed granulated cytoplasm and others appeared vacuolated and empty.

Corticotrops: of both sexes had the same features throughout the year.
**Somatotrops:** of both sexes showed clear seasonal variation as they appeared smaller in size. Some were fully filled with fine cytoplasmic granules. Others, appeared partially degranulated, even, some were chromophobic.

**Gonadotrops:** in both sexes, they were smaller in size and less in field occupation. Most of these cells were densely granulated. Few cells revealed partial degranulation and vacuolation (Fig. 18).

**Thyrotrops:** many thyrotrops of both sexes appeared degranulated and vacuolated (Fig. 19).

**Somatolactotrops and Melanotrops:** Staining intensities and number of both melanotrops and somatolactotrops appeared greatly reduced. Moreover, melanotrops appeared greatly degranulated. The somatolactotrops showed different staining pattern, as they were stained with both lead haematoxyline and periodic acid schiff (Fig. 20).

**Discussion**

In agreement with the results of Ball and Baker (1969) in teleost fish; Yoakim (1971) in Nile catfish (Synodontus schall); Mousa (1998) in Nile tilapia (Oreochromis niloticus) and El-Zoghby et al., (2008) in Clarias lazera, this study revealed that the pituitary gland of Oreochromis niloticus as in most teleosts was composed of two parts without distinct line of demarcation between them; the adenohypophysis which was the glandular part and neurohypophysis which was the neural part of the gland.

In accordance to Ball and Baker (1969); Peter et al., (1990) in teleost fishes; Cinquetti and Dramis (2006) in Padogobius marteusi and Kasper, et al., (2006) in Oreochromis niloticus, our finding revealed that The neurohypophysis gave off ramifications to the different parts of the adenohypophysis. The interdigititation of the neurohypophysis with the pars intermedia (PI) was coarser and more numerous.

Weltzien, et al., (2004) in flatfish (Pleuronectiformes) and Kasper et al. (2006) in Oreochromis niloticus stated that, unlike mammals, teleost fish lack a hypothalamo-hypophyseal portal system for the transport of neurohormonal regulators. Instead, a direct axonal transport existed between hypothalamic neurons and pituitary endocrine cells via the hypophyseal stalk and neurohypophysis.

The adenohypophysis of the Nile tilapia was subdivided into three distinct regions; the most rostral region was the rostral pars distalis (RPD),
the middle region was the proximal pars distalis (PPD), while the most distal region was the pars intermedia (PI). Our classification came in agreement to those obtained by Oliveira and Ball (1964) in teleost; Groman (1982) in striped bass; Peuteet al.,(1984) in *Clarias lazera*; Mousa (1998) in *Oreochromis niloticus*; Gaber (2000) in *Bagrus docmac* and *Bagrus bayad*; Kasper et al. (2006) in *Oreochromis niloticus* and El-Zoghby et al. (2008) in *Clarias lazera*.

In agreement with the results of Kasper et al. (2006) in *Oreochromis niloticus*, the hormone producing cell types were arranged in a mosaic pattern due to the uneven distribution of different cell types within the three regions of the adenohypophysis.

El-Zoghby et al. (2008) in *Clarias lazera* revealed that the adenohypophysis was found to be consisted mainly of two main cell types; acidophils and basophils. Five cell types were identified in the adenohypophysis of the *Clarias lazera*. El-Gohary (2001) in *Oreochromis niloticus* identified seven cells; two of them were of unknown function.

Our results came in agreement with Rizkalla (1963) in *Oreochromis niloticus* and Wai-Sum and Chan (1974) in *Monopterus albus* where they revealed that the cells of the epithelial component of the adenohypophysis were differentiated into two main groups; the chromophobes lack specific granules. On the other hand, the chromophils were differentiated into acidophils, basophils and amphiphils. The acidophils (lactotrops and somatotrops), the basophils (corticotrops, gonadotrops and thyrotrops) and the amphiphils (melanotrops and somatolactotrops).

Acidophilic droplets (colloid) stained positively with orange G and azocarmine often appeared between the adenohypophyseal cellular elements. These were incorporated as an accumulation of hormonal material (Iturriza, 1964) in *Bufo arenarum* or as products of cellular degeneration (Etkin, 1967).

In our investigation; the lactotrops or ("prolactin") cells (PRL cells) formed the major component in the rostral pars distalis (RPD). Lactotrops were separated from the neurohypophysis by the layer of corticotrops cells. Islets of lactotrops were detected in the proximal pars distalis (PPD), and individual cells appeared subcapsular in the pars intermedia. Similar findings were described by Dharmamba and Nishioka (1968) in *Tilapia mossambica*; Massoud et al. (1985) in *Malapterurus electricus*; Gaber (2000) in *Bagrus docmac* and Dramis (2006) in *Crenilabrus melops*; Gaber (2000) in *Oreochromis mossambicus*; Agulleiro, et al., (2006) in Podobius and Borella et al., (2009).
and Bagrus bayad and El-Zoghby et al. (2008) in Clarias lazera.

The present work revealed that lactotrops were not grouped into follicles. The same observations were recorded by Ball and Baker (1969) in striped bass; Benjamin (1979) in Crenilabrus melops and Cinquetti and Dramis (2006) in Padogobius martensi. On the other hands, Takashima and Hibiya (1995) in rainbow trout; Gaber (2000) in Bagrus docmac and Bagrus bayad and El-Zoghby et al. (2008) in Clarias lazera observed that prolactin cells are arranged in definite follicles with ovoid or spherical lumina.

Sanchez et al. (2003) in the greater weever fish emphasized that, in marine fish, prolactin (PRL-ir) cells had been showed to be involved in stress or reproduction.

In our investigation in Oreochromis niloticus, corticotrops (ACTH cells) were arranged into cords and islets in the rostral pars distalis, bordering the neurohypophysis and the rostral pars distalis and in the junction between the rostral pars distalis (RPD) and proximal pars distalis (PPD). Furthermore, isolated cells were found dispersed deep in the proximal pars distalis (PPD), that simulate to the results obtained by Ball and Baker (1969) in teleost; Gaber (2000) in Bagrus docmac and Bagrus bayad; Sanchez et al. (2003) in the greater weever fish (Trachinlus draco); Weltzien et al. (2003) in Atlantic halibut; El-Zoghby et al. (2008) in Clarias lazera and Borella et al. (2009) in Arapaima gigas.

In teleosts, besides its classical functions of stimulating cortisol release and stress-response control, corticotropin (ACTH) acts in adaptation to hyposmotic environments (Mancera and Fuentes, 2006 and Borella et al., 2009).

In the present study somatotrops were arranged into highly convoluted multicellular layers of cords which aligned as long chain bordering the neurohypophyseal tissue which penetrating the proximal pars distalis (PPD) and dispersed among gonadotrops. The same results were recorded by Mousa (1998) and El-Gohary (2001) in Oreochromis niloticus; Sanchez et al. (2003) in the greater weever fish (Trachinlus draco); Agulleiro, et al., (2006) in Oreochromis niloticus and El-Zoghby et al. (2008) in Clarias lazera.

Our results observed that, isolated somatotrops also present in the pars intermedia between the melanotrops and somatolactotrops bordering the neurohypophysis as that recorded by Takashima and Hibiya (1995) in salmonids; Weltzien et al.
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In the present study, the somatotrops exhibited seasonal changes in their activity as they were relatively smaller in size and fewer in number during winter. Melamed et al. (1999) in Tilapia species concluded that gonadotrops and somatotrops actions were of paracrine nature as both of them had the same seasonal changes in relation to the gonads.

Our investigations showed that, the gonadotrops formed the main bulk of cells of the adenohypophysis during spring, summer and autumn seasons. The largest population occurred in the proximal pars distalis. Small clusters were located along the periphery of pars intermedia. Isolated cells were also observed intermingled with other cells of the rostral pars distalis and the proximal pars distalis. Similar findings were described by Yoakim (1971) in Synodontus schall; Gaber (2000) in Bagrus domac and Bagrus bayad and El-Gohary (2001) in Oreochromis niloticus.

In our research, gonadotropic cells of Oreochromis niloticus were numerous and larger in size than other cell types in spring, summer and autumn. Their cytoplasm showed different stages of coarse cytoplasmic granulation, degranulation and vacuolation. Some cells appeared nearly empty.

It remains uncertain whether the teleost pituitary contained one or two types of gonadotropic cells. Some workers had described two distinct cell types; others had found only one type of gonadotrops.

Contrary to the present findings, light microscopical studies of the pituitary of perch (Perca fluviatilis macedonica kar) revealed two types of gonadotrops (Dimovska, 1970 and 1977). Moreover, Yoshiura et al. (1999) in Japanese eel (Anguilla japonica); Parhar et al. (2002) in the cichlid fish and Kasper et al. (2006) in Oreochromis niloticus described two types of gonadotrops in the proximal pars distalis.

On the other hand and in accordance with our findings in Oreochromis niloticus a single type of gonadotrops, located in the proximal pars distalis, had been observed by Gaber (2000) in Bagrus domac and Bagrus bayad; El-Gohary (2001) in Oreochromis niloticus and El-Zoghby et al. (2008) in catfish (Clarias lazera).

During winter the gonadotrops in both sexes were smaller in size and less in field occupation. Most of these cells were densely granulated. Few cells revealed partial de-
granulation and vacuolation. Similar observations were described by Mousa and Mousa (1998) in *Mugil cephalus* and El-Zoghby et al. (2008) in catfish (*Clarias lazera*).

Thyrotrops showed the same histochemical staining affinities (as gonadotrops), but they were weaker or lighter which support the result of Takashima and Hibiya (1995) in some species, such as chum salmon, rainbow trout, carp, tuna and red sea bream.

In the present study, the thyrotrops exhibited seasonal changes in their activity in non-breeding season as many cells appeared degranulated and vacuolated that denied the results obtained by Gaber (2000) in *Bagrus domac* and *Bagrus bayad* and El-Zoghby et al. (2008) in *Clarias lazera*.

In our investigation pars intermedia contained mainly two amphiphilic cell types, one was lead hematoxyline positive which was the predominant cell type (melanotrops) and the other periodic acid schiff (PAS) positive which were scattered throughout the pars intermedia. These results simulate the findings of Wai-Sum and Chan (1974) in *Monopterus albus*; Benjamin (1979) in *Crenilabrus melops* and Cinquetti and Dramis (2006) in *Padogobius martensi*.

Our studies revealed that, during non-breeding season (winter) the staining intensities and number of melanotrops appeared greatly reduced. Moreover, melanotrops appeared greatly degranulated. Melanotrops seemed to have no seasonal role in the channel catfish, *Ictalurus punctatus* (Massoud, 1982).

The work of Ball et al. (1972) in teleost fish indicated that these cells were the source of melanocyte stimulating hormone (MSH).

This distribution pattern of the somatolactotrops cells observed in our study was in agreement with those recorded in *Sparus aurata* (Villaflana et al., 1997); in *Oreochromis niloticus* (Mousa and Mousa, 1999b); in male Atlantic halibut (*Hippoglossus hippoglossus*) (Weltzien et al., 2003); in *Oreochromis niloticus*, (Kasper et al., 2006) and in *Arapaima gigas*, (Borella et al., 2009).

The function of the periodic acid schiff positive somatolactotrops in the pars intermedia was uncertain; they might be involved in the regulation of calcium metabolism (Olive- reau et al., 1981), or in the regulation of background color adaptation (Ball and Batten, 1981), or reproduction (Schreibman et al., 1982).

Kaneko (1996) in rainbow trout suggested that somatolactotrops was
involved in reproduction, calcium metabolism, stress, acid-base regulation, fat metabolism, background adaptation and osmoregulation.

Canepa et al. (2006) concluded that SL was a pituitary hormone present exclusively in fish and was involved in different physiological effect. They added that there was clear evidence towards a possible involvement of somatolactin (SL) in the adaptation to background colors in teleost together with MSH and MCH.

In the present investigation, the two cell types of the pars intermedia showed seasonal changes in their morphology and staining pattern in correlations to seasonal activity which might indicate that they concerned in functions other than control of pigmentation. In our opinions a definitive functions of somatolactotrops has not been determined till now and need more research.

References


cation of adenohypophyseal cells in the pirarucu (Arapaima gigas), an Amazonian basal teleost. Fish Physiol. Biochem. 35: 3 – 16.


Ezrin, C. and Murray, S. (1963): The


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Fig (1): Section of proximal pars distalis of the pituitary gland of mature female Nile tilapia during spring showing: Gonadotrops (g), Vacuoles (V), Capsule (C), Blood vessels (BV). Aldehyde thionin- periodic acid schiff - orange G (Ath-PAS-OG) X1000.

Fig (2): Section of pituitary gland of mature female Nile tilapia during spring showing: Rostral pars distalis (RPD), Proximal pars distalis (PPD), Pars intermedia (PI), Neurohypophysis (NH). H&E. X100.

Fig (3): Section of rostral pars distalis of the pituitary gland of mature male Nile tilapia during spring showing: Adenohypophyseal cells arranged in cords, Acidophilic cells (A), Basophilic cells (B). H&E. X400.

Fig (4): Section between rostral pars distalis and proximal pars distalis of the pituitary gland of mature male Nile tilapia during spring showing: Lactotrops (PRL), Somatotrops (S), Gonadotrops (g), cavity containing orange G positive colloid-like material (arrow), Periodic acid schiff technique - orange G – light green. X1000.
Fig (5): Section of proximal pars distalis and pars intermedia of the pituitary gland of mature male Nile tilapia during spring showing: more extensive interdigitation between the neurohypophysial tissue and pars intermedia (PI). Periodic acid schiff technique - orange G – light green (PAS – OG-LG). X100.

Fig (6): Section of pars intermedia of the pituitary gland of mature male Nile tilapia during summer showing: (PRL): isolated Lactotrops (orange G positive) under capsule in pars intermedia, Gonadotrops (aniline blue positive) (g), Capsule. Azocarmine-aniline blue-orange G. X1000.

Fig (7): Section of rostral pars distalis of the pituitary gland of mature male Nile tilapia during summer showing: Lactotrops (orange G positive) (PRL), Degranulated lactotrops (d), Azocarmine-aniline blue-orange G. X1000.

Fig (8): Section of the rostral pars distalis of the pituitary gland of mature male Nile tilapia during summer showing: Corticotrops appeared deeply stained (C) and others were degranulated (arrow). Lead hematoxyline- periodic acid Schiff (PbH- PAS). X400.
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**Fig (9):** Section of the proximal pars distalis of the pituitary gland of mature female Nile tilapia during summer showing: Somatotrops (S), Gonadotrops (g). Azocarmine-aniline blue-orange G. X1000.

**Fig (10):** Section of the proximal pars distalis of the pituitary gland of mature male Nile tilapia during spring showing: Somatotrops (S), Gonadotrops (g), Neurohypophysis (NH), Pars intermedia (PI). Aldehyde thionin-periodic acid schiff-orange GX100.

**Fig (11):** Section of the proximal pars distalis of the pituitary gland of mature female Nile tilapia during spring showing: Gonadotrops (g), Somatotrops (S). Aldehyde fuchsin-orange G-light green. X1000.

**Fig (12):** Section of the proximal pars distalis of the pituitary gland of mature female Nile tilapia during spring showing: Gonadotrops (g). Aldehyde fuchsin-orange G-light green X1000.
Fig (13): Section of rostral pars distalis and proximal pars distalis of the pituitary gland of mature male Nile tilapia during summer showing: Gonadotrops (g), Thyrotrops (T), Somatotrops (S), Lactotrops (PRL). Aldehyde thionin-periodic acid schiff -orange G. X100.

Fig (14): Section of pars intermedia of the pituitary gland of mature female Nile tilapia during summer showing: Melanotrops (M), Somatolactotrops (SL), Gonadotrops (g), Neurohypophysis (NH). Lead haematoxyline- periodic acid schiff (PbH-PAS). X400.

Fig (15): Section of the pars intermedia of the pituitary gland of mature female Nile tilapia during spring showing: Neurohypophysis contained aldehyde thionin positive fibers (NH), Neurosecretion positive to orange G (NS), Somatolactotropins (SL), Melanotrops (M). Aldehyde thionin-periodic acid schiff -orange G. X400.

Fig (16): Section of pars intermedia of the pituitary gland of mature male Nile tilapia during summer showing: Melanotrops (M), Somatolactotrops (SL), Blood vessels in the Neurohypophysis (arrow). Lead haematoxyline- periodic acid schiff (PbH-PAS). X1000.
**Fig (17):** Section of pars intermedia of the pituitary gland of mature male Nile tilapia during summer showing: Melanotrops (M), Somatolactotrops (SL), Neurohypophysis (NH). Azocarmine-aniline blue-orange G. X1000.

**Fig (18):** Section of proximal pars distalis of the pituitary gland of mature male Nile tilapia during winter showing: Gonadotrops (g), Blood sinusoids in the Neurohypophysis (arrow). Lead haematoxyline-periodic acid schiff (PbH-PAS). X1000.

**Fig (19):** Section of proximal pars distalis of the pituitary gland of mature female Nile tilapia during winter showing: Gonadotrops (g), Somatotrops (S), Thyrotrops (T). Aldehyde fuchsin-orange G-light green. X400.

**Fig (20):** Section of pars intermedia of the pituitary gland of mature female Nile tilapia during winter showing: Melanotrops (M), Somatolactotrops stained with both PbH and PAS (SL). Lead haematoxyline-periodic acid schiff (PbH-PAS). X1000.