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DIFFERENT FECUNDITY RELATIONSHIPS AND GONADOSOMATIC INDEX OF *Clarias gariepinus* INFECTED WITH OVARIAN PARASITE *Myxobolus gariepinus*

Gehad A. Ismail[1] and M.S. Mohamed[2]

[1]*Fish Diseases and Management research Department, Animal Health Research Insti-tute, Agriculture Research Center, Egypt.*

[2] *Feeding Department- Central Laboratory for Aquatic Research, Agriculture Research Center, Egypt.*

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ABSTRACT

This study was conducted to screening for *Myxobolus species* infection in catfish (*Clarias gariepinus*). In addition to, study the effects of ovarian infection by *M. gareipinus* on gonadosomatic index, fecundity and different biometric parameters (ovary weight, egg weight and egg diameter) of catfish (*C. gariepinus*)About 100 fish with average body weight (653.34±3.21g) were originating alive from fish farm from Sharkia Governorate. Giemsa-stained smears of ovarian parasite indicated that, the spores were of *Myxobolus gariepinus*, with prevalence (23.33 %) of examined female fish. Gonadosomatic index (GSI), absolute fecundity and all biometric parameters of *M. gareipinus* infected fish were significantly (P<0.5) lower than those of uninfected fish. In addition to, a linear correlation between fecundity and all biometric parameters of infected females fish was non-significantly positive correlation (r>0.05). While, the linear correlations between fecundity and all biometric parameters of uninfected females fish was significantly positive correlation (r<0.05). We can concluded that, *Myxobolus gareipinus* ovarian infection decreased gonadosomatic index, fecundity and all biometric parameters of catfish (*Clarias gariepinus*). In addition to, *M. gariepinus* lower the rate of increases of the linear relationships between fecundity and all biometric parameters as compared with high rate of increases of uninfected fish. Further confirm investigations including ultrastructure and immunological studies must take place.

Keywords: *Myxobolus gareipinus*, *Clarias gariepinus*, Gonadosomatic Index, Fecundity, Egg weight, Egg diameter.

INTRODUCTION

Myxosporea with 1500 species currently known (Azevedo *et al*., 2005) are obligate parasites of aquatic vertebrates and invertebrates (Lom and Dykova 2006). They are pathogens of freshwater and marine waters where they induced economic losses due to their harm and highest possibility to weaken or to kill their hosts (Iwanowicz *et al*., 2013). The intestinal *M. heterospora* was found with a total prevalence of 42.19 and 26.57% for *Sarotherodon melanotheron* and *T. zillii* ,respectively which and induces total destruction of the intestine structure (Grankoto *et al*., 2003).

Myxosporean taxonomy is dependent on spore morphology, including spore shape, size, number and position of the polar capsules (Noga, 2005). Within the class Myxosporea, the genus Myxobolus includes approximately 900 described species (Eiras *et al*., 2005, Eiras *et al*., 2014). Most species infect specific organs, but some have been reported to infect several organs in the same host species (Folefack-Lekeufack *et al*., 2021). It is noteworthy that studies of Myxosporean infestation was not currently very frequent in fish gonads, that makes this observation more interesting (Grankoto *et al*., 2015).

Clarias gariepinus, is a popular fish species dwelling the River Nile and the interconnecting lakes. They are abundant throughout the year (Hagras, *et al*., 2001), and its. It has good taste with good meat quality with highly nutritive values (Udeze *et al*., 2012). It has been reported to be a suitable aquaculture species in Africa countries, due to, its ability to tolerate a wide range of environmental conditions and high stocking densities under culture conditions, fast growth rate, acceptability of artificial feed, and high fecundity rate among others (Eyo *et al*., 2015). *M. imami* and *M. gariepinus* were firstly described by (Abdel-Ghaffar *et al*., 1998 and Reed *et al*., 2003).

from ovary of *C. gariepinus*. Reproduction is the most critical stage in the life cycle of a species, which determines its survival and success (Al-Deghayem *et al*., 2017) Gonads are enabling the germ cell to differentiate into ripe male and female gamete (Guraya, 2000) The present study aimed to investigate the

presence of Myxosporea parasites in ovary of *Clarias gariepinus*. In addition to, study the effect of Myxobolus *gariepinus* ovarian naturally infection on fecundity of African Catfish (*Clarias gariepinus*).

MATERIALS AND METHODS

Ethics and consent:

The ethic and consent concerning the use of fish for this research were deemed unnecessary according to the Federal Institute of Industrial Research. Meanwhile, the experimental protocol including the number of fishes used for this research was approved and regulated by the Institute. In addition, all the methods were carried out in accordance with relevant guidelines.

Fish:

Hundred *Clarias gariepinus* specimens were collected from private farms of Sharkia Governorate, and transported alive to the laboratory at central laboratory of aquaculture. In the laboratory, the fish were distributed into Glass aquaria of 120-liter capacity each at a rate of 5 fishes per tank. -Differentiation of sexes were based on external features (elongated genital papilla for male and around serrated opening for female) and internal features such as gonad (Nchoutpouen et al., 2011). The following body parameters were measured for each specimen: Total length (TL : from snout to the base of the caudal fin rays), total weight (TW), ovary weight (OW). Measurements were taken to the nearest 0.1 cm and 0.1 g using measuring board for length and Metlar-2000D electronic weighing balance for weight.

Occurrence of Myxosporeans in different tissues:

Fish were examined within 24 h of capture, and fresh smears of gills, stomach, intestine, heart, liver, gonad, bone marrow, kidney, swim bladder, and gall bladder were evaluated under a differential interference contrast microscope (Leica DMLB5000, Leica Microsystems,Wetzlar, Germany) at ×1000 magnification. Samples of liver and ovaries infected with myxozoans were collected for further studies (Vieira *et al*., 2017).

Fish Examination for ovary Myxosporeans Identification:

The females of minimum size of 30cm were submitted to ovarian examination, science fish of 20 cm representing the first sexual maturity (Grankoto *et al*., 2015). Ovary examined with naked eyes, in order to investigate the plasmodia, then with stereoscopic microscope using the 10X lens to look for the cysts. Three smears were made per ovary and examined at a total magnification of 1000X with a light microscope for presence of spores. Cysts were crushed between a slide and a cover glass in a drop of distilled water and their contents were identified with the light microscope using the 100X lens.

Parasitological examination:

Spores were fixed and stained with methanol and May-Grünwald-Giemsa respectively and photographed with a digital camera (Canon Ixus brand). Myxospore morphometry was determined from fresh material. Measurements of Myxosporean species were measured with a calibrated ocular micrometer (n = 25) and taken as ranges (mean ± standard error) in micrometres (µm), according to (Lom and Dykova, 1992). Myxosporean species was morphologically identified according to the identification keys provided by (Fomena and Bouix, 1997; Upadhyay *et al*., 2012; Lom and Dykova, 2006; Eiras *et al*., 2005 and Eiras *et al*., 2014). Myxospores were also compared with recently published worldwide reports.

6-Calculation of parasite prevalence (%):prevalence was calculated according to formula given by (Upadhyay *et al*., 2012) as follows: Prevalence (%) =No. of infected fish/Total No. of fish examined ×100.

Gonado-somatic Index (GSI%):

Gonadal development was determined using the gonadosomatic index (GSI) and was calculated using the formula below:

GSI = Gonad weight (g) /Whole fish weight (g)*100 (Bolger, and Connolly, 1989).

Fecundity and Egg weight:

Absolute fecundity was determined as the product of the number of eggs in 1 g of the egg mass and total weight of the ovary (OW) (Eyo *et al*., 2015). The eggs were collected and washed in distilled water before weighing to the nearest 0.1 g. The collected eggs were preserved in Gilson fluid for 48 h for easy separation of the eggs from the ovarian tissues before estimation. The egg weight and fecundity were determined according to (Ataguba *et al*., 2013).

Measurement of oocytes diameter:

The diameters of 30 eggs (ED) per fish were measured according to protocols outlined by (Mesa *et al*., 2007) using a stereomicroscope with an ocular micrometer eye piece (Mansour *et al*., 2013).

Statistical analysis:

Statistical analysis was performed using the one way analysis of variance (ANOVA), followed by Duncan's multiple range test for comparing between *M. gariepinus* infected and uninfected females. All data were represented as mean of 10 specimens ±SE for from each area. Statistical significance was accepted at $p < 0.05$. The correlations between fecundity of catfish and their body weight, egg weight and egg diameter were calculated and the coefficient of determination (R2) and Pearson correlation coefficients (r) for these relations were determined All Statistics were carried out using Statistical analysis systems (SAS ®) program (SAS, 2009).

RESULTS

Clinical finding:

Based solely on gross observation of the fish, no signs of disease were observed.

Site of infection:

Plasmodia containing spores were found in ovaries and no detected plasmodia in the dorsal musculature, intestine, or nervous tissue from female of infected ovaries (n=46).

Prevalence and Description of plasmodia:

Out of the 60 female specimens (652.32 ±3.1g) examined, 14 (23.33 %) *Clarias gariepinus* were found infected with *Myxobolus gariepinus*. Whitish Spherical plasmodia measuring 2.1–2.8 mm in diameter, visible with naked and attached to the ovaries of the infected specimens (Fig.1-A). The intensity of these plasmodia ranged from 1 to 3 cyst/fish. The parasite is a myxosporidian that belongs to the genus Myxobolus.

Description of spores Myxobolus gariepinus:

Spore body ovoid to spherical with anterior end bluntly rounded, 13.7–14.8.0 (13.6 ± 0.04µm) long. Widest region of the spore observed towards posterior ends of polar capsules, measuring 9.8–11.0 (10.4 ± 0.05 µm). Two pyriform polar capsules of equal size converging in anterior part of spore, 5.7–6.0 (6.0 ± 0.01 µm) long × 2.9–3.4 (3.3 ± 0.03 µm) wide. Five to six coils of polar filaments in polar capsules. Intercapsular process absent. Large iodinophilous vacuole present in sporoplasm (fig.1-B).The morphological of the spores identified the parasite as a member of the genus Myxobolus, according to the classification provided by Lom and Dykova´ (2006), to enabled us to identify it as *Myxobolus gariepinus* Reed *et al*., 2003).

Phylum: Myxozoa (Grasse, 1970).

Class: Myxosporea (Butschli, 1881).

Order: Bivalvulida (Shulman, 1959).

Family: Myxobolidae (Thelohan, 1892).

Genus: Myxobolus Bütschli, 1882

Species: *Myxobolus gariepinus* (Reed *et al*., 2003)

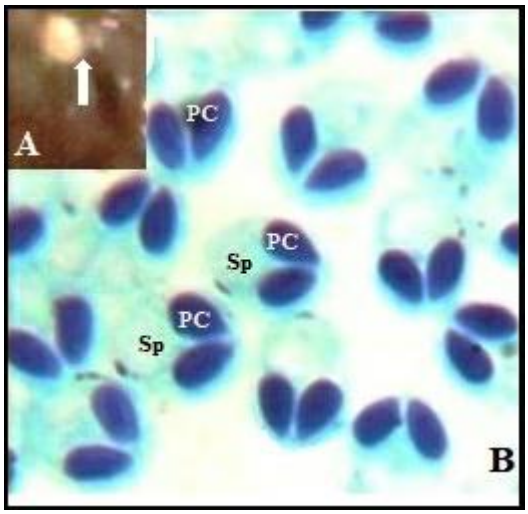


Fig. 1. Photomicrographs of plasmodia (A) and Giemsa-stained (X 1000) *Myxobolus garipinus* sp. n. (B) infecting *Clarias gariepinus*, showering parasite plasmodia (white arrow), polar capsule (PC) and sporoplasm (Sp).

Tabe. 1. Morphometry (µm) of detected *M. garipinus* sp. n. in comparison with Myxobolus species recorded in fish ovaries worldwide.

Myxobolus species	Spore		Polar capsules		Hosts
	Length (µm)	Width (µm)	Length (µm)	Width (µm)	
M. algonquinensis Xiao & Desser, 1997	14.7 (13.6–15.4)	10.9 (10.1–12.1)	5.3 (5.1–5.5)	2.7 (2.5–2.9)	*Notemigonus crysoleucas*
M. dahomeyensis Siau, 1971	12	6	4-5	-	*Synodontis ansorgii*
M. gariepinus Reed *et al*., 2003	13.9 (13.7–15.0)	10.8 (10–11.2)	6.2 (6.0–6.2)	3.5 (3.0–3.7)	*Clarias gariepinus*
M. clarii Chakravarty, 1943	11.3-12.4	10.3	6.1	3.0	*Clarias batrachus*
M. liangshanensis Ma & Zhao, 1998	9.1 (8.1–10.1)	7.9 (7.3–8.1)	5.0 (4.8–5.6)	2.8 (2.4–3.2)	*Garra pingi pingi*
M. pfeifferi Thélohan, 1895	10–13	9–12.2	5–5.7		*Barbel*
Present study	13.7–14.8.0 (13.6 ± 0.04)	9.8–11.0 (10.4± 0.05)	5.7–6.0 (6.0± 0.01)	2.9–3.4 (3.3± 0.03)	*Clarias gariepinus*

According to (Grankoto *et al*., 2015).

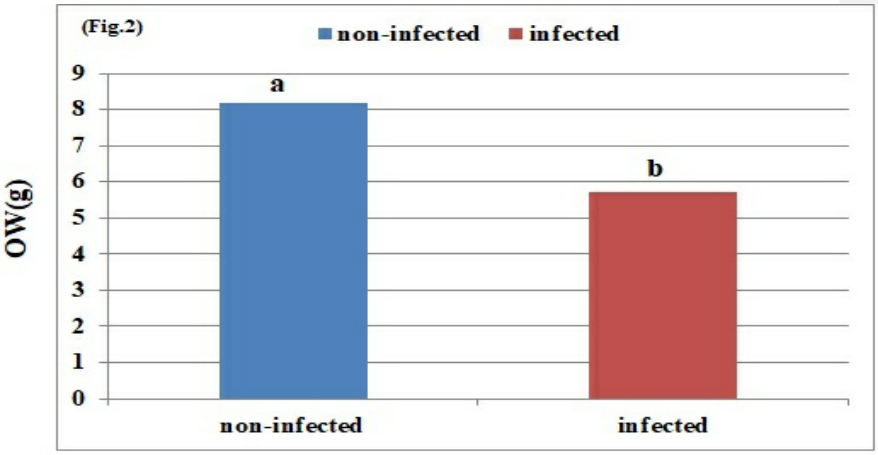
Ovary weight and Gonadosomatic index (GSI):

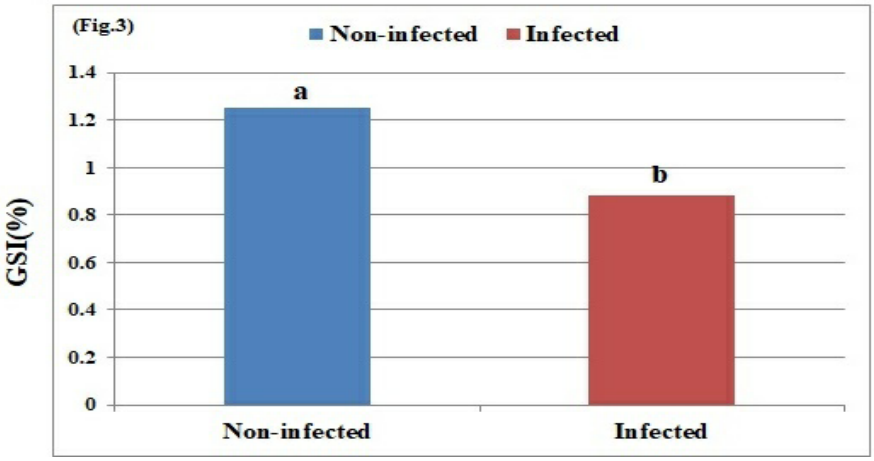
Results of the present study indicated that, *C. gariepinus* infected by *M. gariepinus* showed lower significant difference (P<0.5) of ovary weight (5.73±0.04) and GSI (0.88±0.03%) as compared with those of uninfected fish (8.17±0.03 g) and (1.25±0.01%), respectively (Figs. 2-3).

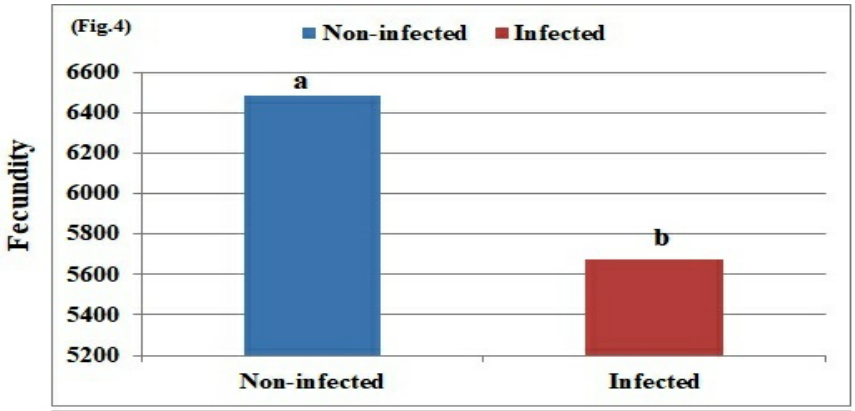
Fecundity, egg weight and egg diameter of C. gariepinus:

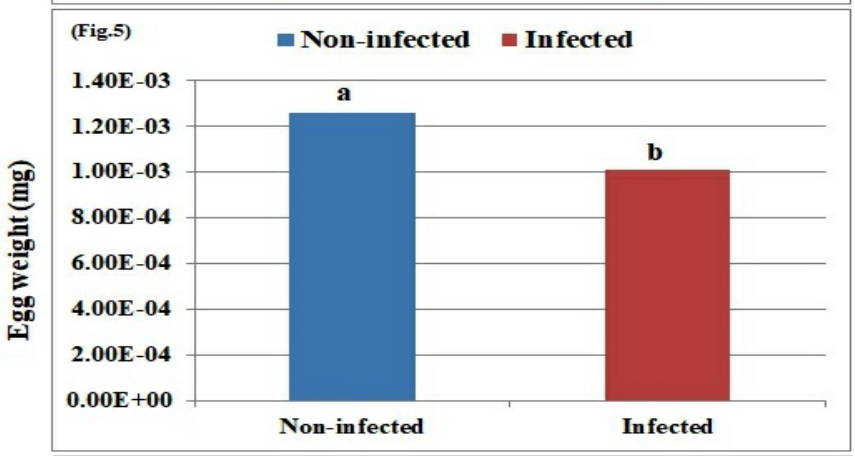
The present study showed that, fecundity (5674.95±6.12), egg weight ($1.01E^{-03}$ ±0.002mg) and egg diameter (1.12±0.01 mm) of infected *C. gariepinus* had lower significant difference (P<0.05) as compared with those of uninfected fish (6481.587±6.98) ($1.26E^{-03}$±0.001mg) and (1.55±0.02mm), respectively (Figs. 4-6).

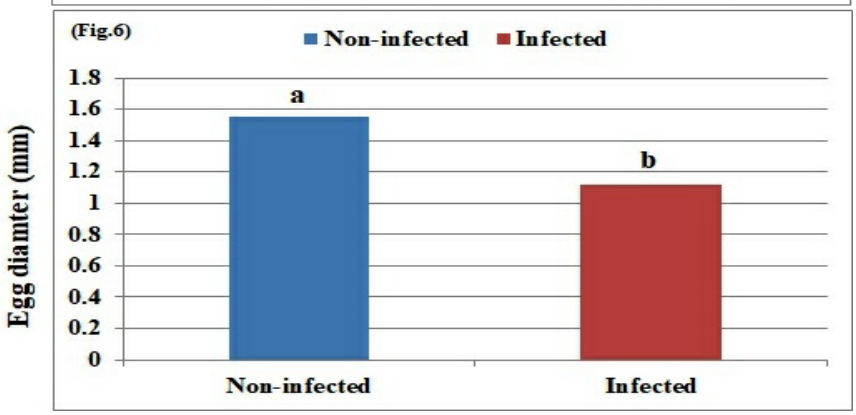
The relationship between fecundity and all biometric parameters (body weight, Egg weight, and Egg diameter) of uninfected and infected fish *C. gariepinus* are presented in Figs. 7-9. In this study, it was found that the individual fecundity of un infected female *C. gariepinus* showed a linear correlation between the fecundity and female total weight, with a significant positive correlation (r= 0.9975; P<0.05) (Fig. 7-a). It was found that the individual fecundity of infected female *C. gariepinus* showed a linear correlation between the fecundity and female total weight with non-significant positive correlation (r=0.9842; P>0.05) (Fig. 7-b). It was found that, a linear correlation was seen between the fecundity and Egg weight of uninfected *C. gariepinus*, with a significant positive correlation (r= 0.9934; P<0.05). (Fig. 8-a). Infected *C. gariepinus* showed a linear correlation between the fecundity and Egg weight with non-significant positive correlation (r=0.9698; P>0.05) (Fig. 8-b). It was found that, a linear correlation was seen between the fecundity and Egg diameter of uninfected *C. gariepinus*, with a significant positive correlation (r= 0.9934; P<0.05) (Fig. 9-a). Infected *C. gariepinus* showed a linear correlation between the fecundity and Egg diameter with non-significant positive correlation (r=0.8948; P>0.05) (Fig. 9-b).


(Fig.2)
non-infected
infected
OW(g)
9
8
7
6
5
4
3
2
1
0
a
b
non-infected
infected


(Fig.3)
Non-infected
Infected
GSI(%)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
a
b
Non-infected
Infected

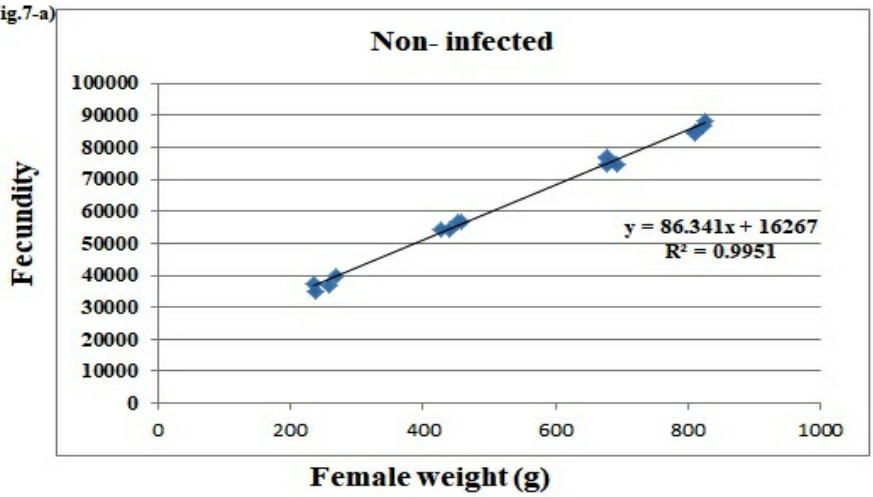






Figs. 2-6. Ovary weight (g) , Gonadosomatic-Index (%) , Fecundity, Egg weight (mg) and Egg diameter (mm) of infected and uninfected female *C. gariepinus* by *M. gariepinus.*

Fig.7-a)



(Fig.7-b)

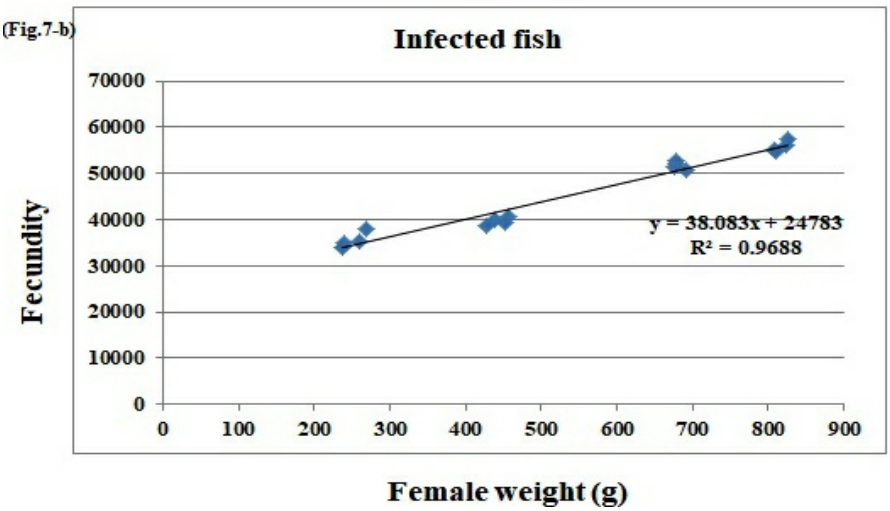
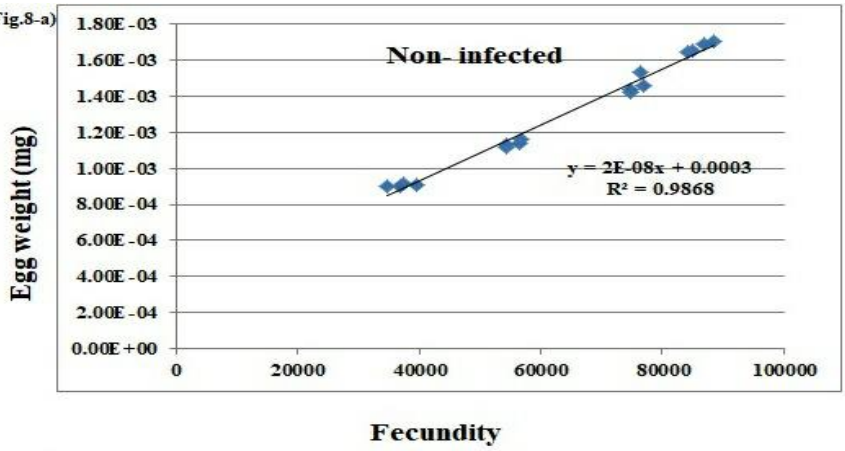


Fig. 7. Relationship between fecundity and female weight (g) of (a) uninfected and (b) infected *C. gariepinus* by *M.gariepinus*.

(Fig.8-a)



(Fig.8-b)

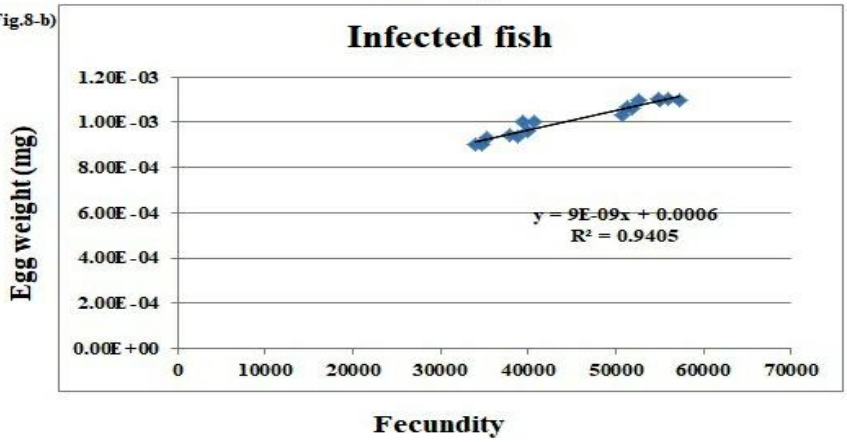


Fig. 8. Relationship between fecundity and egg weight (mg) of (a) uninfected and (b) infected *C. gariepinus* by *M.gariepinus*.

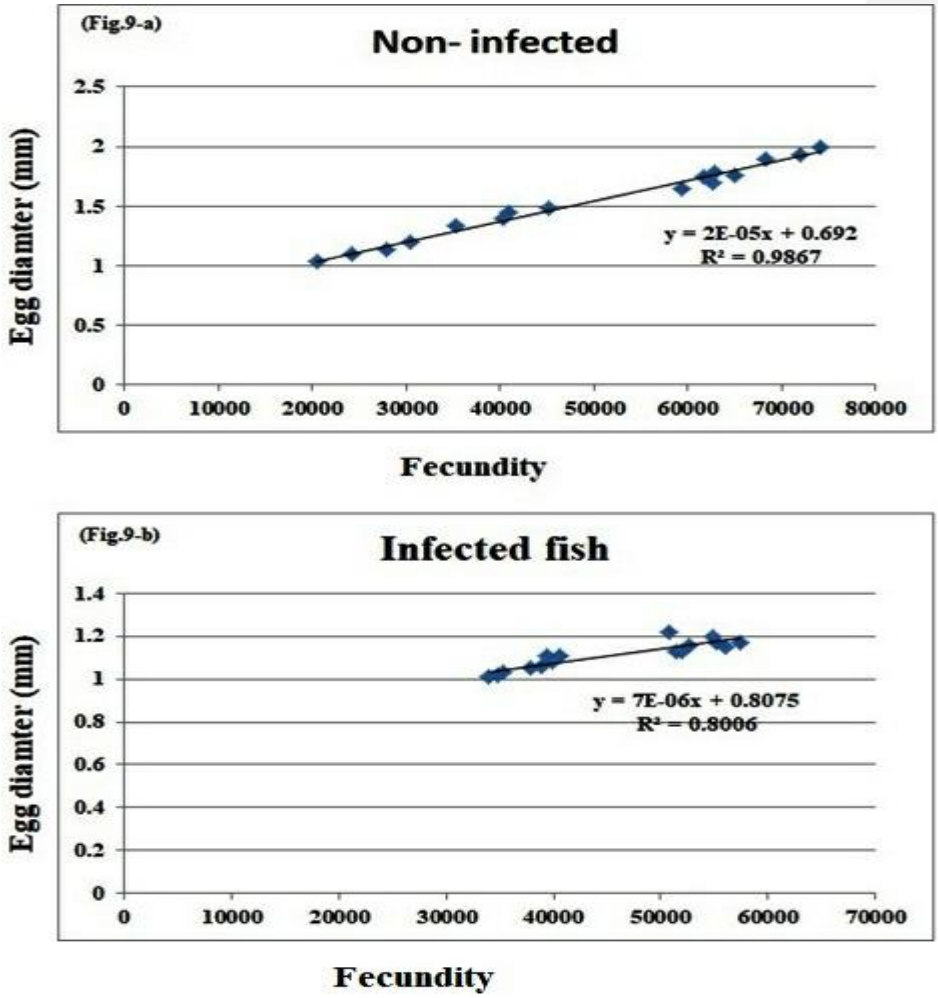


Fig. 9. Relationship between fecundity and egg diameter (mm) of (a) uninfected and (b) infected *C. gariepinus* by *M.gariepinus*.

DISCUSSION

Most myxozoans infecting fish are host, tissue and organ-specific parasites and in most cases they select a specific site for their development in the fish host body (Abd EL-Lateif, and Arafa, 2019). It is noteworthy that studies of Myxosporean infestation was not currently very frequent in fish gonads; that makes this observation more interesting (Grankoto *et al*., 2015). The parasite described in the present work has typical characteristics of the phylum Myxozoa, based on morphology and morphometry, this species belongs

to the genus Myxobolus, and species *Myxobolus gariepinus*. While the number of males analyzed in this study was low, *Myxobolus gariepinus* were only observed in females. Also, *Myxobolus dahomeyensis* was only observed in fish ovaries (Grankoto *et al*., 2015). This may indicate a preference of the parasite for ovaries, scince Myxobolus genus demonstrates a wide range of host specificity (Vieira *et al*., 2017).

In present study, the *Myxobolus gariepinus* showed in ovaries, which had morphological characteristics of the myxospore related to that of *Myxobolus gariepinus* described by (Reed *et al*., 2003). Who recorded that, spores of *M. Myxobolus gariepinus* present in the stroma of the ovary and never seen within the oocyte. Another species of *M. imami* was recorded in ovary of *C. gariepinus* inhabiting lake of Wadi El-Rian in Egypt by (Abdel-Ghaffar *et al*., 1998). Spores of *Henneguya amazonica* were found either in the ovarian stroma or lying between the zona pellucida and the follicular epithelium of the oocytes (Abd EL-Lateif and Arafa, 2019). *Myxobolus algonquinensis* n. sp. infected ovary of *Notemigonus crysoleucas* cysts, found in connective tissues of ovaries or interstitial tissue among eggs (Xiao and Desseri, 1997). Myxosporean *Myxidium* sp. was never seen within the oocytes or within their developmental stages of fish *Lutjanus monostigma* (Al-Jahdali, and Hassanine, 2010). While, the results revealed that, *Myxobolus sp*. (Grankoto *et al*., 2015) and Myxozoa *Kudoa azevedoi n. sp*. (Mansour *et al*., 2013) were found encrusted in the oocyte of infected fish.

M. bilongi, found in the gills of a *Labeo* sp. is morphologically similar species to *M.gariepinus* but the former had two unequal size polar capsules (Fomena *et al*., 1994) *Myxobolus gariepinus* differs from *M. fotoi* since the latter has an almost completely spherical spore and also according to (Fomena *et al*., 1993) has polar capsules that are subspherical and take up approximately

one fourth of the spore cavity. *Myxobolus njinei*, a parasite of various *Barbus* species (Fomena *et al*., 1994), has a much larger and more oval spores, with two distinctly unequally sized polar capsules taking up almost two thirds of the spore body (Fomena et al., 1985). Additionally, the two species, *M. gariepinus*, *M. sp*. and *M. dahomeyensis* had the same numbers of polar filament coils (Grankoto *et al*., 2015).

In this study, the prevalence 23.33 % of ovarian *M. gariepinus* infected *C. gariepinus* is nearly close to the infection level 19.79% and 21% of *M*. sp. (Grankoto *et al*., 2015). and *M. gariepinus* (Reed *et al*., 2003) infected ovaries of *C. gariepinus*, respectively (Grankoto *et al*., 2001a) recorded 18.3 % and 31.6% of *M. dahomeyensis* in the ovaries of *Sarotherodon melanotheron* and *Tilapia zillii*, respectively. The recorded prevalence of *Myxobolus algonquinensis* n. sp. infected ovary of *Notemigonus crysoleucas* was 15.1 % (Xiao and Desseri, 1997). The high overall prevalence 55.5 % of *Kudoa azevedoi* from ovary of *Trachurus trachurus* fish was recorded by (Mansour *et al*., 2013).

Fish ovaries parasitology examination was less done than that of others organs, particularly dealing with Myxosporidia (Grankoto *et al*., 2015). Only several myxosporidian species were recorded in fish ovaries worldwide. Among them, five (*M. pfeifferi*, *M. clarii*, *M. dahomeyensis*, *M. gariepinus* and *M. sp*.) were recovered in Africa (Eiras *et al*., 2005, Eiras *et al*., 2014& Grankoto *et al*., 2015). Study the genus Myxobolus in fish ovaries is judging by the scarce amount of information available. Studies by [14,9] in ovary of *C. gariepinus* and by (Grankoto *et al*., 2001b) in ovary of Tilapia species, are the only recent references available. Neither of these papers deals with the effect of genus Myxobolus on fish fecundity.

In the present study, female *C. gariepinus* infected with *M. gariepinus* had the lower ovary weight, GSI, fecundity, egg diameter and egg weight when compared with those of uninfected fish when compared with those of uninfected fish. These could attributed to that, Myxosporean have serious pathological potential when encysted on reproductive tissues. This suggestion is supported by Al-Jahdali, and Hassanine, (2010), who recorded that, the infection caused by the present Myxosporean *Myxidium* sp. seemed to negatively affect the reproductive capacity of the fish host. They added that, establishment of *Myxidium sp.*infected ovary of *L. monostigma* caused serious lesions, occupying a considerable area within the ovary and some areas within the ovarian tissues appeared to be vacuolated or degenerated.

Myxobolus dahomeyensis, infected ovaries of Tilapia species induced reduction in the reproductive rate of individuals (Grankoto *et al*., 2001b). Although, Myxosporidean *Kudoa paniformis* infects the fish skeletal muscle, it decrease fecundity and depress egg production of Pacific hake *Merluccius productus* (Adlerstein and Dorn, 1998). Ovarian Myxosporea *Kudoa ovivora* reduced growth, fecundity and spawning activity of females of the bluchead wrasse *Thalassoma bifasciatum* (Swearer and Robertson, 1999).

The decrease of egg diameter of infected fish was disagree with the recorded enlarged oocytes of *C. gariepinus* (Grankoto *et al*., 2015). and *Trachurus trachurus* (Mansour *et al*., 2013) infected with *Myxobolus sp*. and Myxozoa *Kudoa azevedoi n. sp*, respectively. These could be due to that, *Myxobolus sp*. and *Kudoa azevedoi n. sp* were found encrusted in the oocyte, while in present study the *Myxobolus gariepinus* present in ovarian stroma.

Fecundity, defined as the number of eggs carried by female fish, is very important aspect of fish culture since it is concerned with the average reproductive characteristics of fish (Eyo *et al*, 2016). The recorded decrease

fecundity in infected fish of the present study, could be attributed to decrease in the ovary weight and egg diameter (Phukon and Biswas, 2012, Buragohain and Goswami, 2014). *M. batalhensis* n. sp. infected *Salminus hilarii* lead to membrane destruction of affected oocytes and vacuolar degeneration most likely affecting their normal development and fertilization (Vieira *et al*., 2017).

Extrinsic factors have been reported to affect fish fecundity (Bhattacharya and Banik, 2015 and Eyo *et al*., 2015). In this study, the fecundity of uninfected females C. *gariepinus* was strongly (positive) correlated with all female biometric parameters (female weight, egg weight and egg diameter). These results were agreed with (Ataguba *et al*., 2013), who recorded strongly (positive) correlate between the fecundity and fish weight and egg weight of C. *gariepinus*. An unusual situation presence of Myxosporean species in fish sexual tissues is usually result in partial or total destruction of host gonads, or partial or total inhibition of host gamete formation (Al-Jahdali, and Hassanine, 2010). This theory can explain that the linear relationship between fecundity and all biometric parameters (body weight, egg weight and egg diameter) were increased with low rate among infected fish than that of uninfected fish. The present results is nearly agree with (Adlerstein and Dorn, 1998), who recorded that, the increase in fecundity with length is linear among Pacific hake fish that carry the *Kudoa paniformis* was lower than that of uninfected fish.

CONCLUSION

We can concluded that, *Myxobolus gariepinus* sp.n. was only observed in ovaries of *C. gariepinus*. Findings of this study provide evidence that, *M. gariepinus sp. n.* reduce GSI, fecundity, egg weighty and egg diameter of African catfish *C. gariepinus*. Also, the leaner relationships between fecundity and other morphometric parameters (body weight, egg weight and egg

diameter) of *M. gariepinus* infected fish was linear with slow rate of increase than that of uninfected fish. Another studies dealing with the effects of *M. gariepinus* sp.n. on fish fecundity must be take place. These require further confirm investigations including ultrastructure and immunological studies.

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علاقات الخصوبة المختلفة ومؤشر نمو المبيض فى سمك القراميط (كلاريس جاريبينس) المصابة بطفيل الميكسوبولاس جاريبينس

[1]جهاد عبد الرحمن إسماعيل، [2]محمد صلاح محمد

[1]قسم بحوث أمراض الأسماك- معهد بحوث الصحة الحيوانية- مركز البحوث الزراعية- مصر.
[2]قسم بحوث التغذيه- المعمل المركزى لبحوث الثروة السمكية- مركز البحوث الزراعية -مصر.

الملخـــــص العربـــــي

أجريت هذه الدراسة للكشف عن وجود طفيل *Myxobolus species* فى سمك القراميط *Clarias gariepinus*. كما تم دراسة تأثير إصابة مبيض سمكة الكلاريس جاريبينس بطفيل ميكسوبولس جاريبينس على معدل نمو المبيض وعلى خصوبة السمك و علاقتها بجميع القياسات البيولوجية (الوزن الإجمالي للإناث- وزن البيضة -وقطر البيضة). تم تجميع١٠٠ سمك بمتوسط وزن (٠٣,٢١± ٦٥٣.٣٤) من مزرعة سمكية بمحافظة الشرقية بمصر.تم نقل العينات حية إلى المعمل المركزى لبحوث الثروة السمكية و تم وضع الأسماك بأحواض زجاجية سعة ١٢٠لتر وبعدد ٥ سمكات بالحوض الواحد، وبفحص السمك تبين وجود الطفيل بنسبة (٢٣.٣٣٪) فى مبيض الأسماك. أظهرت نتائج الدراسة انخفاضاً معنوياً(P<٠.٥) لمؤشر نمو المبيض (GSI) والخصوبة المطلقة ووزن المبيض ووزن البويضة وقطر البويضة في الإناث المصابة بالطفيل مقارنة بالأسماك غير المصابة بالطفيل. بالإضافة إلى ذلك، أظهرت أنثى كلاريس جاريبينس المصابة بالطفيل ارتباطًا خطيًا إيجابى بين الخصوبة والخصوبة وجميع القياسات البيولوجية (الوزن الإجمالي للإناث- وزن البيضة- وقطر البيضة) وهذه العلاقة غير معنوية (r> ٠.٠٥)، بينما أظهرت أنثى كلاريس جاريبينس ارتباطًا خطيًا إيجابى بين الخصوبة والخصوبة وجميع القياسات البيولوجية (الوزن الإجمالي للإناث- وزن البيضة- وقطر البيضة) وهذه العلاقة معنوية (r <٠.٠٥). هذه النتائج تدل على أن العلاقة بين الخصوبة وجميع القياسات البيولوجية فى الأسماك المصابة بالطفيل تعد بطيئة مقارنةً بهذه بمثيلاتها فى الأسماك الغير مصابة بالطفيل. الدراسات على الطفليات التى تصيب مبيض الأسماك تعتبر قليلة وخاصة الخاصة بطفيل الميكسوبولس ونظراً لأن إصابة مبيض أسماك القراميط بطفيل موكسوبولس جاريبينس يقلل من خصوبة الأسماك وبناءاً على ذلك ينصح بمزيد من إجرأ المزيد من الأبحاث وخاصة المتعلقة بالمناعة والتركيب الدقيق للطفيل.