

CHAPTER – 6



SUMMARY AND CONCLUSION

In the present study, the fishes viz. *Schizothorax niger* and *Cyprinus carpio* spp. inhabiting the water bodies of Kashmir valley particularly Dal lake and River Jhelum are constantly exposed to a wide variety of metals by way of geochemical processes and large scale releases into the aquatic environment by anthropogenic activities. Subsequently, these aquatic animals get victimized by various pollutants especially the untraced metals leading to biochemical, physiological and histological alterations of these economically important hosts.

In the first set of research study, the concentration of metals particularly copper, zinc, iron and manganese in Dal lake and River Jhelum were checked seasonally for a period of two years by Atomic Absorption Spectrophotometer. The concentration of copper ranged from 1.020 to 1.070 ppm in Dal lake and 1.002 to 1.006 ppm in River Jhelum throughout the study period. However, the maximum concentration of copper in both the water bodies was found to be highest in summer of 2006-2007. For iron, the concentration ranged between 0.110 to 0.191 ppm in Dal lake and 0.129 to 0.168 ppm in River Jhelum. Like copper, the highest values for iron were found in summer season of 2006-2007. The zinc concentration ranged between 0.150 to 0.542 ppm in Dal lake and 0.100 to 0.483 ppm in River Jhelum. The highest values were also found in summer season of 2006-2007.

The concentration for manganese ranged between 0.021 to 0.822 ppm in Dal lake and 0.0056 to 0.053 ppm in River Jhelum with highest values in summer of 2006-2007 like other metals.

In the second set of research study, the accumulation of these metals in different tissues viz. gills, liver, kidneys and muscles of *Schizothorax niger* and *Cyprinus carpio* spp. estimated by Atomic Absorption Spectrophotometer. In Dal lake, the concentration of copper in gills of *Schizothorax niger* varied from 13.52 to 21.84 ppm and 16.83 to 25.99 ppm in *Cyprinus carpio* spp. throughout the study period. The highest concentration of copper in gills of both the fishes was found in summer season of 2006-2007. However, in River Jhelum the concentration of copper in the gills of *Schizothorax niger* ranged from 10.13 to 19.54 ppm and 14.82 to 23.24 ppm in *Cyprinus carpio* spp. throughout the study period. The maximum accumulation of copper in gills of *Schizothorax niger* and *Cyprinus carpio* spp. in River Jhelum was found in summer season of 2005-2006 and 2006-2007 respectively.

The accumulation of copper in the liver of *Schizothorax niger* varied from 66.77 to 81.63 ppm in Dal lake and 63.69 to 79.52 in River Jhelum. However, in *Cyprinus carpio* spp. the accumulation of copper varied from 99.41 to 139.22 in Dal lake and 131.99 to 97.62 ppm in River Jhelum. The maximum concentration of copper in liver of both the fishes in both the water bodies was found to be highest in summer season of 2006-2007.

In kidneys, the concentration of copper in *Schizothorax niger* and *Cyprinus carpio* collected from Dal lake varied from 64.61 to 78.90 ppm and 96.52 to 132.83 ppm respectively. However, the concentration of copper in kidneys of *Schizothorax niger* and *Cyprinus carpio* spp. collected from River Jhelum showed values ranging from 62.54 to 77.64 and 94.33 to 129.62 ppm

respectively. The highest values were also found in summer season of 2006-2007.

In muscles, the accumulation of copper in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake ranged between 07.81 to 12.72 ppm and 09.99 to 17.58 respectively with highest values observed during summer season of 2006-2007. However, in River Jhelum, the accumulation of copper in muscles of *Schizothorax niger* and *Cyprinus carpio* spp. ranged between 06.33 to 12.72 ppm and 08.24 to 16.27 ppm respectively. The highest value of copper in *Schizothorax niger* and *Cyprinus carpio* spp. was observed in summer seasons of 2005-2006 and 2006-2007 respectively.

In Dal lake, the concentration of zinc in gills of *Schizothorax niger* varied from 52.11 to 72.44 ppm and 56.92 to 87.25 ppm in *Cyprinus carpio* spp. throughout the study period. The highest concentration of copper in gills of both the fish hosts was found in summer season of 2006-2007. However, in River Jhelum, the concentration of zinc in the gills of *Schizothorax niger* ranged from 50.60 to 69.24 ppm and 54.79 to 86.43 ppm in *Cyprinus carpio* spp. throughout the study period. The maximum accumulation of copper in gills of *Schizothorax niger* and *Cyprinus carpio* spp. in River Jhelum was found in summer season of 2005-2006 and 2006-2007 respectively.

The accumulation of zinc in the liver of *Schizothorax niger* varied from 73.81 to 97.84 ppm in Dal lake and 71.99 to 95.43 in River Jhelum. However, in *Cyprinus carpio* spp. the accumulation of zinc varied from 111.35 to 152.61 in Dal lake and 109.98 to 141.81 ppm in River Jhelum. The maximum concentration of zinc in liver of both the fishes in both the water bodies was found to be highest in summer season of 2006-2007.

In kidneys, the concentration of zinc in *Schizothorax niger* and *Cyprinus carpio* collected from Dal lake varied from 88.77 to 101.99 ppm and 119.84 to 159.32 ppm respectively. However, the concentration of zinc in

kidneys of *Schizothorax niger* and *Cyprinus carpio* spp. collected from River Jhelum showed values ranging from 80.42 to 99.84 and 116.31 to 148.92 ppm respectively. The highest values were also found in summer season of 2006-2007.

In muscles, the accumulation of zinc in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake ranged between 29.93 to 39.72 ppm and 34.46 to 44.52 respectively with highest values observed during summer season of 2006-2007. However, in River Jhelum, the accumulation of zinc in muscles of *Schizothorax niger* and *Cyprinus carpio* spp. ranged between 27.18 to 38.12 ppm and 32.17 to 43.44 ppm respectively. The highest value of zinc in *Schizothorax niger* and *Cyprinus carpio* spp. was observed in summer seasons of 2005-2006 and 2006-2007 respectively.

In Dal lake, the concentration of iron in gills of *Schizothorax niger* varied from 130.10 to 192.52 ppm and 153.72 to 201.61 ppm in *Cyprinus carpio* spp. throughout the study period. The highest concentration of copper in gills of both the fishes was found in summer season of 2006-2007. However, in River Jhelum the concentration of iron in the gills of *Schizothorax niger* ranged from 127.52 to 187.46 ppm and 151.92 to 199.52 ppm in *Cyprinus carpio* spp. throughout the study period. The maximum accumulation of iron in gills of *Schizothorax niger* and *Cyprinus carpio* spp. in River Jhelum was found in summer season of 2006-2007.

The accumulation of iron in the liver of *Schizothorax niger* varied from 204.92 to 296.51 ppm in Dal lake and 208.44 to 294.62 in River Jhelum. However, in *Cyprinus carpio* spp., the accumulation of iron varied from 290.32 to 392.21 in Dal lake and 281.81 to 381.43 ppm in River Jhelum. The maximum concentration of iron in liver of both the fishes in both the water bodies was found to be highest in summer season of 2006-2007.

In kidneys, the concentration of iron in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake varied from 200.99 to 292.61 ppm and 286.75 to 388.69 ppm respectively. However, the concentration of iron in kidneys of *Schizothorax niger* and *Cyprinus carpio* spp. collected from River Jhelum showed values ranging from 204.32 to 289.77 and 278.66 to 378.66 ppm respectively. The highest values were also found in summer season of 2006-2007.

In muscles, the accumulation of iron in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake ranged between 40.88 to 49.23 ppm and 51.67 to 62.71 respectively with highest values observed during summer season of 2006-2007. However, in River Jhelum, the accumulation of iron in muscles of *Schizothorax niger* and *Cyprinus carpio* spp. ranged between 31.90 to 48.16 ppm and 49.22 to 61.07 ppm respectively. The highest value of iron in *Schizothorax niger* and *Cyprinus carpio* spp. was observed in summer seasons of 2006-2007.

In Dal lake, the concentration of manganese in gills of *Schizothorax niger* varied from 02.71 to 11.55 ppm and 05.99 to 13.21 ppm in *Cyprinus carpio* spp. throughout the study period. The highest concentration of manganese in gills of both the fishes was found in summer season of 2006-2007. However, in River Jhelum the concentration of manganese in the gills of *Schizothorax niger* ranged from 01.54 to 10.66 ppm and 04.76 to 12.01 ppm in *Cyprinus carpio* spp. throughout the study period. The maximum accumulation of manganese in gills of *Schizothorax niger* and *Cyprinus carpio* spp. in River Jhelum was found in summer seasons of 2006-2007.

The accumulation of manganese in the liver of *Schizothorax niger* varied from 01.13 to 08.30 ppm in Dal lake and 0.87 to 06.73 in River Jhelum. However, in *Cyprinus carpio* spp., the accumulation of manganese varied from 03.92 to 11.72 in Dal lake and 0.97 to 08.95 ppm in River

Jhelum. The maximum concentration of manganese in liver of both the fishes in both the water bodies was found to be highest in summer season of 2006-2007.

In kidneys, the concentration of manganese in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake varied from 0.84 to 06.95 ppm and 01.32 to 09.34 ppm respectively. However, the concentration of manganese in kidneys of *Schizothorax niger* and *Cyprinus carpio* spp. collected from River Jhelum showed values ranging from 0.51 to 03.61 and 0.57 to 06.74 ppm respectively. The highest values were also found in summer season of 2006-2007.

In muscles, the accumulation of manganese in *Schizothorax niger* and *Cyprinus carpio* spp. collected from Dal lake ranged between 0.09 to 03.92 ppm and 0.06 to 06.82 respectively with highest values observed during summer season of 2006-2007. However, in River Jhelum, the accumulation of manganese in muscles of *Schizothorax niger* and *Cyprinus carpio* spp. ranged between 0.05 to 01.00 ppm and 0.24 to 03.43 ppm respectively. The highest value of manganese in *Schizothorax niger* and *Cyprinus carpio* spp. was observed in summer seasons of 2006-2007.

In the third set of research study, the subsequent effects of metals on the biochemical parameters viz. total protein, albumin, globulin, glucose, serum urea, serum creatinine and total cholesterol of fishes collected from Dal lake and River Jhelum were estimated seasonally. The estimation of total protein in *Schizothorax niger* varied seasonally from a low concentration of 1.11 g/dl in winter (2006-2007) in Dal lake to a maximum value of 4.32 g/dl in summer season (2006-2007) in Dal lake. However, for *Cyprinus carpio* spp., the total protein values varied from a minimum of 1.05 g/dl in winter season (2005-2006) in Dal lake to a maximum value of 3.79 g/dl in summer season (2005-2006) in Dal lake.

The estimation of albumin in *Schizothorax niger* varied seasonally from a low concentration of 1.01 g/dl in winter (2005-2006) in River Jhelum to a maximum value of 3.72 g/dl in summer season (2006-2007) in Dal lake. However, for *Cyprinus carpio* spp., albumin values varied from a minimum of 0.92 g/dl in spring season (2005-2006) in Dal lake to a maximum value of 2.23 g/dl in summer season (2005-2006) in River Jhelum.

The estimation of globulin in *Schizothorax niger* varied seasonally from a low concentration of 0.06 g/dl in autumn (2005-2006) in River Jhelum to a maximum value of 2.37 g/dl in summer season (2006-2007) in Dal lake. However, for *Cyprinus carpio* spp., globulin values varied from a minimum of 0.06 g/dl in autumn season (2006-2007) in River Jhelum to a maximum value of 2.13 g/dl in summer season (2005-2006) in Dal lake.

The estimation of glucose in *Schizothorax niger* varied seasonally from a low concentration of 125.5 g/dl in winter (2005-2006) in River Jhelum to a maximum value of 340.1 g/dl in summer season (2005-2006) in Dal lake. However, for *Cyprinus carpio* spp., the glucose values varied from a minimum of 136.1 g/dl in winter season (2005-2006) in River Jhelum to a maximum value of 352.5 g/dl in summer season (2005-2006) in Dal lake.

The estimation of serum urea in *Schizothorax niger* varied seasonally from a low concentration of 16.11 g/dl in winter (2005-2006) in Dal lake to a maximum value of 22.8 g/dl in summer season (2006-2007) in Dal lake. However, for *Cyprinus carpio* spp., serum urea values varied from a minimum of 15.2 g/dl in winter season (2006-2007) in River Jhelum to a maximum value of 24.0 g/dl in summer season (2006-2007) in River Jhelum.

The estimation of serum creatinine in *Schizothorax niger* varied seasonally from a low concentration of 0.09 g/dl in winter (2005-2006) in River Jhelum to a maximum value of 1.16 g/dl in summer season (2006-2007) in Dal lake. However, for *Cyprinus carpio* spp., serum creatinine values

varied from a minimum of 0.14 g/dl in winter season (2005-2006) in River Jhelum to a maximum value of 1.19 g/dl in summer season (2006-2007) in Dal lake.

The estimation of serum cholesterol in *Schizothorax niger* varied seasonally from a low concentration of 36.42 g/dl in winter (2005-2006) in River Jhelum to a maximum value of 100.01 g/dl in summer season (2006-2007) in River Jhelum. However, for *Cyprinus carpio* spp., serum cholesterol values varied from a minimum of 40.11 g/dl in winter season (2005-2006) in River Jhelum to a maximum value of 98.22 g/dl in summer season (2006-2007) in Dal lake.

In the fourth set of research study, the accumulation of metals in tissues of fishes were analyzed histochemically inconsistent with biochemical study. The same tissues were then subjected to histological/ histopathological studies so as to check their deleterious effects histomorphologically.

In this study, the enormous amounts of metals were observed in summer seasons in all the tissues of fishes particularly the liver followed by kidneys and gills. Muscles of both the fishes were found to possess negligible amount of metals. However, least concentrations of metals were observed in winter/ spring seasons.

After localization of metals in tissues of fishes, the same tissues were checked for histomorphological alterations. The liver of both the fishes collected from Dal lake and River Jhelum showed congestion and degenerative changes that varied from mild in winter season to severe vascular degeneration in summer seasons. The general changes observed in gills included congestion, oedema, hyperplasia and hypertrophy. However, the severity of histomorphological alterations were observed in gills of *Cyprinus carpio* spp. collected from Dal lake during summer season. The kidneys showed atrophy of glomerulus, hyperplasia and hypercellularity. The

mild changes in kidneys were observed in *Schizothorax niger* during winter seasons and severe degenerative changes in *Cyprinus carpio* spp. during summer seasons.