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Review Article

STUDIES ON CRABS (BRACHYURA): A REVIEW

Mohammad Moaviyah Moghal[1, 3], Vidya Pradhan*[2], Vishal Ladniya[3]

[1]*Department of Zoology, Dr. Rafiq Zakaria Campus, Maulana Azad College, Aurangabad, Maharashtra, India*
[2] *Department of Zoology, Dr. Rafiq Zakaria College for Women, Naukhanda, Aurangabad, Maharashtra, India*
[3]*Post Graduate and Research Center, Maulana Azad College, Aurangabad, Maharashtra, India.*
**Corresponding author: vidyaspradhan7@gmail.com*

ABSTRACT

In this article a number of published papers on crabs both freshwater and marine water crabs are reviewed, we realized that probably there is not a single review paper available on such studies. So we made an effort in order to present a review paper on the crab studies. We observed that different types of works have been done on crabs (both freshwater and marine crabs). The works can be classified into at least four major sets i.e. 1] Anatomy and Body parts, 2] Effect of parameters on Growth [Environmental Factor, Water quality, Pesticides, Chemicals, Metal Salts etc], 3] Compositional and Nutritional Analysis, 4] Applications [Medicinal Applications, Others Applications]

Keywords: Freshwater crabs, Marine crabs, studies on crabs

1. INTRODUCTION

Brachyurans which are true crabs hold more than 6500 species and are the biggest branch of the decapod Crustacea [1]. At present there are more than 6.700 known species of brachyuran crabs (both Marine water and Freshwater), out of which over 1,300 species are true freshwater crabs. Crabs that have adopted freshwater, semi-terrestrial or terrestrial forms of life, and are distinguished by their potential to complete their life cycle without help of the marine ecosystem are known as freshwater crabs. At present these crabs are classified into eight freshwater families: Pseudothelphusidae, Trichodactylidae, Potamonautidae, Dcckcniidac, Platythelphusidac, Potamidae, Gccarcinucidac and Parathelphusidae.

Generally freshwater crabs occur in the tropical and subtropical regions of the world. These are found in aquatic and terrestrial ecosystem. These crabs are found in more or less all freshwater ecosystems, such as fast-flowing mountain rivers, slow flat rivers, freshwater marshland, sluggish pools, and rice fields. Some freshwater crabs also live in caves [2]. China is the chief producer of farmed crabs Such as swamp and mud crabs (in indo pacific region); however the Philippines and Indonesia are also main crab producing countries, which are followed by Myanmar [3].

Crab Classification:

Kingdom: *Animalia*
Phylum: *Arthopoda*
Subphylum: *Crustacea*
Class: *Malacostraca*
Order: *Decapoda*
Family: *Brachyura*
Scientific name: *Brachyura*

As said earlier crabs are decapods crustaceans and are the essential part of macro fauna. Crabs (*Brachyura*) holds a prosperous diversity and more than 5000 species belonging to 700 genera have been identified worldwide [4]. Crabs are one of the extremely diversified and leading groups among Crustaceans [5]. These crustaceans such as crabs are considered as healthy food for humans because they contain high quality protein and less amount of fat [6]. Crabs are the fundamental parts of the ecosystem; they are supposed to be good for human consumption and taken as food in many countries. Both freshwater crabs and marine crabs are consumed. These crustaceans are economically vital in countries such as Japan, Philippines, China, France, Indonesia, Spain, Thailand and United States etc. Crustaceans are not only a direct source of food, but they are also used as food preservative and fertilizer, particularly crab waste materials (such as crab shell) are used as feed stabilizer [7]. When we compare crab with other aquatic animals, we see that Crab meat is a superb source of high quality nutrients due to its high protein content and less amount of fat [8]. Literature survey revealed that fresh water crabs have historically achieved relatively less attention than marine water crabs. But now this scenario has been getting better over the past few decades [9]. Researchers studied the systematics and biology of freshwater crabs of the different regions of the world. The volunteer contributions of some researchers should not be ignored [10]. Freshwater crabs are generally consumed in many parts of the world for getting vital nutrients such as protein, minerals and vitamins and possess huge potential for aquaculture. In

growing countries such as India is the best way of offering employment and making financial system for farmers [11].

Apart from this, freshwater crabs are also a significant source of chitin. It is the second most abundant biopolymer in the terrestrial and marine habitats after Cellulose [12]. Freshwater crabs considered as ecologically as well as economically important crustaceans because of their position in nutrient cycle, water quality checking and small-scale fisheries [13]. The freshwater crabs are one of the best foods for human consumption. Many species of crabs can be easily cultivated for human consumption. As a result there is rising demand for information about the biochemical composition of these crustaceans. For the farming of these crustaceans a number of significant features, for instance nutrition properties, biochemical structure and growth conditions required to be identified [14]. Freshwater crabs are distributed all over the tropical and subtropical parts of the planet earth. Decapod crustaceans stand for a great number of living species that live in a broad variety of uniform environmental conditions (biotopes). The greater part of species Shows Endemism, living in only a small defined geographic location. These species exhibit Endemism due to their poor dispersal skills and also due to territory damage caused by human. In the tropics and subtropics regions there are around 1,300 species and eight families of freshwater crabs. Regardless of this elevated diversity, the population biology of these creatures is still poorly known [15].

We looked at available literature on crabs and realized that various types of studies have been carried out on crabs (both freshwater and marine crabs). These studies can be divided into following groups namely:

2. RESEARCH RELATED WITH CRABS

1] Anatomy and Body parts
2] Effect of parameters on Growth
- A) Environmental Factor
- B) Water quality
- C) Pesticides
- D) Chemicals
- E) Metal Salts etc

3] Compositional and Nutritional Analysis
4] Applications
- A) Medicinal Applications
- B) Others Applications

2.1. Anatomy and Body parts

Po-Yu Chen *et al* studied the structure and mechanical properties of the exoskeleton (cuticle) of the sheep crab (*Loxorhynchus grandis*). Exoskeleton of crab is a natural composite; it means that it is made up of two or more than two materials with significantly different physical or chemical properties. It consists of extremely mineralized chitin–protein fibers organized in a twisted plywood or Bouligand pattern. They observed that there is a high density of pore canal tubules in the direction normal to the surface. These tubules perform two types of function, first function of these tubules is to transport ions and nutrition and second function of these tubules is to stitch the structure together. They performed tensile tests in the longitudinal and normal to the surface directions were on wet and dry specimens. Convex shape was observed when samples tested in the longitudinal direction, whereas concave shape was observed when samples tested in the normal orientation. The outcomes confirm that the composite is anisotropic in mechanical properties. They also performed Microindentation in order to measure the hardness through the thickness. It was observed that the outer layer is two times harder than the inner layer [16].

U. D. Sherkhane *et al* investigated the description of the gross anatomy and histology of the male reproductive system of *B. cunicularis*. The male reproductive systems consist of a pair of testes, a pair of vas deferens ending into ejaculatory ducts and a pair of penises. Anatomical study showed that in male crab two pairs of gonopods were also present which are known to serve as copulatory organs which transfer the spermatophores into female gonopores. The macroscopic anatomical study of the testes exhibited a similar pattern to that illustrated in other brachyuran species: the paired testes, H like appearance, presence of gonopods, etc. the microscopic anatomy of the testes shows that these testes consist of large number of testicular lobes containing spermatogonial cells that differentiate into spermatocytes and a collecting duct. Both testes were covered by the tunica. Cross section of vas deferens showed that it is more or less circular in shape and has a fibrous sheath of connective tissue and muscle fibers [17].

Kalpana M. Patil and Meena U. Patil studied the length-weight relationship and condition factor of *Barytelphusa gurini*. They used vernier caliper for measuring body dimensions, and Electronic balance for measuring body weight. For measurements they used the carapace length and weight of the body of the crabs. The length-width relationship was determined by applying the formula: W=aLb. The exponent 'b' value for male crabs was 2.83 and the exponent 'b' value for female crab was 2.03, and the exponent 'b' value for both male and female crabs was 2.35. Growth normally exhibited negative allometry in all crabs. For male, the condition factor (K) was 0.000802, for female, it was 0.000669 and for both sexes it was 0.000214. The regression showed high correlation and in male crabs the coefficient of determination (r2) was 97.8%, in female the coefficient of determination (r2) was 98.6%, which was extremely near to 1, and in both sexes it was 93.7%. [18].

R F Pathre and D D Bhutekar conducted Studies on morphometry of freshwater crab, *Barytelphusa cunicularis*. They calculated Secondary sexual organ chela of *Barytelphusa cunicularis*, a freshwater crab (females and males) collected from backwaters of Jayakwadi Dam. They examined Segmental growth of major and minor chela in both male and female crabs. They noticed that in male crabs all the segments

in major and minor chela exhibit positive allometric growth whereas in female crabs they found positive allometric growth only in merus and propodus. On the basis of Analysis of covariance (ANCOVA) of growth of major and minor chelae segments they came to conclusion that there was a noteworthy dissimilarity in growth pattern between major and minor chela in males, while in females there was no noteworthy dissimilarity in growth pattern between major and minor chela segments [19].

Sharmila Joseph *et al* conducted investigational study in order to isolate and identify bacterial and fungal pathogens, from lesioned carapace and limb of the freshwater crab Barytelphusa cunicularis, living in the paddy fields of Mananthavady, Wayanad, Kerala. They used pour plate method to isolate bacterial flora and they made phenotypic identification based on morphological characteristics and biochemical analysis. They isolated fungal pathogen from Sabouraud dextrose agar medium and employed Lactophenol cotton blue stain for morphological identification. They identified (from the infected carapace), nine genera of bacteria - Aeromonas, Alcaligenes, Bacillus, Chromobacterium, Enterobacter, Escherichia, Klebsiella, Micrococcus and Pseudomonas and one fungal pathogen Aspergillus sp. In infected limb Pseudomonas and Escherichia coli were identified [20].

Shipra Sinha studied the relationship between morphometric and allometric analysis of the freshwater crab *Barytelphusa cunicularis*. She collected all samples of freshwater crab (*Barytelphusa cunicularis*) from the field and nearby ponds located in and around Bhilai (21°13' N, 81°26'E), India. For each group, regression and frequency was determined separately. The study was depending on the biometric data, monitoring changes in the relative growth of some body parts related to other. On the basis on the study she arrived at the conclusion that the relative growth follows the allometric function (y=mx+c) [21].

2.2. Effect of parameters on Growth

2.2.1. Environmental Factor

J. Corte Rosaria and Encily R. Martin studied the effect of Low Frequency Electromagnetic Fields (LF-EMF) on the behavior of freshwater crab, *Barytelphusa cunicularis.* They observed that crabs exhibit a total aggregation between 60-90minutes . Higher feeding rate was observed in LF-EMF induced crabs, on the other hand, the eyestalk ablated crabs show voracious and non selective feeding behavior. When they injected crabs with the selective serotonin reuptake inhibitors drugs, viz. citralopam, fluxeotine and setralin. A maximum aggregation and aggressiveness is found in the order of fluxeotine > setralin > citralopam. Hence serotonin neurotransmitters are involved in aggregation and aggressive behavior in crabs [22].

Sakhare S.S and N.A. Kamble conducted investigation in order to study the direct release of industrial waste matters on the histochemical alterations in neutral and acidic mucosubstances, proteins and lipids in hepatopancreas of the freshwater crabs *Barytelphusa cunicularis.* They collected Water samples and crabs *Barytelphusa cunicularis* from Gadhinglaj tahsil. They collected freshwater crab *barytelphusa cunicularis* from site I and from site II where the distillery waste matter is discharged into river. They used only the same size Crabs (carapace width 13.1-13.5 cm and body weight 215-217 gm) for research.

After collection, they subjected sample to Physico-chemical analysis. They observed range of Temperature, pH, Chemical Oxygen Demand, Total solids, Total dissolved solids, and Chloride, Concentrations of the heavy metals were in the order of sodium > iron >potassium >copper >Zinc. On the basis of the study they came to conclusion that there is reduction in the amount of glycogen, protein and lipid which may be due to the direct effect of Physico-chemical factor such as chloride, sodium, Chemical Oxygen Demand, Total solids, Total dissolved solids and metals like iron, potassium, sodium, copper and zinc creating stressful situations and such situations cause distinct changes in secretary physiology with defects at tissue level [23].

Seema *et al* conducted Studies on the seasonal fluctuations in the proximate body composition of *Paratelphusa masoniana* (Henderson) (Female). They collected freshwater crab, *Paratelphusa masoniana* for a period of one year so as to examine the seasonal fluctuation in the proximate composition. They noticed that protein and lipid contents were inversely related to moisture content. During non-spawning period, amount of protein was higher (62.15±0.30%; 55.85±0.48) and amount of lipid was also higher (5.85±0.46%; 5.49±0.38%). On the other hand during spawning months, amounts of protein and lipid were lower. They noticed that protein and lipid have direct relationship. On the basis of the study, they noticed that the local freshwater crab, *P. masoniana*, is a biannual breeder [24].

2.2.2. Water quality

S.S. Sakhare and N.A. Kamble reported the effect of Environmental Pollution on Hepatopancreas of Freshwater Crab *Barytelphusa Cunicularis* (Westwood, 1836). In the study, they explained the effect of physico-chemical factors on the functional morphology of hepatopancreas of crab *Barytelphusa cunicularis.* They collected samples from three different water bodies and studied the morphological and functional state of hepatopancreas in *Barytelphusa cunicularis*. They determined many Physico-chemical parameters of ware, for instance Dissolved Oxygen, Free Carbon dioxide, pH, Temperature, Hardness, Chemical Oxygen Demand, Total Solids, Total Dissolved Solids, Suspended Solids, Alkalinity, Chloride, Nitrate, Phosphate and base level contamination of heavy metals. They used standard H-E (Hematoxylene-Eosin) staining technique for Histological study of hepatopancreas. They observed Cellular damage in F-cells, R- cells and B-

cells. On the basis of the study they came to conclusion that pollutants were the major reasons of pathological signs. They suggested that histological changes in crabs can be used as biomarkers for keeping an eye on pollution in aquatic bodies [25].

They also conducted investigational work so as to find out to the effect of water contaminant on ovarian cells of freshwater crab, *Barytelphusa cunicularis.* For the study they collected freshwater crab *barytelphusa cunicularis*. They used only healthy crabs having the same size (carapace width 13.1-13.5 cm and body weight 215-217 g) for experiment. They found that there was harmful effect on physico-chemical factors due to the release of sewage and industrial waste matter. They observed hypertrophy (the enlargement of tissue from the increase in size of its cells.) with structural break down in Gonadal system of *Barytelphusa cunicularis* , because of the adverse effect of chloride, sodium, Chemical Oxygen Demand, Total solids, Total dissolved solids and Suspended solids on growing oocytes under tense conditions causing gametogenic defects. The physico-chemical parameters produced abnormalities in growing oocytes under tense conditions [26].

2.2.3. Pesticides

Mididoddi Venkateshwarlu and Mallar Shanmugam conducted study in order to find out the effect of Endosulfan on oxygen consumption and succinate and lactate dehydrogenase activities in freshwater crab *Barytelphusa cunicularis.* They carried out investigational work so as to find out the short-range (lethal) and long-standing (sublethal) effect of Endosulfan on oxygen consumption, and to observe succinate dehydrogenase (SDH) and lactate dehydrogenase (LDH) activities of the tissues of the crab. They collected crabs samples from the Bhadra River and nearby places, after collection they acclimatized the crabs to the laboratory conditions for about 10-12days. They divided experimental crabs into three groups; they put 10 crabs in each group. They used first group as a control, and subjected second group to lethal concentration of Endosulfan (2.22µg/L) for four days, and also subjected third group to sub lethal concentration of Endosulfan (0.37µg/L) for 21days. After exposure, they determined oxygen consumption of the crabs and tissue SDH and LDH activities. They observed reduction in the oxygen consumption due to lethal and sub-lethal concentrations of Endosulfan. Succinate dehydrogenase activity in all tissues was observe over the control, while they noticed that LDH activity level was increased in gills, muscles, hepatopancreas, testes and ovaries(In all the tissues samples), On the basis of the study they came to conclusion that Endosulfan possess an harmful effect on crab oxygen consumption [27].

2.2.4. Chemicals

Atul R. Chourpagar and G.K. Kulkarni performed Histological studies so as to study lesions in gills that had resulted from lethal exposure of the freshwater female crab, *Barytelphusa cunicularis* (Westwood) to copper sulphate. They treated crabs with fatal concentrations (282, 258, 238 and 215 ppm) of copper sulphate. After exposure to copper sulphate, the crabs exhibited many histological changes during 1 to 4 day of exposure. They observed that gills exhibited vacuolization in the gill stem, gill lamellae were ruptured, connective tissue cells in the stem were broken, and blockage of haemocytes in the gill lamellae were observed [28].

They also investigated the effect of sublethal [1/5 of 24 h LC50 (0.208 ppm)] concentration of mercuric chloride on protein, lipid and glycogen in the freshwater crab, *Barytelphusa cunicularis.* The crab is a key food source in the parts of Marathwada region. They exposed crabs to mercuric chloride for 7, 10 and 15 days. They observed significant reduction in Protein, lipid and glycogen contents in ovary, hepatopancreas, thoracic muscles, gills and spermathecae of treated crabs as compared to untreated crab controls [29-30].

Shaik *et al* conducted study in order to find out the effect of mercuric chloride on the ovary of freshwater crab *barytelphusa cuniculris*. They collected freshwater crab, *Braytelphusa cunicularis* from Godavari River at Paithan near Aurangabad. They acclimatized the crabs to laboratory conditions for about 2 to 3 days in a plastic container. They exposed crabs to mercuric chloride at lethal and sub-lethal concentrations in order to study the histopathological lesions in the ovary, at the same time they also maintained control groups of crabs.

Microscopic study of the ovaries of control crabs showed that the ovaries were covered by outer slim epithelium and inner germinative epithelial layer from which the oocytes proliferate. They observed that mature oocyte was covered by oocyte membranes. Oocyte contained a big rounded nucleus and one or two nucleoli. Near the oocyte, the nutritive cells were also seen. The oocytes were covered by follicle cells. The ooplasm was efficiently organized with fat yolk granules. Various types of maturing oocytes were present in ovarian follicles. After 24 hours of exposure, they observed pycnosis of nutritive cells and nucleus of oocyte because of reduction in the size of oocyte. They also observed demolition of epithelial layer and deterioration of oocytes. Furthermore, loosely arranged epidermal layer, and vacuolization in the periphery of the oocyte was also observed [31].

2.2.5. Metal Salts

Soundarapandian *et al* carried out investigational work so as to determine Mineral composition of edible crab *Podophthalmus vigil Fabricius.* The estimation was carried out for seven minerals, out of the in male crabs 5 minerals were found and the amount of these minerals was as follows (Sodium> Calcium> Potassium> Iron>Magnesium), In female crabs 7 seven minerals were found and the amount of these minerals were as follows (Sodium>Calcium> Iron>Potassium> Phosphorus> Magnesium>Zinc) and in berried females 4 minerals were found and the amount of these minerals was as follows (Calcium>Sodium>Iron>Magnesium) .They noticed

that in all samples sodium and calcium were maximum and magnesium was minimum. Amount of minerals was higher in females than that of males and berried females. In males, Phosphorous and zinc were absent while in berried females potassium, phosphorous and zinc were absent. Maximum amount of minerals (61.56 mg) was found in females followed by males (39.92 mg) and berried females (35.11 mg). They noticed that females contain maximum amount of minerals. Hence it is better to consume female crabs to obtain maximum amount of minerals [32].

In another study Soundarapandian *et al* studied 11 Mineral Composition of Edible Crab, *Charybdis Natator Herbst*. They found Seven minerals (Sodium > Potassium > Magnesium > Ca lcium > Manganese > Iron > Zinc) in males, females and berried females. The amount of Sodium was maximum and the amount of zinc was minimum in males, females and berried females. In all sexes, very less amount of Copper, mercury and cadmium was noticed. But, extremely small amount arsenic was found in berried females, but they did not find arsenic in males and females. They found maximum amount of minerals (157.65 mg) in berried females followed by males (117.30 mg) and females (93.65 mg). On the basis of the study they came to conclusion that berried female crabs holds greatest amount of minerals than males and females. So it is better to have berried females to obtain maximum amount of minerals [33].

Fagbuaro Omotayo *et al* studied Proximate Composition and Mineral Content of the Land Crab *Sudanonautes africanus*. They collected samples from male and female exoskeleton, flesh and whole body. For proximate analysis they used spectrophotometer for the determination of the mineral content of the crabs. They found that the amount of crude protein was highest in the male exoskeleton samples (39.84±0.25%) whereas in the male flesh samples, amount of carbohydrate was highest (41.59±0.27%), and in the female flesh samples the amount of carbohydrate was highest (57.89±0.28%). *Sudanonautes africanus* was rich in Sodium, Potassium, Calcium, Magnesium, and Phosphorus [34].

Emmanuel *et al* determined the proximate and mineral composition of the whole body (edible parts), flesh and exoskeleton of the male and female common West African fresh water crab *Sudananautes africanus africanus*. They found considerable amount of cobalt, iron, nickel, magnesium and zinc in all the three samples but they did not find copper in all the samples. They observed that the Ca/P ratio was poor (0.08 to 0.20) in all the samples, while Na/K was high (0.86 to 1.35) in all the samples. Hence this crab species is a good source of protein with low fat [35].

Atul R. Chourpagar and G.K. Kulkarni performed severe toxicity tests against the pesticides copper sulphate and mercuric chloride. They found Median Lethal Concentration (LC50) values of Copper sulphate were 282, 258, 238 and 215 ppm respectively for 24, 48, 72 and 96 hours., while Median Lethal Concentration (LC50) values of mercuric chloride were 1.04, 0.84, 0.63 and 0.45 ppm respectively for 24, 48, 72 and 96 hours. They came to conclusion that the crab is more sensitive to mercuric chloride than copper sulphate [36].

H. Niu and B. Volesky found that biosorption of anionic metal species such as gold-cyanide, chromate and anionic vanadate species by acid washed Ucides shells mainly involves anions binding on the positively charged amide groups of the acid-washed Ucides shells. The binding force is likely due to electrostatic attraction. They also reported that acid washed Ucides shells have a promising potential for binding anionic metal species such as gold-cyanide, chromate and vanadate. All selected metals were bound on acid washed Ucides shells at their respective original valent states, i.e. Au(I), Cr(VI) and V(V). The anionic metal species biosorption takes place through a combination of ion-exchange and adsorption. However in the case of vanadate, the binding mechanism may involve other mechanism [37].

N. R. Sayyad conducted study in order to find out heavy metal concentrations in different body part of crab, *barytelphusa cunicularis* from Godavari River. He determined the concentration of heavy metals Arsenic (As) and Chromium (Cr) in hepatopancreas, gills, muscle and whole body of crab, *Barytelphusa cunicularis* during summer, monsoon and winter so as to find out the pollution status of the river. He found different levels of accumulation of Arsenic and Chromium in the crab. He noticed that in all seasons (summer, monsoon and winter season), the level of Arsenic in muscle, gills, hepatopancreas and whole body was higher than the suggested maximum acceptable standards in food, while in summer season Chromium level in muscle and gills was higher, in monsoon season Chromium level in hepatopancreas and whole body and muscle was higher, and in winter season Chromium level in whole body was higher than the suggested maximum allowable standards in food. He observed that the level of Chromium in muscle (in monsoon season), gills (in monsoon and winter seasons), hepatopancreas (in summer and winter seasons) and whole body (in summer season) were lesser than the suggested maximum allowable standards in food. On the basis of the study he came to conclusion that the Godavari river system is infected with heavy metals [38].

2.3. Compositional and Nutritional Analysis

Fagbuaro Omotayo *et al* performed research work in order to determine the proximate compositions of freshwater crabs (*Cardisoma armatum*) and marine crab (*Callinectes amnicola*), mineral contents and anti-nutrient. They observed that protein, fiber and carbohydrate were higher in both male and female of the two crab species. But *C.amnicola* samples had more protein, fibre and carbohydrate than *C.armatum*. They found that Sodium, Potassium, Calcium, and Phosphorus were main elements in both male and female *C.armatum* and *C.armnicola*. Copper was absent in both species of crab. The anti-nutrients such as tannin, phytin and oxalate were present

in both species of crabs but not as high as to damage the nutritional qualities of the crabs. High nutritional values and low anti-nutrient values will make *C.armatum* and *C.amnicola* high-quality substitutes to catfishes and mackerel where these animals could not be afforded [39].

B. A. Moronkola *et al* studied the tissue, crunchy part and walking legs of crab *callinectes amnicola* so as to find out their Proximate and mineral composition (calcium, iron and zinc). The crabs had crude protein ranged between 19.2-28.3 g/100 g and the study revealed that these crabs are rich source of protein , crab tissue sample had highest amount of protein (28.00 ± 0.071 %) while the walking legs contain 19. 233 ± 0.066 % protein and the crunchy had 19.820 ± 0.069 % protein. By applying gravimetric method for estimation of crude fiber and crude fat, they reported that, walking legs contained higher amount of the crude fiber (11.070 ± 0.037 %) , 0.023 ± 0.071% crude fiber was present in the tissue and the crunchy part contains 6.680 ± 0.074% crude fiber. in all three parts (legs, tissue and Crunchy part) the moisture content ranged from 67.37 ± 0.226% to 70.046 ± 0.049% is observed. Average ash content in crunchy part was 1.040 ± 0.017%, It was 1.300 ± 0.001 % in walking legs and 1.041 ± 0.002% in tissue. Atomic absorption spectrophotometer estimation for Calcium, iron and zinc gives: 850 μg/g calcium was present in the tissue and 900 μg/g in the crunchy part. 690 μg/g iron was present in tissue and 820 μg/g in the crunchy part. 128 μg/g zinc was present in the tissue and 388 μg/g in the walking legs. They found that concentrations of the mineral content were within the permitted daily requirement for zinc, iron and calcium per day. Hence, the crab *callinectes amnicola* may be a balanced diet for us and can be used as a substitute dietary supplement of protein and mineral. They came to conclusion that the consumption of crabs could be useful to avoid nutritional deficiencies in the future [39].

Sengul Bilgin and Zeliha Ufuk Canli Fidanbas investigated nutritional properties of freshwater crab (Potamon potamios), captured from the Lake of Egirdir, Turkey, in relation to season and sex. They separated crabs into crab meat and crab shells. They conducted separate test and analysis on crab meat and dried crab shell. On the basis of proximate composition analysis, they found that there were no noteworthy differences in the moisture, protein, fat and ash contents in terms of seasons. But they noticed that there were considerable ($P<0.05$) changes between male and female crab meats in terms of protein values.

In the female crab meat during winter season the highest contents of calcium, sodium and potassium was 17.87±1.356, in summer these were 11.88±0.62 (in female). In the male crab meat during summer season the highest contents of calcium, sodium and potassium was 11.70±0.50 mg/g , while In male during summer season these values for crab shell was 197.50±7.836 , and in winter these values was 3.96±0.583 (In male) and in summer season these values was 6.26±0.222 mg/g (in male), respectively. They reported that Female freshwater crab samples had the highest chitin content (7.80±0.835%) in the summer and Female freshwater crab samples had the highest chitosan content (5.86±0,536%) in spring season [40].

Aygul Kucukgulmez *et al* determined the nutritional composition of the breast, claw meat and hepatopancreas of the blue crab (*Callinectes sapidus*). They analyzed samples to find out proximate composition (protein, fat, ash and moisture) and calcium, magnesium, phosphorus, potassium and sodium contents. Average amount of Protein in breast, claw meat and hepatopancreas of the blue crab was 19.05 g/100 g, average amount of fat in breast, claw meat and hepatopancreas of the blue crab was 0.59 g/100 g, average amount of ash in breast, claw meat and hepatopancreas of the blue crab was 2.10 g/100 g and average amount of moisture in breast, claw meat and hepatopancreas of the blue crab was 76.85 g/100 g,. They found that this species is a rich source of protein, calcium, magnesium, phosphorus, potassium and sodium.

The higher protein concentrations was observed (19.55 g/100 g) in Claw meat followed by both breast meat and hepatopancreas (18.81 g/100 g). The sodium was chief metal among minerals. They observed noteworthy differences between calcium, magnesium, phosphorus, potassium and sodium contents of claw, breast meat and hepatopancreas of the blue crab. Hence the blue crab could be used as an alternative dietary supplement of proteins and mineral matter [41].

Udo Paul Jimmy and Vivian Nneka Arazu studied the nutritional qualities of the flesh and shell of *Uca tangeri* and *Callinectes amnicola* of the Cross River, Nigeria. They brought Specimens of *C. amnicola* for this study from fishermen at the beach of the Cross River behind the University of Calabar, Calabar, Nigeria. Crab species were exposed to proximate analysis. The calculated moisture content of the specimens was 72.31±0.96% for the flesh of *U. tangeri* and 74.54±0.03% for the flesh of *C. amnicola,* whereas 33.60±0.15% moisture was present in the shell of *C. amnicola* . The crude protein content of the flesh of both species was noteworthy ($p>0.05$). The protein level of *U. tangeri* was higher than that of *C. amnicola.* However, the total protein level of *C. amnicola* (flesh and carcass) was higher than that that of *U. tangeri* [42].
Hence all the crab species are rich source of protein and minerals.

G. Rameshkumar *et al* evaluated and Compared Fatty Acid Profile in the Edible Crabs *Scylla serrata* and *Portunus pefagicus.* For this comparative study they collected two species of commercially important food crab *Scylla serrata and Portunus pelagicus* from in and around Parangipettai coastal waters. Fatty acid profile showed that In *Scylla serrata* ovary eicosapentaenoic acid was 8.0 % and this acid is 4.82% in the chelate leg. In *Portunus pefagicus eicosapentaenoic acid* was more

in the chelate leg (4.02%) as compared to ovary (3. 02%). In the *Scylla serrata,* particularly palmitoleic acid (MUFA) in chelate was 4% and in the ovary it was 7%. In the Portunus pefagicus, amount of palmitoleic acid (MUFA) in the chelate was 2.39% and amount of this acid in ovary was 0. 213% [43].

Ozogul *et al* studies and compared fatty acid, trace element and proximate compositions of male and female of blue crabs and swim crabs from Mersin bay, Turkey. They found dissimilarities in protein and moisture content of both female crabs and male crabs' meat of these two crab species ($p<0.05$). 23.3%-24.8% Saturated fatty acid (SFA) was found in blue crabs while in swim crabs amount of saturated fatty acid was 24.7%-24.9%. They noticed that amount monounsaturated fatty acid (MUFA) in the body of blue crabs (26.6%-29.6%) was higher than that of swim crabs (24.1%-25.9%). Furthermore, they observed that amount of polyunsaturated fatty acid (PUFA) in swim crabs (43.8%-45.3%) was higher than that of blue crabs (39.2%-42.8%) ($p<0.05$). On the basis of the study they came to conclusion that crab meat is a rich source of trace element, particularly Copper, Zinc, and Iron [44].

Keivandokht *et al* studied Fatty acid composition and Lipid content in Muscle Tissue of Ghost crab (*Ocypode rotundata*) in Bushehr Coastal Zone in Persian Gulf by employing Blight & Dyer method (1959).They used Gas Chromatography-Mass Spectrometry (GC- MS) for the determination of compounds. They found monounsaturated fatty acid (MUFA) Oleic acid, saturated fatty acids (SFA) Palmitic acid and Stearic acid, polyunsaturated fatty acids (PUFA) alpha- Linoleic acid, two methyl esters of fatty acids including Octadecanoic acid, methyl ester and Hexadecanoic acid, methyl ester, Cholesterol (Cholest-5-en-3-ol (3β) and Alkane including Hexadecane, Heptadecane and Octadecane in both male and female crab samples. They noticed that Omega-3 alpha- Linoleic acid (ALA) was dominant fatty acid in both male and female crabs [45].

Sullivan *et al* studied distribution of n-3 polyunsaturated fatty acids in different edible portions of the blue swimmer crab (*Portunus pelagicus*). They examined lipid content and n-3 PUFA and other fatty acids in muscle, gonad and hepatopancreas in blue swimmer crab (Portunidae: *Portunus pelagicus*). For lipid extraction they used chloroform: methanol mixture (2 volumes of chloroform: 1 volume of methanol) with 10 mg/L of butylated hydroxytoluene and 0.2 mg/mL of tricosanoic acid. Capillary gas liquid chromatography method was used for the separation of fatty acid methyl esters. In all three edible portions, they noticed that n-3 PUFA were considerably different ($P < 0.01$). Highest level of n-3 PUFA was observed in hepatopancrease and lowest level was observed in the muscle. In the three edible portions Total n-6 PUFA was not considerably different, but n-3 exhibited a noteworthy different among these three edible portion. The amount lipid content was higher in hepatopancreas while the amount lipid content was lower in muscle. The higher ratio of n-3/n-6 (3.5) in the Muscle was noticed as compared with 1.8 for gonad and 1.3 for hepatopancreas [46].

Emmanuel I. Adeyeye and Amoke M. Kenni studied the amino acid composition of the whole body, flesh and exoskeleton of the common fresh water West African male crab, *Sudananautes africanus africanus*. They found that Glucine was the most concentrated acid (128.0-130.0 mg/g crude protein) and Leucine (50.0-60.9 mg/gcp) was the highest essential amino acid. The observed range of Total amino acid was 635.8-749.2 mg/gcp and the observed range of total essential amino acid was 298.2-356.6 mg/gcp or 46.9-47.9%. In whole body and flesh, Valine was the limiting amino acid while in the exoskeleton Lysine was limiting amino acid and observed range of Phe + Tyr was 1.0-1.2. Noteworthy differences were found between essential amino acid and non-essential amino acids at $p<0.05$ among the samples. 54.9-57.6% neutral amino acids were found in the samples, 26.2-29.7% total acidic amino acids were noticed in the samples and 15.4-17.3% total basic amino acids were observed in the samples. They came to conclusion that Male *Sudananautes africanus africanus* is a high-quality source of protein mainly the essential amino acids [47].

Kucukgulmez *et al* studied the amino acid composition in tissues (claw, breast meats and hepatopancreas) of the blue crabs (Callinectes sapidus, RATHBUN, 1896), captured from the North Eastern Mediterranean Sea (Turkey). They found that the claw, breast meat and hepatopancreas of the blue crab had considerably different amounts of the amino acid. The Glutamic acid was key amino acid in all parts of the blue crab. The range of total essential amino acids was 7.24 to 7.83 g/ 100 g fresh wt. Essential to nonessential amino acids ratio for hepatopancreas was the highest (1.03), after that breast meat (0.83) and claw meat (0.78) respectively. Furthermore, They found big amount of methionine and lysine amino acids in the samples, which are normally limiting amino acids in routinely eaten food, in the hepatopancreas, the amount of Methionine was the highest (3.38 g/100g protein) and the amount of lysine was the highest in the breast meat (6.82 g/100g protein). They came to conclusion that more or less all of the amino acids are present in the blue crab [48].

M. Sudhakar *et al* performed research work in order to find out nutritive value of hard and soft shell crabs of *Portunus sanguinolentus* (Herbst). They reported the biochemical composition (protein, carbohydrate and lipid) including amino acids and minerals of both soft and hard shell crabs of *P.sanguinolentus*. They found that protein, carbohydrate and lipid contents were higher in hard shell crabs than that of soft shell crabs. Also tested for total ten essential amino acids out of which eight essential amino acids were present in hard shell crabs and seven amino acids were present in soft shell crabs. Amount of essential amino acids in the hard shell crabs was 51.096% and in soft shell crabs was 43.627%.Apart from this, also analyzed for 10 nonessential amino acids, out of which eight nonessential amino acids were present in hard shell crabs

and seven nonessential amino acids were present in soft shell crabs. Hard shell crabs provide 53.783% of non essential amino acids and soft shell crabs provide 49.719% of non essential amino acids. The mineral analysis reveals that the hard shell crabs provide 3.985mg of minerals and the shell crabs provide 3.018 mg of minerals. The protein, carbohydrate and lipid contents were higher in hard shell crabs than that of soft shell crabs. Contribution of hard shell crabs was higher than soft shell crab in the case of individual and total amino acids (essential + non essential). Hard shell crabs provide more minerals than soft shell crabs. It is concluded that hard shell crabs are better than soft shell crabs in terms of nutritive value [49].

P. K. Pati *et al* analysed the biochemical composition of freshwater crab meat of *Sartoriana spinigera* (Wood-Mason, 1871) before and after their spawning seasons during the months of January to March and July to September. They found that protein content of meat of female crabs varied from 30.03% to 59.29%, and lipid content of meat of female crabs varied from 7.01% to 11.29% and ash content of meat of female crabs was between 38.75 and 39.44% dry weight, while the moisture content was between 71.26% and 79.51%. The protein, lipid and ash contents were highest during the month of January to March but, the values of these contents were lowest during the month of July to September [50].

Soundarapandian P *et al* reported that protein content in *Podophthalmus vigil* was higher in females (23.47%) than those of males (21.53%) and berried females (20.93%). They observed that carbohydrate content was considerably higher in berried females (2.76%) and lesser in males (2.09 %) and females (2.06%), whereas in females the lipid contents was considerably higher (1.09%) and lipid contents in berried females was higher (1.05%) than that of males (0.32%). The ash content was maximum in females (0.99%) followed by berried female (0.98%) and males (0.31%). The berried females had maximum moisture content (79%) followed by males (75%) and females (74%). Hence organic constituents of the females are nutritionally better than those of male crabs [51].

Chen *et al* analyzed the nutritional compositions of Chinese mitten crab of commercial size grown in pond with different genders. They observed that total edible yield were 40% for both male and female crabs. Crab muscle meat provides as much as 80% of the total protein. Muscle meat can be consider as a low-fat food with high-protein with relative well-balanced essential amino acids, particularly that from female crabs. Whereas the edible viscera contain 99% of the total fat with rich n-3 fatty acids, particularly Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA), It proves that Chinese mitten crab grown in pond is definitely an n-3 PUFA-rich food for human.

They found no noteworthy differences in all parameters tested between male and female crabs, however male crab contains lower values of essential amino acids than female crabs, pointing out that male and female Chinese mitten crabs have similar nutritional values [52].

Priya Manhas *et al* studied different nutritional aspects such as protein, glycogen, lipid, moisture and ash of the body meat of freshwater crab, *Paratelphusa masoniana* in both male and female crabs. The seasonal variation during a yearlong research was monitored. They found that Lipid and water contents were inversely related. Lipid levels were higher during the pre-spawning months and lower during post-spawning. There was direct correlation between lipid and protein. Pre-spawning period witnessed high energy values and muscle glycogen witnessing a direct correlation with feeding and spawning activity. Hence nutritive value of *P. masoniana* is as good as to other edible species of crustaceans like prawns and shrimps [53].

Sidharth D. Pagare and E. R. Martin performed research work so as to compare the physico-chemical and functional properties of hemolymph protein (HP) from freshwater crab, *Barytelphusa cunicularis* with commercially available proteins viz. Casein, egg albumin and Bovine serum albumin (BSA) for possible use in food technology. At different pH the percentage solubility of proteins, observed were casein>HP>egg albumin>BSA. The emulsifying properties of casein, egg albumin, BSA and HP at pH 7 and 9, do not exhibit any statistically major difference.

The foam stability and capacity of protein were in the order of casein> egg albumin=BSA>HP and casein<egg albumin<HP<BSA respectively. The foam stability and time show a statistically significant relationship. The HP exhibits a less water binding capacity and oil binding capacity when compared to casein, BSA and egg albumin. They recommend that HP is a good contender for use in food processing industries and this protein should not be overlooked [54].

Encily R. Martin studied the hemolymph proteins of freshwater crabs, *Barytelphusa cunicularis* for their physico-chemical and functional properties. He observed that hemolymph proteins of freshwater crabs exhibited high percentage solubility at pH 4 and 9. He also found that emulsifying properties of hemolymph proteins exhibited no major difference at pH 7 and 9; but when he compared hemolymph proteins with albumin and casein, he observed that only egg albumin showed noteworthy differences, whereas casein and hemolymph proteins did not show any considerable difference. The foaming activity and stability of hemolymph proteins was lesser compared to casein and egg albumin. The hemolymph proteins had lesser water and oil binding capacity than egg albumin and casein [55].

Dewei Chen and Min Zhang conducted study so as to investigate Volatile compounds in Chinese mitten crab. They used simultaneous distillation-extraction method for extraction. They identified and quantified using GC/MS total 94 volatile compounds, 86 compounds in whole crab and 83 compounds in crab meat. 76 compounds are present in both samples (whole crab and crab meat), including the 5-9 carbons

aldehydes, methyl ketones, 2, 3-butadione, 1-octen-3-ol, amines, pyrazines, thialdine and thiazoline, etc. on the whole, the concentrations of volatile compounds in whole crab are significantly bigger than that of crab meat [56].

Priya Manhas *et al* conducted Studies on the seasonal variation in the lipid and moisture content of body tissues of *Paratelphusa masoniana*, It is locally available freshwater crab of Jammu. They observed noteworthy variation in the lipid and moisture content of different tissues of *P. masoniana* during the study period. They observed that Changes in the lipid content in all the three tissues were statistically worth mentioning ($P<0.05$). The outcomes uncovered that moisture content was high when lipid was low during the peak spawning pointing out inverse relationship between the two Lipid and Moisture [57].

Jian-xue Lu *et al* analyzed three wild populations of crucifix crab *Charybdis feriatus* for proximate composition, amino acid and fatty acid composition, in order to quantify and compare the nutritional quality from three different locations in China. They found that crude protein content in muscle of female crucifix crab *C. feriatus* from Zhoushan (ZS) and Xiapu (XP) (84.84%-88.35%) were considerably higher than that of crucifix crab *C. feriatus* from Qionghai (QH) (74.33%), at the same time they did not find any noteworthy difference in terms of crude fat content (3.82%-4.07%). The highest content of ash was found in muscle of crucifix crab *C. feriatus* from QH (5.36%). considerably higher contents of total amino acids, essential amino acids, non-essential amino acids and delicious amino acids were found in muscle of crucifix crab *C. feriatus* from ZS and XP than those of QH group ($P<0.05$). The highest content of poly-unsaturated fatty acids (33.64%) and total content of EPA and DHA (22.85%) were observed in the ZS group, followed by XP and QH group ($P<0.05$). On the whole, the differences in chemical composition in muscle of *C. feriatus* from different locations could be due to environmental conditions and maturation stage [58].

Adeyeye and Aremu studied food properties of common West African fresh water male and female crab. They determined food properties such as water, oil, oil emulsion and foaming capacities: WAC, OAC, OEC, FC; foaming and oil emulsion stabilities: FS, OES; least gelation concentration: LGC; protein solubility: PS) of common West African Fresh water crab (*Sudananautes africanus africanus*). They used the soft flesh, exoskeleton and whole crab. They found that in the flesh, levels of WAC, FC, OAC, and OEC were superior in female than those of in male; but they did not find such type of result in exoskeleton and whole crab. In both male and female, LGC values were higher in the flesh than those of the whole crab and exoskeleton. They found low values of FS and OES in all the samples. They noticed that in female whole crabs, the rate of change of FS was lowest (0.54 min–1) but it was highest in male exoskeleton (3.89 min–1). All samples exhibited low oil emulsion stability and it was collapsed within four minutes. Protein solubility was higher in female flesh followed by female exoskeleton > female whole crab > male flesh > male whole crab > male exoskeleton [59].

2.4. Applications

2.4.1. Medicinal Applications

Preyanat Vongchan *et al* studied citosan from marine crab shell in order to find out its anticoagulant activity. They sulfated Chitosan from marine crab shell with a degree of deacetylation of 0.89 using chlorosulfonic acid/dimethylformamide under semi-heterogeneous conditions. The resulting chitosan polysulfate exhibits high solubility in common organic solvents and more notably, dissolves well in water. They separated chitosan polysulfate by gel filtration chromatography for three different products with average molecular weights of 6.6, 3.5 and 1.8 x 104 daltons. All three chitosan polysulfate preparations showed strong anticoagulant activities. Each and every one outcome pointed out that chitosan polysulfate modified by using semi-heterogeneous conditions with potent anticoagulant activity has been synthesized by them [60].

Crab belongs to phylum *Arthropoda* and subphylum *Crustacea*. It has a matchless position in evolution. This animal has lots of bioactive materials with unique functions. Ahmed M. Al-Shammari *et al* extracted compounds from crab shell so as to investigate the antitumor effect of the extract. They used four different extracts derived from crab shell. The burned and normal crab shell powder for extraction was used. Water and methanol were used as solvents. It was found that aqueous and methanolic extracts of burned crab shell powder have Cytotoxic property and inhibit the *in vitro* proliferation of human laryngeal carcinoma tumor cell lines (Hep-2) and human Rhabdomyosarcoma cell line (RD) and one murine mammary adenocarcinoma tumor cell line (AMN3), in dose and time dependant manner [61].

Md. Monarul Islam *et al* extracted chitosan from crab shell in order to study the effect of crab chitosan on the susceptibility of *Staphylococcus aureus* and *Escherichia coli*. Chitosan is a naturally occurring biopolymer, it is nontoxic in nature. It is chemically similar to the plant fiber called cellulose. It can be produced by the deacetylation of chitin; *Chitin* is the second most abundant natural biopolymer after cellulose. Chitin is a major component of the shells of crustaceans such as crab, shrimp, and crawfish. At present, chitosan has got wide attention for its amazing applications in the chemical, food and biomedical industries. Chitosan which is famous to possess many functional properties has made remarkable interest among the researchers because of their biological activities and in the near future applications in the food, pharmaceutical and agricultural industries. They studied antimicrobial activities of chitosan against *Staphylococcus aureus* and *Escherichia coli* [62].

G. Rameshkumar *et al* isolated peptide from the haemolymph of the crab *Thalamita crenata*. In antibacterial

activity test, the highest zone of inhibition in the haemolymph of *T.crenata* against *Proteus mirabilis* (17 mm) and lowest zone of inhibition against *Klebsiella oxytoca* and *Lactobacillus vulgaris* (14mm). But they did not find any activity against the tested fungal pathogens. Hence the haemolymph of T.crenata crabs may have potential antibiotics [37, 63].

Tracy Adole and Barry A. Omogbai extracted compounds from crab shell in order to examine the antibacterial effect of crab shell extract on *Klebsiella pneumoniae* and *Proteus mirabilis*. They isolated *K. pneumoniae* and *P. mirabilis* from urine and wound specimen. They observed that *K. pneumoniae* were sensitive to crab shell extract, at the same time *P. mirabilis* were resistant to crab shell extract. They observed that, at concentration of 200µg/ml of crab shell extract, the highest zone of inhibition of *K. pneumoniae* was 12mm. This highest zone of inhibition of *K. pneumoniae* was low when compared with generally used antibiotics which showed larger zones of inhibition at lower concentration [64].

S. Ravichandran *et al* studied antimicrobial activity of the hemolymph (plasma) and hemocytes (plasma cells) of six brachyuran crabs against 16 pathogenic strains. They observed maximum zone of inhibition in the hemolymph of *Hyas araneus* against *Shigella flexineri. Staphylococcus aureus* and *Salmonella typhi* were vulnerable to all the hemolymph and hemocytes samples. Similarly, highest zone of inhibition by hemolymph and hemocytes samples against *Vibrio cholera* was observed [65].

A. Arul Prakash *et al* carried out an investigation to find out the antimicrobial activity of haemolymph collected from freshwater crab, *Paratelphusa hydrodromous*. Haemolymph was tested for antimicrobial assay by employing disc diffusion method against clinical pathogens. For antimicrobial assay, they selected five bacterial species, namely, *Escherichia coli, Klebsiella pneumonia, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus,* and five fungal strains, namely and *Aspergillus flavus, Aspergillus fumigatus, Aspergillus niger, Rhizopus sp.,andMucor sp.,*. The outcomes exhibited a tough reaction of haemolymph against the bacterial and fungal species which proves the defense system of the freshwater crab [66].

2.4.2. Other Applications

Sunita Das and E. Anand Ganesh used Eccentric method to extract chitin from trash crab (*Podophthalmus vigil*). In chitin purification process, demineralization is an essential step. In conventional demineralization methods, usually strong acids such as HCl are used. These acids damage the physiochemical properties of chitin. Hence they used *Lactobacillus plantarum* produced organic acid instead of Hydrochloric acid and a fungus *Aspergillus niger* for deproteinization.

It is a good idea to use organic acids for demineralization, because organic acids are less destructive to the environment, these organic acids do not damage the nature of the purified chitin [67].

Yildiz Bolat *et al* carried out experimental work in order to extract Chitin-chitosan from freshwater crab (*Potamon potamios*, Olivier 1804). The processes involved are demineralization, deproteinization, decoloration (chitin) and deacetylation (chitosan). They exposed crab shell to boiling, drying and grinding processes. 4.65% Chitosan was obtained from grinded crab shell. Chitosan yield after demineralization was 34.32%, Chitosan yield after deproteinization was 7.25%, and its yield after decoloration was 6.83%. Hence the freshwater crab is an appropriate crustacean to obtain chitin-chitosan [68].

3. CONCLUSION

Crab fishery is one of the fastest growing segments and there is a gigantic scope for the crab meat because of its delicious taste and high nutritional values. A number of species of crabs are fit for human consumption and many others species of crabs are commercially significant for fishmeal industry. Freshwater and marine resources have been utilizing for human consumption worldwide. Freshwater and marine food items, including crustacean such as crabs have been utilizing for their health supporting features. These are nutritionally important source of a variety of mineral and good quality proteins.

Like other crustaceans fishery, Crab fishery is also considered as essential and important shell fishery. Crab meat is considered as an expensive and a good delicious food in many parts of the world, but in India the less consumption of crab is because of unchanging food styles and absence of proper and complete information about the nutritive value of crabs. Many species from Europe and Asia belonging to the two families of the freshwater crabs have been described by Bott. All necessary information about the north and South American river crabs has been provided by Smalley. On the other hand, relatively a smaller amount work has been carried out on the Indian freshwater crabs. The freshwater crabs of Patna and Orrisa were studied and described by Chopra and Tiwari. The effects of acclimatization to high temperature on the blood chloride, free amino acids and osmotic pressure in *Paratelphusa sp.* were examined by Pampathi Rao and his colleagues. The physiology of digestion and pharmacology of the heart of *Potamon martensi* were Studied by Agrawal and his colleagues.

A survey conducted on the freshwater crabs of Marathwada region (Maharashtra State, India) discloses that the crab, *Barytelphusa cunicularis*, is the member of the family *parathelphusidae* of the suborder *Brachyura* appears to be abundant. *Barytelphusa cunicularis* dwells in small water bodies near Aurangabad and in the cultivated fields causing significant harm to the cultivated plans (crops). In view of the fact that, no detailed research had so far been carried out on any Indian freshwater crabs.

When we compare crab fishery with other crustacean fishery, we see that crab fishery has received significant

attention mainly the biology and fishery of the crabs that are of economic importance. Crabs are captured throughout the year; but, in many region of the Indian continent, we see that the crab capturing season starts normally in the month of October and ends in the month of February or March. When we go through the literature we realize that up to now, the majority of the data and information obtainable is merely on marine crabs. On the other hand on freshwater crabs relatively very less interest has been shown by researchers.

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