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Some aspects of Breeding and Crossbreeding of Common Carp (*Cyprinus carpio* L.) and Gold Fish (*Carassius auratus* L.)

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ABSTRACT. *In Sri Lanka, Semi - intensive spawning of common carp using 'kakabans' which are made of different types of material is being practised. The first experiment was carried out to compare the efficiency of coconut (Cocos nucifera L.) fibre with pilla (Tephrosia purpuria L.) leaves as a suitable material for the deposition of eggs. Total number of eggs deposited per bundle of material was found to be significantly higher ($p<0.05$) on coconut fibres than pilla leaves but the percent of fertility and the percent of hatchability did not show significant difference ($p>0.05$) between the two treatments. These results indicate that coconut fibres are more suitable than pilla leaves for egg deposition for common carp.*

The second experiment was carried out to find the suitability of coconut fibres and pilla leaves as egg collecting material for gold fish. The total number of eggs, fertility and hatchability on coconut fibre were found to be significantly higher ($p<0.05$) than that of pilla leaves. Thus, coconut fibres are more suitable even for deposition of eggs for gold fish.

Successful ornamental fish production is also dependent on the development of new strains. Another experiment was performed to find out whether common carp can be crossed with gold fish by hypophysation. The total number of eggs produced when male common carp crossed with female gold fish was found to be significantly higher ($P<0.05$) than that of male gold fish crossed with female common carp. These results indicate that gold fish could be crossed with common carp by hypophysation and male common carp × female gold fish cross is a better combination for crossbreeding.

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INTRODUCTION

Fish culture is practised in many countries of the world, particularly in the Asian region. Culturing of fish to serve as food is still not popular in Sri Lanka. This is partly due to hereto-dependence and higher demand for marine fish. Since the inland areas by virtue of their location cannot be effectively supplied with marine fish and possibly also due to low price, the acceptance of freshwater fish as food is becoming gradually popular among Sri Lankans (Bhowmick, 1982). Since Sri Lanka has vast resources of Inland waters, scientific development of these resources will increase the protein supply in the Island and nutritional status of the population.

The major constraint in aquaculture appears to be the non-availability of seeds of cultured species. Since the procurement of seed fish from the natural sources for replenishing is not possible in Sri Lanka (Chaudhrui and Singh, 1984), induced breeding is the only remedy to overcome the constrain of quality fish seed production.

In addition, the ornamental fishery sector is also basically dependent on the production of quality fish seed and on the successful production of new strains. This phenomenon could be achieved by crossbreeding or hybridization among species or genera which have desirable characters (Hsein-won and Ling, 1964).

Different countries use diverse materials, *e.g.* *'kakabans'* and *'Spawning nests'* for the collection of common carp (*Cyprinus carpio* L.) eggs and gold fish (*Carassius auratus* L.) eggs, respectively (Chaudhuri and Singh, 1984; Matsui and Axelord, 1991). This study was undertaken to find out whether the commonly available coconut (*Cocos nucifera* L.) fibre could be used efficiently as an egg collecting material for the common carp as well as for gold fish.

Naturally occurring common carp × gold fish hybrids have been found in Canadian (Taylor and Mahon, 1977) and Australian waters where both species are exotic (Hume *et al.*, 1983). Different experiments on induced breeding of fish types have been undertaken in different parts of the world (Bhowmick, 1982; Chaudhuri and Singh, 1984; Harvey and Carolsfeld, 1993). Hence, another study was carried out to find whether common carp can be crossed successfully with gold fish by induction.

MATERIALS AND METHODS

Experiment I : Suitability of coconut fibre (*Cocos nucifera* L.) as collection material for eggs of common carp (*Cyprinus carpio* L.)

Coconut fibre was arranged as in a bottle brush with the help of nylon thread. The diameter of each bundle was 10 cm and the length was 25 cm. Cleaned, semi-mature pilla (*Tephrosia purpuria* L.) branches, numbering around 12 were tied together to make bundles with the help of nylon thread. Each bundle was 25 cm in length. The average surface area of pilla bundles was approximately comparable to that of the coconut fibre bundles.

Bamboo poles of 2 m in length and 5 cm in width were used for the construction of each '*kakaban*'. Sixteen bundles of pilla leaves and sixteen bundles of coconut fibre, were tied separately within a two meter distance of bamboo pole. Three outdoor cement tanks with an area of 6 m^2 were used. Each '*kakaban*' was placed in the middle of the tank, and about 20 cm below the water surface.

Mature common carp, approximately of the same size, in a 3:1 male : female ratio were selected for the experiment and provided with running water having optimum physico-chemical conditions (Table 1).

Table 1. Physico-chemical parameters of water used for breeding experiments.

Parameter	Unit	Range
Alkalinity (Total)	mg/l	30.0 - 60.0
Dissolved Oxygen	mg/l	20.0 - 30.0
Hardness (Total)	mg/l	4.8 - 6.8
pH	-	7.0 - 7.8
Temperature (ambient)	^{0}C	26.0 - 29.0
Temperature (water)	^{0}C	23.0 - 27.5

Experiment II: Suitability of coconut fibre as collection material for eggs of gold fish (*Carassius auratus* L.).

Coconut fibre bundles and pilla bundles were prepared as in Experiment I, with a length of 20 cm per bundle. Six *spawning nests* were prepared using pieces of rigidfoam each having a length of 30 cm and a width of 3 cm, as the stem of each *spawning nest.* Of these rigidfoam pieces, three were used for pilla bundles and the remaining three for coconut fibre bundles. Each rigidfoam piece was tied with four bundles of either coconut fibre or pilla by using nylon rope.

Three indoor glass tanks of 122 × 76 cm were used. A *spawning nest* of pilla leaves and coconut fibre per tank were placed randomly in submerged condition. Six mature male and three female gold fish (*Calico variety*) of breedable age were selected for the experiment (male : female, 2 : 1). The Physico-Chemical parameters of water used for these experiments are given in Table 1.

Experiment III: Crossbreeding of common carp and gold fish by hypophysation.

Six mature males and three mature females of approximately the same size were selected from each breeding stock of common carp and the calico variety of gold fish (male : female, 2 : 1).

Six glass tanks measuring 122 cm × 76 cm were used for this experiment. Three tanks were used as replicates for the male common carp × female gold fish combination, while the other three tanks were used for the female common carp × male gold fish combination.

Six *spawning nests* of coconut fibre were prepared as in Experiment II. The *Spawning nests* were kept in submerged condition. In this experiment, the hypophysation technique was used for the induction of spawning of both males and females of common carp and gold fish. Common carp pituitary gland was used as the induction material.

After spawning, the total number of eggs per bundle of material was counted. The number of unfertilized and fertilized eggs, were counted 24 hours after spawning, the unhatched and hatched eggs were counted 72 hours after spawning to calculate the percentage fertility and hatchability. The

observations were statistically analyzed by using Randomized Complete Block Design (RCBD) model.

RESULTS AND DISCUSSION

Physico-chemical parameters of the water used for three experiments showed that they were within the suitable range (Table 1). According to Woynarovich (1975) common carp need water of over 17°C and Hsien-won and Ling (1964) have indicated that dissolved oxygen in clear water should be above 4 mg/l.

Experiments I and II

Pilla leaves were chosen to compare with coconut fibre as an egg collecting material in these experiments. Pilla leaves have been used in Sri Lanka as a traditional method for collection of marine fish in coastal areas. Edirisinghe and Jayabalasingham (1992) have reported that pilla leaves are more suitable than Guinea A (*Panicum maximum*) leaves for common carp egg collection. According to Edirisnghe and Leelawathie (1993), pilla shrubs cannot be used effectively for common carp spawning mainly due to decomposition of the leaves. Therefore in those experiments branches of pilla creepers were used.

However, the results of these experiments (Tables 2 and 3) showed that compared to pilla leaves, the coconut fibre bundles have a significantly higher ($P<0.05$) number of egg deposition, indicating that coconut fibre is more suitable for egg deposition during spawning of both fish species.

Usually the presence of rooted water grasses will stimulate the spawning of common carp under natural conditions. These grasses may have stimulated the fish to spawn when rubbed on their body.

By nature, the gold fish spawn on the roots of floating water plants or on leaves of submerged water plants. However, the spawning of gold fish would also have been stimulated by rubbing the body on the materials used for spawning (Matsu and Axelord, 1991).

The coconut fibre are lignified and are rough in nature, whereas the pilla leaves are smooth. This would have led to higher deposition of eggs by both species on coconut fibres (Tables 2 and 3).

Table 2. Number of eggs deposited/bundle of material, rate of fertility and rate of hatchability in Experiment I.

Treatment	No. of replicates	No. of eggs deposited/bundled	Percentage fertility	Percentage hatchability
1	12	$433^a \pm 8$	$89^c \pm 3$	$90^c \pm 1$
2	12	$1468^b \pm 11$	$95^c \pm 1$	$93^c \pm 1$

Treatment 1 - Pilla leaf bundles Treatment 2 - Coconut fibre bundles
a,b, values having different superscripts within a column differ significantly ($P<0.05$).
c values having the same superscript within a column do not differ significantly ($P<0.05$).

Table 3. Number of eggs deposited/bundle of material, rate of fertility and rate of hatchability in Experiment II.

Treatment	No. of replicates	No. of eggs deposited/bundled	Percentage fertility	Percentage hatchability
1	12	$0.4^a \pm 0$	$33^a \pm 16$	$11^a \pm 6$
2	12	$27^b \pm 4$	$80^b \pm 4$	$63^b \pm 1$

Treatment 1 - Pilla leaf bundles Treatment 2 - Coconut fibre bundles
a,b, values having different superscripts within a column differ significantly ($P < 0.05$).
c values having the same superscript within a column do not differ significantly ($P< 0.05$).

However, the fertility and hatchability of common carp eggs did not show a significant difference ($P > 0.05$) between the two types of spawning materials confirming that pilla leaves do not have any deterious effect on hatchability (Tables 2 and 3).

Experiment III

The results of this experiment showed common carp and gold fish crosses can be bred successfully by induced spawning.

When the two types of breeding combinations were compared, the female common carp × male gold fish bred only in one spawning tank with a relatively low number of eggs whereas the combination of female gold fish × male common carp bred in all the tanks with a relatively higher egg number (Table 4).

Table 4. Number of eggs deposited/bundle of material, rate of fertility in Experiment III.

Treatment	No. of replicates	No. of eggs deposited/bundled	Percentage fertility	Percentage hatchability
1	03	$373^a \pm 12$	$87^a \pm 0$	$76^a \pm 1$
2	03	$60^b \pm 30$	$31^b \pm 15$	$28^b \pm 14$

Treatment 1 - male common carp × female gold fish
Treatment 2 - female common carp × male gold fish
a, b, values having different superscripts within a column differ significantly ($P<0.05$).
c values having the same superscript within a column do not differ significantly ($P<0.05$).

The observed difference in the number of eggs deposited between the two sex combinations of these species may be due to lack of stimulation by the opposite sex, a lack of suitable behavioral pattern between them *etc.* However, both combinations gave viable offspring indicating that common carp could be crossbred with gold fish with either combination.

Most of the fry obtained from this crossbreeding resembled the crusian carp (*Carassius carassius*) with different characteristics such as a single tail, double tail, pearl scale *etc.*

Further experimentation in this new field of research would pave the way to develop multitudinous number of varieties of gold fish types which would be of enormous benefit to the ornamental fish industry. In addition, if the F_1 hybrids become fertile, this will pose a problem in the systemic classification of the two genera.

CONCLUSIONS

The commonly available coconut fibre could be used successfully for the collection of eggs during spawning for the common carp and gold fish, which will lead to increase in fish seed production.

Although the common carp and the gold fish belong to different genera, *Cyprinus* and *Carassius*, they can be bred by induction with a higher rate of fertility and hatchability. Furthermore, crossing male common carp with female gold fish was the better combination compared to female common carp with male gold fish for crossbreeding.

The results of crossbreeding of common carp and gold fish could be used to produce new strains of fish by crossing different varieties of gold fish with different varieties of common carp which will lead to the production of new strains thereby contributing enormously to the development of the ornamental fishery sector in Sri Lanka.

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