Induced Gynogenesis in the Indian Major Carp, *Cirrhinus mrigala* (Ham.)

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JOHN, G., REDDY, P.V.G.K., and JANA, R.K. 1988. Induced gynogenesis in the Indian major carp, *Cirrhinus mrigala* (Ham). In: M. Mohan Joseph (Ed.) The First Indian Fisheries Forum, Proceedings. Asian Fisheries Society, Indian Branch, Mangalore. pp. 107 – 109.

Abstract

Artificial production of gynogenetic *Cirrhinus mrigala* (mrigal) is reported for the first time. Ultraviolet irradiated *Cyprinus carpio* (common carp) milt was used for activating mrigal eggs. Cold shocking at 12°C and heat shocking at 39°C were used for restoring diploidy in activated eggs. Heat shock appeared more effective.

Introduction

Parthenogenetic activation of eggs by genetically inactivated milt results in gynogenesis. These eggs develop into diploids if cold heat pressure shocks are applied to them after 'fertilization'. Shocking prevents separation of polar body from the egg. The usefulness of gynogenesis lies in the production of inbred lines, besides locating recessive genes. The first evidence of gynogenesis was reported by Hertwig (1911) in frogs. Later works include those of Hubbs and Hubbs (1932), Purdom and Lincoln (1973), Golovinskaya and Cherfas (1975), Stanley (1981), Thompson (1983), Purdom (1983), Nagy *et al.* (1983), John *et al.* (1984), Suzuki *et al.* (1985), Hollebecq *et al.* (1986) and Oshiro (1987).

Material and Methods

Pituitary extracts were administered to common carp males and mrigal females. Eggs and milt were collected by stripping. UV irradiation was used for genetic inactivation of milt. Eggs were temperature shocked by placing them in cloth bags in water at the required temperature. Chromosomes of about 15 hatchlings were examined from each group. The methods used in milt irradiation, temperature shocking and chromosome studies have been elaborated by John *et al.* (1984). Induction of gynogenesis was confirmed by chromosomal screening. Supportive evidence was provided by t values of morphometric and meristic characters of normal mrigals, gynogenetic mrigals and mrigal-common carp hybrids. The two controls 1 and 2 (Table 1) were mrigal eggs fertilized by normal common carp milt and mrigal eggs activated by irradiated milt. In both cases no shocking was done. Eggs and milt from two different species were used so that improper irradiation could be indicated by the presence of hybrids.

Results and Discussion

The treatment schedules on eggs from one mrigal and milt from one common carp are given in Table 1. Irradiation appeared effective since only haploids were produced in control 2. Diploid ($2n = 50$) and haploid ($n = 25$) status were shown by chromosomes and haploidy syndrome in hatchlings (Figs. 1-3). The parent species, its hybrid and the general similarity between gynogenetic mrigal and normal mrigal are shown in Fig. 4. Statistical evidence (t values) shows morphological similarity between gynogenetic and normal mrigals. Out of the 21 morphometric ratios and 5 meristic characters of normal and gynogenetic mrigals, significant differences ($P < 0.01$) were seen in 4 and 1 characters respectively. In the case of gynogenetic mrigal and the hybrid, significant differences ($P < 0.01$) were seen in 19 out of 21 morphometric characters and in all 5 meristic characters.

The experiments were done in 1984-85. The hybrids in control 1 showed deformities and poor survival. Only 41 survived after 45 days and 38 after 60 days. A total of 366 diploid gynogenetic mrigals were produced. Of these 141 survived for 45 days and 113 beyond 60 days. Only 10% survived two months after release. 5 specimens were recovered 8 months and later weighed ~ 400 g each.

From the results (Table 1), heat shock appears more useful in inducing diploid gynogenesis. Only 4% were produced by cold shocking while the yield was 20% and 12% through heat shocking. A similar trend was reported in catla (John *et al.*, 1984). The poor survival of gynogenetic fish may be due to inbreeding depression or unmasking of deleterious recessives. It may be expected that natural selection after repeated generations of gynogenesis would lead to improvement (Purdom, 1983).

Acknowledgements

The authors thank Dr. V.R.P. Sinha, former National Project Director of FAO/UNDP projects for the facilities. Help from Dr. S.D. Tripathi, Messers

C.S. Purushothaman, M. Rout, K.K. Sukumaran, H.A. Khan and S.K. Sahu is acknowledged.

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Table 1. Treatment schedules on *Cirrhinus mrigala* eggs. Normal *Cyprinus carpio* sperm used only in control 1 while irradiated sperm in others.

	No temperature shock				Eggs cold shocked 4 minutes after activation with milt (12°C – 10 min.)		Eggs heat shocked 4 minutes after activation with milt (39°C – 1 min.)	
	(Control 1)		(Control 2)					
	Jar	Pool	Jar	Pool	Jar	Pool	Jar	Pool
No. of eggs incubated	200	2000	200	2000	200	2000	200	2000
Number of diploid hatchlings counted 2 days after hatching in glass jars, and 7 days after hatching in plastic pools	78	911	0	0	8	76	39	243
Percentage of diploids yielded	39	46	0	0	4	4	20	12

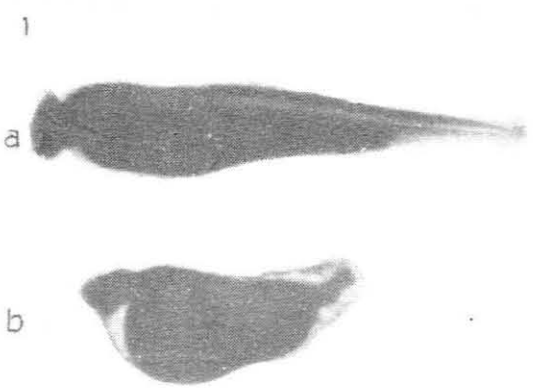

Fig. 1. (a) Diploid gynogenetic mrigal hatchling.
(b) Haploid gynogenetic mrigal hatchling.
(bar = 1 mm)

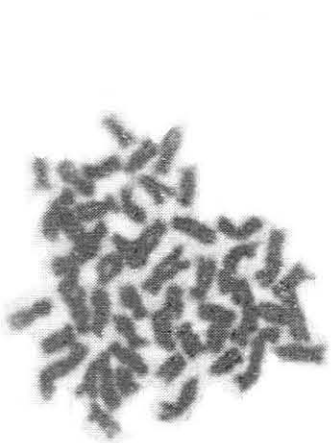

Fig. 2. Chromosomes from cell of diploid gynogenetic mrigal hatchling (2n = 50). (bar = 10 μm)

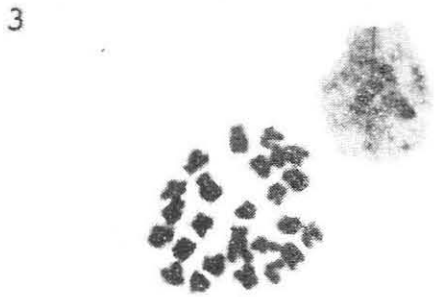

Fig. 3. Chromosomes from cell of haploid gynogenetic mrigal hatchling (n = 25). (bar = 10 μm).

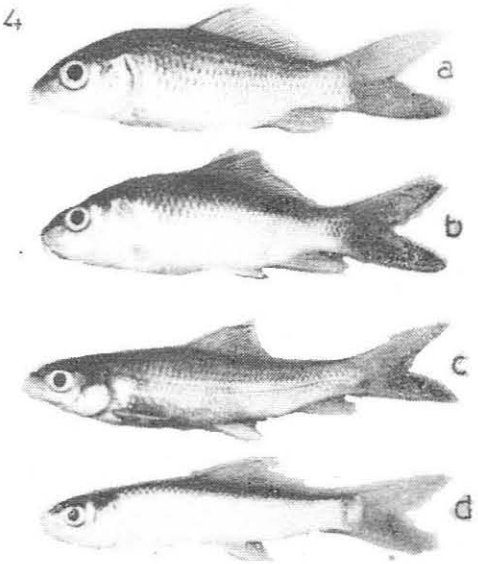

Fig. 4. (a) Common carp.
(b) Mrigal (♀) × common carp (♂) hybrid.
(c) Normal mrigal.
(d) Gynogenetic mrigal.
(bar = 1 cm)