Biological and Applied Environmental Research

Vol. 3 (1): 42-56, 2019

ISSN: 2002-6153
Biol. Appl. Environ. Res.
www.baerj.com
editor@baerj.com

Checklists of Fungi and Fungal-like Organisms Infecting Fishes of Basrah Province, Iraq

Furhan T. Mhaisen[1*] & Khalidah S. Al-Niaeem[2]

[1]Tegnervägen 6B, 641 36 Katrineholm, Sweden
[2]Department of Fisheries and Marine Resources, College of Agriculture, University of Basrah, Basrah, Iraq

*Corresponding author: mhaisenft@yahoo.co.uk

Abstract: Reviewing literature concerning the fungi and fungal-like organisms infecting fishes of Basrah province, Iraq showed the occurrence of three species of the phylum Ascomycota, one species each of the phylum Zygomycota and the phylum Microsporidia, two species of the phylum Choanozoa and five species of the phylum Oomycota. Among the inspected fishes, the cichlid fish *Oreochromis aureus* was infected with the highest number of species (six species), followed by both the cyprinid fish *Cyprinus carpio* and the silurid fish *Silurus triostegus* (four species each), while 11 fish species were infected with only one species each. The choanozoan *Ichthyophonus hoferi* was the commonest species as it was recorded from 12 fish host species, followed by *Saprolegnia* sp. which was reported from ten fish host species, while seven of the remaining fungal and fungal-like organism species infected only one host species each.

Keywords: Checklists, Fungi, Fungal-like organisms, Fishes, Basrah, Iraq.

Introduction

Fungi are common in the aquatic environment. They are responsible along with the bacteria, for the breakdown of organic materials and help in recycling of nutrients in nature. In addition, some fungi are known to be parasitic on algae, other higher aquatic plants and animals (Muhsin, 1977). An interesting list of aquatic fungi of Iraq, of which the majority was from Basrah province, was prepared by Muhsin (2012).

In the last decade, fish farming in several parts of the world has increased many folds. As a result, fish culture has now become commercially an important industry worldwide. The growth of fish culture has also increases issues of fish health. Bacterial haemorrhagic septicaemia, lernaeasis, saprolegniasis and anoxia are the most commonly found fish diseases in pond fishes (Iqbal et al., 2001). Fungal infections are among the most common diseases seen in temperate fishes. Poor water quality can also lead to an increase in fungal infections in an otherwise healthy fish population (Verma, 2008). Fungal diseases are the second most serious cause of fishes, but mostly these fungi are secondarily infected fishes after mechanical damage or come after viral or bacterial infections, or after parasitic infection causing injury to the fish organs (Duijn, 1973). Water moulds infections cause losses of freshwater fishes and their eggs in both natural and commercial fish farms (Bangyeekhun & Sylvie, 2001). Sometime mortality rate reach up to 80-100% due to fungal infection in incubated eggs (Chukanhom & Hatai, 2004). Gozlan et al. (2014) reviewed the current knowledge gaps of fungal and fungal-like parasites and pathogens in fish and put them into an ecological perspective with direct implications for the monitoring of fungal fish pathogens in the wild, their phylogeography as well as their associated ecological impact on fish populations. Chances of fungal infections include poor quality of water, poor hygiene, fish that are injured

Received Sept. 9, 2018, accepted Jan. 20, 2019

have other diseases and dead fish/large amounts of decomposing organic material in the pond (Patel et al., 2018).

As far as the availability of only few articles on fungi and fungal-like organisms infecting fishes of Basrah province scattered here and there, it can be said that fish mycology in Basrah province is neglected when compared with fish parasitology of the same province where a total of 333 parasite species are so far known from previous checklists of different fish parasite groups achieved on the same province (Mhaisen et al., 2013a, b, c; Ali et al. 2014; Mhaisen et al., 2014; Khamees et al., 2015; Mhaisen et al., 2016, 2017, 2018). So, the time now is necessary in this article to provide checklists of fungi and fungal-like organisms infecting fishes of this province. This, hopefully, will attract the concerned researchers to contribute more on fish mycology in this province.

Sources and Methods

A total of 32 references (19 research papers, five unpublished M. Sc. theses, five unpublished Ph. D. theses, one checklist and two conference abstracts) dealing, totally or partially, with the fungal and fungal-like organisms which were isolated from fishes of Basrah province, Iraq were used to prepare the present article. This will be followed by an alphabetically listing of fungi and fungal-like organisms in each major group. Organism listing will include alphabetically arranged fish valid host species involved for each infective organism species together with their references. The total number of host species of such infective organisms so far recorded from fishes of Iraq will be declared depending on the index-catalogue of parasites and disease agents infecting fishes of Iraq (Mhaisen, 2018). Data from such references were gathered to provide a list of fungi and fungal-like organisms as well as a list of fishes and their fungi and fungal-like organisms based mainly on GBIF (2018) in addition to EOL (2018), Index Fungorum (2018) and WoRMS (2018).

Investigations on Fungi and Fungal-Like Organisms of Fishes of Basrah Province

The following is a short historical account on different investigations carried out on fungi and fungal-like organisms infecting fishes of Basrah province. Brief account on these investigations will be given here as their details will be given in the forthcoming parts of this review.

Mhaisen et al. (1993) indicated that the senior author (F. T. Mhaisen) had isolated the fungus *Saprolegnia parasitica* from the eggs of the common carp *Cyprinus carpio* of University of Basrah fish farm at Al-Tannuma, Basrah province in March 1983 and he cured the infected eggs with formalin.

Jori (1998) reported *Saprolegnia* sp. from *Planiliza abu* (reported as *Liza abu*) and *Planiliza subviridis* (reported as *Liza subviridis*) from Garmat Ali river at the site of the campus of University of Basrah.

Adday (2001), while studying the biological aspects of the crustacean *Ergasilus ogawai* infecting some freshwater fish species from Garmat Ali river, detected the fungus *Ichthyophonus hoferi* from both *Mastacembelus mastacembelus* and *Silurus triostegus*.

Al-Daraji et al. (2002) used four chemical compounds to treat both *C. carpio* and *P. abu* (reported as *L. abu*) from the ponds of the Experimental Culture Station at the Marine Science Center which were infected with *S. parasitica* as well as two external parasite species.

Al-Salim & Jori (2002) published an article concerned with the infection of two fish species from Garmat Ali river with *Saprolegnia* sp. as demonstrated above by Jori (1998).

Abed (2005) investigated three fish farms (two in Basrah province and one in Babylon province) for fish enemies (inclusive of parasites and fungi) and detected *Saprolegnia* sp.

from the silver carp *Hypophthalmichthys molitrix* only in Basrah University fish farm at Marine Science Center.

Jarallah et al. (2005) reported the infection of *Gambusia holbrooki* (reported as *Gambusia affinis*) from Al-Hammar marsh with the fungus *S. parasitica*.

Al-Duboon et al. (2006) while transferring *Mesopotamichthys sharpeyi* (reported as *Barbus sharpeyi*) from Qurna marshes to fish ponds in Marine Science Center detected the infection of these fishes with the fungus *S. parasitica*.

Al-Niaeem (2006) indicated the infection of *P. abu* (reported as *L. abu*), *Carassius auratus, C. carpio, G. holbrooki* (reported as *G. affinis*) and *Poecilia sphenops* with the fungus *Saprolegnia* sp. in addition of the infection of some of these fishes with 10 parasite species. *C. carpio, G. holbrooki* and *P. abu* were collected from both Garmat Ali river and fish ponds of Marine Science Center, *C. auratus* was collected from both aquaria of College of Agriculture of the University of Basrah and Al-Amwaj aquarium shop at Basrah city while *P. sphenops* was collected from aquaria of College of Agriculture.

Jori (2006) investigated the parasitic fauna of *S. triostegus* from Al-Hammar marsh and detected two fungal species (*Saprolegnia diclina* and *Saprolegnia* sp.) from this fish species.

Abbas (2007) also investigated the parasitic fauna of *S. triostegus* from Al-Hammar marsh and detected *S. diclina* from this fish species. In addition, he also reported *Glugea plecoglossi* from the same fish species.

Al-Salim et al. (2007) published part of the thesis submitted by Al-Niaeem (2006). They mentioned the infection of *C. carpio, G. holbrooki* (reported as *G. affinis*) and *P. abu* (reported as *L. abu*) with *Saprolegnia* sp. They also gave a comparison in the monthly infection of these three above-named fish species from Garmat Ali river and fish ponds of Marine Science Center with *Saprolegnia* sp.

Al-Salim et al. (2008) published another article abstracted from the thesis submitted by Al-Niaeem (2006). They mentioned the infection of *C. carpio* from fish ponds of Marine Science Center with *Saprolegnia* sp. They experimentally infected *C. carpio* with this fungus and demonstrated its histopathological changes in gills and liver of this fish.

Al-Niaeem & Al-Yassein (2009) carried out the treatment of *G. holbrooki* (reported as *G. affinis*) with *Saprolegnia* sp. by using four types of plant extracts.

Al-Salim et al. (2009) experimentally infected *C. carpio* with *Saprolegnia* sp. and demonstrated some of the physiological parameters of blood of this fish.

Kadhim (2009) investigated the parasitic fauna of *Aphanius dispar, A. mento, G. holbrooki* and *Poecilia latipinna* from Garmat Ali river and Khora canal and detected *Saprolegnia* sp. from both *G. holbrooki* from Garmat Ali river and *P. latipinna* from both Garmat Ali river and Khora canal.

Al-Janae'e (2010) investigated the parasitic fauna of 25 fish species from Garmat Ali river and Al-Salihiya river. He detected the infection of six fish species (*Carasobarbus luteus* as *B. luteus, C. auratus, Leuciscus vorax* as *Aspius vorax, P. abu* as *L. abu, P. subviridis* as *L. subviridis* and *Tenualosa ilisha*) from Garmat Ali river and nine fish species (*Acanthobrama marmid, Arabibarbus grypus* as *Barbus grypus, C. luteus* as *B. luteus, C. auratus, C. carpio, Hemiculter leucisculus, L. vorax* as *A. vorax, P. abu* as *L. abu* and *P. subviridis* as *L. subviridis*) from Al-Salihiya river with the fungus *I. hoferi*. He also detected the infection of two fish species (*C. auratus* and *P. abu* as *L. abu*) from Garmat Ali river and two fish species (*C. auratus* and *P. latipinna*) from Al-Salihiya river with *Saprolegnia* sp.

Al-Saboonchi et al. (2010) published an article extracted from the thesis submitted by Al-Janae'e (2010). The article was concerned with the effect of salinity changes in Al-Salihiya canal on the biodiversity of fish fauna. No parasite- host list was given and the infection with *I. hoferi* and *Saprolegnia* sp. was not provided with a host list.

Badr (2010) isolated *Achlya* sp., *Saprolegnia ferax*, *S. hypogena*, *S. parasitica* and *Saprolegnia* sp. from three stations at Shatt Al-Arab river as well as from aquaria of Marine Science Center and College of Agriculture. She experimentally infected *C. auratus*, *Ctenopharyngodon idella* and *C. carpio* as well as eggs of *C. carpio* with *S. parasitica*. Also, she treated the infected *C. carpio* with three different materials and also investigated the histopathological changes in skin and muscles of *C. auratus* infected with *S. parasitica*.

Mhaisen et al. (2010) prepared a list of parasites and disease organisms infecting cultured fishes of Basrah province in which they included two fungal species (*S. parasitica* and *Saprolegnia* sp.) from seven fish species (*C. auratus*, *C. carpio*, *G. holbrooki* as *G. affinis*, *H. molitrix*, *P. abu* as *L. abu*, *M. sharpeyi* as *B. sharpeyi* and *P. sphenops*).

Badr et al. (2011) published an article, extracted from Badr (2010) dealing with the histological changes in skin and muscles of *C. auratus* experimentally infected with *S. parasitica*.

Hussein et al. (2011) published an article, extracted from Abed (2005) dealing with the parasites and fish enemies in Basrah University fish farm and mentioned the infection of *H. molitrix* with *Saprolegnia* sp.

Al-Niaeem et al. (2012) isolated *Achlya* sp. and *Saprolegnia* sp. from *C. carpio* at fish pond of University of Basrah and investigated the effect of temperature, pH, sodium chloride and antibiotics on the growth of these fungi.

Badr et al. (2012) carried out the experimental infection of *C. auratus* from aquaria of College of Agriculture, as well as *C. idella* and *C. carpio* from fish pond of Marine Science Center with *S. parasitica* in addition with the infection of eggs of *C. carpio*. They treated the infected fish with three chemicals as well as two types of fungicides.

Al-Niaeem et al. (2013) demonstrated the susceptibility of the fungus *Saprolegnia* sp. which was isolated from *C. carpio* to the extract of 16 types of crude plants.

Eassa et al. (2014) investigated the parasitic fauna of *C. carpio* from fish cages at Qurna, Dayr and Abu Al-Khaseeb as well as from Shatt Al-Arab river. They recorded *Saprolegnia* sp. from cage fishes of all these localities and *I. hoferi* from cage fishes at Abu Al-Khaseeb only, while only *Saprolegnia* sp. was recorded from *C. carpio* from Shatt Al-Arab river.

Al-Niaeem (2015) isolated the fungus *Ichthyophonus* sp. from the blue tilapia *Oreochromis aureus* from fish ponds of Marine Science Center and studied the histopathological changes in gills, liver and intestine of these fishes with this fungus.

Al-Niaeem et al. (2015) reported the infection of *O. aureus* from fish ponds of Marine Science Center with the following six fungal species: *Alternaria* sp., *Aspergillus* sp., *Brachiomyces* sp., *Ichthyophonus* sp., *Mucor* sp. and *Penicillium* sp.

Al-Janae'e (2017) detected the infection of *Coptodon zillii* with *Aspergillus* sp., *Penicillium* sp. and *Saprolegnia* sp. in Basrah Prawn Hatchery and carried out a series of experiments for investigating the inhibitory effect of the water extract of 15 aromatic and aquatic plants to combat these fungi. Also, he investigated the effect of water extracts of nine plants to resist the infection of eggs of *C. carpio* with *S. parasitica* in order to be as alternatives for the traditionally-used fungicide malachite green.

Al-Janae'e et al. (2017) tested the efficacy of the aquatic extract of four aromatic plants on treating the eggs of *C. carpio* which were infected with *S. parasitica* in Basrah Prawn Hatchery as alternatives to the malachite green.

Ameen et al. (2018) assessed the efficiency of four plant extracts against the infection of *O. aureus* with *Ichthyophonus* sp. from fish ponds of the University of Basrah.

Finally, it is appropriate to mention here that Herzog (1969) was the first one to report on the fungal infections of fishes of Iraq, beside his major concern of fish parasites, revealed the infection of *P. abu* (reported as *Mugil abu*) with *Saprolegnia* sp., *Oreochromis niloticus* (reported as *Tilapia nilotica*) with *Aphanomyces* sp. and the infection of *A. grypus* (reported

as *B. grypus*), *C. luteus* (reported as *B. luteus*) and *Luciobarbus esocinus* (reported as *Barbus esocinus*) with *Ichthyosporidium hoferi*. The locality of infection was determined for the first two fungal species as Al-Zaafaraniya and Mahmoodiya, respectively in Baghdad province, but no locality information was given in the case of infection with *I. hoferi*. So, nobody can ascertain this infection as from fishes of Basrah province.

Results and Discussion

Surveying literature concerning the fungi and fungal-like organisms which are so far reported from fishes of Basrah province showed the infection of 19 valid fish species with these organisms. The full authority of each valid fish host species is shown in Table 1. Names of fish hosts are quoted as they appeared in the reviewed literature but the valid names were updated in accordance with two well-known electronic sites (Eschmeyer, 2018; Froese & Pauly, 2018).

Table 1. List of valid fish species which showed fungal and fungal-like infections of Basrah province.

Class Actinopterygii
Order Clupeiformes
Family Clupeidae
Tenualosa ilisha (Hamilton, 1822)
Order Cypriniformes
Family Cyprinidae
Acanthobrama marmid Heckel, 1843
Arabibarbus grypus (Heckel, 1843)
Carasobarbus luteus (Heckel, 1843)
Carassius auratus (Linnaeus, 1758)
Cyprinus carpio Linnaeus, 1758
Hemiculter leucisculus (Basilewsky, 1855)
Hypophthalmichthys molitrix (Valenciennes, 1844)
Leuciscus vorax (Heckel, 1843)
Mesopotamichthys sharpeyi (Günther, 1874)
Order Siluriformes
Family Siluridae
Silurus triostegus Heckel, 1843
Order Cyprinodontiformes
Family Poeciliidae
Gambusia holbrooki Girard, 1859
Poecilia latipinna (Lesueur, 1821)
Poecilia sphenops Valenciennes, 1846
Order Synbranchiformes
Family Mastacembelidae
Mastacembelus mastacembelus (Banks & Solander, 1794)
Order Perciformes
Family Cichlidae
Coptodon zillii (Gervais, 1848)
Oreochromis aureus (Steindachner, 1864)
Order Mugiliformes
Family Mugilidae
Planiliza abu (Heckel, 1843)
Planiliza subviridis (Valenciennes, 1836)

List of Fungi and Fungal-Like Organisms Infecting Fishes of Basrah Province

Fungi and fungal-like organisms infecting fishes of Basrah province are grouped here in the following systematic account according to GBIF (2018) as it covers all the concerned organisms in this article. Some information was also obtained from EOL (2018), Index Fungorum (2018) and WoRMS (2018).

Kingdom Fungi
- Phylum Ascomycota
  - Class Dothideomycetes
    - Order Pleosporales
      - Family Pleosporaceae
        - *Alternaria* sp.
  - Class Eurotiomycetes
    - Order Eurotiales
      - Family Trichocomaceae
        - *Aspergillus* sp.
        - *Penicillium* sp.
- Phylum Zygomycota
  - Class Mucoromycetes
    - Order Mucorales
      - Family Mucoraceae
        - *Mucor* sp.

Kingdom Protozoa
- Phylum Microsporidia
  - Class Microsporea
    - Order Glugeida
      - Family Glugeidae
        - *Glugea plecoglossi* Strickland, 1911
- Phylum Choanozoa
  - Class Ichthyosporea
    - Order Amoebidialis
      - Family Amoebidiaceae
        - *Ichthyophonus hoferi* Plehn & Muslow 1911
        - *Ichthyophonus* sp.

Kingdom Chromista
- Phylum Oomycota
  - Class Peronosporea
    - Order Saprolegniales
      - Family Saprolegniaceae
        - *Achlya* sp.
        - *Saprolegnia diclina* Humphrey 1892
        - *Saprolegnia parasitica* Coker 1923
        - *Saprolegnia* sp.
      - Family Incertae sedis
        - *Branchiomyces* sp.

The following is an alphabetical listing of all fungal and fungal-like organisms infecting fishes of Basrah province. For each agent, alphabetically arranged fish hosts involved will be given together with their concerned references.

Achlya sp. was reported from skin of *C. carpio* from fish pond of Basrah University by Al-Niaeem et al. (2012). The first identified *Achlya* species (*A. polyandra*) isolated from fishes of Iraq was by Butty et al. (1989) from both *C. carpio* and *P. abu* (reported as *L. abu*) from Baghdad. Al-Shammeri (2011) and Al-Shammari et al. (2015) reported *Achlya* sp. from eggs, larvae and adults of *C. carpio* from Al-Manahel and Al-Wahda fish hatcheries, middle of Iraq. Al-Shammari (2016) isolated *Achlya* sp. from eggs of *C. carpio* from a private-sector fish hatchery, south of Baghdad. No more records on *Achlya* species are so far known from fishes of Iraq (Mhaisen, 2018). According to GBIF (2018), the genus *Achlya* Nees includes 61 accepted species, while Index Fungorum (2018) lists 101 species in addition to some varieties and forms.

Alternaria sp. was reported from gills, caudal fins and skin of the blue tilapia *O. aureus* from fish pond of Basrah University by Al-Niaeem et al. (2015). This is the only record so far known for this fungus from fishes of Iraq (Mhaisen, 2018). According to GBIF (2018), the genus *Alternaria* Nees ex Wallroth, 1816 includes 538 accepted species and 27 doubtful species. However, Index Fungorum (2018) includes 743 records which also include different varieties as well as different forms. On the other hand, EOL (2018) lists 135 species of this genus and WoRMS (2018) lists three valid marine species.

Aspergillus sp. was reported from skin of *C. zillii* from Basrah Prawn Hatchery by Al-Janae'e (2017) and from head, gills, caudal fins, dorsal fins, pectoral fins and skin of *O. aureus* from fish pond of Basrah University by Al-Niaeem et al. (2015). The first *Aspergillus* species in Iraq (*A. fumigatus*) was reported from both *C. luteus* (reported as *B. luteus*) and *L. vorax* (reported as *A. vorax*) from Diyala river by Al-Rubaie et al. (2003). No more *Aspergillus* species are so far known from fishes of Iraq (Mhaisen, 2018) except eight species from dried marine fish *Scomberoides commersonnianus* which were reported by Salih et al. (2011). According to GBIF (2018), the genus *Aspergillus* P. Micheli ex Link includes 496 valid species and 172 doubtful species. Index Fungorum (2018) includes 1035 records for this genus, inclusive of different varieties as well as different forms. However, WoRMS (2018) includes nine valid marine species within this genus. On the other hand, EOL (2018) lists 206 species of this genus. It is appropriate to mention here that Index Fungorum (2018) considers this genus as belonging to the family Aspergillaceae and not to the family Trichocomaceae as the case in EOL (2018), GBIF (2018) and WoRMS (2018).

Branchiomyces sp. was reported from gills of the blue tilapia *O. aureus* from fish pond of Basrah University by Al-Niaeem et al. (2015). Previously in Iraq, only two species of this genus were reported. These included *B. demigrans* from *C. luteus* (reported as *B. luteus*) by Rahemo & Taha (2012) as well as in a repeated article (Rahemo & Taha, 2013) from Mosul dam lake and *B. sanguinis* from *C. carpio* by Ibrahim (2011) from a fish farm at Duhok province, in addition to unidentified *Branchiomyces* species from both *C. carpio* and *P. abu* (reported as *L. abu*) by Aboud & Mahmood (2013) from undetermined locality. According to GBIF (2018), EOL (2018) and Index Fungorum (2018), the genus *Branchiomyces* Plehn includes only the above-named two species. EOL (2018) does not assigned a family for this genus, while Index Fungorum (2018) states its family as Incertae sedis and GBIF (2018) gives no family for this genus. No any record on *Branchiomyces* is available in WoRMS (2018).

Glugea plecoglossi Strickland, 1911 was reported from skin, liver and intestine of *S. triostegus* from Al-Hammar marsh by Jori (2006) and from the stomach of the same fish from the same marsh by Abbas (2007). Both Jori (2006) and Abbas (2007) erroneously reported the authority of this disease agent as Takahashi & Egusa, 1977 instead of Strickland, 1911. Previously in Iraq. Two species of this genus were reported. These included *G. anomala* from *C. luteus* by Ali et al. (1988a, b) from two man-made lakes at Al-Nibaey region, Salah Al-Din province and from both *A. marmid* and *Capoeta trutta* (reported as *Varicorhinus trutta*) by Abdul-Ameer (1989) from Tigris river at Baiji city of Salah Al-Din province as well as *G.*

dogieli which was reported from *C. luteus* by Ali et al. (1988a) as *Glugea luciopercae* from the same man-made lakes. WoRMS (2018) considers *G. dogieli* as a synonym of *G. luciopercae*, but GBIF (2018) considers both *G. dogieli* and *G. luciopercae* as valid species. According to GBIF (2018), the genus *Glugea* Thélohan, 1819, which belongs to the phylum Microsporidia of the kingdom Protozoa includes 39 valid species and three doubtful species. Index Fungorum (2018) lists 90 species within this genus. According to WoRMS (2018), this genus which belongs to phylum Microsporidia of the kingdom Fungi includes 27 accepted species and 12 unaccepted species. On the other hand, EOL (2018) includes only two species within this genus which is considered within the Microspora of the kingdom Fungi. Both GBIF (2018) and WoRMS (2018) enlist *G. plecoglossi* within the valid species of this genus.

Ichthyophonus hoferi Plehn & Mulsow 1911 was recorded from heart, digestive tract and liver of 12 fish species in Basrah province: *A. marmid* by Al-Janae'e (2010), *A. grypus* (reported as *B. grypus*) by Al-Janae'e (2010), *C. luteus* (reported as *B. luteus*) by Al-Janae'e (2010), *C. auratus* by Al-Janae'e (2010), *C. carpio* by Al-Janae'e (2010) and Eassa et al. (2014), *H. leucisculus* by Al-Janae'e (2010), *L. vorax* (reported as *A. vorax*) by Al-Janae'e (2010), *M. mastacembelus* by Adday (2001), *P. abu* (reported as *L. abu*) by Al-Janae'e (2010), *P. subviridis* (reported as *L. subviridis*) by Al-Janae'e (2010), *S. triostegus* by Adday (2001) and *T. ilisha* by Al-Janae'e (2010). The first record of *I. hoferi* in Iraq was from gills of *C. carpio* by Mhaisen & Abul-Eis (1991) from Babylon fish farm (now Babylon fish farm) at Babylon province. A total of 23 fish host species are so far known for *I. hoferi* in Iraq (Mhaisen, 2018).

Ichthyophonus sp. was isolated from skin of the blue tilapia *O. aureus* from fish pond of Basrah University by Al-Niaeem (2015), Al-Niaeem et al. (2015) and Ameen et al. (2018). A total of five fish host species are so far known for *Ichthyophonus* sp. in Iraq (Mhaisen, 2018), of which that of Al-Niaeem (2015) was the first record of unidentified *Ichthyophonus* species. According to GBIF (2018), the genus *Ichthyophonus* Plehn & Muslow, 1911 which belongs to the phylum Choanozoa of the kingdom Protozoa, includes three doubtful species (inclusive of *I. hoferi*), while Index Fungorum (2018) lists four species (inclusive of *I. hoferi* also), but no any mention for any *Ichthyophonus* species is available in WoRMS (2018).

Mucor sp. was reported from head, gills, dorsal fins, pectoral fins and skin of the blue tilapia *O. aureus* from fish pond of Basrah University by Al-Niaeem et al. (2015). No more records are so far known for this fungus from fishes of Iraq (Mhaisen, 2018). GBIF (2018) considers the genus *Mucor* P. Michel ex Fr. as a synonym of *Rhizopus* Ehrenb. Index Fungorum (2018) includes 728 records within this genus. EOL (2018) includes 701 records for this genus, inclusive of different varieties as well as different forms, while WoRMS (2018) lists only three marine species of the genus *Mucor*.

Penicillium sp. was reported from skin of *C. zillii* from Basrah Prawn Hatchery by Al-Janae'e (2017) and from gills, caudal fin and skin of *O. aureus* from fish pond of Basrah University by Al-Niaeem et al. (2015). No more records are so far known for this fungus from fishes of Iraq (Mhaisen, 2018). GBIF (2018) enlists 492 valid species and 277 doubtful species within the genus *Penicillium* Link while Index Fungorum (2018) includes 1276 records for this genus, inclusive of different varieties as well as different forms. EOL (2018) enlists 246 species within this genus and WoRMS (2018) recognizes only 10 marine valid species and one terrestrial species within this genus. EOL (2018), GBIF (2018) and WoRMS (2018) consider this genus as belonging to the phylum Ascomycota of the kingdom Fungi. It is appropriate to mention here that Index Fungorum (2018) considers this genus as belonging to the family Aspergillaceae and not to the family Trichocomaceae as the case in EOL (2018), GBIF (2018) and WoRMS (2018).

Saprolegnia diclina Humphrey 1892 was reported from skin, fins, gills and skin of *S. triostegus* from Al-Hammar marsh by Jori (2006) and skin of the same fish from the same

marsh by Abbas (2007). It is reliable to state here that both Jori (2006) and Abbas (2007) had erroneously stated the authority of this fungus as Seymour, 1970 instead of Humphrey 1892. No more hosts are so far known for this fungus in Iraq (Mhaisen, 2018). Ismail et al. (1979) isolated *S. diclina* from waters of Shatt Al-Arab river, Basrah who stated the year of authority of *S. diclina* as 1893 instead of 1892 as the case in GBIF (2018) and EOL (2018). WoRMS (2018) demonstrated only the family Saprolegniaceae without nominating any species.

Saprolegnia parasitica Coker 1923 was reported from fins, gills and skin of four fish species from Basrah province: *C. carpio* by Mhaisen et al. (1993), Al-Daraji et al. (2002), Al-Janae'e (2017) and Al-Janae'e et al. (2017), *G. holbrooki* (reported as *G. affinis*) by Jarallah et al. (2005), *M. sharpeyi* (reported as *B. sharpeyi*) by Al-Duboon et al. (2006) and *P. abu* (reported as *L. abu*) by Al-Daraji et al. (2002). Experimental infection with *S. parasitica* in Basrah province was achieved for *C. auratus* by Badr (2010) and Badr et al. (2011, 2012), *C. idella* by Badr (2010) and Badr et al. (2012) and *C. carpio* by Badr (2010) and Badr et al. (2012). As mentioned before, the first record of *S. parasitica* from fishes of Iraq was that of Mhaisen et al. (1993) from *C. carpio*. A total of nine fish host species are so far known for *S. parasitica* in Iraq (Mhaisen, 2018). EOL (2018), GBIF (2018) and Index Fungorum (2018) enlist *S. parasitica* as a valid species, but WoRMS (2018) considers only the family Saprolegniaceae without nominating any species.

Saprolegnia sp. was reported from fins and skin of ten fish species from Basrah province: *C. auratus* by Al-Niaeem (2006) and Al-Janae'e (2010), *C. zillii* by Al-Janae'e (2017), *C. carpio* by Al-Niaeem (2006), Al-Salim et al. (2007, 2008, 2009), Al-Niaeem et al. (2012, 2013) and Eassa et al. (2014), *G. holbrooki* (reported also as *G. affinis*) by Al-Niaeem (2006), Al-Salim et al. (2007), Al-Niaeem & Al-Yassein (2009) and Kadhim (2009), *H. molitrix* by Abed (2005) and Hussein et al. (2011), *P. abu* (reported as *L. abu*) by Jori (1998), Al-Salim & Jori (2002), Al-Niaeem (2006), Al-Salim et al. (2007) and Al-Janae'e (2010), *P. subviridis* (reported as *L. subviridis*) by Jori (1998) and Al-Salim & Jori (2002), *P. latipinna* by Kadhim (2009) and Al-Janae'e (2010), *P. sphenops* by Al-Niaeem (2006) and *S. triostegus* by Jori (2006). The first unidentified *Saprolegnia* in Iraq was reported from *P. abu* (reported as *Mugil abu*) by Herzog (1969). A total of 16 fish host species are so far known for the unidentified *Saprolegnia* species in Iraq (Mhaisen, 2018). EOL (2018) enlists 164 species of which 25 are specific species. GBIF (2018) enlists 49 valid species and 30 doubtful species. Index Fungorum (2018) includes124 records for this genus, inclusive of different varieties as well as different forms. However, WoRMS (2018) considers only the family Saprolegniaceae without nominating any species. It is reliable to state here that EOL (2018) considers this genus within the phylum Myxomycota of the kingdom Chromista, but GBIF (2018) considers it within the phylum Oomycota of the kingdom Chromista.

It is worthwhile to list the records of experimental infection of some fungi and fungal-like organisms achieved on some fish species of Basrah province. These included the following fishes: *C. auratus* with *S. parasitica* by Badr (2010) and Badr et al. (2011, 2012), *C. idella* with *S. parasitica* by Badr (2010) and Badr et al. (2012) and *C. carpio* with *Saprolegnia* sp. by Al-Niaeem (2006), Al-Salim et al. (2008), Al-Niaeem & Al-Yassein (2009), Al-Salim et al. (2009), Badr (2010) and Badr et al. (2012) in addition to the infection of eggs of *C. carpio* with *S. parasitica* by Badr (2010) and Badr et al. (2012).

Finally, Table 2 is given here to include alphabetically arranged fungal and fungal-like organisms infecting alphabetically arranged valid fish species of Basrah province.

Table 2: List of fungal species so far recorded from valid fish species of Basrah province.

Fungal species	Fish host species
Achlya sp.	*Cyprinus carpio*
Alternaria sp.	*Oreochromis aureus*
Aspergillus sp.	*Coptodon zillii*, *Oreochromis aureus*
Branchiomyces sp.	*Oreochromis aureus*
Glugea plecoglossi	*Silurus triostegus*
Ichthyophonus hoferi	*Acanthobrama marmid*, *Arabibarbus grypus*, *Carasobarbus luteus*, *Carassius auratus*, *Cyprinus carpio*, *Hemiculter leucisculus*, *Leuciscus vorax*, *Mastacembelus mastacembelus*, *Planiliza abu*, *P. subviridis*, *Silurus triostegus*, *Tenualosa ilisha*
Ichthyophonus sp.	*Oreochromis aureus*
Mucor sp.	*Oreochromis aureus*
Penicillium sp.	*Coptodon zillii*, *Oreochromis aureus*
Saprolegnia diclina	*Silurus triostegus*
Saprolegnia parasitica	*Cyprinus carpio*, *Gambusia holbrooki*, *Mesopotamichthys sharpeyi*, *Planiliza abu*
Saprolegnia sp.	*Carassius auratus*, *Coptodon zillii*, *Cyprinus carpio*, *Gambusia holbrooki*, *Hypophthalmichthys molitrix*, *Planiliza abu*, *P. subviridis*, *Poecilia latipinna*, *P. sphenops*, *Silurus triostegus*

List of Fishes and Their Fungi and Fungal-Like Organisms of Basrah Province

Names of all fish host species infected with fungi and fungal-like organisms in Basrah province (19 valid fish names and eight synonyms) are alphabetically arranged in the following list. The full authorities of the valid fish species and their orders and families are shown in Table (1). For each valid host species, fungal and fungal-like organisms are alphabetically listed. The present host list includes the valid as well as the synonymous fish names. For fishes, the scientific names were reported as they appeared in their original references, but as indicated earlier in the section of Sources and Methods, fish valid scientific names and their authorities (Table 1) were corrected mainly according to Eschmeyer (2018) and Froese & Pauly (2018).

Acanthobrama marmid
Ichthyosporidium hoferi.

***Arabibarbus grypus* (reported as *Barbus grypus*)**
Ichthyophonus hoferi.

***Aspius vorax*: See *Leuciscus vorax*.**

***Barbus esocinus*: See *Luciobarbus esocinus*.**

***Barbus grypus*: See *Arabibarbus grypus*.**

***Barbus luteus*: See *Carasobarbus luteus*.**

***Barbus sharpeyi*: See *Mesopotamichthys sharpeyi*.**

***Carasobarbus luteus* (as *Barbus luteus*)**
Ichthyophonus hoferi.

Carassius auratus
Ichthyophonus hoferi, *Saprolegnia* sp.

Coptodon zillii

Aspergillus sp., *Penicillium* sp., *Saprolegnia* sp.

Cyprinus carpio

Achlya sp., *Ichthyophonus hoferi*, *Saprolegnia parasitica*, *Saprolegnia* sp.

***Gambusia affinis*: See *Gambusia holbrooki*.**

***Gambusia holbrooki* (also reported as *G. affinis*)**
Saprolegnia parasitica, *Saprolegnia* sp.

Hemiculter leucisculus
Ichthyophonus hoferi.

Hypophthalmichthys molitrix
Saprolegnia sp.

***Leuciscus vorax* (reported as *Aspius vorax*)**
Ichthyophonus hoferi.

***Liza abu*: See *Planiliza abu*.**

***Liza subviridis*: See *Planiliza subviridis*.**

Mastacembelus mastacembelus
Ichthyophonus hoferi.

***Mesopotamichthys sharpeyi* (reported as *Barbus sharpeyi*)**
Saprolegnia parasitica.

Oreochromis aureus
Alternaria sp., *Aspergillus* sp., *Brachiomyces* sp., *Ichthyophonus* sp., *Mucor* sp., *Penicillium* sp.

***Planiliza abu* (reported as *Liza abu*)**
Ichthyophonus hoferi, *Saprolegnia parasitica*, *Saprolegnia* sp.

***Planiliza subviridis* (reported as *Liza subviridis*)**
Ichthyophonus hoferi, *Saprolegnia* sp.

Poecilia latipinna
Saprolegnia sp.

Poecilia sphenops
Saprolegnia sp.

Silurus triostegus
Glugea plecoglossi, *Ichthyophonus hoferi*, *Saprolegnia diclina*, *Saprolegnia* sp.

Tenualosa ilisha
Ichthyophonus hoferi.

Acknowledgements

Sincere thanks are due to Prof. Dr. Hab. Wojciech Piasecki of the University of Szczecin of Poland, Prof. Dr. Samir K. Abdullah of the University of Zakho, Iraq and Prof. Dr. Sabeeh H. Al-Mayah of the University of Basrah, Iraq for providing us with some valuable literature. Thanks also due to both Assistant Prof. Dr. Atheer H. Ali of the University of Basrah, Iraq

and Dr. Ahmed M. S. Al-Janae'e of Directorate of Basrah's Agriculture, Iraq for their comments on some issues related to the materials of this article.

References

Abbas, A.A.-K. (2007). Histopathological studies of some parasites of the Asian catfish, *Silurus triostegus* (Heckel, 1843) and potassium permanganate in the black molly, *Poecilia sphenops* (Valenciennes, 1846). Ph. D. Thesis, Coll. Educ., Univ. Basrah: 144 pp. (In Arabic).

Abdul-Ameer, K.N. (1989). Study of the parasites of freshwater fishes from Tigris river in Salah Al-Dien province, Iraq. M. Sc. Thesis, Coll. Sci., Univ. Baghdad: 98 pp. (In Arabic).

Abed, J.M. (2005). Biological and ecological survey of some enemies of fishes in three fish farms in Iraq. Ph. D. Thesis, Coll. Agric., Univ. Basrah: 111 pp. (In Arabic).

Aboud, H.M. & Mahmood, S. Kh. (2013). Study on *Branchiomyces* infections of fishes in Iraq. Seventh Sci. Conf. Fish. Resour. Basrah: 29-30 Dec. 2013. (Abstract).

Adday, T.K. (2001). Biology of the crustacean *Ergasilus ogawai* Kabata, 1992 which parasitized on some Iraqi fishes. M. Sc. Thesis, Coll. Agric., Univ. Basrah: 117 pp. (In Arabic).

Al-Daraji, S.A.M.; Jori, M.M. & Salim, Y.A.K. (2002). Chemotherapeutic control of some ectoparasitic diseases infesting some Iraqi fishes. Basrah J. Sci., B, 20 (1): 53-62.

Al-Duboon, A.H.; Al-Mukhtar, M.A.; Jassim, A.A.R.; Bader, S.Q. & Al-Zawar, J.M. (2006). Saprolegniasis of *Barbus sharpeyi* Günther (Bunnei fish) in Basrah, Iraq. Iraqi J. Aquac., 1: 25-29.

Ali, A.H.; Mhaisen, F.T. & Khamees, N.R. (2014). Checklists of nematodes of freshwater and marine fishes of Basrah province, Iraq. Mesopot. J. Mar. Sci., 29 (2): 71-96.

Ali, N.M.; Abul-Eis, E.S. & Abdul-Ameer, K.N. (1988a). On the occurrence of fish parasites raised in manmade lakes. Sixth Conf. Europ. Ichthyol., Budapest: 15-19 Aug. 1988: 60. (Abstract).

Ali, N.M.; Abul-Eis, E.S. & Abdul-Ameer, K.N. (1988b). Occurrence of PAS-GL cells, the precursor of mast cells, around *Glugea anomalia* (Microsporidia). Curr. Sci., 57 (18): 1006-1008.

Al-Janae'e, A.M.S. (2010). Parasites of some Iraqi fishes in two localities varied in their trophic levels in inland water of Basrah. M. Sc. Thesis, Coll. Agric., Univ. Basrah: 228 pp. (In Arabic).

Al-Janae'e, A.M.S. (2017). Using of some plant extracts as alternatives for malachite green in treating of the common carp (*Cyprinus carpio* L.) infected with the fungus *Saprolegnia parasitica* and their effects on some blood parameters and their resistance to parasitic infection. Ph. D. Thesis, Coll. Agric., Univ. Basrah: 182 pp. (In Arabic).

Al-Janae'e, A.M.S.; Ali, A.H. & Al-Edany, T.Y. (2017). Efficacy of some aromatic plant extracts on treating the eggs of the common carp (*Cyprinus carpio* L.) against fungal infection in comparison with traditional fungicide malachite green. Basrah J. Agric. Sci., 30 (2): 50-71.

Al-Niaeem, K.S.K. (2006). Infection distribution of fish parasites in Basrah province and pathological effects of *Saprolegnia* sp. and its susceptibility to some plant extracts. Ph. D. Thesis, Coll. Agric., Univ. Basrah: 172 pp. (In Arabic).

Al-Niaeem, K.S.K. (2015). Pathological studies of experimental *Ichthyophonus* sp. infection in blue tilapia, *Oreochromis aureus* (Steindachner, 1864), Iraq. Res. J. Sci. Technol., 7 (4): 234-237.

Al-Niaeem, K.K. & Al-Yassein, R.N. (2009). Treatment of mosquito fish (*Gambusia affinis*) infected with fungi of the genus *Saprolegnia* by dipping with some plant extracts. J. Coll. Basic Educ., Al-Mustansiriyah Univ., Baghdad, 15 (60): 899-910. (In Arabic).

Al-Niaeem, K.S.; Al-Azizz, S.A.A. & Abdullah, J.N. (2012). Effect of temperature, pH, sodium chloride and antibiotices on the growth of *Saprolegnia* sp. and *Achlya* sp. isolated from infected common carp (*Cyprinus carpio* L.). J. Univ. Duhok, 15 (1): 128-132.

Al-Niaeem, K.S.; Al-Salim, N.K. & Khamees, N.R. (2013). Susceptibility of fish mold *Saprolegnia* sp. to some crude plant extracts. First Int. Sci. Conf. Cihan Univ., Erbil: 2-3 April 2013. (Abstract).

Al-Niaeem, K.S.; Ameen, F.; Hatamleh, A. & Bakri, M. (2015). Isolation and identification of pathogenic fungi on *Oreochromis aureus* (Steindachner, 1864) in the University of Basrah fish ponds. Indian J. Geo-Mar. Sci., 44 (8): 1213-1216.

Al-Rubaie, I.A.; Mohammad-Ali, N.R.; Balasem, A.N. & Al-Jawda, J.M. (2003). Study on fish diseases in Diyala river. Iraqi J. Agric. (Spec. Issue), 8 (6): 40-47. (In Arabic).

Al-Saboonchi, A.A.; Khamees, N.R. & Al-Janae'e A.M. (2010). Salinity changes and their effect on the biodiversity in Al-Salihiya river. Basrah J. Sci., 28 (2): 83-91. (In Arabic).

Al-Salim, N.K. & Jori, M.M. (2002). Study of the parasites of two mugilid fish species and the effect of some on the blood parameters. III: First record of two species of parasites in south of Iraq. Mar. Mesopot., 17 (1): 223-235. (In Arabic).

Al-Salim, N.K.; Khamees, N.R. & Al-Niaeem, K.S. (2007). Seasonality of some parasites found in three species of fishes in two different localities. J. Basrah Res., Spec. Issue, Third Sci. Conf. Microbiol.: 32-46. (In Arabic).

Al-Salim, N.K.; Khamees, N.R. & Al-Niaeem, K.S. (2008). Histopathological effects in the common carp *Cyprinus carpio* experimentally infected with *Saprolegnia* sp. J. King Abdulaziz Univ, Mar. Sci., 19: 3-19. (In Arabic).

Al-Salim, N.K.; Khamees, N.R. & Al-Niaeem, K.S. (2009). Study of some physiological blood parameters of common carp *Cyprinus carpio* under laboratory infections with the fungus *Saprolegnia* sp. Euphrates J. Agric. Sci., 1 (1): 64-77. (In Arabic).

Al-Shammari, R.H.H. (2016). A study of anti fungal activity of a combination of essential oils from medical herbs against water molds. Baghdad Sci. J., 13 (4): 1-7. (In Arabic).

Al-Shammari, R.H.; Habib, K.A.R. & Al-Mukhtar, E. (2015). A comparative study in isolation of Saprolegniaceae species from infected eggs, larvae and adults common carp fish in two fish hatcheries, in middle of Iraq. Amer. J. Biol. Life Sci., 3 (6): 223-227.

Al-Shammeri, R.H.H. (2011). Ecological and identification study of the infection of common carp by the fungus *Saprolegnia* sp. in Al-Manahel and Al-Wahda aquaculture. Ph. D. Thesis, Coll. Sci. Women, Univ. Baghdad: 162 pp.

Ameen, F.; Al-Niaeem, K.; Taher, M.M. & Sultan, F.A.H. (2018). Potential of plant extracts to inhibit the *Ichthyophonus* sp. infection in blue tilapia: A preliminary study in vitro**.** Natl. Acad. Sci. Lett., 41 (2): 129-132.

Badr, S.Q. (2010). Isolation and identification of some watermolds and study their pathogenicity against some fish species and their in vitro treatment. M. Sc. Thesis, Coll. Educ., Univ. Basrah: 115 pp. (In Arabic).

Badr, S.Q.; Al-Duboon, A.-H. & Muhsin, T.M. (2011). A study on the histological changes in infected gold fish (*Carrassius auratus auratus*) by the parasitic fungus *Saprolegnia parasitica* in vitro. Iraqi J. Aquac., 8 (2): 125-136. (In Arabic).

Badr, S.Q.; Al-Duboon, A.-H. & Muhsin, T.M. (2012). Laboratory infection of three species of fishes with the water mold *Saprolegnia parasitica* and methods of their treatment. Iraqi J. Aquac., 9 (1): 23-40. (In Arabic).

Bangyeekhun E. & Sylvie, M.A. (2001). Characterization of *Saprolegnia spp*. isolates from channel catfish. Dis. Aquat. Org., 45 (1): 53-59.

Butty, A.K.N.; Mhaisen, F.T. & Ali, N.M. (1989). Isolation of three water molds from two freshwater fishes and insect exuviae. J. Environ. Sci. Heath, A 24 (1): 17-22.

Chukanhom K. & Hatai, K. (2004). Freshwater fungi isolates from eggs of the common carp (*Cyprinus carpio*) in Thailand. Mycoscience, 45: 42-48.

Duijn, van C. Jnr. (1973). Diseases of fishes, 3rd edition, Iliffe Books, London: 372 pp.

Eassa, A.M.; Al-Jenaei, A.M.; Abdul-Nabi, Z.A.; Abood, M.A.; Kzaal, R.S. & Aliwy, Y.J. (2014). Comparative ecological study of pathogens structure between wild and cultured common carp *Cyprinus carpio* L. in Basrah. Marsh Bull., 9 (2): 107-123.

EOL (2018). Encyclopedia of Life on-line database, http//www.eol.org. (Accessed 16 Nov. 2018).

Eschmeyer, W.N. (ed.) (2018). Species by family/ subfamily in the Catalog of Fishes. http://research.calacademy.org/ research/ ichthyology/ Catalog/ SpeciesByFamily.asp (Updated 5 Nov. 2018).

Froese, R. & Pauly, D. (eds.). (2018). FishBase. World Wide Web electronic publication. www.fishbase.org. (Version 06/2018).

GBIF (2018). Global Biodiversity Information Facility, on-line database, http://www.gbif.org. (Accessed 16 Nov. 2018).

Gozlan, R.E.; Marshall, W.L.; Lilje, O.; Jessop, C.N.; Gleason, F.H. & Andreou, D. (2014). Current ecological understanding of fungal-like pathogens of fish: What lies beneath? Front. Microbiol., 5, Article 62: 1-16. doi: 10.3389/fmicb.2014.00062.

Herzog, P.H. (1969). Untersuchungen über die parasiten der süßwasserfische des Irak. Arch. Fischereiwiss., 20 (2/3): 132-147.

Hussein, S.A.; Al-Salem, N.K. & Abed, J.M. (2011). Survey of parasites and fish enemies in three selected fish farms in Iraq. IV: Survey of fish parasites in Basrah University fish farm/ Marine Science Center. Iraqi J. Agric., 16 (1): 82-89. (In Arabic).

Ibrahim, K.S. (2011). Isolation and pathological study of branchiomycosis from the commercial pond of common carp (*Cyprinus carpio*) fish, in Governorate of Duhok/ Iraq. Iraqi J. Vet. Med.; 35 (1): 1-9.

Index Fungorum (2018). www.indexfungorum.org. https://doi.org/10.15468/ts7wsb (Accessed 16 Nov. 2018).

Iqbal, Z.; Minhas, I.K. & Khan, M.N. (2001). Disease prevalence in culturable fish species in Punjab. Pak. J. Fish., 1: 103-112.

Ismail, A.L.S.; Rattan, S.S. & Muhsin, T.M. (1979). Aquatic fungi of Iraq: Species of *Saprolegnia*. Hydrobiologia, 65 (1): 83-93.

Jarallah, H.M.; Al-Daraji, S.A.M.; Bannai, M.A.A.; Mohamad, E.T. & Wanis, A.K. (2005). New description of disease agents affecting mosquito fish (*Gambusia affinis*) in the Basrah marshes. First Sci. Conf. Rehabilit. South. Iraq Marshes. Basrah: 11-12 April 2005. (Abstract).

Jori, M.M. (1998). Study of the parasites of two mugilid fish species and the effect of some on the blood parameters. M. Sc. Thesis, Coll. Agric., Univ. Basrah: 136 pp. (In Arabic).

Jori, M.M. (2006). Parasitic study on the Asian catfish *Silurus triostegus* (Heckel, 1843) from Al-Hammar marshes, Basrah, Iraq. Ph. D. Thesis, Coll. Educ., Univ. Basrah: 192 pp.

Kadhim, A.H. (2009). Disease agents of four fish species in Basrah province. M. Sc. Thesis, Coll. Agric., Univ. Basrah: 102 pp. (In Arabic).

Khamees, N.R.; Mhaisen, F.T. & Ali, A.H. (2015). Checklists of crustaceans of freshwater and marine fishes of Basrah province, Iraq. Mesopot. J. Mar. Sci., 30 (1): 1-32.

Mhaisen, F.T. (2018). Index-catalogue of parasites and disease agents of fishes of Iraq (Unpublished: mhaisenft@yahoo.co.uk).

Mhaisen, F.T. & Abul-Eis, E.S. (1991). Parasites of the common carp *Cyprinus carpio* in the Babylon fish farm, Hilla, Iraq. Thalassographica, 14: 27-33.

Mhaisen, F.T.; Ali, A.H. & Khamees, N.R. (2013a). Checklists of monogeneans of freshwater and marine fishes of Basrah province, Iraq. Basrah J. Agric. Sci., 26 (Spec. Issue 1): 26-49.

Mhaisen, F.T.; Ali, A.H. & Khamees, N.R. (2016). Checklists of protozoans and myxozoans of freshwater and marine fishes of Basrah province, Iraq. Mesopot. J. Mar. Sci., 31 (1): 29-52.

Mhaisen, F.T.; Ali, A.H. & Khamees, N.R. (2017). Checklists of fish parasites of Basrah marshlands, Iraq. Biol. Appl. Environ. Res., 1 (2): 237-278.

Mhaisen, F.T.; Ali, A.H. & Khamees, N.R. (2018). Marine fish parasitology of Iraq: A review and checklists. Biol. Appl. Environ. Res., 2 (2): 231-297.

Mhaisen, F.T.; Al-Niaeem, K.S. & Jassim, A.R.J. (2010). Parasites and disease agents of cultured fishes of Basrah province, Iraq: The present status. Basrah J. Agric. Sci., 23 (Spec. Issue 2): 92-106.

Mhaisen, F.T.; Khamees, N.R. & Al-Daraji, S.A.M. (1993). Parasites and disease agents of marine and freshwater fishes of Basrah province, Iraq. Mar. Mesopot., 8 (1): 45-60.

Mhaisen, F.T.; Khamees, N.R. & Ali, A.H. (2013b). Checklists of trematodes of freshwater and marine fishes of Basrah province, Iraq. Basrah J. Agric. Sci., 26 (Spec. Issue 1): 50-77.

Mhaisen, F.T.; Khamees, N.R. & Ali, A.H. (2013c). Checklists of cestodes of freshwater and marine fishes of Basrah province, Iraq. Basrah J. Agric. Sci., 26 (Spec. Issue 1): 78-98.

Mhaisen, F.T.; Khamees, N.R. & Ali, A.H. (2014). Checklists of acanthocephalans of freshwater and marine fishes of Basrah province, Iraq. Basrah J. Agric. Sci., 27 (1): 21-34.

Muhsin, T.M. (1977). Studies on the Saprolegniaceae of Shatt Al-Arab near Basrah/Iraq. M. Sc. Thesis, Coll. Sci., Univ. Basrah: 120 pp.

Muhsin, T.M. (2012). Aquatic fungi of Iraq: A review. Marsh Bull., 7 (1): 39-47.

Patel, A.S.; Patel, S.J.; Bariya, A.R.; Pata, B.A. & Ghodasara, S.N. (2018). Fungal diseases of fish: A review. J. Vet. Sci. Res., 3 (3): 1-5.

Rahemo, Z.I.F. & Taha, K.H. (2012). First record of *Branchiomyces demigrans* from bizz fishes, *Barbus esocinus* caught from Mosul Dam Lake. Trends Fish. Res., 1 (3): 26-27.

Rahemo, Z.I.F. & Taha, K.H. (2013). First record of *Branchiomyces demigrans* from bizz fishes, *Barbus esocinus* caught from Mosul Dam Lake. Trends Fish. Res., 2 (1): 18-19.

Salih, Y.A.; Al-Shatty, S.M.H. & Al-Fadhly, N.K.Z. (2011). A study of molds and yeasts associated with Thelah fish *Scomberoides commersonianus* dried by solar dryer and by sun light during different storage periods. J. Basrah Res. (Sci.), 37 (2B): 89-103. (In Arabic).

Verma, V. (2008). Fungus disease in fish: Diagnosis and treatment. Vet. World, 1 (2): 62.

WoRMS (2018). World Register of Marine Species at http://www.marinespecies.org. (Accessed 16 Nov. 2018).