*CIBTech Journal of Zoology ISSN: 2319–3883*
*Online, International Journal, Available at http://www.cibtech.org/cjz.htm*
*2024 Vol.13, pp.222-229/Kanmani et al.*
***Research Article** (Open Access)*

# ALLOMETRY AND BIOCHEMICAL COMPOSITION OF HORNED EYED GHOST CRAB *OCYPODE BREVICORNIS* FROM SOUTHEAST COAST OF INDIA

**M. Kanmani[1], S. Jeyanthi[1]* and P. Ayyanar[2]**
*[1]PG & Research Department of Zoology, Ethiraj College for Women (Autonomous)*
*Chennai – 600 008, Tamil Nadu, India*
*[2]Department of Biochemistry, Siddha Central Research Institute, Government Arignar Anna Hospital Campus, Arumbakkam, Chennai – 600 106, Tamil Nadu, India*
*[*]Author for Correspondence: jeyanthi_s@ethirajcollege.edu.in*

## ABSTRACT
Ghost crabs are the macro fauna species which recurrently rest in sandy shores. The present study deals with the estimation of biochemical composition and relationship between carapace length/width-body weight and condition factor (K) of the ghost crab *Ocypode brevicornis* collected from Pattinapakkam, Chennai, South east coast of India. Each crab was separated based on sex and measured. Proximate composition of ghost crabs showed that they had higher protein content 60.8 ± 1.81% followed by carbohydrate 27.4 ± 0.29% and lipid 8.96 ± 0.73% respectively. Parameters of relationship between body weight and carapace length were calculated using the log form of the allometric growth equation. The values of the correlation coefficient (R2) were W=1.1623 + 2.5675 CL in males and W= 1.1238 ± 2.6343 CL in females. The value of a>1 which showed positively allometric in both sexes. The condition factor (K) which is dependent on environmental factors of the crab showed the K factor between two sexes varies significantly, it was 1.02 in males and 0.80 in females. The current study underscores the baseline data about carapace length – body weight relationship and the essential sustenance of ghost crab. The study evaluates to contribute to generate information to demonstrate the allometric relationship of the ghost crab. The findings of the study give pertinent information, crucial for the productive management and utilization of this species.

***Keywords:*** *Allometry, Condition factor, Ghost Crab, Protein, Lipid, Carbohydrate*

## INTRODUCTION
The crustaceans belonging to phylum Arthropoda show an enormous diversity ranging from small planktonic forms to the giant crabs (Susanto, 2021). They are of great commercial significance to humans as food, health, environment and indicator species (Szaniawska and Szaniawska, 2018). A vast array of smaller species contributes to the complexity and functioning of the ecosystem in addition to the importance of a tremendous variety of larger species for human consumption (Hamed *et al*., 2012). Ghost crab belonging to genus *Ocypode* is present enormously on sandy beaches in both tropical and temperate regions all over the world. They have box shaped bodies (trapezoidal) with thick and elongated eyestalks and one claw larger than the other in both sexes. They are not real land crabs, but they have adapted to semi-terrestrial environments through a variety of morphological, physiological, and behavioral changes. Ghost crabs are capable of progressively changing their body color to adapt to their habitat and the time of day but most species have pale bodies that blend in nicely with the sand (Rathbun, 1918; Green, 1964; Poore, 2004). They are crucial scavengers in sandy beaches, feeding on a variety of organic matter that gets washed ashore (Nagarajan *et al*., 2022). In addition, they have evolved the ability to adapt heavy metal stress presenting as an abundant bioindicator species (Budijastuti *et al*., 2023).
Allometry is the oldest method widely functional in biology, and is concerned with the study of the relationship between size in terms of physiology, morphology, life history and functioning of individual

body components and development or size of the whole body (Rowland, 2022). In general, characteristics like metabolic rate, dispersion ability, survival probability, and fecundity can be predicted using differences in body mass across individuals or species. Morphometric measurements serve as a practical tool for both taxonomists and ecologists help inspecting intra and inter specific morphological variations and also complements well with genetic and environmental stock identification methods (Costa and Gomes, 2008; Cadrin, 2000). Determining the growth patterns of aquatic creatures along their developmental routes can also be accomplished in larger manner (Oluwatoyin, 2013). Length-weight relationships allow the conversion of growth-in-length equations to growth-in-weight for use in a stock assessment model precisely for making the most of its use.

Several investigations have been performed around the world regarding the chemical composition and nutritional properties of crab meat (Kucukgulmez *et al*., 2006; Adeyeye, 2002*)*. Crabs are rich in protein having low levels of fat and cholesterol, and are particularly high in critical macro and trace components such vitamins, minerals, fatty acids, and amino acids making them highly nutritious for human consumption (Barrento *et al*., 2010). The biochemical analysis provides important information for facilitating the aquaculture industry in different aspects such as farming, fattening, or processing crab products (Baklouti *et al*., 2013; Gökoolu and Yerlikaya, 2003). Crab tissue comprises distinct amino acids that form the fundamental basis for human growth and functions. It promotes parthenogenesis and treatment of many diseases including rheumatoid arthritis. *Omega-3* polyunsaturated fatty acids (PUFAs) are principally from marine lipids which are crucial for protecting cardiac health. The crab meat is loaded with high levels of PUFAs (Celik *et al*., 2004; Ramamoorthy *et al*., 2016). Infrequent use of shellfishs (crab) in our country is notably due to inexperience in cooking and conservative food habits. Hence the present study attempts to study the interrelationship between various morphometric characters, carapace length in males and females, and the ghost crab's nutritional profile to promote increased use of these species in greater quantities and evaluate their potential as functional food.

## MATERIALS AND METHODS

The site of study, Foreshore Estate (13°02′N, 80°27′E) also known as Pattinapakkam is one of the most crowded beaches in Chennai, Tamil Nadu, India along the Bay of Bengal located at the southern part of Marina beach and extends up to 437 m (1,434 ft). Besides being the major tourist attraction in the city, it is also the most familiar area for fish catching with its rich biodiversity and swarms an exceedingly crowded fish market. Regular field visits were conducted in the months of October and November for collection of samples with the assistance of fishermen early in the morning due to lesser human disturbance and better weather conditions and then transported to the laboratory for further analysis.

**Figure 1: Male Ghost Crab**

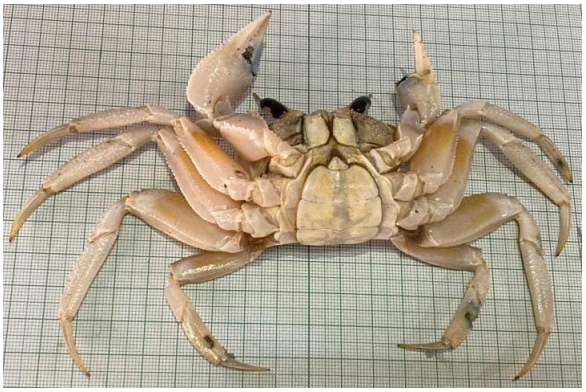

**Figure 2: Female Ghost Crab**

In order to study sexes separately, sample crabs were segregated based on abdomen shape: male crabs with a V-shaped abdomen, while females with round-shaped abdomen (Fig. 1 and Fig. 2) (Dai, 1991). Vernier

calipers with an accuracy of 0.01 mm and a digital balance (0.001 g) were used to measure carapace length (CL) and total weight (BW). The relationship between the carapace length-weight is indicated by the mathematical calculation (Rickter, 1973).

$W = aCL^b$ where W is the total weight (g), CL is the Carapace length (mm) (a) the intercept (b) the slope or allometric growth coefficient. The data were converted on a natural log to fit linear or straight line of log length and log weight. The equation can be demonstrated logarithmically as Log W = log a+ b log CL (King, 1995). Linear relationships between carapace length and body weight were assessed for male and female crabs. To ascertain the strength of association in the linear regression, the coefficient of determination ($R^2$) was chosen. The Fulton's condition factor (K) was calculated from $K= (BW/CW^3) *100$ for both females and males separately (Fulton, 1911); where BW denoted total body weight (g) and CW denoted Carapace width (mm).

***Estimation of Protein*** (Lowry *et al*., 1951)

The biochemical composition of total protein content of crab meat was estimated by employing the Folin-Ciocalteau method with a sample weighing around 100 mg homogenized in 80% ethyl alcohol and centrifuged at 4000 rpm for 10 minutes. The precipitate was re-dissolved in 4 ml of IN NaOH solution and 5 ml of freshly prepared alkaline copper solution and allowed to stand for 20 minutes. 1N NaOH solution and 0.1% bovine serum albumin (W/V) served as blank and standard solution respectively and OD was read at 650 nm using a UV visible spectrophotometer.

***Estimation of Lipid*** (Folch *et al*., 1957)

10 mg of dried powder sample was taken in a test tube containing 5 ml of chloroform and methanol (2:1) mixture and incubated at room temperature for 24 hours. Later, the mixture was filtered using filter paper and collected in a 10 ml pre-weighed beaker, which was kept on the hot plate. The chloroform methanol mixture evaporated leaving a residue at the bottom of the beaker. The weight of difference was calculated to know the weight of the lipid in the sample.

***Estimation of Carbohydrate*** (Dubois *et al*., 1956)

The sample weighing 100 mg was homogenized with double distilled water and centrifuged for 10 minutes at 3000 rpm. To the supernatant, 1 ml of 5 % phenol solution and 5 ml of concentrated sulfuric acid was added and it was allowed to stand for 30 minutes and OD was measured at 490 nm using D-glucose as standard.

## RESULTS AND DISCUSSION

India's economy greatly depends on the coastal ecology because of abundant resources, productive habitats, and rich biodiversity. Crustaceans are extensively employed in studies of relative growth. Ghost crabs belonging to the genus *Ocypode* have been extensively utilized for management and conservation purposes as a dependable bio-indicator species of human impacts on sandy beaches (Wolcott, 1978; Gul and Griffen, 2018). Due to the growing population densities, individual sizes decline dramatically under human pressure. In this study, the interrelationships between morphometric characters such as carapace length and body weight in males and females were analyzed. Among the specimens collected, it is noted that the number of females were drastically higher than the number of males. Maximum length of about 4.89±0.01 cm and a weight of 77.5±0.5 gm was observed in male ghost crabs *Ocypode brevicornis.* Similarly maximum length of 5.05±0.05 cm and weight of 72.15±0.05 gm was observed in female ghost crabs. The results showed that the ghost crabs had positive allometry growth with increasing length and body weight (Table. 1)

Regular variations in the "b" value in the length-weight relationship between different environments has been already reported (Ozaydin and Taskavak, 2006). These variations may be due to the influence of physiological, behavioral, and environmental factors such as feeding patterns, foraging, and temperature. In the present study, the calculated "a" value was >1. Similar results were observed in *Portunus pelagicus* (Josileen, 2011) and *Callinectes danae* (Araujo and Lira, 2012) showing a positive allometry in both the sexes. Supportive data was seen on the relationship between carapace length/ width-body weights of the red ghost crab *Ocypode macrocera* where the carapace length and width were found to be linearly related

to body weight and seem to be highly significant (P<0.001) in each case. Similarly, in this investigation the slope (a) and the regression coefficient value (b) of the length versus weight and width versus weight relationship indicated positive allometric growth. A positive allometric length-weight relationship specifies that, weight increases, as and when the carapace length increases (Dubey *et al*., 2014). The calculated correlation coefficient "r" of males and females indicated a positive correlation between weight and length and the "p" value (0.1) indicated that the variables were not significant.

**Table 1: Parameters of the relationship ($W = aL^b$) and Fulton's condition factor (K) for Ghost Crab *Ocypode brevicornis***

| n | Sex | Carapace Length (CL) (cm) | Carapace Width (CW) (cm) | Body Weight (BW) (gm) | Regression equation (BW = a+b CL) | $R^2$ | K value | P-Value |
|---|---|---|---|---|---|---|---|---|
| | | Mean ± SE | Mean ± SE | Mean ± SE | | | Mean ± SE | |
| 20 | Male | 4.52 ± 0.09 | 4.32 ± 0.11 | 56.96 ± 6.05 | W=1.1623 + 2.5675 CL | 0.103 | 1.02 ± 0.09 | 0.534 |
| 20 | Female | 4.62 ± 0.17 | 4.46 ± 0.20 | 51.4 ± 6.38 | W= 1.1238 ± 2.6343 CL | 0.546 | 0.80 ± 0.07 | 0.154 |

**Table 2: Proximate Composition of Ghost Crab *Ocypode brevicornis***

| Protein % | Carbohydrate % | Lipid % |
|---|---|---|
| Mean ± SE | Mean ± SE | Mean ± SE |
| 60.8 ± 1.81 | 27.4 ± 0.29 | 8.96 ± 0.73 |

The condition factor is usually used in order to compare the condition, heaviness or well-being of marine organisms. The condition factor is highly influenced by exogenous (e.g., environmental factors) and endogenous parameters (e.g., feeding rate, growth rate, sexual cycle, etc.) and may vary over time and across populations (Froese, 2006; Pinheiro and Fiscarelli, 2009). Several factors can affect length-weight relationship including sample size, size-weight distributions, sampling time, and ecological conditions (Aydin, 2018). In ghost crab *Ocypode brevicornis* the condition factor was 1.02 in males and 0.80 in females. Oocyte development and growth in females requires much more energy than gonadal development in males which results lower condition factor in females and the values were in accordance with other findings (SumanKumari *et al*., 2019; Noori *et al*., 2015). Indirectly, temporal changes in the condition of the crabs caught in the area are also reflected in changes in the Fulton condition coefficients (Czerniejewski, 2010). The results will be useful in comparing the different stocks of the same species at different geographical locations as well as in the examination of ontogenetic shifts and various other factors of fish or crustacean population dynamics (Lagler, 1968). The study is also perceived to establish precise mathematical equations between length and weight, so that if one is measured, the other dimension could be computed.

Biochemical studies are very important from a nutritional point of view and biochemical constituents in animals are known to vary with season, size of the animal, stage of maturity, temperature, and availability of food etc. The proximate composition of protein was higher 60.8±1.81% followed by carbohydrate 27.4±0.29 % and lipid 8.96±0.73% respectively. Protein is essential for the sustenance of life and accordingly exists in larger quantities (Okuzumi and Fujii, 2000). The acceptability and easy digestibility

of crab proteins make them very valuable in combating protein malnutrition, especially in children. Crab's protein ability to promote growth gives it a high biological value (Sakthivel *et al*., 2014). Carbohydrates are a group of organic compounds including sugars, starches, and fiber, which are major source of energy necessary for growth of animals (NRC, 1993). Some environmental and physiological factors including seasons and feed intake affect the levels of carbohydrates in fish. However, compared to terrestrial species, aquatic animals use carbohydrates at a very modest rate (Wang and Chen, 2016; NRC, 1993; Zodape, 2023). The biochemical estimation of total carbohydrate values showed significant levels.
In crustaceans, lipids are essential for maintaining cellular integrity and serve as the primary organic reserve and precursor to hormones, eicosanoids, and enzyme cofactors and source of metabolic energy to transports fat-soluble vitamins (Tocher, 2003; Zhao *et al*., 2015). Crab meat is highly beneficial for expectant mothers as it helps to develop the cell membrane of the brain. The results of biochemical analysis obtained in this study will be essential in providing basic information regarding nutrition and health benefits of ghost crab consumption. In terms of biology and management of fisheries, constant observation of natural stocks is essential for sustainable ecosystem management. Culturing crab will serve as income generation as well as protein production for people (Olusoji *et al*., 2010).

## CONCLUSION

These investigations are therefore, believed to be necessary in order to keep an eye on the region's crab supplies. In addition, the findings of this study will constitute an important database for future studies related to the ghost crab species. Allometry study reveals fundamental data for any species to assess the stock management system in aquaculture. Despite their smaller size, the proximate composition of the ghost crab *Ocypode brevicornis* results were promising and showed they are loaded with high nutritive profile.

## ACKNOWLEDGEMENT

The authors are grateful to the Department of Biochemistry, Siddha Central Research Institute, Government Arignar Anna Hospital Campus, Arumbakkam, Chennai, India for providing all necessary facilities during this study. Authors would also like to thank Mrs. P. Anandhi, Head of the Department, Post Graduate and Research Department of Zoology, Ethiraj College for Women (Autonomous) Chennai, India for her encouragement and Ethiraj College Management for their support.

## REFERENCES

**Adeyeye EI (2002).** Determination of the chemical composition of the nutritionally valuable parts of male and female common West African fresh water crab *Sudananautes africanus africanus*. *International Journal of Food Sciences and Nutrition*, **53**(3), 189-196. https;//doi.org/10,1080/09637480220132805.
**Araújo MDSLCD and Lira JJPRD (2012).** Condition factor and carapace width versus wet weight relationship in the swimming crab *Callinectes danae* Smith 1869 (Decapoda: Portunidae) at the Santa Cruz Channel, Pernambuco State, Brazil. *Nauplius*, **20**, 41-50.
**Aydın M (2018).** Length-weight relationships and condition factors of five crab species (Decapoda) in the Black Sea, **50**(4),1519-1524. http://dx.doi.org/10.17582/journal.pjz/2018.50.4.1519.1524.
**Baklouti S, Derbali A, Dhieb K, Kammoun W, Jarboui O (2013)**. Proximate composition and its seasonality of the Mediterranean green crab: *Carcinus aestuarii* Nardo, 1847 (Brachyura, Portunidae), in southern Tunisian waters (Central Mediterranean). *Journal of Marine Sciences*, *989467, https://doi.org/10.1155/2013/989467*.
**Barrento S, Marques A, Teixeira B, Mendes R, Bandarra N, Vaz-Pires P and Nunes ML (2010)**. Chemical composition, cholesterol, fatty acid and amino acid in two populations of brown crab *Cancer pagurus*: Ecological and human health implications. *Journal of Food Composition and Analysis*, **23** (7), pp. 716-725, https://doi.org/10.1016/j.jfca.2010.03.019.

**Budijastuti W, Ambarwati R, Ducha N, Rachmadiarti F, Lisdiana L, and Sahani K (2023)**. Types and Distribution of Macroinvertebrates Stressed by Heavy Metals in Mangrove Forests. *Nature Environment and Pollution Technology*, **22**(2), 835-843. https://doi.org/10.46488/NEPT.2023.v22i02.025.
**Cadrin SX (2000).** Advances in morphometric identification of fishery stocks. *Reviews in Fish biology and Fisheries*, **10**, 91-112. https://doi.org/10.1023/A:1008939104413.
**Çelik M, Türeli C, Çelik M, Yanar Y, Erdem Ü and Küçükgülmez A (2004)**. Fatty acid composition of the blue crab (*Callinectes sapidus* Rathbun, 1896) in the north eastern Mediterranean. *Food chemistry*, **88** (2), 271-273. https://doi.org/10.1016/j.foodchem.2004.01.038**.**
**Costa TARSO and Soares-Gomes ABILIO (2008).** Relative growth of the fiddler crab *Uca rapax* (Smith) (Crustacea: Decapoda: Ocypodidae) in a tropical lagoon (Itaipu), Southeast Brazil. *Pan-American Journal of Aquatic Sciences*, **3**(2), 94-100.
**Czerniejewski, P (2010).** Changes in condition and in carapace length and width of the Chinese mitten crab (H. Milne Edwards, 1853) harvested in the Odra River estuary in 1999-2007. *Oceanological and Hydrobiological Studies*, **39**(2), 25-36.
**Dai A Y (1991).** Crabs of the China seas. *(No Title), 682*.
**Dubey SK, Chakraborty DC, Bhattacharya C, Choudhury A (2014).** Length Weight Relationship of red ghost crab *Ocypode macrocera* (H. Milne-Edwards, 1852) at Sagar Island (Northwestern Bay of Bengal) in Sundarbans Mangrove Eco-Region, India, 24876-24879.
**Dubois M, Gilles KA, Hamilton JK, Rebers PT, Smith F (1956).** Colorimetric method for determination of sugars and related substances. *Analytical chemistry*, **28**(3), 350-356. https://doi.org/10.1021/ac60111a017.
**Folch J, Lees M, Stanley GS (1957).** A simple method for the isolation and purification of total lipides from animal tissues. *Journal of biological chemistry*, **226**(1), 497-509. https://doi.org/10.1016/S0021-9258(18)64849-5.
**Fulton TW (1911).** The sovereignty of the sea: An historical account of the claims of England to the domination of the British seas and of the evolution of the theoretical waters: with special reference to the rights of the fishing and the naval salute. W. Blackwood and sons, Edinburgh, London, 777.
**Froese R (2006).** Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. *Journal of applied Ichthyology*, **22**(4), 241-253. https://doi.org/10.1111/j.1439-0426.2006.00805.x.
16. **Gökoðlu N and Yerlikaya P (2003).** Determinaton of proximate composition and mineral contents of blue crab (*Callinectes sapidus*) and swim crab (*Portunus pelagicus*) caught off the Gulf of Antalya. *Food chemistry*, **4**(80), 495-498. https://doi.org/10.1016/S0308-8146(02)00318-7.
**Gül MR and Griffen BD (2018).** Impacts of human disturbance on ghost crab burrow morphology and distribution on sandy shores. **13**(12). https://doi.org/10.1371/journal.pone.0209977
**Green JP (1964).** Morphological color change in the Hawaiian ghost crab, *Ocypode ceratophthalma* (Pallas). *The Biological Bulletin*, **126**(3), 407-413. https://doi.org/10.2307/1539309.
**Hamed A, Abd Al-Hameid MH, Al-Rasheid KA and Mohamad M (2012)**. Brachyuran crabs (Crustacea: Decapoda) in the Suez Canal, Egypt, and their associated epifauna. *Scientific Research and Essays*, **7**(42), 3665-3672. https://doi.org/10.5897/SRE12.470.
**Josileen J (2011).** Morphometrics and length-weight relationship in the blue swimmer crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Brachyura) from the Mandapam Coast, India. *Crustaceana*, **84** (14), 1665-1681. DOI:10.1163/156854011X607060.
**King M (1995).** Fisheries biology, assessment and management. Fishing News, Books/Blackwell Scientific Books. Oxford, England, 352.
**Küçükgülmez A, Celik M, Yanar Y, Ersoy B and Çikrikçi M (2006).** Proximate composition and mineral contents of the blue crab (*Callinectes sapidus*) breast meat, claw meat and hepatopancreas. *International Journal of food science & technology*, **41**(9), 1023-1026. https://doi.org/10.1111/j.1365-2621.2006.01159.x.

**Kumari S, Sandhya KM, Karnatak G, Sarkar UK, Panda D and Mishal P (2019).** Length-weight relationship and condition factor of *Gudusia chapra* (Hamilton, 1822) from Panchet Reservoir, Jharkhand, India, **66**(3), 138-141. https://doi.org/10.21077/ijf.2019.66.3.81017-18.
**Lagler KF (1968).** Capture, Sampling and Examination of Fishes. In: Methods for assessment of fish production in freshwaters. Ed. Ricker, WE. IBP Handbook, **3**, 7-45.
**Lowry OH, Rosebrough NJ, Farr AL, Randall RJ (1951).** Protein measurement with the Folin phenol reagent. *J biol Chem*, **193** (1), 265-275.
**Nagarajan VM, Yuvan M, Srinivasan R, Satagopan NR, Asokan A, and Anooja A (2022).** Status of important coastal habitats of North Tamil Nadu: Diversity, current threats and approaches for conservation. *Regional Studies in Marine Science*, **49**, 102-106. https://doi.org/10.1016/j.rsma.2021.102106.
**National Research Council, and Subcommittee on Fish Nutrition (1993).** *Nutrient requirements of fish*. National Academies Press, Washington DC, USA, 114.
**Noori A, Moghaddam P, Kamrani E, Akbarzadeh A, Neitali BK, and Pinheiro MAA (2015).** Condition factor and carapace width versus wet weight relationship in the blue swimming crab *Portunus segnis. Animal Biology*, **65**(2), 87-99.
**Okuzumi M and Fujii T (2000).** Nutritional and functional properties of squid and cuttle fish. 35th Anniver. Comme Publ, 223.
**Olusoji OB, Anifowose OJ, Sodamola MY (2010).** Length-weight relationships, condition factor and fecundity of the West Africa freshwater crab, *Sudanonautes africanus* (Milne-Edwards 1883), in Western Nigeria. *West African Journal of Applied Ecology*, **16**(1). https://doi.org/10.4314/wajae.v16i1.55869.
**Oluwatoyin A, Akintade A, Edwin C and Victor KA (2013).** study of length-weight relationship and condition factor of west African blue crab (*Callinectes pallidus*) from Ojo Creek, Lagos, Nigeria. *American Journal of Research Communication*, **1**(3), 102-114.
**Özaydin O and Taskavak E (2006).** Length-weight relationships for 47 fish species from Izmir Bay (eastern Aegean Sea, Turkey). *Acta Adriatica*, **47**(2), 211-216.
**Pinheiro MAA, and Fiscarelli AG (2009).** Length-weight relationship and condition factor of the mangrove crab *Ucides cordatus* (Linnaeus, 1763) (Crustacea, Brachyura, Ucididae). *Brazilian Archives of Biology and Technology*, **52**, 397-406. https://doi.org/10.1590/S1516-89132009000200017.
**Poore GC (2004).** *Marine decapod Crustacea of southern Australia: A guide to identification*. CSIRO publishing.
**Ramamoorthy N, Karuppasamy PK, Priyadarshini RSS (2016).** Proximate, amino acid and fatty acid composition the marine crabs from the southeast coast of India. *Journal of Marine Bioscience*, **2**(1), 91-98. ISSN (P) 2454–3519.
**Rathbun MJ (1977).** *The grapsoid crabs of America.* US Government Printing Office, 97.
**Rickter WE (1973).** Linear regression in fisheries research. *Journal of Fisheries Resources Board Can*, **30**(3), 409-434.
Rowland M (2022). Preclinical prediction of human pharmacokinetics. In *Atkinson's Principles of Clinical Pharmacology*, 4th ed.; Academic Press, 589-601. https://doi.org/10.1016/B978-0-12-819869-8.00007-0.
**Sakthivel D, Vijayakumar N and Anandan V (2014).** Biochemical composition of mangrove carb *Sesarma brockii* from Pondicherry Southeast of India. *International Journal of Scientific Inventions Today*, **3**(3), 187- 202. ISSN 2319-5436.
**Susanto GN (2021)**. The increasing economic importance of crustaceans to humans. *Arthropods - Are they beneficial for mankind*,171-180. http://dx.doi,org/10.5772/intechopen.96255.
**Szaniawska A (2018)**. Function and importance of crustaceans. *Baltic crustaceans*, 185-188. https://doi.org/10.1007/978-3-319-56354-1_11.
**Tocher DR (2003).** Metabolism and functions of lipids and fatty acids in teleost fish. *Reviews in fisheries science*, **11**(2),107-184. https://doi.org/10.1080/713610925.

**Wang X, Li E and Chen L (2016).** A review of carbohydrate nutrition and metabolism in crustaceans. *North American Journal of Aquaculture*, 2, **78**(2), 178-187. https://doi.org/10.1080/15222055.2016.1141129
**Wolcott TG, Wolcott DL (1988)**. When limiting factors aren't: Lessons from land crabs. In *Behavioral Adaptation to Intertidal Life*. Boston, Springer US, 135- 151. https://doi.org/10.1007/978-1-4899-3737-7_11.
**Zhao J, Wen X, Li S, Zhu D and Li Y (2015).** Effects of dietary lipid levels on growth, feed utilization, body composition and antioxidants of juvenile mud crab *Scylla paramamosain* (Estampador). *Aquaculture*, **435**¸ 200-206. https://doi.org/10.1016/j.aquaculture.2014.09.018.
**Zodape GV (2023).** Evaluation of proximate composition from selected species of shrimps collected from Gorai Creek (West Coast) of India. **4**(1), 45- 52. https://doi.org/10.47587/SA.2023.4108.