

# Prevalence of Parasitic Helminthes on Fish in Diyala river, Iraq, and their Immuno Response

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## ABSTRACT

This study was conducted on five sites in the Diyala River, namely Jalawla, Al-Saadia, Lake Hamrin, Baqubah, and Al-Khalis Creek, for the period from December 2022 to September 2023, with the aim of identifying fish species within these sites. 15 species of fish were recorded, Fish, *Cyprinus carpio*, *Luciobarbus xanthopterus*, *Arabibarbus grypus*, *Carasobarbus luteus*, *Mesopotamichthys sharpeyi*, occupied the highest density. While *Siluristriostegus*, *Chondrostomaregium*, *Planilizaabu*, *Carassius auratus*, and *Garra variabilis* had medium density, while *Leuciscus vorax*, *Luciobarbus barbulus*, *Coptodon zillii*, *Cyprinion kais*, and *Mastacembelus mastacembelus* recorded lower densities during the study period. After laboratory examination, it was found that these fish were infected with 27 species of monogenic flatworms, including 17 species of *Gyrodactylus*, 8 species of *Dactylogyrus*, and one species of *Paradiplozoon* and *Cichlidogyrus*. It was also found that the highest concentration of immunoglobulin Igm was in *Cyprinus carpio*, reaching 67.12 mg/ml, and its lowest concentration was in *Chondrostomaregium*, where it reached 21.15 mg/ml.

**Keywords:** Diversity of fish species, Diyala River, Platyhelminthes, Immune Response.

## 1. INTRODUCTION

Fish farming and interest in this activity are of great importance to humans in most countries of the world (Mansour, 2019). Many countries pay attention to fish wealth because of its various benefits on the economic level and human consumption. It is one of the sources of high nutritional value and rich in its protein content, which includes... Many amino acids and a high percentage of fats and vitamins such as vitamin A and D, as well as a high percentage of mineral elements such as phosphorus, calcium, iodine and other important elements for the organisms that you eat (Jamaa, 2021). Most living organisms, including fish, in their diverse environmental habitats, are exposed to many risks and obstacles that affect their biological characteristics and reproduction (Timi & Poulin, 2020). Also, various parasitic infections on different sites of the fish's body have great economic importance in fish farming because they cause many serious infections to fish resources, including poor fish growth, low weight, and high mortality in small fish (Mudeed *et al.*, 2020). Some parasites inflict the organs of the host fish cause various mechanical and chemical damages within the tissues, as they cause obstruction and obstruction of a number of different physiological activities, such as breathing and reproduction, in the body of the fish host (Timi & Poulin, 2020).

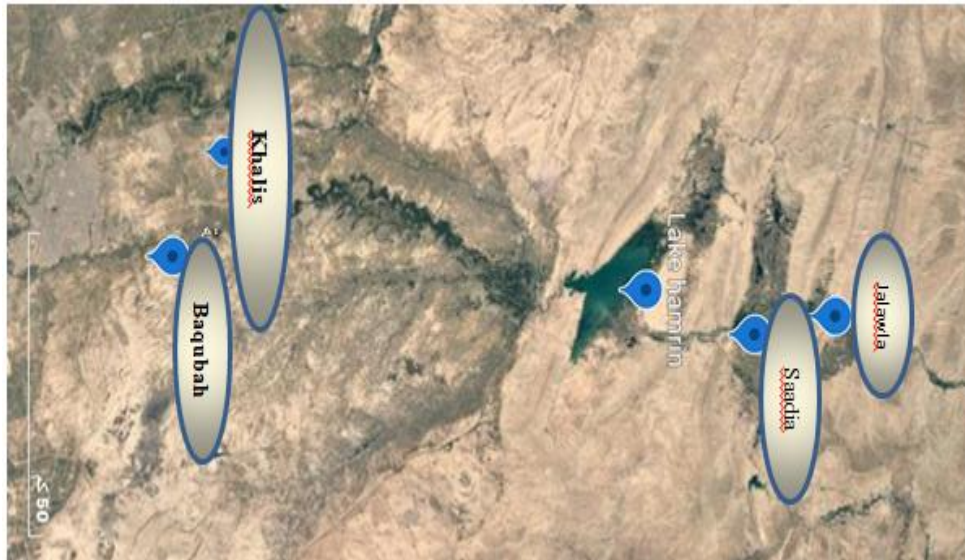
Infection with fish parasites depends on many factors related to the organism, including the geographical location and environment in which the fish live, the season of the year, the animals and plants present in the environment, etc., and these parasites are affected by many physiological, phenotypic, and life characteristics of the fish host, such as the host's food, its digestive secretions, The type and speed of movement, the fish's ability to produce genes, its reproductive time, its activity, its migration, and the age of the host as well as its maturity (Lepak *et al.*, 2021). It must be noted that some fish parasites cause many diseases to humans, simply by eating infected raw or undercooked fish (Juntabanet *et al.*, 2021). Fish parasites in general are considered a risk factor and a source of health concern because they often injure and weaken the fish's immune system, which increases its susceptibility to secondary infections with other pathogens such as fungal infections, bacteria, filters, and others, which causes significant economic losses (Teixeira & Taylor, 2020).

## 2. Materials and methods of work

### 2.1 Description of the study site

The study area represents the Diyala River basin, which is located between latitudes 35° - 33° north and longitudes 46° - 44° east and 40 km northeast of Baghdad (Aziz *et al.*, 2020). The Diyala River is one of the most important tributaries of the Tigris River, which is located in the eastern part. Central Iraq and the western

part of central Iran (Farman & Almkhtar, 2015). The Diyala River consists of the confluence of the Sirwan and Kinjaro tributaries at the Darbandikhan Dam. The length of the Diyala River is about 386 km, 300 km of which is inside Iraq (Al-Asadi&Aktami, 2018). It originates from Iranian territory It continues to flow, penetrating Iraqi territory, reaching a rugged mountainous area filled with the Hamrin Mountains, and then reaching the rest of the regions, passing through Saadiya, Muqdadiya, and Baqubah, dividing it into two halves. It continues until it empties into the Tigris River, south of the city of Baghdad. The Diyala River is called the Angry or Crazy River because of the sudden difference in levels. The river and its discharges (Kadhim& Al-Kubaisi, 2022).



**Fig. 1.** shows the study sites along the Diyala River

## 2.2 Collection and identification of fish samples

The Diyala River was the special site for conducting the current study, and it is located in Diyala Governorate. Samples were collected during the period from the beginning of December 2022 until the end of the ninth month (September) 2023, which is ten months. A total of 975 fish were caught randomly. These fish belong to 15 species and from specific and vital areas extending along the Diyala River, namely (Jalawla, Al-Saadiya, Lake Hamrin, Baqubah and Al-Khalis Creek). Fish samples were collected once a month throughout the study period. The fish were scientifically diagnosed and named according to (Perea *et al.*, 2016) (Sumaila *et al.*, 2022) and (Dunz&Schliwen, 2013), and the fish were classified into their families on the taxonomic scale based on (Eschmeyer, 2016). Many taxonomic sources have been used to diagnose and name parasites, including: (Al-Nasiri & Balbuena 2016); (Amin, 2018).

## 2.3 Isolation and fixation of parasites

The parasites that were isolated from the sites of parasitism in the body of the fish host were placed in Petri dishes containing tap water to get rid of the suspended waste from the sites of parasitism. These samples were confirmed by using a number of techniques for the purpose of reducing parasites, depending on the technique used for each type, as shown:

### 2.3.1 Platyhelminthes / Monogenea

These worms were isolated from their sites of parasitism on the fins, skin, and gills, after separating the gill arch and placing it in a Petri dish containing tap water. The monogenic worms were separated from the mucous materials using a fine needle (Becker, 1967). These parasites were preserved in ethyl alcohol at a concentration of 70%. A plastic medical dropper was used to transfer these worms and place them on a watch bottle slide containing a drop of glycerin and neutral red dye at a percentage ranging between 1:3, and then the cover of the slide was fixed with nail dye, according to what was mentioned in (Gussevet *et al.*, 1993).

## 3. RESULTS AND DISCUSSION

### 3.1 The group of animals parasitic on the fish of the Diyala River

#### 3.1.1 Platyhelminthes / Monogenea

The parasites of this class of flatworms are among the most common parasitic types that infect fish in fresh and marine waters. These parasites have a posterior disc, the Haptor, which is used for fixation and contains a group of small hooks (Muhaisen, 1983). These worms have a direct life cycle (they do not need an intermediate host) and move freely on the external parts of the fish host's body. They feed mainly on the epithelial cells and mucus

of the skin, fins and gills of the infected fish, and they can cause secondary infections such as bacteria and filters (Shia, 2019). These infections are the main cause of death of infected fish and are therefore an obstacle to achieving the required productivity in fish farms (Meneses *et. al.*, 2018).

#### **3.1.1.1 *Cichlidogyrus aegypticus* Ergens, 1981**

This parasite was recorded for the first time in Iraq by (Al-Salmani, 2022) in *Coptodon zillii*. In the modern have a look at, 12 infections had been recorded, with a rate of three.4%, all of which had been remoted from the gills of infected fish. The *Planilizaabu* had the highest infection rate, reaching 12.0%, followed by fish. The *Chondrostomaregium* was at a rate of 6.1%, then the *Garra variabilis* at a rate of 4.5%, then the *Luciobarbus xanthopterus* at a rate of 4.3%, then the *Arabibarusgrypus* and *Cyprinus carpio* at a rate of 2.2%, and then the *Carasobarbusluteus* at a rate of 1.6%. According to (Mhaisen, 2024), *Luciobarbus xanthopterus*, *Arabibarusgrypus*, *Cyprinus carpio*, *Chondrostomaregium*, *Carasobarbusluteus*, *Planilizaabu* and *Garra variabilis* are considered new hosts in Iraq.

#### **3.1.1.2 *Dactylogyrusdirigerus* Gusev, 1966**

This parasite was recorded for the first time in Iraq via (Hamid, 2019) from the *Carasobarbusluteus*, and it changed into later recorded in seven species of fish in Iraq. In the modern-day examine, three infections had been recorded at a charge of zero. 8%, remoted from the gills of inflamed fish. The maximum infection become recorded in *Luciobarbus barbulus* fish at a charge of 7.7%, followed by the *Silurustriostegus* at a charge of 5.9%, and ultimately the *Arabibarusgrypus* at a charge of 2.2%. According to (Mhaisen, 2024), *Luciobarbus barbulus* and *Silurustriostegus* are taken into consideration new hosts for this parasite in Iraq.

#### **3.1.1.3 *Dactylogyrusguadianensis* ElGharbi, Renaud and Lambert, 1993**

For the first time in Iraq, (Hamid, 2019) recorded 4 cases of *Carasobarbusluteus*,... in the present study at a rate of 1.1%. It was removed from the mouths of infected fish. The highest infection rate occurred in *Leuciscusvorax* fish with 10.0%, followed by *Silurustriostegus* 5.9%, then *Planilizaabu* fish with 4.0%, and finally *Carasobarbus lutes* with 1.6 and a record %,1. according to (Mahaisen, 2024) in Iraq, *Planilizaabu* and *Leuciscusvorax* are considered as new hosts for this parasite.

#### **3.1.1.4 *Dactylogyrusmolnari* Ergens and Dulmaa, 1969**

This parasite was recorded from *Cyprinus carpio* for the first time in Iraq by (Mama, 2012). Nine cases, 2.5%, were recorded in the present study. It was removed from the mouths of infected fish. The highest infection rate was recorded in *Planilizaabu* with 8.0%, followed by *Arabibarusgripus* with 4.3%, then *Cyprinus carpio* with 3.3%, and finally *Carasobarbusluteus* with 3.2% (by Mhaisen, 2024) . . . . According to, *Arabibarusgripus* and *Planilizaabu* are considered as new hosts for this parasite in Iraq.

#### **3.1.1.5 *Dactylogyrusoumiensis* ElGharbi, Birgi and Lambert, 1994**

For the first time in Iraq, (Shia, 2019) recorded this parasite from *Carasobarbusluteus* and *Mesopotamichthyssharppei*. In the present study, 9 infections were recorded, at a rate of 2.5%, isolated from the mouths of infected fish. The highest infection rate was recorded in *Chondrostoma* kingdom with 9.1%, followed by *Cyprinus carpio* fish with 4.4%, then *Mesopotamichthyssharppei* with 2.4%, and finally *Luciobarbus xanthopterus* with 2.2% according to (Mhaisen). shown, 2024) in Iraq *Luciobarbus xanthopterus*, *Cyprinus carpio*, and *Chondrostomaregium* are considered as new hosts for this parasite.

#### **3.1.1.6 *Dactylogyruspersis* Bychowsky, 1949**

This parasite was recorded from *Carasobarbusluteus* for the first time in Iraq by (Abdullah, 2013). In the present study, two infections accounting for 0.6% of isolates from the mouths of infected fish were recorded. The highest infection rate was reported in *Silurustriostegus* with 5.9%, followed by *Carasobarbusluteus* with 1.6%. According to (Mhaisen, 2024), other hosts of this parasite in Iraq are *Silurus* and *Triostegus* cats.

#### **3.1.1.7 *Dactylogyrus simplex* Bychowsky, 1936**

The parasite was recorded from *Cyprinus carpio* for the first time in Iraq by (Sadek, 1999). In the present study, 3 infections of 0.8% were recorded, isolated from the mouths of infected fish. The highest infection was recorded in *Mastacembelusmastacembelus* with 20.0%, followed by *Chondrostomaregium* with 3.0%, and finally *Carasobarbusluteus* with 1.6% according to (Mhaisen, 2024) for this pest in Iraqi *Mastacembelusmastacembelus*, *Chondrostomaregium*, *Carasobarbusluteus* and fish are considered as new hosts.

**3.1.1.8 *Dactylogyrussoufii*(Lambert, 1977) Gusev, 1985**

This parasite was recorded from *Chondrostomaregium* for the first time in Iraq by (Hamid, 2019). In the present study, 6 infections were recorded with an incidence of 1.7%. It was removed from the mouths of infected fish. The highest incidence was recorded in *Chondrostoma kingdom* with a prevalence of 6.1%, followed by *Planiliza Abu* with 4.0%, then *Mesopotamichthyssharpeyi* with 2.4%, and finally *Cyprinus carpio* with 2.2% according to the records (Mhaisen, 2024). *Planiliza Abu* are considered new populations of this virus in Iraq.

**3.1.1.9 *Dactylogyruswegeneri* Kulwiec, 1927, Ph.D.**

The parasite was recorded from *Cyprinus carpio* for the first time in Iraq by (Abdul-Ameer, 2006). In the present study, 7 infections, accounting for 2%, were recorded isolated from the mouths of infected fish. The highest infection rate was recorded in *Coptodon zillii* at 12.5%, followed by *Mesopotamichthyssharpeyi* at 4.8%, then *Luciobarbus xanthopterus* at 4.3%, and finally at 3.2% in *Carasobarbusluteus* (Mahaisen, 2024). According to *Carasobarbusluteus*, *Luciobarbus xanthopterus* and *Mesopotamichthyssharpeyi* are considered as new hosts for this parasite in Iraq

**3.1.1.10 *Gyrodactylusbaicalensis* Bogolepova, 1950**

This parasite was recorded from *Cyprinus carpio* for the first time in Iraq by (Salih et al., 1988) followed by *Cyprinus carpio*, *Planilizaabu* isolated from other 11 hosts in Lake Hamrin (Al-Jawda& Ali, 2020), while at a rate of 1.1% of gills isolated from gills in the present study, 4 infections were recorded, two of them in *Carasobarbusluteus* with a rate of 3.2 recorded %, and one case each in *Planilizaabu* and *Arabibarbusgripus* a rate is 4.0%. and 2.2%, respectively. No other hosts of this virus have been recorded in Iraq, according to (Mahaisen, 2024).

**3.1.1.11 *Gyrodactylusbarbi* Ergens, 1976**

This parasite was recorded for the first time in Iraq by (Mama, 2012) from the *Cyprinus carpio* fish. In the current study, 23 infections were recorded, at a rate of 6.5%. 15 infections were recorded in gills, at a rate of 4.7%, and 8 infections were recorded in fins, at a rate of 14.3%, and it was the highest. The highest incidence of infection was in *Mastacembelusmastacembelus* with a rate of 20%, then *Mesopotamichthyssharpeyi* with a rate of 11.9%, followed by *Garra variabilis* with a rate of 9.1%, then *Planilizaabu* with a rate of 8.0%, then the *Carassius auratus* with a rate of 6.7%, followed by the *Chondrostomaregium* with a rate of 6.1%, and then *Siluristriostegus* at a rate of 5.9%, then *Carasobarbusluteus* at a rate of 4.8%, then *Arabibarbusgripus* at a rate of 4.3%, then *Cyprinus carpio* at a rate of 3.3%, and finally *Luciobarbus xanthopterus* at a rate of 2.2%. According to (Mhaisen, 2024), *Luciobarbus xanthopterus*, *Arabibarbusgripus*, *Mesopotamichthyssharpeyi*, *Siluristriostegus*, *Carassiusauratus*, *Garravariabilis*, and *Mastacembelusmastacembelus* are considered new hosts for this parasite in Iraq.

**3.1.1.12 *Gyrodactylusbychowskianus* Bogolepova, 1950**

This parasite was recorded for the first time in Iraq by (Shia, 2019) from *Cyprinion macrostomum*, *Arabibarbusgripus*, and *Carasobarbusluteus*. In the current study, 14 infections were recorded that were isolated from gillfish, with an infection rate of 3.2%. The highest infection rate was recorded in *Siluristriostegus*, with a rate of 3.2%. 17.6%, It was followed by *Luciobarbus barbulus* with 15.4%, while the percentage of *Cyprinion kais* reached 14.3%, followed by *Mesopotamichthyssharpeyi* with an infection rate of 7.1%, then *Carassius auratus* with 6.7%, and then *Cyprinus carpio* followed by a rate of 7.1 % became 3.3%, and finally *Luciobarbus xanthopterus* 2.2%. According to (Mhaisen, 2024), *Siluristriostegus*, *Luciobarbus barbulus*, *Mesopotamichthyssharpeyi*, *Cyprinion kais*, *Carassiusauratus* and *Luciobarbus xanthopterus* are considered as its new hosts in Iraq.

**3.1.1.13 *Gyrodactyluscapoetai* Ergers and Ibragimov, 1976**

This pathogen was recorded from *Arabiabarbusgripus* for the first time in Iraq by (Hamid, 2019), and was recorded secondly in the study presented by (Shuzan, 2024) from *Arabiabarbusgripus*, *Chondrostomaregium*, and *Planiliza Abu*. In the present study, 30 cases were recorded. With 8.5%, the highest abundance was recorded in *Planilizaabu* and *Carassius auratus* with 20.0%, followed by *Luciobarbus barbulus* with 15.4%, followed by *Cyprinion kais* with 14.3%, and then *Luciobarbus xanthopterus* with a prevalence of 10.9% *Garra variabilis* with a prevalence of 9.1%. Then, the *Cyprinus carpio* had an infection rate of 7.7%, followed by the *Mesopotamichthyssharpeyi* with a 7.1% infection rate, then the *Chondrostomaregium* with a 3.0% infection rate, then the *Arabibarbusgripus* with an infection rate of 2.2%. According to (Mhaisen, 2024), the *Luciobarbus xanthopterus*, *Cyprinus carpio*, *Mesopotamichthyssharpeyi*, *Carassiusauratus*, *Luciobarbus barbulus*, *Garravariabilis* and *Cyprinion kais* are considered new hosts for them in Iraq.

**3.1.1.14 Gyrodactyluscottii Roman, 1956**

This parasite was recorded for the first time in Iraq by (Rashid, 2016) from the *Planilizaabu*, In the current study, 21 infections were recorded with an infection rate of 5.9%. They were isolated from the gills and fins of infected fish. The highest infection rate was in *Cyprinion kais* with a rate of 28.6%, followed by *Coptodon zillii* with a rate of 12.5%, and then *Leuciscusvorax* with a rate of 10.0%, followed by the *Garra variabilis* with a percentage of 9.1%, then the *Carasobarbusluteus* with a percentage of 7.9%, then the *Carassius auratus* with a percentage of 6.7%, then the *Mesopotamichthyssharppei* with a percentage of 4.8%, and then the *Luciobarbus xanthopterus*, *Arabibarusgrypus*, and *Cyprinus carpio* with an infection rate of 2.2%. According to (Mhaisen, 2024), the *Luciobarbus xanthopterus*, *Arabibarusgrypus*, *Chondrostomaregium*, *Carasobarbusluteus*, *Mesopotamichthyssharppei*, *Carassiusauratus*, *Leuciscusvorax*, *Garravariabilis*, *Cyprinion kais*, and *Coptodon zillii* are considered new hosts for them in Iraq.

**3.1.1.15 Gyrodactylusdzhililovi Ergens&Ashurova, 1984**

This parasite was recorded for the first time in Iraq by (Rashid, 2016) from *Cyprinus carpio*. In the current study, 25 infections were recorded, with a rate of 7.1%. They were isolated from the gills of infected fish. The highest infection was recorded from *Mastacembelustacembelus*, with a rate of 20.0%, and then *Coptodon zillii* at a rate of 12.5%, followed by *Leuciscusvorax* at a rate of 10.0%, then *Cyprinus carpio* at a rate of 9.9%, then *Garra variabilis* at a rate of 9.1%, then a *Carassius auratus* at a rate of 6.7%, then *Silurustriostegus* at a rate of 5.9%, and then *Carasobarbusluteus* at a rate of 4.8%. %, followed by *Planilizaabu* with a rate of 4.0%, then *Luciobarbus xanthopterus* and *Arabibarusgrypus* with a rate of 4.3%, and finally *Mesopotamichthyssharppei* with a rate of 2.4%. According to (Mhaisen, 2024), the *Luciobarbus xanthopterus*, *Silurustriostegus*, *Planilizaabu*, *Leuciscusvorax*, *Garravariabilis* and *Mastacembelustacembelus* are considered new hosts for this parasite in Iraq.

**3.1.1.16 Gyrodactyluselegansvon Nordmann,1832**

This parasite was recorded for the first time in Iraq by the study presented by (Ali & Shaaban, 1984) from *Planilizaabu* and *Cyprinus carpio*, and after that it was recorded in 24 species of fish hosts. In the current study, 5 infections were recorded that were isolated from fish gills, with a ratio of 1.4 %, as the highest infection rate was recorded in *Garra variabilis* at a rate of 4.5%, while *Arabibarusgrypus* recorded a rate of 4.3%, followed by *Carasobarbusluteus* at a rate of 1.6%, and finally *Cyprinus carpio* at a rate of 1.1%. According to (Mhaisen, 2024), the *Garra variabilis* are considered a new host for this parasite in Iraq.

**3.1.1.17 Gyrodactyluslongiradix Malmberg, 1957**

This parasite was recorded for the first time in Iraq by (Shia, 2019) for *Coptodon zillii*, *Cyprinus carpio* and *Arabibarusgrypus*. In the present study, 11 diseases, with a prevalence of 3.1%, were recorded, all in gill fish. The highest infection rate was in *Leuciscusvorax*, with a rate of 10.0%, while *Planilizaabu* percentage recorded was 8.0%, followed by 7.7% percentage in *Luciobarbus barbulus* in 2000, then 7.1% percent in *Mesopotamichthyssharppei*, then 3.0% *ChondrostomaRegium*, and finally 2.2% *ArabibarusGrypus*, *Cyprinus carpio*. According to (Mhaisen, 2024), *Chondrostomaregium*, *Mesopotamichthyssharppei*, *Planilizaabu*, *Leuciscusvorax* and *Luciobarbus barbulus* are considered as new hosts for this species in Iraq

**3.1.1.18 Gyrodactyluslotae Gusev, 1953**

For the first time in Iraq, (Abbas, 2019) recorded this parasite from *Arabibarusgrypus*. In the present study, 9 infections were recorded at 2.5%, with *Coptodon zillii* having an infection rate of 12.5%, followed by *Leuciscusvorax* recording a rate of 10.0% and then *Luciobarbus xanthopterus* at 4.3%, . followed by *Mesopotamichthyssharppei* at 4.3%. rate, then *Arabibarusgripus* and *Cyprinus carpio* at 2.2% rate, and finally *Carasobarbusluteus* at 1.6% rate According to (Mhaisen, 2024), *Luciobarbus xanthopterus*, *Carasobarbusluteus*, *Coptodon zillii*, *Leuciscusvorax*, *Mesopotamichthyssharppei* for this parasite have Iraq and they are regarded as new hosts

**3.1.1.19 Gyrodactylusmasu Ogawa, 1986**

The parasite was recorded for the first time in Iraq by (Atwan, 2016) for *Cyprinus carpio*, *Mesopotamichthyssharppei*, and *Coptodon zillii*. It was also recorded in *Arabibarusgrypus* gills earlier in the study by (Abbas, 2019). In the present study, 19 diseases were recorded, with a mean of 5.4. %, the highest percentage of skin injuries was recorded at 13, at a rate of 54.2%, then the gills recorded 3 injuries, at a rate of 0.9%, then two injuries in the scales, at a rate of 4.5%, and finally one injury in the fins, at a rate of 1.8%. The *Coptodon zillii* had the highest incidence with a rate of 12.5%, followed by the *Silurustriostegus* with a rate of 11.8%, then the *Mesopotamichthyssharppei* with a rate of 7.1%, then the *Luciobarbus xanthopterus* with a rate of 6.5%, then the *Carasobarbusluteus* with a rate of 4.8%, followed by the *Garra variabilis* with a rate of 4.5%. Then the *Cyprinus carpio* at 4.4%, and finally the *Arabibarusgrypus* at 4.3%. According to (Mhaisen, 2024),

the *Luciobarbus xanthopterus*, *Carasobarbusluteus*, *Silurustriostegus* and *Garravariabilis* are considered new hosts for this parasite in Iraq.

### 3.1.1.20 *Gyrodactylusmatovi* Ergens&Kakacheva-Avramova, 1966

This parasite was recorded for the first time in Iraq by (Rashid, 2016) from the *Cyprinus carpio*, and it was also recorded in *Coptodon zillii*, *Cyprinion macrostomum* and *Mesopotamichthyssharpeyi* in the study presented by (Muhammad, 2017) in the Diyala River. In the present study, 17 diseases were recorded, with an incidence of 4.8 % of all those recorded in gills, *Carassius auratus* was the most abundant at 20.0%, followed by *Silurustriostegus* at 11.8%, then *Arabibarusgrypus* at 6.5%, then *Cyprinus carpio* at 6.5% 5.5 %, Then *Luciobarbus xanthopterus* with 4.3%, then *Mesopotamichthyssharpeyi* 2.4%, and finally *Carasobarbusluteus* 1.6% as (Mhaisen, 2024) *Carasobarbusluteus*, *Mesopotamichthyssharpeyi*, *Silurustriostegus*, and *Carassius auratus* show new hosts

### 3.1.1.21 *Gyrodactyluspewzowi* Ergens, 1980

This parasite was recorded from *Cyprinus carpio* for the first time in Iraq by (Muhammad, 2017). In the present study, 19 infections were recorded, with a prevalence of 5.4%, all of which were isolated from the mouths of infected fish. *Leuciscusvorax* had the highest percentage at 10.0%, followed by *Carassius auratus* at 6.7%, followed by *Cyprinus carpio* at 6.6%, then *Arabibarusgrypus* at 6.5% and *Carasobarbusluteus* at 100% of 6.3% *Mesopotamichthyssharpeyi* 4.8%, followed by of *Planilizaabu* 4.0%, and finally *Luciobarbus xanthopterus* 2.2% According to (Mahaisen, 2024) *Luciobarbus xanthopterus*, *Arabibarusgrypus*, *Carasobarbusluteus* , *Mesopotamichthyssharpeyi*, *Planilizaabu*, *Carassiusauratus*, *Leuciscusvorax* for this parasite in Iraq and they are considered as new hosts

### 3.1.1.22 *Gyrodactylusrarus* (Wegener, 1909)

This parasite was recorded for the first time in Iraq by (Rashid, 2016) from the *Cyprinion macrostomum*. In the current study, 17 infections were recorded, at a rate of 3.8%, 13 infections were recorded in gills, at a rate of 4.8%, and 4 infections were recorded in the skin, at a rate of 16.7%. The highest percentage was occupied by *Silurustriostegus* reaching 23.5%, followed by *Coptodon zillii* with a rate of 12.5%, then *Mesopotamichthyssharpeyi* with a rate of 9.5%, then *Carassius auratus* with a rate of 6.7%, then *Garra variabilis* with a rate of 4.5%, and then *Carasobarbusluteus* with a rate of 3.2%. Then there are *Chondrostomaregium* at a rate of 3.0%, and finally *Arabibarusgrypus* and *Cyprinus carpio* at a rate of 2.2%. Thus, the *Chondrostomaregium*, *Carasobarbusluteus*, *Mesopotamichthyssharpeyi*, *Silurustriostegus*, *Carassius auratus*, *Garravariabilis* and *Coptodon zillii* as new hosts for this parasite in Iraq, according to (Mahaisen, 2024).

### 3.1.1.23 *Gyrodactylusseravschani* Osmanov,1965

This parasite was recorded for the first time in Iraq by (Rashid, 2016) from *Cyprinion kais* and *Cyprinus carpio*. It was also recorded in the study presented by (Muhammad, 2017) in the Diyala River from *Carasobarbusluteus*, *Coptodon zillii*, *Cyprinion macrostomum*, *Cyprinus carpio* and *Mesopotamichthyssharpeyi*. The current study recorded 9 infections at a rate of 2.5%, 7 infections were recorded in gills at a rate of 2.2%, and two infections in scales at a rate of 4.5%. *Luciobarbus barbulus* had the highest rate of infection at 23.1%, followed by *Arabibarusgrypus* at a rate of 4.3%, and then *Carasobarbusluteus* at a rate of 3.2%, then *Chondrostomaregium* at a rate of 3.0%, and finally *Luciobarbus xanthopterus* by 2.2%. According to (Mhaisen, 2024), *Luciobarbus xanthopterus* and *Luciobarbus barbulus* are considered new hosts for this parasite in Iraq.

### 3.1.1.24 *Gyrodactylusprostonae* Sex, 1962

This parasite was first recorded in Iraq from *Cyprinus carpio* by (Al-Zubaidi, 1998), before it was also recorded in *Arabibarusgrypus* (Mhaisen, 2019) This parasite was also recorded in a study by (Muhammad, 2017). as many species The Diyala River had been cleaned of the fish. In the present study, 45 infections were recorded, with a percentage of 12.7% isolated from the gills, fins, and gills of infected fish. Twenty-two cases of Gill were reported. At a prevalence of 6.9%, while 19 cases were recorded at a prevalence of 33.9% in feathers and 4 cases at a prevalence of 16.7% in skin. The highest rate of infection was recorded in the *Cyprinion kais* at a rate of 14.3%, followed by the *Garra variabilis* at a rate of 13.6%, followed by the *Carassiusauratus* at a rate of 13.3%, then the *Carasobarbusluteus* at a rate of 12.7%, then the *Coptodon zillii* at a rate of 12.5%, then the *Chondrostomaregium* at a rate of 12.1%, then the *Planilizaabu* at a rate of 12.0%, then the *Mesopotamichthyssharpeyi* at a rate of 11.9%, and then the *Luciobarbus xanthopterus* and *Arabibarusgrypus* at a rate of 10.9%. Then the *Leuciscusvorax* had a percentage of 10.0%, followed by the *Luciobarbus barbulus* fish with a percentage of 7.7%, and finally the *Cyprinus carpio* with a percentage of 6.6%. According to (Mhaisen, 2024), the *Luciobarbus xanthopterus*, *Chondrostomaregium*, *Leuciscusvorax*, *Luciobarbus barbulus* and *Garra variabilis* are considered new hosts for this parasite in Iraq.

**3.1.1.25 *Gyrodactylustaimeni* Ergens, 1971**

This parasite was recorded for the first time in Iraq by (Abdul-Ameer & Al-Saadi, 2013) from *Cyprinus carpio*, then it was recorded a second time by the study conducted by (Muhammad, 2017) from *Cyprinus carpio* in the Diyala River. Regarding the present study, 5 infections were recorded, at a rate of 1.4%, isolated from the mouths of infected fish. The highest infection rate was recorded in *Leuciscusvorax* with 10.0%, followed by *Cyprinus carpio* with 3.3% and finally *Arabibarbusgripus* with 2.2%. Other hosts of this species in Iraq are *Arabibarbusgripus* and *Leuciscusvorax* (Mhaisen, 2024). According to him.

**3.1.1.26 *Gyrodactylus umbrae* Aioanei, 1994**

The parasite was recorded for the first time in Iraq by (Al-Salmani, 2015) from *Cyprinion macrostomum*, and *Planilizaabu*, and then again (Muhammad, 2017) in a study from *Cyprinus carpio* gills recorded in the Diyala River. Regarding the present study, 20 infections recorded at a rate of 5.7% were isolated from the gills and skin of infected fish. 17 infections were recorded in the gills with an incidence of 5.3% and 3 in the skin with an incidence of 12.5%. The highest infection rate was recorded in *Garra variabilis* with 9.1%, followed by *Luciobarbus xanthopterus* with 8.7%, then *Planilizaabu* with 8.0%, then *Carasobarbusluteus* with 6.3%, and then *Cyprinus carpio* 4.4%, then *Arabibarbusgripus* at 4.3% prevalence, then *Chondrostomaregium* at 3.0% prevalence, and finally *Mesopotamichthyssharppei* at 2.4% prevalence according to (Mhaisen, 2024) *Luciobarbus xanthopterus*, *Chondrostomaregium* for this pest in Iraq, *Carasobarbusluteus*, 2024; *Mesopotamichthyssharppei*, and *Garravariabilis* are considered as alternative hosts

**3.1.1.27 *Paradiplozoonalburni* Khotenovskiy, 1982**

The parasite was recorded from *Alburnusmosulensis* for the first time in Iraq by (Al-Salmani, 2022). In the current study, 5 infections were recorded at a rate of 1.4%. The highest infection rate was recorded in the *Chondrostomaregium* at a rate of 6.1%, followed by the *Carasobarbusluteus* at a rate of 3.2%, and finally *Luciobarbus xanthopterus* at a rate of 2.2%. According to (Mhaisen, 2024), *Chondrostomaregium*, *Carasobarbusluteus* and *Luciobarbus xanthopterus* are new hosts for this parasite in Iraq.

**3.1.2 Immunoglobulin and type of fish**

Although there are three types of immunoglobulins in fish (IgM, IgT, and IgD), the only one whose effect can be quickly observed in blood serum is IgM, and both IgD and IgT play an important role in mucosal immune responses (Ji *et al.*, 2021). Through the results of the current study, it was shown that different concentrations of Igm Fish immunoglobulin were recorded in healthy and infected caught fish during the current study. The highest concentration of this factor was recorded in infected *Cyprinus carpio*, as it reached 67.12 mg/ml, with a numerical percentage of 91 fish that were caught. It was studied from five sites on the Diyala River, knowing that the normal levels of Igm in healthy carp fish range between (9.1-1.7 mg/ml). The results of the current study agreed with what was mentioned before (Solem & Stenvik, 2006), while it was recorded The lowest concentration of immunoglobulin in the *Chondrostomaregium* infected reached 21.15mg/ml, with a numerical ratio of 15 fish caught during the current study. The reason for the discrepancy in the ratios may be due to a number of factors, including temperature and water quality, as well as the size of the fish, which is directly proportional to Igm concentration (Salinas *et al.*, 2021), stress, and parasitic infection (Parra *et al.*, 2016). It was noted that there were highly significant, statistically significant differences at a significant level ( $P < 0.05$ ) between the concentrations of immunoglobulin between the infected fish species, as shown in the table. (3-1).

**Table 2. shows the concentration of IgM in the fish studied**

No	Type of host fish	Total number of samples	Number of healthy fish	Igm mg/ml healthy fish	Number of infected fish	Igm mg/ml infected fish
1	<i>Luciobarbus xanthopterus</i>	96	50	12.02	46	48.97
2	<i>Arabibarbusgrypupus</i>	94	48	15.74	46	47.23
3	<i>Cyprinus carpio</i>	204	113	9.17	91	67.12
4	<i>Chondrostomaregium</i>	69	36	10.91	33	21.15
5	<i>Carasobarbusluteus</i>	149	86	11.57	63	31.17
6	<i>Mesopotamichthyssharppei</i>	92	50	15.52	42	41.25
7	<i>Silurustriostegus</i>	43	26	14.24	46	36.30
8	<i>Planilizaabu</i>	41	16	11.31	25	21.24
9	<i>Carassius auratus</i>	44	29	10.97	15	23.78
10	<i>Leuciscusvorax</i>	27	17	11.42	10	38.67
11	<i>Luciobarbus barbulus</i>	24	11	14.61	46	34.37
12	<i>Garra variabilis</i>	45	23	13.41	22	35.42
13	<i>Mastacembelusmastacembelus</i>	13	8	10.11	5	41.46

14	<i>Cyprinion kais</i>	13	6	14.21	7	33.63
15	<i>Coptodon zillii</i>	21	13	11.42	8	35.69
Sig		<b>975</b>	<b>532</b>	0.780	<b>443</b>	0.680

### 3.1.3 Immunoglobulin and fish condition

Through the results of the current study, it was found that different concentrations of average IgM fish immunoglobulin values were recorded depending on the health status of the fish. This study included 975 fish collected from five locations along the Diyala River. When these fish were examined, it was found that 532 fish were in a healthy and free condition. Of any parasitic infections, with the lowest average immunoglobulin amounting to 0.4972 mg/ml, the results of this study were consistent with what was mentioned before (Salinas *et al.*, 2021) who indicated normal levels of IgM concentration in the serum of fish, while infection of a number of fish was recorded. It was estimated that 443 fish had a variety of parasitic infections, as well as levels of IgM concentrations in them. Gail injuries had the highest percentage of injuries, amounting to 321 injuries, compared to which the highest concentration of immunoglobulin was recorded, reaching 2.6109 mg/ml, followed by skin injuries, amounting to 24 injuries, with an average immunoglobulin of 2.1545 mg/ml, and then fin injuries, amounting to 56 infection with an average immunoglobulin of 1.7841 mg/ml, and finally infections of scales, which amounted to 44 infections with an average immunoglobulin of 1.7841 mg/ml. We note that the percentage of this immune globulin has increased significantly when compared to its natural levels, which range between (0.6-21mg/ml). These levels can be affected by a number of factors, including parasitic infections, as mentioned before (Salinas *et al.*, 2021). The study of IgM immunoglobulin was chosen because it is one of the three immunoglobulins found in bony fish that can increase as a result of parasitic infections, and is the most widespread in fish serum. (Flajnik, 2018) It was noted that there are statistically significant differences at the level of Significant ( $P < 0.05$ ) between the IgM concentration and the condition of the fish (sites of parasitic infections), and no statistically significant difference was observed at a significant level ( $P < 0.05$ ) between the IgM concentration at the scales and fins, as shown in Table (3-2).

**Table 3. shows the average Igm concentration according to the condition of the fish**

Condition of the fish	Total	P<0.05			
		1	2	3	4
Healthy	530	0.4972			
Infected with fins	56		1.7214		
Infested with scales	44		1.7841		
Infected skin	24			2.1545	
Infected with gills	321				2.6109
Sig.	975	1.000	0.793	1.000	1.000

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