PRELIMINARY OBSERVATIONS ON CHINESE CARPS IN INDIA*

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Introduction

Four of the important species of large-sized Chinese carps, extensively utilised for cultivation in ponds, are the grass carp [*Ctenopharyngodon idellus* (C. and V.)], the silver carp [*Hypophthalmichthys molitrix* (C. and V.)], the big head [*Aristichthys nobilis* (Richardson)] and the black carp [*Mylopharyngodon piceus* (Richardson)]. They are native to Chinese rivers, but have been introduced into almost all the south-east Asian countries. Like Indian carps these fishes grow rapidly in ponds but do not breed there. Their natural breeding grounds are in the Chinese rivers where they mature during April-May and breed under flooded conditions during May–June. *Outside* China, these carps have established themselves in the Tone river in Japan where natural breeding to a limited extent takes place every year during June–July. Like Indian carps, they have to be stocked every year in ponds as they only grow there and do not propagate. The seed required for stocking ponds in south-east Asia and elsewhere are now collected every year from Chinese rivers and after rearing in nursery ponds are exported *via* Hongkong.

Introduction of exotic species of fish into a country should be for specific purposes only. In India there is a variety of carps which grow fairly rapidly and which are extensively cultivated in ponds. Some of the Chinese carps are reported to grow very rapidly and one of these, the grass carp, is known for its insatiable appetite for weeds. In order to increase the variety of quick-growing cultivable species of fish and to conduct observations on the use of grass carp for controlling rapid growth of weeds in tropical warm water ponds, experimental consignments of limited number of fingerlings of silver carp and grass carp were introduced into India for the first time in September

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and December 1959 respectively.[1] Details of the consignments received are as in Table I.

TABLE I

Detailed particulars of the first experimental consignment of Chinese carps received at Cuttack in 1959

Date of receipt	Species	Source	No.	Average length (cm.)	Average weight (gm.)	Approximate age	Remarks
1-9-1959	*Hypophthalmichthys molitrix* (Silver carp)	Tone river, Japan	360	5·0	1·4	2 months	Gift consignment from Saitama Prefectural Fisheries Experimental Station, Kazo, Japan.
22-12-1959	*Ctenopharyngodon idellus* (Grass carp)	Hongkong	382	5·5	1·5	5½ months	Fry originally from China

Silver carp fry were produced by artificially fecundating eggs with milt, obtained from spawning specimens collected from the Tone river in Japan, on 29th–30th June, 1959. The hatchlings were reared to fingerling stage in ponds at the Saitama Prefectural Fisheries Experimental Station at Kazo City, Japan, and were transported to Calcutta by air. The grass carp fingerlings obtained from Hongkong came actually from mainland China and were from the 1959 June stock, kept stunted in ponds at Hongkong till December. They were also air-lifted from Hongkong to Calcutta.

OBSERVATIONS AT CUTTACK

Silver carp—Hypophthalmichthys molitrix (*C. and V.*)

The fingerlings were stocked in two 0·1 acre nursery ponds at the rate of 1,800 per acre and were artificially fed daily with a 1 : 1 mixture of mustard oilcake and rice bran. Their growth and survival during the subsequent two months were as in Table II.

[1] A second experimental consignment of 956 grass carp fingerlings, 4–5 cm. in length, was obtained at Cuttack from Hongkong on 21st January 1962 and these are being reared in ponds at the Killa fish farm, Cuttack.

TABLE II

Early growth of silver carp fingerlings in ponds at Cuttack—1959

Date	Pond No. 1				
	Length in cm.		Average weight (gm.)	No. survived	Total weight (Kg.)
	Range	Average			
1—9-1959	4·4- 5·5	5·0	1·4	180	0·25
15—9-1959	7·4- 9·3	8·5	7·0	..	..
1-10-1959	13·0-15·2	14·2	35·2	..	..
15-10-1959	15·1-19·0	16·0	54·0	..	..
1-11-1959	17·9-26·9	19·4	81·0	142	11·50

Date	Pond No. 2				
	Length in cm.		Average weight (gm.)	No. survived	Total weight (Kg.)
	Range	Average			
1—9-1959	4·4- 5·5	5·0	1·4	180	0·25
15—9-1959	7·0- 9·5	8·0	6·7	..	..
1-10-1959	11·0-17·5	12·0	17·5	..	..
15-10-1959	12·6-22·6	14·2	39·5	..	..
1-11-1959	13·4-28·6	16·2	55·0	118	6·49

Survival in both the ponds together has been just over 72% during the period. The average daily growth ranged from 1·83 to 2·36 mm. in length and 0·9 to 1·3 gm. in weight and this can be considered quite satisfactory when compared with the early growth of Indian major carps. The weight of fish produced works out to 65 to 115 Kg. per acre for the 2 months' period or from 390 to 690 Kg. per acre per annum (recalculated).

At the end of the 2 months' period in nurseries the fish were transferred to rearing ponds at the rate of 650 per acre. The stock was thinned out to 550 per acre after one month. At the end of 2 months 95% of the stock survived and they attained an average length of 20 to 22·3 cm. and weighed 82 to 120 gm. each. A few of the larger ones had by then grown to about 40 cm. weighing 730 to 790 gm.

An experiment of about 4 months' duration was carried out in three nursery ponds, each 0·1 acre in area, to find out the growth of silver carp as compared with that of catla. The ponds were manured uniformly. Stocking rate was 1,000 per acre and fish of comparable size and weight were stocked in the 3 ponds as follows:

Pond 1.—Silver carp alone—100 only; 7·7 Kg.

Pond 2.—Catla alone—100 only; 7·5 Kg.

Pond 3.—Silver carp and catla; 50 of each; 7·5 Kg.

Survival at the end of 4 months was as follows:

Pond 1.—Silver carp—99%.

Pond 2.—Catla—78%.

Pond 3.—Silver carp—100%.
Catla 94%.

Survival of silver carp in this experiment was higher than that of catla. Increase in length and weight during the period of the experiment was as in Table III.

The above field experiment clearly demonstrates that growth of silver carp is faster than that of catla, under comparable conditions. Starting from almost the same initial average weight the increase in weight during a period of 3 months was:

Silver carp—191 to 236%.

Catla—47 to 139%.

At the end of 3 months when the stock was thinned out to half in the case of silver carp and to about a third in the case of catla, the increase in growth during the next month was: Silver carp = 65% and Catla = 41% (in spite of the greater thinnning in catla).

In the pond in which silver carp and catla were stocked together, the production was less than that in the pond with silver carp alone and a little over that in the pond with catla along. Though the production by silver carps alone in this pond was over double that of Catla, the mutual presence of these two species in the same pond seems to affect the growth of either adversely. Similarity in feeding habits of the two species will explain this to some extent, besides individual variations in the productivity of ponds. Silver carp is reported to be a predominantly phytoplankton feeder.

TABLE III

Growth of silver carp and catla fingerlings in nursery ponds at Cuttack during 1960

Pond No.	Species	Date of sampling	Length (cm.)		Average weight (gm.)	Total weight (Kg.)	Remarks
			Range	Average			
1	Silver carp alone	6–1–1960	15·9–24·1	20·1	77·2	7·7	
	(*H. molitrix*)	6–2–1960	17·7–26·5	23·2	132·0	13·1	
		7–3–1960	20·1–30·2	27·2	219·0	21·7	
		6–4–1960	20·7–32·7	28·7	257·0	25·5	Stock thinned out to half
		6–5–1960	30·0–37·0	33·2	424·0	20·8	
2	Catla alone	6–1–1960	13·5–26·6	17·7	74·9	7·5	
	(*C. catla*)	6–2–1960	14·5–27·8	19·7	104·6	8·2	Allowing for mortality
		7–3–1960	15·7–27·2	21·6	125·4	9·8	
		6–4–1960	17·4–32·2	22·5	179·0	14·0	Stock thinned out to one-third
		6–5–1960	22·7–30·7	26·4	253·2	7·1	
3	Silver-carp	6–1–1960	14·8–24·0	19·5	74·9	3·75	
	(*H. molitrix*)	6–2–1960	18–4–28·0	22·9	127·4	6·37	
		7–3–1960	19·9–31·0	25·4	169·1	8·45	
		6–4–1960	22·8–32·9	28·3	218·0	10·9	Stock thinned out to half
		6–5–1960	22·9–34·9	29·8	270·0	6·75	
	Catla (*C. catla*)	6–1–1960	13·7–26·0	17·7	74·9	3·75	
		6–2–1960	15·2–27·8	19·5	91·8	4·3	
		7–3–1960	17·0–27·9	20·4	106·0	5·0	
		6–4–1960	17·1–28·0	21·1	110·4	5·2	Stock thinned out to half
		6–5–1960	18·8–24·3	21·6	131·5	2·9	

Fish production in the above ponds for the period of 4 months under observation amounted to as follows:

	Actual weight harvested (Kg.)	Production per acre (Kg.)	Production (Kg./ha./yr.)
	1	2	3
Silver carps alone ..	33·6	336	2520
Catla alone ..	15·93	159	1193
Silver carp + Catla in equal number	17·7	177	1328

Fish weighing just over 400 gm. each, when released in a 0·2 acre pond at the rate of 100 per acre and were regularly fed with a 50: 50 mixture of mustard oilcake and rice bran the following growth was observed during the course of $3\frac{1}{2}$ months (Table IV).

TABLE IV

Growth of yearling silver carp in ponds at Cuttack during 1960

Date	Length (cm.)		Average weight (gm.)	Average monthly increase in weight (gm.)	Total weight of stock (Kg.)
	Range	Average			
15–5–1960	30·3–36·1	33·6	411	..	8·2
4–6–1960	33·9–39·7	37·1	673	262	13·5
4–7–1960	41·5–45·1	42·9	1105	432	22·1
4–8–1960	46·0–50·6	48·2	1560	455	31·2
5–9–1960	51·9–53·9	53·2	2043	483	40·8

Survival during the period was 100 per cent. and from the initial average weight of 0·4 Kg. the fish attained an average weight of 2·04 Kg. when they were just 14 months old. Average daily increase in weight during the period

f 112 days was 14·5 gm. The maximum increase of 483 gm. during ugust–September represents an average daily increase of 15·5 gm. in weight. roduction during the period worked out to 1341 Kg./ha./yr.

Released in large stocking ponds the fish grew rapidly and by July 1961 hen they were only just 2 years old, the average size attained was 66 cm. nd 4·7 Kg. The largest specimen then measured 74 cm. in length and ·5 Kg. in weight (Photo 1). These represent, for the two years' period, a ery satisfactory daily average growth of 6·4 to 9·0 gm. per fish.

ttainment of Sexual Maturity

By the end of February 1961 when the fish were 20 months old, genital rgans in both the sexes were found in the early developing stage. A female pecimen 67·6 cm. long and weighing 3·7 Kg. had the ovaries in the advanced ird stage with a few ova clearly visible to the naked eye. A male specimen ·8 cm. long and 2·9 Kg. in weight had the testes in the advanced third age, appearing whitish. The outer surface of the pectoral fins in the male as rough to touch as described by Tang (1954). A similar condition in e major Indian carps, Catla, Rohu and Mrigal, has been described by haudhuri (1959).

Towards the end of March 1961 about 50% of the specimens were found have developed roughness on the external side of the pectoral fin but none them was oozing milt. However, by mid-April the males started oozing ilt on slight pressure on the abdomen and some of the female specimens ere also found in fairly advanced stage of maturity. Towards the end of ay, specimens of both the sexes were fully ripe. The smallest mature male served in May 1961 was 54·3 cm. long and weighed only 1·87 Kg. One the smallest females then found in ripe condition was 54·6 cm. long and eighed 2·38 Kg. These specimens were then only 23 months old after tching. In ponds in India therefore *H. molitrix* attains sexual maturity ien it is only about 2 years old. Minimum size at maturity observed in dia is thus about 54 cm., weighing 1·8 to 2·4 Kg.

Grass Carp: Ctenopharyngodon idellus (*C. and V.*)

The fingerlings were stocked in two 0·1 acre nursery ponds at the rate 2,000 and 1,800 respectively per acre. Details of their growth in these nds for the next 4½ months are given in Table V.

Compared to silver carps survival in this case during the first 4½ months s poor, being only 25 to 32 per cent. The average length of 17·2 to 20·5 cm,

attained during the above period indicates a daily average growth of 0·9 to 1·1 mm. Growth is not unsatisfactory but the relatively poor survival was probably the result of a fairly widespread infection by *Lernaca* which continued for about 2 months.

TABLE V

Early growth of grass carp fingerlings in nursery ponds at Killa, Cuttack, during 1960

Date	Pond No. 1				
	Length in cm.		Average weight (gm.)	No. survived	Total weight (Kg.)
	Range	Average			
22-12-1959	4·5– 6·9	5·5	1·5	..	0·31
6—1-1960	4·5– 7·1	5·8	2·1	151/200	..
6—2-1960	..	..	..	..	..
7—3-1960	6·8–12·8	9·7	11·3	..	..
7—4-1960	11·0–19·4	13·9	32·0	..	..
7—5-1960	12·5–26·6	17·2	58·4	51/200	2·98

Date	Pond No. 2				
	Length in cm.		Average weight (gm.)	No. survived	Total weight (Kg.)
	Range	Average			
22-12-1959	4·5– 6·9	5·5	1·5	..	0·27
6—1-1960	4·8– 7·2	5·9	2·0	141/180	..
6—2-1960	..	..	..	..	..
7—3-1960	7·6–12·2	10·3	12·0	..	..
7—4-1960	13·9–18·5	16·3	42·0	..	..
7—5-1960	16·8–24·7	20·5	107·5	57/180	6·13

Released in larger rearing ponds the fishes attained an average weight of 0·28 Kg. by the beginning of September. However, in ponds with natural growth of aquatic weeds the fishes showed much better growth, extensively utilising the weeds as food and thereby checking the abundance of weeds in ponds.

Experiments on Control of Weeds

Some preliminary experiments were therefore carried out, to find out whether grass carps could be utilised for effectively checking and eradicating weeds from fish ponds. Details of observations made are given below:

Pond No. 1—(*Nursery No.* 26).—Area 0·1 acre.

Hydrilla growing in fair abundance all over the pond.

20*th July* 1960.—5 grass carps of average length 26·5 cm., and average weight 215 gm., were released (50 fish/10·7 Kg. per acre).

20*th August* 1960.—Weeds still in fair abundance; no appreciable check on growth. Fishes had during the months grown to an average length of 37·8 cm. and weighed 777 gm. each. This represents an average daily increase in length by 3·6 mm. and in weight by 18·1 gm.

7 more fish were introduced, making a total of 12 (120 per acre), in all weighing 7·1 Kg. (average length—35·2 cm.; average weight—596 gm. 71 Kg./acre) in order to control the weeds more effectively.

9*th September* 1960.—Practically no *Hydrilla* left in the pond; a few clumps of *Lagarosiphon* present; water having an algal bloom; pond can be easily drag-netted.

Ten specimens of grass carp recovered averaged as follows:

Length—40·3 cm.; weight—837 gm.; average daily growth: in length—2·5 mm;. in weight—12 gm.

Thus, at 120 fish per acre (weighing 71·0 Kg.) fairly thick growth of *Hydrilla* was checked and eradicated by grass carps within a period of 3 weeks.

Pond No. 2 (*Nursery No.* 3).—Area—0·1 acre.

Abundant growth of *Hydrilla* choking the water; a few patches of *Lagarosiphon* present as also marginal weeds. Pond cannot be drag-netted without removing weeds.

4*th August* 1960.—15 grass carp; average length—24·4 cm.; average weight—210 gm.; were released in the pond (fish—150/31·5 Kg./acre).

5*th September* 1960.—Weeds, particularly *Hydrilla*, almost completely cleared; a few clumps of *Lagarosiphon* and marginal weeds remaining. The

pond could be easily drag-netted. All the 15 specimens of grass carp were recovered by netting. They measured as follows:

Average length—37·5 cm.; average weight—770 gm.; average daily increase in length—4·1 mm.; weight—17·5 gm.

Thus, at 150 fish per acre (weighing 31·5 Kg.) thick growth of *Hydrilla* choking the water was checked and eradicated by grass carp in the course of a month. Within a week of releasing the fish into the pond a noticeable check on the extent of choking by weeds was evident. Every day numerous cut bits of *Hydrilla* floating on the water surface could be seen, indicating active feeding by the fish. It was interesting to observe that as long as *Hydrilla* was present in the pond, clumps of *Lagarosiphon* were being left undisturbed by the fish. This was observed in pond No. 1 also and probably indicates a greater preference to *Hydrilla*.

In ponds with weeds the growth of grass carps was excellent. The total increase in weight of the 15 fish stocked in this poud was 18·5 lb. or 8·4 Kg., during one month. This works out to a production rate of 2,520 Kg./ha./yr.

Pond No. 3 (*Nursery No.* 4):—Area 0·1 acre.

Fair growth of *Hydrilla* all over the pond; several clumps of *Naias* also present.

Four grass carps; average length—23·1 cm.; average weight—134·7 gm. were released on 20th July 1960 (40 fish/5·4 Kg./acre).

By the 20th August 1960, within 30 days, all the *Hydrilla* in the pond had been utilised by the fish. The few clumps of *Naias* were left but they were not expanding or growing. The pond was easily drag-netted and the four fishes measured as follows:

Average length—34·8 cm.; average weight—560·5 gm. This represents an average *daily* increase in length by 3·8 mm. and in weight by 13·8 gm.

The rate of stocking here was only 40 fish/5·4 Kg./acre and they could effectively control and eradicate the relatively sparse growth of *Hydrilla* within a month. As in the other two ponds, growth during the period was excellent. Several other ponds with more or less growth of weeds could be similarly cleared by introducing grass carp at rates varying from 20 to 40 per acre, in the course of 4 to 8 weeks. The cleared ponds almost invariably develop an algal bloom.

When released in ponds without natural growth of weeds the growth of grass carp was relatively poor. To keep the fish in condition and allow them to grow satisfactorily weeds like *Hydrilla, Lemna, Azolla,* etc., were collected from other ponds and regularly introduced into the ponds where grass carps were kept. Stocked at the rate of 50–60 fish/70–90 Kg. per acre they were capable of utilising duck weeds at the rate of approximately 4 lb. per fish per day. By regular feeding with weeds the fish could be kept in good condition (Photo 3).

By July 1961 when they were in the Killa farm for about 19 months they had attained an average length of 60 cm. and weighed about 2·7 Kg. (Photo 2). There is reason to believe that better growth could have been obtained if the specimens were regularly kept on a diet of aquatic weeds.

The preliminary observations recorded in the present paper clearly indicate that the grass carp in appropriate number might be effective in controlling rank growth of at least some of the common aquatic weeds.

Attainment of Sexual Maturity

By the fourth week of March, 1961 when the fish were 15 months only in the farm stray specimens were found oozing milt on pressure; indicating that specimens under 2 years of age attain maturity in ponds. Slight roughness on the outer surface of the pectoral fins was observed in such oozing males. By May 1961 more oozing males were seen and roughness of the pectoral fins was also marked in them. By June 1961 males ranging from 53·5 to 62·3 cm. in total length and weighing 1·8 to 2·6 Kg. were fully ripe and oozing on gentle pressure. Females of the same age in the same ponds were however not sexually ripe.

Discussion

The paper records the first instance of introduction of Chinese carps into India. The main object of the present studies has been to assess how these exotic species respond to and thrive in the new environment. The cultural qualities of these carps, *vis-a-vis* Indian carps have also to be carefully assessed under regular field conditions before they are freely introduced for general caltivation in the country.

In China, fry hatched in April may generally reach a weight of about 450 gm. (length 25 cm.) at the end of the year, while in the second year it reaches a weight of 2 to 3 Kg. and a length of 60 cm. (Lin, quoted by Hofstede, 1952). According to Gidumal (1958) under normal healthy conditions in

China grass carp that hatch in April–May reach 10 inches (25·5 cm.) in length and 1·5 lb. (0·68 Kg.) in weight in one year; at the end of the second year they may weigh 4–5 lb. (1·8–2·3 Kg.) and a mature grass carp, 4 years old, will be over 10 lb. (4·5 Kg.). Lin (1949) states that in fish ponds in Hongkong, grass carp, at stocking rates ranging from 200 to 500 per acre, attains the following size:

	1st year	2nd year	3rd year	4th year
Length (cm.) ..	2·5–8·0	30–38	61	127·5
Weight (Kg.) ..	0·17	1·23	2·4–3·04	4·22–6·04

According to Hickling (1960) grass carp stocked at an average weight of 2 gm. and a density of 280 per acre (survival only 185 per acre) at Malacca attained an average weight of 3·31 Kg. in 267 days. The actual production in this case works out to approximately 2,092 Kg./ha./year and the average daily growth per fish was just over 11 gm. In another pond stocked at 206 per acre (survival 56%, *i.e.*, effective rate of stocking—115/acre) the fish attained an average size of 65·1 cm./4·24 Kg. in 413 days, representing an average daily growth of about 10 gm. and production of the order of about 1,077 Kg./ha./year. Heavy feeding with napier grass was done to obtain the above growth and yield. Approximately 48 lb. (21·8 Kg.) of napier grass were consumed for production of 1 lb. (0·45 Kg.) of fish flesh, in excess of maintenance requirements. Ilan and Sarig (1952) have recorded annual production ranging from 3,500 to 5,000 Kg. per ha. in ponds in Malaya, stocked with a combination of grass carp, big head, silver carp and common carp at a total density of about 3,500 per ha. These ponds are intensely fertilized with organic manures and the grass carp are also artificially fed. In ponds in Israel, grass carp stocked at the relatively low rate of 130–160 per acre attained an average weight of 3·08 to 4·42 Kg. in the course of 21 months when the fish were about 30 months old (Yashouv, 1957). The daily average growth during this period ranged from 3 to 10 gm.

Though the conditions under which the fish were grown are quite different and may not be strictly comparable the average growth reported from different countries may be summarised as in Table VI.

It would thus appear that grass carp could tolerate a wide range of habitats and grow well if adequate feed is given. Its feeding habits would

TABLE VI

Size attained by and average growth of Chinese grass carp (C. idellus) *in various countries*

Country	Age of fish (year)	Rate of stocking (per ha.)	Average size attained		Average daily growth (gm.)	Remarks
			Length (cm.)	Weight (Kg.)		
China ..	2	..	..	1·8–2·3	2·4–3·1	Gidumal, 1958
	3	2000	..	4·0	3·6	Lin, 1949
Hongkong	2	500–1250	30·0–38·0	1·23	1·7	Lin, 1949
Malaya ..	1	1300	..	1·8	5·0	Ilan and Sarig, 1952
	0·75–1·1	500–700	65·8	3·3–4·24	10·2–12·0	Hicling, 1960
Israel ..	2·5	325–400	..	3·0–4·4	4·0–5·6	Yashouv, 1957
India ..	1·6	300–500	600	2·7	4·7	..
Thailand ..	1	857	..	3·0	8·0	Ilan and Sarig, 1952
Singapore ..	3	200	..	15·0	13·7	do.

not conflict with those of Indian carps and it is to be experimentally demonstrated if it would enhance production in ponds in India when stocked with Indian carps. The relatively earlier attainment of maturity in males in ponds at Cuttack indicates that females are also likely to mature in ponds. Inducing breeding of the species by administering pituitary hormones would then be tried and this would appear, at present, to be the only means by which seed supply to south-east Asian countires could be made dependable and economical.*

Even the few observations recorded in this paper indicate that natural growth of several of the submerged, obnoxious aquatic weeds could be easily controlled by introducing grass carp. Depending on the size of the pond, intensity of weed infestation and the size of fish available for stocking, the number to be introduced has to be adjusted. In Japanese farm ponds with heavy infestation of submerged weeds Kuronuma and Nakamura (1957)

* Three years old grass carp and silver carp have matured in ponds at Cuttack and were successfully bred by administering pituitary hormone injections (*vide Curr. Sci.*, 32, 103–106, 1963).

found grass carp at 30 specimens/35 Kg. per hectare curbing the growth of weeds within one year. Observations at Cuttack have shown that complete eradication of weeds is possible in the course of 4–6 weeks at higher rates of stocking.

Detailed observations on the growth of silver carp in ponds under different densities of stocking has already been given. The available data on age and size correlated with the date of stocking are summarised in Table VII.

TABLE VII

Age and size of silver carp, Hypophthalmichthys molitrix, *in ponds at Cuttack*

Age (Days after hatching)	No. examined	Length (cm.)			Weight (Kg.)			Remarks
		Minimum	Maximum	Average	Minimum	Maximum	Average	
65	30	4·4	5·6	5·0	..	..	0·004	
79	60	7·0–7·4	9·3–9·5	8·0–8·5	.. ..	.. ..	0·0067–0·0070	From two ponds, 1800/acre
95	60	11·0–13·0	12·8–15·2	11·8–14·2	..	..	0·0175–0·0352	,,
109	60	12·6–15·1	15·2–19·0	13·6–16·9	..	..	0·033–0·054	,,
127	60	13·4–14·8	19·2–21·1	15·4–19·2	..	..	0·038–0·074	,,
142	59	15·3–15·9	21·8–24·1	18·8–20·3	..	..	0·079–0·100	From two ponds, 650/acre
157	60	16·3–17·7	23·7–25·9	20·0–22·0	..	..	0·078–0·105	,,
187	60	15·8–17·3	24·0–27·6	20·0–22·3	..	..	0·082–0·082	,,
219	30	24·8	31·5	27·5	..	..	0·224	500/acre
246	30	26·7	33·9	29·7	..	..	0·320	,,

TABLE VII—(*Continued*)

Age (Days after hatching)	No. examined	Length (cm.)			Weight (Kg.)			Remarks
		Minimum	Maximum	Average	Minimum	Maximum	Average	
277	39	32·6	43·1	38·3	..	..	0·700	Stocking 100/acre only
277	20	30·5	37·2	34·0	..	..	0·436	Stocking 500/acre
308	30	33·2	40·0	37·1	..	..	0·552	,,
338	30	36·5	44·5	39·3	..	..	0·678	,,
370	25	34·8	48·0	40·5	..	..	0·702	,,
370	20	41·5	45·1	42·9	0·936	1·249	1·105	Stocking 100/acre
386	19	47·2	58·5	51·6	1·022	2·497	1·702	Killa channel, low stocking. 100/acre
402	21	46·0	50·6	48·2	1·334	1·730	1·560	
450	49	49·0	64·1	57·7	1·533	3·292	2·464	Channel, low stocking
462	47	34·0	50·5	45·7	0·340	1·760	1·136	500/acre
472	6	55·6	59·0	57·8	2·611	2·951	2·752	100/acre
496	6	58·3	60·3	59·2	2·866	3·292	3·066	,,
520	56	53·8	70·0	62·1	1·872	4·256	2·979	Channels, low stocking

Growth is quite rapid even considering the relatively low rate of stocking. The actual weight of silver carp, 32–52 cm. long, furnished by Chow (1958) for brackish water ponds of Hongkong compares as in Table VIII with corresponding size fish reared in freshwater ponds at Cuttack.

TABLE VIII

Length and weight of silver carp in ponds in Hongkong and India

Total length in cm.	Hongkong		India (Cuttack)	
	No. examined	Average weight (gm.)	No. examined	Average weight (gm.)
32	1	305	..	..
33	12	369	..	..
34	29	383	20	436
35	42	413	..	..
36	50	465	..	..
37	24	470	30	552
38	26	566	39	700
39	24	560	30	678
40	28	643	..	..
41	21	643	25	702
42	15	697	..	..
43	11	749	20	1105
44	12	804	..	..
45	7	1006	..	..
46	4	916	47	1136
47	3	1160	..	..
48	3	1250	21	1560
49	12	1338	..	..
50	3	1375	..	..
51	3	1559	..	..
52	3	1642	19	1702

Thus, for the given size, fish at Cuttack weigh heavier than at Hongkong and could therefore be considered as normal and healthy.

H. molitrix is a predominantly phytoplankton feeder. It compares with *C. catla* which is a predominantly zooplankton feeder as follows:

Species		Total length (cm.)	Weight (gm.)	Length of gut (cm.)	Gut length / Total length	No. of gill rakers
C. catla	1.	49·8	1850	290·0	5·8	252
	2.	51·4	1900	282·0	5·5	260
H. molitrix	1.	52·9	1800	446·0	8·4	numerous
	2.	55·4	1950	432·0	7·8	

Inaba and Nomura (1956) found the length of gut in silver carp, 5·2 to 36·7 cm. long, increasing with length, from 3·0 to 7·8 times the total length. They have also described the specialised structure of the gill rakers adapted to micro-plankton feeding and have also found phyto-plankton predominant in the gut contents. Though both catla and silver carp are plankton feeders differences in feeding habits are structurally indicated. Analysis of gut contents also confirm such differences. A detailed study of the food consumed by these two carps when reared together in the same pond has been initiated to ascertain how far they mutually compete for food. Observations so far made indicate faster growth of *H. molitrix* than in *C. catla*. For the table also the former is preferred to catla as it is relatively less bony and more tasty. Though further detailed observations are necessary before a decision is taken about large-scale introduction of *H. molitrix* for cultivation in ponds in India, the observations recorded in this paper tend to show that it would be a very desirable addition to augment production in ponds.

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EXPLANATION OF PLATE X

PHOTO 1. Three years old silver carp, *H. molitrix*, weighing over 7·0 Kg.

PHOTO 2. Three years old grass carp, *C. idellus*, weighing about 6·6 Kg.

PHOTO 3. Weighed quantities of aquatic weeds being transported to the Killa farm for feeding grass carp in experimental ponds.