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GROWTH RATE AND CONVERSION EFFICIENCY OF THE AIR-BREATHING CATFISH, *HETEROPNEUSTES FOSSILIS*, IN RELATION TO RATION SIZE

S. RAVICHANDRA REDDY and SHAKUNTALA KATRE

Department of Zoology, Bangalore University, Bangalore 560001 (India)

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ABSTRACT

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Effects of different feeding rates (0—20% live body weight) on food intake, growth and conversion efficiency of *Heteropneustes fossilis* were studied using the oligochaete worm *Tubifex tubifex* as food. An amount of worm substance equivalent to 12.73% live body weight/fish day^{-1} represents the maximum amount which a 4.015 ± 0.340-g *H. fossilis* can consume under laboratory conditions. Geometrically derived feeding rations of 12, 40 and 130 mg/g live fish day^{-1} represent the maintenance, optimum and maximum levels for *H. fossilis*. The SDA (specific dynamic action) increased from 14 mg/g day^{-1} at optimum to 70 mg/g day^{-1} at maximum feeding rate.

INTRODUCTION

Knowledge about the metabolic demands of maintenance, growth and other activities of fish is essential to understand the energy budget and production processes of fish both in nature and in culture in captivity (Winberg, 1956; Gerking, 1971, 1972; Brett, 1971; Pandian, 1975; Vivekanandan, 1976). While there are a considerable number of publications concerning the effects of feeding rates on growth (Gerking, 1955, 1971; Pandian, 1967; Brett et al., 1969; Andrews and Stickney, 1972; Pandian and Raghuraman, 1972), similar studies have not been extended to the siluroid fishes, which are found to adapt well to artificial conditions (Bardach et al., 1972) and have a high food value. Hence, the present study was undertaken to determine the effect of different feeding rates on growth and conversion efficiency of the air-breathing siluroid fish *Heteropneustes fossilis* (Bloch). Studies of this sort contribute towards a better understanding of the food requirement of natural populations of the species as well as providing useful information for further fish culture practices.

MATERIAL AND METHODS

Juvenile freshwater air-breathing catfish, *Heteropneustes fossilis*, were collected from the Vartur tank (near Bangalore) and stocked in the laboratory. Juveniles in the size range of 3.933—4.693 g were selected from this stock for use in the feeding experiments. A series of nine different feeding levels were offered to the experimental individuals. At each level of feeding, five groups of three fish each were tested. The fish in each group were kept in an aquarium containing 20 l of fresh water. As the depth of the water column is known to influence the food intake in *H. fossilis* (Arunachalam et al., 1976), in the present experiments this was maintained at 15 cm. The feeding experiments were carried out at 25 ± 2° C. The fish were fed daily on live *Tubifex tubifex* with rations ranging from 0 to 20% of their initial body weight, i.e. 0, 1, 3, 5, 8, 10, 12, 15 and 20% of live body weight/day. The regime was continued for 30 days at the end of which the fish were sacrificed and weight changes were recorded.

RESULTS

Food intake

Of the different ration levels offered, the latter three groups of *Heteropneustes fossilis* could consume a maximum of 12, 12.73 and 11.06% of live body weight/day, respectively (Table I). Apparently an amount of worm substance equivalent to 12.73% live body weight/fish day^{-1} represents the maximum amount which a 4.051 ± 0.340-g *H. fossilis* can consume under laboratory conditions; i.e. 127.26 mg/g live fish day^{-1} (Table I).

TABLE I

Effect of different feeding levels on the food intake, growth and conversion efficiency of *Heteropneustes fossilis* (mean ± SD)

Ration level (% initial live body weight of fish)	Food accepted (% initial live body weight/day)	Feeding rate (mg/g live fish day^{-1})	Growth (mg/g live fish day^{-1})	Conversion efficiency (%)
0	0.00	–	– 4.90 ± 0.935	–
1	1.00	9.98 ± 1.710	– 5.62 ± 2.147	–
3	3.00	30.00 ± 2.691	+ 6.98 ± 1.216	23.28 ± 2.336
5	5.00	50.00 ± 4.116	+ 9.40 ± 0.852	18.84 ± 1.761
8	8.00	79.94 ± 2.319	+ 10.50 ± 1.305	13.16 ± 0.967
10	10.00	100.00 ± 3.478	+ 14.35 ± 1.516	14.32 ± 2.642
12	12.00	120.00 ± 3.372	+ 16.09 ± 1.372	13.42 ± 1.254
15	12.73	127.26 ± 4.725	+ 14.76 ± 1.323	11.65 ± 0.455
20	11.06	110.59 ± 3.466	+ 10.90 ± 1.045	9.86 ± 1.981

Growth

The amount of live substance gained or lost by the experimental fish after the 30-day feeding period was calculated and expressed as mg live substance gained or lost/unit weight of fish day^{-1} (Table I). The group which received no food exhibited an average loss of 4.90 mg/g live fish day^{-1}, while the group fed on 1% ration lost 5.62 mg/g live fish day^{-1}. This difference was found to be statistically insignificant. The loss in body weight in either of these two groups of fish may be due to the oxidation of fat and protein, as observed in *Lepomis macrochirus* (Savitz, 1971) and *Tilapia mossambica* (Pandian and Raghuraman, 1972). Growth was exhibited by fish in all other ration groups, reaching a maximum of 16.09 mg/g live fish day^{-1} in fish which received food at 12% live body weight/day (Table I). Beyond this level of feeding the growth rate decreased considerably.

The relation of growth to feeding rate for *H. fossilis* is presented graphically in Fig. 1. From this it is evident that 12.0, 40.0 and 130.0 mg/g live fish day^{-1} represent the maintenance (the point at which the curve cuts the Y axis, see Fig. 1, where there is neither gain nor loss in original body weight), optimum (where food conversion is best), and maximum levels, respectively.

Food conversion

Conversion efficiency (K_1) was expressed as a percentage and calculated as described by Katre and Reddy (1978). The highest efficiency (23.28%;

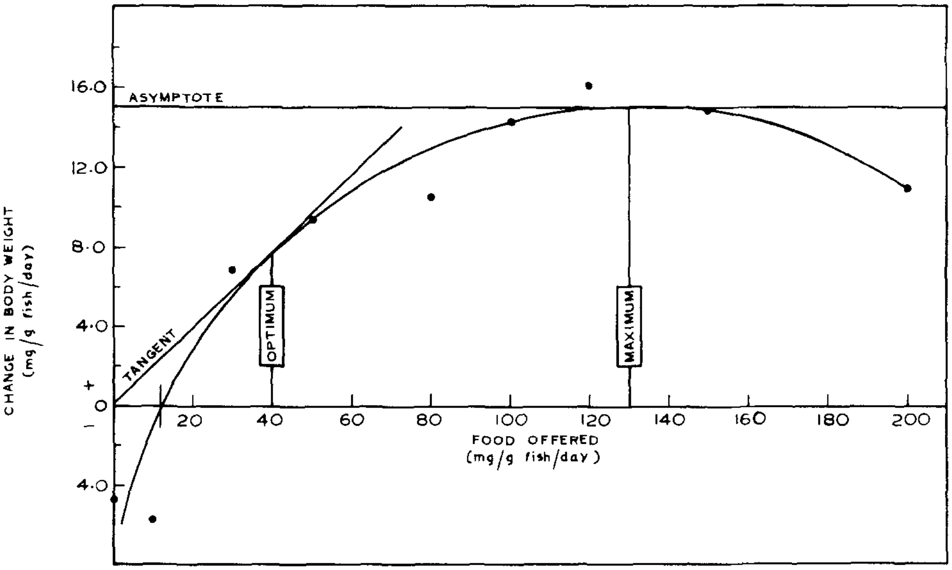

Fig. 1. *Heteropneustes fossilis*: geometric derivation of maintenance, optimum and maximum feeding rates.

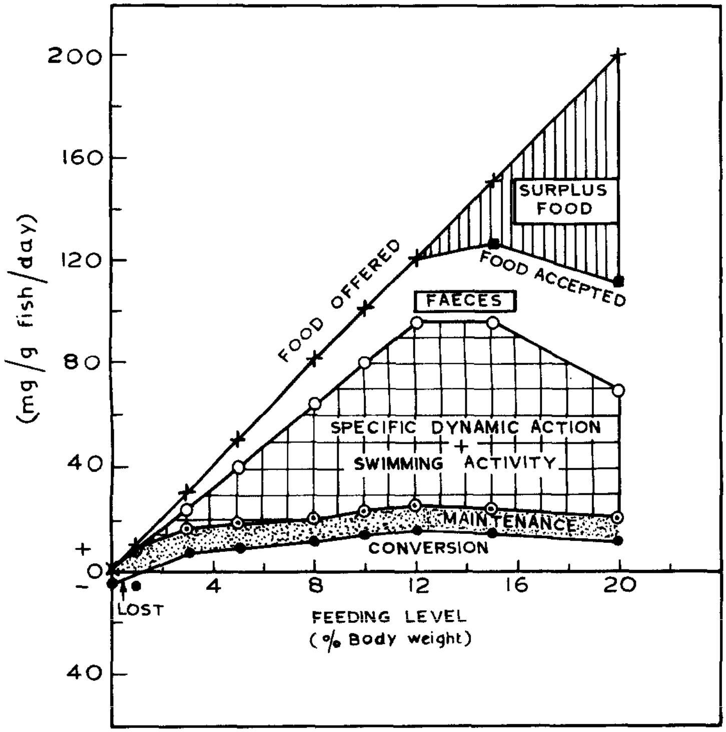

Fig. 2. *Heteropneustes fossilis*: energy budget at different feeding levels.

Table I) was observed in fish receiving food at the rate of 3% body weight/day. Beyond this ration level the efficiency of food conversion decreased steadily.

Fig. 2 presents the quantitative relations of feeding rates to the food energy absorbed, metabolized and converted into body substance in *H. fossilis*. The absorption efficiency was not directly estimated but assumed to be 80% of food consumed (Winberg, 1956). As the maintenance ration had been estimated for *H. fossilis* (see Fig. 1), assuming that the energy required for maintenance remained the same for all feeding levels, the level of 'specific dynamic action' (SDA) (Brody, 1945; Beamish et al., 1975) or calorigenic effect (Kleiber, 1961) could be calculated. The estimated SDA of *H. fossilis* was 14 mg/g day^{-1} for fish feeding at the optimum level (Fig. 2). This SDA increased 5 fold (70 mg/g day^{-1}) at the maximum level of feeding, indicating that the energy cost of converting food into body substance increased at higher feeding levels.

DISCUSSION

It is evident from the above results that a 4.015-g *Heteropneustes fossilis* can consume a maximum of 127.26 mg/g live fish day^{-1}. This value is comparable to the value of 120 mg/g day^{-1} for *Gasterosteus aculeatus* (Beukema, 1968). This value is higher than the value reported for another freshwater air-breathing fish *Ophicephalus striatus* (70 mg/g day^{-1}; Pandian, 1967) and the euryhaline fish *Tilapia mossambica* (65 mg/g day^{-1}; Pandian and Raghuraman, 1972), but appears to be lower compared to the reported value of 157.6 mg/g day^{-1} for the non air-breathing freshwater catfish *Mystus vittatus* (Arunachalam, 1978) and 190 mg/g day^{-1} for *Cichlosoma bimaculatum* (Hari Sethi, 1970). Perhaps the lower feeding rate exhibited by *H. fossilis* at the maximum feeding level may be due to the 'surfacing activity' of the air-breathing fish as compared to the non air-breathing *M. vittatus.*

The present weight range of *H. fossilis* (4.015 g) is closely comparable to the 4.0-g *Ictalurus punctatus* studied by Andrews and Stickney (1972). *I. punctatus* fed at 2, 4 and 6% of the fish body weight at 26° C were reported to grow at the rate of 19.05, 38.09 and 47.62 mg/g day^{-1}, respectively (recalculated from Andrews and Stickney, 1972). Compared to these values, the present value for growth rate obtained for *H. fossilis* at feeding levels of 2% (3.6 mg/g day^{-1}), 4% (8.6 mg/g day^{-1}) and 6% (10.0 mg/g day^{-1}) are markedly less. The low rate of production may be due to the quality of food offered (Fischer, 1970), and suggests that *Tubifex tubifex*, though known to be highly nutritional (Galinat, 1960) and easily digested by fish (Mann, 1935), may not meet the total nutrient requirement of the fish. A composite pelleted food, as used by Andrews and Stickney (1972), may be more nutritional and yield better growth in fish.

Irrespective of the water temperature, *I. punctatus* showed the best food conversion ratios at 2% ration level (Andrews and Stickney, 1972). Similarly, better conversion efficiency (23.28%) for *H. fossilis* was exhibited at the lower feeding level of 3% than at higher feeding levels. The significant decrease in conversion efficiency of *H. fossilis* at higher feeding levels may be due to the increased SDA (Fig. 2), and/or probable evacuation of the undigested food by the fish, and/or excess swimming activity due to surfacing (see also Arunachalam et al., 1976).

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