TROPHIC ECOLOGY OF FISHES: CONSOLIDATING THE BASIC(TRADITIONAL) METHODS

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ABSTRACT

Studies of food and feeding ecology are important to investigate trophic interrelationships of fishes in their resident water bodies. These are usually achieved using various important methods. However because no single measure gives an overall representation of the feeding habits of fish, best results are achieved only when methods are used to complement one another. This paper reviews various methods used in studying trophic fish ecology and suggests consolidation of the traditional or basic methods with relevant statistical indices and local ecological knowledge. More advanced methods are also proposed as valuable tools because they compensate for some possible errors that may arise from the use of quantitative methods.

INTRODUCTION

A key part of many ecological studies is the determination of the trophic relationships within an ecosystem (Trites, 2003) cited in Deagle (2005). Problems could however arise as regards obtaining reliable data on diet composition for most species. Studies on the food and feeding habits of fishes using different methods have been undertaken by various authors including Hyslop (1980) and Cortes (1997).

The most prominent practice in fish trophic ecology is the analysis of stomach contents which include the use of traditionally recognized methods (occurrence, volume, weight, numerical, points and dominance) and more complementary methods such as indices; which convey different information on the feeding life - history of the fish. Chemical or analytic methods also provide information on the nutritive and energy composition of both the prey and the predator. They include advanced methods such as stable isotope analysis (Jarman *et al.*, 1996), fatty acid analysis, DNA analysis and trace metal concentration (Domi *et al.*, 2005) as a new approach in feeding ecology (Michener and Schell, 1994). Ethno-ichthyologic approach has also been found somewhat valuable as a complementary method in fish feeding ecology basically due to its low cost and logistical ease (Andraso, 2005; Roseman *et al.*, 2009). An attempt is made here to classify some of the available statistical indices that serve as complements to the extant traditional methods. Some advanced or recent methods including the ethno-ichthyologic approach were also highlighted. Consolidation of the basic methods with statistical indices and more recent methods will improve the quality of information obtainable from studies relating to fish trophic ecology, owing to some of their merits.

(1) Basic/Traditional Methods of Stomach Content Analysis

These are methods of stomach contents analysis which include:

a. Frequency of Occurrence/Numerical Methods (see Hyslop, 1980; Ugwumba and Ugwumba, 2007).
b. Volumetric /Gravimetric Methods: (Hyslop, 1980; Ugwumba and Ugwumba, 2007).
c. Points Method: (Hynes, 1950).
d. Dominance Method: (Frost and Went, 1940).

(2) Complementary Methods of Stomach Content Analysis

These methods serve to consolidate the information from basic methods. The methods highlighted here include an array of statistical indices as well as ethno-ichthyologic approach.

Statistical Indices: These include various mathematical measures which convey information on the following:

Degree Of Stomach Fullness
Gut Fullness Index/Feeding Intensity: (Ugwumba and Ugwumba, 2007)
Gut Repletion/ Vacuity Index: (Ofori-Danson and Kumi, 2004)
Degree of Importance
Index of Relative Importance: (Pinkas *et al.*, 1971; George and Hadley, 1979)
Percentage Index of Relative Importance: (Cortes, 2007)
Simple Resultant Index: (Mohan and Sankaran,1988)
Index of Preponderance (IP): (Ofori-Danson and Kumi, 2004)
Geometric Index of Importance: (Preti *et al.*, 2008).
Modified Food Object Number (MFON): (Udo, 2002)
Degree of Similarity
Similarity Index: (Ofori-Danson and Kumi, 2004).
Diet Overlap Coefficient(C): (Morte *et al.* 2002)
Morisita-Horn Index: (Smith and Zaret, 1982)

Degree Of Diversity
Shannon-Weaner Diversity Index (Shanon and Weaner, 1963).
Tokeshi Analysis (Tokeshi, 1991)
Margalef's Index for Species Richness (Margalef, 1968).
Degree Of Selection
Food Preference/Selection Index: (Lazzaro, 1987)
Inter Specific Competition (CI): (Richard, 1963),
Levin Standardized Index (Krebs, 1989; Labropoulou and Eleftheriou, 1997).

Local Ecological Knowledge (LEK)

This is a method that considers the knowledge of local fishermen in fish dietary studies, basing it on the fact that the fishermen's knowledge regarding fish diet composition could be very wide (Andraso, 2005). The value of this method basically lies in its low cost and logistical ease (Roseman *et al*., 2009). It should therefore be used as a complementary method.

(3) Advanced or Chemical Methods

These are more sophisticated methods for analyzing the trophic ecology of fishes. They involve the use of chemical analyses to characterize the feeding life history of fish species. These methods solve the problem of unidentified prey items in a fish's diet. They however do not provide taxonomic information on fish diet.

a. Stable Isotope Analysis: This involves the analysis of stable nitrogen (15N) and carbon (13C) isotope ratios of fish body tissue (e.g scales and muscle) (Asante *et al*., 2010). This technique assumes that during the ingestion of food and excretion of wastes, there is an enrichment of the heavier isotope (i.e.13C or 15N) in a process known as fractionation (Olive *et al*., 2003). A predator will therefore have a higher proportion of the heavy isotope than the prey on which it feeds.

b. DNA Profiling: This technique helps in identifying dietary items by their respective dna profiles employing methods such as the polymerase chain reaction (PCR). Using this method, Deagle (2005) analysed the DNA in scats (cephalopod beaks, fish otoliths and bones) from captive Steller Sea lions.

Fatty Acid Signature: Using fatty acid biomarkers, fatty acid signature of species where little or no dietary information exist can be compared with those of known dietary information in order to elucidate their trophic position (Stowasser, *et al*., 2009).

Trace Metal Analysis: By analyzing the trace metal concentrations (Zn, Cd, Fe, Cu, Se and Hg) in the tissues of predatory fishes, relevant information on their feeding habits could be deduced (Domi *et al*., 2005). After being weighed and dried, muscle samples are digested in a solution of nitric acid and slowly heated to 100°c until complete digestion. Atomic absorption is then used to determine trace metal concentrations.

CONCLUSION

It is evident that no particular method used in trophic ecology gives complete information. In order to glean maximum information from a study the prudent investigator should employ a combination of methods capable of giving comprehensive information on the trophic ecology of fish species examined.

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