CHAPTER TWO

REVIEW OF LITERATURE

CHAPTER – II

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The review of literature have been discussed under following heads.

1. Taxonomy of Prawns:

So far the study on the taxonomy and distribution of fresh water, estuarine and marine prawns is concerned, some works have been done by various workers. In this context reference may be made to (de Man, 1911; Henderson and Mathai, 1910; Kurup et al, 1989, Choprae, 1939 and 1940; Menon, 1957; Calman, 1939; Tiwari, 1949; Choprae and Tiwari, 1949; Kunju, 1956; Yaldwyn, 1955; Jhingran, 1991; Halthius, 1980; Anon, 1962; Rajyalakshmi, 1974 and 1980; Ibrahim, 1962; Bhimochar, 1962; Subramanyam, 1966; Pantula, 1965; Rao, 1965; Gopalkrishnan and Rao, 1978; George *et al.*, 1966; Jone, 1969; Rajyalkshmi and Randhir, 1969; Kushy, 1969; Yaldwyn, 1966, 1971 and 1973; Fujimora and Okamoto, 1972; Fujimora, 1974; Rajyalakshmi, 1974 and 1980; Smith et al, 1978; Agarwal, 1976; Brody *et al.*, 1980; Joychandran and Joseph, 1982, 1985 and 1990; Joycharan, 1984 and 1989; Ra'aman and Cohen, 1985; Reddy *et al.*, 1985; Sagi *et al.*, 1986; Zylva, 1990; Rao, 1990; Venugopal & Thumpy, 1990; Muthu *et al.*, 1992; Qureshi, 1994; Kurian and Sebastian, 1993; and Dutta, 2001)

Joychandran & Joseph (1990) prepared a key for the field identification of commercially important *Macrobrachium* spp. of India. They characterized the various morphological structure viz. carapace, rostrum, body size, chelate and non chelate legs, telson of *M. malcolmsonii, M. lamerrie, M. birmanium choprae, M. idella, M. rosenbergii* etc.

In the genus *Macrobrachium*, the 2nd cheliped of the male is considered to be of taxonomical importance for identifying different species (Qureshi 1994). Accordingly to Qureshi (1994), in *M. lamarrie lamarrie*, the chelipeds of the 2nd pair are slender, shorter than the body and similar in both the sexes without exhibiting any sexual dimorphism. Qureshi (1994) reported that in both *M. malcolmsonii* and *M. dayanum*, the chelipeds of 2nd pair are strongly developed, sexually dimorphic and generally as long as the body in case of male. But in female they are less strongly developed. *M. malcolmsonii* were recorded as the largest (200 – 230 mm in total length) species found in Madhya Pradesh, *M. dayanum* was found to be largest (29 mm in total length), (Qureshi 1994). The monsoon river prawn *M. malcolmsonii* has a maximum size of 230 to 243 mm (male) and 200 mm (female) – (Holthius 1980, Joychandran & Joseph 1986 and Venketaswamy 1993). Krishna and Rao (2000) taxonomically studied three morphological characters of *M. malcolmsonii* and these are the ratio between the 2nd period (claw) length and total body length, claw pink colour in male and spine cernamentation on claws and other periopods. Very large sized *M. malcolmsonii* with hard chitin covered bodies (Rajalakshmi, 2000). According to Qureshi (1994), certain freshwater prawns viz. *M. malcolmsonii, M. lamarrii* etc. are recorded from all the water bodies. According to Holthius (2004), showed the distribution of *M. manoni* from India and Bangladesh and *M. malcolmsonii* from India, Pakistan and Bangladesh. To study the relative growth of different male *M. rosenbergii.* Karplus *et al*, (2004), showed the relationship of propodus and carpus length to carapace length. According to Patricia *et al*, (2004) in *M. amazonicum*, translucent cheliped is provided with a few spines cheliped length is greater then post orbital length and presence of spines on the carapaces and propodus. Ready (2005) studied certain distinguishing feature viz toothed, rostrum, armed carapace with branchiostegal groove, last three legs with dactylus and exopods of maxillipeds of genus *Macrobrachium*. He also further described about the sexual dimorphism of *M. rosenbergii*. According to him male develops 2nd pair of pareopods with prominent spines. Gonopore situated at the 5th pair of pareopods and covered by flaps. Male has bigger head than females. Mature males possess blue relatively large claw, covered with prominent spines, orange claw male possess medium sized spineless and orange coloured claws. Sexually mature female gonopore appear on the coxa of 3rd pair of pareopods covered with membrane. Female exhibit a typical brood chamber formed by the 1st, 2nd and 3rd abdominal pleurae. Also exhibit reproductive setae on pleopods and thorax.

Habitated ecosystem :

There exists a close relationship between the occurrence of total prawns and the ecological characteristics of water such as temperature, P^{H}, dissolved oxygen, free carbon dioxide, total alkalinity, chloride, calcium and total hardness, phytoplankton, zooplankton and aquatic macrophytes. It was observed that low temperature, sufficient food supply and abundant occurrence of marginal macrophytes constitute favourable conditions for the occurrence and abundance of prawns (Qureshi 1994), During summer, as temperature rises water bodies start shrinking resulting in the destruction of marginal vegetation. Destruction of marginal vegetation, consequently thins down prawn population and ultimately during hot summer, they become scarce in catches. The distribution of prawns depended upon ecological balance between various physico-chemical and biological factors but fluctuations in prawn abundance during present studies could not be fully correlated with any single physical, chemical or biological factor. It is thus apparent that perhaps several factors together contribute in influencing the occurrence and abundance of prawns (Qureshi 1994).

Physico-Chemical Conditions of Water:

The role of some important physico-chemical parameters for the growth and survival of various types of prawns are clearly explained by many workers – (Fry & Norris, 1962, Kurup & Samuel, 1987, Raman 1967, Rao 1969, George 1969, Andrill & Thompson 1975, Hatting *et al.* 1975, Nair *et al*

1977, Munbodh 1979, Alias Siraj 1988, Read 1986, Venugopalan & Thompy 1990, Raman 1990, Durairaj *et al.* 1990, Biswas *et al.* 1990, Jones *et al.* 1993, Sebastian *et al.* 1990, Unikrishnan *et al.* 1990, Ahmed & Varghese 1990, Parameswaran *et al.* 1990, ICAR (CIFE) 1996 and KSU Prawn Production Manual 2002).

The productivity of prawn fishery depends upon the quality of water and soil. Under vital life processes in the crustacean fishery, water are at the optimum, when the physical and chemical conditions of water are normal. The importance of water quality parameters viz. dissolved oxygen, free carbondioxide, ammonia and P^H in closed system transport of prawn had been started by some workers like Fry & Norris 1962, Hatting *et al.* 1975, Alias & Siraj 1988. Physio-chemical parameters for the larval stages of *Macrobrachium* spp are recorded (Raman 1967, Rao 1969, George 1969, Nair *et al.* 1977, Read 1986 and Venugopalan & Thampy 1990).

It is essential to have a clear knowledge of all the possible related ecosystems of various prawns viz. physio-chemical condition of water, various types of plankton (phytoplankton and Zooplankton), soil and macrophytes. Available information on the physico-chemical conditions of water where prawns are found, was reported by (Kurup and Samuel, (1987). For both survival and juvenile growth of young *Macrobrachium* (Parameswaram *et al.* 1990), studied the various physio-chemical parameters viz. water, temperature, P^H, total alkalinity etc. during cultural practice. The water quality management programme of ICAR (CIFE) (1996) reported the ideal level of dissolved oxygen, P^H and transparency etc. for shrimp culture. The maximum depth, temperature, dissolved oxygen, total hardness, P^H, light penetration and dissolved organic matter influence the occurrence of the crustaceans. High temperature, low dissolved oxygen, extreme hardness limit the occurrence of the species.

Prakash and Reddy (2005) reported that hardness in water where prawns are cultured is caused by certain dissolved compound like calcium carbonate, calcium bicarbonate, Magnesium carbonate, Magnesium bicarbonate, calcium sulphate, magnesium sulphate. They found range of level of hardness (mg/L) from 0 – 300 above. If hardness concentration during prawn culture is more than 50ppm, then there is a good plankton growth in water.

Transparency:

It is yet another important factor which has a direct impact on freshwater prawns. During culture, due to the large number of fallen leaves which form a sort of mat in the bottom, sometimes discolour the water showing high turbidity and it can be corrected by the application of lime (Joseph *et al.* 1990).

P^H: The high P^H value, at times are enough to stress or kill prawns. This is primarily caused by metabolism of the phytoplankton blooms in the ponds. As all plants do, during the daylight hours, the bloom consumers carbon dioxide through photosynthesis. Since carbon dioxide in water forms a weak acid (low P^H), as it is removed by photosynthesis, the pond P^H tends to rise during the day. After the sun goes down and photosynthesis ceases, P^H falls as the plants breadth out carbon dioxide. This is a normal cycle of P^H rising during the day and decreasing at the night. The water quality management programme of ICAR (CIFE) (1996) reported the ideal level of P^H for shrimp culture. P^H should be maintained during fertilization of prawn with a slow requisite dose of oxygen (Sebastian *et al.* 1990) and examined the distribution of limnotic crustaceans, zooplankton species and their species association and the effect of P^H ranged on the structure of these communities. Aquacop (1979) observed P^H controlled in experimental prawn ponds water by controlling phytoplankton limitation with an algaecide. Boyd (1979) and Mulla and Rouse (1985) showed the great fluctuation in P^H can cause low survival and poor growth to prawns.

The optimum level of P^H for prawn larval rearing is 7.0 – 8.5. During prawn cultural practice, according to him, if the phytoplankton blooms are not maintained at desired level, the P^H level increases drastically and heavy prawn mortality may occur (Reddy, 2005). For survival of prawn the P^H should be maintained at 7 – 8.5 (Upare, 2005). For better survival of some freshwater prawn P^H must be ranged from 5.5 – 8.3 (Boyd and Zimmermann, 2004).

Free Carbondioxide: Increase of free carbon dioxide during transportation of prawn may show heavy mortality (Hatting *et al.* 1975, Singh *et al.* 1985). KSU Prawn Production Manual (2002), reported that during the daylight, the algal bloom consumes CO_2 through photosynthesis. Since CO_2 in water forms a weak acid (low P^H), as it is removed by photosynthesis, the pond P^H tends to rise during the days. After sunset and photosynthesis ceases, P^H falls as the plants breadth out CO_2. During pollyculture, the better survival of *Macrobrachium* spp. showed negligible variation in free CO_2 (Ahmed and Varghese 1990).

Dissolved Oxygen: KSU Prawn Production Manual (2002) reported that shallow ponds will store less oxygen depleted water than deeper ponds since their water volume per unit of surface area is less. With shallow ponds, there is less risks of prawn loss due to dissolved oxygen depletion caused by pond water "turnover". KSU Prawn Production Manual (2002) further described that the low dissolved oxygen (below 3ppm) at anytime may cause prawns to crawl out of the ponds or congregate at the pond edge during day light. This will increase their vulnerability to predation.

A high oxygen content is always necessary for prawn culture (Sebastian *et al.* 1993 and Tripathi 1990) de Zylva (1990) reported that during prawn culture, the oxygen aerators are used in each pond to enhance turbidity and to achieve maximum oxygen saturation. The oxygen holding capacities of prawns and crabs varies from species to species. The effect of population density on burrowing is also studied to determine the optimum of individuals and oxygen holding capacity. The survival rate during transportation can be seen to be more closely related to dissolved oxygen level than to any other water quality parameters (Green 1979, Harrison & Lutz 1980, Frose 1985, New 1990 and Venkatswamy *et al* 1990). According to Hora and Pillay (1973), the decreased oxygen levels have been shown to increase the toxicity of unionized ammonia in some freshwater prawns. Whenever there is mortality of prawn in ponds, there is very low level of dissolved oxygen also. After reaching the peak of growth, the algae start rotting, thereby causing oxygen depletion, the process of decaying consuming a lot of oxygen from the system. At the same time, the death of algae put on end to their oxygen producing roles. Side by side with these developments, a swarm of zooplankton appear as a natural sequence feeding on the decaying algae. These zooplankters also draw heavily on the already depleted oxygen budget of the system, bringing the dissolved oxygen to alarmingly low levels resulting almost total mortality of prawns (Raman 1990).

Roger and Fast (1988) reported that prawns become stressed at dissolved oxygen level below 2ppm. According to Upare (2005), dissolved oxygen content should be higher than 75% saturation i.e. 5 to 10 ppm for better survival of prawn. When dissolved oxygen concentration falls below 1mg/L for *M. rosenbergii*, results exhaustion with serious physiological effects leading to suffocation. (Boyd and Zimmermann, (2004), Reddy (2005) described that dissolved oxygen should be not below 4ppm for juvenile growth of both larval and mature prawns.

Total Alkalinity: During cultural practice, when the water is acidic with poor minerals, the ponds are often fertilized to enhance plankton booms with liming (Lacroix and Gondowin, 1990). For survival and growth of young *Macrobrachium*, Parameswaran and his associates (1990), studied the total alkalinity during cultural practice. High alkalinity in the water causes the death and decay of phytoplankton blooms by showing higher BOD. Higher alkalinity value helped to utilize calcium carbonate from the water by prawns for development of exo-skeleton (Ahmed and Varghese, 1990). For the better survival of some freshwater prawn, the alkalinity must be ranged from 7 – 102 mg/L (Boyd and Zimmermann, 2004). Ponds with a total alkalinity above 20mg/L can produce an abundance of prawns. If the alkalinity is below 20mg/L, liming is necessary (Reddy *et al.*, 2005).

Total Hardness: Sebastian and his co-workers (1974) reported that the total hardness influence the occurrence of the crustaceans. They also observed that the extreme hardness limits the occurrence of the species. Poor hardness in the prawn ponds enhances the phytoplankton for greater production after liming. For better survival of some freshwater prawn the hardness must be ranged from 10 – 75mg/L (Boyd and Zimmermann, 2004).

Temperature: Low winter temperature plus severe dry season affects in juvenile prawns production (Thompson *et al.* 1990). Johnson (1966) found that, some factors like temperature and salinity influenced the distribution and migratory behaviours of *M. rosenbergii* in the aquatic eco-system. Roger and Fast (1986) reported that prawns were stressed by temperature below 22^0C. Freshwater prawns are poikilothermic (cold blooded) – (Neill and Bryan 1991). The temperature should be ranged from 18^0C to 34^0C with optimum range of 27^0C to 31^0C for prawn survival (Upare, 2005). Optimum temperature for the development of various giant fresh water prawn is 20 – 30^0C. He also reported that sudden change in water temperature of even 1^0C may cause stress shock and even mortality of larvae (Reddy 2005). Sahoo *et al.* (2005), temperature 25 – 30^0C play a vital role on the normal development and better survival of freshwater prawn like *M. rosenbergii.*

Plankton: The role of many types of plankton in the growth and survival of various types of prawns are explained by many authors, Thangadurai, 1990; Ibrahim, 1962; Uno & Sao, 1969; Ling, 1969; Fujimora & Okamoto, 1970; Wickin, 1972; Sandifer & Smith, 1974; Sick & Beauty, 1974; Andrill & Thompsons, 1975; Sorgeloos, 1978; Aquacop, 1979; Mumbodh, 1979; New, 1979; Subramanyam, 1984 & 1986; Natarajan, 1981; Venkataraman, 1983; Alikunhi & Ali, 1984; Sankolli *et al.* 1984, New & Singholka, 1985; Smith, 1985; Ahmed & Varghese, 1990; Raman, 1990; Sebastian & Co-worker, 1990; Laws & Weisburd 1990, Zylva 1990; Lacroix & Gondown, 1990; Raje & Joshi, 1990; and Kurian & Sebastian 1993.

Phytoplankton

The limitation of phytoplankton with pH range can be controlled by the application of an algaecide during *M. roresbergii* culture in experimental pond water (Aquacop, 1979). He further reported that pH value of 10.5 due to plankton bloom cause prawn mortality. Prawn ponds are often fertilized by liming, chicken manure etc. to enhance phytoplankton bloom (Lecroix and Gondown, 1990). Fresh and blackish water living *M. malcolmsonii* prefer to live in water where there is availability of debris. mud and algae (Ibrahim, 1962). The depth of the algae put an end to their oxygen producing role during prawn survival. Side by side with these development a swarm of zooplankton appeared as a natural sequence, feeding on the decaying algae (Raman, 1990). Though many prawns have a preference for rotifers and smaller stages of chladoceran and copepods, but they are known to devour all types of phytoplankton (Natarajan, 1981). The mortality of *Macrobrachium* spp. is due to the depletion of dissolved oxygen caused by sudden collapse of a bloom of Chlorella sp. (Ahmed & Varghese, 1990). During the culture of certain giant prawns, like *M. rosenbergii* when there is excess of zooplankton, phytoplankton and filamentous algae in the intensive farming of freshwater prawns, grass carps are then introduced to control them for better survivality of the prawn (Sebastian *et al.*, 1990). Many phytoplankton in the larval tanks of prawn is beneficial as the algae are capable of converting the excretory products toxic to larvae to less harmful compound (New, 1979). A blue green algae spirulina is a protein (Venkataraman, 1983 and Joseph *et al.*, 1990) and β Carotene, β complex vitamins and minerals sources (Venkataman, 1985) are the very delicious food for prawn development. The presence of algae in some amount actually helps in maintaining water quality, $\mathbf{P^H}$ and DO, as also in preventing excessive light penetration and high temperature to the prawn pond bottom. Algal bloom must be controlled by application of algaecides (Reddy, 2005).

Reddy *et al.* (2005) reported that shading the bottom of the pond preventing the growth of benthic algae, providing a darker environment which is less stressful for the prawn. It will also produce oxygen when adequate sunlight is available. Many fresh water algae like *Microcystis, Aphanizomenon, Anabaena, Nodularia* pose great threat to many giant fresh water prawn (Nayak, 2005). Excessive phytoplankton blooms may lead to low dissolved oxygen concentration discouraging high prawn production (Boyd and Zimmermann, 2004). Many algal genera like *Anabaena, Botryococcus, Chlamydomonas, Chlorella, Dunaliella, Phaeodactylum, Porphyridium, Sprirulina* are the good and favourite food of many prawns shrimps etc. (Dube, 2005).

Zooplankton: During the formation of algal bloom in the water where prawns are available, there is also development of swarm of zooplankton feeding on the decaying algae. The zooplankton are drawn heavily on the already depleted oxygen budget of the system bringing the dissolved oxygen to alarmingly low level resulting in almost a total mortality of prawn. Sometimes, prawn prefers to consume considerable number of many larval stages of zooplankton thereby reducing their swarming population (Raman, 1990). According to Parameswaram and his associates (1990) some compatible species of carps are introduced to control over production of zooplankton during prawn culture. New (1979) has mentioned that the presence of phytoplankton in the larval rearing tank of prawn is beneficial because they may workout the excretory products toxic to the larvae of many zooplankton to less harmful nitrate thus improving the water quality. Many prawns prefer to stay with rotifers (Natarajan, 1981; Rao, 1983; and Kurian & Sebastian, 1993). Subramamyan, 1984) also reported that many freshwater prawns are the good feeders of rotifers. Natarajan (1981) observed that many prawns like to stay with smaller stage of cladocerans. Many cladocerans are the favourite food of many *Macrobrachium* spp. (Raje and Joshi, 1990); Ibrahim, 1962) found that fresh and brackish water living *M. malcolmsonii* prefers to live water where there is availability of Cladocerans. Many Cladocerans species are dominated in the monoculture of *M. rosenbergii* (Ahmed and Varghese, 1990).

Aquatic Vegetation

The role of many types of aquatic vegetation in the growth and survival of various types of prawn are discussed by many workers (Ibrahim, 1962; Ling, 1962 & 1969; Sidthimunka & Choapman, 1968; Fujimora and Okamota, 1970; Smith & Sandifer, 1979; Andrill & Thompson, 1975; Rao, 1990; Raman, 1990; Parameswaran *et al.*, 1990; Padmakumar *et al.*, 1990; Sebastian, 1990 and Thompson *et al.*, 1990.

Plants grow in patches at a few point in the pond for improving oxygen, Simply taking care that they do not spread all over the pond. In addition to oxygen supply, the plants provide shade, shelter and feeding pastures for the prawns. Plastic strips are used in prawn ponds to provide shade and shelter (Raman, 1990). Aquatic vegetation provided seen to have increased the availability of habitant in the nurseries and their carrying capacity. In addition the vegetation offer shelter to the small and soft moulting prawns and appears to have reduced cannibalism (Smith & Sandifer, 1975; and Parameswaram *et al.*, 1990). Rao (1990) in his investigation reported that the distribution of fresh waterprawn in standing water viz. lake, is limited to the regions subjected to total tidal oscilation. Many submerged vegetation, planted as habitat to prawn often get out of control causing oxygen, stress for the stalk (Andrill & Thompson, 1975; Munbodh, 1979).

The cladoceran, *Daphnia* and *Moina* are the good food for many *Macrobrachium* larvae. *Artemia* has been found to give better rate of larval survival (Sebastian, 1990). Reddy (2005) found that *Moina micrura* culturally is one of the cheapest sources of live for feeding prawn larva. Many species of copepods dominated in the monoculture of many *Microbrachium* species (Ahmed and Varghese, 1990). According to Natarajan (1981) many prawns prefer to stay with copepods. A number of eustuarine copepods are the favourite food of *Macrobrachium* spp. (Raje and Joshi, 1990). *Moina and Artemia* are commonly used as life food for certain freshwater *Macrobrachium* species (RamaKrishna Rao *et al.*, 2000 and Reddy, 2000). *Artemia nauplii*, due to the presence of yolk containing all essential fatty acids and significance concentration of vitamins, hormones, caretenoids and proteins, is one of the favoutire foods of many prawn larvae (Reddy, 2005). Barros and Velenti (2002) found the *Artemia franciscana* is the favourite food of larva stages as well as adult *Macrobrachium rosenbergii* (Aquacop, 1983).

Soil: The role of various types of soil in the growth and survival of different types of prawns are explained by many authors (Ling, 1962 & 1969; Sidhimunka & Choapanam, 1969; Fujimora and Okamoto, 1970; Smith & Sandifer, 1979; Joseph, 1990; Malecha *et al.*, 1986; Smith *et al.*, 1983; Raman & Cohen, 1984; Tripathi, 1990; Mercy & Sankaran, 1990; Joseph *et al.* 1990 and Muthu and his co-worker ,1992.

The different types of soil in beels, rivers, ponds etc. play an important role in the habitat and distribution of decapod crustaceans. Small shallow ponds with a little slope towards one side for easy draining are good for scientic prawn culture (Tripathi, 1990). Paremeswaran and his collaborators (1990), jointly reported that some giant freshwater prawns are cultured, is fully of `clay, often pudding with increased organic constituents including phytoplankton, detritus etc. But there is lack of using different types of soil substrata found in different water bodies to certain prawns like *M. rosenbergii* during larval development (Mercy & Sankaran, 1990).

Soil particles sizes ranged from $\leqslant 2$ µm (clays), 2 µm to 2 mm (fine to coarse silts) and 2mm to 2 cm (fine to coarse sands) are responsible for normal development and better survivality of many freshwater prawns. (Muir and Lombardi, 2004). According to Upare (2005), the ideal soil for Macrobrachium culture should be clay silt mixture or sandy loam comprising of 60% sand and 40% silt with good retention capacity. Good bottom soil condition and high quality water are essential ingredients for successful pond prawn culture. (Saharan, 2005). A sandy clay to clayey loam is the best type of soil for prawn growth and culture (Chandrakant and Prakash, 2005).