Monitoring Male *Oreochromis niloticus* Reproduction and Health Influenced by Temperature Fluctuations

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Abstract

This research studied effect of water temperature increase on male *O. niloticus* experimentally and survey. One hundred male *O. niloticus* delivered from private farm fish divided into four groups: 1 st kept at room temperature (Control) and others at 30, 33 and 36 ºC for 2 weeks. Two Survey groups collected from El-monib at 27 ºC (Control) and at 36 ºC water temperatures.

Experimental fish suffered from nervous manifestations, detached scales, ulcers, tail rot. Unsymmetrical testis which appeared thread like especially at 36 ºC and survey.

Growth measurements revealed highly significant drop in B.W., WH and WG. In addition, relative fecundity F.B.W. and F.O.W (only at 33 ºC) registered highly significant decrease. Sperm density and sperm live % also showed highly significant drop.

On the contrary, survey group B.W., WG, WH, and IG as well as parameters of relative fecundity (F.B.W. and F.O.W) showed highly significant increase. Oppositely, Sperm density and sperm live % copied highly significant decrease.

At 30 ºC and 36 ºC water temperatures and survey total protein and globulin decreased highly significant. Estradiol hormone decreased highly significant at experimental and survey groups. Glucose and testosterone increased highly significant at experimental and survey groups.

Malformation and distortion of seminiferous tubules with lesser number of sperms. Hepatic cells appeared swollen with vacuolar degeneration.

Favorable water temperature for *Oreochromis niloticus* to achieve their maximum reproductive performance and their health is 27 ± 2ºC.

Thus, recommendation to increase aerators in brood stocks ponds or to be covered during summer season.

Key words: temperature, fecundity, liver and testis.

Introduction

The majority of species in which mono sex culture is practiced, the male is more economically attractive than the female because of faster growth rate. In addition to the males, the metabolic energy is channeled towards growth. They benefit from anabolism enhancing androgens. In females, there is a greater reallocation of metabolic energy towards reproduction ***(Khater et al., 2017).*** They said that male Tilapia production has an economic importance to its producers and sellers. The increase in employment in the sector outpacing world population growth and employment in traditional agriculture is a crucial source of income and livelihood for hundreds of millions of people around the world. It could play an important role to provide food security for the general population as an excellent source of high-quality protein.

Pushkar et al. (2010) had presented temperature being one of the major abiotic environmental and ecological factors controlling all important vital processes in fishes particularly. Moreover, ***Pandit & Nakamura (2010)*** pointed out those global warming scenarios will affect survival, growth, physiological behavior and other body functions of the influenced species. They assisted that rearing Nile tilapia reached utmost at water temperature 27 - 32 ºC resulted in reduced growth and increased mortality.

Whereas, ***Pushkar et al. (2010)*** indicated that optimum growth and food conversion efficiency in *Oreochromis niloticus* were achieved at constant temperature close to 28 ºC.

Water temperature is a fundamental physical regulatory factor in the lives of fishes and this effect is expressed particularly strongly in the control of all reproductive processes from gamete development and maturation, ovulation, spermiation, spawning, embryogenesis and hatching, to larval and juvenile development and survival.

The goal of this study is to shed light on the mismatch between rise of water temperature experimentally (at three water temperatures 30, 33 and 36ºC) and in survey on *O. niloticus* fecundity together with biochemical parameters (total protein, albumin, globulin, glucose, estradiol and testosterone) and histopathological alternations.

Materials and methods

Fish:

a. A total number of 100 male *Oreochromis niloticus* with an average body weight 100±20 g. was collected alive from a private farm at Wadi El-Natroon in summer 2018 and transported into large plastic containers supplemented with battery aerators, to Biology Unit - Fish Diseases Dept. at Animal Health Research Institute, Dokki.

b. A total of 50 apparently healthy *Oreochromis niloticus* with an average body weight 100 ± 20 g were collected from EL-monib to make survey at different water temperatures 27 ± 2 °C (control) and 36 °C.

Aquaria:

Fish were kept 2 weeks for acclimation in fully prepared glass aquaria supplied with electric air pumps for continuous aeration and heaters.

Experimental design:

80 fish were divided into 4 groups (20 each). In 3 groups, water temperature was adjusted at 30, 33 and 36 °C using heaters. Temperature was raised gradually at a rate of 1°C/day in order to avoid thermal shock. The 4th group (control group) was kept at a temperature 27 ± 2 °C. The experiment lasted for 2 weeks.

Two survey groups (20 each) were collected from River Nile (EL-Monib) at water temperature 27 ±2 °C (Control survey) and 36 °C (Survey).

Fish Growth Measurements:

For each fish body Length (B. L.), body Weight (B.W.), gonds weight (WG) and hepatic weight (WH) were measured for each fish separately in experiment and survey groups.

Morpho – anatomical Parameters:

For each fish Gonado-somatic Index (I_G) and Hepato-somatic Index (I_H) indices as well as Condition factor (K) were calculated according to ***Sun and Pankhurst (2004).***

Clinical examination:

Testis and liver of each fish were examined macroscopically to detect any abnormality and experimented fish were kept under investigation for any abnormal behavior.

Survival rate:

It was calculated for each group

Fecundity evaluation:

Reproductive performance and relative fecundity were calculated for each fish according to ***Nashwa (2009)***.

Serum was carefully collected in clean dry Epindorff tubes from each fish separately and preserved at -4 ^{O}C until analysis.

Biochemical Investigation:

-Serum Total protein (T.P) and Albumin were estimated for each fish according to ***Young DS (1995).***

-Serum Globulin was estimated for each fish by subtracting Albumin from Total proteins.

-Serum Glucose was estimated for each fish according to ***Tietz (1995 a)***

-Sex hormones levels: concentration of testosterone (T) and estradiol (E2) hormones were measured for each fish by ELIZA kits according to ***Tietz (1995 b and c)***.

Histopathological Examination:

Testis and liver samples from each group under test were kept in Bouin's solution for 48 hours before being prepared, for histopathology ***(Takashima and Hibiya, 1995).***

Statistical Analysis: The obtained data were statistically analyzed according to ***SPSS 14 (2006)*** using T test.

Results:

Clinical signs and postmortem findings:

Clinical signs: At 33 and 36ºC, fish suffered from nervous manifestation, suffocation as well as abnormal swimming, abnormal skin pigmentation, detached scales, skin ulcer and tail rot.

Postmortem lesions: Unsymmetrical testis at both 33 and 36ºC , at 36ºC majority of testis appeared thread - like.

Effect of Temperature on *O. niloticus* (experimental and survey female)

Survival rate for each experimental group was tabulated in Table (1).

The results of growth measurements, morpho – anatomical parameters, relative fecundity and reproductive performance of the experimental and survey groups were tabulated in Tables (2) and (3).

Results of the biochemical parameters for experimented and survey groups were tabulated in Table (4).

Table 1: *Showing the Survival rate of Male O.niloticus:*

Temp ºC	Initial Number	Final Number	Survival rate %
30	20	16	80
33	20	12	60
36	20	12	60

Table 2: *Comparison between male growth measurements and fecundity at different examined temperatures (Mean±S.D.)*

Reproductive parameter		Control	At 30˚C	At 33˚C	At 36˚C
Growth Measurements	B.L	21 ± 0.7	19.8 ± 0.8	20.4± 1.2	20.2± 0.8
	B.W	127 ± 1.2	107.2±5***	86.4± 8***	95.6± 12 ***
	WH	3.3 ± 0.4	1.52±0.3***	1.26± 0.3***	1.28± 0.2***
	WG	1.5 ± 0.2	1.28± 0.4	1.3± 0.2	0.72± 0.3**
Morpho - anatomical parameters	Ig	1.8 ± 0.3	1.2± 0.3	1.58± 0.3	0.66± 0.2*
	Ih	1.3 ± 0.02	1.5± 0.3	1.66± 0.4	1.06± 0.3
	K	1.6 ± 0.1	1.22±0.2	4.22± 0.3***	1.3± 0.2
Relative Fecundity	FBL	1251 ± 9	1221±1	1187± 1	1240± 1
	FBW	880 ± 3	778±3***	634± 4***	790± 1***
	FOW	539 ± 4	612±6	638± 5***	538± 8
Absolute Fecundity	Sperm Density	2442 ± 2	1938±5***	1244± 5***	716±3***
	Live %	84 ± 3	80.6± 3	73.2± 6***	36± 1***
	Dead %	16 ± 1	19.4± 2	26.8± 6***	64± 1***

N=10 *P < 0.05 **P < 0.01 ***P < 0.001

Table 3: *Comparison between male growth measurements and fecundity of survey at temperature 36℃ (Mean ±S.D.)*

Reproductive parameter		Control	Survey
Growth Measurements	B.L. (cm.)B.L. (cm.)	19.5 ± 0.5	22.5 ± 1.6***
	B.W. (g)	96.1± 1	135 ± 3***
	W_H (g)	1.25± 0.1	1.7 ± 0.1***
	W_G (g)	1.4 ± 0.1	2.55 ± 0.2 ***
Morpho- anatomical parameters	I_G	1.75 ± 0.2	2.8 ± 0.2***
	I_H	1.49 ± 0.2	1.25 ± 0.2
	K	1.65 ± 0.5	1.173 ± 0.02
Relative Fecundity	FBL	1158.6 ± 6	1552.5 ± 2***
	FBW	705.6 ± 8	1010 ± 1***
	FOW	558.2 ± 2	650 ± 6***
Absolute Fecundity	Sperm Density	2246.5 ± 2	1030 ± 1***
	Live %	90 ± 1	71.5 ± 2***
	Dead %	10 ± 1	28.5 ± 2***

N=10 *P < 0.05 **P < 0.01 ***P < 0.001

Table 4: *Comparison between female biochemical parameters at the different examined temperatures and the survey with the control (Mean ±S.D.)*

Biochemical parameters	Control	At 30	At 33	At 36	Survey
Total protein mg/dl	7.16±0.8	4.12± 0.02***	4.07±1.16***	6.56± 1.8***	2.87±0.06***
Albumin mg/dl	0.55± 0.04	1 ± 0.74	0.75± 0.45	0.58± 0.09	1.6 ± 0.90***
Globulin mg/dl	6.61± 0.8	3.12± 0.7***	3.32± 1.6***	6 ± 1.8	1.27± 0.9***
Glucose mg/dl	28± 1.1	29 ± 6.3	59 ± 24***	48 ± 11***	61± 4.2***
Estradiol µg	1075 ± 3	790 ± 3 ***	871 ±3 ***	736 ± 2 ***	1025 ±2 ***
Testosterone pg	16.6 ± 1.1	18.5 ± 0.5 ***	17.4 ± 0.1	18.2± 0.2 ***	18.4± 0.1 ***

N=10 $^*P < 0.05$ $^{**}P < 0.01$ $^{***}P < 0.001$

Photo (1): ***O. niloticus*** *exposed to high water temperature (36 ˚C) showing detached of scales.*

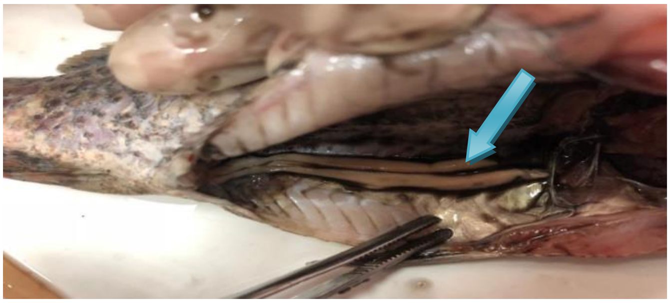

Photo (2): ***O. niloticus*** exposed to high water temperature (36˚C) showing asymmetrical testis.

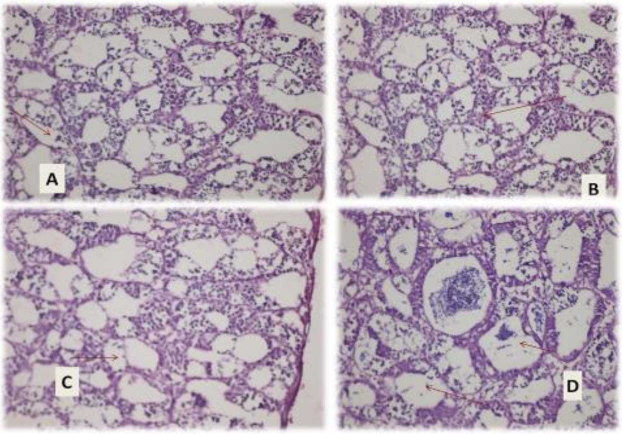

Plate 1 (H&E stain)

a. Testis presence of small foccal areas of necrosis with malformation and distortion of architecture of seminiferous tubules*400

b. Testis together with degenerative changes in some interstitial cells*400

c. At 36°c testis showing seminiferous tubules appeared lucent*400

d. At 36°c testis showing lesser number of sperm. *400

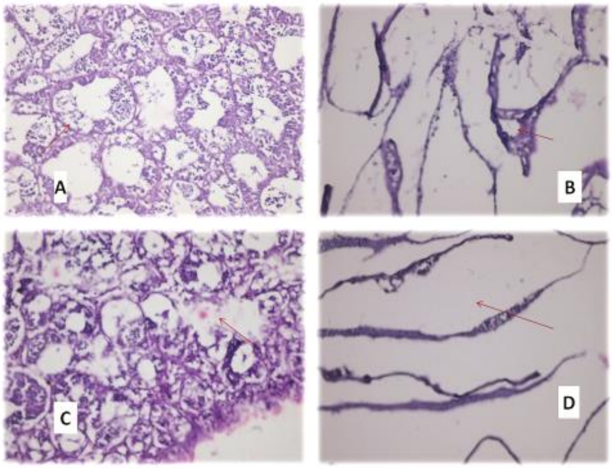

Plate 2 (H&E stain)

a. At survey and 36°c testis interstitial liydic cells showed necrobiotic changes*200

b. At 36°c testis showing free of sperms indicating lack of active spermatogenesis*200

c. At survey testis showing oedema was pronounced in between semineferous tubules*200

d. At 36°c testis showing free of sperms indicating lack of active spermatogenesis*200

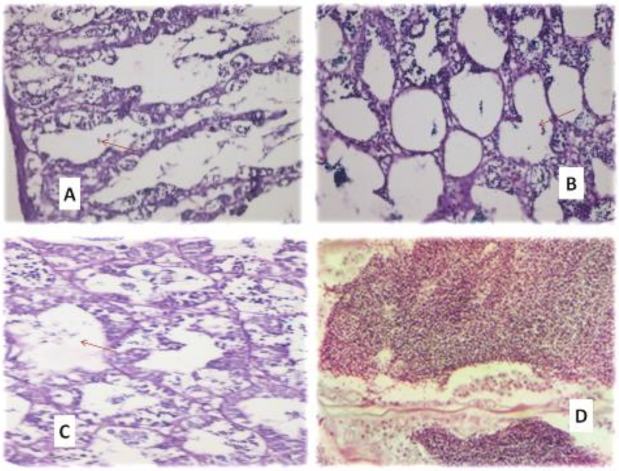

Plate 3 (H&E stain)

a. At survey testis showing oedema between semineferous tubulesWhich also lead to burst of them. *200

b. At survey testis semineferous tubules were in the form of cystic formation*200

c. At survey and 36°c testis contained abnormal sperm (head only or tail only)*200

d. Control testis.*200

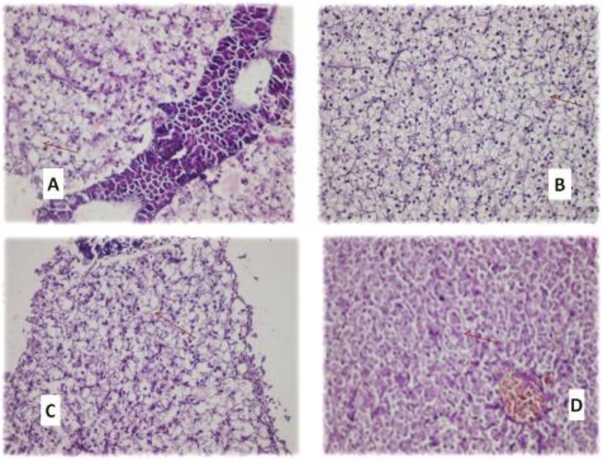

Plate 4 (H&E stain)

a. At 30˚C and 33˚C liver The hepatic cells showing vacuolar degeneration*200

b. A at 30˚C and 33˚C The hepatic cells appeared swollen with clean cytoplasm, their nuclei near wall of affected cells *200

c. At survey hepatic cell appeared vacuolar with ruptured hepatic wall showing aphthae formation*200

d. At survey hepatic cells appeared in the form of adenoid formation*200

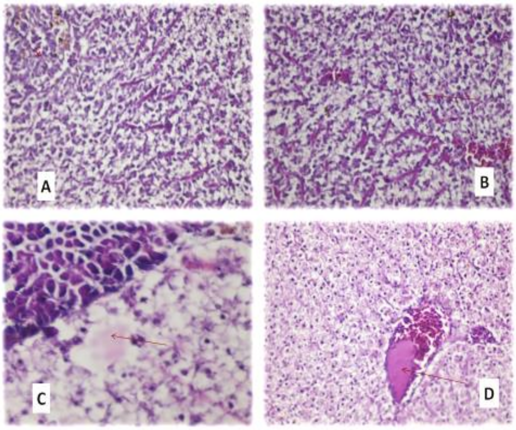

Plate 5 (H&E stain)

a. At 30˚C liver showing mild congestion in hepatic blood vessels. *200

b. At 33˚C liver showing mild congestion in hepatic bl. Vessels &sinusoids*200

c. At survey male liver revealed oedema and multiple degrees of necrosis. *400

d. At 36˚C liver showing congestion in hepatic blood vessels with hemolysed blood*200

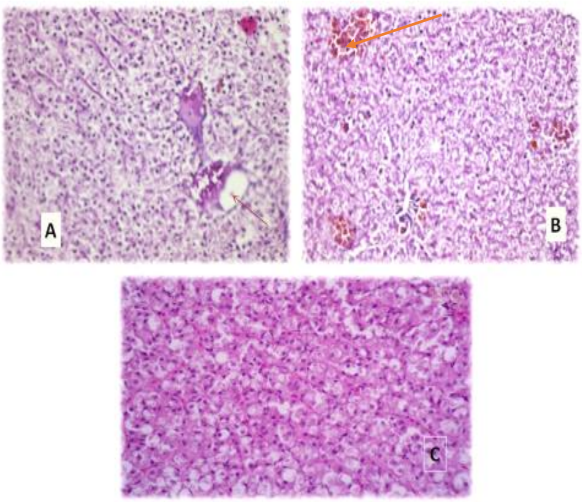

Plate 6 (H&E stain)

a. At 36˚C hepatic parenchyma showing hemolysed blood*200

b. At 36˚C liver showing hyperplasia of bile duct with collongitis beside aggregation of melanomacrophage cells in hepatic parenchyma*200

c. Control liver*200

Discussion

Temperature being one of the most important ecological factors controlling and influencing all patterns of various main vital processes (respiration, growth, energetics, physiological behavior, reproductive performance and fecundity. Temperature influences on aquatic organisms are performed at constant temperatures forecasted as optimal.

O. niloticus fish exposed in this research to high temperatures showed nervous manifestation which began mild at (30˚C) and reached maximum at (36˚C). This agreed with ***Sherif and Soaad (2013)*** who proved that fish subjected to temperature 35˚C showed off food, emaciation, nervous manifestation and erratic movement. Moreover, ***Zakia et al. (2007)*** proved that *Oreochromis niloticus* at 33 ˚C showed surface swimming and grouping at the corner. While at 37 – 40 ˚C they exerted mouth breath due to decreased dissolved oxygen with increased opercular movement and hemorrhage on the whole body.

There is an inverse relation between water temperature and the dissolved oxygen in the waters, ***Malini et al., (2018)***, therefore the higher the temperature will lead to a lower oxygen solubility rate.

Dissolved oxygen decreased with increasing temperature ***Zvavahera et al., (2018)*** thus if dissolved oxygen concentration in Tilapia decreased than 3mg /l it exerts stress accompanied with fish mortalities. They added that solubility of oxygen in fish ponds decreased as temperature increased. Thus the researcher used to measure daily dissolved oxygen and adjust it through increasing aerators.

Jeremy et al. (1996) showed that survival rate of *Oreochromis niloticus* at 32˚C was non-significant, whereas ***Baras et al. (2001)*** registered survival rate at 37 ˚C ranged from 41.9 % - 74 % of Nile tilapia reared at 27 – 33 ˚C. Also, ***Pandit and Nakamura (2010)*** proved that survival rate of Nile tilapia was reduced at 35˚C and 37˚C. ***Khater et al. (2017)*** had registered mortality rates 14.09 % and 14.28 % at water temperature 30˚C and 35˚C respectively in Nile tilapia after one-week exposure which increased with increase of exposure period. This was on contrary with this study where survival rate at 30˚C was 80 % which decreased slightly at 36˚C to become 60 %. Thus, survival rate of males *Oreochromis niloticus* decreased with temperature increase.

Jeremy et al. (1996) showed that K condition of

Oreochromis niloticus at 28˚C and 32˚C was highly significant than that at 24˚C.

Jin et al. (2015) presented K values as a parameter to estimate the characteristics of fish body structures. Moreover, condition factor (K) of a fish as per ***Datta et al. (2013)*** reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors. This also indicates the changes in food reserves and therefore an indicator of the general fish condition. Therefore, information on condition factor can be vital to culture system management because they provide the producer with information of the specific condition under which organisms are developing.

Getso et al. (2017) added that condition factor is an index reflecting interaction between biotic and abiotic factors in the physiological conditions of fishes. The K condition as the wellbeing of the species influenced by different biological and environmental factors. It provides information about the growth pattern, general health, habitat conditions, life history, fish fatness and condition, as well as morphological characteristics of the fish, ***Jisr et al. (2018)***.

In this study, K condition factor of experimented males *Oreochromis niloticus* registered a highly significant increase only at 33˚C which might be referred to Getso ***et al. (2017)*** opinion that the highest K values are reached in species if the fish is fully mature, and have higher reproductive potentiality.

Jeremy et al. (1996) showed that body weight of *Oreochromis niloticus* at 28˚C was significantly decreased than that at 24˚C. In addition, ***Zakia et al. (2007)*** had proved that body weight of *Oreochromis niloticus* decreased significantly with temperature increase. Consequently, body weight (B.W.) registered highly significant drop among the three experimented water temperatures.

On the contrary, ***Khater et al. (2017)*** proved that body weight of Nile tilapia fry increased with the water temperature increase which was in agreement with survey group where B.W. registered highly significant increase at 36˚C compared to control survey group.

Liver weight (W.H.) showed highly significant decrease among the three experimented water temperatures which was approved by multiple degrees of necrosis in the hepato-pancreatic duct.

In the survey group the mild congestion in hepatic blood vessels or swollen hepatic cells appeared in accordance with the highly significant increase in the W.H. as well as the highly significant decrease in total protein.

Sperm density and sperm live % registered highly significant decrease. Primary reproductive investment is represented by gonadal weight and gonado-somatic index which is an indicator of somatic and reproductive measurement of mature fish, ***Malavasi et al. (2004).***

Also**, *Al – Deghayem et al. (2017)*** proved that gonadosomatic index (Ig) of *Clarias gariepinus* decreased in males at 28˚C and 32˚C which appeared the contrary in the survey group where the gonado somatic index (Ig) highly significant increased.

Influenced by ***Sun and Pankhurst (2004)*** opinion, the researcher in this study found the highly significant drop in body weight (B.W) and its relative fecundity (F.B.W) in the three experimented degrees of water temperature a logic explanation for the mobilization of a great portion of energy in reproductive performance forming an interaction between fish growth and reproduction.

Male *O. niloticus* exposed to 30˚C, 33˚C and 36˚C water temperature showed highly significant drop in body weight (B.W) and its relative fecundity (FBW). Similarly, the sperm density in both groups recorded highly significant drop which was approved by the presence of small foccal areas of necrosis with malformation and distortion of architecture of seminiferous tubules (plate 1 a) together with degenerative changes in some interstitial cells (plate 1 b). In addition, the effect of 36˚C water temperature showed much more severity compared to others. The highly significant drop (which reached in some fish zero) sperm density as well as their living percent were assisted by testis showing seminiferous tubules appeared lucent and nearly free of sperms indicating lack of active spermatogenisis (plate 1 c), (plate 2 b, d).

Concerning the survey group, males proved a correlation between increase in water temperature and significant increase in both fish body weight (B.L), gonads weight (Wg) and accordingly the fecundity related to body weight (F.B.L) and gonadal weight (FOW). Pathological examination of testis proved that oedema was pronounced in between semineferous tubules (plate 2 c) which also lead to burst of them (plate 3 a) while in others testis semineferous tubules were in the form of cystic formation (plate 3 b) . This might be opposite to ***Mahmoud and Allam (2002)*** who proved a negative correlation between fish gonads and their body length.

Proteins are involved in the architecture and physiology of the cell and in cell metabolism. Blood serum proteins were defined by ***Moustafa (1999)*** to be a fairly biochemical system, precisely reflecting the condition of the organism and its physiology under the influence of internal and external changes.

Zeynep et al. (2017) showed increase total protein in Black sea trout due to acute thermal stress. Thermal stress is associated with heat shock protein, ***Nadirah et al. (2017)***. They added that total protein of red hybrid tilapia slight decreased with increased degree and exposure duration to thermal stress. In agreement, in this study, total protein levels registered highly significant drop among both sexes in the experimental temperature degrees as well as survey. This was approved with ***Lucas et al. (2019)*** who had registered the lowest value for total plasma protein in females *Lophiosilurus alexandri* at 29˚C.

This result at 30˚C and 33˚C degrees of water temperature was attributed to the pathological changes which appeared in the liver. The hepatic cells appeared swollen with clean cytoplasm, their nuclei near wall of affected cells (vacuolar degeneration) as (plate 4 a, b). Other slides showed mild congestion in hepatic blood vessels and sinusoids (plate 5 a, b).

At 36˚C degree of water temperature some liver showed hyperplasia of bile duct with collongitis beside aggregation of melanomacrophage cells in hepatic parenchyma (plate 6 b). Others showed congestion in hepatic blood vessels with hemolysed blood (plate 5 d).

In some examined samples of survey group hepatic appeared vacuolar with ruptured hepatic wall showing aphthae formation (plate 4 c) or hepatic cells appeared in the form of adenoid formation (plate 4 d).

Concerning the male survey group, Albumin in fish involves in plastic metabolism and plays an important role in transport functions of exogenous chemicals and endogenous metabolites ***Kovyrshina and Rudneva (2012).*** Thus, albumin determination in fish plasma or serum is considerable diagnostic tool which reflects the health of the animal, liver function, metabolic status and stress conditions. They added that their studies have been shown that fish physiological status, age, season and habitats influenced on serum protein properties, especially albumin.

According to ***Andreeva (2010)*** seasonal dynamics of blood albumin level had a feedback relation with the protein synthesizing activity of hepatocytes. This is assisted by the hepatopancreatic duct showing multiple degrees of necrosis (plate 5 c).

Baker (2002) had proved that Albumin binds and transports steroid hormones, including sex hormones.

The survey group recorded highly significant increase in albumin level. This could be explained according to ***Baker (2002)*** by the induction of albumin synthesis in spawning time because it plays an important role in transport function of various components needed for gonads formation. In addition, it was marked that at the period of fish maturation and reproduction the physical and chemical properties of albumin including electrophoretic mobility were changed.

The author found the seasonal factor a second explanation for the albumin increase in survey group which was collected in summer season according to ***Kovyrshina and Rudneva (2012)*** who proved that albumin concentration was significantly higher in fish caught in summer. Under the condition of stress, ***Ray and Sinha (2014)*** proved that fish body immediate responses recognized as primary and secondary responses. Secondary responses occur as a consequence of the released stress hormone, causing changes in the blood and tissue chemistry e.g. an increase in plasma glucose.

This entire metabolic pathway produces a burst of energy to prepare the fish for an emergency situation. ***Biswas et al. (2002)*** reported increase glucose level in red sea bream accompanied with increased water temperature. While ***Zaragoza et al. (2008)*** defined glucose as a good indicator for thermal stress which was altered in Oreochromis mossambicus acclimated at 24 ˚C, 28˚C and 32˚C.

Sherif & Soad (2013) claimed that under stress, fish rapidly consume glucose as the main function of the central nervous system is maintaining hemostasis and with peak activity of fish, glucose increase by almost 30 - fold. ***Nakanon et al. (2014)*** found that increased temperature caused increased glucose level in Salmon. In stress blood glucose is elevated as a result of both glycogenolysis and gluconeogenesis, ***Ray and Sinha (2014).***

Moreover, ***Rebl et al. (2018)*** had proved that acute temperature rise resulted in slight increase in glucose level. In accordance, this study explained the highly significant increase of glucose level in males *O. niloticus* at 33˚C and 36˚C water temperatures as well as survey group as a secondary physiological response for energy use which is involved in innate defense mechanism according to ***Zeynep et al. (2017).***

Reproduction in fish is hormonal regulation whereas the main hormones are gonadotropins and gonadal steroids including androgens (Testosterone and its derivatives) and estrogens (estradiol and its derivatives) secreted from gonads ***Sulistyo et al. (2000).*** They specified steroids role for spermatogenesis and spermiation in males and oogenesis to final oocyte maturation in females.

Tang et al. (2017) had defined Estrogen receptors are expressed in male fish, and the testis is one major site of expression, suggesting that estrogens are involved in regulating reproduction in males. The plasma levels of 17β-estradiol (one of the natural estrogens in vertebrates) increase at the beginning of the reproductive cycle in teleosts. Furthermore, 17β-estradiol has been implicated in the later stages of spermatogenesis. Taken together, these findings indicate that estrogens are an indispensable male hormone that plays an important role in male reproduction in fish. This was the explanation for the highly significant drop in estradiol level in males at the three experimented degrees of water temperature together with the survey group. This was also assisted with some testis showing with abnormal sperms (plate 2 a).

Throughout the three increased experimented degrees of water temperature as well as survey group fish registered highly significant increase in testosterone (T) level which was approved by ***Taghizadeh et al. (2013)*** who observed the highest testosterone level in summer season, and this increase could be associated with the increase in the water temperature which occurs at the summer season. Temperature appears to be a possible cue causing testosterone to peak which leads to the gonads, and subsequently their gametes, reaching reproductive maturity.

In males ***Maheswarudu et al. (2015)*** had proved that testosterone enhances reproductive performance.

Lucas et al. (2019) also proved that testosterone hormone decreased to the lowest value in *Lophiosilurus alexandri* at 29˚C. On the contrary, this study revealed that Testosterone level increased highly significant throughout the three experimented degrees and the survey group.

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تأثير تقلبات درجة حرارة المياه علي الحالة الصحية والتكاثر في ذكور البلطي النيلي

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في هذه الدراسة تم الكشف عن تأثير أرتفاع درجة حرارة المياة على ذكور اسماك البلطى النيلي المستزرعة و أسماك البلطى النيلي من مياه النيل فى الدراسة الاستقصائية
100سمكه بلطي نيلي من الذكور جمعت من مزارع خاصة بوادى النطرون لأجراء التجربة مجموعة ضابطة فى درجة حرارة الغرفة و3 مجموعات اخري فيها درجة حرارة المياة 30 و33 و 36 لمدة اسبوعين .وتجميع 50 سمكة من الذكور للدراسة الاستقصائية من المنيب عند درجة حرارة المياه 2±27 و C ° 36 لفحص عوامل النمو و الخصوبة و الفحص الكيميائى.
- اثبت الفحص الظاهري ظهورعلامات عصبية على السمك وعدم القدرة علي التنفس والحركة بطريقة غير طبيعية و صبغات و تقرحات على الجلد مع وتساقط القشور و وتأكل في الذيل.
- وقد تبين من الصفة التشريحية وجود احتقان في المناسل مع وجود عدم تماثل في الطول للخصية و أصبحت مثل الخيط .
- سجل الذكور فى وزن الجسم و وزن الكبد و الخصوبة المتعلقة بوزن الجسم و أوزان المناسل ومعامل التغير في المناسل و كثافة الحيوانات المنوية و نسبه الحيوانات المنوية الحية للحيوانات المنوية الميتة انخفاضا معنويا مقارنة بالمجموعة الضابطة.
- معامل K و الخصوبة المتعلقة بوزن المناسل فقد أعطت أرتفاعا معنويا عند درجة حرارة 33 مقارنة بالمجموعة الضابطة.

الدراسة الاستقصائية للذكورسجل طول الجسم وزن الجسم و وزن الكبد و وزن المناسل ومعامل التغير في المناسل والخصوبة المتعلقة بالطول والخصوبة المتعلقة بالوزن والخصوبة المتعلقة بوزن المناسل ارتفاعا معنويا بينما فى كثافة الحيوانات المنوية و نسبه الحيوانات المنوية الحية للحيوانات المنوية الميتة فقد أظهرت انخفاضا معنويا فى جميع درجات حرارة التجربة مقارنة بالمجموعة الضابطة.
الفحص الكيميائى - إن نسبه البروتين الكلى والجلوبيولين و الاستراديول قد سجلت انخفاضا معنويا في الذكور ماعدا درجة حرارة 36 مقارنة بالمجموعة الضابطة

- الجلوكوز و التستستيرون سجل ارتفاعا معنويا فى الذكور فى جميع درجات حرارة التجربة و الدراسة الاستقصائية

-أوضح الفحص الهستولوجى للخصيه وجود مساحات من النكرزه وتحلل جوفي للقنوات سيمينفرس. كما ظهرت بعض هذه القنيات خيطيه وذلك لخلوها من الحيوانات المنويه. أيضا لوحظ اوديما بين قنوات سيمينفرس مع وجود حيوانات منويه بأشكال غير مكتملة النمو (رأس بدون ذيل او ذيل بدون رأس)و للكبد أوضح تضخم في الخلايا الكبديه مع تحلل فجوي لبعض الخلايا ووجود النواه ملاصقه لجدار الخليه. كذلك وجود درجات مضاعفه من النكرزه في القناه بين الكبد والبنكرياس.