COMPARATIVE DATA ON EXOTIC FISH EMBRYOS SUITABLE FOR CLASSROOM AND LABORATORY DEMONSTRATIONS AND EXPERIMENTS*

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Many writers in the past have called attention to the excellent teaching and experimental material to be found in the embryos and young of the fish. However, textbooks and other sources of reference available to the majority of teachers fail to suggest the use of this material. For this reason, it has been thought desirable to discuss and compare a few of those forms which might be suitable for classroom and laboratory use.

Before taking up the comparative merits of some of the Exotic Fish it might be well to again call attention to the uses to which this type of material may be put in the classroom and laboratory.

Perhaps the most frequent and simplest use is to demonstrate a circulatory system in action. Most fish eggs are transparent—or at least the chorion is—and the movement of the corpuscles through artery, vein, capillaries and even the heart can be observed with a minimum of equipment and effort. The young fish is contained within its shell and obligingly pumps the blood around for all to see. Unlike the frog, it doesn't jerk or run away and thus spoil the demonstration. In many of the forms studied it is possible not only to see the capillaries, etc. but also to see the cellular structure of the heart, blood vessels and other organs. The relationships of the circulatory system to other structures is in this way made clearer.

Many of these exotic fish have unusual color patterns and shapes which have been shown to be inherited according to Mendelian laws. They can be used as striking demonstrations of these principles. Others have unusual courtship behavior and nesting habits and can be used in demonstrating methods of reproduction and care of the young. Comparisons between ovipariou s and viviparous forms are easily demonstrated.

However, it is in the field of embryology that the authors feel the fish embryo can be used most advantageously. In some of these forms the process of cell division occupies only 15-20 minutes for a complete mitotic cycle. The entire development from the time of fertilization to a young free swimming fish occupies only a few hours. Here then is a vertebrate animal which in a single day, a student or research worker may observe undergoing morphogenesis from an undifferentiated egg to a completely differentiated organism. It is almost like watching the plot of a moving picture unfold.

In our embryology classes, we furnish the students with live fish embryos in various stages of development and they observe the changes occuring

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under the microscope. They can see cleavage happen and the formation of the blastula. The formation of the embryonic axis and closure of the blastopore occurs as they watch. The embryo undergoes differentiation with the formation of optic vesicles, neural tube, somites, heart, tail bud, etc. All this can be seen happening at a speed that makes it interesting even to an adolescent. It is also much easier to understand what happens in the chick and pig embryos after observing the development of the living fish.

Specimens for these studies may be obtained at any season of the year and the expense of equipment and breeding stock is slight. All that one needs is a medium sized aquarium, a heater, thermostat and a pair of fish. Specific details concerning the maintenance of aquaria and breeding habits of the various fish may be obtained from almost any pet shop or water garden. References considered of especial value are included in a brief bibliography at the close of this paper.

The following table lists data obtained from various references and compares five forms studied and used by the authors in the Zoology Department at Oklahoma A.&M. College. There are many other forms which may be just as satisfactory. These were chosen because of their availability and because of the rapidity with which they develop. All are oviparous. For those who wish to study genetic characteristics only, the live bearers—i.e., Guppies, Moons, etc.—are especially recommended.

TABLE I

Comparative Data on Exotic Fish Suitable for Classroom and Laboratory Work

COMMON NAME	BETTA	PARADISE	BLUE OR THREE-SPOT GOURAMI	DANIO OR ZEBRA	MEDKA
Zoological Name	*Betta splendens*	*Macropodus opercularis*	*Trichogaster tricopterus*	*Brachydanio rerio*	*Oryzias latipes*
Size of Fish	3″	3-4″	4-5″	1½″	13/4″
Disposition	Peaceful with other fish. Males must be kept separate	Must have own tank or be kept with large fish	Peaceful. Kept in cummunity tank with young or old	Peaceful. Kept with other fish	Very peaceful
Hardiness	Hardy. High mortality of young	Very hardy	Very hardy	Hardy	Hardy
Food Preference	Live	Live	Omnivorous	Omnivorous	Omnivorous
Time to Mature	6 months	6 months	6 months	3-7 months	1½-3 Mo.
Temperature Range for Adult Fish	68-90° F.	50-85° F.	60-85° F.	50-100° F.	40-80° F.
Optimum Temperature for Adult Fish	73-75° F.	73-75° F.	73-75° F.	70-75° F.	60-70° F.

TABLE I (continued)

Comparative Data on Exotic Fish Suitable for Classroom and Laboratory Work

Common Name	Betta	Paradise	Blue or Three-spot Gourami	Danio or Zebra	Medka
Breeding Temperature	80° F.	78-82° F.	80° F.	80° F.	64-68° F.
Size of Tank for Spawning Fish	5 gal. or larger	5 gal. or larger	5 gal. or larger	20-30 in 5 gal.	1 gal. per pair
Size of Egg Approximate	0.30 mm.	0.30 mm.	0.30 mm.	0.60 mm.	1.27 mm.
Number of Eggs per Spawn	500-1000	100-500	100-500	95	1-80
Frequency of Spawn (if conditioned)	2 weeks	2-3 weeks	2 weeks	12-14 days	Every day during season
Ease of Obtaining Eggs	Eggs on the surface of nest	Same as Betta	Eggs and young float	Picked up from bottom with pipette or siphon	Attached to female or on plants in bunches
Incubation Period (to hatching)	48 hours	48 hours	36 hours	76 hours	6-10 days
Time After Hatching to Free-Swimming Stage	60 hours	72 hours	60 hours	——	——
Time to Complete Spawn	1-4 hours	1 hour	1-3 hours	30 minutes	——
Relative Price of Breeding Stock (Based on one company's list)	$2.00 per pair	$1.00 per pair	$1.00 per pair	$0.50 per pair	$0.60 per pair

In obtaining eggs from these fish it has been our observation that temperature and food are the critical factors in securing abundant egg production.

The first three fish listed in the table: Betta, Paradise, and Gourami are all Labyrinthine (air breathers). The male builds a nest of bubbles and takes care of the eggs and young. The female must be removed soon after completing her spawn or the male will injure her in protecting his brood. The courtship and breeding procedure is rather elaborate but characteristic. It is therefore easy to obtain embryos within seconds after fertilization. With all three forms, artificial insemination or stripping is feasible and practicable.

The eggs of these forms are all small and tend to float. The chorions are clear, delicate and transparent. Because they float, it is possible to study them with a microscope without special equipment. A hollow ground or "well" slide also gives excellent views. The Betta eggs are opaque both as to protoplasm and yolk but the optical density differs between the two substances so that cleavage is if anything more striking than in the transparent forms. The Gourami eggs are completely transparent while the Paradise are intermediate.

Perhaps the easiest of all fish to culture and also one of the best for these purposes is the Danio or Zebra fish. We cover the bottom of a 5 gallon aquarium with marbles, place in it about three dozen fish, set our temperature and provide them with a variety of food. Daily, we siphon off the debris on the bottom of the tank, allow it to settle, decant off the water and return it to the tank. Under binocular microscopes we pick up the eggs with a pipette and organize our cultures in finger bowls. Pint fruit jars ½ full of distilled water and floated in the aquaria will make excellent culture dishes and eliminate the need for an incubator. The Danio egg is transparent and small. The fish are hardy, attractive to watch and will usually furnish abundant material at all seasons of the year.

The Medaka egg is larger and has sticky threads on the outside. It remains attached to the vent of the female and thus necessitates handling her in order to obtain the eggs. However, for demonstration of circulation they are hard to beat. The embryo develops slower than do the others mentioned and for this reason is more susceptable to fungus attack. However, once hatched the young are easy to raise.

The development of both the Betta and the Danio has been photographed and moving pictures are available. (See bibliography)

SUMMARY. Attention is called to the desirability of using Exotic Fish eggs and/or embryos for various laboratory researchs or demonstrations. They have been found especially suitable for demonstrating circulation, inheritance, embryological development and for various types of research. A comparative table showing characteristics of five forms studied is submitted.

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