CHAPTER V

OBSERVATIONS ON OVARIES AND OVARIAN CYCLES
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1. General.

Brook (1978) provided a classical account of the teleost gonads based on an examination of 57 species, and distinguished eight different morphological types. Hickling and Hatenberg (1936) state that the ovary is an indicator of spawning seasons of fishes; Bretschneider and Duyvende de Wit and Cooper (1952) accounted for some teleost ovaries, giving their ovarian cycles.

The ovaries, of all the five fish species from Kashmir studied, exhibit great variety as regards their shape, size, weight, colour and extensions in the body cavity, depending upon intrinsic and extrinsic factors such as age, breeding habits, size of the fish, spawning season, temperature, availability of food and space etc.

In all the fishes selected for investigations, the ovaries are a pair of thickened coelomic epithelium (genital-ridge) in their earliest condition (stage I), containing spherical ova in the form of microscopic oogonia, with large round nuclei. The nuclei contain evenly distributed chromatin granules but no readily visible nucleolus. The faintly stained cytoplasm of the ova is finely granular and the cell membrane is distinct. These oogonia are surrounded by connective tissue supporting cells, which convey nutrition to them and are the follicular cells. The arrangement of follicles within the supporting tissues varies greatly in different species.

The ovaries start as two genital ridges along the dorsal coelomic wall, one on either side of the dorsal mesentery of the gut between it and the embryonic excretory organ. These occupy a considerable part of the body cavity in later stages, and are of the Cystovaria -n type. The increase in volume and weight of the ovary in the
maturing season is due to certain changes undergone by the contents of the eggs, resulting in the formation of yolk.

The intra-ovarian ova vary not only in their size but also in their inclusions. There are several batches of oocytes which originate in the ovary; and as the spawning continues, every season, these batches pass on from one stage to another being ultimately extruded from ovaries as eggs.

Hjort (1911) described seven distinct stages of maturity for the herrings of eastern North Sea and Icelandic waters. This classification, which slight modifications was subsequently followed by a number of workers (Graham - 1924, Hickeling - 1930, Clark - 1934, Hickeling and Rutenberg - 1936; Fairbridge - 1951; and Bower and Holliday 1963 (1961). The same scale has been applied in the present work with the only difference that the VI and VII stages have been grouped as one and named as stage VI, since there was no significant difference between the two stages.

The various stages of maturity defined in the present thesis are as follows:

**Stage I:** It corresponds to the stage described in the internationally accepted scale for the ovarian maturity. In this stage the ovaries are thin, small, wine-coloured epithelial ridges. Microscopic, transparent oogonia are present but not visible to the naked eye. The size varies in different species but all the ova are of the same small size (stage I).

**Stage II:** It corresponds to the internationally accepted second stage. The ovaries are pale yellow compact lobes, the right lobe often shorter than the left. This also includes recovering ovaries which are large bag-like and blood shot. The oocytes are with traces of yolk and visible to the naked eye. The diameter of the oocytes and ova varies greatly, half being somewhat large and half small (Stage II).
Stage III: The ovaries are large and yellow in colour. The ova are at the penultimate stage of maturity, being semi-opaque. The ova diameter varies in different species, about one third of the ova being small (Stage III).

Stage IV: The ovaries are large and bright yellow in colour. The ova are fully laden with yolk and almost of the same size. Some ova may pass out of the genital pore on lightly pressing the abdomen at this stage (Stage IV).

Stage V: The ovaries are large and jelly-like, very much distended and speckled appearance due to large transparent ova. All the ova are of large size. The mature ova come out with even slightest pressure on the belly of the fish. Stripping is successful only at this stage (Stage V).

Stage VI: The ovaries are shrunken, flaccid, bag-like and blood shot. They are very much reduced in volume and occupy very little space in the body cavity. There may be a few large, hard, pale yellow old ova inside, still persisting.

2. The Species.

1. Oreamus Plagiostomus (HECKEL)

The ovaries are elongated, bilobed anteriorly, but fused posteriorly (Plate I). Each lobe is stumpy and covered over by a thin black sheath of peritonium. They lie one on either side of the air-bladder, and remain attached to the latter by means of the Mesovarium. The mature ovary attains a length of 9.5 cm., and weighs about 13-15 grms in a fish with a length of 24 cm and weighing between 300 g to 350 kg.

The Seasonal Ovarian Cycle:

Oreamus plagiostomus is amongst the early spring spawners of Kashmir fishes. It starts spawning by the end of April and continues up to the end of May. The Seasonal ovarian Cycle of Oreamus plagiostomus as revealed by month wise study are given below:
JANUARY and FEBRUARY: During these months the ovaries are of medium size and, therefore, do not cause the bulging out of the abdomen of the fish. A large number of mature ova are present as compared with the tiny immature ova, which forms about half of the ova in ovaries. The ovum is fully laden with yolk, which is in the form of spherules. The average larger ova diameter is 2mm. This is the late II stage of the ovary (Plate I fig. 2).

MAY:

During the month of May, the ovary is at the climax of its activity (spawning season). The temperature of water in lakes is comparatively high (10°C - 12°C), but very low in the hill streams which are fed by ice water. The fully mature ova are spherical, of large size and filled with dense mass of yolk. A few smaller ova are also present. The yolk is increased considerably at this time and forms the greater bulk of the egg. The cytoplasmic area is increased in size and the nucleus is proportionally reduced, with nucleoli arranged along the nuclear membrane. During the month of May, most of the ova are extruded from the ovary and natural spawning takes place. The ovary is in the V stage of maturity and the ova diameter is about 3mm. Even slight pressure on abdomen causes ova extrusion and stripping is easy. This stage is also called the running stage.

JUNE and JULY:

The ovaries are almost devoid of ova or in a gradual declining condition. Most of the fishes have such spent ovaries, which contain either immature or a few unspawned ripe ova (Plate I stage W).

AUGUST, SEPTEMBER and OCTOBER:

The ovaries of Orthias plagiotomus are considerably reduced in size and are flaccid during the months of August, September and October. There is rapid beginning of vitellogenesis of ova during these months. Most of the ova are in I and late II stage of maturity, although some may have attained stage II. The ovaries are
however in stage I of the maturity. (Plate I, Stage I).

NOVEMBER and DECEMBER:

The ovaries are in reformative phase. The ova are maturing through at a comparatively slow rate, the previous primary and secondary oocyte stages being changed into larger ova in which yolk formation has set in. The ovaries gain in size, and by the end of December these have attained II and III stages of maturity (Plate I).

2. Schizothorax asocimus HECKEL:

The ovaries are two large elongated structures which occupy a considerable part of the body cavity, fused caudally just dorsal to the genital pore (Plate IV). They form a single bilobed structure. Each lobe is covered externally by a thick black layer of peritoneum and lies on each side of the air-bladder by means of their mesovarium. When the ovary is mature, it attains very large sizes of the order of 15 cm in length in a fish of 45.6 cm in length and 1453 gms in weight, and weighs as much as 188 g. It is of cream colour.

The Seasonal Ovarian Cycle:

The ovarian cycle as revealed by month wise study of the ovaries is given below:-

JANUARY and FEBRUARY:

The ovary contains ova in III stage of maturity. The ovary, therefore, is not much expanded and does not cause protrusion of the abdomen. The mature ova, which are densely packed with yolk globules. The cytoplasmic vacuolisation is complete, in mature ova and the immature ova also show the tendency for vacuolisation. The average diameter is 2.5 mm (Plate IV, Stage III), and the ovary is in stage III.

MARCH and APRIL:

The ovary, during the months of March and April, is at its peak of activity (spawning season). The snow on the mountains melts and feeds the hill streams which is the usual spawning venue of Schizothorax asocimus. During these months the fishes start
migrating to the hillstreams. The mature ova are round, spherical, and of large size, filled with a dense mass of yolk. The size of the nucleus is relatively reduced, with nucleoli arranged along the nuclear membranes. The mean ova diameter is 3.5 mm. (Plate II, Stage IV).

This is the IV stage of the ovary, when few fish of the genus Schizothorax is present in the lakes of Kashmir, since almost all the mature fishes are migrating or have migrated for spawning.

**MAY:**

The ovary is fully mature and the fish is in running condition, the ripe eggs being expelled out of the genital aperture at spawning. The eggs are pale yellow in colour and the average ova diameter is 3.5 mm. (The largest reaching even 4 mm.) (Plate II, Stage V) At this time the ovary is in stage V (international). A few fish are also spent.

**JUNE:**

All the fishes are spent, but some ovaries have a few large ova (3.5 mm) left even in June. The ovaries are flaccid, shrunken and mostly in an absolutely spent condition.

**JULY and AUGUST:**

The condition of the ovary is almost the same as found in the month of June. Upto the middle of August, however, there are present inside the ovary some newly formed immature ova and thus the ovary is in stage I.

**SEPTEMBER and OCTOBER:**

The ovaries are reforming but are still very small in size. Their size and shape is exactly like the germinal ridges found in first forming ovaries. The oogonia are microscopic and not visible to the naked eye (Plate II, Stage II) and are wine red in colour. The ovaries are in the early II stage of maturity during September and October.
The ovaries are heading towards maturity, but at a very slow pace, since the water temperature is very low (of the order of 2°C to 3°C). There is an increase in the size of the ova, which are now slightly visible to the naked eye. The vacule formation has also started near the periphery, and extends inwards. The nucleolé are arranged along the walls of the oocytes (Plate II A). The ovaries are still in late stage II.

3. *Gyprinus Carpio Commum* LINN:

The mature ovaries are very large, occupying considerable space in the body cavity and weighing as much as 36.4 g in a fish with 14.4 cm in length and 88 g in weight.

The ovaries are two elongated structures fused caudally. These are not covered over by black peritoneum as in the case of *Schizothorax, Orasimus plagiopterus* and *Namachilus*, but by a very thin transparent membrane of peritoneum. The ova are attached to the thin folds of ovigerous lamellae which are densely packed. The colour of the ovary is shining yellowish brown. The ovaries remain attached to the air-bladder by means of thin mesovaria.

The Seasonal Ovarian Cycle

The seasonal ovarian cycle in *Gyprinus Carpio communis* differs a good deal from those observed in other fishes of Kashmir. This may be attributed to a long continuous breeding period. The ovaries contain fully mature ova from the middle of April to the middle of June and then after an interval of one month i.e., up to the middle of July, it again spawns up to the end of July. The seasonal cycle is as follows:

**JANUARY and FEBRUARY**

A large proportion of mature ova is present, as compared with
the smaller bulk of tiny immature ones. The ovum is fully laden with yolk, which is deposited in the form of globules. The cytoplasm has also undergone noticeable vacuolisation (Plate III A (left)). The ovary is in III stage, although some ova remain in the II stage of development.

MARCH:

The ovaries exhibit renovating activity. The weight and the size of the ovaries undergo tremendous change due to the rapid addition of yolk in cytoplasm. The densely packed ova in the ovary are slightly loosened during this month. The cytoplasmic area in the egg has increased in size and the nucleus is proportionately reduced with the contained nucleoli arranged along the nuclear membrane. The ovary is in the IV stage of maturity. The diameter of the ova is 1.9 mm. Besides, there are some primary immature ova also present. (Plate III A (left)).

APRIL:

The ovaries are fully mature with eggs of considerably large size (Plate III C (left)). The ovary has enlarged very much with the result that the abdomen of the fish is appreciably swollen. This is the oozing stage and thus stage V of the ovary. The eggs from such ovaries flow spontaneously. The ova diameter is as much as 2.5 mm. There are also some immature ova present in the ovary.

MAY:

The ovary is reduced in size. It contains ova in V stage i.e., large with completely vacuolated cytoplasm and some in the I and II stages reforming ova in which the yolk formation has just started.

JUNE:

The ovary is regaining its size. It contains ova which
in IV stage i.e., fully laden with yolk. There are also present a smaller bulk of immature ova (Plate IV Stage IV). But developmental activities are very rapid. Some ova are in primary and a few ova in the secondary oocyte stages.

**JULY and AUGUST:**

The ovaries are again fully mature, but in some ova are in IV stage while still others in V stage. The ovaries are oozing during the last week of July and upto middle of August. This is the main breeding season of the Scale carps in Kashmir.

**SEPTEMBER and OCTOBER:**

The partially spent ovaries are heading towards reformation (II & III) stages. There is increase in the size of ova and thus regeneration of the ovary. But these changes are rather slow. Some ova are perfectly mature (Plate IV left), and the cytoplasm has undergone vacuolation (Stage IV). Some individuals may spawn even in September (Stage V). Thus, there is second spawning of the fish in a year.

**NOVEMBER and DECEMBER:**

A large proportion of mature ova are present but development is suppressed and ova lie dormant during the cold months in stage IV. The ovary has gained in size and weight.

4. **Gambura affinis holbrooki (BAIRD & GIRARD)**

This ovary differs from those of the other forms studied, being single lobed (Plate IV). The ovary is very small in size i.e., 3.5 mm when immature and only 10 mm when in fully mature fishes of 3.5 cm to 3.6 cm. length and about 93 g in weight, when fully mature. The mature ova measure upto 3.0 mm in diameter and are of reddish brown colour, and contain a large number of fat globules. The ovaries are covered over by a thick membrane of peritoneum
which is never black.

The Seasonal Ovarian Cycle:

The growing oocytes are held back almost in the ovary, till the suitable temperature in the months of June, July, August and September. During these four months there is repeated productions of broods at regular intervals of 5 to 45 days, each brood consisting of 20 to 25 young ones.

The intra-ovarian ova develop from March to June and in July to September the embryos are formed after internal fertilisation and nourished in the ovarian placenta.

5. Nemachilus Kashmiriensis HORA :-

The ovaries are bilobed only anteriorly and occupy large space in the body cavity when fully mature (Plate V). Each is more or less of the shape of a beatle leaf. It is enveloped by a black peritoneal membrane, and is attached to the air-bladder anteriorly by means of a thin mesovarium. The ovary is dirty white in colour.

The Seasonal Ovarian Cycle:

Amongst all the Kashmir fishes, this is the first spawner of the season, from beginning of April to the end of April. The ripe ova of the months of November and December remain dormant during the cold months of January and February till the arrival of the month of March when they mature rapidly and are spawned at the beginning of April.

JANUARY, FEBRUARY and MARCH:

The mature ovaries contain small number of immature ova also. In the month of March, the ovary is heading towards maturity and thus in great activity. The temperature of the water is rising, making the environments more appropriate for development. There are
mature ova of considerably large size present in large numbers. The cytoplasmic area increases in size, being rich in yolk, and the nucleus is proportionately reduced. (Plate A) The ovary is thus identified as in stage IV. The diameter of the ova is 1.9 mm.

APRIL:

The ovary is fully mature and the ova of considerable size. The diameter of the ova is about 2 mm. The cytoplasm is completely vacuolated (Plate ). The fish is said to be running, as the flow of the ova is with great ease. A few immature ova are also present.

MAY and JUNE:

There is gradual decline in the condition of the ovary as compared with the condition in the previous month. The ovaries have ovulated and are in spent condition. The ovaries contain some large unspawned ova and some ova in I and II stage of maturity.

JULY and AUGUST:

The condition of the ovary is almost in similar condition to that found in the previous months, but they contain immature ova only. The size of the reformed ova was also very small.

SEPTEMBER:

The ovary contains only immature ova at the primary and secondary oocyte stages. The ova had central nucleus and were devoid of yolk deposition. The ovaries are seen to be starting growth after the spent up condition. The ova in the ovary are microscopic (Plate C). The nucleus occupied greater part of the ovum. The ovary is thus in stage II only.

OCTOBER:

The ovary is heading towards reformatory stages with great speed. The Yolk formation and vacuolisation has started at periphery
and extends inwards. The nucleoli are arranged along the nuclear wall of the oocytes. The ova are now sufficiently developed. This is the III stage of the ovaries.

**November and December:**

A large proportion of the mature ova is present as compared to the small immature ones. The ovum is fully laden with yolk which is in the form of globules. (Plate Y - See). The rate of transition from the previous condition is rather slow on account of the low temperature.
Schizothorax esocinus Heckel
Gambusia affinis holbrooki (Baird & Girard)

Plate IV

Maturation stages of the Ovary of Gambusia affinis holbrooki \( \times 4 \)

Stage I
- Oogonia
- Vagina
- Ov. ap.

Stage II
- Oocyte
- Vagina
- Ov. ap.

Stage III
- Immature ova
- Maturing ova
- Vagina

Stage IV
- Mature ova
- Ov. ap.

Stage V
- Embryos
- Ripe ova
- Ov. ap.
Plate V

Maturation stages of the Ovary of Nemachilus kashmiriensis Natural size

- stage I: oogonia, ov. sp.
- stage II: oocyte, ov. sp.
- stage III: immature ova, maturing ova
- stage IV: right ovary, mature ova
- stage V: ripe ova
- stage VI: ripe ova, spent ovary