

REPUBLIC OF TURKEY
FIRAT UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED
SCIENCE



**A STUDY ON THE PARASITE FAUNA OF COMMON
CARP (*Cyprinus carpio*) IN SOME AREAS OF ERBIL
PROVINCE OF NORTHERN IRAQ**

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Master Thesis
Department: Fish Breeding
Thesis Supervisor: Prof. Dr. Mustafa DÖRÜCÜ (F.Ü)

May 2017

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DECLARATION

I declare and guarantee that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. Based on these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.



Rostam Kareem WSW
ELAZIĞ – 2017

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ABSTRACT

A STUDY ON THE PARASITE FAUNA OF COMMON CARP (*Cyprinus carpio*) IN SOME AREAS OF ERBIL PROVINCE OF NORTHERN IRAQ

In this study, three different areas of Erbil province were chosen to collect data on parasite fauna of common carp (*Cyprinus carpio*) in ponds such as Ainkawa Fish Hatchery, Qushtapa (Southern Erbil) and Koya (Eastern Erbil). The aim of the present study was to have the knowledge on the parasites that infect *C. carpio* in three different environments. A total of 134 common carp *Cyprinus carpio* (51 fishes in Ainkawa fish Hatchery, 39 fishes in Qushtapa area and 44 fishes in Koya area) were collected and 90 fishes were found to be infected. Ammonia, nitrite, nitrate, pH, oxygen and temperature were measured before collecting samples from the ponds. Sampled fishes were inspected in aspects of parasitology in laboratory to determine the species of parasites. There were 5 species of different ectoparasites in the present study. In the class of copopoda *Ergasilus briani* and *ergasilus parasiluri* were recorded. *Lernaea cyprinacea* in the family of Lernaeidae was also recorded. A protozoan *Trichodina acuta* from the family of Trichodinidae and a monogenean *Gyrodactylus cyprini* from the group of Gyrodactylidae were also identified. It was concluded that different parasites were found in different areas of the present study, but there was a strong link of disease transmission between the Ainkawa fish hatchery and other two areas (Qushtapa and Koya) in particular, and there was a link of disease transmission between all three locations. Prevalence, mean intensity and abundance were relatively different in three different areas.

Key Word: Erbil province of Iraq, Parasite fauna, Different ectoparasites, *Cyprinus carpio* *Gyrodactylus cyprinid*.

ÖZET

KUZEY IRAK ERBİL BÖLGESİNİN BAZI ALANLARINDA SAZAN (*Cyprinus carpio*) PARAZİT FAUNASI ÜZERİNE BİR ARAŞTIRMA

Bu çalışmada, aynalı sazan (*Cyprinus carpio*)'ın parazit faunası hakkında veri toplamak için Erbil'in üç farklı bölgesinden göletler seçildi (Güney Erbil'den Ainkawa Balık Üretim Tesisi ve Qushtapa; Doğu Erbil'den Koya Göletleri). Bu çalışmanın amacı *C. carpio*'yu üç farklı ortamda enfekte eden parazitler hakkında bilgi sahibi olmaktır. Ainkawa Balık Üretim Tesisi'nden 51 adet, Qushtapa'dan 39 adet ve Koya'dan 44 adet olmak üzere toplam 134 adet *C. carpio* toplandı balıkların 90 adedinin enfekte olduğu gözlemlendi. Göletlerden numuneler toplanmadan önce amonyak, nitrit, nitrat, pH, oksijen ve sıcaklık ölçüldü. Örneklenen balıklarda parazit türlerini belirlemek için laboratuvarında parazitoloji yönünden incelendi. Bu çalışmada 5 farklı türde ektoparazite rastlandı. copopoda sınıfından *Ergasilus briani* ve *Ergasilus parasiluri* rastlandı. Lernaeidae Ailesinden *Lernaea cyprinacea* kaydedildi. Ayrıca Trichodinidae ailesinden bir protozoan *Trichodina acuta* ve Gyrodactylidae grubundan bir monogenean *Gyrodactylus cyprini* de tespit edildi. Bu çalışmanın farklı alanlarında farklı parazitlerin bulunduğu sonucuna varıldı. Ancak özellikle Ainkawa Balık Üretim Tesisi ile diğer iki alanda (Qushtapa ve Koya) olmak üzere üç bölge arasında hastalık geçişi olduğu belirlendi. Prevalans, ortalama yoğunluk ve bolluk üç farklı alanda da nisbeten farklıydı.

Anahtar Kelimeler: Kuzey irak erbil, Parasite fauna, Farklı türde ektoparazite, *Cyprinus carpio*, *Gyrodactylus cyprinid*.

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1. INTRODUCTION

The Common carp (*Cyprinus carpio* L. 1758), which is known as most widely distributed fishes in freshwater and ponds in the world (Vilizzi et al. 2015), and it was firstly introduced in Al-Zaafaraniya fish farm (Baghdad/Iraq) in 1955 (Mhaisen, 1993a; Mama and Abdullah, 2013). Gül et al., 2010 stated that the characteristics of Common carp are known as a hardy, rapid growth, high fertility (long-term reproduction), live on different kinds of foods, illness resistant and easy to regenerate under suitable states and survive in a wider range of temperatures of water (3-35°C).

During last three decades, the industries of common carps have developed and culture of such species became a dominant cultured fishes in several fish farms in Iraq and North of Iraq. Many farms of Pond fishes have been established in the Iraq (Mhaisen, 1993b). This fishes was firstly introduced in northern of Iraq at the Dokan lake in 1967.

Cyprinus carpio belong to Order Cypriniformes, Family Cyprinidae. This family includes 356 genera. The genus *Cyprinus* includes 23 species in freshwater fish in lakes and large rivers in Europe and Asia (Froese and Pauly, 2011). In Iraq, this species is now widespread found in all main rivers and marshes. The common names of this fish are carp, karp and samti (Coad, 2010).

Several parasitic species have been found in wild and cultured carp, because of the adaptations of common carps from wide range of climatic and geographical condition. Tekin-Özan et al. (2008) stated that the most complete checklist of carp parasites recorded a total of 310 parasite species. Amlacher (1970) reported that the importance of fish parasites is immediately connected to the importance of the fishes that they might infect and consequence in various types of injuries and damages.

Most cultivated populations of fished are infested with parasites but in the majority of cases no significant harm appears to ensue. Surprisingly, few reports of parasites reported causing mortality or serious damage to feral fish populations, but this may be largely because such effects go unnoticed. Parasites in wild fish are usually only remarked upon when they are so obvious as to lead to rejection of fish by fishermen or consumers (Barnham, 2011).

Several fishes disasters which occurred in fish farms were caused by different parasites, i.e. Hines and Spira (1974) reported that the parasite *Ichthyophthirius multifiliis* led

to mortalities of *C. carpio* in hatcheries in North American. Schmahl (1991) mentioned that the parasite *Gyrodactylus salaris* causing loss evaluated about 300 ton in salmon cultures in Norway. Hoffman (1998) reported that *Dactylogyrus vastator* led to damage to the gill filaments and severe mortalities of carp and goldfish in California. It is necessary to discuss more literatures on the parasites of fishes.



2. LITERATURE REVIEW

2.1. Parasites of Fish

The parasites fauna of fish in Northern Iraq are poorly known compare to the other countries in the world. Fishes are vulnerable to large hazards which exerted through parasitic diseases and other disease agents, particularly when insufficient management, extensive culture and insufficient control measures are recorded (Mhaisen 1993ac, 1996; Mhaisen et al., 2012). Most of the parasites, which are direct life cycles in particular, could easily transmit and spread between fishes in conditions of poor and crowd management (Mhaisen 1983a).

According to Mhaisen et al. (1991), this was the first review study on the parasitic species in Iraq, revealed the existence of 10, 14 and 26 valid parasitic species in silver, grass, and common carp, respectively. Therefore, Mhaisen (2012), updated the number of parasitic species of silver, grass and common carp, which are consists of 30, 38 and 136 parasite species, respectively. Parasitic species found in fishes are initially crustaceans, hirudineans, helminthes (acanthocephalans, nematodes and platyhelminths) and protozoans (Tonguthai, 1997), so both endoparasitic and ectoparasitic species are very common in fishes. Tonguthai, 1997 stated that external parasitic species are less able to lead hazards and/or damages to their hosts than internal parasitic species.

The damage led by helminthes to their hosts usually connected to the intensity of parasitic diseases of infected host and the depth parasitic penetration in the tissue of host. According to Dezfuli et al. (2003), most helminthes including nematodes, cestodes and trematodes, which caused the intestine of host, do not show severe damage to the gastrointestinal tract of the vertebrate. When they show in the high intensity, they might indicate growth retardation (Tonguthai, 1997). On the other hand, some acanthocephalan genera including *Southwellina* (Dezfuli et al., 1998), *Pomphorhynchus* (Dezfuli et al., 2002) and *Acanthocephalus* (Taraschewski, 2000), penetrate by the wall of intestine as well as provoke sever damage to the gastrointestinal tract. Tonguthai (1997) stated that the fish gills might be infected by the larval stages (metacercariae) of trematodes resulting in disrupting the respiratory system, which are causing to high mortality rate.

2.1.1. Protozoan Parasites

Almost all parasitic infections of pond fishes are caused by parasitic protozoa (Durborow, 2003). The phylum protozoan parasite collects many organisms evolutionarily various, which might work or infect as endo- and ecto-parasites in fish and other vertebrates and invertebrates. In global aquaculture, the protozoa parasites are the causative disease agents which cause to decrease growth rate and damage of host fishes (Martins et al., 2015).

Many species of protozoa, including *T. domerguei*, *I. multifiliis*, *C. cyprini* and *Apiosoma pisiocola*, have been found by Ali et al. (1988a) on *Cyprinus carpio* farmed fishes in Al-Latifayah and Suwirau in Baghdad province. Two species of protozoan parasites such as *T. domergui* and *Glugea anomala*, have been isolated by Ali et al., (1988b) in two man-made lakes in Al-Nibaey in north of Baghdad as well.

It has been reported that the existence of six parasitic protozoans including *Apiosoma amoebae* (Sadek, 1999; Al-marjan and Abdullah, 2009; Mama and Abdullah, 2013) , *Trichodina reticulate* (Mama and Abdullah, 2013) , *Trichodina nobilis* (Al-marjan and Abdullah, 2007; Mama and Abdullah, 2013) *Trichodina acuta* (Al-Marjan and Abdullah, 2009; Mama and Abdullah, 2013), *Chilodonella cyprini* (Sadek, 1999; Abdullah and Mhaisen, 2006; Al-Marjan and Abdullah, 2009; Mhaisen, 2012; Mama and Abdullah, 2013) and *Ichthyophthirius multifiliis* (Abdullah, 2005; Abdullah and Mhaisen, 2006; Al-Marjan and Abdullah, 2009; Mama and Abdullah, 2013), in common carp fish farms in Iraq and North of Iraq. Mama and Abdulla (2013) found *Chilodonella cyprini* on the skin with a prevalence of 6.19 %, found *Ichthyophthirius multifiliis* on the gills, fins and skin with prevalence of 8.09% of *C. carpio* in Ainkawa fish hatchery-Erbil. Mama and Abdulla (2013) also found *Trichodina reticulata*, which was first recorded in North of Iraq (Kurdistan region-Iraq) from a new host of *C. carpio*, on the fins and skin with a prevalence of 3.33% in Ainkawa Fish Hatchery-Erbil. *Trichodina nobilis* has been found on the gills and skins (Al-Marjan and Abdullah, 2007; Mama and Abdullah, 2013) and fins (Al-Marjan and Abdullah, 2007) from common carp in Ainkawa fish hatchery-Erbil.

According to Herzog (1969), *Ichthyophthirius multifiliis*, which is protozoan parasite, was firstly found from *Mugil dussmien* host in Iraq. In addition, such species has been recorded by Mhaisen (2012) in 23 different fish host species including common carp.

Abdullah (2005); Abdullah and Mhaisen (2006); Al-Marjan and Abdullah (2009) found *Ichthyophthirius multifiliis* in different fish species from Ainkawa fish hatchery-Erbil, Greater Zab river and Lesser Zab river and Darbandikhan lake in North of Iraq (Kurdistan region-Iraq). Ali et al. (1989) firstly recorded *Apiosoma* amoebae from *Hypophthalmichthys molitrix* in Babylon fish farm-Hilla in Iraq and Mhaisen (2012) reported some other species of *Apiosoma* including *A. poteriformis*, *A. piscicola*, *A. minuta*, *A. cylindriiformis*, *A. amoeba* in various freshwater fishes in Iraq. *Trichodina reticulate* was firstly found in Iraq on the gills of *Silurus triostegus* from Al-Hammar marshes in Basrah city (Jori, 2006). Mhaisen (2012) recorded 14 other genus species of those *Tricjodina reticulate*, *Trichodina acuta* and *Trichodina nobilis* in Iraq such as *T. kurdistani*, *T. erbilensis*, *T. pediculus*, *T. pediculus*, *T. ranae*, *T. murmanica*, *T. elegini*, *T. borealis*, *T. heterodentata*, *T. prowazeki*, *T. mulabilis*, *T. gracilis*, *T. cottidarum*, *T. nigra*, *T. domerguei*.

2.1.2. Monogeneans

Most of the monogeneans are ectoparasites belongs to phylum platyhelminths with have direct life cycles. They usually have specific host, monogeneans typically infect gills and external body surfaces of fishes (Buchmann and Bresciani, 2006; Abdullah and Abdullah, 2013). They are generally classified into two major lineages including polyopisthocotyleans and monopisthological that vary normally in reproductive, physiology and morphological traits (Buchmann and Bresciani, 2006). Those monogeneans cause fish death and mass mortalities as a result of fungal infections, secondary bacterial, respiratory distress and tissue damage, which are related to huge loss of economics (Abdullah and Abdullah, 2013; Akmirza, 2013). Dezfuli et al. (2007) reported that most of their ecological and biological characteristics (hermaphroditism, rapid reproduction and monoxeny) enable them to lead dangerous injurious not just only in farmed stock fish but also in wild fish species. For instance, strong damage of the gill filaments and sever mortalities have been reported by *Dactylogyrus vasator* in both gold and carp fishes in south Ontario and California fish farms (Hoffman, 1998; Abdullah and Abdullah, 2013). As well as, about 300 tons of salmon farms have been lost by *Gyrodactylus salaris* in Norway (Schmahl, 1991; Abdullah and Abdullah, 2013).

The first monogenean *Diplozoon kasimii* have been recorded on the gills of *Cyprinion macrostomum* in River of Tigris, Mosul-Iraq (Fattohy, 1975). At the checklist of parasites of fishes in Iraq recorded 104 monogeneans species from 21 genera (Abdullah and Abdullah, 2013). It has been reported that the existence of some parasitic monogeneses including *Gyrodactylus sprostonae* (Al-Zubaidy, 1998; Abdullah and Abdullah, 2013), *Gyrodactylus molnari* (Abdullah and Abdullah, 2013), *Dactylogyrus baueri* (Al-Aubaidi, 1999; Mama, 2012), *Dactylogyrus anchoratus* (Mhaisen, 1997; Al-Aubaidi, 1999), on gills in common carps (*C. carpio*) in Iraq and North of Iraq. There are many research reported *Dactylogyrus macrostomi* on the gills of *C. macrostomum* in Bahdinan river, Greater Zab and lesser zab rivers and Tigris river-near Baiji in North of Iraq and Iraq (Abdullah, 2002; Abdullah and Mhaisen, 2004; Bilal and Abdullah, 2009; Abdullah and Abdullah, 2013). *Dogielius persicus* have been reported by Abdullah and Mhaisen (2005); Al-Saadi (2007) in *B. luteus* and *B. grypus* in Iraq.

In Gökçeada-Turkey, the waters are characterized by high fish species richness. While Ulutürk (1987) cited in Akmirza (2013) recorded 144 fish species from 60 families near Gökçeada, Keskin and Ünsal (1998) detected 76 fish species. Many of these fish species have commercial value and play an important role in Turkish fisheries. Some monogeneans including *Gastrocotyle trachuri*, *Cyclocotyla bellones*, *Octosoma scombri*, *Microcotyle erythrini*, *Aspinatrium trachini*, *Pseudaxine trachuri* and *Choricotyle chrysophrii* have been detected in some parasitic studies conducted in such location (Akmirza, 1997,1998, 2003, 2004, 2013).

2.1.3. Cestodes

Cestodes, which are known as tapeworms, are endoparasitic platyhelminths. They have indirect life cycle with involving one or more intermediate hosts. Young cestodes are mainly detected in the gastrointestinal tract system (Dick et al., 2006). According to Dick et al. (2006), larval phases might be detected in different organs; larval stages are usually more host-specific than adults. In the gastrointestinal tract, adult cestodes might lead to mechanical damage or decreased absorption of nutrition; while migrating larvae is known the most serious pathologic that cause to fish hosts (Dick et al. 2006). It has been reported that there are little

nature investigations on the host-parasite interactions between Cestodes and fishes in natural environments (Loot et al., 2001).

Proteocephalus turulosus and *Bothriocephalus gowkongensis* (Batsch, 1786; Yeh, 1955 cited in Khalifa, K.A., 1986) were identified in Baghdad area and also in some ponds near Samarra City. Most of the infected *Cyprinus carpio* were infected with both species, whereas gattan were uninfected; Voucher specimens have been deposited in the British Museum (Natural History), Cromwell Road, London, England (4 June 1981, Ref. No. DIG/TMJ). This is the first report of these parasites in Iraq (Khalifa, K.A., 1986). Five tapeworms of the class Cestoda were recorded from fishes of fish farm Al-Furat. These belong to genera *Proteocephalus* (two species), *Bothriocephalus*, *Gryporhynchus* and *Ligula* (one species each) (Mhaisen et al., 2011). The species were *Bothriocephalus acheilognathi* (Mhaisen et al., 1993; Al-Zubaidy, 1998 reported as *B. opsariichthydis*), *Proteocephalus osculatus* (Al-Zubaidy, 1998), *P. torulosus* (Al-Zubaidy, 1998), *Ligula intestinalis* (Al-Zubaidy, 1998), *Gryporhynchus cheilancristrotus* (Al-Zubaidy, 1998).

Many specimens of larvae and adults of parasitic cestode of *Bothriocephalus acheilognathi* have been also detected by Mama and Abdullah (2013b), in intestine of common carps. Even though, such parasitic cestodes was firstly detected by Khalifa (1982) from common carp in some farm fishes in Bagdad-Iraq. As well as, about 19 fish hosts have been reported in whole Iraq (Mhaisen, 2012). Kappe (2004) found two species of parasitic cestodes including *Khawia sinensis* and *Bothriocephalus acheilognathi* in *C. carpio* from two different fish farms in the south of Leipzing (Saxong) in Germany. Kir et al. (2004) also reported three species of parasitic cestodes such as *Ligula intestinalis*, *Caryophyllaeus laticeps* and *Bothriocephalus acheilognathi* from common carp from Karacaören-I Dam Lake in Turkey. *Bothriocephalus acheilognathi* (Cestoda) have been isolated from common carp in Eber Lake in Turkey (Öztürk, 2005). Tekin-Özan et al. (2008) stated two species of cestodes such as *Caryophyllaeus laticeps* and *Bothriocephalus acheilognathi* and from common carp in Beyşehir Lake in Turkey. Kir and Tekin-Özan (2007) reported *Caryophyllaeus laticeps* and *Bothriocephalus acheilognathi* (Cestoda) from common carp in Kovada Lake in Turkey. It has been studied the morphology of the scolex of *Bothriocephalus acheilognathi* which was reported from the intestinal tract of common carp in North Chungcheong province of South Korea (Han et al., 2010).

Khalifa (1989) reported two species of cestodes such as *Caryophyllacus* sp. and *Bothriocephalus gowkongensis* in his survey studies of parasites of four species of fish farm in Baghdad region, Sammara and in Therthar chanal. Jassim (2007) reported two species of parasitic cestodes of *Nippotaenia* sp. and *Bothriocephalus acheilognathi* from *C. carpio* at three stations in Basrah City, Iraq.

2.1.4. Nematodes

Nematodes, which are known as roundworms, are endoparasitic species that might be characterized as direct life cycle, for example, *Camallanus cotti* (Lavsén 2001), even though several species that infect fishes have indirect life cycles, with a single intermediate host and one or more paratenic hosts. Fishes might be either definitive, intermediate or paratenic hosts for nematodes (Coyner et al. 2001; Akther et al. 2004). Larvae of nematodes found in a different organs such as viscera, body cavity, skin and gastrointestinal tract, as well as adults of parasitic nematodes generally found in gastrointestinal tract (Molnar et al. 2006).

Nematodes showed rapidly decreased densities, diversity and richness in sediments beneath fish farms (Mirto et al., 2002). According to Mirto et al. (2002), nematodes start increase in their biomass after forty-five days. Al-Nasiri *et al.* (2002) reported one species of nematode larva such as *Contracaecum* sp. in *C. carpio* collected from a man-made lake in north of Baghdad City. Jassim (2007) reported two species of parasitic nematodes of *Proleptinae* gen. sp. from *C. carpio* at three stations in Basrah City, Iraq. Abdullah (2002) reported one species of parasitic nematode such as *Contracaecum* spp. in Lesser Zab River near Alton-Kuprri town in south of Erbil City.

2.1.5. Crustacean Parasites

The crustacean parasites detected in the class Malacostraca, Branchiura and Copepoda, they are invariably ectoparasitic on fish farm and have a direct life cycle. Crustacean stages are generally blood feeders on the skins, fins or gills of the fishes or host, it is become very serious pathogenic impacts when large numbers of parasitic crustacean are existed in the host (Lester and Hayward, 2006).

Crustaceans are distinguished from all other arthropods by the fact they possess two pairs of antennary appendages in front of the mouth together with the presence of biramous limbs. Crustaceans form a large and highly diverse group of arthropods that have adapted to a number of different environments ranging from deep sea to shallow marine (e.g. shrimp, crab and lobster) to brackish water and freshwater habitats (e.g. crayfish, water-fleas and tadpole shrimps) and in some instances are fully terrestrial (e.g. the modern woodlouse).

Most of the found parasitic crustacean species that have been described are copepods class, as well as most of the copepods that infest freshwater fishes come from Ergasilidae and Lernaecidae families (Ho, 1998; Lester and Hayward, 2006). The most wide geographic distribution is Lernaecidae family, which is known as anchor worms, is majority from Asia to Africa. According to Ho (1998), 113 species of lernaecid copepods have been recorded from 322 species of freshwater fishes belonging to 161 genera in 41 families. These are over 40 species in the genus *Lernaea*. *Lernaea cyprinacea* is the most widespread species (Bond, 2004; Perez-Bote, 2005).

Several species of parasitic crustacean were detected on the gills of fishes. Bilal and Abdullah (2008) reported *Lamproglana pulchella* on the gills of *B. barbatus* and *B. kersin*. Khalifa (1989) recorded *Argulus foliaceus* and *Lernaea cyprinacea* in Baghdad region, Sammara and in Therthar chanel. Aydogdu *et al.* (2001, 2009) and Cengizler *et al.* (2001) recorded *Ergasilus sieboldi* and *Argulus foliaceus* from common carps in Turkey. Khan *et al.* (2003) recorded *Lernaea cyprinacea* from common carp in different freshwater habitats of Pakistan. Kir *et al.* (2004); Öztürk (2005) isolated *Argulus foliaceus* from common carp in Turkey. Boane *et al.* (2008) detected *Lernaea cyprinacea*, *Lamproglana monodi* and *Dolops ranarum* from *C. carpio* in Limpopo River and Chuãli Lagoon in Mozambique. Al-Aubaidi *et al.* (1999) and Muhammed (2000) reported that the common carp from Al- Zaafaraniya fish farm in Baghdad City were infested by *Lernaea cyprinacea*.

2.2. Research Statement (Rationale of Research)

The development of aquaculture in North of Iraq is very important in the country's development. Although one of the most important freshwater fish species culture in the country is the common carp (*C. carpio*) some are known about their parasites, also it is noted

that knowledge concerning parasites of fish farms of Kurdistan is very scarce. The study of fish parasites is necessary to increase the productivity of pond farms, to improve the stocks of valuable commercial fisheries in the natural waters and to the possibility of fish acclimatization in new sites or localities (Shul'man, 1961).

2.3. The Aim of Study

The aim of the present study was to have the knowledge on the parasites that infect *C. carpio* in three different environments; Ainkawa fish hatchery, Qushtapa area and Koya area in North of Iraq, and to make a comparison between their infections.

2.4. The Objectives of Study

The objectives of the present study were to:

1. To find parasites in fishes in ponds in different areas in Erbil-Iraq.
2. Whether different species of fish parasites can be found in different areas.
3. Whether Species of parasites in Ainkawa fish hatchery (Source of fish in Erbil) are the same species of fish parasites in other areas, if parasites can be found.
4. Estimate prevalence, intensity and abundance of parasite species.

3. MATERIALS AND METHODS

Three different areas of Erbil province, which is located at north of Iraq, were chosen to collect data on common carp *Cyprinus carpio* in ponds such as Ainkawa Fish Hatchery (Figure 1 and 2), Qushtapa area (Southern Erbil) and Koya area (Eastern Erbil) (Figure 3). A total of 134 common carp *Cyprinus carpio* (51 fishes in Ainkawa fish Hatchery, 39 fishes in Qushtapa area and 44 fishes in Koya area) were collected and 90 fishes were found to be infected; in order to avoid bias, some ponds were chosen randomly in each area; those areas are different in several aspects such as management, environment and feeding. Sampled fishes were inspected in aspects of parasitology in laboratory to determine the species of parasites.

Before taking samples from the ponds at these different areas of Erbil provinces, aquarium pharmaceutical test kits were used to measure ammonia, nitrite and nitrate. The pH and temperature were measured by pH meter (TPS-WP-80). DO meter (YSI-550A) was used to determine dissolved oxygen in the ponds.



Figure 1. A sample of fish pond in specified site location



Figure 2. Sample of infected Common carp with *Lernea*

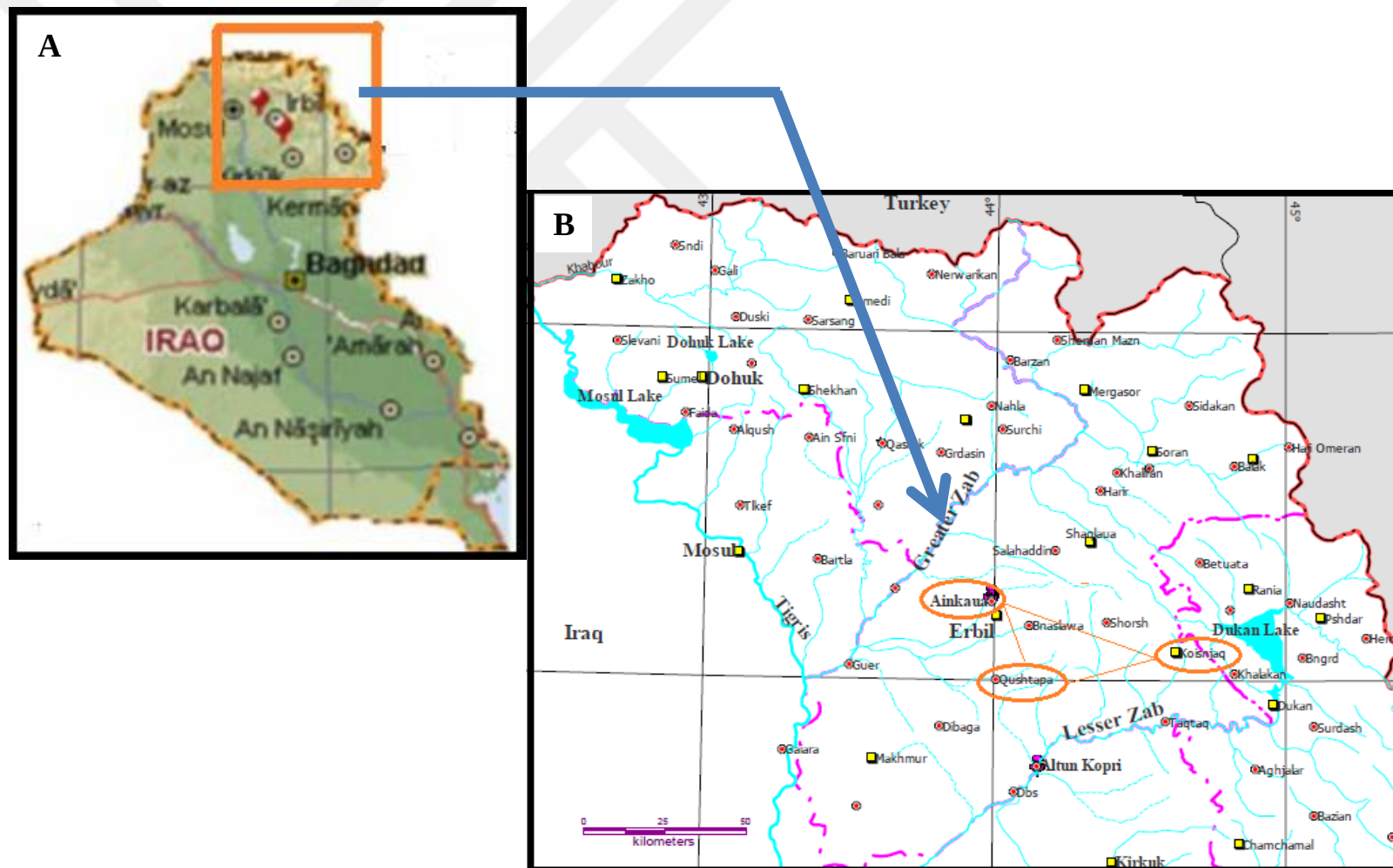


Figure 3. A- Map of Iraq showing North of Iraq. B- Map of Erbil Province showing Ainkawa Town and Qushtapa Area and Koya Area (Google Images).

Data Collection

All fish sample were collected by using gill nets. This study was conducted between 03/05-25/09/2016. All fishes were kept in a box, which was included same water of sample fishes and transferred to the Laboratory of Veterinary of Harem/ Ministry of Agricultural and Water Resources of KRG (Figure 4) and Laboratory of Animal Resources Department/Directorate of Agricultural Research-Erbil. The fish samples were examined within 2 days of their captures. Fishes were identified based on Froese and Paulty (2006). Thereafter some found parasites were kept in Formalin (% 5).

Examenation For Parasite

The procedure were to:

1. Examine skin, fin and gills for larger parasites that were seen with the naked eye (e.g., *Ichthyophthirius*, larger monogeneans, leeches, etc.). If the fish was small, it was placed into a petri dish with water or normal physiological saline and examined using a dissecting microscope. The fins and gills were removed from larger fish and examined similarly.
2. Prepare a mucus wet-mount by scraping the dorsolateral surface of the fish with the dull side of a scalpel blade. Transfer the mucus to a clean microscope slide, add a drop of saline and cover with a cover slip. Remove several fins and prepare a wet-mount. Examine preparations for smaller external protozoa using 100 magnification of a compound microscope.
3. Remove the operculum of the fish with a scissor. If the fish was small, removed the entire gill arch and transfer to a slide. Added saline and covered slip. With larger fish, it was necessary to remove the body arch before preparing the gill wet-mount or use a few filament tips removed with a scissor. Examine the gills with 100x of a compound microscope looking for external protozoans, cysts (which may be *Ichthyophthirius*, trematode metacercariae, *Mirosporea* or *Myxosporea*) and monogenetic flukes.
4. Open the fish. In order to examine the body cavity for encysted parasites. Small amount of blood from the heart were removed. Dilute 1:1 with saline at 100x for

Trypanoplasma and Trypanosoma were examined. Blood smears were also prepared at this time and later stained for blood sporozoa.

5. Remove the viscera completely from fish. For small fish this were done in saline with the use of a dissecting microscope. Tease apart the organs with fine forceps or dissecting needles. A drop or two of fluids and mucus were removed from the intestinal tract and transfered to a slide. A coverslip was Added and examined for protozoa (*Hexamita*, *Schizamoeba* and *Eimeria*). The intestinal tract the entire length were Opened and examined with a dissecting microscope for helminthes. Examination of the intestinal tract was facilitated by compressing a longer section of the intestine between two glass slides and examining with a compound microscope. Individual organs of larger fish were removed, transferred to saline in a petri dish and examined for larval parasites. Squashes of kidney, liver, spleen and gonads were prepared. The swim bladder was removed, being careful not to deflate it and examined with dissecting microscope for nematodes and trematodes. The entire intestinal tract was stretched out and cut to open longitudinally with a small fine point dissecting scissors.
6. Carefully remove the gall bladder with fine forceps and examined for trematodes. Prepare at wet-mount and examined for sporozoans and ciliates. Likewise, the urinary bladder was removed and examined for *Phyllodistomum* and sporozoans.
7. Remove each eye using a forceps and scissor and placed into a petri dish with saline. Low power of a dissecting microscope was used to observe any movement of digenetic unencysted larval flukes (*Diplostomulum*). The eye was cut to open and examined lend for the eye fluke *Diplostomum sp.*
8. The musculature was examined by slicing the epaxial musculature at regular intervals and looking for larval worms, sometime encysted and Microsporea and Myxosporidea cysts.
9. Concentration methods for myxosporidians were sometimes required, such as for detecting *Myxobolus cerebralis* by Pepsin-trypsin Digesting Method (Becky L. 2004).



Figure 4. Laboratory of Veterinary of Harem/ Ministry of Agricultural and Water Resources of KRG

Data Analyses

Data analysis was carried out by using Margolis *et. al.* (1982); Bush *et.al.* (1986), formula to calculate the prevalence, abundance and mean intensity of parasites which were found given infections on the fishes. The formula for calculation might be referred as follows:-

Prevalence = Number of infected fish ÷ Total number of fish examined × 100

Mean intensity=Total number of individual of a particular parasite species in a sample of a host species ÷ number of infected individuals of the species in the sample

Abundance= Total number of individuals of a particular parasite species in a sample of host ÷ total number of individuals of the host species in the sample (Margolis *et al.*, 1982)

4. RESULTS AND DISCUSSIONS

A total of 134 common carp *Cyprinus carpio* were collected and inspected for parasites in fish ponds from three different locations which are Ainkawa fish hatchery (51), Qushtapa area (39) and Koya area (44).

In the present study, five species of parasites were identified. In the class of *copepod* *Ergasilus briani* and *copopoda* *Eragasilus parasilusi* were recorded. *Lernaea cyprinacea* in the family of Lernaeidae was also recorded. A protozoan *Trichodina acuta* from the family of Trichodinidae and a monogenean *Gyrodactylus cyprini* from the group of Gyrodactylidae were also identified. Classifications of all recorded parasites are shown in Table 1. Prevalence, mean intensity, abundance, host organs in the targeted locations are given in Table 2.

4.1. *Ergasilus briani*

In the present study, a poecilostomatoida *Ergasilus briani*, which is as specie of Triopsidae family also known as a (tadpole shrimp), was observed on the skin and mouth of *C. carpio* in Ainkawa Hatchery fish ponds (Figure 5) with prevalence of 45.10 % and the mean intensity of 0.14% (Table 2). However, there was no poecilostomatoida observation of any species in Qushtapa and Koya fish ponds. Researchers reported that the tadpole shrimp prefers a pH between 6 and 7.8 also hatching temperature ranges between 10 °C and 24 °C (Kuller and Gasith; 1996; Behroz *et al*; 2013). Abundance of *E briani* in Ainkawa hatchery ponds could be attributed to the importing broodstock from Iran, due to the wide distribution of this species in this country which is explained by (Behroz *et al*; 2013). The same researchers have stated that the Triops granaries has a largest geographical distribution among all poecilostomatoida. It ranges from Africa through the Middle East to India, China and Japan. Size of the species is nearly 2 mm, no larger one has been observed due to the low quality of environmental conditions in the hatchery ponds. However, this species can grow more and reach to 42 mm–60 mm in length.

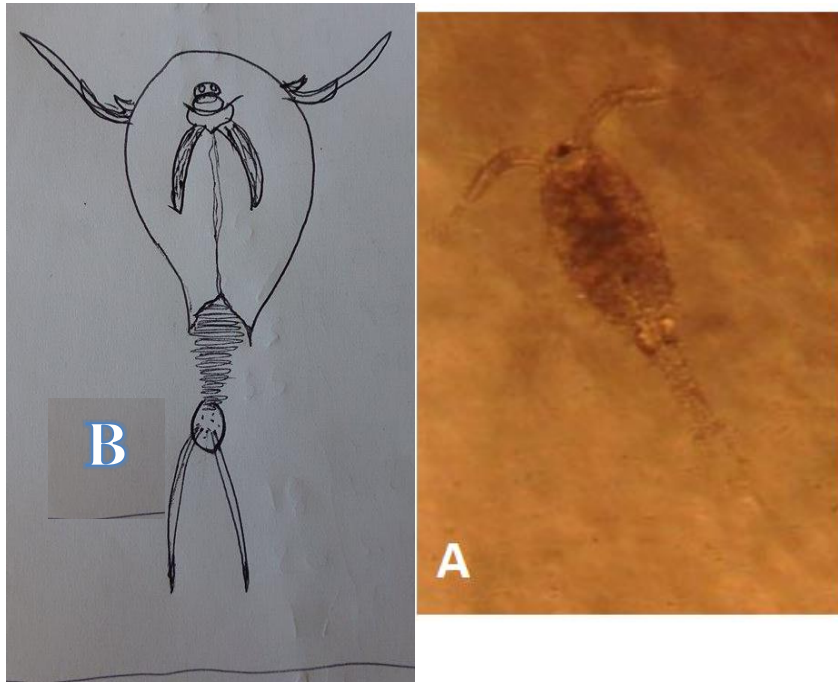


Figure 5. *Ergasilus briani*

A: Microscope image 100X

B: Drawing.

Table 1. Scientific classifications of identified parasite species found in gill, skin and mouth of common carp in Ainkawa Hatchery, Qushtapa and Koya fish ponds.

Species	Scientific classification
1 <i>Ergasilus briani</i>	Kingdom: metazoa Phylum: Arthropoda Subphylum: Crustacea Class: copopoda Subclass: Phylopoda Order: poecilostomatoida Family: Ergasilidae Genus: Ergasilus Species: <i>Ergasilus briani</i>
2 <i>Ergasilus parasiluri</i>	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Hexanauplia Subclass: copopoda Order: Poecilostomoida Family: Ergasilidae Genus: Ergasilus Species: <i>Ergasilus parasiluri</i>
3 <i>Trichodina acuta</i>	Kingdom: Protista Phylum: Ciliophora Subphylum: Oligohymenophorea Class: Peritrichia Subclass: Mobilida Order: Trichodinidae Family: Trichodina Genus: <i>Trichodina acuta</i> Species:
4 <i>Gyrodactylus cyprinid</i>	Kingdom: Animalia Phylum: Platyhelminthes Class: Monogenea Order: Monopisthocotylea Family: Gyrodactylidae Genus: Gyrodactylus Species: <i>Gyrodactylus cyprinid</i>
5 <i>Lernaea cyprinid</i>	Kingdom: Animalia Phylum: Arthropoda Subphylum: Crustacea Class: Maxillopoda Subclass: Copepoda Order: Cyclopoida Family: Lernaeidae Genus: Lernaea Species: <i>Lernaea cyprinid</i>

Table 2. Prevalence, mean intensity, abundance and host organs of identified parasites on *C. carpio* in Ainkawa Hatchery, Qushtapa and Koya fish ponds.

	Parasites	Sp.	No. of Examined	No. Infected	Prevalence (%)	No. of Parasites	Mean intensity	Abundance	Host organs
Ainkawa hatchery ponds	Crustaceans	<i>Ergasilus briani</i>	51	23	45.10	27	1.17	0.52	Mouth,skin
		<i>Ergasilus parasiluri</i>	51	32	62.75	35	1.09	0.68	Mouth,gill
		<i>Lernaea cyprini</i>	51	30	58.82	45	1.5	0.88	Skin,gill,fins
	Monogenean	<i>Gyrodactylus cyprini</i>	51	37	72.55	40	1.08	0.78	Gill,fins
	Protozoan	<i>Trichodina acuta</i>	51	35	68.63	36	1.02	0.70	Gill,skin
Qushtapa fish ponds	Crustaceans	<i>Ergasilus parasiluri</i>	39	22	0.43	25	1.13	0.64	mouth
		<i>Lernaea cyprini</i>	39	22	0.43	27	1.22	0.69	Gill,skin,fins
	Monogenean	<i>Gyrodactylus cyprini</i>	39	20	0.39	23	1.15	0.58	Gill,fins
	Protozoan	<i>Trichodina acuta</i>	39	33	0.65	35	1.06	0.89	Skin,gill
Koya fish ponds	Crustaceans	<i>Ergasilus parasiluri</i>	44	14	27.5	18	1.28	0.40	Mouth gill
		<i>Lernaea cyprinid</i>	44	14	27.5	20	1.42	0.45	Skin,gill,fins
	Monogenean	<i>Gyrodactylus cyprini</i>	44	14	27.5	17	1.21	0.38	Gill,fins
	Protozoan	<i>Trichodina acuta</i>	44	20	39.2	25	1.25	0.56	Skin,gill

4.2. *Ergasilus parasiluri*

A genus of *Ergasilus* is a crustaceans belongs to class of Ergasilidae also known as a “fairy shrimp” (Timms; 2001); (Geddes; 1981). This genus has numerous species and some of them are threatened to be extinct (Timms; 2001). This genus found in many parts in the world especially in Australia. In the present study, *Ergasilus parasiluri* which is one species of *Ergasilus* genus has been observed in the skin and mouth of common carp in fish ponds in all targeted locations (Figure 6). This species has prevalences 62.75 % and 27.5 % in Ainkawa Hatchery and Koya fish pond respectively, and with mean intensity 1.09 and 1.28 respectively (Table2). However, the prevalence and mean intensity of Qushtapa was much lower than other two locations which was 0.43%. Significant proportion of this genus is found in Australia with at least 34 species (Timms; 2001). However, *Ergassilus parasiluri* have not been well studied and literature about this specie is limited.

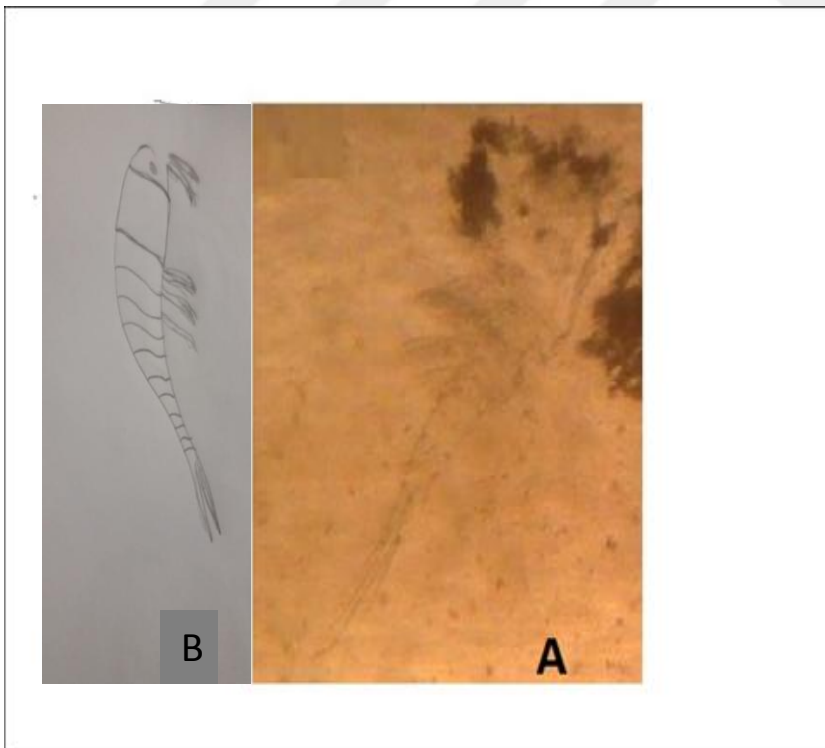


Figure 6. *Ergasilus parasiluri*

A: Microscope image 40x
B: Drawing.

4.3. *Trichodina acuta*

Ciliated protozoan *Trichodina* species are in the family Trichodinidae. Pathogenic and the disease caused by them is called trichodinosis (Kibria *et al.*, 2010; Durborow, 2003). *Trichodina* is circular when viewed from the top and it has dome shape from side view of the organ and it has three rings of cilia used for locomotion and feeding (Durborow, 2003) (Figure 7).

Trichodina acuta is one of the most widespread species of its genus. *T. acuta* was originally described by Lom (1961) from five species of freshwater fishes including *C. carpio* (Lom, 1961). In the present study, *T. acuta* was identified from the skin and gills of *C. carpio* in Ainkawa fish hatchery, Qushtapa and Koya fish ponds with a prevalence of 68.63%, 0.65 and 39.2% respectively (Table 2). This finding is in agreement with Van As and Basson (1989), Abdullah and Mama (2013) and Al-Marjan and Abdullah (2007) which is isolated from gills, fins, and skin of *C. carpio*. According to (Lom, 1961), this Ciliated protozoan infest host organs such as skins and fins which is in agreement with the present study and occasionally could be identified from gills. However, Kibria *et al.*, (2010) only observed this protozoan in gills of *Mystus bleekeri*. Also, *T. shitalakshyae* and *T. shitalakshyae* which are other two species of *Trichodina* found only in gills of freshwater fishes (Kibria *et al.*, 2010).

Also, Asmat *et al.* (1997) have identified *T. acuta* and *T. shitalakshyae* from *Glossogobius giuris* (Tank goby) and *Mystus bleekeri* during December to January.

Due to lack investigations in the region about this cilia, it is not possible to determine whether wide spread is through translocation of Asian and European species or it is indigenous one.

Holdfasts branched

Holdfasts branched

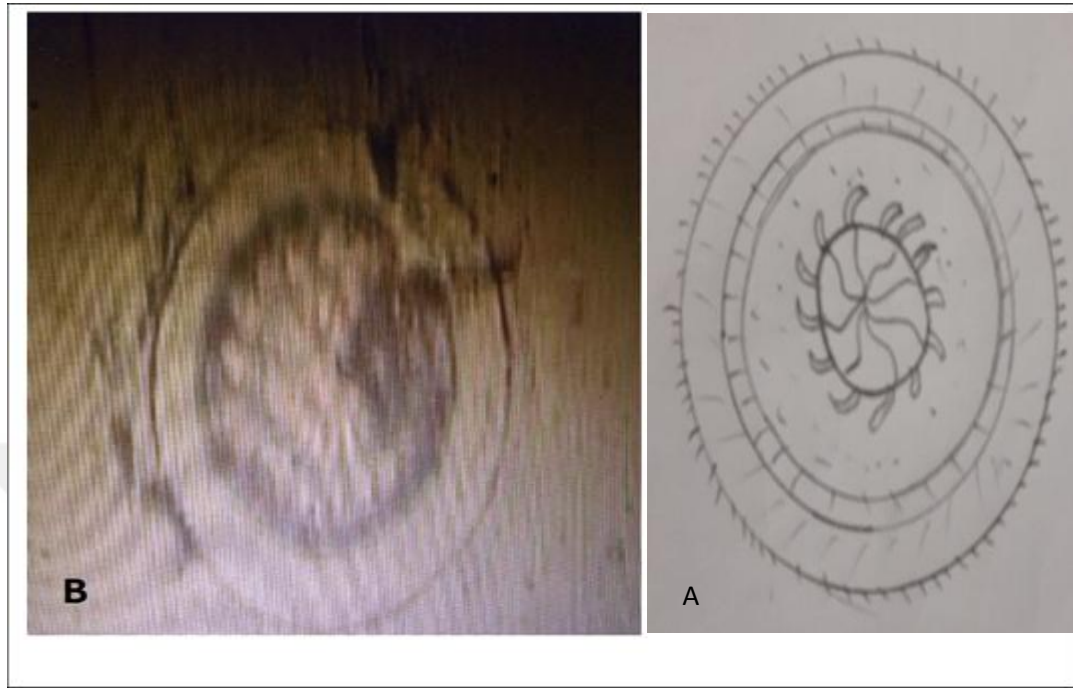


Figure 7. *Trichodina acuta*

(A): Drawing

(B): Photomicrograph 40X

4.4. *Gyrodactylus cyprini*

Class Monogenea is the largest groups of Platyhelminthes and group of Gyrodactylidae are consists of several species such as *Gyrodactylus cyprini* (Pugachev et al., 2010; Öztürk and Özer; 2014; Abdullah and Mama; 2013). This Monogenea species was identified in the present study from the skin and gills of *C. carpio* from all three targeted locations (Figure 8). The prevalence of this species in Ainkawa Hatchery, Qushtapa and Koya 72.55%, 0.39% and 27.5 % respectively (Table 2). Also, the mean intensity of the same species in all three locations 1.08, 1.15 and 1.21 respectively (Table 2). According to these results, fish in Qushtapa location had considerably less prevalence compared with other targeted locations which is might attribute to the management level in Qushtapa location and better water quality parameters. An experiment by Abdullah and Mama (2013) was conducted in Ainkawa fish hatchery during the period from August (2010) until the end of May (2011) which is the same

target location in the present study. They found this specie in the skin of *C. carpio* with prevalence 2.38%, which is considerably lower form prevalence in the present study. In addition, this finding of the present study is in agreement with Pugachev *et al.*, (2010), who found *G. cyprini* on the skin and gills of *C. carpio*. also.

Öztürk and Özer; (2014) have found the same specie on *C. carpio* with prevalence of 0.9%. These researchers have demonstrated that *G. cyprinis* a relatively little known species as a parasite specific to *C. carpio*. They have also stated that this specie was found only in season among fish samples collected all seasons in Turkey and they have demonstrated that this species was first time recorded in their country by them.



Figure 8. *Gyrodactylus cyprinid*

A: Drawing a: Twee grotr haken b: Krans van kleinere haken

c: Levendbarend vaak zlichtbaar embryo

B: Microscope image of *Gyrodactylus cyprinid*

4.5. *Lernaea cyprinacea*

Lernaea is a parasitic on freshwater fishes. It is a genus of copepods crustaceans belongs to family of Lernaeidae also commonly “Anchor worm”. In the present study, *L. cyprinacea* have been noticed in all three targeted locations (Figure 9). Fish from Ainakawa Hatchery was severely affected by this species with a prevalence of 58.82 % and the mean intensity was 1.5. However, prevalence and mean intensity of infected fish in Koya was 27.5% and 1.42 respectively. In another words, fish in Koya was less infected with anchor worms compared with Ainkawa Hatchery. In contrast, fish in Qushtapa was healthier in terms of infection with anchor worms with prevalence 0.43% and mean intensity 1.13.

The anchor parasite was firstly recorded in Iraq on seven fish species in Al-Zaafaraniya fish farm in Baghdad (Al-Hamed and Hermiz, 1973). Mhaisen (2012) recorded from 24 fish host species from many inland water bodies in as well as from many fish farms in Iraq. In North of Iraq, Abdullah (1990, 2005); Al-Marjan (2007) recorded from five species of fishes such as: *Leuciscus lepidus*, *Cyprinus carpio*, *Barbus luteus*, *Barbus grypus* and *Barbus barbulus* from Dokan, Darbandikhan lakes and Ainkawa fish hatchery.

Baur (1962) in his study showed that *L. cyprinacea* is an exceptional thermophilic organism and performs better at high temperatures. Temperatures between 23-30 C are the most favorable for development. Therefore, according to the study of Baur (1962), due to favorable temperature in Ainkawa Hatchery abundance of *L. cyprinacea* was 0.88 compared with Koya and Qushtapa locations which the abundance of observed parasite was 0.45 and 0.69 respectively. Also, the high infection rate of common carp with anchor worm is related to ponds management and low water quality parameters that have been recorded during sampling.

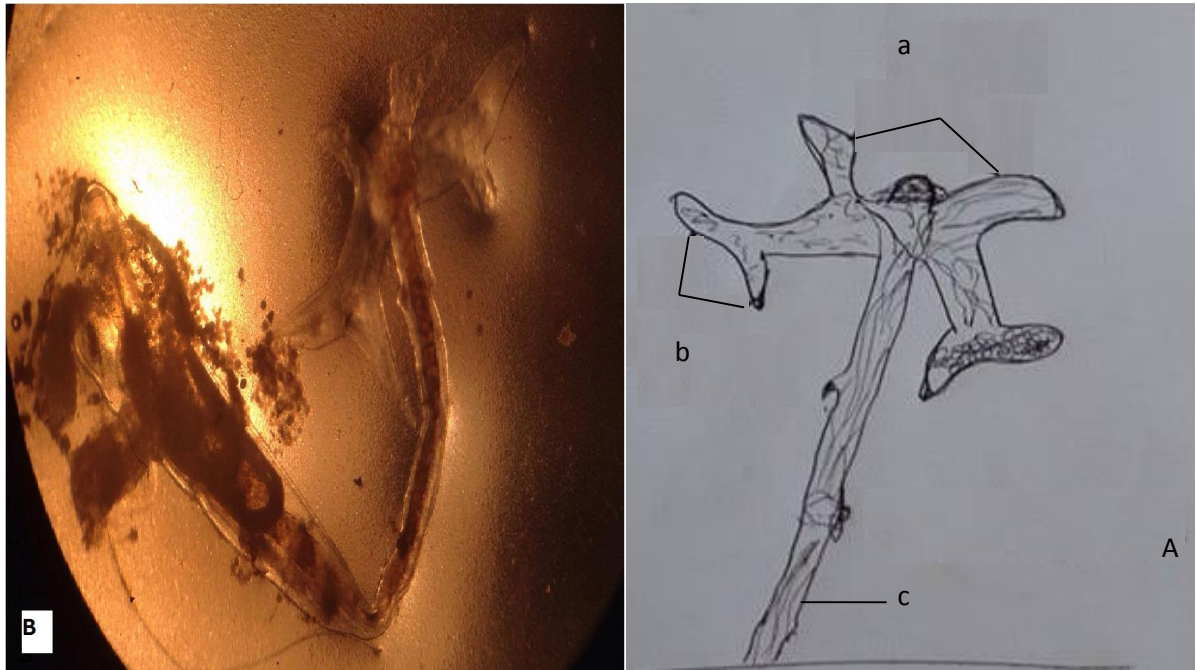


Figure 9. *Lernaea cyprinacea*

A: Drawing *Lernaea cyprinacea* a: Holdfasts branched b: Holdfasts simpl c: *Lernaea cyprinacea*

B: Microscope image of *Lernaea cyprinacea*

5. CONCLUSIONS AND RECOMMENDATIONS

It has been concluded that the results shows during the external and internal examination of *C. carpio* in Ainkawa fish hatchery, Qushtapa area and Koya area, in three areas 5 different ectoparasites species were found in the present study.

Different parasites were found in different areas of the present study, but there was a strong link of disease transmission between the Ainkawa fish hatchery and other two areas (Qushtapa and Koya) in particular, and there was a link of disease transmission between all three locations. Prevalence, mean intensity and abundance was different in all three different areas.

In the class of *Ergasilus Briani* and *Ergasilus parasiluri* were recorded. *Lernaea cyprinacea* in the family of *Lernaeidae* was also recorded. A protozoan *Trichodina acuta* from the family of *Trichodinidae* and a monogenean *Gyrodactylus cyprini* from the group of *Gyrodactylidae* were also identified.

In the present study, a Copopoda *Ergasilus briani* was observed on the skin and mouth of *C. carpio* in Ainkawa Hatchery fish ponds with prevalence of 45.10 % and the mean intensity of 1.17. However, there was no observation of any *Ergasilus* species in Qushtapa and Koya fish ponds.

In addition, *Ergasilus parasiluri* has been observed in the skin and mouth of common carp in fish ponds. This species has prevalence of 62.75 % and 27.5 % in Ainkawa Hatchery and Koya fish pond respectively, and with mean intensity 1.09 and 1.28 respectively. However, the prevalence and mean intensity of Qushtapa was much lower than other two locations which was 0.43%.

Trichodina acuta was identified from the skin and gills of *C. carpio* in Ainkawa fish hatchery, Qushtapa and Koya fish ponds with a prevalence of 68.63%, 0.65 and 39.2% respectively. *Gyrodactylus cyprini* was identified from the skin and gills of *C. carpio* from all three targeted locations. The prevalence of this species in Ainkawa Hatchery, Qushtapa and Koya 72.55%, 0.39% and 27.5 % respectively, and the mean intensity of the same species in all three locations 1.02, 1.06 and 1.25 respectively.

In the present study, *Lernaea cyprinacea* has been identified in all three targeted locations. Fish from Ainakawa Hatchery was severely affected by this species with prevalence of 58.82 % and the mean intensity was 1.5. However, prevalence and mean intensity of infected fish in Koya was 27.5% and 1.42 respectively. On the other hand, fish in Koya was less infected with anchor worms compared with Ainkawa Hatchery. In contrast, fish in Qushtapa was healthier in terms of infection with anchor worms with prevalence of 0.43% and mean intensity 1.22.

It is recommended that further studies are required to do survey for parasites of the fishes because north of Iraq is rich in natural water bodies and aquaculture most of them did not undergo any study. It has been also recommended that the fish breeding ponds should be designed in a way which ensures proper sterilization of the water in order to prevent the infection of fish with different microorganisms.

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