Control Of Aquatic Weeds By The White Amur In Rajasthan, India

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INTRODUCTION

Herbivorous fish are being used in many countries for aquatic weed control and production of high quality protein food. Many herbivorous species of fish have been tried for aquatic weed control, but the most suitable appears to be the white amur (*Ctenopharyngodon idella* Val.). This fish is recommended by the Central Inland Fisheries Research Institute, Barrackpur, India as the most effective biological control of submersed weeds under Indian conditions.

Experiments on efficacy of the white amur for controlling aquatic weeds have been conducted in India at the Cuttack Substation in fish ponds and laboratory conditions (7). At this station, workers were also successful in artificially spawning the fish. In other countries, work is being done on artificial spawning, weed consumption, and growth rate of the white amur. The growth rate of the white amur feeding on hydrilla (*Hydrilla verticillata* Casp.), Southern naiad (*Najas guadalupensis* (Spreng. Magnus), waterhyacinth (*Eichhornia crassipes* (Mart.) Solms), and common duckweed (*Lemma minor* L.) has been determined (3). In this study it was found that white amur gained more weight while consuming Southern naiad and hydrilla than while being fed two commercial preparations of dried fish food. Growth rates of 3.2 to 13.5 g/day were obtained in pools containing submersed plants. Cross (4) compiled a list of aquatic plants eaten by white amur in order of preference. In his studies consumption of *Chara* sp. was higher than most of the other plants. Avault (1) studied the feeding habit of the white amur in small pools which were planted with twelve aquatic plants. The fish preferred filamentous algae, then soft, succulent needlerush (*Eleocharis acicularis* (L.) R & S), water threat pondweed (*Potamogeton diversifolius* Raf.), Southern naiad, and waterweed (*Elodea densa* Planch.). Waterhyacinth was the least preferred in this study. Avault (2) obtained excellent control of chara, waterthreat pondweed, succulent needlerush, and *Rhizoclonium* sp. in 1 to 3 months with 25 to 40 cm white amur stocked at the rate of 49, 74, and 99 per ha. Stott and Orr (8) estimated the conversion rate of aquatic weeds (wet weight) to fish flesh by the white amur to be about 224:1. Verigin *et al* (9) studied food selectivity and daily ration of white amur. He classified sago pondweed (*Potamogeton pectinatus* L.), coontail (*Ceratophyllum demersum* L.),elodea (*Elodea canadensis* Michx.), and star duckweed (*Lemna trisculca* L.) as most preferred, and eelgrass (*Vallisneria spiralis*) and watermilfoil (*Myriophyllum* sp.) as average. Krupauer (6) fed 104 species of plants including terrestrial and crop plants; of these plants, 72

species were eaten very intensively, including needlerush. broadleaf cattail (*Typha latifolia* L. and giant reed (*Phragmites communis* Trin.). Hora and Pillay (5) found that the white amur begins feeding on small aquatic plants such as common duckweed when the fish are 2 to 5 cm long.

In order to solve aquatic weed problems in the Chambal Commanded Area, Kota, Rajasthan, some experiments were conducted (1) to determine the order of preference of aquatic weeds by the white amur, (2) to observe the effectiveness of the control, (3) to determine the quantity of weeds consumed per day, and (4) to determine the ratio between body weight and plant consumption.

METHODS AND MATERIALS

In August 1970, 680 fingerlings were received from Cuttack and reared by the Fisheries Department, Kota, until they attained a size of about 15 cm. From these fish, 20 were placed in each of four nursery ponds, 14 m by 7 m at Kaithoon, which were infested with aquatic weeds. Fish in these ponds attained about 200 g after 2 months while the rest of the fish, which were in the original pond, were about 50 g in weight. Fish from these ponds were then used in the individual experiments.

Experiment 1

During December 1970, at the Kaithoon fish farm, five fish (average weight of 200 g) were placed in each of six partly submersed hapas (Figure 1). The hapa dimensions were 2 m by 2 m by 2 m. Weighed quantities of sago pondweed, American pondweed (*P. nodosus* Poir.) *P. perfoliatus*, eelgrass, *Najas joveolata* and hydrilla were placed in each hapa after tying each with yarn. The consumption of weeds was noted every 48 hours. This experiment was conducted for 26 days. In March 1971, another experiment was done in the same way for 24 days using fish of an average initial weight of 65 g, but this time only one species of plant was placed in a hapa. In this feeding trial seven hapas were used.

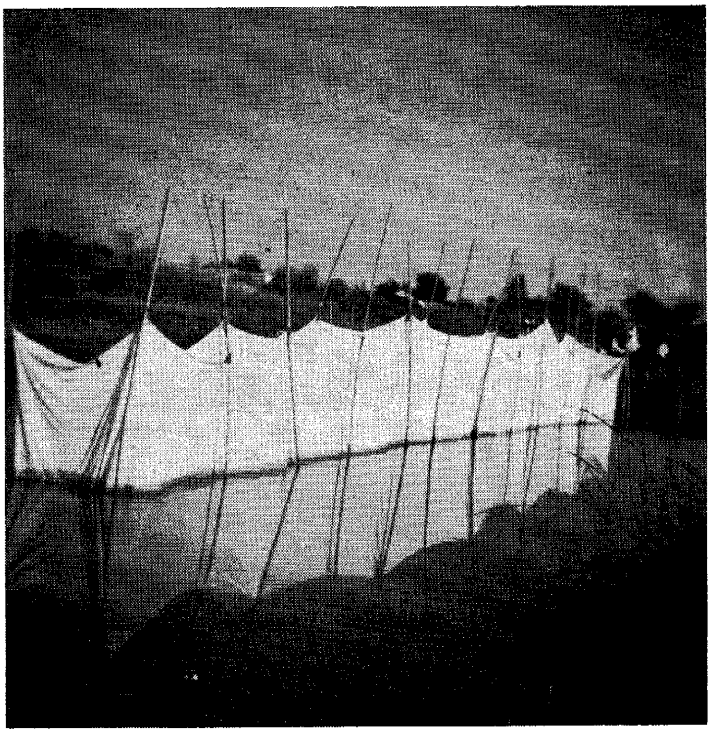

Figure 1.—Hapas, in which experiments 1 and 2 were conducted.

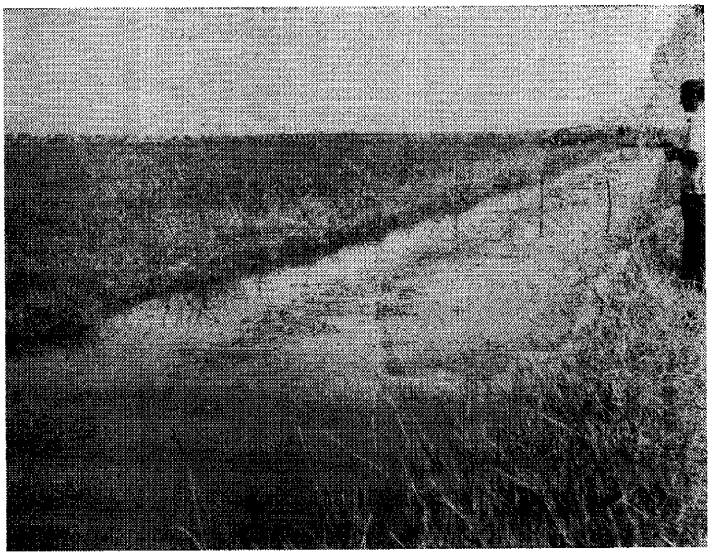

Figure 2 a—Motipura minor Number 1 infested with American pondweed before release of the white amur.

Experiment 2

In Motipura minor[1] which was heavily infested with American pondweed (40%), eelgrass (40%), and *N. foveolata* and other aquatic weeds (20%), 50 fish (20 of an average weight of 250 g and 30 of an average of 50 g) were placed in a 200 m² area on January 22, 1971. Metal nets (1.3 cm mesh) were placed on both sides of the area to contain the fish (Figure 2). The amount of weeds at that time was 577 g fresh weight m². Since after 20 days no control was evident, though some of the leaves of American pondweed were consumed, 70 additional fish (average weight of 55 g) were released. In March 1971, the metal nets and fish were moved to another 200 sq m area. The density of weeds in this location was 1425 g fresh weight/sq m.

Experiment 3

In Borkhandi minor,[2] 46 fish (average initial weight of 16 was 325 g and 30 of 80 g were released in a 61 m² area. This minor was heavily choked with *Chara* sp. 2100 g fresh weight m². This experiment was repeated with 100 fish of an average initial weight of 50 g placed in an 180 m² area.

Experiment 4

In Chandesel minor,[3] which was infested with hydrilla, *N. foveolata* sago pondwood, *P. perfoliatus*, and eelgrass, 94 fish of an average weight of 256 g were placed in a 200 m² area during the month of May, 1971.

[1]A tributary of Right Main canal with dimensions of approximately 4 m wide by 1 m deep.

[2]A tributary of Right Main canal with dimensions 1 m wide by 0.2 m deep.

[3]A tributary of the same canal with dimensions of 2.5 m wide by 0.75 m deep.

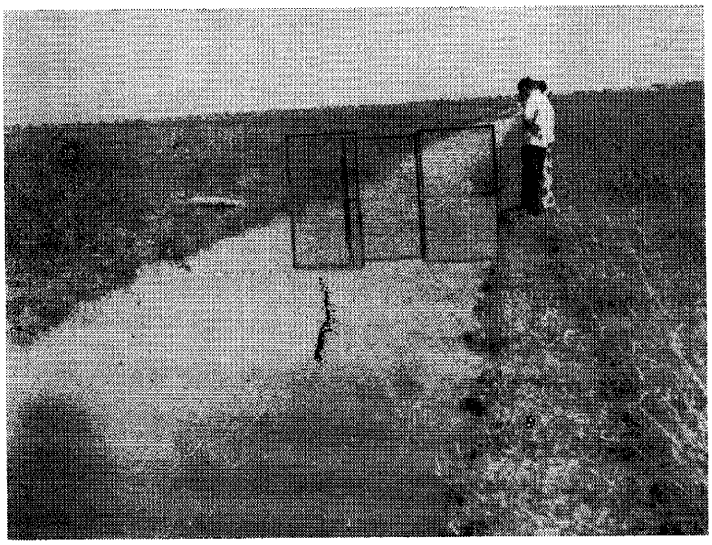

Figure 2 b.—The same area after 12 days.

Some of the experiments were conducted in weed free areas of Chandesel and Borkhandi minors to determine the ratio between body weight and consumption of different weeds. For these experiments, weighed amounts of weeds were given for certain periods. Table 1 shows the locality, number of fish used, average initial weight of the fish, consumption of food per day and the ratio between body weight and food consumption.

RESULTS AND DISCUSSION

Experiment 1

Table 2 shows the consumption of six species of weeds by 200 g fish. During this feeding period, the average daily consumption of one fish was 40.7 g. The order of preference of these six aquatic plants is given in Table 3. The fish preferred sago pondweed while the least preferred was *P. perfoliatus* and hydrilla.

Table 4 shows that the order of food preference by small fish is different that for large fish. Small fish preferred filamentous algae, *Chara* sp., *N. foveolata,* and eelgrass. At this stage of growth, the fish did not readily consume hydrilla, sago pondweed, *P. perfoliatus,* or American pondweed.

TABLE 2. CONSUMPTION OF AQUATIC WEEDS BY FIVE WHITE AMUR IN HAPAS.

Date (1970 to 1971)	Amount consumed (g)[a]
December 26	83 ± 27
December 28	334 ± 181
December 30	301 ± 191
January 1	431 ± 334
January 3	504 ± 349
January 5	361 ± 144
January 7	351 ± 65
January 9	242 ± 18
January 11	337 ± 61
January 13	325 ± 89
January 15	337 ± 85
January 17	458 ± 92
January 19	488 ± 67

[a]Total fresh weight of six aquatic plants. Each value is the mean of six hapas. The standard deviation follows each mean.

Experiment 2

At Motipura minor-1, 12 days after releating 70 fish, no leaves of American pondweed, sago pondweed, or *N. foveolata* could be found. Only stems of American pondweed and small plants of eelgrass with female flowers were found. The density of weeds at this time was only 340 g fresh weight/m^2 which consisted mainly of stems of American pondweed and a few eelgrass plants. The control area contained 780g /m^2 even after one manual cleaning (Figure 2).

TABLE 3. CONSUMPTION OF DIFFERENT TYPES OF WEEDS BY THE WHITE AMUR (200 g) IN HAPAS.

Aquatic weed	Amount consumed (g)[a]
P. perfoliatus	8.16 ± 3.2
Sago pondweed	59.77 ± 16.7
American pondweed	36.27 ± 8.7
Hydrilla	13.22 ± 9.4
N. foveolata	32.49 ± 6.0
Eelgrass	31.50 ± 9.4

[a]Each value is the mean of six hapas. The critical difference is 8.45 at the 90% confidence level. The standard deviation follows each mean.

TABLE 1. RATIO OF BODY WEIGHT OF THE WHITE AMUR TO THE AMOUNT OF AQUATIC PLANTS CONSUMED.

Locality	Plants fed	Duration of feeding (Days)	Number of fish	Initial wt of fish (g)	Average daily consumption of plants/fish (g)	Ratio of body wt to plant consumption[a]
Borkhandi minor	*N. foveolata*	14	100	96	141.0	1.46
Chandesel minor	Eelgrass Hydrilla *N. foveolata* mixture	12	94	223	267.0	1.19
Chandesel minor	Narrowleaf cattail	14	94	200	7.2	0.03
Borkhandi minor	Hydrilla	12	105	76	21.02	0.27
Borkhandi minor	*P. perfoliatus*	9	46	205	32.7	0.15
Borkhandi minor	Sago pondweed	7	46	190	123.9	0.65
Borkhandi minor	*Chara* sp.	10	46	165	278.5	1.68

[a]Average daily plant consumption divided by the initial fish weight.

TABLE 4. CONSUMPTION OF AQUATIC PLANTS BY THE WHITE AMUR IN HAPAS. EACH HAPA RECEIVED ONLY ONE TYPE OF PLANT.

Name of weed	Consumption of aquatic plants (g)[a]
N. foveolata	57.3
Chara sp.	49.6
Eelgrass	47.4
Hydrilla	31.5
Sago pondweed	29.7
P. perfoliatus	19.7
American pondweed	10.4

[a]Each value is the mean of 24 days and five fish.

The other area in the same minor, which was choked with American pondweed, was almost clean within 22 days. The density of weeds at that time was 106 g fresh weight/m^2 and consisted of stems of American pondweed. Plant density in the control plots was 1,556 g/m^2.

Experiment 3

In Borkhandi minor, the areas of 61 and 180 m^2 were cleared of *Chara* sp. within 10 and 18 days, respectively. This experiment indicates that white amur of a 50 g body weight will eat chara.

Experiment 4

The total weight of the aquatic vegetation in the area at Chandesel minor was about 390 kg, which was consumed by the 94 fish within 10 days.

The experiments (Table 1), which were conducted to determine the ratio between body weight and plant consumption, also showed the same results as above experiments. The fish consumed *Chara* sp. and *N. foveolata* at 1.6 and 1.4 times, respectively, their body weight.

SUMMARY AND CONCLUSIONS

A series of experiments were conducted in fish ponds at Kaithoon in Kota and some of the minors of Chambal Commanded area, Kota, Rajasthan with fish having different body weights. It was found that the white amur is a voracious eater of all the dominate weeds of this area; for example *N. foveolata, Chara* sp., eelgrass, American pondweed, sago pondweed, *P. perfoliatus,* and hydrilla. Among these weeds, fish (of approximately 65 g) preferred *Chara* sp., *N. Foveolata,* and eelgrass, while the larger fish (200 gm) preferred sago pondweed, American pondweed, eelgrass, and *Najas* sp. Fish of 200 g weight consumed only small amounts of hydrilla, *P. perfoliatus,* and narrowleaf cattail. Large fish may flourish on these weeds and may be able to masticate leaves of tough plants and fibrous grasses.

All observations on the white amur to date are most favorable and point out the benefits of using them in situations where the use of herbicides is not possible. However, information is needed regarding the optimum rates of stocking with fish of various sizes to achieve weed control.

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