

Variations in Stomach Contents & Biochemical Composition of Tissues in Some Marine Fishes

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Received 9 November 1979; revised received 6 February 1980

Relationship between calorific values and protein, fat and carbohydrate of the stomach contents (food) and body tissues of marine fishes, *Sardinella longiceps* Valenciennes, *Rastrelliger kanagurta* (Cuvier), *Otolithus ruber* (Schneider) and *Lactarius lactarius* (Schneider) is studied. Ratios of food cal to body cal in *S. longiceps* (phytoplankton - detrital feeder) is 0.3 while in *R. kanagurta* (phyto - and zooplankton feeder), *O. ruber* (carnivore) and *L. lactarius* (carnivore) it is between 0.7 to 0.8. *S. longiceps*, with the lowest ratio, is the most efficient energy converter among the 4 and also as compared to detritus - animal matter feeders like prawns.

Information on the energy content and biochemical constituents of the food of fishes is important for the determination of their food conversion efficiency and their position in the trophic web¹. Though the food and feeding habits of marine fishes are known, very little has been done on chemical estimation of the stomach contents^{2,3}. In most of the studies on the food and feeding habits of fishes the preliminary chemical analysis of food into organic and inorganic components has seldom been attempted. Identification of organisms present in the gut alone will not reveal the real nature of the feeding habits or the energy conversion efficiency of a fish. As many of the fishes ingest large quantities of detritus and bottom sediments, the qualitative analysis of organisms alone in the gut will sometimes lead to erroneous conclusions. Since the aim of all food consumption studies is to know the energy utilisation efficiency, chemical analysis of the gut contents seems to be the most direct approach. It has been shown that from the organic carbon values of the stomach contents of fishes their calorific value can be determined^{1,2}. In the present work attempts have been made to determine the relationship between the energy values of food and body tissues and their biochemical constituents (protein, fat, carbohydrate and ash).

Materials and Methods

Fresh fish, viz. *Sardinella longiceps* Valenciennes, *Rastrelliger kanagurta* (Cuvier), *Otolithus ruber* (Schneider) and *Lactarius lactarius* (Schneider), kept under refrigeration soon after landing at the Panjim

fisheries jetty in Goa were used. Immediately after bringing to the laboratory, the fishes were separated into different species and their weights and lengths determined. Portions of the flesh from each species were taken. After finding the wet weight, they were dried in an oven (60 to 70°C) for further chemical analyses. The fishes were carefully cut open and the viscera was washed many times to remove mucus and blood. The stomach portions of each were removed, their contents separated and pooled in glass bowls containing melting ice to avoid bacterial decomposition before drying. The number of stomachs taken varied from 40 to 13 in *S. longiceps*, 13 to 6 in *R. kanagurta*, 11 to 10 in *O. ruber* and 14 to 7 in *L. lactarius* in different collections. Stomach contents of each species were thoroughly shaken and 2 or more subsamples were taken from each for qualitative analysis.

Major portion of stomach contents was then transferred to glass petridishes and was dried in a hot air oven (60-70°C). After drying, the stomach contents and the fish flesh were ground into fine powder using glass pestle and mortar, and stored in stoppered specimen tubes until analysis. The energy values of stomach contents and fish flesh were determined by wet combustion⁴. Water, protein, fat, carbohydrate and ash contents were determined by standard procedures⁵. Sampling of the fish were done almost about the same time of the day.

Results

The results are presented in Table 1 and Fig. 1. In the oil sardine (*S. longiceps*), a phytoplankton feeder^{1,6,7}, during all months of observation the major portion of the stomach contents was unidentifiable organic aggregates and fine sand grains. Eventhough the

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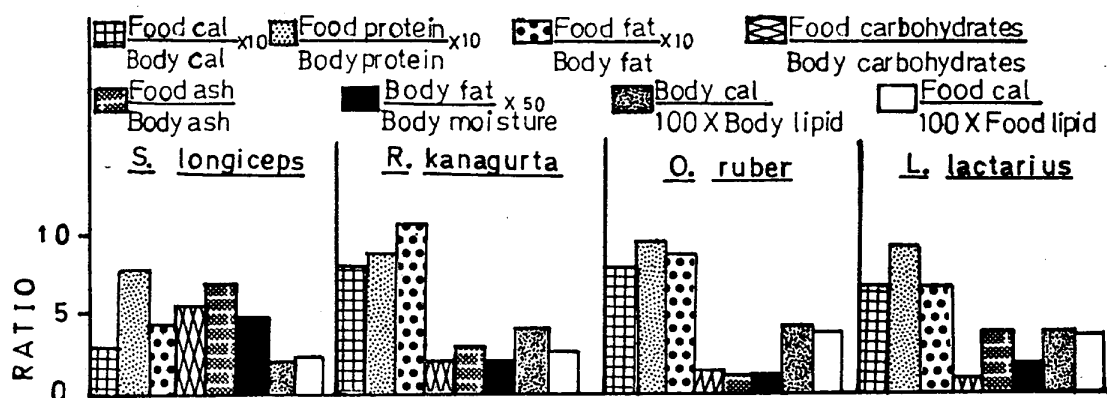


Fig. 1—Ratios of different biochemical parameters of fishes

Table 1—Date of Collection, Length and Weight and Other Parameters of Stomach Contents and Body Tissues of Fishes

Collection* date	Av. Lg. (cm)	Av. Wt (g)	Muscle moisture (%)	Total cal/g dry wt		Proteins (%)		Fats (%)		Carbohydrates (%)		Ash (%)	
				B	F	B	F	B	F	B	F		
<i>Sardinella longiceps</i>													
17-1-75	13.8	20.5	74	5586(5814)†	2169(3050)†	63.1	57.20	30.7	6.81	2.20	7.11	3.92	28.88
4-2-75	18.0	51.7	79	5307(5566)	2376(3545)	67.02	51.14	25.5	9.60	2.82	6.28	4.66	32.98
19-2-75	13.7	15.5	70	6190(6447)	1569(2382)	62.66	45.55	31.7	10.70	1.66	9.63	3.98	34.12
14-3-75	17.9	45.4	74	6057(6322)	783(1102)	59.79	50.90	34.9	4.41	1.41	15.75	4.20	28.94
23-4-75	18.5	45.8	72	5266(5539)	1330(1563)	59.00	33.60	32.9	45.05	3.16	6.43	4.94	14.92
17-5-75	13.6	15.0	83	4622(4775)	755(1029)	69.84	58.54	25.7	2.14	1.26	12.66	3.20	26.66
<i>Rastrelliger kanagurta</i>													
17-1-75	20.3	91.5	74	4195(4365)	3700(4310)	76.37	63.88	13.7	15.70	6.03	6.24	3.90	14.18
4-2-75	20.3	97.0	72	4704(4874)	2052(2217)	78.58	76.35	8.5	7.30	9.42	8.91	3.49	7.44
19-2-75	20.6	84.0	81	4068(4206)	4058(4476)	79.82	62.30	12.8	14.40	4.12	13.97	3.28	9.33
<i>Otolithus ruber</i>													
4-5-76	19.8	69.0	84	4494(4681)	3755(3991)	79.82	73.90	7.9	7.52	8.27	12.66	4.01	5.92
27-5-76	12.5	20.5	78	4342(4537)	2921(3103)	72.86	70.49	14.6	10.88	8.84	12.77	4.30	5.86
<i>Lactarius lactarius</i>													
28-4-76	13.7	32.1	76	5827(6130)	3349(4000)	77.95	71.50	13.5	8.54	4.41	3.68	4.94	16.28
4-5-76	15.5	45.0	80	5653(5822)	3063(3601)	79.34	73.60	12.4	8.65	6.25	2.81	2.01	14.94
27-5-76	9.4	9.6	78	4621(4859)	4259(4675)	78.87	76.91	12.6	8.96	3.63	5.25	4.90	8.88

*No samples collected during monsoon months because of rough weather conditions

†Ash free basis

B=Body and F=food

colour of the material varied from grey, green, and bluish grey, the texture was always pulpy like fine mud. The identifiable organisms included phytoplankton like *Nitzschia*, *Coscinodiscus*, *Biddulphia* and *Rhizosolenia* and zooplanktonic organisms like ciliates, *Ceratium*, copepods, tintinnids and foraminiferan shells. Compared to zooplankton remains, phytoplankton was always more in quantity. *Nitzschia* and *Coscinodiscus* were found in all collections except in April.

Stomach contents and the low range of their calorific values (2376 to 755 cal/g dry wt) in the oil sardine indicate that a large quantity of bottom sediments are ingested by these fishes. The quantity of identifiable phytoplankton was always little compared to fine sandy particles in the stomach.

In the mackerel (*R. kanagurta*), a phytozooplankton feeder^{1,8}, major portion of the stomach contents during all collections was unidentifiable organic aggregates and the colour varied from brown

to grey. Eventhough the general texture of the contents was pulpy there were no sand grains except in one collection. In addition to the zooplankton remains (ciliates, foraminiferan shells and copepods) there were identifiable phytoplankton like *Nitzschia*, *Coscinodiscus* and *Rhizosolenia*. However, compared to the quantity of phytoplankton, zooplankton remains were the most important group. Unlike in oil sardine, the variations in calorific values and biochemical parameters of the stomach contents of *R. kanagurta* were not very marked (Table 1).

In *O. ruber*, a carnivore^{1,9}, the stomach contents during all collections were the remains of comparatively large animals. Of the 2 collections in May, the stomach contents of the specimens in the first collection were almost exclusively of *Acetes*. The variations in the water content, calorific values and biochemical parameters of the body tissues were not marked except fat content (Table 1).

Stomach contents of *L. lactarius*, a carnivore^{1,9}, were mostly the remains of larger crustaceans and small fishes. The stomach contents were generally grey. In April the stomach contents were the remains of prawns, *Lucifer* and fish larvae, while in the 2 collections in May they were mostly *Acetes* as in *O. ruber*. In addition to *Acetes*, other crustaceans like isopods, amphipods and fish remains also were found.

Discussion

From the analysis of gut contents of these fishes their trophic relationship is also fairly well established. The oil sardine and the mackerel are the most important components in the catches of the neritic - pelagic complex next only to the prawns. Eventhough *O. ruber* and *L. lactarius* are not of much commercial importance, they have been selected for the investigation as representatives of the carnivorous fishes.

S. longiceps—Previous observations^{2,10} from other localities support the present observation that oil sardines ingest a large quantity of bottom sediments. Low calorific values and high ash percentage of the stomach contents also support the above conclusion. Hornell¹¹ surmised a phase of bottom feeding habit for this fish during October to December based on the occurrence of flocculent muddy unrecognizable matter in the stomachs. Hornell and Nayudu¹² concluded that oil sardines browse on the settled detrital material at the bottom. However, successive workers referred to the presence of sand grains and bottom sediments in the stomach contents as accidental and that oil sardine is a predominantly phytoplankton feeder⁷. But the present observations on chemical analysis of the stomach contents strongly support the earlier conclusions of Hornell and Nayudu¹². On the basis of

similarities in the stomach contents and their calorific values in oil sardine and established detrital feeders like *Mugil macrolepis*, the former may be considered as a phytoplankton - detrital feeder². The ranges in calorific values of the stomach contents and body tissue, the moisture percentage and other biochemical parameters of the body tissues are comparable to the results reported^{2,13-16}.

R. kanagurta—Results of the present study and of studies carried out by Qasim and Jacob² also are in agreement with the view that *R. kanagurta* is primarily a plankton feeder¹⁷. However, as a simultaneous study on the qualitative and quantitative aspects of the plankton available in the environment was not made, it is not possible to correlate the occurrence of planktonic organisms in the stomach of mackerels with those in the environment. From such studies Bhimachar and George¹⁸ have pointed out that the planktonic forms occurred in the stomachs in proportion to their availability in the plankton. However, from studies conducted along the Karwar coast Pradhan¹⁹ has observed that the order of abundance of various planktonic organisms is not always the same in corresponding analysis.

The range in the calorific values of the stomach contents and body tissue, the moisture percentage and other biochemical parameters of the body tissues are comparable to previous reports^{2,8,14-16}.

Variations have been studied^{20,21} in the fat content of mackerels of different sizes and in different seasons and its correlation to the food available in the environment, intensity of feeding and state of maturity. According to Venketaraman and Chari²⁰ while the tendency of ash and protein content of mackerel is to remain constant, the water and fat components are subject to seasonal variation and have an inverse relationship. They have also reported that the fat content in mackerel rises to maximum between September to November and falls gradually thereafter. Chidambaram *et al.*²¹ have shown that larger sized mackerels (>16 cm) have greater percentage of fats than the smaller ones. Higher fat content is attributed to their intensive feeding on the plankton which is abundant during certain months. They maintain that the heavy accumulation of fat during March-April is for building up reserve energy for spawning which follows immediately, when feeding is much restricted. Venketaraman and Chari²² correlated fat content of plankton with the fat in the muscle of the mackerel and also in the whole fish. They have confirmed the observations of Chidambaram *et al.*²¹ that the fat content is maximum during October-November and March-April. This they attribute to the mackerel's intense feeding on plankton rich in fat. In the present observation, fat of the body tissue is comparable to the

values reported by Chidambaram *et al.*²¹ during January and February. Body calories, amount of moisture, protein and ash are more or less constant during the present studies whereas the amount of body carbohydrates show fluctuations. As no biochemical observations on the plankton of the environment was done, it is not possible to compare the fat content of plankton and the body tissue. However, it can be noticed that the amount of fat of the stomach contents and the body tissue shows direct correlation in the present observation also.

O. ruber—Teleosteans and *Acetes* formed the major part of the diet of *O. ruber*¹⁷. In the present study also, conducted during May, in one collection the stomachs were full of *Acetes*. Venketaraman⁹ also lists large numbers of mysids, echinuroid worms, *Amphipods*, post larvae of fish and crab megalopa in the stomach during some months.

As in *Nemipterus japonicus* (Bloch)², which is another carnivore, the general range of calorific values of body tissues and stomach contents are similar in *O. ruber* also. However, body moisture content is slightly higher than in *Nemipterus*, but is similar to that of *L. lactarius* in the present observation. The range of the other biochemical parameters of the body tissues are comparable to the results of the previous works^{14,15}.

L. lactarius—Fish formed the most prominent diet practically throughout the year; the major species of fishes (both post larvae and adults) being *Thrissoctes*, *Leiognathus*, *Anchoviella* and *Cynoglossus*⁹. Others included small and large sized penaeids [mainly *Parapenaeopsis stylifera* (Milne-Edwards), *Penaeus indicus* (Milne-Edwards) and *Metapenaeus dobsoni* (Miers)]. As in the case of *O. ruber*, *Acetes* occurred in good numbers in the stomachs from March to the first half of June. Venketaraman⁹ lists polychaetes, decapod larvae, copepods, *Amphipods*, *Lucifer*, *Squilla*, *Hippa*, *Mysis* and cladocerans also in the stomach contents.

As in *N. japonicus*² and *O. ruber* which are carnivorous fishes the general range of calorific values of body tissues and stomach contents are similar in *L. lactarius* also. The body calorific value 4028 cal/g dry wt reported for *L. lactarius*¹⁶ is also close to the present value. Range of body moisture also is similar to *O. ruber*. The general range of proteins, fats and ash in the body tissues, calorific values, protein and fat in the stomach contents in *L. lactarius* and *O. ruber* are similar. However in *L. lactarius* the ranges of body tissue ash and carbohydrates are low compared to those of *O. ruber*, whereas the ash percentage is high. In general the ranges of biochemical parameters like protein, fat, carbohydrates and ash in the body tissue of *L. lactarius* are comparable to those of the previous results^{14,15}.

According to Qasim and Jacob² the range of ratios of food cal : body cal in oil sardine are from 0.123 (March, 1972) to 0.138 (April, 1972). The ratio in the lowest range in the present investigation is similar. However, the highest range is about 3 times more than the ratio of the previous work. The ratio (0.319) found by Qasim *et al.*¹³ also lies in the range of the present observation. In *R. kanagurta* the ratios of food cal : body cal found by Qasim and Jacob² (0.813 to 0.789) are close to the highest ratio obtained in the present investigation. The range of ratios of food cal : body cal reported for *N. japonicus*² (0.793 to 0.796) is similar to the ratios obtained for *O. ruber* and *L. lactarius* in the present investigation because all are carnivores. Another feature is the general constancy of the ratios in *O. ruber* and *L. lactarius* unlike in oil sardine which might also be because of the carnivorous feeding habit.

From the calorific values of stomach contents and body tissues obtained in the present observation and from the values of Qasim *et al.*¹³ it can be inferred that *S. longiceps* with the lowest ratio (0.3) for food cal : body tissue calories is the most efficient energy converter among the 4 fishes. Even compared to other phytoplankton - detritus feeders like *Europlax surattensis* (Bloch) and detritus - animal matter feeders like *Metapenaeus monoceros* (Fabricius) and *Metapenaeus dobsoni*¹³, *S. longiceps* has the lowest food cal : body cal ratio and consequently the highest energy conversion efficiency. The other 3 fishes, where the ratio ranges from 0.7 to 0.8 are almost equally efficient compared to each other and are similar to *Thrisa purava* (Valenciennes), but more efficient than *Thrisa malabarica* (Bloch) and *Thrisa mystax* (Bloch and Schneider)¹³.

Acknowledgement

The authors are deeply indebted to Dr S.Z. Qasim, Director, for facilities and encouragement.

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