Influence of Health-Related Factors on Water Quality and Prevalence of Ecto- and Endoparasites in Fish within the Tigris River Spanning Tikrit City

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Abstract

This study encompasses two aspects: firstly, the examination of various physical and chemical properties of the Tigris River water in Tikrit city; secondly, the identification of parasitic animal groups affecting multiple fish species in the Tigris River, along with determining their prevalence and intensity. The study revealed alterations in certain physical and chemical properties of the water between November 2021 and October 2022. Notable fluctuations were observed in average temperature, ranging from 48.0-13.0 degrees Celsius for air and 29.0-11.7 degrees Celsius for water. The pH varied between 7.0-8.7, turbidity values spanned 20.4-27.5, sodium ions ranged from 14.2-19.8 mg/L, potassium levels were between 2.0-5.8 mg/L, and total dissolved solids varied from 200-270 mg/L. Dissolved oxygen values fluctuated between 8.3-5.0 mg/L, BOD values ranged from 1.2-4.3 mg/L, total hardness values were 200-306 mg/L, and sulfate values were between 86-120 mg/L. During this period, 618 fish from several species within the Cyprinidae family were collected. Examination results indicated infection with various types of parasites at differing prevalence rates, including Dactylogyrus vastator, Ligophorus imitd, Lamproglena pulchella, and Pseudulamproglena annulata. Statistical analysis revealed significant temporal and spatial differences at a significant level ($P < 0.05$).

Keywords: *Tigris River, Tikrit city, physical properties, chemical properties, water quality, parasitic animal groups, fish species, Cyprinidae family, Dactylogyrus vastator, Ligophorus imitd, Lamproglena pulchella, Pseudulamproglena annulata, prevalence, intensity, temperature, pH, turbidity, sodium ions, potassium levels, total dissolved solids, dissolved oxygen, BOD, total hardness, sulfate values, statistical analysis.*

INTRODUCTION

Water possesses distinctive physical and chemical properties, making it highly suitable for biological systems. These characteristics are crucial factors that determine water's various applications, as organisms living in water exhibit great sensitivity to any changes in the physical and chemical properties of their

aquatic environment (Smith, 2000). Consequently, numerous definitions have been formulated to clarify the concept of environmental pollution, including the gradual or sudden alteration in the chemical, physical, geological, or biological properties of water (Zalasiewicz et al., 2021). Any factor that degrades water quality renders it unsuitable for the environment, as it adversely affects living organisms, including fish (Cunningham et al., 2007).

Focusing on the freshwater environment, which typically exhibits a high level of biodiversity, it is worth noting that freshwater rivers, lakes, and wetlands only constitute approximately 0.8% of the Earth's surface area and around 0.02% of its habitable volume. Yet, they are home to nearly 10% of all known free-living animal species. Several studies have uncovered a rich parasitic fauna within freshwater fish (Onyia, 1970; Kennedy et al., 1986; Ugwuzor, 1987; Onwuliri and Mgbemena, 1987; FAO, 1996; Kadlec et al., 2003).

Objective: The purpose of this study is to collect data on the physical and chemical characteristics of the Tigris River and to analyze the ectoparasitic fauna of three fish species native to the river.

A - Study Area: The studies were conducted in Salah al-Din, a governorate in central Iraq., situated between latitudes 33.45-35.20 North and longitudes 42.30-45.10 East. The Tigris River, a vital river in Iraq, stretches 1,718 kilometers from its origin in Turkey to its delta, with 1,418 kilometers of its length within Iraq.

Sampling Stations: Six stations were established along the Tigris River in Tikrit:

Station 1 (Control sample): Positioned 150 meters downstream with a rocky bedrock bottom.

Station 2: Located at the downstream area with untreated contaminated water.

Station 3: Situated 25 meters from the downstream area.

Station 4: Found 75 meters from the downstream area.

Station 5: Located downstream, a mere 150 meters away.

Station 6: Situated at a distance of 300 meters from the downstream region.

B - The study involved the collection of water samples on a monthly basis from five distinct locations along the Tigris River, spanning from November 2021 to October 2022.

C - The study conducted physical and chemical tests to measure various parameters such as water temperature, total dissolved solids (TDS), pH, dissolved oxygen (DO), and biological oxygen demand (BOD).

D - The study employed a fish sampling technique whereby fish were captured at random intervals, ranging from three to four times per week, from diverse locations along the Tigris River over the course of the study duration. Samples were either examined directly or frozen for later analysis. Ectoparasites were identified and preserved using appropriate methods.

E - Statistical Analysis: The study utilized Analysis of Variance (ANOVA) to assess the effects of various months on the quantitative characteristics of ectoparasites. The study employed a chi-square test to assess the variations in infection rates among the

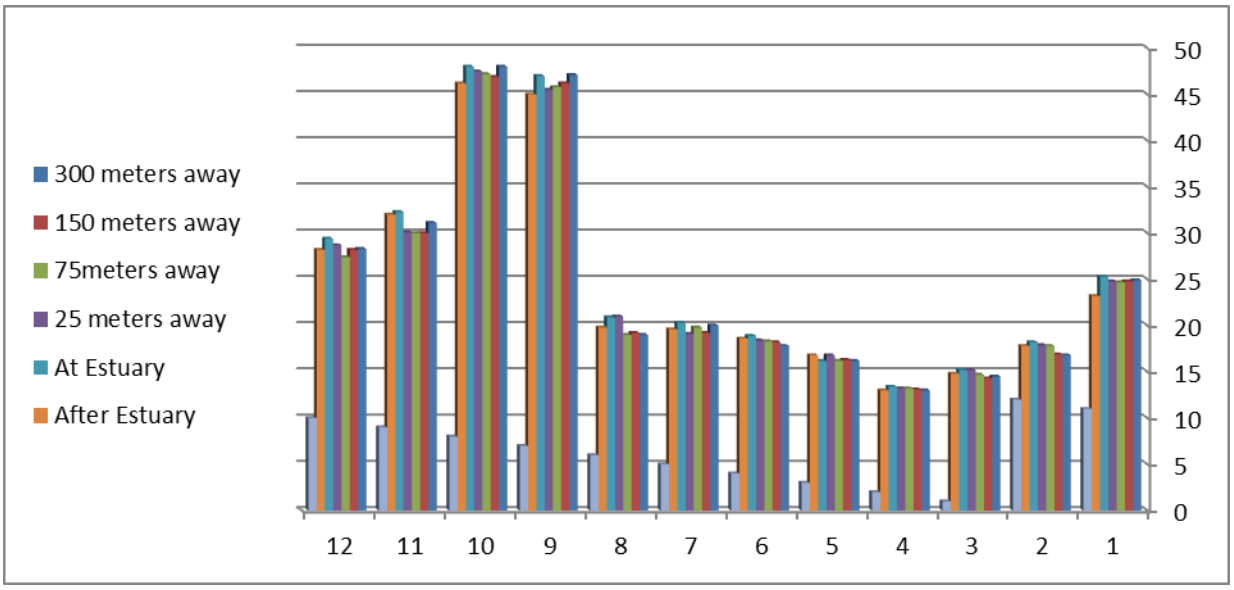
principal parasite populations in the fish species under investigation.

Results and discussion

Physical and Chemical Factors:

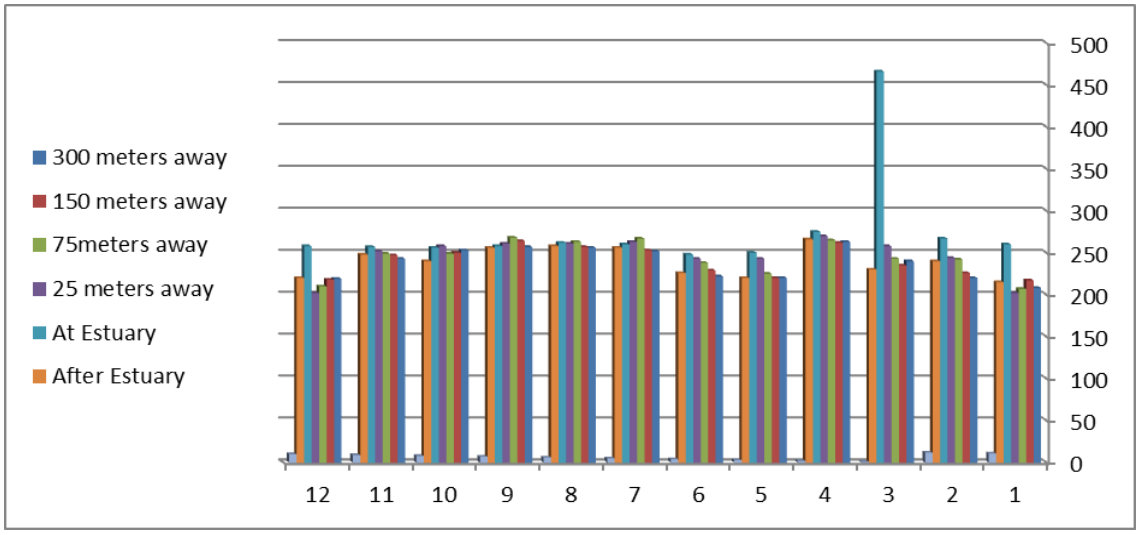
The fluctuation in water temperature was attributed to meteorological factors. The fourth station, located 75 meters downstream, recorded the lowest temperature of 11.7°C in December 2021, while the second station, situated near the outfall, registered the highest temperature of 29°C. The results of the statistical analysis conducted on the water temperature data revealed that there were no noteworthy spatial variations among the stations. Nevertheless, notable temporal differences were detected at a significance level of $P < 0.05$.

Figure 1: Spatial and Temporal Variation of Water Temperature



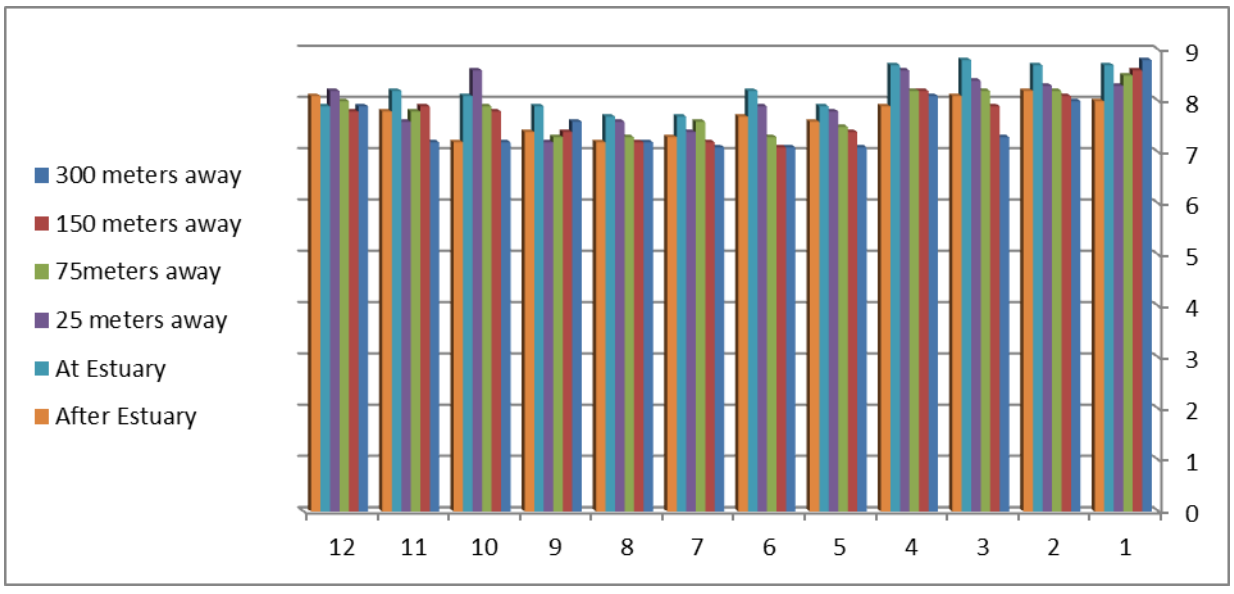
The study revealed that the level of total dissolved solids varied from 200-270 mg/l. The maximum value of 270 mg/l was documented in March at the third station located 25 meters downstream. Conversely, the minimum value of 200 mg/l was noted at the same station in October. The concentration of dissolved solids in the water examined in the present study was found to deviate from the established benchmarks for Iraqi potable water as outlined by the Central Organization for Standardization and Quality Control (1996), as well as international standards set forth by the CEOH (2003), US-EPA (2003), and WHO (1999), which typically fall within the range of 1000-430 mg/l. The statistical analysis yielded noteworthy spatial and temporal variations with a significance level of $P < 0.05$.

Figure 2: Spatial and Temporal Variation of Total Dissolved Solids



The study's findings indicate that the pH values observed fell within the range of 7.0 to 8.7. In January, the sixth station (located 300 meters from the outfall) recorded the maximum value of 8.7, whereas the minimum value of 7.0 was observed in August at the third station (located 25 meters from the mouth). The study conducted by Golan (2005) revealed a discernible decline in pH levels during the summer season, followed by a rise in the winter season. This trend could be attributed to the possibility of dilution taking place as water levels increase and precipitation intensifies. According to the World Health Organization (WHO, 2004), the efficacy of chlorine is adversely affected by a pH level exceeding 7.2 (Goyal et al., 1977). As per the Iraqi specifications for potable water No. 417 of 1996, the appropriate pH range for drinking water is between 6.5 and 8.5. The statistical analysis revealed that there were no significant differences at a significance level of $P < 0.05$.

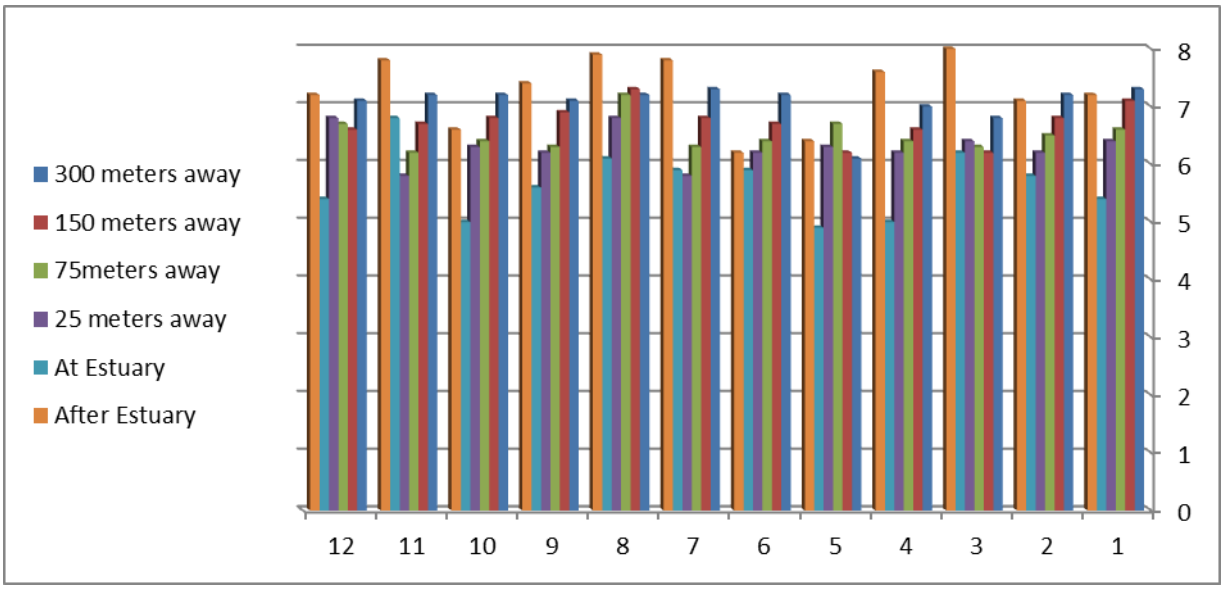
Figure 3: Spatial and temporal variation of pH



High pH values in the river water during rainy seasons can be attributed to lower temperatures, which increase the dissolution of carbon dioxide in water, forming carbonic acid (Bochnke and Delumyea, 2000).

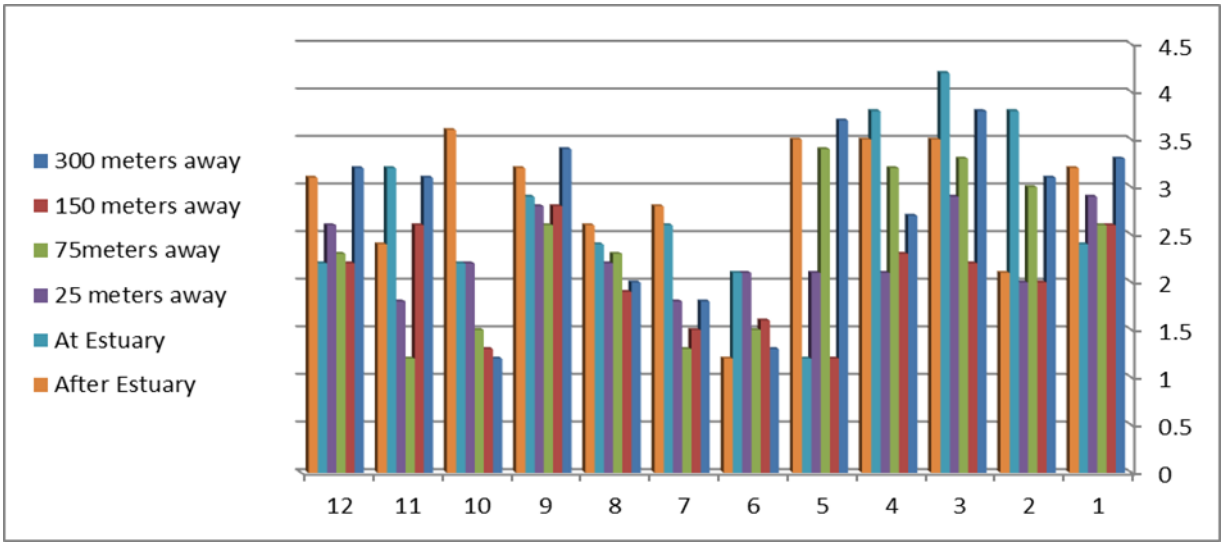
It is important to note that the study found significant temporal differences in dissolved oxygen values (P <0.05), but no significant spatial differences between stations. The decrease in dissolved oxygen levels during the summer season can be attributed to the increase in water temperature, which leads to an increase in microbial activity and organic matter decomposition, thus depleting the oxygen levels in the water. The results of the study indicate that the dissolved oxygen levels in the Tigris River do not meet the standard specifications for Iraqi drinking water and international standards.

Figure (4) The spatial and temporal variation of Dissolved Oxygen



BOD5: In August 2022 at the second station, the BOD peaked at 4.3 mg/L, while in February 2022 at the sixth station (300 meters distant), it dropped to 1.2 mg/L. It meets national (CEOH, 2003; US-EPA, 2003; WHO, 1999) and international (CEOH, 2003; US-EPA, 2003; WHO, 1999) criteria for potable water quality with concentrations of less than 3 mg/L.Both spatial differences and lack of differences were found to be statistically significant (P 0.05).

Figure (5) The spatial and temporal variation of the BOD5



Six hundred eighty fish representing numerous species of fish native to Iraq were gathered from the region beneath the Medical Rehabilitation Hospital in Tikrit for this research of parasites on Tigris River fish. Parasite kinds were cataloged based on the test results.

Two species of Ergasilus were identified, and their ancestors may be traced back to the Lamproglena genus, as shown in the tables below.

Lamproglena pulchella Nordmann , 1832

Phylum:- Arthropoda

Class:-Maxillopda

Order:-Cyclopida

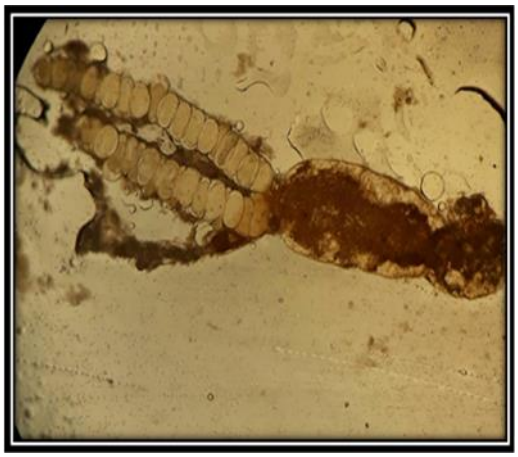
Family:- Lernaeidae

Lamproglena pulchella

Parasitic crustaceans have a long, slender body with a squared off head and five segments for a chest; the abdomen is divided into three segments that eventually narrow to two short appendages; and the egg bag is attached to the posterior of the final thoracic segment. It typically measures around 3.5 mm in length (picture 1). According to the Reference Guide to Parasites and Pathogens of Iraqi Fish (Mhaisen, 2018), this parasite was first recorded on fish galls by L. pulchell and later by Rahemo (1977) on the pharyngeal fishChondrostma regium and the spotted petal Capoeta trutta, which was renamed Varicorhinus truuta from the Tigris River at Mosul.

More than 40 species of prehistoric freshwater fish families belong to the genus Lamproglena pulchella, which has been documented in numerous studies from locations across Asia, Africa, Europe, and South America.

Photo (1) Lamproglena pulchella of the donkey fish under study 100x magnification power



The carp and alhumari fishes were used to isolate this parasite. Initially discovered on Ghalasm, spotted filament, and royal oak trees in Mosul by Rahemo1988, this crust has now been documented on 17 more hosts in Iraq, including the Shilk fish (Abdel Amir, 1989).

: Pseudulamproglena annulata Boxsh1976

Phylum:- Arthropoda

Class:-Maxillopda

Order:- Copepoda

Family:- Lernaeidae

Pseudulamproglena annulata

It is easy to see the specialization in the cylindrical body plan of crustaceans, which consists of a large, concave head on the dorsal side and a four-part breast. The first section joins the top of the chest vertically from the front. Cephalothorax and an abdominal cavity that splits into four segments and splits into two lobes at its apex. Each lobe of this parasite on the fish has a very short tail, measuring an average of 1.97 mm in length (picture 2). According to the Reference Guide to Parasites and Pathogens of Iraq Fish (Mhaisen, 2018), this crustacean was first documented as a new species of Cyprinion macrostomum in the Tigris River in Mosul in 1976.

Photo (2) P. annulata of the carp fish under study

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