

Eye Affection Syndrome Wild and Cultured Fish

Noor El Deen, A. I. E and Mona S. Zaki

Hydrobiology Department, National Research Centre, Dokki, Giza, Egypt
dr_ahmednoor2002@yahoo.com

Abstract: Fish eyes syndrome is often one of the causes which induce difficulties in the life of both wild and cultured fish. The clinical fish eye syndrome is either local or systemic. The most common syndromes affecting wild fish are exophthalmos (pop-eye) and cataracts while those recorded in cultured one are exophthalmos, cataracts and enophthalmos (sunken-eye). The syndrome is associated with various infectious causes such as parasitic, chemical, mechanical, traumatic and hormonal imbalance. The epidemiology of these syndromes depends on the cause of infection of the eye in both wild and cultured fishes of all species and ages. Also, the diagnosis of these syndromes depends on: case-history, behavioral abnormalities and clinical examination (clinical signs and laboratory diagnosis). Histopathological examinations of eye syndromes affecting wild and cultured fish are graded from inflammation in acute form (traumatic causes) to cataracts and keratitis in chronic form (parasitic causes), retro-retinal gas bubbles (GBD). Prevention and control of fish eyes' syndrome depends on strict hygienic measures including the use of prophylactic treatment of parasitic and biological control. Treatment and removal of the causative agent are considered to be the most important factor in treating these diseases. In conclusion, eye affection syndrome is a group of non specific clinical signs which are associated with various infectious and non infectious diseases and the best approach to ocular disease is the prevention or avoidance through either strict hygienic measures or treatment and removal of the causative agent.

[Noor El Deen, A. I. E and Mona S. Zaki. **Eye Affection Syndrome Wild and Cultured Fish.** *Life Sci J* 2012;9(3):2568-2575]. (ISSN: 1097-8135). <http://www.lifesciencesite.com>. 372

Keywords: Fish; eye; syndrome; clinical examination; laboratory diagnosis

1. Introduction

Fish eye is considered a very important organ. It is adapted for the vision in air as well as waters either in wild and cultured fish which do display some differences to the mammalian eyes (Lee, 2002). Wild fish are free living in open water their feeding depends on phyto and zooplankton. While cultured fish are bred and live in aquaculture systems such as cages and ponds and depend on either artificial or sometimes on natural feeding (Woo, 2006). Eye syndrome infection is an important health problem among fish all over the world. Ocular diseases of fish are common and represent a significant problem within the aquaculture industry and ophthalmic diseases that may cause the fish to be off food and leading to retardation growth (Noor El- Deen, 2007). The most common parasitic syndrome affecting fishes are of digenetic trematode (*Diplostomiasis* (cataracta parasitica), copepod *Ommatokoita elongate*, *Myxobolus dermatobia* while, keratitis, sunken eye, absence of eye, small eye and neoplasma of cornea, retina and other parts could be a result of physical, physiological and hormonal deficiency (Bjerkas *et al.*, 2006). The pathogenesis differs according to the route of infection (Austin and Austin, 2007). Hygienic measures, such as sanitation have become important aspect of aquaculture (Bostock, 2002).

The use of antiparasitic, antibacterial and antifungal drugs in the treatment of eye affections are of value (Noga, 2010). Also, traditional medicinal plants and biological control can control some parasitic

pathogens (Noor El -Deen *et al.*, 2010). In Egypt, many studies reported the eye syndrome affections among wild and cultured fish that recorded parasitic and non infectious causes of eye syndrome affection have much lower rates of developmental (El-Seedy *et al.*, 2009).

The present review is disseminating knowledge on fish eyes' syndrome in wild and cultured fish to stimulate further explanatory research that contribute in establishing a new effective strategy for prevention and control.

Etiology of eye affection syndrome

In wild fish:

Infectious causes:

Parasitic causes.

Many species of metacercariae are found encysted or free in the eyes of fish which are found within the retina, vitreous humour and lens of the eye. Greatest damage is caused by those species occurring in the lens. Possibly the most important species is *Diplostomum spathaceum* or 'eye fluke' which is found in many species of fresh water fish in Europe, Africa and North America (Roberts, 2012). Some copepod parasites may be found attached only superficially and probably cause little harm to the eyes of fish. Others may penetrate deeper into the eye, causing severe damage. Also, the parasitic copepod *Ommatokoita elongata* (Grant) were collected in Arctic waters of Victor Bay, North-west Territories, Canada were firmly attached to the corneas of Greenland sharks, *Somniosus microcephalus* by an

anchoring structure, one per eye (**Borucinska et al., 1998**). Also, metacercariae that isolated from cultured Japanese eel in Taiwan caused swollen, cloudy and white eyes and the causative agent of the disease of eye of the fish, detected in three South American trout's was *Diplostomum compactum* and showed unilateral exophthalmia (**Vazquez-Gamboa et al., 2001**). In Egypt, *Diplostomum* metacercariae infection was found in eyes of wild and cultured catfish causing unilateral corneal opacity and blindness (**Eissa 2006**). In Nile tilapia *Diplostomum* in early stages caused exophthalmia without eye opacity and in chronic stages caused complete eye cataract and white dots around the eye cornea. While, *Myxobolus sp* was isolated from eye of some marine fish in red sea region (**Abd El-Monem et al., 2005**).

Non infectious causes:-

Physical causes.

Sudden change in water temperature, salinity and gas supersaturation are responsible for developing eye cataract and gas bubble disease in wild fish (**Woo, 2006**). Post capture eye damage to sockeye salmon may be related to supersaturation of the River in adult Columbia River fish's gas bubble disease. Moreover, exophthalmos in West Australian dhufish occurred more frequently in summer season (**Stephens et al., 2002**). Cataract in atlantic salmon (*Salmo solar* L) has been recorded from subzero water temperature (**Ferguson et al., 2004**). Gas supersaturation was observed in the Parana River, Argentina. The gas bubble was observed in fins, eyes and skin (**Domitrovic et al., 2000**).

Chemical causes.

Eye lesions and other clinical abnormalities are positively associated with water pollution. Inflammatory lesions of the eyes were interpreted as circumstantial evidence for contamination by wastes from titanium dioxide production (**Delthlefsen, 1984**). Eye lens cataract was common in fish of Elizabeth River, Chesapeake Bay, Virginia due to contamination of water with polycyclic aromatic hydrocarbons (**Williams et al., 1992**). Skeletal deformities, scale disorientation, gill, eye, soft tissue deformities and other kinds of deformities were reported in tilapia and other native fish species from southern Taiwan contaminated rivers (**Sun et al., 1998**). The exposure of larval fishes to sewage plumes off the coast of Sydney, Australia can potentially affect the health of larvae and cause deformities to the eyes (half pigmented eyes) (**Kingsford et al., 1997**).

In cultured fishes:-

Infectious causes:-

Parasitic causes.

The available literature recorded that eye flukes, *Myxosoma sp* and metacestodes were responsible for

affections in various farmed fish. *Myxosoma sarigi* isolated from the orbit and cornea of infected *O. niloticus* fishes were cultured at the kainji Lake research Institute, Nigeria (**Okaeme et al., 1988**).

Ichthyophthirius multifiliis causing cataracta in ornamental Golden fish (**Noga, 2010**). In Egypt, the most common parasites were; *Diplostomum spathaceum*, or 'eye fluke' isolated from tilapia sp. at Abbasa fish farm, Sharkia (**El-Bouhy, 1995**); *Myxobolus sp* isolated from *Tilapia zilli* at Giza province causing unilateral eye opacity (**Mohamed et al., 2004**). *Myxobolus dermatobia* from *Oreochromis niloticus*, hybrid tilapia and *Sarotherdon aureus* at Kafr El-Sheikh Governorate causing petechial haemorrhages and focal to large haemorrhages in orbit, exophthalmia and in advanced cases unilateral eye opacity (**Abd El-Aal, 2002**). *Cataracta parasitica*, the most common cause of eye opacity is metacercaria of digenean trematodes (**Eissa, 2006**).

Non infectious causes:-

Physical causes.

Cold, rapid fluctuations in water temperature, high water temperature, direct of water flow are important physical factors for inducing eye affection in fishes (**Woo, 2006**). Atlantic salmon (*Salmo salar* L) cultured in nets in sea water was appeared in some of them cataract after a period of elevated surface water temperature with simultaneous rapid in water temperature (**Bjerkas and Bjornstad, 1999**). Gas supersaturation, change in breeding techniques, temperature fluctuation and seawater transfer time are capable of development of eye abnormalities and other clinical signs in cultured fish as rapid growth rate and most severe cataracts in Atlantic salmon during the rearing stage (**Bjerkas et al., 2001**).

Mechanical causes.

Corneal abrasions and ulcerations are common sequel of trauma, especially in large individuals. This can result not only from fighting, but also, from bumping into sharp objects, such as rocks or coral, in an aquarium. Ophthalmic trauma, which can eventually lead to phthisis bulb, is common in large aquarium fish (**Noga, 2010**). Phacogenic uveitis is often found in Rainbow trout, *Salmo gairdneri* association with the lenticular lesions, and retinal detachment often occurs as a result of vitreous trauma (**Shariff et al., 1980**). As a result of probable damage of common snook broodstock *Centroponus undecimalis* during netting from Terra Ceia Bay, Florida, USA, the cornea of most fish in captivity began to turn opaque white within 24h of capture, while, the untreated fish became blind (**Kraxberger-Beatty et al., 1990**).

Hormonal causes.

Injection of high doses of methyl testosterone and L-thyroxine inhibited growth and was bulging eyes of

Red sea bream, *Pagrosomus major* and cultured *O. niloticus* caused corneal opacity (**Aml El-Asaly, 2004**).

Therapeutic causes.

Incriminated Nugvan used to control sea lice on salmon was found to induce cataract in seabass (*Dicentrarchus labrax L*) (**Bjerkas et al.,2003**). Corneal opacity was observed with the deficiency of Ascorbic acid (**NRC, 2011**) and probiotic in tilapia *O. niloticus* (**Taoka et al., 2006**).

Physiological causes.

The cataract observed in rapidly growth Atlantic salmon *Salmon salar L.* smolt in Norway might be related to smoltification process (**Bjerkas et al., 2006**).

Epidemiology of eye affection syndrome

Eye affection syndrome is a group of non specific clinical signs which were associated with various infectious and non infectious diseases. Therefore, the epizootiology of this syndrome is dependent on the cause of eye disorder. This problem is worldwide in distribution affecting both wild and cultured fishes of all species and ages.

Incidence of eye affections syndrome:-

In wild fish.

The available data showed that prevalence of eye lesions ranged from near negligible level to 100% (**Eissa, 2006**). In addition , **Iglesias et al. (2001)** recorded three species of *Myxobolus* (*Myxobolus dermatobia*, *Myxobolus spheroidalis* and *Myxobolus ocularis*) in different locations in the skin, gills and eyes of *Chondrostoma polylepis* in Galicia, New Spain.

Naturally occurring cases of exophthalmos that examined were mostly unilateral and occurred more frequently in summer months during periods of increasing water temperature. Changes varied from a hazy opacity in the interior part of the lens to cataract affecting the whole lens. Severely affected lenses appeared swollen and large vacuoles were visible in the opaque areas. Large vacuoles in the otherwise clear lenses were seen in 1 of 4 adult salmon examined (**Bjerkas et al., 2003**).

In cultured fish.

Numerous reports have been released concerning the prevalence of eye affection syndrome in aquaculture. They reported that the spreading of the eye problems among cultured fish is worldwide in distribution.

In Egypt, *Myxobolus sp* were isolated from both *Tilapia sp* and *Clarias lazera* at Behera province causing unilateral eye opacity. *Myxobolus spheroidalis* and *Myxobolus ocularis* from *Oreochromis niloticus* were illustrated to cause exophthalmia and in advanced cases unilateral eye opacity (**Abu El-wafa, 1988**).

Cataract and other optical changes in traditional pond farms in lower Saxony, Germany was low incidence (**Schlotfeldt and Wegener, 2000**). They also

added that the cataract problem and more severe eye changes. Also, present in freshwater fish farming, seen to be less prevalent than the marine production of Atlantic salmon. The prevalence of cataracts in seawater farmed atlantic salmon, *Salmon salar* was 83% in spring entry groups and 79% in autumn entry groups respectively (**Ersdal et al., 2001**). Spontaneous exophthalmos was common in cultured West Australian dhufish *Glucosoma hebraicum* Richardson which is a potentially valuable aquaculture species (**Stephens et al., 2002**).

Factors influencing the eye affections syndrome:-

The incidence of ocular abnormalities is greatly affected by various factors involving fish type, species, age, environmental temperature and others (**Woo, 2006**). Eye disorders are more common among farmed fish because stresses associated with culture (overcrowdness, artificial feeding, unfavorable water quality, rough handling) render them more susceptible than feral fishes. The rate of eye diseases varies from one species to another (**Woo, 2006**). Pop - eye which is the main signs of GBD can be seen in winter (**Isaacson, 1977**) as well as in summer (**Stephens et al., 2002**). The West Australian dhufish, *Glucosoma hebraicum* Richardson (family Glucosomatidae) is a potentially valuable aquaculture species, but spontaneous exophthalmos is common in freshly caught and cultured dhufish. Naturally occurring cases of exophthalmos that examined were mostly unilateral and more frequently in summer during periods of increasing water temperature (**Stephens, et al., 2002**). Meanwhile, chemical pollution enhances to a great extent the eye disorders incidence of deformities in larval fishes (**Kingsford et al., 1997**), in tilapia and other native fish species from Southern Taiwan contaminated rivers (**Sun et al., 1998**). Eye lens cataract was reported to be the most common sign in some fish species in Poly cyclic aromatic hydrocarbons heavily contaminated sites of the Elizabeth River, Virginia, USA was reported (**Williams et al., 1992**).

Epidemiological occurrence of eye affection syndrome:-

Depending on what was mentioned earlier, it is clear that there are several epizootiological patterns of eye affection syndrome due to cause's variation.

The most common eye affection was *Cataracta parasitica* which caused by metacercaria of digenean trematodes (mostly *Diplostomum sp*) which is found in fishes as second intermediate host (**Karvonen et al., 2001**). Several fish-eating aquatic birds are the primary hosts of the fluke. Adult trematode in the birds produced large amount of eggs that shed and passed in feces to the water and fish (**Eissa, 2006**).

Gas-bubble disease due to helicopter was transport in young pink salmon (**Hauck, 1986**). It has now been observed clinically in a wide variety of farmed species and under a number of different circumstances. Uni or

bilateral exophthalmia, another pattern of occurrence and associated environmental and management factors were detected (Speare, 1998).

Pathological changes of eye affection syndrome

The eye affection syndrome is associated with infectious and non-infectious diseases, the different pathogenesis should be considered. Histopathological examination of eye affected by several fluke larvae within the lens revealed localized granulomatous reactions around the dead ones (Saburoh *et al.*, 1982). As shown in **plate,1**. Diplostoma in tissue of cornea causing eye opacity. Corneal epithelial ulceration and heterophilic keratitis was observed (Reborts, 2012). As shown in **plate,2**. Epithelial proliferation is a frequent finding in cataract in fish. The Ocular enucleation, persistent corneal cataracts and panophthalmitis are the dramatic sequel of Gas bubble disease (Woo, 2006). The ocular cataracts happened to yearling salmonids after seawater exposure cause damage of cortical fibers as a result of exposure to hypertonic solution and defective osmoregulation (Bjerkas *et al.*, 2003).

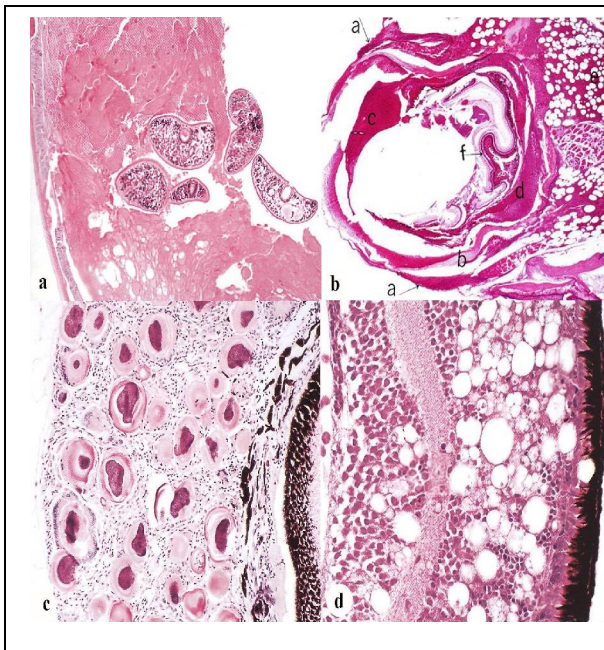


Plate (1). (a) Diplostoma in tissue of cornea , (b) Infected eye. Bacteria invade the conjunctiva(a), sclera (b), iris(c), choroid(d) and orbital adipose tissue(e), the retina(f) is separated,the eye ball is forced out of the orbit. H-E, x 10.,(c) Retinitis in tissue of cornea . (d) . Uveitis and vacuoles are the typical findings which are seen in all layers of the retina (Saburoh *et al.*, 1982).

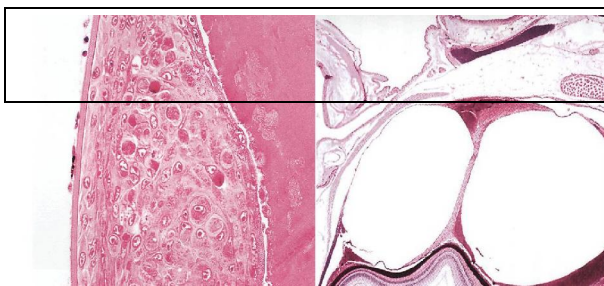


Plate (2). (a) Epithelial proliferation, is a frequent finding in cataract in fish. (b) Massive retro-retinal gas bubbles result in unilateral loss of vision in this aquarium species, largely due to distortion of retina, (Saburoh *et al.*, 1982) .

Diagnosis of eye affection syndrome

Case History:-

Many factors should be reported such as; recent stress exposure (overcrowdness, transportation, decrease in water flow / exchange, overfeeding) (Noga, 2010), Mechanical injury (netting, grading, fish sampling) (Kraxberger-Beatty *et al.*, 1990) , rapid fluctuation in water temperature, sudden increase (Eissa and Zaki, 2010) or decrease in water temperature (Bjerkas and Bjornestad, 1999) , snails and aquatic birds spreading (Eissa, 2006) and chemical pollution (Williams *et al.*, 1992) should be considered in diagnosis of eye affections .

Clinical examination:

Fish should be examined first for detection of any behaviour changes, then representative fish sample was taken and fish were inspected individually for detecting gross lesions.

Behaviour abnormalities.

Fish floating to water surface and increase in time devoted to feeding (Noor El-Deen, 2007), random swimming into objects (Karlsbakk *et al.*, 2002) and sluggish movement (Ness and Foster, 1999) are considered the most common behavioral abnormalities.

Clinical signs.

Most common clinical signs were stunted growth (Ersdal *et al.*, 2001), acute or chronic mortality (Sogma *et al.*, 1999), Diplostomum flukes (Eye flukes) (Crowden and Broom, 1980), adult female Ommatokoita elongata (Borucinska *et al.*, 1998), exophthalmos(Saburoh *et al.*, 1982). **Plate,1(a,b,c and d).**

Myxobolus cysts, endophthalmos (Noor El -Deen, 2007), Cataracta parasitica in Tilapia (Eissa, 2002). **Plate,2 (a,d,c and b)** . unilateral or bilateral eye lens opacity cataract (Vasquez-Gomboia *et al.*, 2001 and Austin and Austin, 2007), unilateral or bilateral exophthalmos (Russo *et al.*, 2006), presence of gas emboli (Domitrovic *et al.*,2000). **Plate,3(d)**, Vision

impairment (Bjerkas *et al.*, 2003),("pop-eye) (Eissa, 2006), blindness (El-Bouhy, 1995.

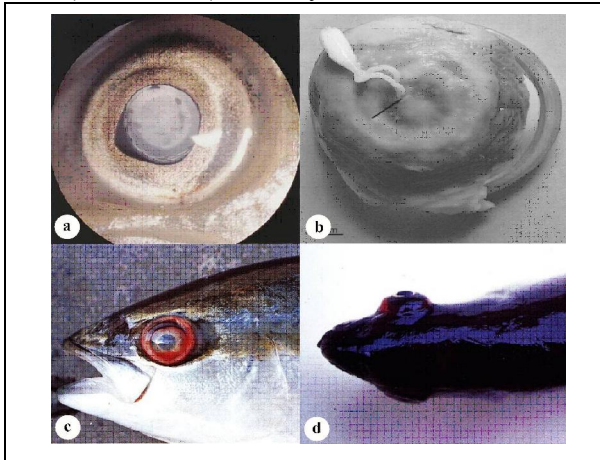


Plate (1). (a) Diplostomum flukes (**Eye flukes**) showed in the cortical layer where there is a concurrent cataract development (Saburoh *et al.*, 1982). (b) The eye of a Greenland shark infected with adult female Ommatokoita elongata (arrow indicates point of parasite attachment) (Borucinska *et al.*, 1998). (c) A yellowtail fish exhibits exophthalmos with hemorrhage of the conjunctiva and iris (Saburoh *et al.*, 1982). (d) This fish exhibits exophthalmos. (Saburoh *et al.*, 1982).

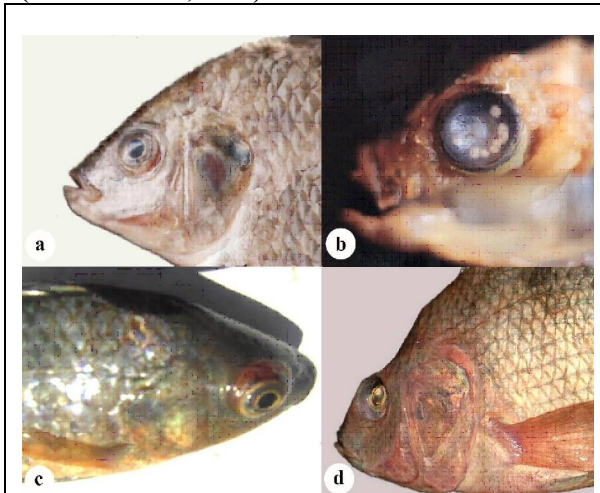
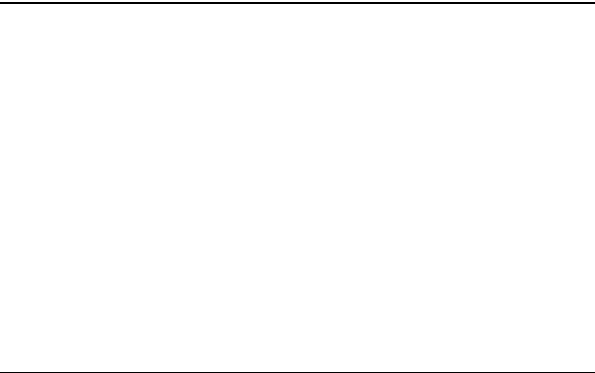
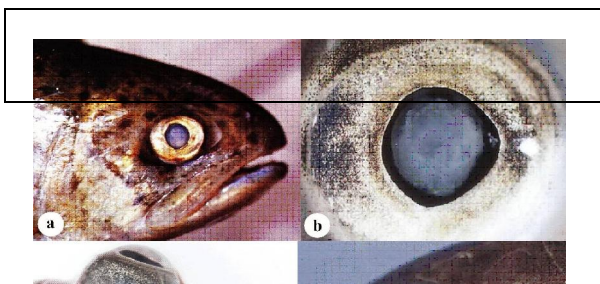


Plate (2). Myxobolus cysts in the eye and slight exophthalmos (Noor EL- Deen,2007). (b): Showing Cataracta parasitica in Tilapia (Eissa,2006). (c) *Oreochromis niloticus* with exophthalmia eye (Noor EL- Deen, 2007). (d) *Oreochromis niloticus* with sunken eye (Noor EL-Deen,2007).



Plate(3). (a) A rainbow trout with cataract and a cloudy lens (Saburoh *et al.*, 1982). (b) Diplostomum flukes (**Eye flukes**) in the cortical layer (Saburoh *et al.*, 1982). (c) Retrobulbar gas has pushed the eye forwards and out of the orbit, resulting in exophthalmia in this cod (Saburoh *et al.*, 1982). (d) Small gas bubbles in the anterior chamber of rainbow trout (GBD) (Saburoh *et al.*, 1982).

Laboratory diagnosis.

First, freshly prepared fish samples are essential for isolation and identification of parasitic, bacterial, fungal and viral examinations. **Parasitic diagnosis** depends on isolation and identification according to Lukey (1977)

Prevention and control of eye affection syndrome

Numerous studies with controlling of eye affection syndrome in wild and cultured fish were concerned.

Managerial prevention.

Quarantine of new fish and good sanitation practices should be used at all times (Eissa, 2006). Nutritional deficiency as a cause of eye syndrome affections should be balanced (Noga, 2010). Stress factors must be avoided with added to the feed anti stress substances such as ascorbic acid (Taoka *et al.*, 2006). Also, Aerating the water sources in a reservoir to allow it to equilibrate with air or stripping of excess gas by using vaccum, the excess gas may leave solution in the blood stream, forming emboli in various tissue causing gas bubble disease (Woo,2006).

Drug therapy control.

In parasitic infections and /or infestations.

Antiparasitic drugs should be used as in case of eye fluke *Diplostomum spathaceum* in Channel catfish which treated with 2 mg Praziquantel/l in water bath for 2-4 h (Plumb and Rogers, 1990). Eye affections associated with parasitic infections and/ or infestations, antiparasitics were recommended for controlling of this condition. An oral praziquantel used as inhibiting attachment of parasites to *O. niloticus* (Osman *et al.*, 2008). Recently, electrical currents,

ultraviolet radiation and supersonics are used for eradication of cercariae (Eissa, 2006).

Biological control.

In addition to controlled indirectly through eradication of snails. Several methods were used for snail destruction, but abiological control by black carp is the best (El- Khatib, 2003). Avoid exposure of culture waters to the aquatic birds (Noga, 2010). Probiotics, live microbes that may serve as dietary supplements to improve fish immune responses, have received some attention in aquaculture (Kesarcodi-Watson *et al.*, 2008).

Conclusion:

Fish eyes syndrome is a disease that causes many problems to both wild and cultured fish. Treatment of this syndrome in wild fish depend on great extent on getting rid of the causative agent. In cultured fish, prevention and control of fish eyes' syndrome problems could be balance of nutrition.

Methods used to control ocular diseases are:-

Good farm management, environmental stresses and associated disease, high water quality, applying lime to the ponds, low rearing densities, and excellent nutrition. Quarantine and health certificate form which is a part of the control microbial diseases.- Paying attention for eradication of any parasitic, bacterial, fungal and viral causes in fish farm. Employing some molluscicides chemically or biological and trials for elimination of the aquatic piscivorous birds, dead fish. Application of vaccination programs for fish, or using medicinal plant extracts which are the alternatives to the antibiotics for preventing and controlling the infectious diseases in fish farms. Recently, electrical currents, ultraviolet radiation and supersonics methods are used for eradication of cercariae in cultured fish at water inlet.

Corresponding author

Noor El Deen, A. I. E

Hydrobiology Department, National Research Centre, Dokki, Giza, Egypt

1. dr_ahmednoor2002@yahoo.com

2. References

3. Abd El-Aal, A. M. I. (2002): Studies on tissue parasites in fish. Ph.D. Thesis, Fac. Vet. Med., Tanta Univ.(Kafr El-Sheikh branch).
4. Abd El-Monem, S.A; Bayoumy, S.M and Mahdey, E.A.(2005): Description of five new Myxosporean parasites infecting some sea fishes in Egypt. Egypt J. Zool., 45 : 333-348.
5. Abu El- Wafa, S.A.D. (1988): Protozoa- parasites of some fresh water fish in Behera governorate, Egypt.M.V.Sc.Thesis, Fac. Vet.Med., Alexandria Univ.

6. Aml El- Asaly, M. E. (2004): Studies on steroid induced monosex Nile Tilapia. M. V. Sc. Thesis, Fac. Vet. Med., (Banha Branch, Moshtohor) Zag. Univ.
7. Austin B. and Austin D. (2007): Bacterial fish pathogens, diseases of farmed and wild fish, 4th Ed. UK, p.552.
8. Bjerkas, E.; Breck, O. and Waagbø, R. (2006): The role of nutrition in cataract formation in farmed fish. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 1, 1–16.
9. Bjerkas, E. and Bjornestrød, E. (1999): Is there a connection between rapid fluctuation in water temperature and cataract development in the Atlantic salmon (*Salmo salar*). *Bull. Eur. Assoc. Fish Pathol.* 19(14): 166-169.
10. Bjerkas, E.; Bjornestrød, E.; Breck, O. and Waagbø, R. (2001): water temperature regimes affect cataract development in smolting Atlantic salmon, *Salmo salar* L.J. *Fish Dis.* 24(5): 281-291.
11. Bjerkas, E.; Holst, J.C.; Bjerkas, I. and Ringvold, A. (2003): Osmotic cataract causes reduced vision in wild Atlantic salmon postsmolts. *Dis. Aquat. Org.* 55(2): 151-159.
12. Borucinska, J. D.; Benz, G. W. and Whiteley, H. E. (1998): Ocular lesions associated with attachment of the parasitic copepod *Ommatokoita elongata* (Grant) to corneas of Greenland sharks, *Somniosus microcephalus* (Bloch & Schneider). *Journal of Fish Diseases.* 21, 415-422.
13. Bostock, J. (2002): *Animal Pharm Report. Aquaculture: A Global Market Study.* PJB Publications Ltd.
14. Burker, J.S.; Seikai, T.; Tanaka, Y. and Tanaka, M. (1998): Experimental intensive culture of summer flounder, *Paralichthys dentatus*. *Aquaculture 98 book of abstracts.* pp. 81.
15. Crowden, A.E. and Broom, D.M. (1980): Effects of eye fluke, *Diplostomum spathaceum* on the behaviour of dace (*Leuciscus leuciscus*). *Anim. Behav.* 28 (1), 187-24.
16. Delthlefsen, V. (1984): diseases of North sea fishes by water pollution. *Verh. naturwiss ver. Bremen.* 40(3):233-252.
17. Domitrovic, H.A.; Bechara, J.A.; Flores-Quintana, C.; Roux, J.P. and Gavilan, G. (2000): A survey study of gas supersaturation and fish gas-bubble disease in the parana River below Yacyreta Dam, Argentina, *Revista deictiologia orientes.* 8(1): 29-40.
18. Eissa, A. E. and Zaki, M. M. (2010): *Flavobacterium columnare* Myxobolus tilapiae Concurrent Infection in the Earthen Pond Reared Nile Tilapia (*Oreochromis niloticus*) During the Early Summer in Egypt. *Proceedings of the*

- WAVMA International Aquatic Veterinary Conference. Athens, Greece.
19. Eissa, I.A.M. (2002): Cataracta parasitica. Parasitic fish diseases in Egypt. (ed). Dar El-Nahdda El-Arabia Publishing, Cairo, Egypt.
 20. Eissa, I. A. M. (2006): Parasitic fish diseases in Egypt. 2nd Edt, Dar El- Nahda El- Arabia publishing, 23 Abd El- Khalak Tharwat St. Cairo, Egypt.
 21. Ersdal, C.; Midtlyng, P.J. and Jarp, J. (2001): An epidemiological study of cataracts in seawater farmed Atlantic salmon, salmon salar. *Dis.Aquat. Org.* 45(3):229-236.
 22. El-Bouhy, A.M. (1995): Some studies on fish's eye in health and disease. M.V. Sc., fish diseases & management. Dept. of poultry and fish diseases, Fac. Vet. Med. Zagazig Univ.
 23. El- Khatib, N. R. H. (2003): Biological eradication of some parasitic diseases in fishes using bacillus thuringiensis agerin® product. *Vet. Med. J.Giza.* 51(1)19-28.
 24. El-Seedy, F.R.; Hassan, W.H.; El-Newery, H. and Husien, M. (2009): A study on the biological and immunological characteristics of *Vibrio anguillarum* and *Vibrio vulnificus* extracellular products. *Beni-Suef. Vet. Med. J.*, 19(2), 53-61.
 25. Ferguson, H.W., Hawkins, L., MacPhee, D.D. and Bouchard, D. (2004): Choroiditis and cataracts in Atlantic salmon (*Salmo solar* L) recovering from subzero water temperatures. *Veterinary Record* 155:333-334.
 26. Hauck, A.K. (1986): Gas-bubble disease due to helicopter transport in young pink salmon. *Trans. Am. Fish. Soc.*, 115, 630-5.
 27. Iglesias, R.; Parana, A.; A; Varez, F. leiro, J. and Sanmartin, M. L. (2001): Myxoboloid parasites infecting the gills of the Iberian nase, *Chondrostoma polylepis* (Steindachner), in Galicia (Nw Spain), with a description of *Myxobolus gallaicas* sp. Nov. *J. fish Dis.*, 24 : 125-134.
 28. Isaacson, P.A. (1977): Theoretical consideration of the cause of the gas-bubble disease in fish in a heated effluent. *N.Y. Fish Game J.* 24(1): 95.
 29. Karlsbakk, E.; seather, P.A.; Hostlund, C.; Fjellsay, K.R. and Nylund, A. (2002): Parvicapsula pseudobranchicola n. sp.(Myxozoa) a myxosporidian infecting the Pseudobranch of cultured Atlantic salmon (salom salar) in Norway. *Bull. Eur. Assoc. fish Pathol.* 22(6): 381-387.
 30. Karvonen, A.; Seppaelae, O. and Valtonen, E.T. (2001): Parasite induced changes in host behaviour, studies with Diplostomum. *Bull.Scand. Soc. Parasitol.* 11(1): 21- 24.
 31. Kingsford, M.J.; Suthers, I.M. and Gray, C.A. (1997): Exposure to sewage plumes and the incidence of deformities in larval fishes. *Mar. Pollut. Bull.* 33(7)201-212.
 32. Kraxberger – Beatty, T., McGrey, D.J., Grier, H.J. and Lim, D.V. (1990): Vibrio harvayi, an opportunistic pathogen of common snook, Centropomus undecimalis (Block), held in captivity. *J. Fish Dis.* 13(6): 557-560.
 33. Lee, W.R. (2002): *Ophthalmic Histopathology (2nd edition)*. Springer-Verlag, London, U.K. 23.
 34. Lucky, Z. (1977): Methods for the diagnosis of fish diseases, Amerind. publishing Co., P V T. Ltd., New Delhi, Bombay, India .
 35. Mohamed, M.A.; Ezz El Dien and Elsayed, E.E. (2004): Tissue protozoa (*Myxobolus dermatobia*) from the eye in Tilapia zilli in Egypt. 1st inter conf. Vet. Res. Div., NRC, Egypt, pp. 307- 319.
 36. Ness, J.H. and Foster, S.A. (1999): Parasitic-associated phenotypic modifications in threespine stickleback. *Oikos.* 85(1):127-134.
 37. Noga, E. J. (2010): Fish disease Diagnosis and Treatment. Mosby-yearbook, Inc. watsworth publishing Co., USA. p.366.
 38. Noor El-Deen, A. I. E (2007): Studies on prevailing parasitic diseases affecting monosex tilapis and natural male tilapia in Kafr El Sheikh Governorate. PH D.Sc.Thesis, Fac. Vet.Med., Kafr El Sheikh Univ.
 39. Noor El- Deen, A.I. E. ; Mona, S. Zaki; Razin, A.M. and Shalaby S. I. (2010): Field Study on the use of Artemisa cina (Sheih Baladi) and humates (Humpol-Fis) in control of *saprolegniosis* in fingerlings of Nile tilapias and Mugil cephalus in freshwater fish farms. *Life Science Journal*, 7(3)125-128.
 40. NRC (National Research Council) (2011): *Nutrient requirements of fish*, Washington, D.C.: National Academy Press 114 pp.
 41. Okaeme, A. N.; Obiekezie, A. I.; Lettman, J.; Antai, E. E. and Madu, C. T. (1988): Parasites and diseases of cultured fish of lake kainji area , Nigeria. *J. Fish Biol.*, Vol. 32, No, 3, pp. 479 – 481.
 42. Osman, H.A.; Tagred, I. Borhn; Noor El-Deen, A.E. and Laya F. El-Bana (2008): Estimation of skin and gill monogenea and musculature in *O. niloticus* treated by praziquantel using HPLC. *Life Science Journal.* 5 (3): 41 – 46.
 43. Plumb, J.A. and Rogers, W.A. (1990): Effect of droncit (Prazicontael) on yellow grubs *Clinostomum marginatum* and eye flukes *Diplostomum spathaceum* in channel catfish. *J. Aquat. Anim. Health.* 2(3): 204-206.
 44. Roberts, R. J. (2012): Fish pathology. 4th edition published by Blackwell, Publishing Ltd., UK.
 45. Russo, R.; Mitchell, H. and Yanong, R.P.E. (2006): Characterization of *Streptococcus iniae* isolated from ornamental cyprinid fishes and development of challenge models *Aquacult.* 256, 105–110.

46. Saburoh, S.K.; Teruo, M. and Syuzo,E.(1982):Color Atlas of fish pathology. Shin.Suisan,Shin bun.Sha,Ltd. Roppongi,Minato-Ku,Tokyo,Japan.
47. Schlotfeldt, H.J. and Wegener,A.(2000): Clinical screening for cataracts in rainbow trout and non-salmonid fish in traditional freshwater pond farming. Bull.Eur.Assoc. Fish Pathol. 20(6):252-255.
48. Shariff, M.; Richards, R.H. and Sommerville, C. (1980): The histopathology of acute and chronic infections of rainbow trout *Salmo gairdneri* Richardson with eye flukes, *Diplostomum* spp.*J. Fish Dis.*, 3, 455-65.
49. Somga, S. S. ; Somga, J. R. ; Reantaso, M. B. and Regidor, S. E. (1999): Preliminary health assessment of small scale grouper culture in Philippines . Fourth symposium on diseases in Asian aquaculture,book of abstracts.pp,75.
50. Speare, D. J. (1998): Disorders associated with exposure to excess dissolved gases. Fish diseases and disorders,Vol, 2: Non -infectious disorders (eds. J. F. Leatherland and P.O.K.Woo).pp.207-222.
51. Stephens, F. J.; Cleary, J. J.; Jenkins, G.; Jones, B.; Radial, S. R. and Thomas, J. B.(2002): Pathogenesis and epidemiology of spontaneous exophthalmos in the West Aust. dhufish,*Glaucosoma hebraicum* Richardson.*J.Fish Dis.*24(9):515-522.
52. Sun, P.L.; Overstreet,R.M.; Hawkins, W.E.; Tsai, S.H. and Brown-Peterson, N.(1998): Morphological abnormalities in tilapia and other native fish species from Southern Taiwan contaminated rivers, also discuss the possible cause of those abnormalities. World aquaculture society p. 524.
53. Taoka, Y.; Maeda, H.; Jo, J.Y.; Kim, S.M.; Park, S.I. and Sakata, T. (2006): Use of live and dead probiotic cells in tilapia *Oreochromis niloticus*; *Fish. Sci.* 72, 755-766.
54. Vazquez- Gamboa, L.; Usma- Oviedo, J. S. and Liceth- Garcia, C. (2001): Nematode and Trematode parasites in South American trout (*Drycon Whitei* Myers and Weitzman, 1960). (Pisces: Characidae) from the Morador River, Portuguea state, Venezuela. *Memoria De. La. Fandaction La. Salle. De. Ciencias Naturales.*61(155): 133- 137.
55. Williams,C.D.;Faisal,M. and Huggett,R.J. (1992): Polynuclear aromatic hydrocarbons and fish lens cataract: Effects of benzo(a) piyrene 7, 8-dihydodiol on the macromolecular synthesis of cultured eye cells.*Mar.Environ.Res.*34(1):4.
56. Woo,P.K.(2006):Fish diseases and disorders. CAB, Int.Wallingford, Oxon, Uk. pp.78-83.

9/2/2012