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DOCTORAL SCHOOL OF GEOSCIENCES

FIELD OF ENVIRONMENTAL SCIENCE

Feeding ecology of fish populations in the Oituz River basin

PHD THESIS ABSTRACT

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2025

Abstract

Aquatic ecosystems, through the complexity of their trophic structures and the dynamic interactions between the species that inhabit them, play a crucial role in maintaining ecological balance at the global level. These ecosystems are fundamental for supporting biodiversity and for managing biological and chemical processes that influence the planet's natural resources (Carpenter et al., 2001).

Studies of fish feeding habits have historically been based on quantitative and qualitative analyses of stomach contents (Hynes, 1950). This provides valuable information on the trophic structure of aquatic ecosystems, forming a clear picture of food sources. In this way, the main types of food consumed by fish are identified. Previous studies have demonstrated that analyzing fish stomachs is a valuable tool for assessing the diversity and abundance of macroinvertebrate species, as well as for examining ecological interactions between species (Córdova et al., 2009). In addition, this method can provide indicators of ecological and water quality changes, essential for assessing the state of the aquatic ecosystem (Jimenez-Broncano et al., 2025). Macroinvertebrates are an important group of organisms in aquatic ecosystems, as they reflect the physical, chemical, and biological quality of freshwater (Tupinambás et al., 2015). Some are very sensitive to pollution, while others tolerate this aspect. The presence or absence of certain taxa is often correlated with pollution levels or habitat changes, which is why these organisms are used in the biotic assessment of ecosystem quality (Bonada et al., 2006).

Most freshwater fish are omnivores (Thompson et al., 2012). They feed on both plant and animal matter and can exploit a variety of food resources (Lancaster et al., 2005). The advantage that omnivorous species have is that they are flexible in terms of food and can adapt to ecosystems with limited resources (France, 2012). In a global analysis of the introduction of freshwater fish into various ecosystems,

omnivorous species were those that adapted most quickly to new conditions (Green et al., 2005).

The behavior of a species and/or an individual is also strongly influenced by the main food categories it consumes. Such ecological information is of great value in the development of conservation strategies and, therefore, represents a key element in protecting species and ecosystems (Braga et al., 2012).

Pollutants are becoming increasingly common in the environment as a result of human activities, including the improper management of solid waste. Even cosmetic products are not completely absorbed by the skin and end up in surface waters (Friot and Boucher, 2017). On a global scale, rapid changes in land use represent a significant threat to aquatic ecosystems. These changes have intensified considerably in recent decades, harming biodiversity and water quality (Barletta et al., 2010). Other sources of contamination of aquatic habitats include the improper disposal of solid waste on the banks or in the main riverbeds, fishing activities (by abandoning plastic equipment), as well as the wear of tyres or synthetic clothing, whose particles reach the water (Eerkes-Medrano et al., 2015).

The aim of this work is to analyze the diet of fish from the Oituz River, with a focus on identifying macroinvertebrates consumed and evaluating the presence of microplastics in the stomach contents, to assess the ecological state of the ecosystem. At the same time, it is intended to capitalize on the results obtained through scientific articles that contribute to understanding the impact of pollution on aquatic food webs and to support conservation measures and ecological management of freshwater habitats.

The objectives of the work were formulated to support the understanding of the complexity of the studied aquatic ecosystem. These include:

O1. Investigating the diet of fish from the Oituz River based on the presence of macroinvertebrates in the stomach contents.

O2. Using ecological indices to interpret the trophic structure and ecological status of the aquatic ecosystem.

O3. Characterizing the identified microplastics.

O4. Correlating the presence of macroinvertebrates and microplastics in the fish diet with nearby pollution sources and habitat quality.

O5. Elaborating relevant conclusions based on the investigations carried out and providing useful recommendations for environmental managers.

This thesis is structured into three main chapters, each playing an essential role in the complex analysis of the ecological issues addressed.

Chapter 1 provides a general framework for understanding the study area, with a description of the physical-geographical characteristics of the Oituz River and the ecological context in which the research was conducted. The physical-geographical characterization of a river is a fundamental element in its scientific analysis. It provides essential information for understanding the interactions between natural and anthropogenic factors, allowing a detailed assessment of the environmental impact, hydrological risks, and available water resources. In this chapter, the focus is on the analysis of the ichthyofauna in this area, in order to understand the diversity of fish species and their ecological relevance. The importance of feeding in fish ecology is also analyzed, highlighting food sources and their distribution, as well as environmental factors that influence feeding behaviors. This chapter includes a detailed presentation of microplastics in the aquatic environment, presenting their sources and impacts.

Chapter 2 focuses on the methodology used in the research, describing in detail the techniques for collecting samples by electrofishing and the process of preserving them for further analysis. Then, the trophic spectrum analysis is detailed, including the approaches used to examine diets and identify macroinvertebrates in stomach contents. Another important point of this chapter is

the description of the method for analyzing microplastics. In addition, it discusses the expression of the results through relevant ecological indices and how these indices help to assess the health of the studied ecosystem.

Chapter 3 consists of the results obtained from the analysis of the collected samples. The presence of macroinvertebrates in the diet of fish is analyzed qualitatively and quantitatively. Data on microplastics detected in the stomach contents of fish are also presented.

Six fish species were analyzed in the study: *Barbatula barbatula* (Linnaeus, 1758), *Phoxinus phoxinus* (Linnaeus, 1758), *Alburnoides bipunctatus* (Bloch, 1782), *Gobio obtusirostris* Valenciennes, 1842, *Squalius cephalus* (Linnaeus, 1758), and *Salmo trutta* Linnaeus, 1758. In the 840 stomachs analyzed, 1,541 macroinvertebrates were identified, belonging to a total of 24 taxonomic groups. The most macroinvertebrates identified were Chironomidae, with a total of 498, followed by Ephemeroptera (276 individuals) and Trichoptera (193 individuals). Coleoptera (176 individuals) and Diptera (147 individuals) also indicated an important food source for fish. Other groups, such as Dytiscidae, Ceratopogonidae, and Julidae, had a lower presence, and those such as Oligochaeta, Lepidoptera, *Tipula* sp., and others, although in small numbers, were still present, forming part of the fish diet.

Both the Shannon index and the evenness had average, sometimes low values, indicating moderate trophic diversity, but with tendencies towards an uneven distribution of prey in the diet of some species. The Pianka index revealed high trophic overlap between *Phoxinus phoxinus*, *Gobio obtusirostris*, and *Barbatula barbatula*, suggesting competition for similar resources. *Alburnoides bipunctatus* has a distinct trophic niche, and *Salmo trutta* and *Squalius cephalus* show moderate overlap with the other species. The diet of the species analyzed is dominated by aquatic insects, especially the groups Chironomidae, Ephemeroptera,

and Trichoptera. Some species, such as *Phoxinus phoxinus* and *Barbatula barbatula*, have a varied diet, while others, such as *Gobio obtusirostris* and *Alburnoides bipunctatus*, have more restricted food preferences.

In addition to the macroinvertebrates identified, other components such as feathers, plant fibers, pebbles, and fat droplets were also observed in the stomach contents of the fish. Anatomical fragments from other fish, such as scales, vertebrae, radii, heads, and larger pieces of fish, were also identified, suggesting a varied feeding behavior.

The analysis of microplastics in the stomachs of fish revealed a significant particle density, with an average of 15.03 particles per individual, the highest values being recorded in *Squalius cephalus*. Most of the microplastics identified were small fibers, predominantly blue, with dimensions below 2 mm. Following factorial ANOVA tests, it was found that the accumulation of microplastics is significantly influenced by habitat and feeding behavior, and the weight of the fish is positively correlated with the amount of particles ingested. Micro-FTIR analysis identified the presence of polyamide and polyethylene terephthalate, polymers frequently found in consumer products. The persistence of microplastics in the collected samples indicates continuous pollution, highlighting the need for urgent measures to protect aquatic ecosystems. Continuous monitoring of the presence of microplastics in the aquatic environment and the correlation with the proximity of pollution sources can form the basis of sustainable public policies and local interventions.