CHAPTER – VII
CONCLUSIONS
CONCLUSIONS

- In all the five selected ponds, water temperature was always found to be less than air temperature and follows the trend of air temperature. A positive significant correlation between air and water temperature was observed.
- Wide seasonal fluctuations were recorded in the depth in all the five selected ponds which might be related to evaporation at high temperature and precipitation.
- Water colour of all the five ponds varied (green, brownish yellow and brownish) in different seasons which might be related to phytoplankton bloom, decomposition of organic matter, turbidity and polluted nature of these water bodies.
- Lower values during summer and monsoon might be due to entry of huge amount of suspended and colloidal matter, silt and clay and evaporation of water.
- Higher values of dissolved oxygen content in winter could be related to increased oxygen retention capacity of water and reduction in respiratory consumption of oxygen due to reduced metabolic rate. Lower values during summer might be due to death and decomposition of organic matter, increasing water temperature leading to decrease in oxygen retention capacity of water and increase in the respiratory consumption of oxygen due to increased metabolic rate.
- Carbon dioxide was recorded absent in pond I and IV throughout the study period. The absence of free CO₂ in present study might be attributed to increase values of pH (8.5 or above) and temperature, utilization during photosynthesis and due to conversion of free carbon dioxide into bicarbonates by reacting with carbonates while presence of Carbon dioxide in pond II, III, and V might be related to lower rates of photosynthesis and higher rates of decomposition of organic matter.
- Fluctuations in total alkalinity in the selected ponds were mainly due to the seasonal effects, planktonic populations, bottom deposits and water currents and entry of sewage from the catchment area. Carbonates were completely absent in pond II and III and for the most of the study period at site V, which could be related to the presence of free CO₂ during this period. Bicarbonate alkalinity was
recorded present in all the ponds except pond IV, were it was found absent during the month of February and March, 2009.

- High values of pH (mostly above 8.0) were recorded in all the selected ponds throughout the course of study, which might be related to enhanced photosynthesis carried out by phytoplankton and macrophytes, wherein CO$_2$ is removed, and hence pH is raised.

- Higher values of hardness were recorded throughout the study period in all the five selected ponds, which might be due anthropogenic activities in and around these water bodies, addition of sewage and detergents by washer men.

- High values of calcium were recorded in all the five selected ponds, which might be attributed to heavy input of sewage from surrounding area, weathering of calcareous materials and domestic effluents.

- Lower values of magnesium were recorded during winter in all the five selected ponds, which might be attributed to higher sedimentation rate leading to settlement in the bottom and utilization by plankton. Higher values during summer months were related to higher evaporation rate, decomposition of organic matter and bathing and washing.

- Higher values of chloride during summer in all the five selected ponds might be due to the higher rate of evaporation and organic pollution of animal origin, whereas lower values during winter could be related to reduction in siltation or allochthonous import of chloride along with rain from catchment area. Moreover, higher content of chloride was recorded in pond I and IV than pond II, III and V.

- Higher values of NO$_3$-N were recorded during monsoon in the selected ponds which could be related to influx of decaying organic matter, nitrates from the catchment area and sewage contamination, whereas lower values in winter could be attributed to reduced rate of decomposition and its utilization by macrophytes.

- Higher values of PO$_4$-P during summer were related to increased decomposition at higher temperature, release of nutrients and evaporation of water at high temperature, whereas lower values could be attributed to its utilization by macrophytes and algae for their growth, low calcium level and low temperature.
Insect fauna of these water bodies comprised of order Diptera, Hemiptera, Coleoptera Trichoptera, Odonata and Ephemeroptera.


*Chironomus larva* was very common and found to be the most abundant species amongst all recorded genera, occurring in higher numbers in all the selected ponds. Its population density varied from a minimum of 274/ m² in June, 2009 to a maximum of 635/ m² in January, 2010 in pond I, 245/m² in August, 2009 to 467/m² in January, 2010 in pond II, 195/ m² in October, 2009 to 545/ m² in December, 2009 in pond III, 249/ m² in June, 2009 to 510/ m² in December, 2009 in pond IV and 306/ m² in June, 2009 to a maximum of 701/ m² in January, 2010 in pond V.

*Chironomus* exhibits high tolerance to eutrophic conditions, showing significant increase in abundance in response to anthropogenic organic enrichment and consequent water quality deterioration, being considered a reliable environmental indicator. The presence of *Chironomus* sp. in high number indicates the eutrophic nature of these water bodies.

Hemiptera formed the second most abundant group of insect fauna in the selected ponds. This group was represented by the genera *Belostoma* sp., *Bueno* sp., *Coroxid* sp., *Gerris* sp., *Hebrus* sp., *Hesperocorxa* sp., *Mesovelia* sp., *Nepa* sp., *Neoplea striola*, *Notonecta insulate*, *Pelocoris* sp., *Ranatra* sp., and *Sigara* sp.

The high or low abundance of Hemiptera in present study can be related to presence of macro- vegetation /macrophytes in these selected ponds.

The dominance of Coleopteran during summer in present study in all the five ponds can be related to the availability of food and vegetation, which enhanced the growth of insects during this period. The findings are in conformity with the findings of Kaur et al. (1995) and bath and Kour (1998).


Trichopterans showed low numerical abundance; across selected ponds. This clearly indicates that they are sensitive to pollution. It can be further concluded that these insects can live in polluted water which can be related to the availability of food and oxygen in these ponds in addition to other factors.

Odonata constituted the fifth most abundant group of insect fauna. This group was represented by *Aeschna* nymph, *Argia* nymph, *Coenagrion* nymph, *Cordulia* nymph and *Ischnura* nymph.

The present investigation clearly indicates that Odonatans can live in polluted as well as clean water, but the algal abundance and luxuriant growth of macrophytes are prerequisite.

Ephemeroptera constituted the sixth most abundant group of insect fauna. This group was represented by *Baetis hiemalis* nymph, *Caenis* nymph, *Ephemerella* nymph and *Heptagenia* nymph.

Mayfly larvae were present in all the water bodies studied. Their presence indicates that these larvae are able to survive in polluted waters provided there is sufficient oxygen (> 2.8 mg/l).

In general population abundance of aquatic insects was quite high in Pond I, III, IV and V which could be related to organically rich waters and thick vegetation in these water bodies, whereas in pond II, insects showed lowest abundance which could be attributed to lack of vegetation in this pond in addition to other factors.

Among the invertebrate taxa, aquatic insects form an important component of food chains and energy flow pathways. Aquatic insects constitute an important part of animal production within wetlands, ponds and are tightly integrated into the structure and functioning of their habitats (e.g. organic matter processing,
nutrient retention, food resources for vertebrates, such as amphibians, fish or birds).

- Aquatic insects are often good indicators because they are present in some capacity in almost every type of habitat and many are habitat specialists.
- Odonate species prefer to live in freshwater, non-contaminated and well oxygenated habitats. Hence, they can serve as valuable bio-indicators for environmental contamination studies.
- Though odonates were recorded in present study but they showed least diversity and were very sparse in distribution, thereby indicating their preference for freshwater, non-contaminated and well oxygenated habitats.
- In addition to the odonates, aquatic insects mostly sensitive to water pollution are the Ephemeropterans (may flies), plecopterans (stone fly) and tricopterans (caddisfly). The sparse distribution, low numerical abundance and low species diversity in present study is therefore, indicative of the ponds that have been severely disturbed. Thus, by cataloguing the number and species composition in these derelict water bodies, it may be possible to determine what type of pollutants may be present and what is the pollution level in water.
- Aquatic Diptera are the most ubiquitous of the entire macrobenthic invertebrate group in tropics. Due to eutrophic nature of Dipteran larvae, they have been used as reliable indicators of organic pollution and related perturbation. The preponderance of saprophilic insects (insects restricted to heavily enriched habits e.g. ‘bloodworm’ midge larva) at all the selected sites under study clearly indicate that all these water bodies are organically enriched and are grossly polluted.
- The high abundance of Chironomus sp. at all the selected sites in present study indicates that these water bodies are highly eutrophic.
- Aquatic Hemiptera holds an important place in the ecology of fresh water ecosystems. Hemipterans are exceedingly important in relation to fish production. They are the primary food for many wild and cultivable fishes, which make them valuable predators, are also occasional pests in the manmade nursery ponds for fish culture where they feed on young fish. Certain families of bugs may be utilized in the biological control of mosquito larvae.
Amongst aquatic insects Coleopterans are used as food in many countries of the world. Beetles are highly prized in the kitchen in many countries. They are prepared roasted or smoked and are used in “tamales”, “quesadillas”, “sopes”, etc.

The absence of plecoptera during present study clearly indicates the water quality degradation and physical alteration of these derelict water bodies under study as these are restricted to habitats where there is a little human development, clear water, and high dissolved oxygen content.