Control of Aquatic Weeds by Grass Carp (*Ctenopharyngodon idellus* VAL)

By MINORU TSUCHIYA

Saitama Prefectural Fisheries Experimental Station

The grass carp, native to China-continent, belongs to Cyrinidae (Plate 1). It was introduced to Japan in 1941–1945 during the World War II. Although there was a definite opinion that the grass carp does not perform natural reproduction in any place outside its native place, the reproduction was confirmed in the Tone River system in 1948. It is still going on, but only in that river system. As the fish has a habit to spawn at the time of river rise and the hatching occurs during the flowing down of ova in the river, it was not able to produce fingerlings in fish ponds. However, artificial induction of spawning was made possible by the hormone-injection (Plate 2), so that seed production by pond spawning has become practical.

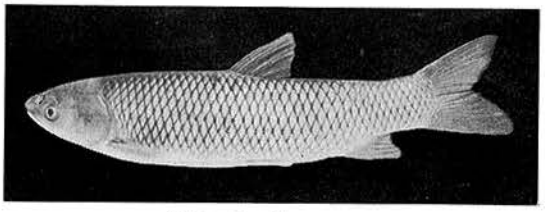

Plate 1. Grass carp

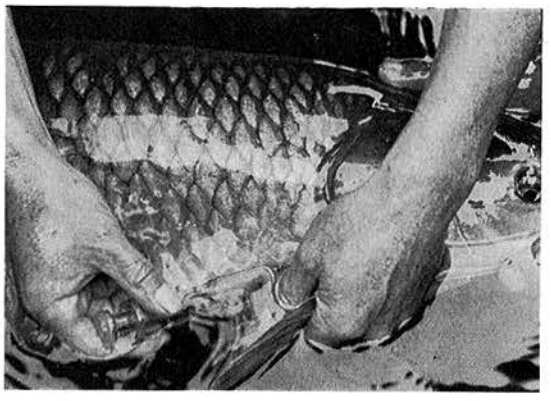

Plate 2. Hormone-injection to grass carp

The Japanese name, Sogyo, which literally means a herb fish, is given to the fish, because it feeds well on herbs. Control of aquatic weeds by the use of this feeding habit has advantages of more economical and less influencial to environment than chemical methods of weed control.

Utilization of grass carp for aquatic weed control in various waters will be reported briefly.

Weed control in reservoirs and fish ponds

It is practiced to release grass carp to irrigation reservoirs or fish ponds for controlling aquatic weeds. The Ueda Sub-Station (located in the suburbs of Ueda City) of Fresh Water Fisheries Research Laboratory carried out an experiment on weed control by grass carp using a reservoir in which extremely abundant weeds grow, to know the size and number of fish required for effective weed control. The result showed that the stocking rate necessary to suppress aquatic weeds was 100 fish/ha when an average fish size was 200 g, 50 fish/ha with an average size of 750 g, and 30 fish/ha with an average size of 2,000 g. This relation can be expressed by a formula,

$$W^{2/3} \cdot N > 4 \times 10^3$$

where W=fish weight (g) at the time of stocking, and N=number of fish/ha.

The aquatic weeds observed in this reservoir were coontail (*Ceratophyllum demersum* L), Eurasian water milfoil (*Myriophyllum spicatum* L), *Hydrilla verticillata* Casp, *Potamogeton crispus* L, Water chestnut (*Trapa natus* L), Giant reed (*Pharagmites commu-*

nis Trinius), annual wild rice (*Zizania latifolia* Turcz), river bulrush (*Scirpus fluviatilis* A. Gray), and *Glyceria acutiflora* Torrey, and all of them were eaten by grass carp. Under the condition of this reservoir, the grass carp grew from 0.7–6 g to 500–750 g in a year, 2,700–3,000 g in two years, and 4,700 g in three years[1)].

As the grass carp hardly feeds on other kinds of fish due to it's feeding habit, the release of grass carp at the above stocking rate standard is widely practiced with good results in fish (eel and carp) culture ponds with weed troubles, or castle moats, park ponds and factory's reservoirs which are not for fish culture.

Weed control in paddy fields

Culture of common carp and *Tilapia mossambica* in paddy fields is widely practiced in Japan and southeast Asian countries (Thailand, Indonesia, Vietnam, Taiwan, etc). The purpose is, needless to say, the fish production by utilizing natural feeds available in paddy fields, but some people expect the weed control effect in addition.

In Japan, the carp accounts for more than 95% of paddy field fish culture. It has been known that the carp culture can control submerged weeds, but not suitable to control floating leaved weeds like salvinia (*Salvinia natans* All), large leaf pondweed (*Potamogeton distinctus* A. Bennet), and giant duck-weed (*Spirodela polyrhiza* Schleid). By considering this point, the Saku Branch of Fisheries Experiment Station of Nagano Prefecture carried out an experiment on weed control in a paddy field by using grass carp. It was made clear that all kinds of paddy field weeds can entirely be controlled at the stocking rate of 1～6/10 m² with grass carp of 14 cm long and 30 g in weight. Weeds in this field were water starwort (*Callitriche fallax* Petrov), *Ammannia multiflora* Roxb, monochoria (*Monochoria vaginalis* Presl), slender spikerush (*Eleocharis acicularis* Romer et Schuttes), *Sagittaria pygmaea* Miq. *Ottelia alismoides* Persoon, *Lemna Paucicostata* Hegelm, and salvinia (*Salvinia natans* All). Of them, floating leaved weeds disappeared completely at 1–1.5 month after stocking and submerged weeds were eaten a little later.

Thus, the highly effective weed control in paddy fields can be expected by the use of grass carp. However, this fish has a preference to Gramineae weeds, so that the stocking must be made after a complete establishment of rice seedlings and the overhead submergence of the seedlings should be avoided.

In recent years, an attempt has been made in several areas to use grass carp for weed control in idle paddy fields, because most of the idle paddy fields are in marshy lands, and they will be covered by perennial weeds when left without care. The purpose is to keep the idle fields submerged and control perennial weeds by grass carp. Experiments proved that the weeds which are difficult to be controlled, like common cattail (*Typha latifolia L.*), *Isachne globosa* O. Kuntze, giant reed (*Pharagmites communis* Trinus) etc. can be suppressed successfully. The grass carp used was within a range of 50–2,000 g in weight and each fish could cover 4–30 m², depending on its size.

Weed control in irrigation canals

In recent years an extraordinary weed growth which impedes water-flow occurs everywhere in irrigation canals due to the eutrophication of irrigation water. Traditional practice to clean up irrigation canals becomes a burden of farmers due to recent labor shortage, so that the use of grass carp has been attempted as a substitute for human labor.

Result of an experiment conducted in Iwatsuki City by the Kasukabe Agricultural Extension Office of Saitama Prefecture is summarized as follows: The irrigation canal used for the experiment is 2.5 m wide and about 2,000 m long. It intakes water from Ayase River running at a west end of the city to irrigate about 100 ha of paddy fields. Water of the Ayase River is being eutrophicated by city drainage and agricultural drainage water,

showing 0.56–1.16 ppm of amonial-N by the 1976 survey. Aquatic weeds, *Potamogeton malaianus* Mig, P. *oxyphyllus* Mig and *Vallisneria asiatica* Mik (eelgrass) grown in the entire canal causes a chronic water shortage in about 40 ha of down-stream area.

In 1976, grass carp was released in the canal (plate 3) after a screen for preventing fish

Plate 3. Irrigation canal used for the experiment

escape was installed, and the weed control effect has been examined in relation to stocking rate, initial fish size, and time of release. As a result, it was made clear that:

1) Within a range of 20 g/m^2 to 50 g/m^2 of stocking rate, the higher the rate, the earlier the weeding effect was recognized. However, the weeding effect can also be expected at the lower rate than that range, judged from the residual weeds at the fish harvest time.
2) Within a range of 300 g to 1,000 g of initial weight of fish, difference in the weeding effect by fish weight was not apparent. But, bigger fish took longer time to start feeding than small fish.
3) The screen mesh depends on the initial size of fish, but a 3 cm mesh is a limit for management reason. This mesh can retain fish of more than 250 g in weight.
4) Fish released just before or immediately after the weed sprouting gave the highest effect, but weight gain of fish was less.

In addition, labor for cleaning up canals was compared to that for grass carp stocking (release and harvest of fish, dust removal and taking care of screen). By adopting the grass carp method, labor hour was saved by 60% and labor wage by 69%. Cost for grass carp stocking (equipment, seeds, and labor) was found to be only 52% of the cost for cleaning up canal[3].

Thus, the weed control in various water surfaces by grass carp is now at the stage ready for practical application. However, to get high effectiveness with certainty, it is necessary to understand the following habits of grass carp:

1) As grass carp is a warm water fish, its living activity is reduced at water temperatures below 15°C or higher than 30°C.
2) It feeds on almost all kinds of aquatic weeds and also upland weeds of Gramineae, Compositae, Leguminosae, etc.
3) Amount of consumption of weeds is almost proportional to the fish size. But, small grass carp can not feed weeds with certain shape and size.
4) Grass carp does not jump up and eat weeds above the water surface. It does not seize weeds laterally in mouth nor eat them from their side portions.
5) In case of palatable weeds, grass carp consumes the weeds equivalent to as much as 145%, usually 30–100% of its body weight per day.
6) The size of fingerlings is usually 30–50 g for the reason of spawning time, so that the weed control effect can not be manifested to a full extent unless

after the second year.

7) Grass carp is somewhat difficult to become tame, and is liable to be astonished by noise.
8) Grass carp does not like a rapid stream, and its habitat is in the slowly running water and static water.
9) Growth is pronounced, reaching more than 30 kg of body weight.

Finally it must be added that grass carp is a tasty food, and is used for fishing. After its role of weed control is finished, the grass carp offers various uses.

References

1) Nakamura, K.: Relationships between the production of fish and weed control by Chinese grass carp, *Ctenopharyngodon idellus*, in farmponds. *Fresh Water Fisheries Research and Technique*, **23**, 1–17 (1960) [In Japanese].
2) Nagano Pref. Fisheries Exp. St.: Control of weed in paddy field and farmpond by the use of tilapia and grass carp. *Experimental Report*, 1–12 (1959) [In Japanese].
3) Yokoi, J. et al.: Weed control in irrigation canal by grass carp. Experimental Report of Kasukabe Agriculture Extention Office, 1–40 (1978) [In Japanese].
4) Baily, W. M.: Arkansas' Evaluation of the desirability of introducing the White Amur (*Ctenopharyngodon idella*, Val.) for control of aquatic weed. Proceedings of the 102nd Annual Meeting of the American Fisheries Society and the International Association of Game and Fish Commissioners (1972).
5) Haller, W. T.: Hydrilla, a new and rapidly spreading aquatic weed problem. Institute Food and Agricultural Science, University of Florida, 1–13 (1977).