SUMMARY

From the thorough studies on histological, cytological (autoradiographic), hydrobiological and annual gonado somatic index (G.S.I.) variation at their reproductive cycle in both the hot spring and fresh water fishes I have arrived at this view that (I) earlier maturation prevails in hot spring fishes. It has also been suggested that several physico-chemical parameters are favourable for pre-ripening of the testes. The detailed study on hydrobiology reveals that (i) the pH of hot spring water recorded for the consecutive couple of years ranging from 7.5 to 9.3 is also very helpful for pisciculture at that water mass; (ii) the depth of water mass (1.4 meters) and turbidity due to heavy planktonic growth are also useful for productivity at the said water mass; (iii) besides the favourable physico chemical parameters, the hot spring water of the said dissertation spot is enriched with certain essential inorganic components viz. nitrogen, phosphate, sulphate, potassium, calcium and magnesium promoting the growth of several flora and fauna in the said water area as those are in urgent need of fish growth, maturity and spawning; (iv) one of the most important physical parameters is the temperature that plays a vital role for enhancing the power of maturation and spawning (as the temperature in hot spring spot always become higher from 3 to $7^\circ C$ than the normal fresh water bodies).
In all the four species of hot spring fishes (viz. in *C. fasciata*, *P. sophore*, *M. pancalus* and *A. panchax*) the spermiation starts much more earlier than the individuals of the same species in fresh water fishes. In hot spring fish, *C. fasciata*, the active spermiation occurs in May and continues upto July but in the fresh water species, the spermiation starts in June and continues upto August. In hot spring fish, *P. sophore*, the active spermiation period starts in April and continues upto June but in fresh water fishes the said period starts in June and continues upto August. In hot spring fish, *M. pancalus*, the spermiation begins in April and continues upto June but in fresh water fishes, the active spermiation begins in June and lasts upto August. In hot spring fish, *A. panchax*, the active spermiation starts in April that continues upto end of June but the said period in fresh water habitat starts in May that continues upto July. It has been suggested that the early maturation property of males in hot spring fishes is an adaptive significance to the successful spermiation that is wanting in fresh water fishes. (II) All the four species of hot spring fishes show 'biphasic' gonadal cycle whereas the fresh water fishes are all 'monophasic' excepting *A. panchax* that exhibits 'biphasic' gonadal cycle. On the occurrence of frequency percentage of different germ cell types i.e. in terms of relative abundance of different germ cell types in histological preparation and the availability of annual G.S.I. value, it has been suggested that all the four species of hot spring fishes show
two peaks in their gonadal cycle, one in summer months (i.e. from April to June) which is designated as summer phase or first spawning phase and the other in winter months (i.e. from October to November) which is called as winter phase or second spawning phase. The total duration of spermiation period (combining summer phase and winter phase) in all the hot spring fishes is much prolonged than the duration of active spermiation period in fresh water fishes as all the fresh water fishes excepting A. panchax show only one peak in their gonadal cycle.

The occurrence of frequency percentage of different germ cell types in histological preparation suggest that the testicular cycle in hot spring fishes has been divided into two resting, growth, maturation and spawning phases each but in fresh water fishes the said cycle has been divided into one resting, growth, maturation and spawning phase each. The detailed study on histological and cytological preparation suggest that during the spawning phases the lobule boundary walls of the testes in C. fasciata are thick, indistinctly surrounded by thick boundary wall in P. sophore, very thin in M. pancalus and becomes thin but distinct in A. panchax. Inside the lobule boundary walls of the seminiferous lobule of the testes in hot spring fishes of C. fasciata, P. sophore and M. pancalus, many cysts or nests of different developmental stages are predominant but each cyst or nest always contains only one type of germ cell but in
A. panchax numerous cysts in a lobule of one type of germ cells are obtained. The cell size measurement of a particular germ cell type present in different phases at their reproductive cycle shows a little differences. The maximum size is obtained either in growth or maturation phases while its minimum size is available in their resting phases. The cell size of a particular cell type in hot spring fishes is somewhat larger than the cellular dimensions of the same cell type of fresh water fishes. On the basis of their cellular shapes, sizes, staining intensities and specific morphological characteristics in both the hot spring and fresh water fishes, eight different kinds of cell types have been suggested viz. primary spermatogonium, secondary spermatogonium, primary spermatocytes, secondary spermatocytes, early spermatid, mid-spermatid, late-spermatid and spermatozoa.

From the thorough autoradiographic studies on the chronology of meiosis and spermiogenesis in four species of fishes in both the hot spring and fresh water bodies it has been observed that the duration of meiosis is much shorter than the duration of spermiogenesis. The study further suggests that the duration of meiosis in hot spring fishes is shorter in comparison to the duration of meiosis in fresh water fishes. The duration of meiosis in hot spring fishes is about in between 3.00 and 3.36 days, in between 3.04 and 3.20 days, in between 2.04 and 2.25 days and in between 3.82 and 4.36 days in C. fasciata, P. sophore, M. pancalus and A. panchax respectively.
The duration of meiosis in fresh water fishes is about in between 3.25 and 3.50 days, 3.50 and 3.64 days, 2.50 and 2.80 days and in between 3.95 and 4.60 days in C. fasciata, P. sophore, M. pascalus and A. panchax respectively. The duration of spermiogenesis in hot spring fishes becomes completed in between 4.64 and 5.40 days, 6.10 and 6.70 days, 6.63 and 7.16 days and in between 5.64 and 6.82 days in C. fasciata, P. sophore, M. pascalus and A. panchax respectively while the time requires for completion of spermiogenesis in fresh water fishes is in between 6.00 and 6.43 days, 7.16 and 7.60 days, 8.70 and 9.30 days and in between 4.60 and 6.95 days in C. fasciata, P. sophore, M. pascalus and A. panchax respectively.

The life span of spermiogenesis in hot spring fishes is much shorter than the duration of spermiogenesis in fresh water fishes. So far as the duration of individual stages of meiosis is concerned it has been revealed that the duration of zygotene stage remains for a very short time in all the species of both hot spring and fresh water fishes. The duration of zygotene in hot spring fishes persists .12 day to .36 day, .11 to .42 day, .16 to .38 day and less than .32 day in C. fasciata, P. sophore, M. pascalus and A. panchax respectively while the said duration in fresh water fishes exists from .10 to .19 day, .18 to .39 day, .12 to .55 day and less than .30 day in C. fasciata, P. sophore, M. pascalus and A. panchax respectively. The duration of pachytene in both the hot spring and fresh water fishes is the
longest among all other meiotic stages. It has also been suggested that duration of the stage in hot spring fishes is somewhat shorter than the duration of this stage in fresh water fishes. In hot spring fishes the duration of this stage has been recorded in between 1.38 to 1.68 days, 1.50 to 2.47 days, .75 to 1.14 days and 2.32 to 2.80 days in C. fasciata, P. sophore, M. pancalus, and A. panchax respectively, while in fresh water fishes the pachytene period persists in between 1.73 to 2.00 days, 2.56 to 2.90 days, 1.29 to 1.55 days and 2.10 to 2.95 days in C. fasciata, P. sophore, M. pancalus and A. panchax respectively. It has been noted that the duration of the remaining stages of meiosis lasts for a brief period.

Lastly it can be concluded that water temperature along with other physico-chemical parameters in the dissertation spot is the probable cue for initiation of spermatogenesis in fishes and as the dissertation spot harbours a higher level of zooplankton throughout the year the gonadal maturation is considerably influenced by the availability of such nutritional value whereas comparatively low temperature and difference in physico-chemical status in fresh water bodies probably induces to arrest their gonadal maturation in winter phase.