MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
UNIVERSITYAKLI MOHAND OULHADJ–BOUIRA
FACULTY OF NATURAL AND LIFE SCIENCES AND EARTH SCIENCES DEPARTMENT OF BIOLOGY

Ref:……./UAMOB/FSNVST/2024

Dissertation

OVERVIEW OF OBTAINING THE DIPLOMASTER

Domain: SNV **Sector**: Ecology and environment

Speciality : Biodiversity and Environment

Presented by:

BENDIAF SIDAHMED & DAHMANI ABDELHAK REDHA

Theme

Parasitic study of some species of fish (Bouira)

Supported on:24/06/2024 **Ahead of the jury:**

First and last name	*Grade*		
Mr. ARAB AMAR	*MCA*	*Univ.from Bouira*	*President*
Mrs . IDER DJAMILA	*MCB*	*Univ. from Bouira*	*Supervisor*
Mrs.MAIBECHE YASMINA	*MCB*	*Univ. from Bouira*	*Examiner*

Academic Year:2023/2024

بسم الله الرحمن الرحيم

THANKS

First and foremost, we thank God, our Creator, for giving us the strength and courage to accomplish this work.

We thank the members of our families for their support and encouragement.

At the end of this work, we express our deep gratitude to our supervisor, IDER DJAMIAL, for the competent help he provided us, for his patience, trust, encouragement to structure this work, and for improving the quality of the various sections of our thesis. We thank him wholeheartedly.

We would like to express our sincere thanks to all the professors who taught us and who, through their competence in our studies, have contributed to our success.

An exceptional thank you to all my friends and all the students of the 2024 graduating class.

At the end of this work, our deep gratitude also goes to all the people who have helped and supported us, near or far, directly or indirectly, in the realization of this thesis.

Dedicatio

I dedicate this thesis to:
Those who are dearest to me in the world: my father and mother for their sacrifices and support throughout my studies.
To my dear parents, SIDALI and KERMIA SOUAD, to whom I have never had the chance to express my love.
To my dear brothers: ISLAM, HAKIM, FOUDIL, who have never ceased to be examples of perseverance and courage for me.
To my dear sisters: CHAHLA and ILHAM.
To all my grandparents, uncles and aunts, and my cousins.

MBnot pairHAKOUAnd HAS all her family.
Allm are HASmi(e)s AndTHEs peoplethateI HAVEme.

To my partner HAKOU and to all his family. To all my friends and the people I love.
SIDAHMED

SID AHMED

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Those who are dearest to me in the world: my father and mother for their sacrifices and support throughout my studies.

To my dear parents, to whom I have never had the chance to express my love.

To my dear brothers, who have never ceased to be examples of perseverance and courage for me.

To my dear sister.

To all my grandparents, uncles and aunts, my cousins.

To my partner SIDOU and to all his family.

To all my friends and the people I love.

ABDALHAK

List of paintings

Introduction

Biodiversity plays an essential role in the analysis of ecosystems, maintenance and preservation of biological diversity.Fish are a valuable food source; the economic importance of a large number of fish species lies in the high nutritional value of their flesh which contains, on average, 19% protein and 28% fat. fresh state (LEGAY, 1995).

The fish fauna in Algeria plays an essential role in the process of repopulating freshwater areas. The potential spoilage of fish by various beneficial or pathogenic microorganisms requires monitoring. Our knowledge of the ichthyofauna of the continental waters of North Africa in general and of Algeria in particular is limited, often based on old studies such as those of Cuvier and Valenciennes (1842), Playfair and Le Tourneux (1871). , Cauvet (1913, 1915).

The study of parasitic epidemiology has developed and strengthened naturally on medical and veterinary subjects, whether exclusively terrestrial continental parasitoses or so-called "water-transmissible" parasitoses when water plays a role as vector of the virus. . On the other hand, our understanding of the epidemiology of parasitoses which could have an impact on our ichthyological heritage is very late (Price, 1980).

Parasitology plays a vital role in ecology and evolutionary biology, by renewing its approaches and methodology with the aim of proposing the most relevant models. In this way, thanks to their own diversity (taxonomic, ecological and genetic diversity), as well as their influence on the biology and regulation of host populations, parasites play an essential role in the evolution and therefore in the diversity of the living world. The study of the biology and parasitology of fish is of great importance because the parasites have a great biological variety and affect the fish by causing more or less serious disorders depending on the host species (Combes, 1995; Blondel, 1995).

This work is divided into four chapters:

- The first chapter is generalities about fish.
- The second a general overview of parasites.
- The third chapter sets out all the methods and techniques used during this study and brings together the results obtained, argued through discussions, and at the end conclusion.

The fourth chapter result and discussion.

Chapter 1

General information about fish

General characteristics of fish

The term "fish" refers to aquatic animals, ectotherms. They breathe through their gills and have fins [Gill and Mooi, 2004]. The diversity of fish is very high, with more than 34,725 species representing more than 50% of all vertebrates on the planet, of which approximately 1,385 have a cartilaginous skeleton (rays and sharks); 127 are agnathans, that is to say jawless fish (lampreys and hagfish); Other fish are described as having jaws and true bony skeletons [Eschmeyer and Fong, 2018].

I. Classification of freshwater fish

The ecophysiological classification (classification according to habitat and morphology) shows 40 orders, 205 families and 2,261 genera of primary freshwater fish, secondary according to their tolerance to salinity (Myers, 1949, 1966).

The primary groups of freshwater fish have evolved in freshwater since the installation of the first teleosts, are confined there and cannot support seawater (strictly freshwater). Among these groups, we find electric eels (Gymnotiformes) and tetras (dwarf fish) (Characiformes), Dipnoiformes, Polypteridae, Osteoglossiformes and Otophysi. [Darlington, 1957]

Secondary groups of freshwater fish,which are currently restricted to fresh water, but which originate from estuaries or seas, are relatively tolerant of sea water for short periods, such as cichlids (Cichlidae) and poeciliids (Cyprinodontiformes), Clupeidae, Potamotrygonidae, Bedotiidae, Melanotaeniidae (Darlington, 1957).

A national overview of all native and exotic species has been published by Kara (2011). Brahimi et al. (2018) described new species in the genus Luciobacter,in the study by Baikeche et al. [2022] on the diversity of freshwater fish in western Kabylia (northern Algeria), a total of 18 species were identified, including seven native species and 11 non-native species.

Table 01: List of freshwater fish species in Algeria (Kara, 2012, Baikach)

Family	Species	Common name	Introduction location	Origin	Introductory purpose
Acipenseridae	*Acipense rsturio*(Linnaeus, 1758)	Sturgeon	-	-	-
Alosidae	*Alosa algeriensis*(Regan, 1916)	North African shad	-	-	-
	Alosa alosa(Linnaeus, 1758)	Allishad	-	Palearctic	-
	Alosa falax(Lacépède, 1802)	Twaite shad	-	Palearctic	-
Aphaniidae	*Aphanius fasciatus*(Valenciennes, 1821)	Mediterranean barred killifish	-	Palearctic	-
	Apricaphanius iberus(Valenciennes, 1846)	Spanish toothcap	-	-	-
	Apricaphaniussaourensis(Blanco, Hrbek, Doadrio, 2006)	Aphanius of the Sahara	-	-	-
	Tellia apoda(Gervais, 1853)	-	-	-	-
Anguillidae	*Anguilla anguilla*(Linnaeus, 1758)	European eel	-	Palearctic	-
Atherinidae	*Atherina boyeri*(Risso, 1810)	Large-scale sand casting	-	-	-
Alestidae	*Brycinus macrolepidotus*(Valenciennes,	True large-scale tetra	-	-	-

	1850)				
Blenniidae	*Salaria fluviatilis*(Asso, 1801)	Freshwater blenny	-	Palearctic	-
Cichlidae	*Astatotilapia desfontaini*(Lacepède, 1802)	-	-	-	-
	Coptodon zillii(Gervais, 1848)	Red-bellied Tilapia	-	-	-
	Hemichromisbimaculatus(Gill, 1862)	The Jewfish	-	Ethiopian	-
	Hemichromis letourneuxi(Wild, 1880)	Jewel fish	-	Ethiopian	-
	Oreochromis my crochir(Boulenger, 1912)	Long-billed Tilapia	-	Ethiopian	Aquaculture
	Oreochromis mossambicus(Peters, 1852)	Mozambique Tilapia	Ain skhouna	Ethiopian	-
	Oreochromis niloticus(Linnaeus, 1758)	Nile Tilapia	Dams and agricultural farms	Ethiopian	Aquaculture
	Sarotherodon galilaeus(Linnaeus, 1758)	Mango Tilapia	-	Palearctic	-
	Hemichromis saharae(Wild, 1880)	-	-	-	-
Cyprinidae	*Carasobarbus fritschii*(Gunther, 1874)	-	-	-	-
	Carassius auratus(Linnaeus, 1758)	Red colored fish.	-	Palearctic	Ornament
	Carassius carassius(Linnaeu	Ordinary crucian carp	The Aïn Zada pond	Continental Palearctic	Occurred in an accident

	s, 1758)				
	Cyprinus carpio(Linnaeus, 1758)	Common carp	Mitidja wadis	Palearctic	Aquaculture
	Enteromius deserti(Pellegrin, 1909)	-	-	-	-
	Luciobarbus biscarensis(Boulenger, 1911)	-	-	-	-
	Luciobarbus callensis(Valenciennes, 1842)	Beard of Algerian origin	-	-	-
	Luciobarbus chelifensis(Brahimi, Freyhof, Henrard and Libois, 2017)	-	-	-	-
	Luciobarbus leptopogon(Schimper, 1834)	-	-	-	-
	• *Luciobarbusmascarensis*(Brahimi, Freyhof, Henrard &Libois)	-	-	-	-
	Luciobarbus nasus(Gunther, 1874)	-	-	-	-
	Luciobarbusnumidiensis(Brahimi, Libois, Henrard & Freyhof,2018)	-	-	-	-
	Luciobarbus setivimensis(Valenciennes, 1842)	-	-	-	-
	Clarias anguillaris(Linnaeus, 1758)	Mud fish	-	Ethiopian	-

Clariidae	*Clarias gariepinus*(Buchell, 1822)	North African catfish	-	Ethiopian	-
Centrarchidae	*Lepomis gibbosus*(Linnaeus, 1758)	Pumpkin seed	Tell	Nearctic France	Sport fishing
	Micropterus salmoides(Lacepède, 1802)	Largemouth Black Bass	Dams	Nearctic France	Sport fishing
Esocidae	*Esox lucius*(Linnaeus,1758)	Northern pike	Oued Foudha	Nearctic Palearctic France	Aquaculture
Gasterosteidae	*Gasterosteus aculeatus*(Linnaeus, 1758)	three-spine stickleback	Mitidja wadis	Nearctic Palearctic France	Aquaculture
Gobiidae	*Gobius paganellus*(Linnaeus, 1758)	Rock Goby	-	-	-
Gobionidae	*Pseudorasbora parva*(Temminckand Schlegel, 1846)	Pierre Moroko	Kebir River	Indo-Malaysian	-
Leuciscidae	*Abramis brama*(Linnaeus,1758)	Freshwater sea bream	Ain Zada Dam	Palearctic	Accident
	Alburnus alburnus(Linnaeus, 1758)	Bleak	Cap Djinet Dam	Palearctic	-
	Leuciscus aspius(Linnaeus,1758)	Asp	-	-	-
	Pseudophoxinusc allensis(Guichenot, 1850)	-	-	Palearctic	-
	Scardiniuserythro phthalmus(Linnaeus, 1758)	Rudd	Oueds Mazafran	Palearctic France	Sport fishing
	Chelon	Golden gray	-	-	-

Mugilidae	*auratus*(Risso, 1810)	mullet			
	Chelon labrosus(Risso, 1810)	Thick gray mullet	-	-	-
	Chelon ramada(Risso, 1810)	Thin gray mullet	-	-	-
	Chelon Saliens(Risso, 1810)	Leaping mule	-	-	-
	Mugil cephalus(Linnaeus, 1758)	Gray Flathead Mule	-	-	-
Moronidae	*Dicentrarchus labrax*(Linnaeus, 1758)	European sea bass	-	-	-
Poeciliidae	*Gambusia affinis*(Baird and Girard, 1853)	Mosquito fish	-	Nearctic	Bio control
	Gambusia holbrooki(Girard, 1859)	Eastern Mosquito	Oueds Mazafran	Nearctic	Bio control
	Poecilia reticulata(Peters, 1859)	Guppy	Blessed Abbes	Neotropic	-
Percidae	*Perca fluviatilis*(Linnaeus, 1758)	European perch	Ain Zada Dam	Palearctic	Accident
	Sander lucioperca(Linnaeus, 1758)	Zander	Lake and dams of Oubéira	Palearctic Hungary	Aquaculture
Petromyzontidae	*Petromyzon marinus*(Linnaeus, 1758)	Sea lamprey	-	Palearctic Nearctic	-
Pleuronectidae	*Platichthys flesus*(Linnaeus, 1758)	Flounder flonder	-	-	-
	Oncorhynchus mykiss(Walbaum,	Rainbow trout	El Milia	Nearctic	Aquaculture

Salmonidae	1792)			France	
	Salmo macrostigma(Duméril, 1858)	Brown trout	-	Palearctic	-
	Salmo trutta(Linnaeus, 1758)	sea trout	Ghrib Dam	Palearctic France	Sport fishing
Siluridae	*Silurus glanis*(Linnaeus, 1758)	Wels catfish	DjorfTorba Dam	Palearctic Hungary	Aquaculture
Syngnathidae	*Syngnathus abaster*(Risso, 1827)	Black Striped Pipefish	-	-	-
Tincidae	*Tinca Tinca*(Linnaeus, 1758)	Tench	El Golea	Palearctic France	Sport fishing
Xenocyprididae	*Ctenopharyngodn idella*(Valenciennes, 1844)	Grass carp	Lake and dams of Oubéira	Hungary	Aquaculture
	Hypophthalmichs molitrix(Valenciennes, 1844)	Silver carp	Lake and dams of Oubéira	Palearctic Hungary	Aquaculture
	Hypophthalmichs nobilis(Richardson, 1845)	Bighead carp	-	-	-

II. Biology of freshwater fish

1. Morphology of freshwater fish

a) The shells

Fish have bodies covered with fairly solid skin, armored by dermal structures, scales, arranged in longitudinal and diagonal rows, the type, number and size of which are important data for the biology of the species, ranging from a layer of ridged, flexible bony plates to a few plates that cover only the caudal region of the fish(*Cyprinus carpiospecularis*).

And since the scales develop with the growth of the fish, these scales are used to determine the age of the fish through the observation and recording of growth (Laita and Aparıcio, 2005)

Figure 01:"Cascudo", Siluriforme of the Loricariidae family. Detail of modified plate-shaped scales. Scale bar: 2 cm (Ricardo et al., 2020)

b) Fins

The fins of fish are generally pectoral, pelvic, dorsal, anal and caudal (Fig. 2). Many Characins and Salmoniformes (trout and salmon) also have a small adipose fin without rays, located between the dorsal and the caudal, considered as an ancestry specific to these groups. According to Moyle and Cech (1988), the mackerel (Scomberomorus cavalla) This species exhibits several tiny ventral and dorsal swimming appendages, positioned between the dorsal and anal fins, as well as the caudal fin.

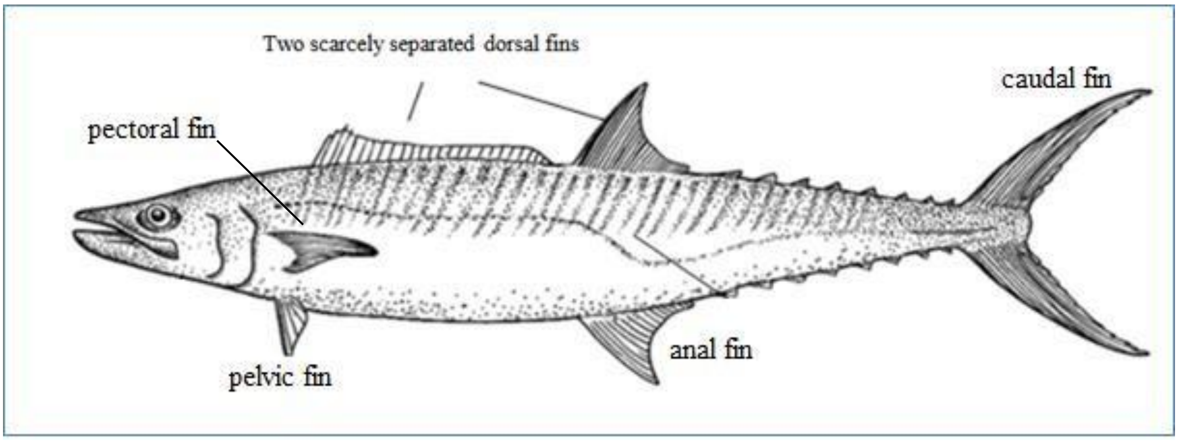

Figure 02: Different fins of fish (Frédou et al., 2021).

Fish use their pectoral and pelvic (or ventral) fins to maintain balance and move through the water (Yamanoue et al., 2010). The viola catfish (*Loricariichthys spp*.) is a bottom-dwelling catfish whose pectoral fins run parallel to the body, allowing it to cling to substrates and support the rapid flow of water. water (Laita and Aparicio, 2005). Some species like the sunfish (Mola sp.) may lack pelvic fins. Dorsal and anal fins act like keel The configuration of the fins protects the fish from pitching movements and facilitates sudden stops and rotations. The only mode of movement in the South American symbranch is coiling (*Synbranchus spp*.). Some fins have flexible rays while others have rigid rays or spines (Yamanoue et al., 2010). The anal fin rays of some male Characins such as *Astyanax spp*. and *Salminus spp*. function as characteristics of temporary sexual dimorphism, exhibiting small "hooks" during the reproductive period (Casciotta et al., 2003).

2. Freshwater Fish Anatomy

a. Digestive system

Throughout evolution, many fish organ systems have undergone morphological and functional transformations. The digestive tract of fish has been particularly impacted by this phenomenon, with morphological changes that have allowed species to explore a variety of niches and foods (Buddington and Kuzmina, 2000). The digestive tract of fish generally consists of the oral cavity and teeth, esophagus, stomach (absent in some species, such as common carp), intestine (with or without pyloric appendages), and d accessory organs (liver, gallbladder, pancreas).

Eating habits and position in the water column are related to mouth location. The mouth can be located in a ventral position (rays and armored catfish) or terminal (nektonic fish, such as Astyanax).

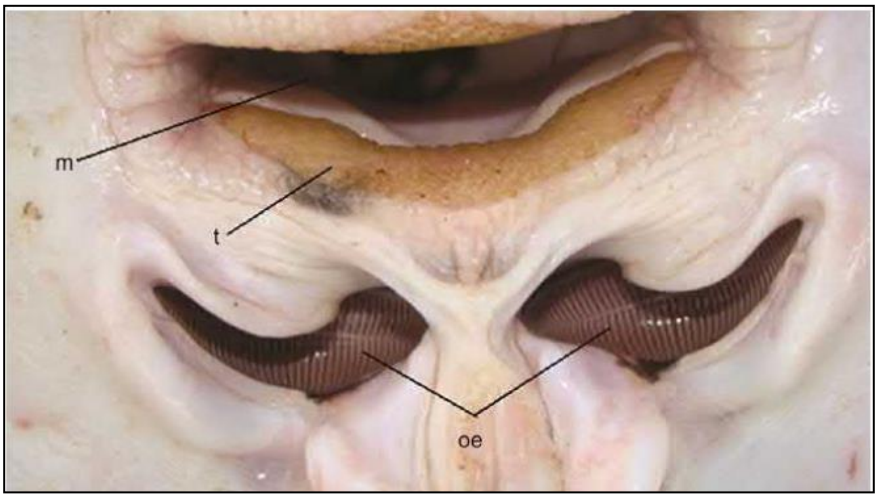

Figure 03 : Ventral view of Potamotrygon motoro(the skate) showing the mouth (m), teeth (t) and nasal opening or nostrils with olfactory epithelium (oe). (Ricardo et al., 2020)

b. Swim bladder

For most teleosts, the gas bladder is located just above the food duct and below the spine (thus almost below the kidneys). The presence of air or oxygen in swim bladders plays a key role in maintaining neutral buoyancy and reducing energy costs for fish to remain at a certain depth (Helfman et al., 2009).

c. Reproductive system

The vast majority of freshwater fish are gonochoric, that is to say with distinct sexual organs. According to Redding and Patino (2000), males have testes where sperm are made, while females have ovaries where oocytes are made.

Nutrition in freshwater fish

Food behaviors and habits of fish refer to the process of seeking and consuming food, as well as the manner and incentives related to eating.

Fish can be classified as follows: Herbivores: are those that feed only on plants. Carnivores: those who only consume animal products. Omnivores: are those who eat plants and animals. Those that feed on plankton, that is to say microscopic plant and animal life present in water, such as bacteria. Those that feed on decaying matter are called detritivores. The adaptation of teleosts to virtually all aquatic habitats has been successful. Their eating habits demonstrate this ability to adapt. Furthermore (Banan Khojasteh and Abdullahi 2008).

III. Freshwater fish habitat

In freshwater, fish hide under stream structures, such as rocks, submerged logs and branches (snags), vegetation, and deep pools or low banks. Juvenile predators are found in estuaries, seagrass meadows and mangrove forests. Habitat modification does not have a direct impact on the fish, but on their diet. It is possible that any change in fish habitat could impact their survival, such as destroying the shelters of juvenile and adult fish, making them more visible to predators. Most aquatic habitats are populated by fish, such as Lake Baikal, the deepest lake in the world (at least 1,000 m) and 7,000 m underground.

I. Geographic distribution of freshwater fish in Algeria

One of the most important zoogeographic groups is that of freshwater fish, because they are more or less circumscribed by drainage systems which can be likened to dendritic islands of water surrounded by land, themselves surrounded by a salt water barrier. The peripheral primary and secondary divisions are made up of 139 families. Our knowledge of the ichthyofauna of the continental waters of North Africa in general and of Algeria in particular is limited. These are frequently old studies such as those of Cuvier and Valenciennes (1842), Playfair and Letourneux (1871), and Cauvet (1913, 1915(.

Chapter 2:

General information on parasites

I. Fish parasites

Parasitism is an antagonism (beneficial for one species and detrimental for the other), considered to be a lasting relationship between the host and the parasite.One of the two partners can be killed by this phenomenon, as is the case for parasitoids, which kill their host to continue their life cycle. With regard to food webs, parasitism therefore plays a crucial role in modifying, or even controlling, the dynamics of host populations. (Chambouvet, 2009)

Parasites are present everywhere. Generally, the aquatic environment provides adequate conditions, such as physiologically stable, watertight and viscous conditions, for the distribution and survival of parasite eggs and larvae, as well as for the free movement of adults in the environment. (endoparasites) or on the body (ectoparasites) of host fish. The complex feeding interaction between aquatic organisms can also result in a complex parasite life cycle. However, the place of fish in aquatic ecosystems, mainly as consumers in food chains, and the large surface area for encounter and colonization that they offer, allow parasitic organisms to exploit them as hosts (According to Barber et al. 2000)

Generally, fry and young fish are affected by fish parasites, which can cause considerable damage to the fish sector (Iyaji and Bandyopadhyay, 2018). According to Abowei and Briyai (2001), these pathogens have the ability to disrupt the normal physiology of fish, thereby leading to massive die-offs. Parasites are clearly serious pathogens that can cause direct death or make fish more vulnerable to predators or other opportunistic diseases, in addition, these fish parasites can lead to muscle degeneration, liver disorder, disruption of nutrition, disturbance of respiratory functions, disturbance of the cardiac system, alteration of the nervous system, castration or mechanical interference With spawning, a decrease in body mass and weight loss, fish cannot be consumed by humans due to liver dysfunction, interference with nutritional intake, disruption of respiratory functions, cardiac disorder, impairment of the neurological system, sterilization or mechanical interference with spawning, weight loss and gross body deformation (Iyaji and Eyo, 2008).

II. Classification of freshwater fish parasites

According to Roberts and Janovy (2005), there are two categories of parasites: ectoparasites and endoparasites. Regarding these two groups, they are divided according to the physical properties of the parasite, its life cycle and the place of attachment on the green organism. (table 01).

1. Fish ectoparasites

Parasites are present on the surface of the body and live according to Ectoparasites are organisms living outside the tissues of their hosts (Marchand, 1994). It is the external parts of the host that are occupied, such as the integument or the cavities open to the outside (gill and mouth cavities) (Combes, 2001).

They are undoubtedly the main pathogens responsible for mortality in fish farms in Africa. Lesions caused by ectoparasites are generally then contaminated by fungi and bacteria (Van As 1984). Protozoa, monogeneans, leeches, crustaceans and bivalve mollusk larvae are ectoparasites (Paperna 1996).

a) Platyhelminths

All flatworms are called platyhelminths and parasitize different groups of aquatic organisms. According to Möller and Anders (86), these parasitic species have specific organs which allow them to attach to the tissues of their hosts (Grasse, 1980). According to Rohde (2005), Platyhelminths are classified into monogeneans, trematodes, digeneans and cestodes. According to Roberts and Janovy (2000), flatworms of the class Monogenea are ectoparasites, while flukes (Trematoda Digenea) and tapeworms (Cestoda) are parasites that infect internal organs.

The Monogeneans

Most of them are ectoparasites with a direct evolutionary cycle. These parasites proliferate rapidly and lead to reinfestations which have serious consequences on aquaculture, with predominances sometimes reaching 100% (Luta, 1941;Petrushevski & Shulman, 1958).

The existence of these parasites on the skin covering and/or the gills causes irritation and erosion of the integument, excessive secretion of mucus and damage to the gill tissue. According to Sindermann (1989), the most frequently observed species are Gyrodactylus arcuatus and Gyrodactylus bychowskyi.

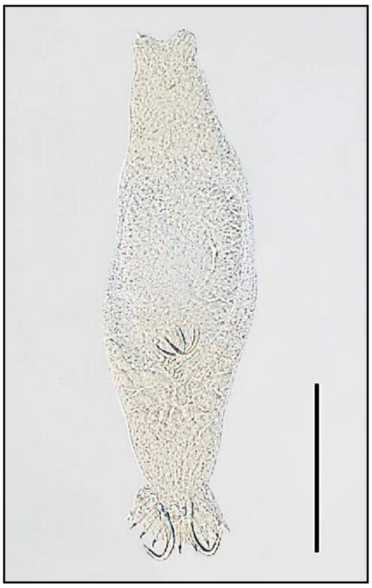

Figure04: General view of a Monogene. Scale bar: 100 µm. (Stoyanov et al., 2023).

b) The crustaceans

There are many species of crustaceans that are ectoparasitic on fish. They are part of different taxonomic groups. Isopods, particularly copepods and Branchioura, play a crucial role. In general, these arthropods are ectoparasites, with bilateral symmetry, a segmented body and articulated legs, covered with a rigid or semi-rigid chitin carapace (Roberts, 1979).

Parasitic crustaceans are indeed pathogenic and it is necessary to better understand their taxonomy and the dynamics of parasitic populations. Research on crustacean parasites of freshwater fish has been very limited in Algeria.

1) Copepods

This group of crustaceans has many distinct shapes, with the head, trunk and abdomen present in typical shapes. This is generally composed of a cephalothorax, a thorax and an abdomen. According to Benz et al. (2001), the cephalothorax includes the antennules, antennae, mandibles, maxillae, maxillae and maxillipeds, as well as 1 to 3 pairs of thoracic legs on the ventral side..Parasitic copepods present monoxenous and heteroxenous cycles (Kabata, 1979), and reach the adult stage by going through several larval stages (molts).

It should be emphasized that copepods

Parasites can cause illnesses in farmed freshwater fish (Kabata, 1985; Piasecki et al., 2004; Boucenna 2017). Some are responsible for the deterioration of gill tissues, while others are responsible for mass mortality of stocks (Fryer, 1968; Johnson et al., 2004, Rückert et al., 2009; Meddour, 2009).

Figure 05: General view of a copepod (Lernaeolophus sultanus). Scale bar: 1 mm. (Justine et al., 2012)

2) Isopods

Isopod parasites are easily distinguished from other crustaceans by the division of their bodies. In their life cycle, parasitic isopods rely on an intermediate host, such as an isopod. There are three main groups: Cymothoids are aquatic parasites, while Epicarids are parasites of crustaceans and fish. Gnathiids are larvae that parasitize fish, while adults are free. The fact that isopods are present on their hosts would reduce the commercial value of fish and crustaceans, in addition to causing lesions which would be entry routes for viruses and bacteria (Bunkley et al., 2006).

Figure 06: Overview of an isopod from the family Cymothoidae; scale bar: 1cm (Ravichandranet al., 2019)

3) Branchioura

Around 175 species of Branchioura have been recorded, divided into four genera and grouped into a single family, the Argulidae (Soes et al., 2010). The morpho-physiological diversity of Branchioura species allows them to live in a wide diversity of habitats and lifestyles, ranging from planktonic species to parasites. According to Sah and Bandyopadhyay (2015),

Argulus, a species of sea lice, is a common parasite in fish. It is a large ectoparasite capable of moving on the surface of the fish body (Degidio et al., 2017). Argulus species are common parasites of freshwater fish. Extensive research has demonstrated that freshwater fish transmit parasites and other diseases throughout the world (Schram et al., 2005).

Figure 07:Overview of a Branchioure (*Argulus foliaceus*,Linnaeus, 1758); scale bar: 0.5 mm (Öktener and Ünal, 2020)

2. Fish endoparasites

These are internal parasites of fish classified as flukes (Trematodes), tapeworms (Cestodes), spiny-headed worms (Acanthocephales) and roundworms (Nematodes). They are present in the body cavity, in the intestines and in different internal organs, and sometimes in the flesh. When they are in large quantities, they have an impact on the health of the fish (Darwin and Stefanich, 1996). Endoparasitic helminths generally have a heteroxenous life cycle, that is, the parasite goes through at least one intermediate stage before becoming an adult (Roberts and Janovy, 2000).

Platyhelminths

1) The Digenes

Digeneans, which are small parasites, attack the internal organs of fish, and can be the primary or secondary host, depending on the species of Digeneans. Adults use anterior and ventral suckers to attach to their hosts on surfaces. According to Stewart and Bernier (1999), they have an indirect life cycle with at least one intermediate host, usually a snail or a clam.

They have a complex life cycle and are composed of larval stages that mainly infect juvenile fish, bottom dwellers in inland waters, such as in tropical African countries (Iyaji and Eyo 2008). According to Khalil (69), it is possible that species of Sanguinicola (the blood fluke) contaminate Synodontisschall and Auchinoglanus occidentalis in Sudan. Metacercaria is the most commonly observed life stage in fish, which encysts in tissues. Adugna and colleagues (2018) reported the presence of three genera of Digeneans, namely Clinostomum, Euclinostomum and Tylodelphys, at Gilgel Gibe-I (a dam in Ethiopia). Bekele and colleagues reported the presence of trematode species, including Clinostomum, in the gill filaments and thoracic cavity of Oreochromisniloticus and Clarias gariepinus *al*., (2015).

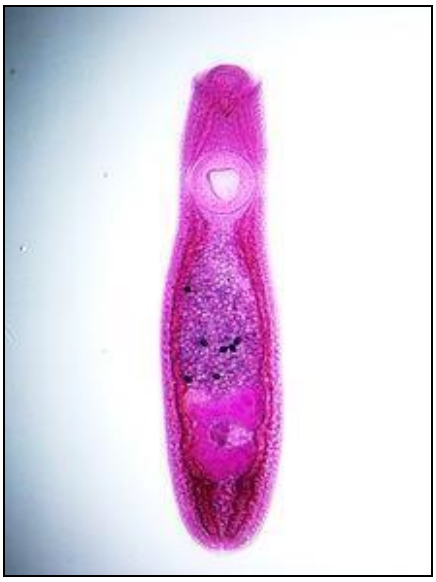

Figure 08: General view of a Digenes; scale bar: (Caffara et al., 2011).

2) Cestodes

Cestodes, whose evolutionary cycle requires at least one intermediate host, are endoparasites, with the exception of the Caryophyllidae family. The intestine is infected by adults and the larvae are often encysted in the muscles or viscera. Reptiles, fish-eating birds and mammals are the definitive hosts. In the viscera or in the flesh of the fish, the presence of these parasites makes this species unmarketable, which has harmful consequences on the economy. This is the case for larvae of Cestodes Trypanorhynchidae (Brill et al., 1987). Symptoms of a significant infestation include hemorrhagic enteritis, deterioration of the intestinal epithelium, swelling of the abdomen, adhesions in the mesentery and peritoneum. The following genera of cestodes pathogenic for fish can be mentioned: Gymnorhynchus and Poecilancistrium (Schlicht and Mcfarland, 1967).

Figure 09: General view of aCestode; scale bar: (Stewart and Bernier 1999).

a) Nemathelminths

Nemathelminthes are round and covered with a cuticle. The digestive tract of these worms is simple, straight, with a mouth (often hooked), a pharynx, an esophagus, an intestine and a ventral anus. According to Rastogi (1997), their nervous system consists of a perioesophageal ring and two nerve cords, the male being identifiable by a copulation organ at its posterior end.

Intermediate stages of nematodes that infect internal organs sometimes develop in different tissues of the host. According to Robert and Janovy (2000).

The Nemathelminthes were reduced by Haeckel (1868) to Chaetognatha, Nematoda (with a digestive tract) and Acanthocephala (without a digestive tract).

- **Nematodes**

The shape of nematode worms is very specific, with a strong and resistant cuticle, which allows them to live longer (FAO, 1996). Nematodes are widespread throughout the world, particularly species that parasitize intermediate or transient fish hosts and cause more severe infections in predatory fish by affecting all organs of their hosts (Table 1) (Klinger and Floyd, 2002; FAO , 1996). According to Khalil (1971), 40 species of adult nematodes have been recorded in Africa, representing 9 families of fish. The Oxyuroidae are monoxenous (a single host) and are found in the intestines of detritivores (Citharinus, Distichodus) and omnivorous fish (Synodontis, Oreochromis and Barbus). The Camallanidae, Cucullanidae, Philometridae and Anguillicolidae have copepods as intermediate hosts (FAO, 1996).

Camallanid infections are abundant and heavy, up to 20 or more, especially in the stomach of Clarias sp and many other catfishes (Paperna, 1964; Khalil, 1969; Mashego and Saayman, 1980; Boomker , 1982).

Massive infections by Capillaria and Capillostrongyloides have caused weight loss and deaths in neotropical cichlids and silurids raised in aquariums. (Moravec and Gut, 1982; Moravec et al., 1987). Moravec and Rehulka (1987) obtained similar results concerning a massive infection of cosmocercoid nematodes in Synodontis eupterus of African origin in aquariums. The genus Amplicaecum, Contracaecum and Porocaecum is a genus of larval nematodes reported from fish in the family Anisakidae (Heterocheiliadae), while the genera Rhabdochonidae includes the genera Rhabdochona and Spinitectus (FAO, 1996).
According to the FAO (1996; Ibiwoye et al., 2004), these larval nematodes can either be contained in tissues or released into body cavities, usually in the abdominal or pericardial cavity.

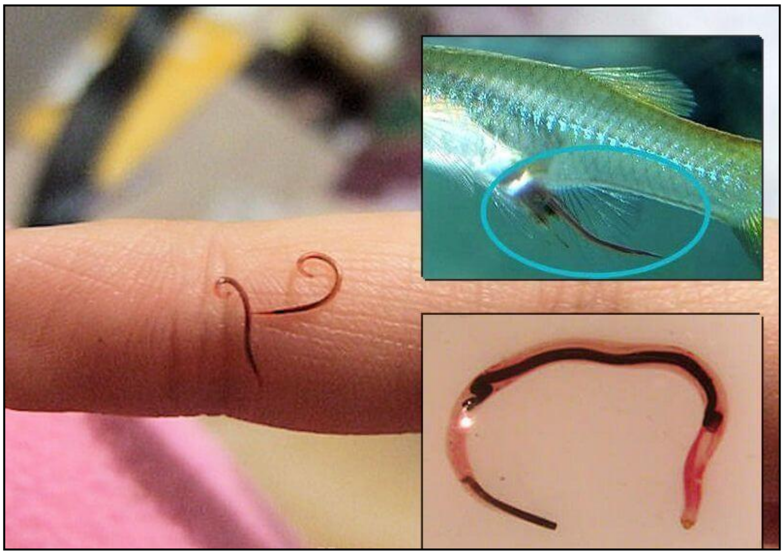

Figure 10: General view of a Nematode; scale bar: (Camallanuscotti species) (aquaportal,2020)

c) The Acanthocephalans

The evaginable proboscis of acanthocephalan worms is easily identifiable thanks to several rows of curved hooks (FAO, 1996). The main criteria for species differentiation are the number and position of the hooks on the proboscis, although a greater number of anatomical details are taken into consideration when determining higher taxa (Kabata, 1985).

Representatives of the genera Echinorhynchus and Neoechinorhynchus are quite common among salmonids.

The alimentary canal of acanthocephalans is non-existent and they are heteroxenous, while adult worms are intestinal parasites (FAO, 1996). The feces carry the eggs laid into the intestinal cavity and are consumed by the first intermediate hosts such as amphipods, isopods, copepods or ostracods (FAO, 1996). where they hatch into first instar larvae, the acanthella or the acanthor. Development to the adult stage of some species has been reported by George and Nadakal (1973) and Schmidt (1985), when their larvae in intermediate hosts are ingested by the definitive vertebrate hosts, which may be fish, amphibians or reptiles.

The attachment of the adult parasite in the digestive tract and the encapsulation of the larval stages in the tissues are responsible for the pathogenic effects of acanthocephalans. The extent of damage is proportional to the depth of penetration of the proboscis (FAO, 1996; Oniye et al., 2004).

The damage is very severe with extensive granulomas and subsequent fibrosis when the worm's proboscis is anchored in the muscular layer or completely perforates the intestinal wall (Paperna and Zwerner, 1974; McDonough and Gleason, 1981; Kabata, 1985), which may differ depending on the host fish (Taraschewski, 1988). The only attached specimen of Acanthogyrus tilapia in juvenile cichlids, in farmed fish, was observed by Dovellou (1992a, b), without apparent clinical consequences. Acanthocephalans have variable host specificity, as they invade different fish families (Khalil, 1971; Troncy and Vassillides, 1973; Troncy, 1974; 1977; Batra, 1984; Dovellou, 1992a, b; and Oniye et al. 2004).

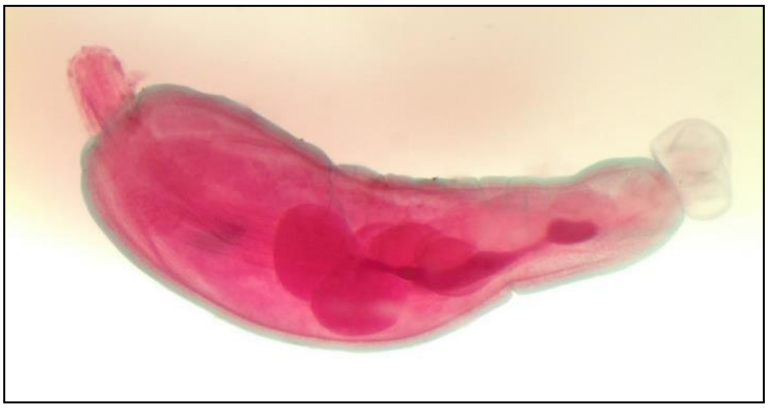

Figure 11: General view of an Acanthocephalus; scale bar: (dailyparasite, 2010)

- **Monoxene parasites**

Holoxenes (or monoxenes) are direct-cycle parasites with a single host. The parasite passes from one host individual to another host individual. The dispersal stage, also known as the infestation stage, guarantees passage to the external environment. According to Esch and Fernández (1993), the infesting stage guarantees passage into the external environment. According to Rohde (2005), parasites which have a direct evolutionary cycle are frequently ectoparasites such as Monogeneans, some copepods, isopods and gill rakers.

- **Heteroxene parasites**

Heteroxene cycle parasites require assistance from various hosts in order to survive and complete their cycle. Such a lifestyle presents increased complexity (see Combes, 1991) and is therefore vulnerable to many variations in living conditions. Since this may require changes to the environment and different hosts are not always willing to meet. In heteroxenous cycles, the sexual form of the parasite is hosted by the definitive host, while the asexual forms are hosted by the intermediate host (Kinkelin et al., 1985).

It often happens that the first intermediate host is specific, that is to say that a parasite species corresponds to a unique host species. Therefore, each ovule will generate several sexual larvae: the sporocysts (male) and the redia (female).

Cercariae are the second intermediate host which receive one or more larvae from sporocysts and redia. They will root in the second intermediate host and wait that it is devoured by a final host (Combes, 1995)

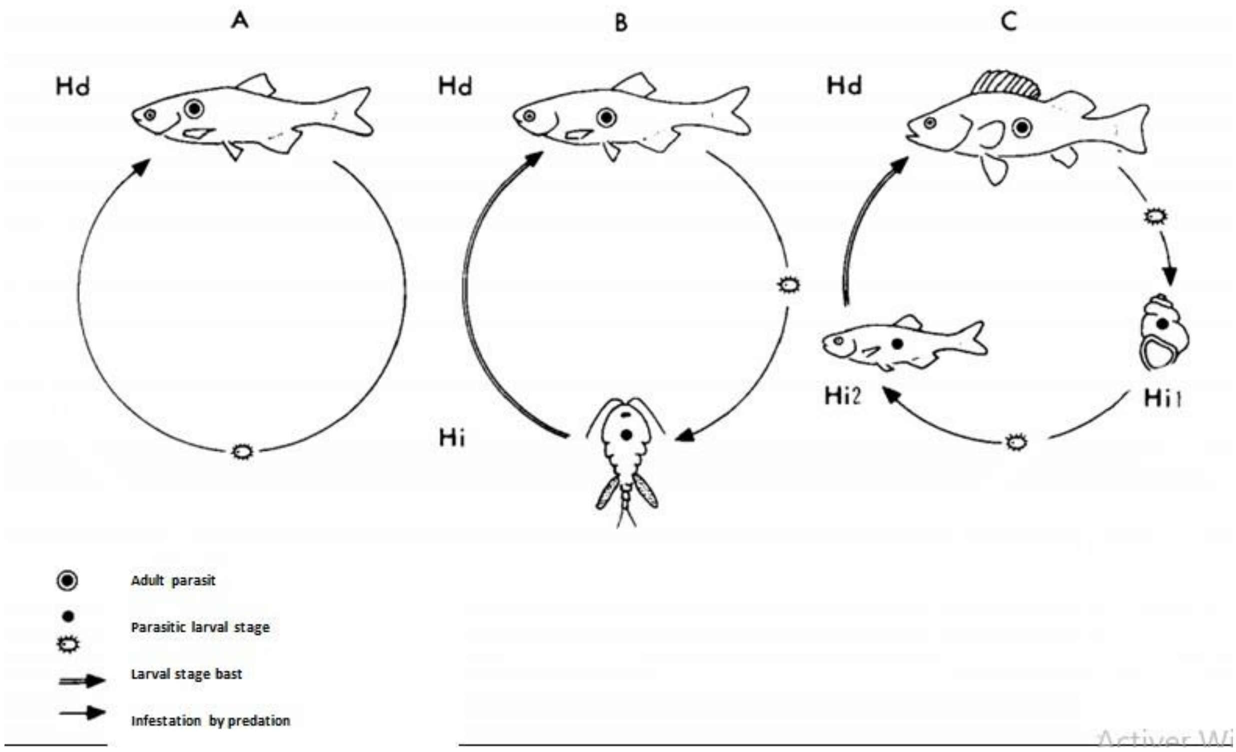

Figure 12: Different types of cycles in fish parasites.(Denis et al., 1983)

A - Direct monoxene cycle (Protozoa, Monogeneans, Copepods, etc.)

B - Dixene cycle with 2 hosts (Cestodes, Acanthocephalans, Nematodes...)

C - Heteroxene cycle with 3 hosts (Trematodes, Cestodes, Acanthocephales). In this type of cycle, there is generally a pathogenic phenomenon at the level of the 2nd intermediate host (the definitive host may be a fish-eating bird).

HD: definitive host; HI: intermediate host

Table 02 : Classification of fish parasites according to the site of attachment to the host.(Stewart and Bernier, 1999)

LOCALIZATION ON OR IN FISH	INVERTEBRATE PARASITE (* larval forms; M = marine)	
	CLASS	**GENDER**
The eyes	TREMATODA	*Diplostomum*
The fins	CRUSTACEA	*Salmincola*
	HIRUDINEA	*Piscicola*
The skin	CRUSTACEA	*Coregonicola*
	HIRUDINEA	*Piscicola*
The gills	CRUSTACEA	*Salmincola*
	HIRUDINEA	*CystobranchusPiscicola*
	MONOGENEA	*DiscocotylTetraonchus*
Oral cavity	CRUSTACEA	*Salmincola*
	HIRUDINEA	*Piscicola*
Body cavity	CESTODA	*Diphyllobothrium*
	NEMATODA	*Philonema*
Surface of the intestine (i.e. the viscera)	CESTODA	*Diphyllobothrium Triaenophorus*
	NEMATODA	*ContracaecumRaphidascaris*
Inside the stomach, pylorus, or intestine (i.e., gastrointestinal tract)	ACANTHOCEPHALA	*CorynosomaEchinorhynchusNeoechinorhynchus*
	CESTODA	*BothrimonusBothriocephalusCyathocephalusEubothriumGlaridacris Proteocephalus Triaenophorus*

	NEMATODA	
	TREMATODA	
		HaplonemaHysterothylaciumRaphidascarisTruttae dacnitis
		Brachyphallus Crepidostomum
Gallbladder	NEMATODA	*Hysterothylacium*
	TREMATODA	*Crepidostomum*
The gonads	NEMATODA	*Philonema*
Heart, kidney	TREMATODA	*Icthyocotylurus*
Liver	CESTODA	*Triaenophorus*
		Philonema
Swim bladder	NEMATODA	*Cystidicola* *Hysterothylacium* *Philonema* *Raphidascaris*
Muscle	CESTODA	*Diphyllobothrium* *Triaenophorus*

Chapter3:

Expéerimental Part

I. Presentation of the study area

1. Presentation and location of theOued Lakhal dam

The Oued Lakhal dam is located on Wadi Lakhal, as its name suggests. The location of this dam is 5 km from the daïra of Ain Bessam in the wilaya of Bouira. Construction began in 1982 and was completed in 1985. It had a retention capacity of 30 million m3 when it was commissioned in 1987. Originally intended for irrigation, the dam was used for irrigation of Aribs perimeters (Raouraoua, Aïn Bessem, Bir Ghebalou) and mainly for the irrigation of potato crops. But due to insufficient water, it leads to the distribution of drinking water (Hamaidi, 2009). Its height is 45 meters and its length is 660 meters.

The device is equipped with a free surface lateral flood spillway, divided into three (03) compartments, with rounded piers, in order to reduce vibrations and disturbances in the surroundings of the piers. The water intake tower The dam is approximately 60 meters high, spread over three levels, and is equipped with a limnometric ruler to monitor the water level for the plan. (ANB, 2000).

Figure13: Geographical location of the Lakhel Dam (Google map, 2024)

2. Presentation and locationfrom wadi Isser

The location of Wadi Isser is part of the watershed that bears its name (Wadi Isser), located in northern Algeria. It is bordered by the daira of Drâa El Mizane to the North-East, by the wilaya of Bouira to the South-East, by the daira of Ain Boucifau to the South-West, by the daira of Ksar El Boukhari and the wilaya of Médéa to the North -West, by the dairas of Tablat and Larbâa to the North-West and by the Mediterranean Sea to the North.

The Wadi Isser basin covers an area of 4126 km2. It is located approximately 70 km southeast of Algiers. From an administrative point of view, this basin crosses several wilayas: Médéa, Bouira, Tizi-Ouzou and Boumerdes. The region in which the watershed develops is made up of the Algerian Tell Atlas in the North, with an altitude of 1130 meters at Jebel Tamesguida, and the Bibans chain in the South, with an altitude of 1810 meters at Jebel Dira. The Aribs plain, at an altitude of 550 meters, separates these two ranges.(Benkaci, 2006)

Figure 14:geographical location of wadi Issser (googel maps, 2024)

3. Presentation and location of theTilesdit dam

The construction of the Tilesdit dam is located on the El Dhous wadi in the commune of Bechloul, approximately 47 km northeast of the capital of the wilaya of Bouira. It was commissioned in 2003. The waters of this dam, which has a capacity of 167 Hm3, or 167 million m3, are affected in the following way: The town of Bouira and its surroundings: 20.23 Hm3/year ; the industrial zone of Sidi Khaled: 1.15 Hm3/year; the deserts of El Asnam (2,200 Ha): 12 Hm3/year; the Sahel valley (3,400 Ha): 27.2 Hm3/year. The Tilesdit dam is part of the Soummam watershed and is distinguished by its surface area of 843 km2 and its average annual precipitation of 655 mm(Arbane and Moussi, 2020)

Figure 15:the geographical location of the Tilesdit dam**(Google Map, 2024)**

II. Sampling and sample processing

1. Sampling

Sampling was carried out between March and May 2024 by ourselves BENDIAF Sidahmed and DAHMANIAbdelhak. Fish were caught randomly using a fishing rod and a fishing net.

2. Sample identification

In this study, fish species were identified according to morphological criteria. According to Kottelat and Freyhof (2007), these observations involve examining pigmentation, body shape or appendages (e.g. mouth location, fin shape).

2.1. Body shape

Their physical structure takes a distinct form depending on their swimming ability and their mode of existence. Categorizing them arbitrarily based on the elongation of their frame can be done using the ratio between standard length and body height (L/H). According to Melanie (2017), we distinguish different body shapes in fish mode: anguilliform or serpentiform, very elongated, elongated, short or medium, high.

The head: Many external elements play a crucial role in taxonomy in order to distinguish certain species. The premaxilla, the maxilla and, in some families, the supramaxilla are generally distinguished from the mandible (lower jaw) (fig. 1A). According to Lévêque and Bigorne in 1978,

The jaws can be more or less equivalent and normally developed (Alestidae, certain Cyprinidae) (fig. 1 B) or very elongated in the shape of a beak (rostrum) (Belonidae) (fig. 1 C); in both cases, we speak of a terminal mouth. The location of the mouth may be upper (Aplocheilidae, Poeciliidae) (fig. 1 D), sub-lower (some Mormyridae) (fig. 1 E), or lower (Mochokidae) (fig. 1 F) in some cases. Finally, there are species whose mouth is protractile (Serranidae, Gerreidae). According to Lévêque et al. (1990), in certain genera such as Labeo, Garra and Chiloglanis, the mouth has very developed lips, sometimes forming an adhesive disc (fig. 1H), which allows the fish to attach to rocks and remain in the water. fast current.

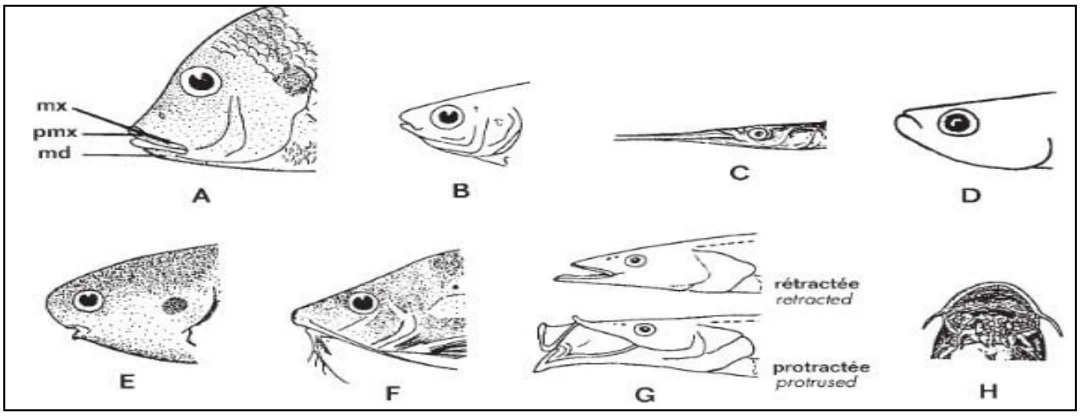

Figure16: Jaws and mouth. Premaxilla (pmx), maxilla (mx), mandible (md) (A); equal jaws normally developed (B); equal in the shape of a rostrum (C); upper mouth (D); subinferior mouth (E); lower mouth (F); protractile mouth (G); lower mouth forming an adhesive disc (H)(Lévêque et al., 1990)

2.2.The fins

The swimming limbs are paired or odd, the pectorals and ventrals (or pelvis) are the paired limbs. In the axial plane of the body, three types of odd limbs can be distinguished: the dorsal, the caudal and the anal (Watson 1937; Denison 1979).

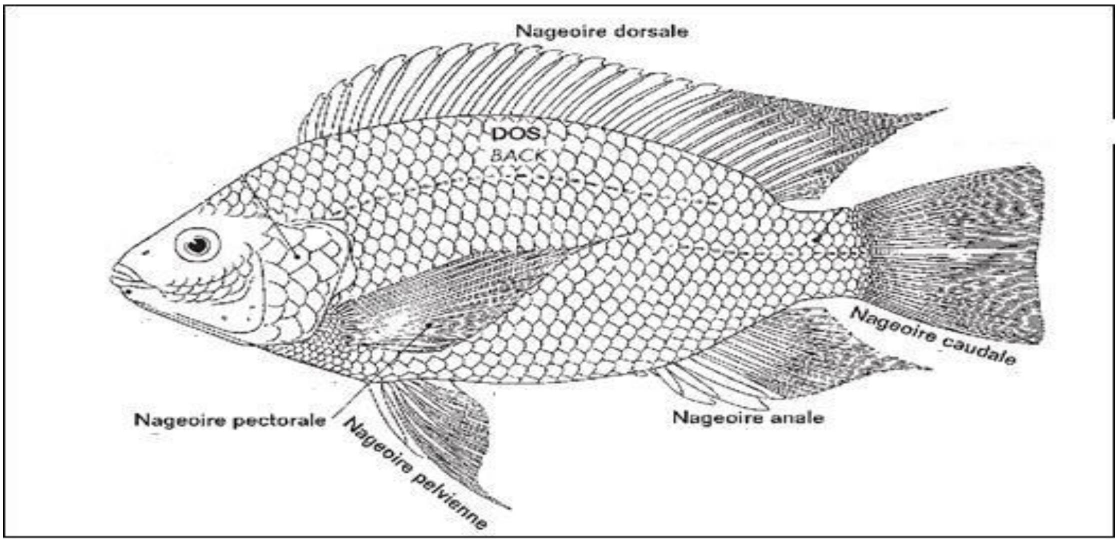

Figure17:main external anatomical names of a fish (*Stiassny et al., 2007).*

- The pectorals are the only swimming appendages still present. They are almost always located longitudinally behind the head after the operculum.

- Ventral fins are rare in several families such as Gymnarchidae, Tetraodontidae, Anguillididae and Mastacembelidae. When they exist, they can be very close to the pectorals in the thoracic position (Tilapia) or more or less distant in the abdominal position (Yamanoue et al. 2010). The anal form is common among Gymnarchidae and can be confused with the caudal form (Protoptera, Anguillididae, Mastacembelidae). Caudal: it is possible that the caudal is absent (Gymnarchidae). It can be confluent with the anal (Notopteridae) or with the anal and dorsal (Anguillididae) when present. It is never complex and is generally well individualized. It is possible that it is bilobed, with the ventral and dorsal lobes separated by a more or less deep notch (Alestes) or, on the contrary, separated by a single piece. The caudal may be rounded (Heterotis) or truncated (some Sarotherodon) in the latter case.

Figure18: Different tail fin shapes (Moore and Colas, 2017)

Dorsal: the dorsal fin is very generally present with the exception of Xenomystus for example. It may be followed by a second dorsal of an adipose nature (case of Characidae, Citharinidae and many Siluriformes). According to Stewart et al. (2014), (Lauder and Drucker 2004) The development of the adipose is generally modest (Alestes, Disthichodus, Eutropius), but can be very important in certain catfish (Porcus, Synodontis).

2.3.The colour :

The color of fish constitutes an important element for the identification of species, this pigmentation is due to the bodily reflection of certain of the wavelengths which make up the incident white light, the other wavelengths being absorbed (Chibon 1967).

Several other fish take their color from the foods they eat, for example the red pigmentation of salmonids is due to carotenoid pigments of plant origin.**(**Choubert, 1992).

3. Searching for parasites

After wiping the fish samples and placing them under a magnifying glass, we placed them in petri dishes to detect parasites.

Figure 19:photo of the magnifying glass (original, 2024)

- We haveThe fins of the fish were removed and placed in petri dishes with water added. Then they were rubbed and placed under the magnifying glass.

Figure20:photo of fish gill arches (original, 2024)

- The fish intestines were removed and emptied, then placed under the magnifying glass after adding water.
- The same steps were repeated with the liver.

4. Age estimate

Many fish species have a lifespan of more than 20 years, which therefore requires precise knowledge of their age (Campana & Thorrold, 2001). We use direct techniques to estimate the age and growth of fish: squamometry and otolithometry.

4.1. Squamometry

According to Lea (1911), squamometry consists of analyzing and measuring the growth streaks that form each year on the scales (Chakroun-Marzouk & Ktari, 2003). According to Beamish and Harvey (1969), lost scales are regenerated and cannot be used for squamometry because they do not have old streaks. It is therefore necessary to collect the scales intended for squamometry from under the pectoral fins, which reduces the risk of removal (Mahé et al., 2009).

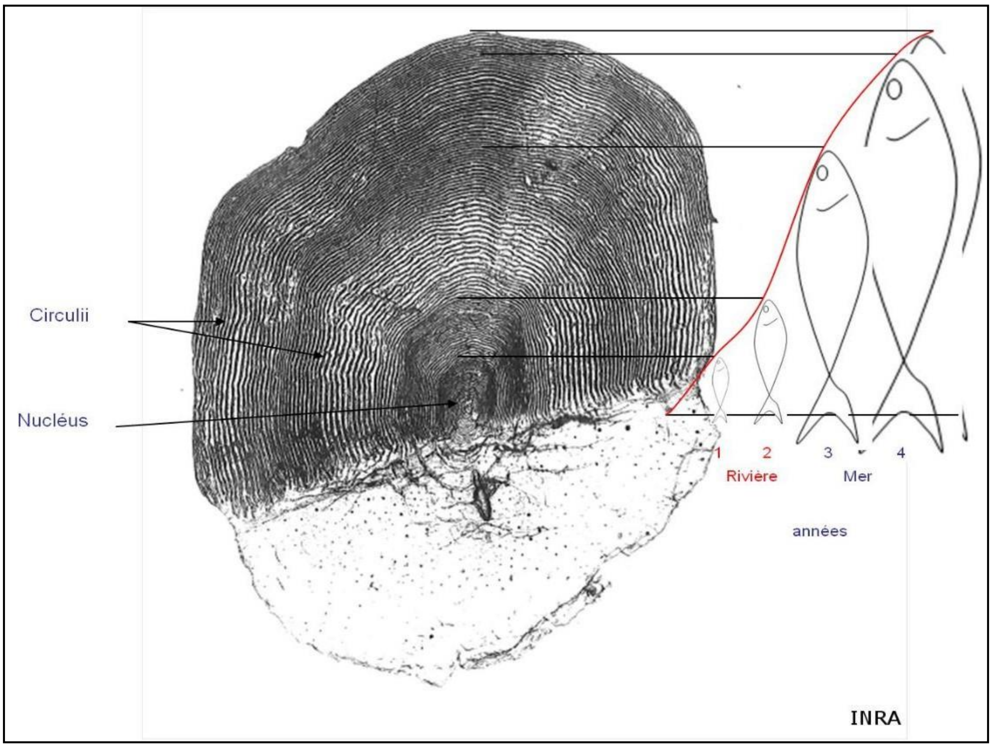

Figure 21: fish scales (INRA-ONEMA, 2008)

4.1. Otolithometry

4.2. According to Campana and Thorrold (2001), otoliths are calcareous structures located in the internal hearing organ of teleost fish, which play a primary role in hearing and balance. There are three pairs and age studies are conducted on the largest, the sagittates (Chater et al., 2018). According to Mahé et al. (2009), these calcified structures are the only ones that develop throughout the life of the fish. However, otoliths develop through localized limestone deposition, which results in the formation of growth streaks on different scales: daily (microstriations) and often annual (macrostrias), alternating between a dark streak during winter and a streak clear during the summer (Morales-Nin & Moranta, 1997; La Mesa et al., 2010). These streaks also reflect major events such as the transition from the larval stage to the juvenile stage and the development of sexual maturity (Allain & Lorance, 2000; Scarcella et al., 2011). Counting these growth streaks, called otolithometry, makes it possible to determine the precise age of a fish and to monitor its growth (Lecomte-Finiger, 1992; Choat et al., 2003).

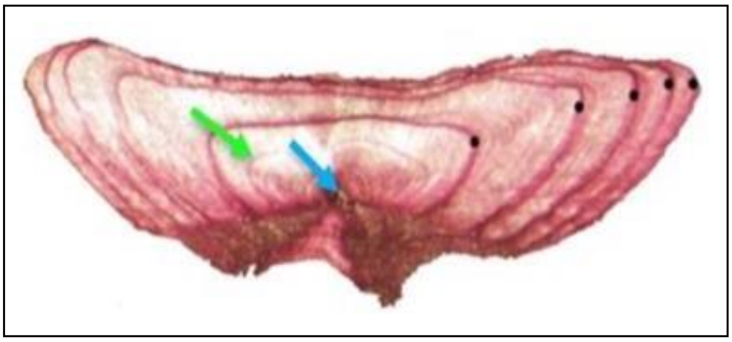

Figure 22: Transverse section of stained otolith. Azure arrow: core; emerald arrow: streak of metamorphosis in the juvenile phase; black spots: annual streaks. (Mahé et al., 2009).

Otoliths can be examined in two ways, depending on their size and configuration. The flat and thin otoliths, which are the youngest, can be read entirely by transmitted light and immersed in a translucent fatty medium (Allain & Lorance, 2000), or calcined to facilitate their reading (Ragonese et al., 2004; Mahé et al., 2009).

The cross section is necessary for thicker and opaque otoliths, which have very close and fine striations (as is the case for older fish) (Allain & Lorange, 2000; Reñones et al., 2007). According to Mahé et al. (2009), they are integrated into a resin in order to make cuts at the level of the core by sawing and/or sanding. Then the sections are analyzed using transmitted light and can be illuminated. The practice of otolithometry involves the sacrifice and dissection of the observer's head. (Allain & Lorange, 2000; Bilgin & Çelik, 2009)

4. Relative growth or height-weight relationship

This mathematical equation is essential for evaluating fish biomass and analyzing ontogenetic variations as well as various aspects of population dynamics (Safran, 1992).

Relative growth is observed in different areas of biology, physiology, ecology and fisheries resource management. This growth is used in fisheries sciences to estimate mass from size (Beyer, 1991), mass from age (Petrakis and Stergiou, 1995) and to express the equation of linear growth in weight growth. (Pauly, 1993). It also makes it possible to distinguish life history and morphology from one species to another, as well as between populations in different habitats and regions (Gonçalves et al. 1997).

Relative growth is used to assess the existence of a relationship between fish mass and size and to represent this relationship. The mass of the fish, if it maintains the same general shape and mass throughout its life, will be proportional to the cube of its length.

It is a relation of the form: W= a Lb

With:

M: Fish weight (g)

L: total length (cm).

a: constant.

b: allometry coefficient.

-The type of growth is determined based on b:

- b=3: growth isometry between mass and length.
- b<3: decreasing allometry (the cube of length increases faster than the mass).
- b>3: increasing allometry (mass increases faster than the cube of length).

5. Sex determination

From the age of one month, the primary sexual characteristics are developed: the lobular testicles are two fleshy, whitish, elongated blades placed between the somatic vault. The female gonads, an asymmetrical orange-yellow, penetrate the posterior part of the abdominal cavity in the shape of a thimble (Barton, 1981; Deniel, 1981).

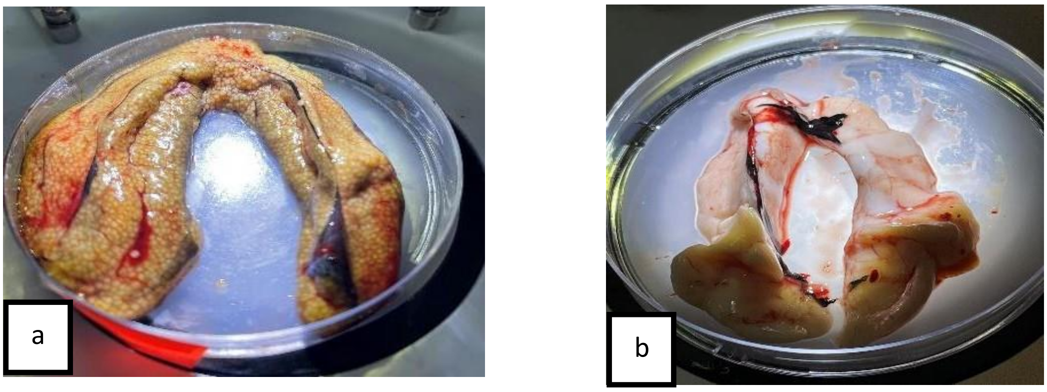

Figure 23:Photograph of female gonad (a) male gonad (b).

6. Calculation of Fulton's condition coefficient K.

The condition coefficient is calculated for each individual based on the formula proposed by Fulton in 1911 in order to verify the possible role of muscle reserves in gametogenesis and to evaluate the weight balance of fish and their growth rate.:

$$\mathbf{K = (Pe / Lt3) \times 100}$$

with:

Pe: Weight of gutted fish;
Lt: Total length of the individual.

The relationship between overall mass and the cube of total length is provided by this index, which was assessed globally and by distinct genus. According to Fehri-Bedoui et al. (2002), Ouannes-Ghorbel et al. (2002) and Mining (2003)

Chapter 4:

Result and discussion

I. Sample identification

Sampling carried out in the Tilesdit dam, Oued Isser and Oued Lakhal, allowed us to identify 5 species of fish belonging to the Cyprinidae family.

Table No. 02 represents the size and weight (maximum and minimum) of these fish.

The Cyprinus carpio species represents the largest size, with a length of 55 cm, and has the heaviest weight (2 kg 500).

Table 04: Numbers, size and weight of fish species sampled.

Species	Workforce	Nm	Nf	Neither	Ltmax Lt min (cm)	Max Pt Pt min (g)
Carassius autarus	38	1	35	2	Max length: 24cm Min length: 11 cm	Max weight: 222 g Min weight: 20 g
Carassius carassius	9	2	7	0	Max length: 22 cm Min length: 11 cm	Max weight: 149 g Min weight: 22 g
Cyprinus carpio	2	0	1	1	Max length: 55 cm Min length: 14.2 cm	Max weight: 2 kg 500 Min weight: 40 g
Rutilus rutilus	1	0	0	1	Max length: 14.3cm	Max weight: 30.11 g
Bearded Bearded Man	1	0	1	0	Max length: 17cm	Max weight: 68 g

Nm: number of males; Nf: number of females; Lt max: maximum total length; Lt min: minimum total length; Pt max: maximum total weight; Pt min: minimum total weight

A. The common crucian carp,*Carassius carassius*(Linnaeus, 1758)

The common crucian carp has a length of up to 50 cm with a weight of 1 kg. It has a very tall and stocky body, compressed on the sides, no barbel, massive scales. It has pharyngeal teeth, a well-developed caudal fin and a high, rounded dorsal fin.

ü Ecology

The crucian carp is a typically lake fish, inhabiting stagnant, warm or warm waters (it is sensitive to cold waters). It frequents lakeshore areas, shallow ponds and swamps.

ü Diets

It is an omnivore which feeds on aquatic plants and small benthic organisms, notably chironomid larvae.

ü Reproduction

It reaches sexual maturity at three years for males and at four years for females. It reproduces in spring, between April and June, at temperatures of 15° to 19°C (Neveu, 2002; Kottelat & Freyhof, 2007).

Figure 24: Photograph by *C. carassius*

B. Common carp,*Cyprinus carpio*(Linnaeus, 1758)

✓ **Description**

The common carp measures 50 to 75 cm, it can reach a maximum of 1.50 m and a weight of 35 kg. It has an imposing body, moderately tall, a protractile terminal mouth with 4 sensory barbels, without oral teeth but pharyngeal teeth. It has large, firmly established cycloid scales which cover the entire body with the exception of the head. The lateral line is clearly visible, and its dorsal fin is long and truncated.

- ✓ **Ecology**

Carp frequent lukewarm or hot, stagnant water (lakes, ponds, reservoirs) or slow water (lower watercourses in the bream area). It is a gregarious and benthic species, sedentary and of rather nocturnal habits (which lives in the middle of the night). It is mainly photophobic (or lucifuge), preferring environments with low light intensity, with seasonal variations. It likes habitats with heavy vegetation.

- ✓ **Diet**

The carp is an omnivorous fish with a strong carnivorous tendency, it has a broad dietary spectrum with a preference for benthic food (Michel & Oberdorff, 1995; Billard, 1997).

- ✓ **Reproduction**

The sex ratio favors females, with the imbalance between the two sexes increasing with age. The age at first sexual maturity is 2 years for males and 3 years for females.

Figure 25: Photograph by *C. carpio*.

C. The Roach, *Rutilus rutilus* (linnaeus, 1758)

- ✓ **Description**

The common roach has an elongated and flattened body, measuring between 25 and 30 cm in length and weighing between 250 and 400 g, or even 1 kg. It is distinguished by a short caudal peduncle, an arched back and a rounded ventral edge between the ventral fins and the anus .

- ✓ **Ecology**

R. rutilus favors stagnant water such as lakes, ponds and reservoirs, but it can also be found in flowing water. This species appreciates temperatures ranging from 28 to 30°C (Jacques & Jean-Pierre, 2013).Diet

The roach is an omnivorous animal that feeds on a wide diversity of prey: algae, macrophytes, insects, arachnids, molluscs and amphibians (Kassiet al., 2018).

- **Reproduction**

Roach reproduction takes place in spring, between April and June until July. Sexual maturity is reached in males in 2 to 3 years and in females in 3 to 4.

Figure26: Photograph by *R. rutilus.*

D. The barbell , *Bearded Bearded Man*(Linnaeus 1758)

- **Description**

The genus Barbus is distinguished by its fusiform body, with cycloid scales, a small eye, a mouth with thick and mobile lips, two pairs of barbels, hence the name barbel. It generally has a complete lateral line and has denticulated or non-denticulated pharyngeal bones (fig 3).

- **Ecology**

These are rheophilic and lithophilic species which appreciate gravel-bottomed waterways. It is mainly active at night to feed, and sometimes during the day after a storm (Bouhbouh, 2002).

- **Diet**

Its food is mainly composed of insect larvae and plant debris. The small ones (less than 13 cm) are zoophagous, mainly dipteran and mayfly larvae (Cherghouet al., 2002).

- **Reproduction**

It breeds between May and July. During the first three years, size is average and independent of sex (12-13cm), with sexual dimorphism very evident from 4-5 years of age. Females are 40 cm at the age of 10 years and males are only 27 cm (Aberkane & Iguer-Ouada, 2011).

Figure 27 : Photograph by *B. bearded*. (Original, 2024)

E. Golden crucian carp, *Carassius auratus* (Linnaeus, 1758)

- **Description**

The golden crucian carp differs from the common crucian carp by its concave dorsal fin and by the higher number of gill rakers (fig 4).

- **Ecology**

The golden crucian carp is a species of quiet, stagnant or little water, it frequents the eutrophic zone, which is thermophilic and undemanding in terms of dissolved oxygen and water quality, and resistant to environmental stresses (Bruslé & Quignard , 2001).

- **Diet**

This goldfish feeds on zooplacton, molluscs, plants and especially detritus.

- **Reproduction**

Its sexual maturity is influenced by a warm temperature (24°C) and a long photoperiod (16 hours of daylight).

Figure 28: Photograph by *C. autarus*.

Results of the parasitological study

We used the magnifying glass to search for parasites but we found nothing on the surface and at the level of the digestive tract in the 51 samples.

II. Growth study results

III.1. Age estimate

The age of the fish was estimated by both methods (scalimetry, otolithometry). The age of each species is reported in the tables below.

III.1.1. Age Relationship-Size of *C. carassius*

Table 5 represents the results of the age-size relationship of the species C. carassius

Table 05:*C. carassius* Age-Size Key

Height/age	1	2	3	4	5
[11,13[	1				
[13.15[			1		
[15,17[				1	
[17,19[			1		
[19,21[				2	
[21,23[			1	1	1

We note that ages 1 and 5 years are the least represented, with a number of only 1 individual for each age, followed by the age of 3 years with 3 individuals and the age of 4 years with 4 individuals.

Khelifi et al. (2018) reported the presence of 7 age classes with sizes ranging from 16 to 33 cm at the Beni Haroun dam (Mila, Algeria).

II.1.2. Age Relationship-Size of *C. auratus*

The results of the age-size relationship for the species C. auratus are reported in the following table:

Table 06:*C.auratus* Age-Size Key

Height/age	1	2	3	4
[11,13[	7	6		
[13.15[	1	2	1	
[15,17[		3	1	
[17,19[		3	3	3
[19,21[	1	1	1	1
[21,23[			2	1
[23.25[			1	

Our results reveal the presence of 4 age classes, where age class 4 is the least represented with 4 individuals of varying sizes between 17 and 23 cm, followed by classes 1 and 3 years with 9 individuals each and the age of 2 years with the most representative workforce (15 individuals).

On the other hand, Boubouzal & Hamdous (2015) identified 4 age classes ranging from 2 to 5 years at the Taksebt dam (Tizi Ouzou), but the 3 year age class is the most represented.

II.1.3. Age Relationship-Size of *C. carpio*

The results of the age-size relationship for the species C. carpio are reported in the following table:

Table 07:*C.carpio* Age-Size Key

Height/age	1	2	3	4	5
[14,55[		1			
[55.96[					1

Table 5 shows that the age of all individuals of the species Cyprinus carpiovaries between 1 and 5 years with a size of 14 to 55 cm.

In the same species, Sahtout et al. (2017) observed six age groups ranging from 2 to 7 years in the Foum el-khanga dam, Souk-Ahras. Additionally, the most predominant age groups are 2, 3 and 4 years old.

II.1.4. Age Relationship-Size of *R. rutilus*

The results of the age-size relationship for the species R. rutilus are reported in the following table:

Table 08: *R. rutilus* Age-Size Key

Size/age	1	2
[14,15[		1

The age study of the species shows that R. rutilus presents a single age class, with a size varying between 14 and 15 cm.

According to the Arab study (2021) in 3 Dams; Ghrib, Guenitra and Sekak, the age of two is the most common with sizes of 16-17 cm, 13-14 cm and 14-16 cm respectively.

II.1.5. Age relationship-Size of *B. barbus*

The results of the age-size relationship for the species B. barbus are reported in the following table:

Table 09: *B. barbus* Age-Size Key

Size/age	1
[17,18[	1

.

The age study of the species shows that B. barbus presents a single age class, with a size varying between 17 and 18 cm.

However(Kraiem, 1842),he observed 5 age classes with dimensions ranging from 11 to 20 cm in Oued Ghezala (Tunisia).

III.2. The height-weight relationship

III.2.1. The size-weight relationship of the species *Carassius carassius*

The results of the length-weight relationship for the species *Carassius carassius* are reported in the following figure:

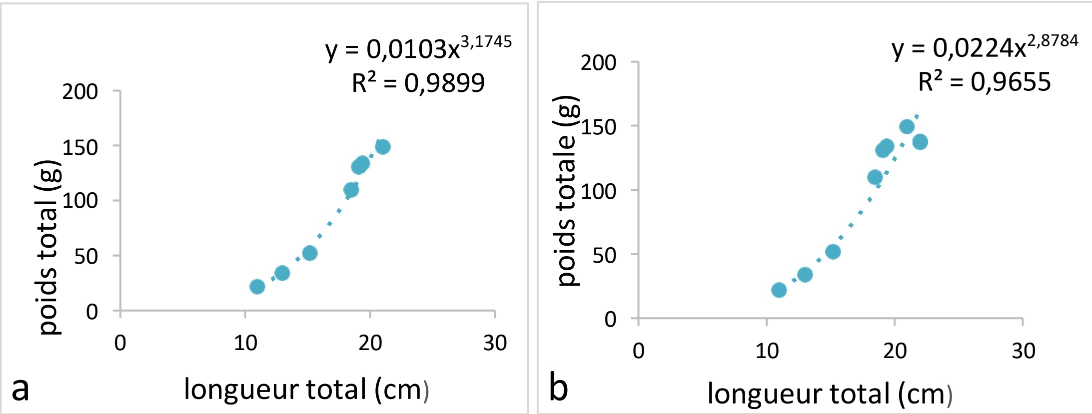

Figure29: Height-weight relationship of individuals of the species *Carassius carassius*.
a: females, b: the entire sample.

The value of the allometry coefficient (b) of the height-weight relationship for females is greater than 3 (b>3), (ba= 3.1745), which means increasing allometry, which means that the weight increases more quickly than the length.

The value of the allometry coefficient (b) of the height-weight relationship for the entire sample is less than 3 (b< 3), (bb=2.8784), so there is a lowering allometry between the two variables, the weight increases less quickly than length.

The value of the correlation coefficient between total length and total weight among all individuals of *Carassius carassius* is close to 1, (R2 = 0.9899), (R2 = 0.9655). This indicates a strong correlation between the two variables.

The analysis of the height-weight correlation of the species *C. carassius* reveals that males, females and the entire sample present a greater allometry, with an allometry coefficient greater than 3, and a coefficient correlation close to 1, which signals a strong correlation. The two variables present a correlation opposite to that reported by Khelifi et al. (2018).

III.2.2. The size-weight relationship of the species *Carassius autarus*

The results of the size-weight relationship of the species *Carassius autarus* are reported in the following Figure:

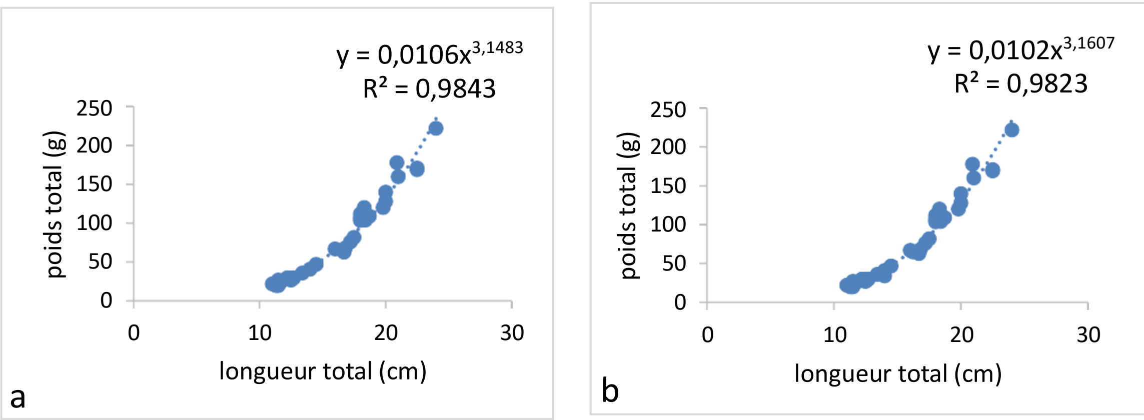

Figure 30: Length-weight relationship of individuals of the species *Carassius autarus*.

a: females, b: the entire sample.

The value of the allometry coefficient (b) of the height-weight relationship for females and the entire sample is greater than 3 (b>3), (ba=3.1483), (bb=3.1607), Ce which means increasing allometry, which means that weight increases faster than length.

The value of the correlation coefficient between total length and total weight among all individuals of *Carassius autarus* is close to 1, (R2 =9843), (R2=9823). Which indicates a strong correlation between the two variables.

The value of the lowering allometry for the total number of individuals of *C. auratus* is close to that observed by Boubouzal & Hamdous (2015) in the Taksebt dam in Tizi Ouzou, who obtained a value of b = 3.25, which indicates increased allometry. The correlation (R2 =0.966) is very close to what we mentioned in our findings.

- ***Note: Given the presence of only one and two individuals in the C. carpio species; R. rutilus and B. barbus, the size-weight relationship has not been calculated***.

II.3. Condition coefficient K

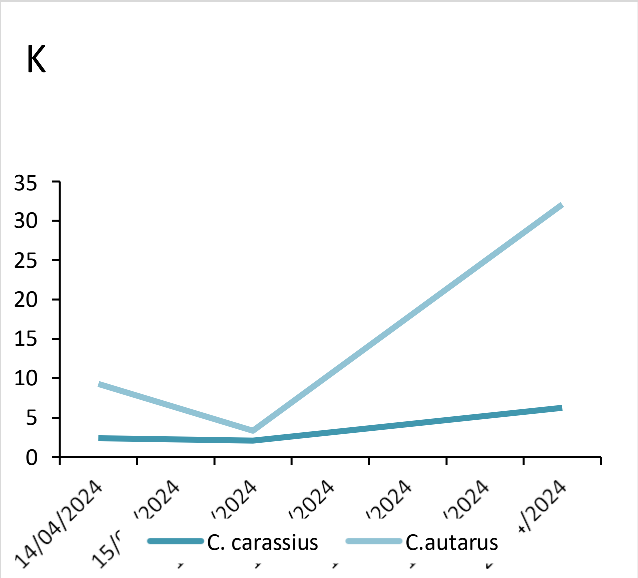

Figure 31: The condition coefficient K of the species *C. carassius* and *C. autarus.*

Figure 24 represents the evolution of the condition coefficient K as a function of the sampling date; In *C. autarus* we see an increase in K values on 04/14/2024 (K=9.30) but it decreases to reach its minimum on 04/16/2024 (K=3.34). Then it gradually increases during the period from 04/16/2024 until 04/20/2024 and which corresponds to the last captures (K=32.08). In *C. carassius* it is in the development stage until (6.27) on 04/20/2024.

Boubouzal and Hamdous (2015) and Khelifi et al. (2018) reported a condition coefficient K less than 1 on *C.auratus* sampled between April and June and *C.carassius* respectively.

IV. Results of the reproduction study

IV.1. Sex ratio study (SR)

Table 10: Sex ratio between males and females of the 5 species (*C. carassius, C. autarus, C. carpio, R, rutilus, B. barbus).*

Species	Sex ratio	Masculinity rate	Femininity rate
C. carassius	0.28571429	22.22222222	77.77777778
C. autarus	0.02857143	2.777777778	97.22222222
C.carpio	0	0	100
R. rutilus	0	0	0
B.barbus	0	0	100

Male and female rates vary among different species. *C. carassius* exhibits a dominance of females over males, even in the species *C. autarus* shows a marked predominance of females over males.

On the other hand, the masculinity rate in *C. carassius* is higher than the femininity rate, this result is obtained by Belhadef & Berdamane (2020) in the AinZada dam in Bordj Bou Arreridj.

The female rate of *C. auratus* is slightly predominant compared to the male rates. This result contrasts with those already obtained by Boubouzal & Hamdous (2015) who inventoried fish species at the Taksebt dam (Tizi Ouzou),

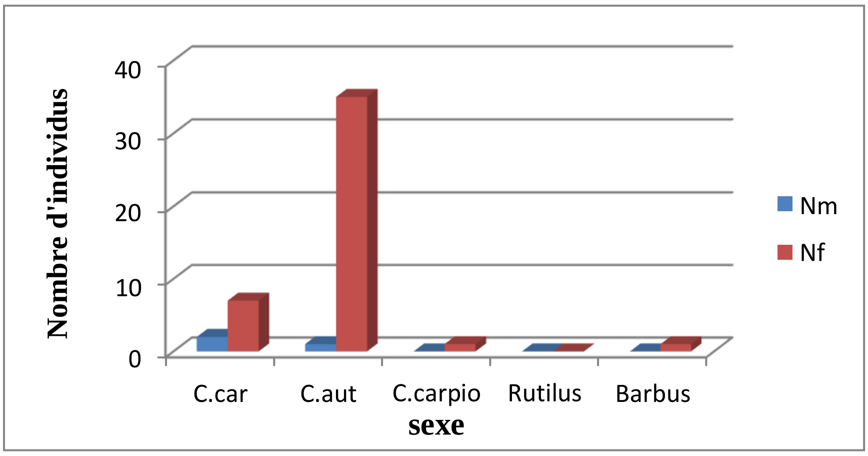

Figure 32: Histogram representing the sex ratio according to species.

Conclusion

We contribute to the analysis of parasites present in the three dams Isser, Tilesdit and Oued Lakehal (in Bouira), by sampling host individuals. We identified five (5) species of the Cyprinidae family during this study: the *C. Crucian* (*C. carassius*), the Golden Crucian (*Carassius auratus*), the Common Carp (*Cyprinus carpio*), the Garbon (*Rutilus rutilus*) and the Barbel (*Barbus barbus*).

According to our data, parasites are completely absent from sample individuals of all species. The sizes of the individuals are very different and average sizes are predominant during the study period. Fish is a constantly evolving system where fluctuations in water, pH, nutrient composition and microflora occur over time. Therefore, it would be wise to:

- Increase the number of fish sampled, which would make the study more precise and clearer and identify as many parasites as possible.
- Increase good knowledge about freshwater fish parasites.
- Obtain a device that specializes in accurately determining the age of fish.

Do further research on other fish species in the same area to look for other different parasites.

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Summary

Studies on ichthyoparasitology (fish, molluscs and crustaceans) are in their infancy. According to the Algerian Ministry of Fisheries and Fisheries Resources, the conservation status of freshwater fish is worrying since 42% of species are threatened with extinction. This state results from an increasingly significant degradation of watercourses in Algeria following increasing anthropization and the introduction of species as part of repopulation activities.

This study focuses on the identification of parasites that infest freshwater fish. As part of this work 50 fish specimens of different species (*Barbus sp; Carassius carassius.*). In Algeria there is little work on freshwater fish parasites. The first work on the native species *Barbus callensis.*

The study of fish population dynamics shows the predominance of medium sizes. As well as a predominance of females during the study period is noted in the fish studied.

Keywords: *Barbus callensis*; parasites; poisons; fresh water.

Résumé

Les études sur l'ichtyo parasitologie (poissons, mollusques et crustacés), en sont à leurs prémices. D'après le Ministère de la Pêche et des Ressources Halieutiques Algérien, l'état de conservation des poissons d'eau douce est préoccupant puisque 42 % des espèces seraient menacées de disparition. Cet état résulte d'une dégradation de plus en plus importante des cours d'eau en Algérie suite à une anthropisation croissante et l'introduction d'espèces dans le cadre d'activités de repeuplement.

Cette étude porte sur l'identification des parasites qui infestent les poisons d'eau douce. Dans le cadre de ce travail 50 spécimens de poissons de différentes espèces (*Barbus sp ; Carassius carassius.).* En Algérie les travaux portant sur les parasites des poissons d'eau douce sont peu nombreux, Les premiers travaux sur l'espèce autochtone *Barbus callensis.*

L'étude de la dynamique de population des poissons montre la prédominance des moyennes tailles. Ainsi qu'une prédominance des femelles durant la période d'étude est notée chez les poissons étudiés.

Mots –clés : *Barbus callensis* ; parasites ; poisons; d'eau douce

ملخص

لا تزال الدراسات حول الطفيليات السمكية (الأسماك والرخويات والقشريات) في مهدها. وفقا لوزارة الصيد والموارد السمكية الجزائرية ، فإن حالة حفظ أسماك المياه العذبة مثيرة للقلق حيث أن 42% من الأنواع مهددة بالانقراض. تنتج هذه الحالة عن التدهور المتزايد في المجاري المائية في الجزائر بعد تزايد الأنثروبولوجيا وإدخال الأنواع كجزء من أنشطة إعادة التوطين.

تركز هذه الدراسة على التعرف على الطفيليات التي تصيب أسماك المياه العذبة. كجزء من هذا العمل 50 عينة من الأسماك من العمل 50 عينة من الأسماك من أنواع مختلفة (Barbus sp؛ Carassius carassius.)

في الجزائر، هناك القليل من العمل على طفيليات أسماك المياه العذبة. العمل الأول على الأنواع المحلية Barbus callensis.

تظهر دراسة ديناميكيات تجمعات الأسماك هيمنة الأسماك ذات الأحجام المتوسطة. وكذلك لوحظت غلبة الإناث خلال فترة الدراسة في الأسماك المدروسة.

الكلمات المفتاحية: باربوس كالينسيس؛ الطفيليات. السموم. مياه عذبة