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Stomach Content Analysis Techniques in Fishes



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Introduction

Cent Fish gut content analysis provides an important insight into feeding patterns & quantitative assessment of feeding habits

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Direct observation on the feeding habits of a fish in its natural habitat is nearly impossible and therefore to ascertain the nature of a fish food, the best way is to examine its gut contents.

The study of feeding habits of a fish is based on gut content analysis which is a standard practice.

Accurate description of diets and feeding habits also provides the basis for understanding trophic interactions in aquatic food webs.

The analysis of the different food items is difficult as the food items are normally found in a crushed or semi-digested condition.



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Limitations of gut content analysis

Fish when captured or when preserved in formalin for study, often vomits the remains of its last meal as a result of the chemical shock

Whatever material is found in the gut, cannot be considered as food

Other methods such as morphological (position of mouth, relative gut length, etc.) and environmental (food spectrum in the aquatic system) evidences should be calculated for verification and confirmation of the gut analysis data.



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Separation of gut content

The region between the oesophagus and the pyloric sphincter in the alimentary canal forms the **stomach**.

To study the food habits of fishes,

the total length of the fish,

the body weight of the fish,

sex,

feeding intensity,

the stage of sexual maturity of the fish has to be recorded.

The stomach should be removed from the fish and it should be preserved in 5 % formalin,

dried between sheets of filter paper and slit open with a pair of scissors.

If the stomach appears empty or contains only traces of food (less than 1.0 mg),

it is rinsed with water directly into a petri dish



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If it contains a weighable quantity of food, the excess water is removed using absorbent tissue paper.

The contents of the stomach are then weighed and washed in petri dish and examined under a microscope.

The food items are identified and sorted into various taxonomic groups and the numerical percentage is estimated.

Usually fragments of crustaceans (e.g. appendages), polychaetes (e.g. setae), molluscs (e.g. radula, mandible, shell parts) are counted as full animals however depending upon the type of fragments, the scaling of animals is left to researchers.

Before fixing in formalin, the intensity of feeding has to be recorded.



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Feeding intensity

Gorged stomach:

A stomach in which the gut contents are full and occupy the entire stomach.

The wall of stomach appears transparent and organisms inside the stomach could be seen.

Full stomach:

A stomach in which the food items occupying the entire cavity of the stomach.

$\frac{3}{4}$ Full Stomach:

A stomach in which the food items occupying $\frac{3}{4}$ of the stomach



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½ Full Stomach:

A stomach in which the food items occupying ½ of the stomach

¼ Full Stomach:

A stomach in which the food items occupying ¼ of the stomach

Trace stomach:

Very little or few organisms are present in the stomach

Empty stomach:

There will be no food item in the stomach.

A little digested secretion may be present.

Regurgited stomach:

There will be no food item in the stomach.

Wall of the stomach is shrunken.



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Methods of Gut Content Analysis

Fish diets can be measured in a variety of ways, and methods of gut content analysis are divided into two categories, viz., **quantitative** and **qualitative**.

The quantitative method is the measure of quantity of gut content and is of three types, viz.,

1. numerical,
2. gravimetric and
3. volumetric.

The **qualitative** analysis consists of complete identification of the organisms in the gut contents.

QUANTITATIVE AND QUALITATIVE ANALYSIS OF GUT CONTENT

Clip slide

1. Numeric-
Occurrence method (Presence/absence),
Number method (%), Dominance method,
Point (numerical)method,
2. Volumetric-
Eye estimation, Point (volumetric) method,
Displacement method
3. Gravimetric-





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Occurrence method

The number of stomachs in which a particular food item (i.e. a particular species) as a percentage of the total number of stomachs is determined.

The **frequency of occurrence** (i.e. the number of times of occurrence) of all the food items among the stomachs examined is summed and the frequency of occurrence of each diet expressed as a percentage of the total number of specimens examined.



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Stomachs	Fish	Crab	Mollusc	Plant	Shrimp	Total
1	√	√	√		√	4
2	√	√		√		3
3	√		√		√	3
4	√	√	√		√	4
5	√			√		2
6	√	√		√	√	4
7	√	√		√		3
8	√		√		√	3
9	√	√		√		3
10	√	√			√	3
Total	10	7	4	5	6	32

Fish = Number of stomachs in which fish occurred / Total number of stomachs

$$= 10/10 * 100 = 100 \%$$

$$\text{Crab} = 7/10 * 100 = 70 \%$$

$$\text{Mollusc} = 4/10 * 100 = 40 \%$$

$$\text{Plant} = 5/10 * 100 = 50 \%$$

$$\text{Shrimp} = 6/10 * 100 = 60 \%$$



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Numerical Method

The total number of individuals of each food item is recorded and expressed as percentage of the total number of food organisms in the stomachs examined.



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Stomachs	Fish	Crab	Mollusc	Plant	Shrimp	Total
1	2	1	2	3	2	10
2	3	2	1	1	2	9
3	2	1	2	2	1	8
4	1	1	0	3	2	7
5	5	1	0	1	0	7
6	1	3	3	0	0	7
7	2	1	1	1	0	5
8	4	4	0	0	1	9
9	1	2	2	0	2	7
10	3	0	1	1	1	6
Total	24	16	12	12	11	75

Fish = Number of fish observed in the stomachs / Total number of food items*100

$$= 24/75*100 = 32.00 \%$$

$$\text{Crab} = 16/75*100 = 21.33 \%$$

$$\text{Mollusc} = 12/75*100 = 16.00 \%$$

$$\text{Plant} = 12/75*100 = 16.00 \%$$

$$\text{Shrimp} = 11/75*100 = 14.66 \%$$



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Volumetric Method

Volume of each food item is determined by the displacement method and expressed as a percentage of the total volume of the stomach contents.

Volumetric and gravimetric methods are the best method.



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Stomachs	Fish (cm ³)	Crab (cm ³)	Mollusc (cm ³)	Plant (cm ³)	Shrimp (cm ³)	Total (cm ³)
1	2	1	2	3	2	10
2	3	2	1	1	2	9
3	2	1	2	2	1	8
4	1	1	0	3	2	7
5	5	1	0	1	0	7
6	1	3	3	0	0	7
7	2	1	1	1	0	5
8	4	4	0	0	1	9
9	1	2	2	0	2	7
10	3	0	1	1	1	6
Total	24	16	12	12	11	75

Fish = Volume of fish in the stomachs/Total volume of stomach contents*100

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Gravimetric method (Based on weight)

Total weight of all food items is determined.

Weight of each food item is expressed as a percentage of the total weight of stomach contents.

It may be done by wet weight or dry weight.

The dry weight is determined by drying the food items in an oven at 60 – 80°C until a constant weight is obtained and then weighing the dried matter.

The wet weight is determined by removing the excess water by removing the surface water by



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Stomach	Fish (g)	Crab (g)	Mollusc (g)	Plant (g)	Shrimp (g)	Total (g)
1	2	1	2	3	2	10
2	3	2	1	1	2	9
3	2	1	2	2	1	8
4	1	1	0	3	2	7
5	5	1	0	1	0	7
6	1	3	3	0	0	7
7	2	1	1	1	0	5
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Points method

Points are given to each food item. The number of points depends on whether the organism is very common in the stomach contents (highest number of points) or rare (lowest number) and the size of the organisms (i.e. one larger organism is counted as equal to a large number of small ones).

Each category is then allotted a number of points and all the points gained by each food item are summed and expressed as percentage of the total points.

It is rapid, easy and requires no special apparatus; with experience, this method could be very accurate.



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Points Method Based on the Stomach Fullness

The stomach is opened and is described according to the amount of food it contained as: full, $\frac{3}{4}$ full, $\frac{1}{2}$ full, $\frac{1}{4}$ full, less than $\frac{1}{4}$ full, empty or trace.

Then according to the degree of fullness, it is allotted 100, 75, 50, 25, 12 or 6 points respectively.

The contents are then placed in a petri dish and the relative amount of each food item present is estimated visually.

Points are allotted to each category as a result of this visual estimation.



For example,

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if a stomach $\frac{3}{4}$ full (75 points) contains a mass of *Leiognathus* sp. and a mass of *Penaeus* sp.

equal to about $\frac{1}{2}$ **the amount** of *Leiognathus* sp.

and *Sepia* sp. equal to **about** $\frac{3}{4}$ of *Penaeus* sp.,

then the allocation of **75 points** would be:

***Leiognathus* sp. 40;**

***Penaeus* sp. 20**

and *Sepia* sp. 15.

Evaluation by points thus taken into account
about the amount of food in the stomach as well



Index of Relative Importance (IRI)

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This index is useful in evaluating the relative importance of various food items. Based on the frequency of occurrence, number and volume of each item, this can be determined by:

$$\text{IRI} = (\% N + \% V) \% F$$

Absolute Importance Index (AI)

N = Number of items
 V = Volumetric percentage (items) can be determined as follows:

F = Frequency of occurrence percentage

$\% W$ is the percentage by weight



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Comparative Feeding Index

- This is a combination of the points method and the relative importance method and depends on the volume, fullness and frequency of each food item.
- This method involves the allotment of points to each food organism and the mean value per fish is multiplied by the percentage of total fish sampled.



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Index of Preponderance

This index is a composite one based on the volume and the occurrence index. If V_i and O_i are the volume and occurrence index of food item i (as indicated by their percentage), the combined index l for food i may be determined as follows:

$$l_i = \frac{V_i O_i}{\sum V_i O_i} * 100$$

This is the best method

a. Volumetric Method: (V)

10 Stomachs	Fish	Crab	Mollusc	Plant	Shrimp
Total	24	16	12	12	11



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b. Occurrence Method: (O)

10 Stomachs	Fish	Crab	Mollusc	Plant	Shrimp
Total	10	7	4	5	6

$$\text{Fish (ViOi)} = 24 \times 10 = 240$$

$$\text{Crab} = 16 \times 7 = 112$$

$$\text{Mollusc} = 12 \times 4 = 48$$

$$\text{Plant} = 12 \times 5 = 60$$

$$\text{Shrimp} = 11 \times 6 = 66$$

$$\text{Total } \Sigma \text{ ViOi} = 526$$

$$\text{Fish} = 240 / 526 * 100 = 45.63 \%$$

$$\text{Crab} = 112 / 526 * 100 = 21.29 \%$$

$$\text{Mollusc} = 48 / 526 * 100 = 9.13 \%$$

$$\text{Plant} = 60 / 526 * 100 = 11.41 \%$$

$$\text{Shrimp} = 66 / 526 * 100 = 12.55 \%$$



Gastrosomatic Index (GoSI)

$GoSI = \frac{\text{weight of the stomach}}{\text{weight of the fish}} * 100$

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- This index is very low during the peak spawning season because of the more number of empty stomachs.
- The rise and fall of gastrosomatic index always show an inverse relationship with the Gonadosomatic Index



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END.

Assignment:

Food and feeding habits of commercially important fishes.