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Maternal and Paternal Characters Affecting the Growth and Survival of Progeny of Jayanti Rohu (Female) × Rohu (Male) and Jayanti Rohu (Male) × Rohu (Female)

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A B S T R A C T

The present study emphasizes how the maternal and paternal characters affect the embryonic development, growth and survival of the young ones in the controlled conditions. Healthy males and females of Jayanti Rohu (improved variety of *Labeo rohita*) and Rohu (*Labeo rohita*) were induced to breed in the captive condition with suitable physico-chemical parameters like water movement, water exchange, water temperature and dissolved oxygen. The embryos were observed under the microscope. Eggs and young ones were kept under observation for 31 days, placed in the setup with continuous water flow, aeration and proper feeding. The present study revealed that the young ones of cross of Jayanti Rohu (Female) × Rohu (Male) had a better growth, survival, and faster embryonic development as compared to the young ones of cross of Jayanti Rohu (Male) × Rohu (Female).

Introduction

Rohu (*Labeo rohita*) Hamilton (1822) is a species from family Cyprinidae. It is omnivore species found in the river of South Asia. This is an Indo-Gangetic riverine species and natural inhabitant of the riverine system of northern and central India. Rohu also inhabits the river of Bangladesh, Myanmar, Pakistan. It has different life stages with specific food preference, majorly feeding on zooplankton and some smaller phytoplankters like desmids, algal spores and phytoflagellates (Khan and Siddiqui, 1973; Majumder *et al.*, 2016). It has a nibbling type of mouth and soft fringed lips with sharp cutting edges. Teeth are not found in the bucco-pharyngeal region which makes the fish able to feed on soft aquatic vegetation which does not require seizure and crushing. They have well developed and modified thin gill rakers which help them to sieve water to eat phytoplankton. Jayanti Rohu is the first genetically improved variety of Rohu in India developed through selective breeding of Rohu collected from different waters of North India. Selective breeding of rohu has been initiated

for the first time to genetically improve Rohu for better growth in India by ICAR-CIFA (Central Institute of Freshwater Aquaculture) in collaboration with Institute of Aquaculture Research (AKVAFORSK), Norway. Rohu (*Labeo rohita*) has been chosen as the candidate species for selective breeding because its consumer preference is very high. Jayanti Rohu has 17% higher growth efficiency per generation has been reported (Handbook of Fisheries and Aquaculture, Ayyappan *et al.*, 2006).

Larval growth is strongly linked to individual life history traits such as size and growth, but the processes that influence variability in these traits are poorly understood. We investigate the relative significance of maternal and paternal influences on the larval growth. Parental effects on the growth rate of fish are readily acknowledged and incorporated by breeding and selection (Kinghorn, 1983; Dunham *et al*., 1987). Environmental factors encompass the physical and biotic processes acting on developing eggs and larvae. However, in wild fish populations, less than 40% of the variation in larval growth is accounted by environmental factors (Wilson and Meekan, 2002; Caldarone *et al.* 2003). It suggests that other processes, like parental effects, must account for a substantial amount of variability in growth. In general, due to the nutritional provisioning of an embryo, the maternal contributions are considered more important than paternal contributions (Bernado, 1996). In fishes, embryo and larval characteristics such as egg size, developmental rate, metabolism, growth and viability are affected by the body condition and genotype of the Female parent (Chambers *et al*., 1989; Chambers and Leggett, 1996; Kerrigan, 1997; Marteinsdottir and Steinarsson, 1998). Non-genetic maternal contributions take many forms that directly influence survival probabilities of larvae, including nutritional reserves (Kerrigan, 1997), levels of developmental, metabolic hormones (Brown *et al.*, 1988, McCormick, 1998), and parental care (Bernado, 1996). While paternal effects have been identified in fishes (Heath *et al*., 1993; Herbinger *et al.*, 1995; Hoie *et al*., 1999a; Yamamoto and Reinhardt, 2003), they are not detectable in all larval traits (Hoie *et al*., 1999b) and are often not considered. Research on maternal effects in marine fishes has engrossed on commercially important species, which generally spawn benthic eggs or pelagic eggs and show no parental care (e.g. Altantic cod *Gadus morhua*, capelin *Mallotus villosus*; Chambers and Leggett, 1996). Males are generally responsible for nest-tending and nest-site selection in species that lay benthic eggs, (Clutton-Brock, 1991). Development of offspring is enhanced by parental care (Sargent, 1997). Therefore, it is a mechanism by which males can devote in the survival potential of their offspring. Consequently, it is likely that variation in the size and condition of offspring from parentally tended eggs will reflect the male's contribution (Bernado, 1996). The present study is to examine the effect of maternal and paternal characters on the embryonic development, growth and survival of the young ones of Jayanti Rohu (Female) × Rohu (Male) and Jayanti Rohu (Male) × Rohu (Female).

Materials and Methods

Experimental fish

For the experiment, we selected healthy matured brooders of Jayanti Rohu and Rohu of +2 Age group from the Experimental fish farm of College of Fisheries, G.B.P.U.A&T, Pantnagar, Uttarakhand the length and weight of the selected brooders are given in table 1 and 2.

Hormone injection and the dose of hormone

The brooders were injected (intramuscular) with the hormone GonoPro-FH which is a gonadotropin-releasing hormone. It is a new

highly potent and ready to use an injectable formulation containing a synthetic peptide analogous to the naturally occurring hormone salmon GnRH. The formulation also contains a dopamine antagonist. One-time dose of 0.20-0.40mg/kg for female and 0.10-0.20mg/kg for male was injected.

Experimental condition

After the injection, brooders of Jayanti Rohu (Female) and Rohu (Male) were kept in breeding tank one and Jayanti Rohu (Male) and Rohu (Female) were kept in breeding tank two. The continuous movement of water was maintained in both the tanks for the successful spawning, fertilization and survival. Continuous aeration with the help of showers was maintained in both the breeding tanks. After the spawning eggs of Jayanti Rohu (Female) × Rohu (Male) and Jayanti Rohu (Male) × Rohu (Female) were transferred to the hatching tank 1 and 2 respectively.

Collection of fertilized eggs

Spawning and fertilization took place in the hatchery in captive condition. Fertilized eggs were collected with the help of scoop net. Defective eggs were discarded and only the healthy eggs were taken to observe the different stages of development of embryos with the help of over-mounted digital microscope camera connected to a computer (Motic Digital Microscope).

Sampling and data collection

Sampling was done at regular intervals of time with the help of wide mouthed dropper and spatula. Eggs were collected and observed under the over-mounted digital microscope camera connected to a computer to determine the developmental stages and pictures were taken simultaneously. The sampling was more frequent in the initial stages of development of embryos because of rapid changes in the early embryonic stages. Eggs were examined daily, and the time periods of observations were 3h, 6h, 9h, 12h, 15h, 27h, 60h, 77h, 85h, 100h, and 110h. After 110h, 100 spawns were randomly collected from hatching tank one and two of Jayanti Rohu (Female) × Rohu (Male) and Jayanti Rohu (Male) × Rohu (Female) respectively and placed them in the setup made with two troughs with a continuous exchange of water. The cross of Jayanti Rohu (Female) × Rohu (Male) spawns were kept in trough one and the cross of Jayanti Rohu (Male)× Rohu (Female) spawns were kept in trough two. The nutritional feed was provided in both the troughs with the same amount. In the initial stages plankton was provided in both troughs. After few days powdered feed was mixed with the plankton was given in both the troughs and the data were observed.

Results and Discussion

The different embryonic developmental stages of Jayanti Rohu (Female) × Rohu (Male) and Jayanti Rohu (Male) × Rohu (Female) are compared in plate 1.

After 3h of fertilization, we observed that the eggs of Jayanti Rohu (Female) × Rohu (Male) were at the late morula stage whereas that of Jayanti Rohu (Male) × Rohu (Female) were still at early morula stage which shows the initial growth was slow in case of eggs of Jayanti Rohu (Male) × Rohu (Female). After 6 h of fertilization, we observed the blastodisc in Jayanti Rohu (Male) × Rohu (Female) whereas embryo hanging over yolk sac in Jayanti Rohu (Female) × Rohu (Male). Muscle segmentation started, and well differentiated head and the tail region was seen in Jayanti Rohu (Female) × Rohu (Male) after 9h but no such muscle segmentation was observed in the developing embryos of Jayanti Rohu (Male) × Rohu (Female). A bigger size of yolk mass

was seen in the embryos of Jayanti Rohu (Female) × Rohu (Male). Yolk mass plays an important role in the development and survival of embryo as it is the nutritional reserve of developing embryo (Kerrigan 1997). After 15 h, twitching movement was observed, which was faster in embryos of Jayanti Rohu (Female) × Rohu (Male). Eggs completely hatched between 15h to 27h. Advanced brain vesicles and organ vesicles were seen in the hatchlings of Jayanti Rohu (Female) × Rohu (Male) after 27h. Development of eyes was observed after 60 h in both cases. After 77 h a fibrous ball of waste material was seen in both. After 100h pectoral fins were visible in the hatchlings of Jayanti Rohu (Female) × Rohu (Male) whereas no such development in the hatchlings of Jayanti Rohu (Male) × Rohu (Female) which developed the pectoral fins later. Complete yolk sac absorption was observed after 110h of fertilization in both. After 110h, 100 spawns were observed for mortality rate at regular intervals of time for one month which is represented in table 3. On day 31st, 10 spawns were collected randomly from both the troughs and their length and weight was observed and depicted in table 4 and 5. We observed that maternal character not only affect the growth and survival of embryo but also the growth and survival of spawn.

Table.1 Length and weight of Jayanti Rohu (Male)×Rohu (Female)

S.No		Jayanti Rohu (Male)×Rohu (Female)		
	Weight(Kg)	**Length(cm)**	**Weight(Kg)**	**Length(cm)**
1	0.750	39.0	0.950	41.5
2	0.750	41.2	1.000	42.0
3	0.700	38.0	1.100	43.5
4	0.750	39.5	1.000	41.8

Table.2 Length and weight of Jayanti Rohu (Male)×Rohu (Female)

S.No		Jayanti Rohu (Female)×Rohu (Male)		
	Weight(Kg)	**Length(cm)**	**Weight(Kg)**	**Length(cm)**
1	0.900	41.5	1.000	41.0
2	1.250	46.5	0.500	29.5
3	1.000	40.0	1.000	42.5
4	0.750	38.0	0.900	41.5

Table.3 Mortality of the hatchlings in troughs

Days (After fertilization)	Mortality (in numbers)	
	Jayanti Rohu(Female)×Rohu(Male)	**Jayanti Rohu(Male)×Rohu(Female)**
Day7	2	4
Day10	4	6
Day13	3	5
Day16	4	4
Day19	1	3
Day22	1	0
Day25	1	2
Day28	0	0
Day31	0	0
Total	16	24
Survival	**84%**	**76%**

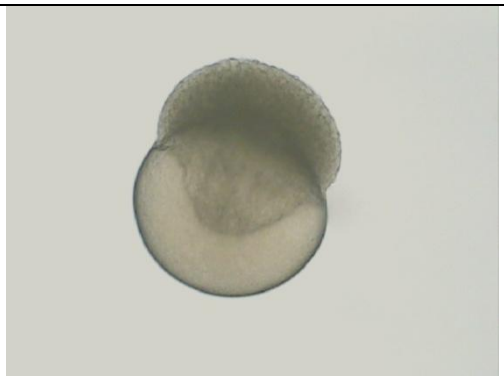
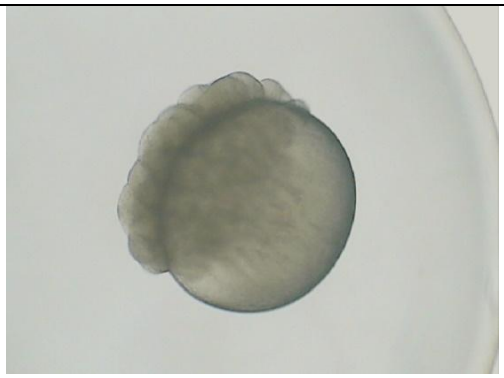
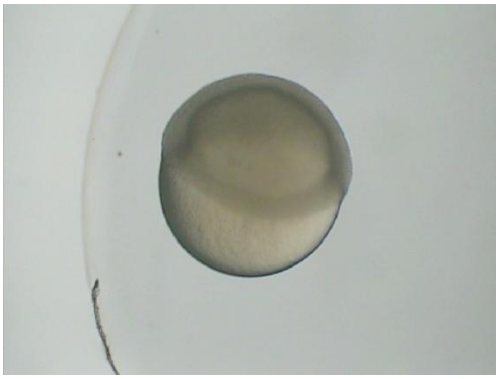
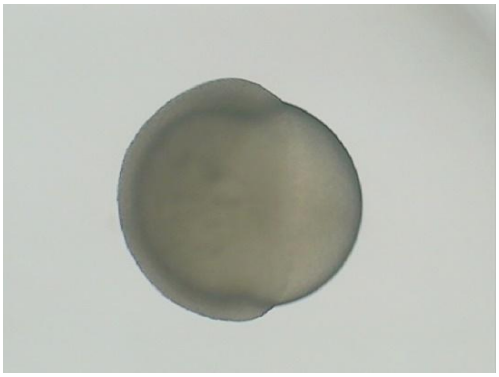
Table.4 Length (cm) of spawns of Jayanti Rohu(Female)×Rohu(Male) and Jayanti Rohu(Male)×Rohu(Female) on day 31

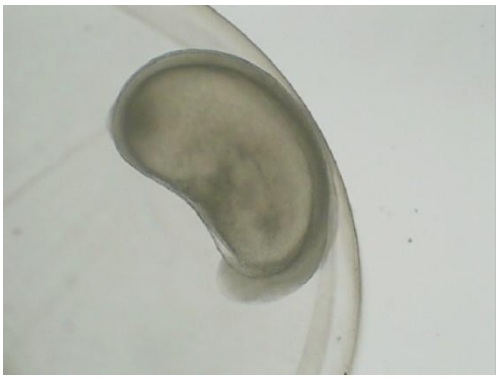
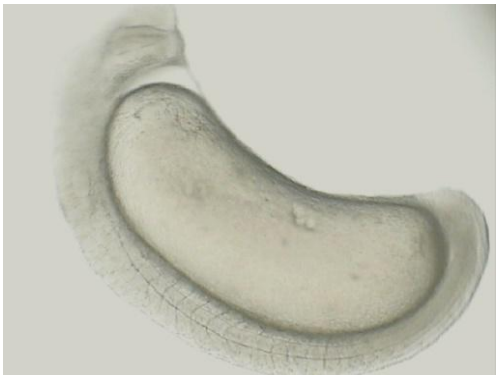
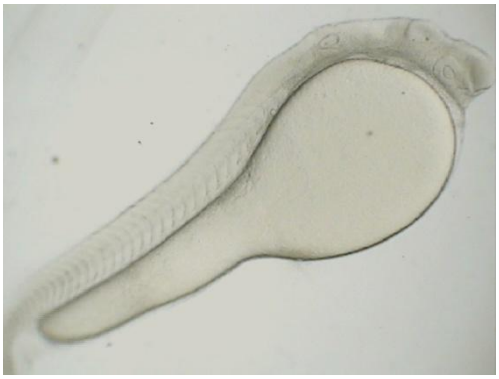
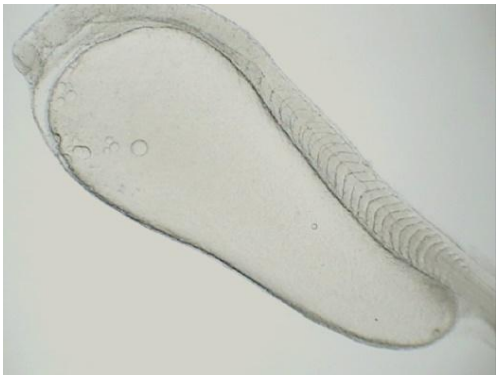
S.No.	Jayanti Rohu(Female)×Rohu(Male)	Jayanti Rohu(Male)×Rohu(Female)
1	1.0	1.4
2	0.9	1.0
3	1.0	1.0
4	1.1	1.0
5	1.0	0.9
6	1.2	0.8
7	1.1	0.9
8	1.1	0.9
9	1.0	1.0
10	1.1	1.0
Total	10.5	9.9
Average length	1.05	0.99

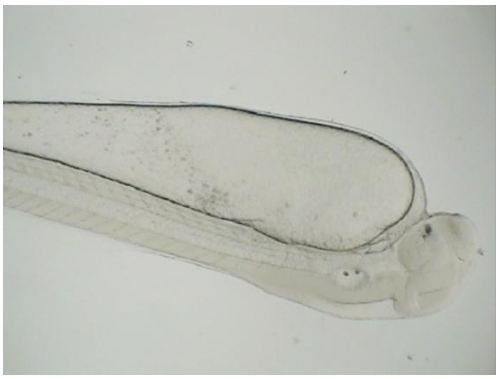
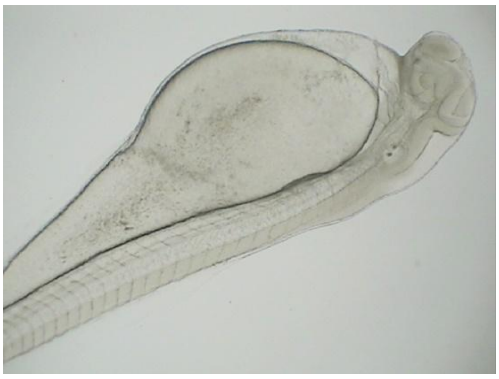
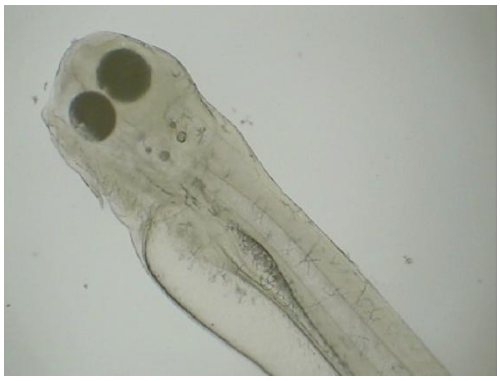
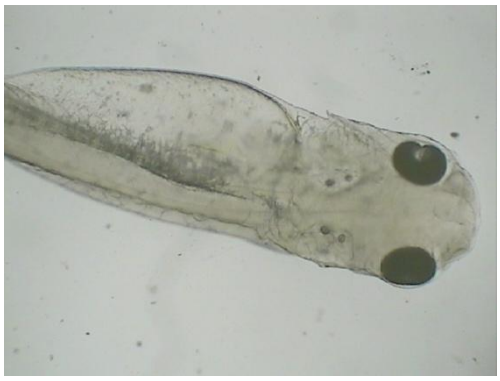
Table.5 Weight of spawns of Jayanti Rohu(Female)×Rohu(Male) and Jayanti Rohu(Male)×Rohu(Female) on day 31

Weight (g)	Jayanti Rohu(Female)×Rohu(Male)	Jayanti Rohu(Male)×Rohu(Female)
Total	0.0840	0.0801
Average	**0.0084**	**0.0080**

Plate.1 Embryonic development of cross of Jayanti Rohu (Female) × Rohu (Male) and cross of Jayanti Rohu (Male) × Rohu (Female)

TIME	Jayanti Rohu (Male) X Rohu (Female)	Jayanti Rohu (Female) X Rohu (Male)
3 Hrs		
	Early morula stage	Late morula stage
6 hrs		
	Development of blastodisc	Yolk plug stage

9 hrs		
	Developing embryo with well differentiated head and tail region	Developing embryo with well differentiated head and tail region Muscle segmentation started
12 hrs		
	Developing embryo showing head region and somites	Developing embryo showing head region and somites and larger amount of yolk sac
15 hrs		
	Embryo showing head region and somites	Embryo showing head region and somites

27 hrs		
	Embryo showing brain parts and yolk sac	Embryo showing brain parts and yolk sac
60 hrs		
	Hatchling with well developed eyes	Hatchling with well developed eyes
77 hrs		
	Hatchling showing fibrous ball of waste and body pigmentation	Hatchling showing fibrous ball of waste and body pigmentation

85 hrs		
	Hatchling with slower rate of yolk sac absorption	Hatchling with faster rate of yolk sac absorption
100 hrs		
	Hatchling with no pectoral fin development	Hatchling showing development of pectoral fin
110 hrs		
	Yolk sac completely absorbed	Yolk sac completely absorbed

Mortality rate was counted every third day from the day of transfer of hatchlings in the troughs. On the 31st day a total mortality of 16% in spawns of Jayanti Rohu (Female) × Rohu (Male) and 24% in spawns of Jayanti Rohu (Male) × Rohu (Female) was observed. On the same day 10 spawns were randomly selected and length and weight of the spawns were taken with a scientific weighing scale. Spawns of Jayanti Rohu (Female) × Rohu (Male) showed an average length of 1.05cm and weight of 0.0084gm on the other hand length and weight of spawns of Jayanti Rohu (Male) × Rohu (Female) were 0.99cm and 0.0080gm respectively. Above calculations clearly indicates that embryo and spawn of Jayanti Rohu (Female) × Rohu (Male) had a better growth and survival compared to Jayanti Rohu (Male) × Rohu (Female). Embryonic development and survival depends on various factors like physico-chemical parameters of water, body size of brooders, age group of brooders, method of breeding, etc. Other than these, maternal and paternal traits play an important role in the development of embryo and survival. Similar results to the present study were reported by other studies which reveal that maternal characters play major role in development and survival of embryo and spawn (Bernado, 1996). In fishes, body condition and genotype of the female parent affects the embryo and larval characteristics such as egg size, developmental rate, metabolism, growth and viability (Chambers *et al*., 1989; Chambers and Leggett, 1996; Kerrigan, 1997; Marteinsdottir and Steinarsson, 1998). However, maternal traits are considered more important than the paternal traits due to nutritional provisioning of embryo (Bernado, 1996). In the present study we observed a better development and survival of embryo of Jayanti Rohu (Female) × Rohu (Male) than Jayanti Rohu (Male) × Rohu (Female). We observed that cross with female Jayanti Rohu showed a better development and survival which supports the fact that maternal character play major role in development and survival.

With the experiment conducted we may conclude that maternal characters play a more important role in the development and survival of the embryo and spawn as compared to the paternal characters. Because of the better maternal traits due to selective breeding of Jayanti Rohu (Female), the embryos of cross of Jayanti Rohu (Female) × Rohu (Male) performed better as compared to the embryos of cross of Jayanti Rohu (Male × Rohum (Female). Jayanti Rohu (Female) × Rohu (Male) showed a faster embryonic development and better survival than Jayanti Rohu (Male) × Rohu (Female).

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