

The Testicular Development of the Silver Carp, *Hypophthalmichthys molitrix* (C. & V.), in Captivity in Relation to the Repressive Effects of Wastes from Fishes*

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The fish culturists of Asia are confronted by the necessity of developing methods for breeding the food fish in ponds, since the most important species of cultivated fish such as milkfish, *Chanos chanos*, and various Chinese and Indian cyprinids do not reproduce under artificial culture conditions. The silver carp, *Hypophthalmichthys molitrix* (C. & V.) is one of the most important species of Chinese carps cultivated in Taiwan. The young of this fish are collected in association with other principal Chinese cyprinids, namely the big-head, *Aristichthys nobilis* (RICHARD.) and grass carp, *Ctenopharyngodon idulus* (C. & V.) from their spawning rivers in the China Mainland and transferred to Taiwan by ship or aircraft. Under cultivation in ponds, the ovaries of this fish are reported to have grown to an advanced state of maturation after reaching about 3 or 4 years of age, and some of these matured females are said to be able to spawn spontaneously without the presence of ripe males, but the testis of this fish has never been found to develop well when they are reared in captivity (TOMIYAMA, 1953 and TANG, 1954).

The first attempt in Taiwan to solve this problem in fish culture by means of hormone treatment was made by the Tainan Fish Culture Station of the Institute in 1951, and followed up in 1952 and 1956. In these experiments, the collection, preservation and extraction of the pituitary glands from fish or frogs, and the techniques employed in administration of the extracts to the test fish followed those successfully used by KAWAMURA (1944), KAWAJIRI *et al.* (1948), NISHINO (1948 and 1949) and FONTENELE (1955). In spite of the efforts made in these three years of experiments, we failed to bring about the testis of this fish to develop in any measurable extent, and even secondary sexual characteristics failed to appear. On the other hand, high mortalities of the test fish occurred in each treatment as a result of injury from

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Many environmental factors involving the physical and chemical conditions affecting the reproduction in fish are known by fisheries biologists, but less intensive work on physiological influence to the reproductive activities of fish has been made in comparison with other higher vertebrates. Insomuch as the pituitary is instrumental in bring about secretion of the gonadotrophic hormones responsible for the reproductive phenomena, it is highly probable that external environmental factors coming through either the sense organs or the blood stresms in some way stimulate or repress the pituitary to secrete gonadotrophins. It is, therefore, suggested that the external actuating factor or the combination of factors should be determined and controlled artificially so that the silver carps will naturally provide the necessary hormones and thereby achieve testicular development and activity.

SWINGLE (1956) first demonstrated that fishes excrete a hormone-like substance or substances which prevent the reproduction of the same species or other species of warm-water fishes in confined waters. In experiments with artificial breeding of the common carp, *Cyprinus carpio*, the Station has further confirmed the existence of this repressive factor, though the exact nature of the substance or substances is not known. When the small stream water, underground water or tap water was slowly circulated through the breeding tanks, where the sexually ripe carps of both sexes were introduced from sexwise segregating ponds in the evening, the brood fish usually successfully spawned in the following morning and the fertilized eggs were obtainable following the spawning. However, running water pumped from ponds containing fish was unable to induce the carp to spawn. Further experiment was made with running water from concrete tanks in which the tap water, small stream water or underground water was impounded and the carp fry, adult carp, or other fresh-water fishes of various sizes including *Carassius carassius*, *Tilapia mosambica* and several common species of small cyprinids were heavily stocked for 24 to 48 hours. These waters also failed to stimulate the carp to spawn, although the dissolved oxygen content in these waters was restored to an appreciable level by agitation or by natural diffusion. It is apparent that the carp fry, adult carp or other species of freshwater fish excreted wastes into the water through their metabolic activities and these waste materials contaminated the water and resulted in preventing the common carp to spawn. The toxicity and other harmful effects of the fish excretory products to fish have been studied by IVLEV (1935) and BROKWAY (1950). Ammonia and some of the amine and amine-oxide derivatives which consist the main part of the wastes eliminated through their gills and kidneys are known to distress the fish when these substances accumulate to a certain extent. The outstanding chemical characteristic of the running water which has failed to induce the common carps to spawn in these experiments as determined by general analysis was the higher content of ammonia. It is probable that ammonia itself may not be the repressive factor, but there is

reason to believe that many other excretory substances are present in quantities proportionate to the amount of ammonia. This metabolic repression factor in control of reproduction in fish, as stated by SWINGLE (1956), is probably widespread among fishes in nature and it is especially important in control of many river fish populations.

Since it has recently been reported by TANG (1960a and 1960b) that two species of Chinese carps had reproduced in a reservoir in Taiwan, questions as to whether this metabolic repression factor is responsible for the development of the testes of the silver carps and whether this factor alone or in combination with other factors actually regulate the spawning of these carps in that body of confined water has arisen. Preliminary observation has shown that the development and growth of the testes of the silver carps is somewhat proportionate to the volume of water increased due to natural precipitation. We have examined and found that the male silver carp of over 480 mm. in total length began to develop and grow testis when the catchment of rain water run-off from the drainage of the impoundment increased at the beginning of the spring season. However, fully matured males of silver carp could only be found in this reservoir following sudden rise of water when the volume of water in the reservoir had increased to approximately 3 to 5 times the volume of water during the dry season. Although the testicular development and growth of the silver carp in this reservoir cannot yet be attributed to the elimination of the metabolic repression factor by dilution of rain water, but the evidence does indicate the need for further study.

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