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Transformation of food in the fish *Megalops cyprinoides*

II. Influence of quantity of food*

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Abstract

A *Megalops cyprinoides* of 60 g wet weight is able to consume daily a maximum amount of food (the prawn, *Metapenaeus monoceros*) equivalent to 5% of its own body weight. This amount of food is absorbed at the same efficiency as by an individual consuming daily the equivalent of 2% of its body weight. Hence the quantity of total food absorbed and converted per day must increase as a function of feeding rate. However, the increase in conversion efficiency showed a diminishing trend at a feeding level of 4% body weight per day.

Introduction

This paper reports the influence of different feeding rates on the rates and efficiencies of absorption and conversion in the eurysaline fish *Megalops cyprinoides*. It is based on previous work concerning the influence of body weight and quality of food upon the food transformation in *M. cyprinoides* (PANDIAN, 1967a, b). Previously, THOMPSON (1941), using *Micropterus salmoides*, BROWN (1946), using *Salmo trutta* and RICKER (1949), using *Lepomis macrochirus*, have shown that with increasing feeding rate, conversion efficiency increases; but after attaining a certain level the amount of efficiency increase is reduced. Since these workers gathered data on conversion but not on absorption, it is not known whether this reduction is due to less efficient absorption or to a reduced efficiency of conversion. The present paper represents a contribution to this unsolved problem.

Material and Methods

Maintenance of *M. cyprinoides* BROUSSONET (Elopidae) and of the prawn *Metapenaeus monoceros*, used as food source, as well as details concerning the methods employed have been published previously (PANDIAN, 1967a, b). All experiments were conducted at 28° ± 1.5° C in freshwater. Faecal matter was collected once every 7 to 10 days by filtering the entire aquarium water. The "sacrifice method" (MAYNARD and LOOSLI, 1962) was used to collect data on the amount of protein nitrogen and energy transformed by the test individuals during the experimental feeding period. Protein content was estimated by nitrogen analysis following the standard procedure of STEYERMARK (1951), and the energy content by employing the moist combustion method of IVLEV (1935).

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Results

Five experiments were performed using 5 individuals of *M. cyprinoides* of equal body weight (60 g). The feeding rates obtained were 2.1, 3.2, 3.9, 4.8 and 5.0% body (wet) weight per day. The test fish were fed once a day at about 10 a.m. in the first three cases; the other two individuals were fed at about 9 a.m. and 4.30 p.m. When the feeding frequency was increased to three times per day i.e. 8 a.m., 1 p.m. and 6 p.m., the fish usually did not fed at either 1 p.m. or 6 p.m. Force feeding (as done by HUNT, 1960), beyond 5% body weight per day, attempted on three other individuals was not successful; the fish disgorged the entire meal a few minutes after force feeding. Thus, apparently an amount of food equivalent to 5% body weight represents the maximum which a 60 g fish can consume under experimental conditions.

Table 1. *Absorption and conversion efficiencies of protein fraction and total food consumed by Megalops cyprinoides. The prawn Metapenaeus monoceros was used as food source. Each value represents the result of a single experiment on one individual kept in freshwater at 28° ± 1.5 °C*

Feeding rate (% body wet weight/day	Absorption efficiency (%)		Conversion efficiency (%)	
	Protein fraction	Total food	Protein fraction	Total food
2.1	97.5	93.4	20.6	16.2
3.2	95.7	89.8	25.7	26.6
3.9	93.7	87.1	33.8	42.6
4.8	94.0	88.5	33.1	42.9
5.0	97.0	86.4	36.9	44.2

Tab. 1 gives the values obtained for absorption and conversion efficiencies in *M. cyprinoides* fed different food rations. Protein absorption efficiency varied from 93.7 to 97.5% of the total protein consumed but indicated no declining tendency with increasing food uptake. Total food absorption efficiency decreased somewhat from 93.4% for the individual fed the equivalent of 2.1% of its body weight per day to 86.4% for the one fed 5.0% body weight per day.

Since the absorption efficiencies do not show appreciable variations, the rate at which nutrient matter is absorbed must have increased as a direct function of the amount of food intake. It can be seen from Tables 2 and 3 that the increase in absorption rates ranges from 37.7 mg nitrogen per day and 1.3 Cal

per day for fish fed at the minimum rate to 100.3 mg nitrogen per day and 3.1 Cal per day for the one fed at maximum rate. Correspondingly, the rates of conversion also increase. The quantities of protein and energy retained by the test individuals were determined by subtracting the protein and energy content of the fish at the beginning and end of the experiment. 7.8 mg nitrogen and 0.2 Cal energy were converted per day by the fish which received 2.1% of its body weight per day. These values increased to 37.0 mg nitrogen and 1.4 Cal energy per day in the test individual fed at a rate of 5% body weight per day.

Table 2. *Total nitrogen balance of Megalops cyprinoides fed with prawn at different feeding levels during 20 day-experiments. N residual represents the amount of nitrogen expended on the metabolic process; it is derived by subtracting the quantity of nitrogen converted from that absorbed. Each value represents the result of a single experiment on one individual kept in freshwater at 28° ± 1.5 °C*

Feeding rate (% body wet weight/ day)	N consumed (mg/day)	N in faeces (mg/day)	N absorbed (mg/day)	N converted (mg/day)	N residual (mg/day)
2.1	38.6	0.95	37.65	7.75	29.90
3.2	63.2	2.70	60.50	15.55	44.95
3.9	71.5	4.50	67.00	22.65	44.35
4.8	92.5	5.50	87.00	28.70	58.30
5.0	103.3	3.05	100.25	36.95	63.30

Table 3. *Total energy balance of Megalops cyprinoides fed with prawn at different feeding levels during 20 day-experiments. Food residual represents the amount of energy expended on the metabolic process; it is derived by subtracting the quantity of energy converted from that absorbed. Each value represents the result of a single experiment on one individual kept in freshwater at 28° ± 1.5 °C*

Feeding rate (% body wet weight/ day)	Food consumed (Cal/day)	Undigested food (Cal/day)	Food absorbed (Cal/day)	Food converted (Cal/day)	Food residual (Cal/day)
2.1	1.348	0.090	1.258	0.204	1.054
3.2	2.206	0.224	1.982	0.526	1.456
3.9	2.494	0.322	2.172	0.849	1.323
4.8	3.231	0.371	2.860	1.226	1.634
5.0	3.634	0.493	3.141	1.387	1.754

Conversion efficiencies increased rapidly from 20.6% for protein and 16.2% for total food in the fish fed at 2.1% body weight per day to 33.8% for protein and 42.6% for total food in the one which received the equivalent of 3.9% of its body weight per day (Tab. 1). After that level, the increase in conversion efficiency with increasing feeding rates is less marked.

Another interesting point is that the increase in conversion rate appears to alter the chemical composition of the fish. For instance, the caloric value of the fish fed at 2.1% body weight per day was 4.2 Cal per g dry weight and the one fed with 5.0% body weight per day was 4.6 Cal per g dry weight. This is probably due to the accumulation of fat in the fish; accumulation of considerable amounts of fat has been observed by GERKING (1955), who fed *Lepomis macrochirus* at different feeding levels.

Discussion

The data presented throw some light on a few interesting points. No marked difference in absorption efficiency has been observed in *M. cyprinoides* fed daily amounts of food ranging from 2 to 5% of its own body wet weight. KARZINKIN (1935, quoted in RICKER, 1946, p. 380) reported that "sparingly-fed carp absorbed 90 percent of their food (*Chironomus* larvae), while those given a lot of food absorbed only 78%". He presumed that a portion of the food remained in the alimentary canal for a short time and was less completely absorbed than the other. DAWES (1930) observed the same phenomena in the plaice *Pleuronectes platessa* and believed that the sooner the second meal is offered, the faster the first meal is passed along, regardless of the completion of digestion and absorption. Since these workers speak of feeding rate in relative terms, it is not clear at which feeding rate absorption efficiency begins to decrease. Further, it is understood from their statements that the digestion rate remained unchanged, irrespective of the increased food consumed by the fish. A recent publication shows that, at least in a few carnivorous fishes, digestion rate increases in accordance with the amount of food consumed. HUNT (1960), who fed *Lepisosteus platyrhincus* the equivalent of about 8% of its body weight per day (three times more than the normal rate), reported that the normal digestion rate doubled. In *M. cyprinoides*, absorption rate increased more or less directly proportional to the feeding rate; there is some indication too for a direct increase in digestion rate. GERKING (1955), working on *Lepomis macrochirus* at 24 °C, found that protein absorption efficiency, over a comparable feeding range from 1.2 to 3.6% body weight per day, remained constant at about 97%. DAVIES (1963, 1964) fed carp *Carassius auratus* of about 35 g from 1.5 to 38.7 mg dry weight of food per g fish (the latter corresponds to about 13% body wet weight per day) and observed no appreciable difference in their energy extraction efficiency. There seems to be a range of nutritional levels over which food absorption remains unchanged; only when consuming food in excess to this range, fishes such as *Pleuronectes* (DAWES, 1930) and *Carassius* (KARZINKIN, 1935) digest and absorb less efficiently; others, such as *M. cyprinoides*, stop consuming and when force fed, simply disgorge the food.

Conversion efficiency increased initially but after reaching a level of about 4% body weight per day, this increase diminished. For a nearly 250% increase in the daily food ration, there was about 200% increase in protein nitrogen and 175% increase in

energy expenditure on metabolic processes (residual N and residual food, Tabs. 2 and 3, 6th columns). In general, this is said to be due to the specific dynamic action (BRODY, 1945). The energy cost for converting food is increased considerably at a very high feeding level.

Summary

1. The influence of different feeding rates on the rates and efficiencies of absorption and conversion has been studied in the fish *Megalops cyprinoides*, using the prawn *Metapenaeus monoceros* as food source.

2. The maximum daily amount consumed by a 60 g test individual was equivalent to 5% of its body wet weight; when force fed in excess to this range, the fish disgorged the entire meal. Apparently, feeding at the rate of 5% body weight per day represents maximum consumption.

3. An individual fed the equivalent of 5% of its body weight per day absorbed (total food and protein fraction) at about the same efficiency, as did a fish fed the equivalent of 2% of its body weight per day. The quantities of food and protein absorbed and converted per day increased as a direct function of the food consumed.

4. Conversion efficiency increased initially; but when fed the equivalent of 4% body weight per day or more, the increase in conversion efficiency diminished. This fact is attributed to the specific dynamic action; the energy cost for converting food is considerably increased at very high feeding rates (BRODY, 1945).

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