SUMMARY

The study has been made on some fresh-water cultivable fishes with special reference to environment. The cultivable major carps such as *Labeo rohita* (Ham. Buch.), *Catla catla* (Ham. Buch.), *Cirrhina mrigala* (Ham. Buch.) and *Cyprinus carpio* (L.) are of economic value and cultured throughout India. A study of the cultivable major carps with reference to physico-chemical and biological conditions of a body of water has not been done so far in detail. Therefore, the present work on the cultivable fishes like *Labeo rohita* (Ham. Buch.), *Catla catla* (Ham. Buch.), *Cirrhina mrigala* (Ham. Buch.) and *Cyprinus carpio* (L.) has been selected for environmental studies. Culture of major carps, in the
water of Sagar lake was started from 1965-66 by the Fisheries Department, Government of Madhya Pradesh.

Sagar lake is situated in the heart of Sagar city. The lake is surrounded by a number of ghats and by human habitation. The present area of the lake is about 200 acres, and the catchment area is about 5.51 acres. Macrovegetation is present all along the littoral zones. The number of predatory fishes are comparatively more than the cultivable fishes. The present study incorporates a survey of the lake in respect to its history, geology and climatic conditions, monthly collection of the water samples, soil samples, zooplankton and monthly collection of fishes from the ten different sampling stations; five littoral and five limnetic zones. Seasonal, spatial, seasonal variation of physico-chemical factors, biological study of water and population of cultivable fishes are represented in tabular form, climograph, pie-diagrams and histograms. The data were analysed statistically to obtain the analysis of variation (’F’ test), and the correlation coefficient (’r’) between cultivable fishes and different factors of the water and soil.

The present investigation shows the following facts:

1. The climate of Sagar is generally pleasant and salubrious. Winter lasts from November to February, summer from March to June, and the rainy season from July to October. December and January are the
coldest months of the winter, and have an average mean
monthly temperature of 17.8°C. The average mean monthly
temperature reaches the highest point of 30.6°C in the
month of May and the rainfall reaches the highest point
of 567 mm in the month of August. During the rainy
season, generally heavy clouds or overcast skies are
observed.

2. During the present investigation the average air
temperature ranged from the minimum of 20°C to the
maximum of 33.8°C. However, the average water
temperature ranged from 18.6°C to 29.7°C. Analysis
of variance of air and water temperature showed
significant F value with season.

3. Transparency of water showed monthly variations. The
average transparency varied from the lowest, 16.8 cm
at littoral zones to the highest, 64.2 cm, at limnetic
zones. Significant F = 9.95 value of analysis of
variance of transparency with season supports the
seasonal variation. The analysis of variance of
transparency with zones also shows significant F value.

4. The average pH of the lake water ranged from 7.16 at
limnetic zones to 8.46 at littoral zones. Statistical
analysis of variance of pH shows significant F = 328
value with season.
5. Dissolved oxygen of water ranges from average minimum of 4.64 ppm at littoral zones and average maximum of 13.6 ppm at limnetic zones. Analysis of variance of dissolved oxygen shows significant F value with season and also with zone. In the present finding, the higher value of dissolved oxygen coincided with low water temperature. An inverse correlation of moderate degree (r = -0.58) between dissolved oxygen and water temperature has been obtained.

6. The average percent oxygen saturation of the lake water varied from lowest of 58.96% at littoral zones to highest of 166.23% at limnetic zones.

7. Chloride contents of the lake water showed monthly variations, and ranged from the average minimum of 9.8 ppm at limnetic zones to the average maximum of 50.56 ppm at littoral zones. The lowest chloride concentration was recorded during the rainy season and the highest in the summer months. Analysis of variance of chloride shows significant value with season and also with zone.

8. Average carbonate alkalinity of lake water ranged from the minimum of 0 ppm to the maximum of 37.1 ppm. Seasonal variation of carbonate alkalinity is supported by the analysis of variance which is F = 279.63, highly significant.
9. Bicarbonate alkalinity of lake water varied from the average minimum of 71 ppm at limnetic zones and the average maximum of 164.3 ppm at littoral zones. Statistical analysis of variance $F = 81.83$ and $F = 22.48$, shows significant values with season and zone.

10. The average nitrate nitrogen of the lake water ranged from minimum of 0.16 at both zones to maximum of 4.21 ppm only at littoral zones. Significant $F = 18.29$ value of analysis of variance with seasons support the seasonal variation.

11. Specific conductivity of lake water showed monthly variations and varied from average minimum of 309.08 microhm/cm at limnetic zones to the average maximum of 575.49 microhm/cm at littoral zones. Statistical analysis of variance of specific conductivity with season shows significant $F = 16.59$ value.

12. The average maximum calcium hardness of 18.32 ppm at limnetic zones and the average minimum of 56.5 ppm at littoral zones has been found. The average minimum magnesium hardness of 4.96 ppm and average maximum of 26.56 ppm was noted only at limnetic zones and the average value of total hardness varied from 87 ppm at limnetic zones to 227 ppm at littoral zones. The statistical analysis of variance shows significant $F$ value with season for calcium hardness and total hardness.
13. The total dissolved solids of the lake water varied from
the average minimum of 199.06 ppm at limnetic zones to
the average of 368.27 ppm at littoral zones. Significant
F = 7.92 value of analysis of variance with season
confirmed the seasonal variation of total dissolved
solids.

14. The average pH of the lake soil ranged from 7.2 to 8.3
at littoral zones and 7.9 to 8.3 at limnetic zones.

15. Sodium contents of lake soil showed wide range of
monthly variations and ranged from the average of 3.1 ppm
to 44.4 ppm at littoral zones and average of 5.5 ppm
to 48.9 ppm at limnetic zones.

16. The average potassium concentration of the lake soil
varied from 9.84 ppm to 16.7 ppm at littoral zones and
8.9 ppm to 17.85 ppm at limnetic zones.

17. Exchangeable calcium contents of lake soil showed
average variation from 221 ppm to 432 ppm at littoral
zones and 235 ppm to 431 ppm at limnetic zones.

18. In the present observations, specific conductivity of
lake soil varied from the average minimum of 269
micromhos/cm to the average maximum of 757.96
micromhos/cm at littoral zones, and the average minimum
of 269.93 micromhos/cm to 738.1 micromhos/cm at
limnetic zones.
19. Total dissolved solids of the lake soil varied from the average minimum of 169.74 ppm to the average maximum of 485.36 ppm at littoral zones and the average minimum of 189.63 ppm to the average maximum of 472.24 ppm at limnetic zones.

20. The available phosphate of the lake soil varied from a low to a high amount, and the available nitrate also varied from a very low amount to a high amount during the period of study.

21. In the present investigation, only dominant groups of zooplankton have been studied. Rotifera represented by twelve genera; cladocera represented by three genera; Copepoda represented by only Mesocyclops and Crustacean nauplii only by nauplius larvae.

22. The total zooplankton population showed 3 peaks; an October peak due to abundance of Copepods and crustacean nauplii; a March peak due to copepods, nauplii and cladocerans and a third zooplanktonic peak in May due to rotifers, cladocerans, copepods and nauplii. Highly significant F value of analysis of variance with season supports the seasonal variation of zooplankton.

23. The rotifer showed two peaks, one in the month of February and the other in the month of May. The cladocera have been observed in abundance during the months of March and May, while the copepods showed
October, March and May as peak months during the present investigation, however, the crustacean nauplii were found in abundance in the months of October, March and May. All the above-mentioned groups showed significant F values of analysis of variance with season.

24. The population of zooplankton showed positive correlation with water temperature, transparency, chloride, carbonate alkalinity and bicarbonate alkalinity whereas a negative correlation has been noted with dissolved oxygen, specific conductivity and total hardness.

25. The maximum population of *Labeo rohita* (Ham. Buch.) has been recorded in winter while the maximum population of *Catla catla* (Ham. Buch.) was noted in the rainy season. However, the maximum population of *Cirrhina mrigala* (Ham. Buch.) and *Cyprinus carpio* (L.) has been found during the summer months. Statistical analysis of variance of the above cultivable fishes showed significant F value with seasons.

26. The population study of cultivable fishes also revealed that *Labeo rohita* (Ham. Buch.) and *Catla catla* (Ham. Buch.) were observed higher in limnetic zones than in littoral zones throughout the period of study except in the rainy seasons, while the population of *Cirrhina mrigala* (Ham. Buch.) was higher at limnetic zones except in summer months and the population of *Cyprinus carpio* (L.) has been observed to be higher only at
littoral zones during summer and the rainy season. Analysis of variance of the population of *Cirrhina mrigala* (Ham. Buch.) and *Cyprinus carpio* (L.) shows significant F value with zones.

27. Population of *Labeo rohita* (Ham. Buch.) shows positive correlation with transparency, bicarbonate alkalinity, dissolved oxygen and nitrate contents of the lake water and sodium and exchangeable calcium contents of the lake soil, while the population of *Catla catla* (Ham. Buch.) shows positive correlation with pH of lake water and exchangeable calcium content of the soil. However, statistical positive correlation of the population of *Cirrhina mrigala* (Ham. Buch.) has been found with temperature, carbonate alkalinity, chloride concentration, specific conductivity, total dissolved solids of the lake water, with zooplankton population and with sodium and exchangeable calcium contents of the soil.

28. The population of *Cyprinus carpio* (L.) shows positive correlation with temperature, carbonate alkalinity, chloride, specific conductivity, total dissolved solids of water, zooplankton population and also with sodium, exchangeable calcium and total dissolved solids of the soil.
29. The population of *Labeo rohita* (Ham. Buch.) shows negative correlation with air temperature, water temperature, carbonate alkalinity, specific conductivity, magnesium hardness, total hardness, total dissolved solids of the lake water and with zooplankton population and also with potassium contents of the soil at both zones.

30. The population of *Catla catla* (Ham. Buch.) shows negative correlation with dissolved oxygen, chlorides, bicarbonate alkalinity, specific conductivity, magnesium hardness, total dissolved solids and zooplankton population and with sodium contents and specific conductivity of the lake soil.

31. The population of *Cirrhina mrigala* (Ham. Buch.) shows negative correlation with transparency, pH, dissolved oxygen, calcium hardness, magnesium hardness, total hardness of water and potassium and specific conductivity of the lake soil. In the case of the population of *Cyprinus carpio* (L.) negative correlation with transparency, pH, dissolved oxygen bicarbonate alkalinity, nitrate, calcium hardness, total hardness of water and pH, potassium and specific conductivity of the lake soil has been noted.

32. The above mentioned correlation coefficient between cultivable fishes and physico-chemical, and biological
factors do not show marked correlation of high degree but are found either at low degree or a moderate degree.

33. In the Sagar lake, there is no proper place for breeding of cultivable fishes. Seed culture of these fishes is carried out five miles away from the lake in an entirely different environment. A large number of predatory fishes spoil the fingerlings of cultivable fishes.

34. The physico-chemical and biological parameters do not show favourable effect on the production of cultivable fishes but decline of fish population is also marked due to pollution and progressive eutrophication of the lake. Thus the lake is not suitable for the good production of cultivable fishes. The Fisheries Department has also stopped the cultivation of major carps in the lake since 1982.