GENERAL SUMMARY AND CONCLUSIONS
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Our country has a traditional system of carp culture which dependent on naturally occurring fish spawn/early fry, of major carps mixed with undesirable species. The Central Inland Fisheries Research Institute gradually developed a technology of practices of carp culture. Modern carp culture technology which has come to be known as composite fish culture aims at fuller utilization of pond productivity at different ecological niches by culturing together fast growth six compatible species of complementary feeding habits, *(Catla, Catla catla, silver carp, Hypophthalmichthys molitrix, rohu Labeo rohita, grass carp Ctenopharyngodon idella, mrigal Cirrhinus mrigala, and commoncarp Cyprinus carpio)*. Of these, catla and silver carp are surface feeders, rohu is a column feeder, grass carp is a macro-vegetation feeder and mrigal and common carp are the bottom feeders. At Hadapsar near Pune city in Maharashtra State 6 stocking ponds were chosen to establish sub-centre of the Central Inland Capture Fisheries Research Institute for composite fish culture including all the above species. Perusal of literature revealed paucity of information on some biological aspects including reproduction of silver
carp, Hypophthalmichthys molitrix (Velenciennes). Hence, the present study was undertaken with the view to understand the growth in terms of length-frequency distribution and length weight, relative condition, gastro-and gonado somatic indices, size at first sexual maturity, maturity and spawning, fecundity, sexual dimorphism and sex-composition, and macro- and microscopic observations on male and female gonads. Physical and chemical conditions of water like temperature, pH, dissolved oxygen, free carbon-dioxide, total alkalinity and transparency were also determined during the study period.

Length frequency study revealed that the hatchlings belong to June, July and August broods. The June hatchlings show uniform growth throughout the first year, giving a mean growth of 26.93 mm per month. The July hatchlings show fast growth from August to February during the first year, giving a mean growth of 42.58 mm per month, from March to May they give a mean growth of 32.32 mm per month and from June onwards 28.69 mm per month. These hatchlings give a mean growth of 35.75 mm per month growth during the first year. The August hatchlings show faster growth than July hatchlings from September to February giving a mean growth of 55.55 mm per month, but from March to May they give a mean growth of 29.41 mm per month and from June onwards 28.35 mm per month during first year. These hatchings
give a mean growth of 38.82 mm per month during the first year growth. The June hatchlings after completion of one year life merge into July hatchlings and these fishes of both the broods give a mean growth of 23.02 mm per month during second year. The August hatchlings after completion of one year life merged into the above group (June-.July) from October onwards i.e. after completion of 14 months. All these fishes belonging to different ages show similar rate of growth by giving a mean growth of 19.77 mm per month till August, i.e. till completion of second year life. Thus, the fishes grow to a mean length of 335 mm by the end of first year and by the end of second year they grow to a mean length of 425 mm. The retardation of growth in fish has been correlated with the beginning of summer (March) till the close of monsoon (August-September). This period has been correlated with high temperature, decrease in transparency, and spawning.

Length weight relationship show a logarithmic of equation Log W = -4.4555 + 2.7934 Log L for undifferentiated sexes including adult males and females. For males it is log W = -5.1324 + 3.0629 Log L and for females Log W = -4.5567 + 2.8417 Log L. The correlation coefficient (r) between log length and log weight is 0.9834, 0.9707 and 0.9943 for undifferentiated sexes including adult males and females for males, and for females, respectively.
Relative condition (Kn) is low at 98 mm length and then increases steadily till 140 mm. However, it decreases steadily upto 225 mm. From 232 to 251 mm it suddenly increases showing a peak of 251 mm and subsequently decreases little from 286 to 336 mm. It gradually increases 350 to 378 mm and 450 mm with a peak at 378 mm, showing decrease at 408 mm. Increase in Kn from 98 to 196 mm is probably due to intensive feeding habit in juveniles and from 242 mm due to onset of maturity. Gradual decline in Kn from 387 mm is probably due to sexual activity and further recovery. In males Kn showing peak at 316 and 337 mm is attributed to the feeding activity and maturation of gonads. Subsequent decrease is indicated by spawned out gametes. In females Kn showing high value at 346 mm indicates onset of maturity and subsequent decrease is associated with spawned out gametes.

Gastro-somatic index on the juvenile till to the maturation of sex products show decrease in gastrosomatic index in February, June to September and December is correlated with low feeding activity and maturation of sex products. High values in January, March to May and further in October reveal high feeding intensity. Gonado somatic index shows that with rise in value from February to April coinciding with maturation of gametes and as these gametes
mature the index increased in May and June. As the gametes spawned out the index decreased during July to September.

(S) Size at first sexual maturity, determined on the basis of macro- and microscopic observation of gonads of different fish length of 1st and 2nd year size group from March to August shows 365 mm fish length for males and 375 mm for females when the fish is about 11 months old for males and 20 months old for females.

Maturity and spawning studied on the basis of determination of ova-diameter and classifying into 7 stages show that ova in stage 1 and 2 are found throughout the year but not from May to August. Maturity stage 3 occur in March and stage 4 in April. By May mature stage 5 and 6 appear and continue till August. The percentage of mature females increase from May to June and from July to September it decreases, indicating a single spawning season from June to August.

Fecundity in relation to fish length shows that the number of eggs increase with size giving an expression \( \log F = -3.5020 + 3.2652 \log L \) and \( r' = 0.7731 \). Fecundity in relation to fish weight gives an expression \( \log F = 2.0712 + 1.0230 \log Wt. \) and \( r' = 0.6275 \). Fecundity in relation
to ovary length gives an expression $\log F = 0.4866 + 2.1561 \log O_l$ and $'r' = 0.6020$, revealing the increase in number of ova at a rate of 2.1561 times the length of ovary. Fecundity in relation to ovary weight shows increase in number of ova at a rate of 0.8293 times the ovary weight and gives an expression $\log F = 3.3057 + 0.8293 \log O_w$ and $'r' = 0.9604$. Relative fecundity shows that all the fishes belonging to the second year age group at lengths 372 and 378 mm in stage 5 and from 380 to 464 mm in stage 6. Relative fecundity per gram body weight generally increase in stage 6 than in stage 5. Similar trend is observed when relative fecundity is calculated as per gram ovary weight. The average number of eggs per gram total weight is 140 and per gram ovary weight is 946. Total fecundity is less in the ovaries belonging to stage 5 than those belonging to stage 6.

Sexual dimorphism study shows roughness of the pectoral fins during maturing and mature males and become larger than females. This feature disappears after breeding season. Maturing and mature females show soft bulging and round abdomen, and perfectly with swollen and pinkish vent. Sex composition study made in fishes from 300 to 479 mm show no significant
difference in abundance of any sex. However, from 300 to 389 mm males outnumber and from 390 mm females outnumber. A chi-square test show that there is no significant difference between the hypothetical ratio and observed one. Hence, sex ratio in population is 1:1.

The testes are symmetrically placed on either side of the air bladder and are attached by a thin mesorchium to the dorsal side of the abdominal cavity. Mature testes, milky white in colour are paired, elongated, dorso-ventrally compressed, and thick in middle and slightly narrow at the free ends which unite posteriorly in a common genital opening laying between the alimentary canal and kidneys. The ovary is small, thin tubular or ribbon shaped occupy nearly half of the abdominal cavity. It is also attached by thin peritoneal membrane. The ovary makes its first appearance near the vent and then develops anteriorly. Mature ovaries are paired elongated structure and occupy almost entire body cavity. They are suspended from the dorsal wall of the body cavity by mesoovarium. Both thelobes of the ovary are united posteriorly to form a short oviduct which opens to exterior through a common urinogenital pore.
In immature fish the gonad can be anatomically differentiated as either presumptive testes or ovary. The youngest gonad examined consists of pear shaped lamellae connected by a short stalk of fibrous tissue to the abdominal wall at both sides of mysentary. They are formed by one or a few primordial germ cells surrounded by a thin sheet of fibroblast. As the gonads develops, further anatomical differences take place. Lamellae become large with wider vascular side and more abundant fibrous connective tissue and also in the germinal part. In this part, the germ cells, either single or in small nests, are more numerous, either single or in cords. Such structure is found in fishes from 85 to 120 mm in length. Gonad is differentiated microscopically from fish length 110 - 185 mm onwards. The broad gonadial attachment to the dorsal peritoneum is indicative of anatomical differentiated ovary (70 - 90 mm). The narrow gonadial attachment to the dorsal peritoneum is indicative of anatomical differentiated testes (60 - 90 mm). As the gonads are differentiated with the growth of the fish 6 stages in males and 7 stages in females are recognised both in external appearance and in histological preperations in one year and two year old fishes. In males, virgin gonad appears in January, maturing virgin from February to
April, maturing from March to May, mature in May and June, gravid during June to August, and spawning/spent from June to November. In females, virgin gonads appear during January and February, maturing virgin from March to June, developing from July to October, developed from November to March, gravid from April to August, spawning from June to September and recovery from October to March. In males 5 stages in sperm development occur germ cells, spermatogonia, primary and secondary spermatocytes, spermatids and development of sperms. During this development process interstitial cells and intralobular somatic cells also differentiate. In females 7 stages in yolked oocyte development occur - germ cells, oogonia, early peri nuclear oocyte, reserve fund oocyte, late perinuclear oocyte, opaque oocytes with yolk vesicles and development yolk granules oocytes. In males development of sperms is observed in 11 months and in females development of yolk granule oocyte is observed in 20 months. Thus, the maturing virgin appearing for the first time in first year, fish in February and March in males and females, respectively, which had small gonad and a few spermatogonia with abundant spermatocytes and a
few oogonia with early perinuclear oocytes, changed during the 4 and 15 months into a male and female, respectively, capable of spawning in which the gonad filled the body cavity and contained large numbers of mature gametes.

Silver carp do not breed in confined waters and for breeding, induced breeding technique is therefore required. The maturation of gonads occur within the temperature range from 26.5 to 32°C and has a direct bearing on the monsoon cycle with increasing rainfall, humidity and decreasing transparency.