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# Drastic parasitic infestations among cultured tilapias at El- Abbassa fish farms, Egypt, with respect to stressors of abiotic factors

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**ABSTRACT**

The Egyptian expansion in fish aquaculture requests betterment in fish health management systems. This study was carried out to investigate the infestation prevalence of gill and skin parasites infecting the farmed tilapias at El-Abbassa fish farms with respect to abiotic factors. Water physicochemical parameters of culturing ponds were analyzed seasonally from March 2020 to February 2021. Results demonstrated that water quality measurements of fishponds were within normal values that cultured tilapia species can tolerate. Parasitological examinations of four different farmed tilapia species revealed critical parasitic infestations with *Chilodonella hexasticha* (Ciliate), *Cichlidogyrus tilapiae* (Monogenea) in addition to *Lernaea elegans* and *Lamproglena monody* (Copepoda). Detailed morphological characteristics and symptoms of infestations of the four parasites were mentioned. The highest prevalence of *C. hexasticha* (71.4%) infecting *T. zillii* was recorded during winter, while the highest percentage (100%) of *C. tilapiae* infesting *O. niloticus*, *O. aureus* and *S. galilaeus* was recorded during spring. Finally, the highest prevalence of the crustacean parasitic copepods (100%) infecting *O. niloticus*, *T. zillii*, and *S. galilaeus* was reported during autumn. The total parasitic infestation rates were superior during summer while their minimal levels were recorded during winter, autumn, and spring, respectively. The intimate relationship between the intensity of infection with the monogenean gill parasite *C. tilapiae* and seasonal physicochemical parameters (temperature, dissolved oxygen, pH, nitrites, nitrates, visibility, total hardness, total alkalinity, salinity, total ammonia and unionized ammonia) were discussed briefly.

## INTRODUCTION

Fish diseases are closely related to environmental exertion and the aquatic environment includes a diversity of features that influence maintenance of homeostasis **(Roberts, 2012)**. Pollutants and intensive fish aquaculture cause stressful environmental alterations on farmed fish, in a way that decrease their resistance and result in the privation of parasitic infestations (**Rottman *et al*., 1992**; **Lio-po & Lim, 2002; Green & Haukenes, 2015**). Fish parasites cause serious economic losses in aquaculture as a result of weight losses, malformations and high mortality rates **(Eissa, 2002)**. Fish diseases account up to forty percent of missing aquaculture production **(Bastos *et al.*, 2017a)**. Considerably, the tilapia fish has been classified as disease resistant with a minimal existence of pathogenic organisms (**Lamtane, 2008**). Tilapias are globally important cultured fish in the world, that have been introduced to about 140 countries and considered as worldwide invasive species and transmitting their parasites everywhere (**Deines *et al.*, 2016 ; Shuai *et al.*, 2019)**. Chilodonelids are ciliated protozoa found worldwide and can be serious to aquaculture **(Jee *et al.*, 1996 ; Pádua *et al.*, 2013)** on invertebrate **(Das, 2003)** and vertebrate hosts **(El-Tantawy & El- Sherbiny, 2010)**. *Chilodonella hexasticha* and *C. piscicola* caused diseases and economic losses in fishes globally **(Bastos *et al.*, 2017c).** *Cichlidogyrus* (Ancyrocephalinae) are monogenean ectoparasites infesting the gills of many cichlid fishes **(Antoine & Louis, 1995)**. About 71 species of Cichlidogyrus have been introduced globally with their particular tilapias **(Shuai *et al.*, 2019)**. The trematods, *C. tilapiae* and *C. sclerosus* were reported to invade fish farms in many African countries such as Ghana **(Paperna, 1965)**, Uganda **(Paperna, & Thurston, 1969; Akoll *et al.*, 2012)**, Egypt **(Ergens, 1981)**, Zimbabwe **(Douëllou, 1993)**, Burkina Faso, Cameroon, Guinea, Niger **(Pariselle *et al.*, 2003)** and in Senegal and Congo, **(Rehulkova *et al.*, 2013)**. Lernaeidae is the major family of cyclopoid parasitic copepods comprising ten genera and *Lamproglena* and *Lernaea* constituting about 77 percent of this family **(Ho, 1984)**. Members of this family considered as mischievous parasites of fresh water cultured fishes **(Ho and Kim, 1997)**. The genus *Lamproglena* is typically gill parasites of freshwater fish and they have the capability to cause dramatic fish losses in aquaculture **(Öktener *et al.*, 2008)**.The crustacean copepod *Lamproglena monody* is reported to infest fish gills of family Cichlidae in Egypt, Congo, Zimbabwe, Namibia and Uganda **(Hassan *et al.*, 2013)**. *Lamproglena pulchella* was detected in the Black Sea, the Caspian Sea, the Aral Sea, and some rivers in Turkey, France, Germany **(Saglam, 1998)** and Italy **(Boni *et al.*, 1992; Galli *et al.*, 2001)**. Lernaeasis in farmed warm water fishes was a major problem of this industry in Iran **(Reza, 2014)**. The heteroxenous parasites must have suitable environmental conditions especially for their free-living developmental stages **(Mackenzie, 1999)**. On the other hand, monoxenous parasites with direct life cycle are less affected by environmental stressors **(Pérez-del Olmo *et al.*, 2007)**. Altering the environmental conditions and intrusion of some new fish species produced changes in parasitic communities within Victoria Lake, Kenya **(Outa *et al.*, 2021)**. The present study was conducted to investigate the prevailing of gill and skin parasites infesting four different species of cultured tilapias, in relation to some stressful ecological factors, at El-Abbassa fish farms.

## MATERIALS AND METHODS

### Fishes

Seasonally, a total number of 486 of tilapia species, 154 *Oreochromis niloticus*, 128 *Oreochromis aureus*, 86 *Tilapia zillii* and 118 *Sarotherodon galilaeus* with different body weights were randomly collected from El-Abbassa fish farms, Sharkia Governorate starting from March 2020 to February 2021. The collected specimens were transported as quickly as possible to the lab. in plastic bags partially filled with its natural water. Fish were subjected to clinical and parasitological examinations precisely.

### Water samples

Water samples were collected seasonally using a vertical water sampler from different sites and depths of El-Abbassa fish farms. Measurements of temperature, dissolved oxygen, pH, nitrites, nitrates, visibility, total hardiness, total alkalinity, salinity, total ammonia and unionized ammonia were carried out according to the method of **Boyed (1990).**

### Parasitological examinations

Investigation of the ectoparasitic ciliates occurred by mucus scrapings of the skin and gills on glass slides. Slides containing parasites were air-dried, stained with Giemsa or impregnated with 2% silver nitrate for 8 min. and were inspected by optical microscopy **(Klein, 1958)**. Gills, skin, fins and bronchial chambers of the tilapias were examined using magnified lens to detect parasitic trematodes and copepods. The isolated specimens were preserved immediately in 4% formalin, rinsed in water, kept in 70% alcohol for 24 hours before clearing in 85% lactic acid for microscopical examination **(Lucky, 1977)**. Isolated parasites were identified according to **Yamaguti (1963)**.

### Statistical analysis

Statistical analysis was carried out using the SPSS version 20(SPSS, Richmond, VA, USA) as described by **Dytham (2011)**. One-way ANOVA was used to compare the values of physicochemical parameters. Significant differences at $P < 0.05$ were performed using Duncan test as a post-hoc test. Data were represented as means ± SD.

## RESULTS

### 1- Identification of isolated skin and gill parasites

Morphological and parasitological examinations were carried out on 486 tilapia species (*O. niloticus*, *O. aureus*, *T. zillii* and *S. galilaeus* ) collected from El- Abbassa fish farms in Egypt. The isolated skin and gill parasites were identified as *Chilodonella hexasticha*, Kiernik, 1909 (Protozoa: Ciliata); *Cichlidogyrus tilapiae*, Paperna and Lahav, 1971 (Monogenea); *Lernaea elegans* Kabata, 1985 and *Lamproglena monody*, Yamaguti, 1939(Copepoda).

## 2- Morphological characteristics of the isolated parasites

### 2.1. Chilodonilla hexasticha

Findings revealed that the gill parasitic ciliate *C. hexasticha* (Family: Chilodonelidae) has an ovate and flattened body almost attached to the host gill filaments. Its length reaches about 50-70 µm and has a characteristic peculiar gliding movement. The macro- and micronuclei of *C. hexasticha* were oval- shaped and situated posteriorly. The chromatin materials of macronuclei are feeble while in micronuclei they are granular. The bottom surface of this ciliate is flattened, while its upper surface was slightly convex. The cytoplasm is granulated and comprises a single large anterior contractile vacuole (Plate 1, A1 and A 2).

### 2.2. Cichlidogyrus tilapiae

Separated infestations with *C. hexasticha* were observed accompanying the presence of the monogenian gill parasite *Cichlidogyrus tilapiae* (family: Ancyrocephalidae). Those ectoparasites were attached to gill filaments of the examined tilapias of El- Abbassa fish farms. The body of the adult flock is elongated with a total length of 0.5 mm and body width of 0.15 mm. A well-developed buccal sucker or prohaptor is noticeably located anteriorly to insure firmly attachment of the parasite with gills of the host fish. Two pairs of eyes are located dorsally in front of the muscular pharynx. The pharynx is followed by two lateral intestinal caeca which are united posteriorly. A large copulatory organ is located posterior to the pharynx. The opisthaptor is found posteriorly and is provided with many anchoring hooklets (Plate 1, B1 and B2).

### 2.3. Lernaea elegans

Females of the crustacean copepod *L. elegans* are characterized by an inserting anchor usually embedded in the gill, fins or body tissues of host fishes for feeding. The length of adult female may reach up to 8 mm and can be seen easily by the naked eye. It has a small globular cephalothorax which contains the mouth. A well-developed anchor is formed of four arms (two bifurcate dorsal processes and two simple ventral processes) and found on the cephalothorax of the $10^{th}$ free copepodid stages. The trunk of late copepodid stages (infective stage) carries four pairs of legs. The abdomen of adult ovigorous female is small and carries two lateral ovisacs that project behind the body taking Y-shaped appearance (Plate 2, k). The life cycle of *L. elegans* includes 3 free-living naupliar stages, 5 copepodid stages located on fish skin and an adult stage. The late copepodid stage of female (infective stage) clings to a fish host (Plate 1. C), while the male is free-living and dies after copulation. The anchor of cyclopoid female is inserted within the skin of the host and differentiates into an unsegmented adult (Plate 2. a - k).

### 2.4. Lamproglena monody

*L. monodi* is a highly modified copepod found clinging to the gill arches and gill filaments of the tilapias. Mature females are parasitic while males are free-living. The female has an elongated slender body about 3. 5 mm length and its head is fused to the first thoracic segment forming the cephalothorax. The cephalothorax is anteriorly broad and posteriorly cylindrical. The head is unsegmented carrying a pair of antennae which are three segmented, uniramous and provided with many sensory setae. A pair of uniramous antennules is formed of two segments and is stocked with sensory setae. The thorax is flattened dorsally and consisted of three poorly marked segments. The trunk is the broadest region and is provided with four pairs of swimming biramous legs. The abdomen is slender, 1.2 mm in length, formed of three equal segments and terminated with uropods. The caudal ramus is forked. Eggs are arranged in uniserial sequence within two elongated lateral ovisacs extending posteriorly and containing a sequence of about 30 grayish eggs (Plate 1. D).

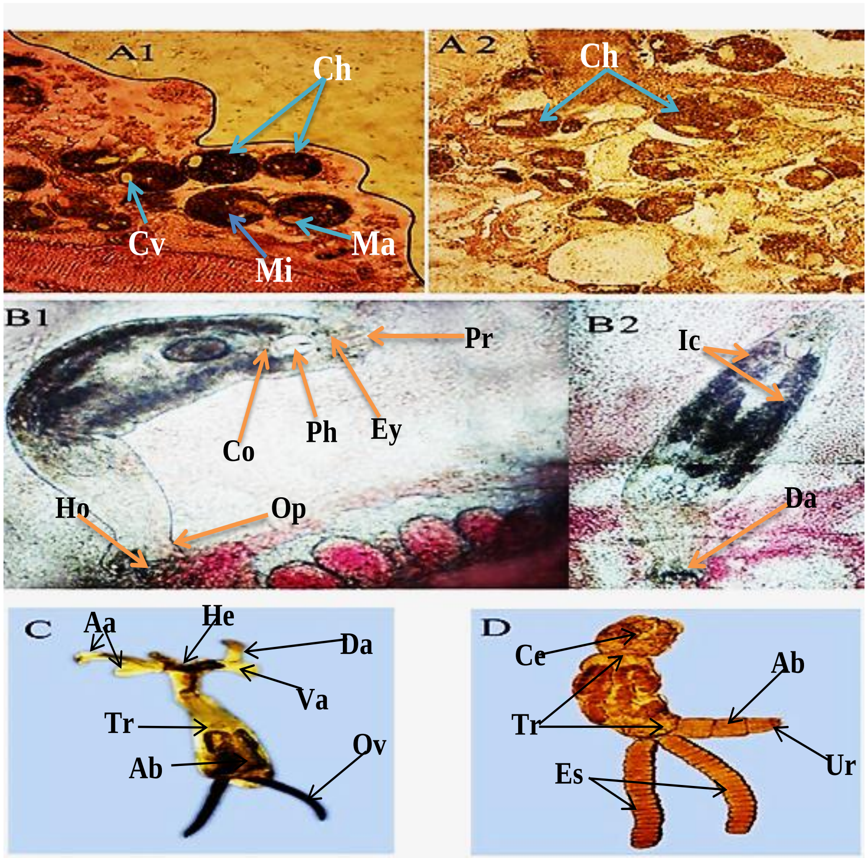


**Plate (1):** Photomicrographs showing mature stages of gill and skin parasites infesting tilapia collected from El-Abbassa fish farms. **(A1& A2):** heavy infestations of *Chilodonella hexasticha* on gills of *T. zillii* and *S. galilaeus* respectively (X 100). *Ch: C. hexasticha; Cv: Contractile vacuole; Ma: Macronucleus; Mi: Micronucleus.* **(B1 & B2):** wet mounts *of Cichlidogyrus tilapia* on gills of *O. niloticus* and *O. aureus* respectively (X 100). *Co: Copulatory organ; Da: Dorsal anchor; Ey: Eye; Ho: Hooklets; Ic: Intestinal caecum; Op: Opithhaptor; Ph: Pharynx; Pr: Prohaptor.* **(C):** the infective stage of *Lernaea elegans* isolated from external body surface (base of gill cover) of *Oreochromis aureus*. (X 40). *Aa: Anchor arms; He: Head; Os: Ovisacs; Dl: Dorsal lobe arm; Tr: Trunk; Vl: Ventral lobe arm.* **(D):** *Lamproglena monodi* isolated from gills of *Oreochromis niloticus* with ovigerous sacs. (X 40). *Ab: Abdomen; Ce: Cephalothorax; Es: Egg sacs; Tr: Trunk; Ur: Uropod*.

## 3. Pathogenesis of infested tilapias:

### 3.1. Clinical signs of C. *hexasticha infestation*

Heavily infected fishes with the ciliate *C. hexasticha* suffered from flamed gill opercula, breathing difficulty (swim with their heads directed upwards) and their skin was pale and ulcerated. Extensive mucous secretions and gill lesions were observed.

## 3.2. Clinical signs of C. tilapiae infestation

Attacked fishes with the monogenean *C. tilapiae* sustained inflammation of gills combined with extensive mucous secretions and swilling of gill filaments. Hypersecretion of mucous on gill surface and irritation may lead to impairment of respiratory demands and finally ends with fish death. Severe infections cause hemorrhaging and infected fishes usually scratch their gills on rocks.

## 3.3. *Clinical signs* of L. elegans infestation

Lernaeasis is diagnosed by fibrotic nodules on the external body surface of infested fish combined with severe skin ulcers, damages of scales and hemorrhage. The anchor worm invasion caused intense inflammation leading to fatal secondary microbial infections. Large aggregations of those parasites on the gill can impair respiration and finally cause death.

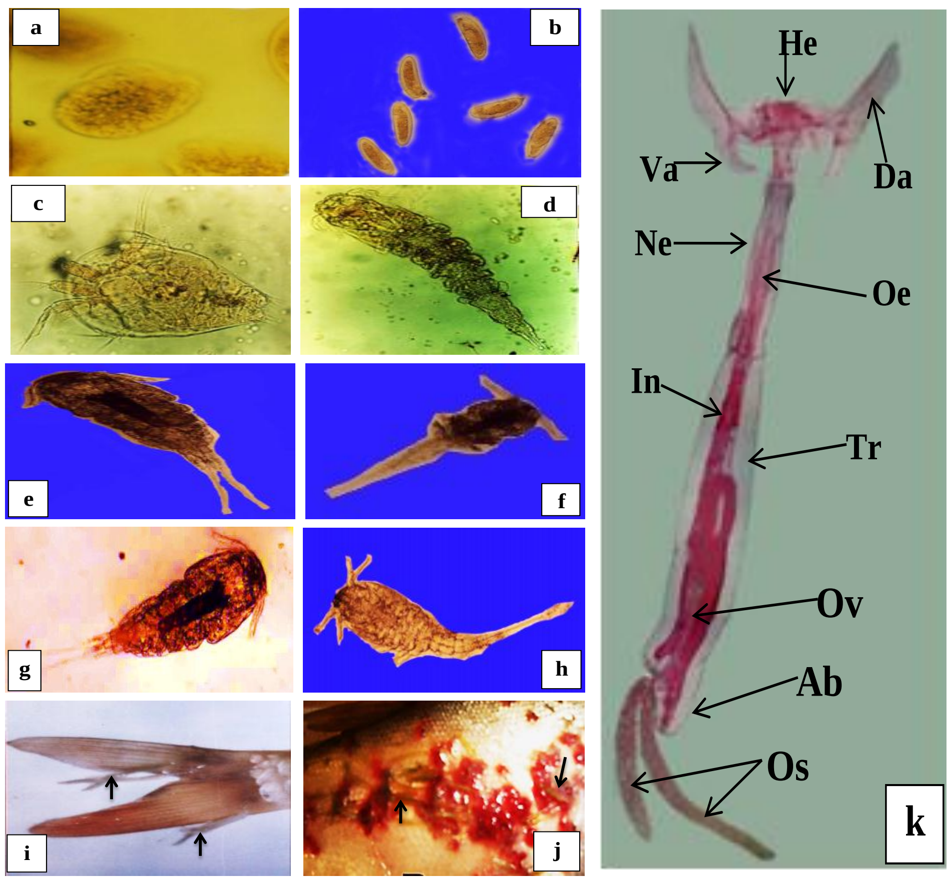


**Plate (2):** Photographs showing the different developmental stages of *Lernaea elegans*(X 100). **(a):** fertilized eggs **(b):** newly hatched nauplius stage. **(c):** well developed nauplius stages.**(d):** 1st copepodal stage **(e):** 4th copepodal stage. **(f):** 5th copepodal stage. **(g):** 9th copepodal stage. **(h):** 10th copepodal stage (infective stage). **(i & j):** Mature anchor worm inserted in the caudal fin and skin of the host fish with posterior end emerged out of the fish body.**(k)**: whole mount of adult *Lernaea elegans* (X 100). *Ab: abdomen; Da: dorsal arm; He: head ; In: intestine; Ne: neck Oe: oesophagus ; Os: ovisacs ; Ov: ovary ; Tr: trunk; Va: ventral arm.*

### 3.4. Clinical signs of L. monody infestation

Infected fishes with *L. monody* are characterized by loss of appetite, reduced respiratory ability, altered growth, blood loss and weakness of the fish hosts. Injuries and irritation as a result of infestation may act as a vector for other pathogenic microbes.

## 3. Prevalence of gill and skin parasitic infections among examined tilapia species

Table (1) shows the total prevalence of gill and skin parasites infecting different tilapias species collected from El- Abbassa fish farms from Marsh 2020 to February 2021. Low infestation percentage with the ciliate *C. hexasticha* and the crustacean copepod *L. elegans* were reported. Moderate infestations were recorded by the monogenean gill parasite *C. tilapiae* and the gill parasitic copepod *L. monody* respectively. In general, the highest total prevalence was recorded in *O. niloticus* (20.1%) followed by *S. galilaeus* (17.8%), *T. zillii* (17.4%) and *O. aureus* (17.2%) respectively.

**Table (1):** Total prevalence of gill parasites infecting different tilapias species collected from El- Abbassa fish farms from Marsh 2020 to February 2021.

| **Tilapia species** | ***O. niloticus*** | | ***O. aureus*** | | ***T. zillii*** | | ***S. galilee*** | |
|---|---|---|---|---|---|---|---|---|
| ***No. of exam. tilapias*** | ***154*** | | ***128*** | | ***86*** | | ***118*** | |
| **Parasite** | No. of infected tilapias | **%** | No. of infected tilapias | **%** | No. of infected tilapias | **%** | No. of infected tilapias | **%** |
| ***Chilodonella hexasticha*** | 0 | 0 | 1 | 0.78 | 4 | 4.7 | 3 | 2.5 |
| ***Cichlidogyrus tilapiae*** | 20 | 12.9 | 16 | 12.5 | 5 | 5.8 | 11 | 9.3 |
| ***Lernaea elegans*** | 1 | 0.65 | 1 | 0.78 | 0 | 0 | 0 | 0 |
| ***Lamproglena monody*** | 10 | 6.5 | 4 | 3.1 | 6 | 6. 9 | 7 | 5. 9 |
| ***Total*** | 31 | 20.1 | 22 | 17.2 | 15 | 17.4 | 21 | 17.8 |

## 4. Seasonal prevalence of gill parasitic infection in examined tilapia species:

**Table (2):** Seasonal prevalence of different parasitic infections among examined tilapia species.

| Seasons | *O. niloticus* | | | | *O. aureus* | | | | *T. zillii* | | | | *S. galilee* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **No. of infected** | **Protozoa** | **Monogenea** | **Crustacea** | **No. of infected** | **Protozoa** | **Monogenea** | **Crustacea** | **No. of infected** | **Protozoa** | **Monogenea** | **Crustacea** | **No. of infected** | **Protozoa** | **Monogenea** | **Crustacea** |
| Spring | 3 | 0 (0%) | 3 (100%) | 0 (0%) | 2 | 0 (0%) | 2 (100%) | 0 (0%) | 0 | 0 (0%) | 0 (0%) | 0 (0%) | 4 | 0 (0%) | 4 (100%) | 0 (0%) |
| Summer | 21 | 0 (0%) | 14 (66.7%) | 7 (33.3%) | 13 | 0 (0%) | 10 (76.9%) | 3 (23.1%) | 6 | 0 (0%) | 3 (50%) | 3 (50%) | 7 | 0 (0%) | 4 (57.1%) | 3 (42..9%) |
| Autumn | 3 | 0 (0%) | 0 (0%) | 3 (100%) | 2 | 0 (0%) | 1 (50%) | 1 (50%) | 2 | 0 (0%) | 0 (0%) | 2 (100%) | 3 | 0 (0%) | 0 (0%) | 3 (100%) |
| Winter | 4 | 0 (0%) | 3 (75%) | 1 (25%) | 5 | 1 (20%) | 3 (60%) | 1 (20%) | 7 | 4 (71.4%) | 2 (14.3%) | 1 (14.3%) | 7 | 3 (42.9%) | 3 (42.9%) | 1 (14.3%) |

Table (2) shows seasonal prevalence of gill parasitic infection in tilapia species. The highest prevalence (71.4%) of the ciliate parasite *C. hexasticha* was recorded during winter infecting *T. zillii*. The highest prevalence (100%) of *C. tilapiae* was discovered during spring infesting *O. niloticus*, *O. aureus* and *S. galilaeus*. The highest prevalence of the crustacean parasitic copepods (100%) was reported during autumn parasitizing *O, niloticus*, *T. zillii* and *S. galilaeus*. The total parasitic infection showed the maximal peak during summer while the minimal levels were recorded during winter, autumn and spring respectively.

## 5. Parasitic infestations in relation to physicochemical parameters of water

**Table (3):** Seasonal prevalence of the monogenian gill parasitic *Cichlidogyrus tilapiae* infecting tilapias in relation to physicochemical parameters.

| Seasons | *O. niloticus* | | *O. aurus* | | *T. zillii* | | *S. galilee* | | Physicochemical parameters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No of examined. | No. of infected | No. of examined. | No. of infected | No. of examined. | No. of infected | No. of examined. | No. of infected | Temp.(c) | DO mg/l | SD (cm) | pH | Salinity ppm | TAN mg/l | UIA mg/l | $NO_2$ mg/l | $NO_3$ mg/l | T.H mg/l | T.A mg/l |
| **Spring** | 41 | 3 (7.3%) | 32 | 2 (6.3%) | 20 | 0 (0%) | 37 | 4 (10.8%) | 23.23 $\pm1.21^{\mathbf{b}}$ | 6.3 $\pm0.2^{b}$ | 16.3 $\pm1.4^{b}$ | 8.7 $\pm0.4^{a}$ | 0.27 $\pm0.02^{a}$ | 0.82 $\pm0.02^{b}$ | 0.16 $\pm0.02^{b}$ | 0.016 $\pm0.002^{c}$ | 0.64 $\pm0.03^{a}$ | 163.3 $\pm9^{c}$ | 337 $\pm9^{c}$ |
| **Summer** | 41 | 21 (51.2%) | 36 | 13 (36.1%) | 16 | 6 (37.5%) | 26 | 7 (26.9%) | 27.8 $\pm0.89^{a}$ | 5.5 $\pm0.2^{c}$ | 13.7 $\pm1.8^{ab}$ | 8.7 $\pm0.3^{a}$ | 0.25 $\pm0.01^{a}$ | 1.11 $\pm0.02^{a}$ | 0.27 $\pm0.02^{a}$ | 0.022 $\pm0.002^{b}$ | 0.51 $\pm0.04^{b}$ | 197.3 $\pm6^{b}$ | 380 $\pm7^{a}$ |
| **Autumn** | 44 | 3 (6.8%) | 32 | 2 (6.3%) | 30 | 2 (6.7%) | 29 | 3 (10.3%) | 22.3 $\pm1.34^{\mathbf{b}}$ | 6.5 $\pm0.3^{b}$ | 15.3 $\pm1.4^{b}$ | 9.1 $\pm0.4^{a}$ | 0.25 $\pm0.01^{a}$ | 0.54 $\pm0.02^{c}$ | 0.18 $\pm0.01^{b}$ | 0.03 $\pm0.001^{a}$ | 0.24 $\pm0.02^{c}$ | 240 $\pm7^{a}$ | 355 $\pm5^{b}$ |
| **Winter** | 28 | 4 (14.3%) | 28 | 5 (17.9%) | 20 | 7 (35%) | 26 | 7 (26.9%) | 15.9 $\pm0.32^{c}$ | 7.4 $\pm0.4^{a}$ | 20.6 $\pm2.1^{a}$ | 9.1 $\pm0.2^{a}$ | 0.27 $\pm0.03^{a}$ | 0.56 $\pm0.02$ c | 0.13 $\pm0.01^{c}$ | 0.033 $\pm0.002^{a}$ | 0.26 $\pm0.02^{c}$ | 253.3 $\pm8^{a}$ | 306 $\pm9^{d}$ |

-Data are represented as means of 3 samples ± SD. -Mean values with different letters are significantly different at $P < 0.05$ (Two-way ANOVA and subsequent post hoc multiple comparison with Duncan's Multiple Range Test)

Data in Table (3) indicated that seasonal water temperature, dissolved oxygen, degree of transparency, total ammonia, un-ionized ammonia, nitrite, nitrate concentration, total hardness and total alkalinity concentrations showed significant differences seasonally. Furthermore, values of pH and salinity showed no significant differences. There was a strong correlation between water parameters and the incidence of infection with the monogenian gill parasite *C. tilapiae*. The highest prevalence of *C. tilapiae* ( 51.2%) occurred during summer in *O. niloticus*, (37.5%) in *T. zilli*, (36.1%) in *O. aurus* and (26.9%) in *S. galilaeus*, respectively. In addition, the lowest prevalence (0%) was recorded during spring in *T. zillii*. Results revealed also that the maximum average value of surface water temperature in the El-Abbassa fish farms was recorded during summer (27.8$^{o}$c) then decreased gradually during spring and autumn (22.3$^{o}$c) while its minimum values were recorded during winter(15.9$^{o}$c). The lowest dissolved oxygen values were recorded during summer (5.5 mg/l) while the highest value (7.4 mg/l) occurred during winter. Turbidity in El-Abbassa fish farms was elevated during winter and spring months then decreased gradually during autumn and summer, respectively. The highest pH levels were recorded during autumn and winter. The present study revealed that nitrite value was 0.016 mg/l during spring and 0.033 mg/l during winter. Concerning nitrate concentration, the lower level was recorded during autumn (0.24 mg/l) while the highest was reported during spring (0.64 mg/l). Total hardness was elevated sharply during winter then decreased gradually during autumn and summer and reached its lowest value during spring. The highest values of total hardness (253.3 mg/l) were recorded during winter and autumn (240 mg/l) while the lowest value was observed during spring(163.3 mg/l). The maximum total alkalinity value was detected during summer (380 mg/l), while its minimum value was reported during autumn (306 mg/l).

## DISCUSSION

Tilapias are important aquaculture fishes that have been introduced widely all over the world spreading their parasites to regions where they were imported **(Shuai *et al.*, 2019)**. Morphological and parasitological examinations in this study showed that the tilapias collected from El- Abbassa fish farms were infested with the ciliate *C. hexasticha*, the monogenian *C. tilapiae* in addition to the copepods *L. elegans* and *L. monody*. This study revealed that the ciliated protozoan *C. hexasticha* has flattened oval-shaped body about 50 µm with oval macro- and micronuclei situated posteriorly and single anterior contractile vacuole. In agreement with these findings, **Bastos *et al.* (2017 b)** reported the same characteristic features of *Chilodonella* and depicted also the productivity losses in over sixteen species of farmed freshwater fishes in more than fourteen countries. Similarly, massive *C. hexasticha* infestation resulted in mortality in aquaculture of yellowtail tetra *Astyanax lacustris* **(Ramos *et al.*, 2019)**. The monogenean *C. tilapiae* has elongated body, well-developed prohaptor, two pairs of eyes and muscular pharynx. The pharynx is followed by two lateral intestinal caeca which are united posteriorly and an opisthaptor provided with many anchoring hooklets. The two haptors act as suckers for anchoring the gills of the fish host. Contrarily, **Morsy *et al (*2012)** reported that, this species is characterized by 4 pairs of eyes and large copulatory organ with a slightly long ejaculatory tube. The exotic monogenean *C. tilapiae* was recorded in all waters of Africa, Near East and Southeast Asia **(Batra, 1984)**. The monogeneans genera such as *Cichlidogyrus, Gyrodactylus* and *Dactylogyrus*, infested a number of farmed fishes and caused serious economic losses **(Marzouk *et al.*, 2013)**. The highly modified parasitic copepod *L. elegans* female has a small globular cephalothorax, well-developed anchor formed of four arms, and trunk carries four pairs of legs and small abdomen carrying two egg sacs. These findings are in agreement with those of **Hossain *et al.* (2018)**. The copepod *L. monodi* was found clinging on the gill arch and has an elongated slender body, the head is unsegmented, antennae consists of three segments while the antennules are formed of two segments, the trunk is provided with four pairs of swimming biramous legs and eggs are arranged in uniserial sequence in two elongated ovisacs. These results coincide with those of **Ibrahim and Izawa (2000)**, **Elsaied and Elsheikha (2009)**, **Hassan *et al.* (2013)** and **Fahmy *et al.* (2019)**. Clinical examinations of the infested tilapias in this study showed clearly that heavily infected tilapias by *C. hexasticha* suffered from flamed gill opercula, breathing difficulty and extensive mucous secretions. In accordance, infected farmed *O. niloticus* in Brazil exhibited skin ulceration, excessive mucus production and gill lesions (**Padua *et al*., 2013)**. Additionally, infected tilapias with the monogenian gill ectoparasite *C. tilapiae* were manifested by inflamed gills with extensive mucous secretions and swilling of gill filaments (**Ho & Kim, 1997**). Lernaeosis in the present study is diagnosed by fibrotic nodules on the external body surface of infested fish combined with severe skin ulcers, damages of scales and hemorrhage while infected fishes with *L. monody* reduced appetite and were detected with severe injuries **(El-Shaer, 2008 ; Hossain *et al* ., 2013)**. In Burkina Faso *L. monodi,* caused mechanical damages and negative physiological consequences in *O. niloticus* **(Boungou *et al*., 2013; Furtado et al., 2019)**. Low infestation percentage with *C. hexasticha* and *L. elegans* were reported, while moderate infestations were recorded by *C. tilapiae* and *L. monody.* Low infestations among the tilapias may be due to the efficient immune mechanisms exerted by fishes against infection such as mucus secretions, skin, scales and inflammatory responses that prevent parasites from invading their bodies. Tilapias have been reported as disease resistant (**Lamtane, 2008**). Some sugar related chemical substances existing in fish epithelium may induce the attachment of the monogenean *Benedenia seriolae* **(Yoshinaga *et al*., 2002)**. The lowest rates of infection observed in *O. aureus* may be due to the short period needed to reach maturity. Environmental conditions have efficient effects on parasitism **(Eissa *et al*., 2011; Shehata *et al*., 2018)**. The present study showed the seasonal prevalence of examined gill and skin parasites infecting the tilapias, and the maximal peak of total infections occurred during summer, while the minimal value was recorded during winter, autumn and spring respectively. These findings were supported by **Saha *et al.* (1995)** and **El Seify *et al*. (1997)**. The variation in prevalence could be related to the susceptibility of the fish host to infection, water pollutants and the suitable water temperature degrees. Contrarily, **Martins *et al.* (2010)** reported that, the hot season is the less favorable for copepod infestations. The prevalence of infection was higher in dry season than in rainy ones, and this may be due to eutrophication, which increases parasitism because of productivity increments that may increase the abundance of invertebrate intermediate hosts **(Lafferty & Kuris, 1999)**. In accordance, the highest prevalence of *L. cyprinacea* infestations found in major carps, minor barbs, catfish and perches were detected from January to March, while the lowest prevalence was recorded during April-June **( Hossain *et al*., 2018)**. The aforementioned results agree with those of **Eissa and Gharib (2005)**, who found that the more prevalent of *L. monodi* in *O. niloticus* occurred in summer followed by spring and autumn. Moreover, **M'bareck (2019)** reported that the season has a highly significant effect on parasite indices of *L. monodi* on the tilapia collected from the Senegal River while sex and weight have no significant effects. Fish diseases are widely expanded among cultured fishes due to poor understanding of farm managers of how onsets are related to seasonal changes in water physicochemical parameters**( Bastos *et al*., 2017a)**. This study indicated that there was a strong correlation between water parameters and the percentage of parasitic infections. The present findings are nearly similar to the observations detected by **Bichi and Ibrahim (2009)** and **Shehata *et al.* (2018)**. The hatching and life span of the monogenea *C. tilapiae* and *Benedenia seriolae* were temperature dependent **(Tubbs *et al.*, 2005**; **Akoll *et al.*, 2011)**. The lowest dissolved oxygen values in the present study were recorded during summer while the highest value occurred during winter. High dissolved oxygen readings during winter may be attributed to the flourishing of phytoplankton **(El-Nagaawy, 2000).** Turbidity in El-Abbassa fish farms elevated in winter and spring and gradually decreased during autumn and summer, respectively **(Osman & Kloas, 2010**). The highest pH levels were recorded during summer and spring. The present study revealed that nitrite value was during spring and winter. Concerning nitrate concentration, the lower level was recorded during autumn while the highest was reported during spring. Total hardness was elevated sharply during winter then decreased gradually during autumn and summer and reached its lowest value during spring. The highest values of total hardness were recorded during winter and autumn while the lowest value was observed during spring. The maximum total alkalinity value was detected during summer while its minimum was reported during autumn. The obtained results are similar to those of **Shehata *et al.* (2018)**. The pH values were significantly elevated, and this may be due to depletion of carbon dioxide as a result of increased photosynthetic rates. The highest values of total alkalinity (carbonate and bicarbonate) were observed during summer while the lowest values were found during spring and this may be attributed to feeding behaviour and organic fertilizers used **(Boyd & Lichtoppler, 1979)**. Increments of ammonia concentration during spring and summer may be contributed to the high stock of fish, excretion of fish and decomposition of excess feed representing another ammonia source in ponds **(Shehata *et al.*, 2018)**. In agreement with **Ashmawy *et al.* (2018)** and **Jerônimo *et al.* (2020)** the present study indicated that, there was an inverse relationship between the incidences of fish parasites and parameters of water quality.

## CONCLUSION

El- Abbassa fish farms are promising projects for culturing some economic fish species and ensuring supplementary food resources for a sector of Egyptian people. These farms received some invasive gill and skin exotic parasites with the introduction of newly cultured tilapias species. Mild infestations by *C. hexasticha*, *C. tilapiae* in addition to *L. elegans* and *L. monody* were recorded. Water physicochemical parameters of culturing ponds were within normal levels that the tilapia species can tolerate and culture. Both *S. galilaeus* and *O. niloticus* showed high resistance against parasitic infestations more than other cultured tilapias. Efforts must be carried out for controlling these deleterious parasites using environmentally safe techniques.

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