CHAPTER – II

REVIEW OF LITERATURE

Insects are present almost all the habitat of the nature. They are present in scorching sun of the tropic to frozen Antarctica. They may be aerial, terrestrial or aquatic forms. Insect originated in lower devonoian period and are considered to be descent of Subphyla – Myriapoda or Protoptera (Tembhare, 2012). Insects are arthropods bearing distinct head, thorax and abdomen, a pair of antennae, three pair of segmented leg, one or two pair of wing or without wing. Insects represent about 80% of the animal kingdom (Kumar and Nigam, 2001). Study of insects in India was first initiated in 1779 in south India by S.G. Koenig. Donovan was the first who published general work on Insect of Asia in the beginning of 19th centaury. Linnaes (1758-68) first classified an entire group of insect into nine orders- Coleoptera, Orthoptera, Hemiptera, Lepidoptera, Neuroptera, Hymenoptera, Diptera, Thysanura and Aptera.

Insects those who spend some part of their life cycle closely associated with water, either living beneath the surface or skimming on the surface of water are called aquatic insects. Several workers have done work on aquatic insects in India and other parts of the world. Literature showed scattered work on the taxonomy of aquatic insect along with terrestrial forms (Distant, 1902,1906,1910), d’Orhhymont(1928) . Insect diversity of British India was reported from the studies of Ochs (1930). Insects have close relationship with certain aquatic flowering plants (Mc. Gaha ,1952) . Motwani et al.,(1956) Studied the habitat ecology of the aquatic insects in high altitude.
Studies of Needham (1957) showed diversity of freshwater aquatic insects with other aquatic invertebrates. Tonapi (1959) studied on the aquatic insects of Poona in India. Tonapi et al., (1969a, 1969b) further studied the aquatic Coleoptera. A more detailed study of the Coleoptera was reported by Varzirani (1970). According to Cheng (1976) about 3% of the total population of insects are aquatic, while according to Pennak (1978) aquatic insects forms about 1% of the total animal diversity. Mc-cafferty (1981) observed that a few aquatic insects inhabit the limnetic and profoundal zones and recorded that Odonata naiads are most common in ponds, marshes, lake margins and shallow water streams. The functioning of the freshwater ecosystem is somehow depend on aquatic insects (Roy and Sharma, 1983). Mahadevan and Krishnaswamy (1984) found that in organically polluted water bodies the density of chironomid increases.

Larson (1985) revealed that small and temporary water bodies have more species as compared to large and permanent ones. Cheng (1985), Glausiusz, (1997) and Daly (1998) reported that there are almost no insects associated with the marine environment. Study of Ebert and Balko, (1987) recorded that Aquatic insects have strong relationship with water surface fluctuation. Insects may comprise over 95% of the total individual or species of macro invertebrates though less than 3% of all species of insects have aquatic stages in some freshwater habitat (Ward, 1992). Faunal account of the species in the west Bengal region has been reported from the studies of Srivastav (1993), Bal and Basu (1994a,1994b), Srivastava and Sinha (1995), Biswas et al., (1995a), Bisawas and Mukhopadhyay (1995) and Choudhury and Chattopadhyay (1997). In most freshwater ecosystems aquatic insects comprise bulk of the biomass along with other three groups viz.
Molluscs, Crustacean and Fish (Odum, 1996). Daly (1998) reported that with increased nutrients in lentic water tend to increase in the diversity of insects.

Khan and Ghosh (2001) revealed presence of 70 species of aquatic insects from 20 different wetlands of West Bengal, India. Study of Khan (2002) in flood plain ox-bow lake of west Bengal revealed 44 species of aquatic insects; out of which 4 species of Odonata, 6 species of Hemiptera, 5 species Coleoptera and one species of Diptera numerically abundant. Study carried out by Thirumalai (2002) reported presence of 128 species of Gerromorpha in India, which is 8.7% of the world fauna of Gerromorpha. Mitra (2003) reported that India have five hundred species and subspecies of Odonata, of which 40% is endemic and 60% is non endemic. He also pointed out the effect of urbanization and industrialization in the lives of dragonflies.


The insects are estimated to comprise more than 75% of the known species of the animals and approximately 0.9 million species of insects have been described throughout the world (Jain et al., 2010). Thakare et al., (2011) reported 13 water beetles in Kolkas region of Melghat Tiger Reserve of Central India. Studies of Gupta and Narzary (2013) revealed 9 species of aquatic insects in a oxbow lake of Cachar in Assam. Mazumder et al., (2013) reported 31 species of aquatic insects from urban fresh water Lake of Tripura. They found that insects of the order Hemiptera, Diptera, Odonata and Coleoptera showed high species richness and abundance. Studies on the insects fauna of pond ecosystem in Karwar done by Vasantkumar and Roopa (2014) revealed presence 15 species belonging to 6 orders. They recorded highest number of aquatic insects from the order Hemiptera and the most abundant order was the Coleoptera. Barman and Gupta (2015) recorded presence of 21 species of aquatic insects belonging to 14 families and 7 orders in Bakuamari stream of Chakrasila Wildlife Sanctuary of Assam. Aquatic forms of insects spread over to order Collembolan, Plecoptera, Ephemeroptera, Odonata, Hemiptera, Coleoptera, Diptera, Megaloptera, Neuroptera and Trichoptera.

The life history of aquatic insects greatly influenced by temperature. Water Temperature play significant role in solubility of oxygen. The seasonal cycle of insects remarkably influenced by temperature. (Elliot, 1967; Hynes, 1970). Nebeker(1971) opined that temperature play an important role in
accelerating the emergence of aquatic insects. Bisht and Das (1979) shown that the physico-chemical characteristics of water affect distribution and relative abundance of aquatic insects in cold water Kumoun lakes. Kaul and Handoo (1980) noted that the increased metabolic activities of autotrophs increased the surface pH in water bodies. Studies carried out by Dey (1981) and Lahon (1983) in different freshwater lakes and Beels of Assam revealed that increasing in free carbon dioxide result in the decrease of total alkalinity and vice versa. According to Sweeney (1984) various aspects of nature, temperature and photoperiod are the most vital environmental factors that influence the life style of aquatic insects. Schwind (1985) showed that habitat preference of aquatic insects are influenced by nature of the light i.e. polarized and unpolarized light.

The studies on limnochemistry of Panday et al. (1986) showed a relationship between various physico-chemical parameters of water and aquatic forms of life. Ebert and Balkoa (1987) found that aquatic insects diversity fluctuate with the fluctuations of water quality. Alkalinity is important for aquatic life in a freshwater system because it equilibrates the pH changes that occur naturally as a result of photosynthetic activity of phytoplankton (Kaushik and Saksena, 1989). It was reported by Sarwar and Wazir (1991) in the freshwater pond of Srinagar that during the active periods of growth where there was exuberant growth of macrophytes there was relatively low content of nitrate-nitrogen. Singh and Panday (1991) analyzed the water quality of 13 stagnant water bodies of Bihar (North) and found that the high temperature range (24°-30°C) affecting the dissolved oxygen concentration and alkalinity of water. Panda and Dash (1993) noted that that during the rainy and summer seasons there was
maximum turbidity and concentration of solids with greater values of hardness and calcium. Courtney and Clements (1998) found that pH and Salinity can affect the aquatic insects diversity. Study of Hellenthall (2000) on the effect of light on colonization patterns of aquatic insects showed that light play an important role. He found that during colonization, along with light feeding mechanism of insects also influence the process. Studies of Thomas and Azis (2000) on Peppara reservoir found that pH value was decrease during monsoon and post monsoon periods. Koshy and Nayar (2000) observed that for normal aquatic life the EC value of 250 µS per centimetre is sufficient. Free CO2 is essential for photosynthesis and its concentration affects the phytoplankton, and its productivity. Usually the amount of CO2 in water decreases when the amount oxygen is increased (Radhika et al., 2004). A study carried out by Verma et al., during the period 1999-2001 in Shahjangi Talab Fish Pond at Bhagalur showed significant correlation of temperature, pH, DO, and Chloride. They established negative correlation of FCO2 and phosphate with total annual insect abundance values (Varma et al., 2008).

Study of Bath (2008) in Hareke wetland depicted maximum insect population when the temperature ranged between 30°C and 40°C. During this season he found that insect population was on rise two times in winter. He found positive correlation of temperature, fluorides and total hardness with insect population while chloride and phosphate negatively correlated. Whiteson (2009) found a significant relationship between aquatic insect diversity and water chemistry while comparing aquatic insects communities between manmade and natural ponds. Das and Gupta (2010) found that insect diversity showed
significant relationship with pH, Total alkalinity, Dissolved Oxygen, Free CO$_2$ and TDS. Gupta and Paliwal (2010) found that Dipetran species diversity inversely proportional to dissolved oxygen. Study of Wahizatul (2011) revealed that total suspended solids (TSS) and pH showed a significant correlation to the abundance of aquatic insects. The TSS concentration was negatively correlated with the number of aquatic insect; as TSS concentration increased, the diversity and abundance of aquatic insects declined but the pH level was positively correlated to the number of Insects. Tara et al., (2011) found an inverse correlation between insects abundance and air temperature, water temperature and Free Carbon dioxide and positive correlation between insects abundance and pH and dissolved oxygen. Because of different respiratory rate and metabolism each species requires a specific range of water temperature to live aquatic mode of life (Devi, 2013). Study of Vasantakumar and Roopa (2014) showed positive correlation of water temperature. The study of Barman and Gupta (2015) revealed significant positive correlation with insect diversity and abundance with pH, EC, DO in Bakuamari Stream of Chakrasila Wildlife Sanctuary of Assam.

Rosine (1955) revealed that macrophytes increase niche space, provide structural support to the aquatic invertebrate habitat. A few study on faunal composition associated with vegetation carried out by Srivastava (1959). According to Odum (1959) macrophytes formed very rich detritus load at the bottom. Pennek, (1966) reported high faunal diversity in the vegetative habitats. Study of Nayyar et al.,(1976) revealed the preferable habitat of Hydrophilids is decomposing vegetable matter. Crowder and Cooper (1982) opined that the composition of freshwater invertebrate communities, species richness and total
abundance affected by the vegetation density. Macrophytes increases the abundance of invertebrates because it cover them from predators (Crowder and Cooper 1982) and provide higher food quality (Carpenter and Lodge 1986).

Aquatic macrophytes are an important habitat for invertebrates as they utilise them as a spawning and attachment sites (Keast 1984). Srivastava (1986) reported that Ephemeroptera and Odonata are abundant during emergence of last instar nymphal stages into adult phages of aerial existence. Downing (1986) recorded that the macrophytes bed is related to the abundance of plant-dwelling invertebrates. The most preferable habitat for Dytiscids and Hydrophilids are emergent vegetation, mats of plant debris or flooded terrestrial vegetation along the shoreline (Jach and Margalit, 1987). Cyr and Downing (1988) determined that the abundance of aquatic invertebrates depend on plant morphology, surface texture, epiphytic algal growth and community composition, nutrient content of plant tissues and presence of defensive chemicals in the plant tissue. Saxena et al., (1989) reported a number of insect fauna preferably associated with large water hyacinth.

The appearance of Odonate species largely depend on habitat heterogeneity especially the quality and quantity of aquatic and semi-aquatic plant communities (Lenz, 1991). According to Mishra et al., (1992) majority of insect species used macrophytes as shelter, food, and few used them as egg lying sites. *Hydrophilus sp.* preferred herbivorous or detrivorous type of feeding which are mainly bottom or sediment feeder (Pandit ,1992).
The littoral macrophytes habitats supported a greater diversity and abundance of aquatic invertebrates (Wollheim and Lovvom, 1995). Observation of Kaur et al., (1995) and Bath and Kaur (1998) showed that availability of food and vegetation enhanced the growth of insects during the summer period.

According to Jhingran (1997) macrophytes associated insects play an important role in aquaculture. Cattaneo et al., (1998) found that highly dissected leaves a higher surface area which supports a greater biomass of epiphytic growth for grazing aquatic invertebrates. Bhattacharya (2000) reported 21 species of insects belonging to five orders viz. Hemiptera, Coleoptera, Odonata, Diptera and Ephemeroptera associated with large water hyacinth. They used this plant species for their different needs such as shelter for different biological need, as food etc. Pal et al., (2000) found 73 insect species associated with 39 species of aquatic macrophytes. He found that Coleopteran comprising the largest number with 32 species followed by 25 species of Hemiptera in fresh water wetlands. The macro invertebrate community present on macrophytes may be determined by some external factors such as water quality, temperature and water regime (Strayer et al., 2003). Studies of Langelloto & Denno (2004), Denno et. al., (2005), Sanders et. al., (2008) showed that complex habitat structure provides refuges for prey and lowers the searching efficiency of predators. The survival rates of aquatic invertebrate prey exposed predators depend on complexity of the vegetation which is species specific (Warfe and Barmuta, 2006). The findings of Sanders et al., (2008) suggested that predator-prey interactions mainly rely on the effect of habitat structure.
In hydro ecosystems macrophytes play a vital role by providing breeding substrate for aquatic organisms including Aquatic Insects (Ratusshnyale, 2008). The study of Yaqoob et al., (2008) of habitat ecology of aquatic insects in two lakes of Kashmir also revealed that quality and quantity of aquatic vegetation plays an important role in determining the distribution, diversity and abundance of insect communities. Many predatory aquatic insects crawl on aquatic vegetation which provides perching sites. Aquatic vegetation also serve as a supporting structure to gain easier access to planktonic food (Klecka, 2010). Deepa et al., (2013) found members of Halipidae live among the aquatic vegetation when they studied aquatic coleoptera from Durgaram Cherevu, Hyderabad. Study of Vasantkumar and Roopa (2014) revealed that water hyacinth serves as an ideal habitat for the grouping and enriching of diverse aquatic insects species. The interaction between macrophytes and macroinvertebrates has implications on the aquatic food webs. It plays a key role in structuring aquatic communities (Habib and Yusuf, 2015).

Extensive reviews of literature indicated that very few studies were conducted to assess the aquatic insects diversity in the north eastern region of India in general and state of Assam in particular. Therefore, the present study was undertaken to understand the insects diversity and their habitat utilization in Kapla Beel, a fresh water wetland ecosystem in Assam.