Proc. Indian Acad. Sci. (Anim. Sci.), Vol. 91, Number 6, November 1982, pp. 507–513.

Effect of teleostean prey size and salinity on satiation amount, satiation time and daily ration in the glassy perchlet *Chanda* (=*Ambassis*) *thomassi* (Day) (Pisces : Centropomidae)

J RAJASEKHARAN NAIR and N BALAKRISHNAN NAIR

Department of Aquatic Biology and Fisheries, University of Kerala, Beach P.O. Trivandrum 695 007, India

MS received 26 June 1982

Abstract. Results of the experiments conducted to estimate the maximum single food intake, satiation time and daily ration in the predator, *Chanda thomassi* using different size groups of teleostean prey (guppies) and in six non-lethal salinities are presented. The results suggest that satiation amount and satiation time vary considerably with the size of the fish prey. It is seen that the appetite of the fish is lost on consuming relatively fewer number of larger fish prey, while the predator could accommodate a much larger number of smaller prey fish of greater gross size. Also the satiation amount decreases when the prey is available in bulk than when given at regular intervals. The computed daily ration of the predator shows high values when compared with available data on other tropical predators. The over all results project the destructive potential of this predatory species coupled with its shoaling habits.

Keywords. Satiation ; teleostean prey ; predator ; *Chanda thomassi*.

1. Introduction

Within the genetic potential of any species to grow, many abiotic and biotic factors limit maximum growth. The daily rate at which food can be consumed is a prime factor. This in turn is related to the capacity of the stomach (satiation feeding) and the rate of digestion. Thus, knowledge of food consumption in fish populations is, therefore, essential for interpretation of the influence of a variety of factors on fish production (Warren *et al* 1964 ; Windell 1966 ; Brocksen *et al* 1968 ; Brett *et al* 1969 ; Swenson and Smith 1973).

Information on the satiation amount i.e., the amount of food necessary to satisfy the fish (Brett 1971), the satiation time (time to attain satiation), and details regarding daily ration, and the gastric evacuation rates of a piscivorous predator are essential prerequisites for assessing the feeding capacity of these predators on valuable fish fry and fingerlings in the natural waters and culture systems. *Chanda* (= *Ambassis*) *thomassi* (Day) is a medium sized piscivorous predator found in shoals in the fresh and low saline waters of Kerala in South

India. With a view to estimating the satiation amount, satiation time and daily ration in the case of *C. thomassi* adults under laboratory conditions, a series of tests were conducted using four different size groups of the fish prey (*Poecilia* (= *Lebistes*) *reticulata* Peters) and six different salinities.

2. Materials and methods

Healthy individuals of *C. thomassi* immature adults (4·250 ± 0·250 g and standard length (SL) 7·1 ± 0·5 cm) were acclimated and reared in large plastic buckets (20 litre capacity). The temperature of the water was 27 ± 1° C and the oxygen content maintained at air saturation level. The fish were fed with an excess amount of fry, juveniles and adults of *Poecilia reticulata* for nearly fifteen days prior to experiments. The prey fish (*P. reticulata*) were then grouped into 4 size groups :—

Group I	fry (average SL 8 mm, average Wt. 16·3 mg)
Group II	juveniles (average SL 14·2 mm, average Wt. 57·0 mg)
Group III	mature males (average SL 18·6 mm, average Wt. 98·4 mg)
Group IV	mature females (average SL 24·8 mm, average Wt. 175·4 mg)

All the prey fish of each size group were almost of the same size and weight and the averages were calculated after weighing and measuring more than 50 fish collected at random from each group. Preliminary tests were conducted to find out the feeding intervals for each size group and the rate of feeding at each interval. They were estimated as 2 min and 5 fish (Group I), 5 min and 3 fish (Group II), 7 min and 3 fish (Group III) and 10 min and 2 fish (Group IV).

(1) At intervals (Expt. I)—The individuals of *C. thomassi* were starved for two days prior to the experiment in order to effect complete stomach evacuation. The precalculated numbers of prey fish were presented during each time interval removing the excess until the fish completely stopped feeding. To accommodate an initial high rate of feeding (Brett 1971), food was presented twice as fast during the first time interval. Fish were considered satiated when they would no longer accept any food, in the presence of excess, after a period of active feeding. The time from start to voluntary cessation is defined as the satiation time. Each experiment was done in triplicate.

(2) As a bulk (Expt. II)—Another experiment was done after a days starving presenting each fish with a bulk of fish prey (more than twice the satiation amount of the previous experiment) of each size group at a single instant. The fish were considered satiated when they did not capture a prey for a fifteen minutes time lapse. The satiation time was considered as the time from the start of feeding to the time of the last feed. Rough estimates of daily ration were made from the results of these experiments.

(3) In different salinities (Expt. III)—Also the fish were reared in 6 precalculated non-lethal salinities (0·96‰, 6·83‰, 9·75‰, 12·69‰, 15·62‰) and were provided with a bulk of prey (Group II) and the total amount consumed during the first 25 min, up to 12 hrs and up to 24 hrs were noted so as to roughly estimate the daily ration at different salinities.

3. Results

The satiation time, satiation amount, satiation amount as percentage of predator body weight (wet) and the amount of food consumed per unit time for the different prey fish size groups (feeding at intervals and in bulk) are illustrated in figures 1 and 2. It can be clearly discerned that with the increasing prey fish size there

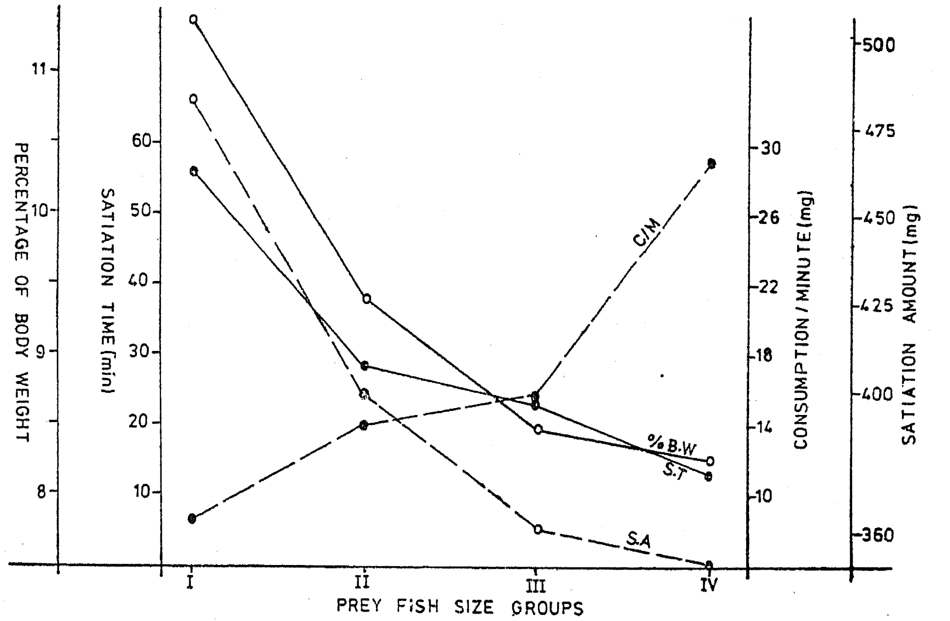

Figure 1. Effect of teleostean prey size on satiation amount, satiation time and consumption per unit time in *Chanda thomassi* when fed at intervals.

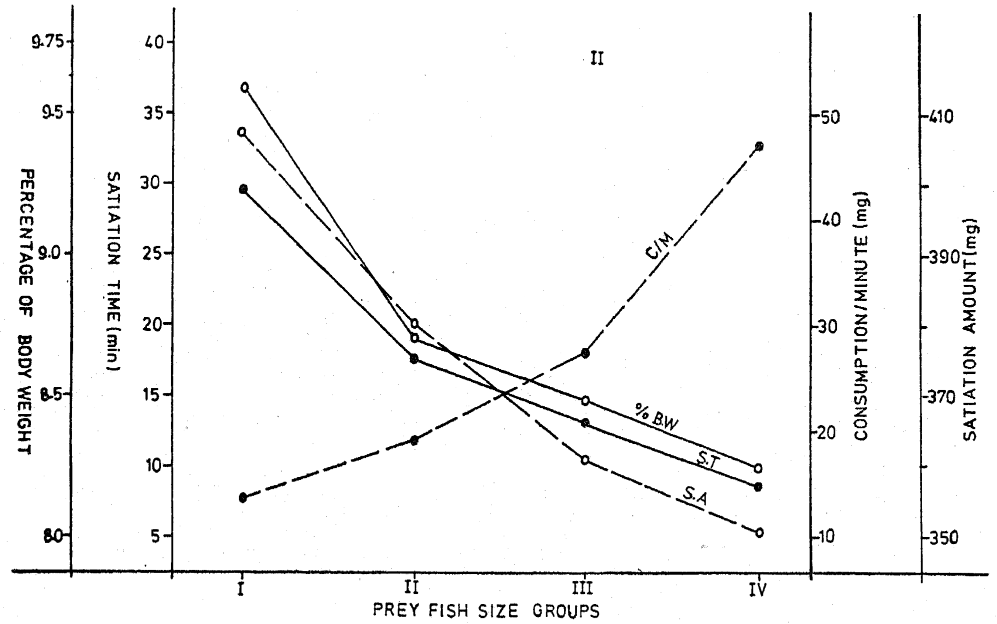

Figure 2. Effect of teleostean prey size on satiation amount, satiation time and consumption per unit time in *C. thomassi* when fed in bulk.

is a decline in satiation time, satiation amount and correspondingly in the amount consumed as percentage body weight whereas the amount of food consumed per unit time shows a steady increase. From the two experiments the satiation time ranges from 27–58 min and satiation amount from 391·2 mg--505·3 mg for group I, 15·0–30·0 min and 342·0–456·0 mg for group II, 10·5–28·0 min and 295·2–393·6 mg for group III and 6·0–20·0 min and 350·8 mg for group IV.

Taking into account only the light phase of the 24 hr day (the fish were found to rest on the bottom individually and not to feed during the night and to reshoal and start feeding at dawn), and the time for 100% stomach evacuation (9 hrs),

Table 1. Effect of teleostean prey size on the daily ration of *C. thomassi* (immature adults) when fed at intervals and in bulk.

At intervals		In bulk	
Prey fish size groups	Daily ration as % wet body weight of predator	Prey fish size groups	Daily ration as % wet body weight of predator
Group I	22·76	Group I	19·18
Group II	18·78	Group II	17·88
Group III	16·98	Group III	16·98
Group IV	16·50	Group IV	16·50

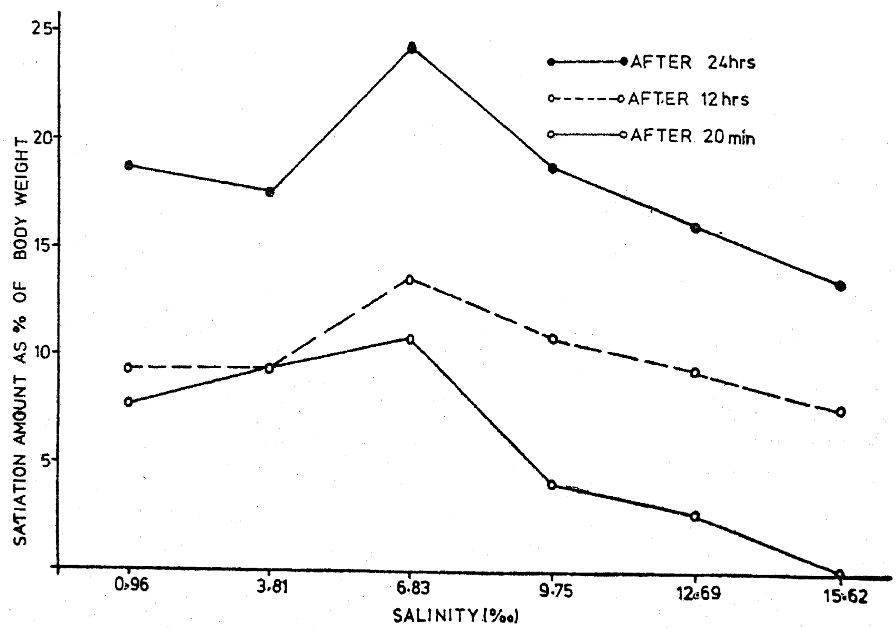

Figure 3. Effect of six non lethal salinities on the food consumption (25 min and 12 hrs) and daily ration of *C. thomassi.*

it was found safe to assume that active feeding is restricted mainly to the dawn and dusk (twice a day). Thus a rough estimate of the daily ration was made as twice the satiation amount and presented as percentage of the predator body weight in table 1.

The satiation amounts for the first 25 min, for 12 hrs and 24 hrs for the six different salinities are shown in figure 3. The highest amount of food intake in 24 hrs is shown to be at 6·83‰ S i.e., 24·14% of the predator body weight, the lowest amount being at 15·62‰ S i.e., 13·41% of the predator body weight. Thus in the 0·9‰–15·62‰ salinity range, a rough daily ration range of 13·41%–24·14% of the predator body weight is seen.

4. Discussion

The results suggest that the satiation time and satiation amount vary considerably with the size of the fish prey. The satiation amount and time are inversely proportional and the amount of food consumed per unit time is directly proportional to the size of the fish prey. It would appear that the appetite of the fish is lost on consuming relatively fewer number of larger fish prey, while the predator could accommodate a much larger number of small fish prey of greater gross size.

An analysis of the available information would indicate that (1) Stretch receptors in the stomach wall constitute one of the mechanisms controlling the appetite of vertebrates (Lepkovsky 1948 ; Paintal 1954). Consequently the size of individual particles would apparently determine the point at which further distention is declined. This will also be checked to some extent by the shape of the individual particles, especially in predators where the prey is swallowed as a whole as in the present study, so as to utilise the maximum space of the total available extended stomach volume. (2) Animals tend to eat to satisfy their energy demand so that the calorific content of the food will also affect the size of daily ration (Rozin and Mayer 1961).

The predator's maximum single intake (satiation amount) of the prey fish fry and juveniles (Groups I and II) decreases when the prey is available in bulk than at regular intervals (483·57 to 407·5 mg and 399·0 to 380·0 mg). Thus the predator may consume more food if the fry and juveniles of the prey fish form scattered groups being available to the predator as individuals at short intervals than when they are in abundance forming large tight-knit shoals.

Thus, it would appear that a 58 min feeding time with feeding at intervals, and 35 min feeding time with feeding in bulk would be quite adequate to satiate *C. thomassi* immature adults at 27 ± 1° C independent of the size of the fish prey. The Jack mackerel (*Trachurus japonicus*) and the rainbow trout (*Salmo gairdneri*) feeding on mackerel meat and 'compound feed' at 25° and 10° C, respectively, required 60 and 65 min to reach satiation, whereas two other species, the puffer (*Fugi vermicularis*) and the file fish (*Stephanolepis cirrhifer*) were satiated within 6 and 13 min respectively, indicating a marked species difference (Ishiwata 1968). Brett (1971) found the satiation time for three different sizes of the sockeye salmon, *Oncorhynchus nerka* varied from 33 to 50 min while feeding on 'Abernathy pellets' (Fowler and Banks 1969) at 15° C, The maximum single intake (satiation amount) for *C. thomassi* (4·250 ± 0·250 g) ranged from 8·25% to 11·38% of the predator wet body weight. Brett (1971) found that the amount of food in a full stomach of the sockeye salmon varied from 3 to 13% among the small fish (3 to 6 g) and from 1 to 5% among the larger fish (150–350 g).

The computed maximum daily intake (daily ration) from the two experiments and for the different salinities shows a range of 16·50 to 22·76% (for different prey size) and 13·51% to 24·14% (for different salinities) of the predator wet body weight at a water temperature of 27 ± 1° C. In terms of single and daily maximum intake the smaller prey fish contributed to the maximum values and *vice versa*. The daily rations of the Cuban predaceous fish from the family Serranidae were 2·41–5·7% of the body weight during the summer at 28 to 29 ° C (Reshetnikov and Popova 1975 ; Reshetnikov *et al* 1975). According to Brett (1971), the total daily intake decreased from 16·9% of dry body weight for the 4 g fish to 4·3% for the 216 g fish (sockeye salmon) when fed on pellets. It is of interest to note that daily rations are highest in young fish during the transition to predation, 9 to 40%, an average of 21·9% of the body weight in new broods of 4 to 5 cms sheat fish, 9·50% in fry 5–7 cms and 7·7% in individuals 7 to 9 cm long (Popova 1978). The transition to a piscivorous feeding habit is during the late juvenile and immature adult stages in glassy perchlets and may be one of the reasons for the high values for daily ration obtained (22·76% and 24·14%) in the present study. Also in the extreme instance of a starving predaceous fish (starving for 2 days prior to feeding during the experiments), the pattern of feeding may lead to degrees of stomach distension that considerably exceed that of the maximum capacity exhibited by the daily particulate feeder. However, these results only give the maximum single and daily intake under laboratory conditions whereas the daily ration and maximum single intake will be different in the natural waters as the intensity of feeding of predaceous fish and their daily ration will change with the seasonal changes in ecological conditions, but it is important that during favourable periods they can attain these or higher values.

The results of the present study thus show the destructive potential this predator has in the form of high values of food intake (piscivorous). At the same time the study also reveals how the size of the prey fish and mode of feeding can be favourably manipulated in captivity to maximise the daily food intake and thereby promote growth in the culture of other predaceous fish.

Acknowledgements

One of us (JRN) is thankful to the Council of Scientific and Industrial Research, Government of India for a Research Fellowship during the tenure of which the present work was carried out.

References

Brett J R 1971 Satiation time, appetite and maximum food intake of sockeye salmon (*Oncorhynchus nerka*) ; *J. Fish. Res. Bd. Canada* **28** 409–415

Brett J R, Shellbourn J E and Shoop C T 1969 Growth rate and body composition of fingerlings sockeye salmon, *Oncorhynchus nerka*, in relation to temperatuie and ration size ; *J. Fish. Res. Bd. Can.* **26** 2363-2394

Brocksen R W, Davis G E and Warren C E 1968 Competition, food consumption and production of sculpins and trouts in laboratory stream communities ; *J. Wildl. Manage.* **32** 51–75

Fowler L G and Banks J L 1969 Tests of vitamin suppliments and formula changes in Abernathy salmon diets, 1966–1967 ; *U.S. Fish. Wildl. Serv. Tech. Pap.* **26** 1–19

Ishiwata N 1968 Ecological studies on the feeding of fishes IV. Satiation curve ; *Bull. Jpn. Soc. Sci. Fish.* **34** 691–693

Lepkovsky S 1948 The physiological basis of voluntary food intake (appetite) ; *Advan. Food Res.* **1** 105–148

Paintal A S 1954 A study of gastric stretch receptors. Their role in the peripheral mechanism of satiation of hunger and thirst ; *J. Physiol.* **126** 271–285

Popova O A 1978 The role of predaceous fish in ecosystems ; in *Ecology of freshwater Fish Production* (ed.) S D Gerking (Oxford : Blackwell Scientific Publications) pp. 215–249

Reshetnikov Yu S and Popova O A 1975 The daily rations and rate of food digestion in tropical fish ; *Sbornik 'Biologiya Shelfa'*, Vladyvostok, 144–145

Reshetnikov Yu S, Sylva A, Claro R and Popova O A 1975 Rates of food digestion in tropical fishes ; *Zool. Zh.* **54** 1506–1514

Rozin P and Mayer J 1961 Regulation of food intake in the gold fish ; *Am. J. Physiol.* **201** 968–974

Swenson W A and Smith L L Jr 1973 Gastric digestion, food consumption, feeding periodicity and food conversion efficiency in Walleye (*Stizostedion vitreum vitreum*) ; *J. Fish. Res. Bd. Canada* **30** 1327–1336

Warren C E, Wales J H, Davis C E and Doudoroff P 1964 Trout production in an experimental stream enriched with sucrose ; *J. Wildl. Manage.* **28** 617–660

Windell J T 1966 Rates of digestion in the blue gill sunfish ; *Invest. Indiana Lakes and Streams* **7** 185–214