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Hybridization Experiments in Cyprinid Fishes. VI. Reciprocal Crosses between *Gnathopogon elongatus elongatus* and *Gnathopogon japonicus*

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In order to elucidate whether or not the success of hybrid developments is correlated with supposed degree of taxonomic differences among cyprinid fishes, hybridization experiments between them have been conducted by SUZUKI (1962, 1963a, 1963b, 1963c, 1963d). In one of his recent paper of this series (SUZUKI, 1963a), it is suggested that the cyprinid hybrids which are able to be reared until the adult stage are confined to the intergeneric or interspecific hybrids among the same subfamily.

In the present study, *Gnathopogon elongatus elongatus* and *Gnathopogon japanicus* are reciprocally crossed. These two species are sympatric, *viz.*, their habitates being confined to the same geographical area of river. Provided above SUZUKI's suggestion was correct, we would expect that the hybrids between them could be reared to reach the adult stage. Artificial insemination is applied in the present experiments.

Results

1) Viability. Eggs from *Gnathopogon japonicus* ♀ × *Gnathopogon elongatus elongatus* ♂ go through cleavage almost identical with that of straight-fertilized eggs and develop into embryos without any observable deformity. These crossed embryos hatch and resulted fry grow normally. Eight hybrids are reached the adult stage.

Eggs from the reverse cross, *viz.*, *G. e. e.* ♀ × *G. j.* ♂, develop also into embryos and hatch normally. The hybrid fry grow well and reach the six-month old with a survival rate similar to that of controls. Only one hybrid could be reared until the adult stage; two-year old, though the other all hybrids died of a technical mistake during about seven months after hatching.

2) External characters. Although *Gnathopogon japonicus* resembles closely *Gnathopogon elongatus elongatus* in external appearance, they are distinguishable each other in the following characters: In the former species, the presence of conspicuous silvery reflections on the body surface is one of their characteristics (Fig. 1*A*). Furthermore, their scales removed from the laterocentral region of the body are almost round and have a few primary apical grooves being 2 to 5 and many secondary grooves, 11 to 18. The latter species, *G. e. e.*, have also silvery reflections, while

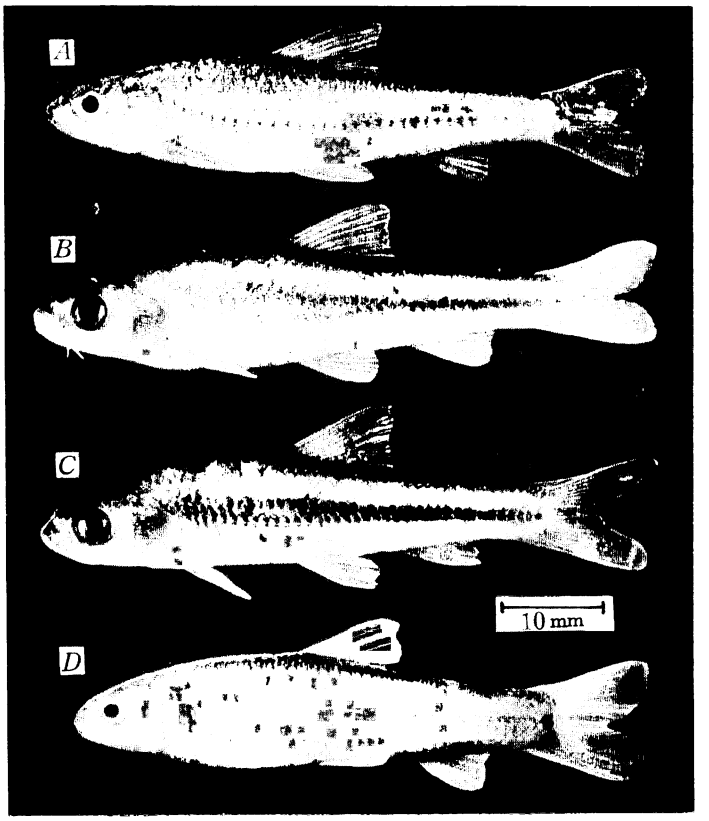

Fig. 1. *A.* An adult specimen of male, *Gnathopogon japanicus*. *B.* A hybrid male, *Gnathopogon japocus* ♀ × *Gnathopogon elongatus elongatus* ♂. *C.* A hybrid male, *Gnathopogon elongatus elongatus* ♀ × *Gnathopogon japonicas* ♂. *D.* An adult specimen of male, *Gnathopogon elongatus elongatus*. All of them are two-year old.

they are more feeble than *G. j.* There is a small black spot on the posterior region of the caudal peduncle (Fig. 1*B*). They have tongue-formed scales which have the primary grooves being 10 to 20 and the secondary grooves, 7 to 14.

Hybrids of two-year old are typically intermediate in these characters between those of the parental species. That is, hybrids from *G. j.* ♀ × *G. e. e.* ♂ have more conspicuous reflections than those of *G. e. e.* control, while somewhat feeble than those of *G. j.* control. A small black spot on the caudal peduncle is less conspicuous than that of *G. e. e.* control (Fig. 1*B*). Hybrid scales are generally round, though the middle of the apical margin are more protoruded than that of *G. j.* The numbers of the primary and the secondary apical grooves are 5 to 10 and 7 to 12 respectively. These intermediate characters are almost similar to those of the hybrid produced from the reverse cross (Fig. 1*D*). Some typical examples of scales of hybrids and controls are shown in Fig. 2.

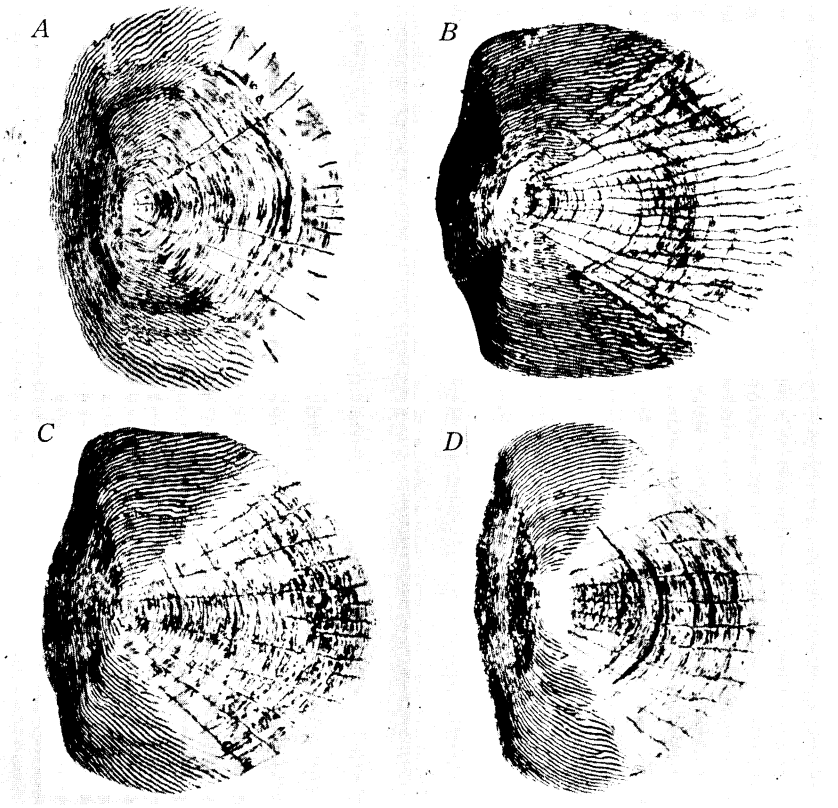

Fig. 2. Scales of *Gnathopogon japonicus* (*A*), *Gnathopogon elongatus elongatus* (*B*), *Gnathopogon japonicus* ♀ × *Gnathopogon elongatus elongatus* ♂ (*C*) and *Gnathopogon elongatus elongatus* ♀ × *Gnathopogon japonicus* ♂ (*D*). (× ca. 14).

3) Sex and male sterility. Of eight hybrids from *G. j.* ♀ × *G. e. e.* ♂, seven are female and the remaining one is male. One hybrid from the reverse cross is male. Anatomical observation during the spawning season reveals that the testes of the two hybrid males of two-year old are nearly normal in external form. None of the spermatozoa, however, is observed in their testes which is fixed with formalin, while there are numerous spermatocytes. This fact may indicate that spermatogenesis is impaired. On the other hand, many spermatozoa are observable in control testes. Of seven hybrid females, three have a few unripe ovarian eggs in their ovarian tissues. But no eggs are observed in the remaining four females.

Discussion

The present results that the interspecific hybrids between *Gnathopogon elongatus elongatus* and *Gnatopogon japonicus* can be reared untile the adult stage may justify SUZUKI's suggestion described above. Many external characters of the present hybrids are typically intermediate between those of parental fishes. Thus, these facts

are equivalent to those of the intergeneric *Gnathopogon* hybrids reported by SUZUKI (1962, 1963a, 1963b, 1963c).

As reported previously by SUZUKI (1962), intergeneric hybrids between *Gnathopogon elongatus elongatus* and *Pseudorasbora parva* are fertilizable and produce F_2 progeny. Also, on another intergeneric hybrid between *Gnathopogon elongatus elongatus* and *Pseudorasbora parva pumila*, males produce abundant spermatozoa (SUZUKI, 1963b). Whereas, present interspecific *Gnathopogon* hybrids are completely male sterile. These findings may tell us that the genetical relation between *Gnathopogon elongatus elongatus* and *Gnathopogon japonicus* is far more apart each other than those between the former species and *Pseudorasbora parva* or *Pseudorasbora parva pumila*. Thus, this relation is not in accord with that of the taxonomy of gobionine fishes.

Summary

Artificial interspecific hybrids, *Gnathopogon elongatus elongatus* ♀ × *Gnathopogon japonicus* ♂ and the reverse cross, can be reared until they reach the adult stage with a survival rate similar to that of controls. Their external characters ars typically intermediate between parental species. Of nine hybrids reared to adulthood, two are sterile males and another seven are females, three of them having a few unripe ovarian eggs.

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