Methodology for fish stomach contents study (NIMRD "*Grigore Antipa*")

Methods of stomach contents analysis on fish are diverse but must be critically evaluated in order to properly use them to determine the importance of food. An objective analysis is one that highlights both quantitative and qualitative aspects of food. Thus, a simple way of recording data by analysing stomach contents is to record the number of stomachs that contain one or more individuals in each food category, the number can be expressed as a percentage of the total stomachs analysed (Hyslop, 1980).

Sikora et *al*. (1972) determined average dry weight in predatory species and expressed this as "biomass units". Variation in the average total weight of stomach contents relative to the size of the fish is commonly used in determining the daily rate of food behaviour (Staples, 1975 Changes in the average weight of the annual gastric content indicate differences in feeding intensity. Values that incorporate body weight are probably much more useful because they are a measure of food consumption relative to the size of the fish.

a. Stages of analysis of stomach contents in fish:

- individuals of small size will be taken and placed completely in formaldehyde (4% solution) and then analyzed in the laboratory;
- from large individuals the stomach will be collected; with the help of the scissors the digestive tract will be cut to its extreme parts and then the ends will be connected and then it will be introduced into formaldehyde (4% solution);
- the meristic characteristics of the analyzed individuals, the date and the sampling station will be noted;
- the organisms present in the stomach will be identified up to the group level and, where possible up to the family level;
- depending on purpose different indicators will be calculated (frequency of occurrence, dominance, feeding coefficient, relative importance index (IRI), etc.).

Stomach content analysis in turbot (NIMRD photo)

Stomach content research has been an important area of activity in fisheries biology. Fish food studies cannot be treated in isolation, as they must be discussed in correlation with the whole marine environment in which fish are mere elements. For the laboratory study of the stomach contents, the establishment of trophic relations, it is necessary to collect the digestive tract. The proper collection consists in the cutting with the scissors of the digestive tube at its extreme points, the introduction at one end of a note, the number of which will indicate the meristic characteristics of the fish in the age frequency form. The digestive tubes collected and thus labeled are attached to both ends with thread, placed in a gauze bag and placed in formaldehide (4% solution) as soon as possible, to reduce as much as possible the alteration of the stomach contents.

Quantitative analysis is done by weighing method. The whole stomach content is weighed on the analytical balance as well as each element separately. In order to link these data with the individual to whom they belong, the stomach filling coefficient is calculated or as the fish feeding coefficient is also called.

Two methods are used for the determination, namely: qualitative and quantitative. The qualitative analysis consists in the complete identification of the food components present in the stomach of the fish. The quantitative method consists of numerical analysis (frequency of occurrence, dominance) and gravimetric analysis (feeding coefficient, index of relative importance (IRI). The frequency of occurrence and the numerical percentage of food components are generally calculated to characterize stomach contents (Hyslop, 1980). The frequency of occurrence (FO%) is expressed as the percentage of the total number of stomachs in which the respective species appears:

FO% = FOi/ FOt x 100 where, FOi = number of stomachs in which species I appears;

FOt = total number of stomachs

A first evaluation can be determined by determining the filling coefficient of the digestive tract or the weighting coefficient. With the help of an electric scales, the stomach and the individual are weighed before and after the stomach is taken. Regarding the calculation formula regarding the filling coefficient of the stomach (of the digestive tract) there are several variants of calculation.

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Regarding the formula for calculating the coefficient of filling of the stomach (digestive tract) are more alternatives:

*Schreck et al., 1990 propose the following formula:

CU = <Cs/(Gt-Cs)> x 1000 where, CU = the filling coefficient;

Cs = weight content stomach; Gt = total weight of the fish

* Porumb I., 1961, carrying out studies on the biology of horse mackerel, proposes the following calculation formula for the filling coefficient of the stomach:

CU = ms x 10000 / mp where, CU = the coefficient of filling of the digestive tract in fish;

ms - mass of stomach contents;

mp - total mass of the fish.

* Smyly (1952) working with only a small amount of stomach content calculated the average weight of the whole content:

total stomach content / total weight of fish x 100

Relative importance index (IRI)

This index is an integration of the measurement of the number, volume and frequency of occurrence to help evaluate the relationship between the different types of food found in the stomach. It is calculated by summing the numerical and volumetric percentage values and multiplying by the frequency of the occurrence percentage (Pinkas et al., 1971):

IRI = (%N + % V) x %F

where, N% = number in percent,

V = volume;

F = frequency of occurrence

Bibliography:

- ICES. 2020. Workshop on Better Coordinated Stomach Sampling (WKBECOSS). ICES Scientific Reports. 2:26. 73 pp. http://doi.org/10.17895/ices.pub.5991;
- Hyslop, E.J. 1980. Stomach content analysis – a review of methods and their application J. Fish Biol. 17 (4); 411- 429;
- Porumb I., 1961. Contributions to the study of the biology of Trachurus mediterraneus ponticus, from the Black Sea. Adult food, youth as well as youth growth along the Romanian Black Sea coast. Scientific Annals of "Alexandu I. Cuza" University of Iasi, Natural Sciences, Volume VII, Fasc. 2, 285-312 (*in Romanian*);
- Pynkas, L., Oliphant., M.S., and Iverson I.L.K. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Fish Bull. 152 1-105;
- Schreck, C., B., Moyle, P., B., 1990. Methods for fish biology. American Fisheries Society, Bethesda, Maryland, pag.: 363-382;
- Sikora, W. B., Heard, R. W. & Dahlberg, M. D. 1972. The occurrence and food habits of two species of hake *Urophycis regius* and *Urophycis flridanus* in Georgia estuaries. Trans. Am. Fish. SOC. 101,515-516;
- Smyly, W. J. P., 1952. Observations on the food of fry of perch (*Perca fluviatilis* Linn.) in Windermere. Proc. zool. Soc. Lond. 122, 407416;
- Staples, D. J., 1975. Production biology of an upland bully *Philvpnodon breviceps* Stokell in a small New Zealand Lake. I. Life history, food, feeding and activity rhythms, Fish Biol. 7, 1-24.