Population structure and fecundity of a Xanthid crab *Leptodius exaratus* (H. Milne Edwards, 1834) on the rocky shore Gujarat state, India

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Background Population structure and breeding biology of a Xanthid crabs *Leptodius exaratus* (H. Milne Edwards, 1834) were studied on the rocky intertidal shore of Shivrajpur beach of Saurashtra coast, Gujarat, India.

Methods Monthly sampling was conducted from March 2021 to February 2022 during low tide time using catch per unit effort in the 500 m2 area. the collected individuals were categorised into male, non-ovigerous females or ovigerous females. The morphology of crab specimens (carapace width and body weight) as well as the egg size, number, and egg mass weight were recorded for fecundity estimation.

Results There was a clear demarcation of sexual dimorphism where males were larger than females. The overall as well as monthly sex ratio skewed towards females with bimodal distribution in male while unimodal in female. The population breeds throughout the year which was indicated by the occurrence of ovigerous females throughout the year with peaks from February to May. There was a positive correlation obtained between the morphology of ovigerous female (carapace width and wet weight) and size of eggs, number of eggs and weight of egg mass.

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Keywords: Breeding pattern, Gujarat coast, Population ecology, Rocky intertidal, Seasonal breeding, Sex ratio, Xanthidae

Introduction

Population structure studies on intertidal crabs started in early 1940s (Flores and Paula, 2002) which can reveal the patterns of species interactions and their roles within ecosystems. Accounts on population structure and breeding biology majorly try to understand the genetic diversity, age, spatial distribution, abundance, sex ratio, variation in year-round composition, juvenile recruitment, and fecundity of the species (Litulo 2005; Saher and Qureshi 2010; Manzoor et al., 2016; Hu et al., 2015). The life history pattern of a species can vary region wise or even by habitat (Lycett et al., 2020). For example, slight variation in the latitude leading to climatic variation can cause differences between the populations. Variations in the population trends is also due to the effect of several biotic and abiotic factors affecting populations differently (citation). Studies on the population structure and breeding biology of a species provide an insight of the ecological stability of a species in the specific habitat and helps in understanding the biology of the species (Santos et al., 1995; Takween and Qureshi 2005). This knowledge helps ecologists understand how different species coexist, compete, and interact, influencing ecosystem dynamics. However, such studies have not been carried out so far on some of the commonly occurring brachyuran crabs on Gujarat coast.

The Saurashtra coast of Gujarat state, India is characterised by its rocky intertidal coasts which support great diversity of marine organisms including intertidal crustaceans. With its major inhabiting marine intertidal species being crabs majority of the studies conducted in this region have focused on the diversity of crabs (Trivedi and Vachhrajani, 2013a, b; 2015; 2016a; 2018; Trivedi et al., 2015a, b; 2016a, b; 2020a, b; 2021; Gosavi et al., 2017a, b; 2021; Patel et al., 2020; 2021; Bhat and Trivedi, 2021; Padate et al., 2022), little is known about the population dynamics of these important intertidal organisms (Trivedi and Vachhrajani, 2016b; 2017; Patel et al., 2022). *Leptodius exaratus* (H. Milne Edwards, 1834) is one of the most common Xanthid crab which is commonly occurring in the rocky intertidal region of Saurashtra coast (Patel et al., 2021).

Leptodius exaratus is one of the most common Xanthid crab which is widely distributed in the Indo-Pacific region (Naderloo, 2017). The species is a commonly found in the intertidal zone especially in rocky substrate with rock crevices and cobbles (Kneib & Weeks, 1990). It is an omnivorous species that prefers benthic fauna over algae to feed upon and is expected to have a considerable impact on how the benthic ecosystem is structured (Al-Wazzan et al., 2020). The crab's life cycle includes four zoeal stages and one megalopa stage (Fielder et al., 1979) with around 13 instar stages before its maturation (Lwin et al., 2007). In the Indian subcontinent *L. exaratus* is recorded from Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu, Andaman and Nicobar Island, and Lakshadweep Islands (Trivedi et al., 2018a). Though the species is very common on the Saurashtra coast of Gujarat, studies only on its taxonomy (Chopra & Das, 1937; Trivedi and Vachhrajani, 2015) and colour variation (Patel et al., 2021) have been carried out so far. Hence the present study was carried out to understand the population structure and breeding biology of *L. exaratus* occurring on the rocky intertidal region of Saurashtra coast Gujarat state, India to gain a wider knowledge of the ecology of the rocky shore habitats.

Materials & Methods

Study area

Present study was carried out at the rocky intertidal region of Shivrajpur village located on the Saurashtra coast of Gujarat state (Figure 1). The width of exposed intertidal area ranges between 60 and 150 m from high tide to low tide where *L. exaratus* occurs in high abundance (Patel et al., 2023).

Field methods

Monthly field work was carried out for 12 consecutive months (March 2021 to February 2022). The specimens were collected randomly by catch-per-unit effort using hand picking method by one person for the time period of four hours during low tide time. For this method, firstly 500 m^2 area in the intertidal region was marked during low tide and thoroughly scanned for the presence of L. exaratus. Small rocks were also upturned for the presence of *L. exaratus* which they prefer to occupy. Whenever an individual was encountered, it was collected and preserved in 10% formalin until further analysis.

Laboratory analysis

The crabs were identified and categorised into male, non-ovigerous female, or ovigerous female. For morphological character, carapace width (CW) was measured using vernier callipers (0.01 mm accuracy) and wet weight of crabs was measured using weighing balance (0.001 g accuracy).

Fecundity was estimated by carefully removing the egg mass from the pleopods of ovigerous females (n=34) and measuring three parameters i.e., total number of eggs, weight of egg mass and size of eggs (diameter). For the total number of eggs, the egg mass was transferred into 20 ml of sea water and mixed gently so that the eggs get distributed evenly in the water. From this solution, three samples of 2 ml each were taken in a petri dish and observed under a stereomicroscope to count the total number of eggs. The total number of eggs in each sample was divided by 3 and multiplied by the dilution factor (10) to obtain the total number of eggs (Litulo, 2004). Oviparous females were weighed both with and without egg mass, and the difference in their weight was considered as the weight of egg mass. Eggs (n=10) from each ovigerous female were measured by means of an ocular micrometre under a microscope for the size range (Saher and Qureshi, 2010).

Data analysis

For overall size frequency distribution, the specimens were grouped in 5 mm size class intervals from 5 mm to 30 mm CW. Shapiro Wilk test was conducted to analyse the normality of the collected data which suggests that the data distribution was not normal ($p<0.001$). Hence Non-parametric analysis was carried out. For the assessment of sexual dimorphism, Kruskal–Wallis (KW) test was carried out to evaluate the variation in the mean values of carapace width of male, non-ovigerous females and ovigerous females of *L. exaratus*. On getting significant difference ($p<0.001$) in the CW between different sexes, Dunn's post hoc test was carried out for multiple comparison. To obtain month wise variation in size and sex wise composition of *L. exaratus* individuals, the monthly data of individuals' size (carapace width) and sex were plotted. For the evaluation of sex ratio between males and females (non-ovigerous females and ovigerous females), chi-square test ($\chi2$) was carried out. For the determination of size at first maturity of females, percentage of ovigerous females among different size classes was calculated from the total samples collected. Individuals smaller than the smallest ovigerous female were considered as juveniles (Baeza et al., 2013). The data of monthly occurrence of juvenile and ovigerous females against ambient and water temperature was plotted to understand the effect of temperature on the breeding and juvenile settlement of *L. exaratus*. Pearson's correlation was carried out between relative juveniles frequency and mean ambient temperature. Regression analysis was conducted to understand the relationship between morphological parameters of eggs (total number of eggs, egg mass weight and size of eggs) and crabs' morphology (carapace width and weight). The statistical significance was accepted if $p<0.05$. Statistical analyses were performed using PAST software, version 4.03 (Hammer et al., 2001) and Microsoft Excel.

Results

A total of 1216 individuals were examined during the study period from which, 559 males (45.93%) and 657 females (54.07%) (Table 1). The carapace length of *L. exaratus* males ranged from 5.15 mm to 29.98 mm, while in females it ranged from 5.26 mm to 28.63 mm. there was no significant difference between the size of male and female individuals (Kruskal-Wallis, H= 0.209, p=0.646). (Table 1).

Overall, the highest number of individuals was observed in the month of April. The average ratio (1:1.7) of *L. exaratus* showed that the population is female biased (Table 2). The number of females was always higher than males throughout the year, except in the month of September (1:0.8), October (1:0.9) and November (1:0.7) (Table 2). Month wise the number of males was highest in May and lowest in June whereas in case of females it was highest in May and lowest in July. Ovigerous females were collected all along the year, which shows the species is breeding throughout the year. However, highest percentage of ovigerous females were observed from month of February to May which indicates the peak breeding season.

Leptodius exaratus individuals were recorded from all the size classes of carapace with, ranging from 5 mm to 30 mm. The size frequency distributed of male showed bimodal distribution with the highest peak observed in the 5-10 mm CW size class and 25-30 mm CW size class. On the other hand, the size frequency distribution of female individuals showed a unimodal distribution, with the maximum peak observed in the 15-20 mm CW size class (Figure 2).

A significant difference was observed in the population of juvenile (< 12 mm) and adults during the months of April, May, June, and July (summer season) which was very less as compared to adult male and female population. Moderately, less number of juveniles were also observed during the months of December to March (winter season) than August to November (Monsoon season) as compared to adult male and female (Figure 3).

During majority of the months, male individuals had bimodal distribution whereas non-ovigerous females had unimodal distribution. Ovigerous females showed only unimodal distribution throughout the year. Moreover, it was also observed that juvenile individuals occurred throughout the year (Figure 4). Pearson's correlation analyses suggested a negative correlation between the relative frequency of juveniles and mean ambient temperature ($r= -0.39$) (Figure 5).

The fecundity data revealed that the maximum and minimum size of ovigerous *L. exaratus* female were 24.02 mm and 10.38 mm respectively with average size of eggs being 18.1 ± 3.8 mm (n=34). Similarly, the weight of ovigerous female ranged from 4.64 to 0.41 with average ovigerous female was 2.04 ± 1.2 g (n=34). The maximum and minimum number of eggs recorded were 8730 and 920 eggs respectively with average number of eggs being 4529 ± 2003 (n=34). The maximum and minimum size of eggs recorded were 0.54 and 0.19 mm respectively with average size of eggs being 0.36 ± 0.07 mm (n=34). The maximum and minimum egg mass weight recorded were 0.88 and 0.04 mm respectively with average egg mass weight being 0.29 ± 0.18 g (n=34) (Table 3). It was observed that the total number of eggs, and egg weight showed significant relation with the carapace width and body weight of the ovigerous females (Figure 6).

Discussion

The present study found significant difference in the mean carapace width between different sexes of *D. blanfordi* with males being significantly larger than non-ovigerous females. Studies carried out on population structure of *Matuta planipes* and *Ashtoret lunaris* (Saher et al., 2017), *Uca bengali* (Tina et al., 2015), *Scylla olivacea*, *S. tranquebarica*, and *S. paramamosain* (Waiho et al., 2021), C. rhabdodactylus (Patel et al., 2020a, 2022), Diogenes custos (Patel et al., 2020b), and C. ransoni (Patel et al., 2021) also exhibited similar results. It has been observed that the growth rate of female individuals is generally reduced as a result of greater energy investment in gonadal development that leads to decreased somatic growth in comparison to male individuals (Mantelatto et al., 2010). Another hypothesis suggests that the chances of attracting and obtaining females for the purpose of mating increases with increased size of male individuals (Wada et al., 2000), while the difference in size also reduces intraspecific competition among different sexes for available resources (Abram, 1988).

The overall sex ratio was female biased while the monthly sex ratio was also skewed towards female during most of the months except September, October and November months. Generally, natural selection favours a sex ratio of 1:1 parental expenditure on offspring (May, 1983) however, deviation from the ideal sex ratios are common in marine Crustaceans as observed in *Calcinus tibicen* (Fransozo and Mantelatto, 1998), *Limulus polyphemus* (Smith et al., 2002), Crangon crangon (Siegel et al., 2008), *Opusia indica* (Saher and Qureshi, 2011), and *Macrophthalmus* (*Venitus*) *dentipes* (Qureshi and Saher, 2012). The sex ratio also differed during different growth stages with showing ideal sex ratio (1:1) in smaller size classes (1–3 mm CW), female biased in intermediate size classes (3–6 mm CW) and exclusively male biased in larger individuals (6–8 mm CW). Similar results have been obtained in several other studies (Gherardi and Nardone, 1997; Fransozo and Mantelatto, 1998; Bezerra et al., 2007; Mishima and Henmi 2008; Manzoor et al., 2016). Numerous factors can be responsible for such deviation in the sex ratio including local mate competition (Hamilton, 1967), competition for local resources biasing sex ratios (Silk, 1984), unequal investment into male and female offspring (Kobayashi et al., 2018), sexual selection (Swanson et al., 2013). Sexual dimorphism in size is one of the possible explanations of the deviation from the ideal sex ratio in various size classes. The reason why the sex ratio of the intermediate-size class often has a female bias has been attributed to the higher probability of male mortality (Asakura, 1995). Moreover, males grow to bigger sizes quickly than females, hence the sex ratio in the larger size class is greatly skewed towards men (Wenner, 1972). Disparities in sexual mortality and dispersion may potentially contribute to unbalanced sex ratios in crab populations (Johnson, 2003).

Present investigation found that the size frequency distribution of *L. exaratus* males had a bimodal distribution while the females had a unimodal distribution. Also, there was a considerable difference in the seasonal size frequency distribution. Similar results have been observed in *Paguristes tortugae* (Mantelatto and Sousa, 2000), *Chaceon affinis* (López Abellán et al., 2002), *Pilumnus vespertilio* (Litulo, 2005), *Dilocarcinus pagei* (Taddei et al., 2015) *Aegla georginae* (Copatti et al., 2016) and *Clibanarius rhabdodactylus* (Patel et al., 2023). The size and frequency distribution of a population may vary over a period of time as a result of reproduction and rapid larval recruitment (Thurman, 1985). Different explanations have been put forth for such distributions, including differential mortality (Diaz and Conde, 1989), growth rates (Negreiros-Fransozo et al., 2003), and varying migratory patterns (De Arruda Leme and Negreiros-Fransozo, 1998; Flores and Negreiros-Fransozo, 1999). According to Zimmerman and Felder (1991), it is commonly found in organisms that undergo several rounds of reproduction and generate a large number of clutches every season. Unimodality is frequently observed in stable populations with constant recruitment and mortality rates throughout the life cycle and a roughly equal number of individuals joining the population and those leaving it (Thurman, 1985; Diáz and Conde, 1989). On the other hand, bimodality could be an indication of the general tendencies in population increase.

The ambient temperature of the study site ranged between 22.1 to 32.5, which is within the range of a tropical environment that may support continuous reproduction. Hence, the ovigerous females were recorded throughout the year which suggests the L. exaratus is a continuously breeding species that has maximum recorded frequency from December to April. Studies carried out on *Scylla olivacea* (Ali et al., 2020), *Opusia indica* (Saher and Qureshi, 2011), *Emerita portoricensis* and *E. asiatica* (Goodbody, 1965), *Ilyoplax frater* (Saher and Qureshi, 2010), *Diogenes brevirostris* (Litulo, 2004) and *Petrochirus diogenes* (Bertini and Fransozo, 2002). There was not any association found between the frequency occurrence of ovigerous females and ambient temperature. However, it was found that juvenile percentage occurrence increased with a decline in ovigerous female percentage occurrence, whereas juvenile percentage occurrence declined when ovigerous female percentage occurrence increased. Such outcomes demonstrates that the species may recruit juveniles throughout the year as a result of rapid reproduction and short incubation time. Similar outcomes have been reported in several other studies including *Deiratonotus japonicus* (Oh and Lee, 2020), *Scylla olivacea* (Rouf et al., 2021), and *Clibanarius rhabdodactylus* (Patel et al., 2023), *Dardanus deformis* (Litulo, 2005), and *Menippe nodifrons* (Fransozo et al., 2000). There are a number of variables, including the availability of food for adults (Goodbody, 1965),), the ecology of larvae (Reese, 1968), the amount of time to attain sexual maturity, the timing of mating and gonadal development as well as the length of the incubation period (Sastry, 1983), which can lead to periodicity in the reproductive season. A variety of abiotic and biotic variables, including water temperature (Chou et al., 2019), salinity (Huang et al., 2022), the nutritional quality of the females (Matias et al., 2016), variations in photoperiod (Zhang et al., 2023), the amount and availability of nutrition (Viña-Trillos et al., 2023), and the threat of predation (Touchon, 2006), may affect the reproductive maxima among populations.

It was found that the carapace width and wet weight of *L. exaratus* were positively correlated with the number of eggs and weight of the egg mass. Similar results have been observed in several other studies (Patel et al., 2023; Crowley et al., 2019; Hamasaki et al., 2021; Aviz et al., 2022; Mustaquim et al., 2022). Additionally, it has been demonstrated that ovigerous females with the same CW had variations in the number of eggs, egg mass weight, and egg size resulting from variations in the food supply, variation in egg production, and egg loss (Hines, 1982).

Conclusions

The present study was aimed to understand the population structure and breeding biology of *L. exaratus.* Significant sexual dimorphism was found, with males being bigger than females, most likely as a result of the size of gamete formation differing between the sexes and females investing more in egg production. Population skewed towards female in the overall and monthly populations (1:1.7) may be a result of differential biology and behaviour as well as the impact of biotic and abiotic variables on male and female individuals. Year round occurrence of ovigerous females suggests continuous breeding of the population and an inverse relationship between the peak in juvenile recruitment and the occurrence of ovigerous females which is a common phenomena of tropical brachyuran crabs. There was a positive correlation between the egg parameters ((weight of egg mass and number of eggs) and the morphology of ovigerous females (carapace width and body weight). Fecundity may be impacted by a variety of internal and external variables, such as the amount of energy used for somatic development and egg production.

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References

Abrams PA. 1988. Sexual difference in resource use in hermit crabs; consequences and causes. In: Chelazzi G, Vannini M eds. *Behavioral adaptation to intertidal life*. MA: Springer, 283–296.

Ali MY, Hossain MdB, Sana S, Rouf MA, Yasmin S, Sarower MdG. 2020. Identifying peak breeding season and estimating size at first maturity of mud crab (*Scylla olivacea*) from a coastal region of Bangladesh. *Heliyon* 6:e04318. DOI: https://doi.org/10.1016/j.heliyon.2020.e04318.

Al-Wazzan Z, Giménez L, Behbehani M, Le Vay L. 2019. Trophic niche separation in sympatric rocky shore crabs. *Journal of the Marine Biological Association of the United Kingdom* 99:1171–1180. DOI: https://doi.org/10.1017/s0025315419000134.

Al-Wazzan Z, Le Vay L, Behbehani M, Giménez L. 2018. Hatching rhythm and larval release in *Leptodius exaratus* (H. Milne Edwards, 1834) (Decapoda: Brachyura: Xanthidae) from rocky shores in Kuwait. *Journal of Crustacean Biology* 38:804–811. DOI: https://doi.org/10.1093/jcbiol/ruy080.

Al-Wazzan Z, Vay LL, Behbehani M, Giménez L. 2020. Scale-dependent spatial and temporal patterns of abundance and population structure of the xanthid crab Leptodius exaratus on rocky shores in Kuwait. *Regional Studies in Marine Science* 37:101325. DOI: https://doi.org/10.1016/j.rsma.2020.101325.

Asakura A. 1995. Sexual Differences in Life History and Resource Utilization by the Hermit Crab. *Ecology* 76:2295–2313. DOI: https://doi.org/10.2307/1941703.

Aviz D, Carmona PA, Barbosa AC de C, Santos CRM dos. 2022. Fecundity and reproductive patterns of the fiddler crab *Uca maracoani* Latreille 1802-1803 in an Amazonian estuary in northern Brazil. *Invertebrate Reproduction & Development* 66:197–207. DOI: https://doi.org/10.1080/07924259.2022.2125353.

Baeza JA, Furlan M, Almeida AC, Barros-Alves S de P, Alves DFR, Fransozo V. 2013. Population dynamics and reproductive traits of the ornamental crab *Porcellana sayana*: implications for fishery management and aquaculture. Sexuality and Early Development in Aquatic Organisms 1:1–12.

Bertini G, Fransozo A. 2002. Breeding Season of the Hermit Crab Petrochirus Diogenes (Anomura: Diogenidae) in the North Coast of São Paulo State, Brazil. In: Escobar-Briones E, Alvarez F eds. *Modern Approaches to the Study of Crustacea*. Boston, MA: Springer, 145–152.

Bezerra LEA, Matthews-Cascon H. 2007. Population and reproductive biology of the fiddler crab *Uca thayeri* Rathbun, 1900 (Crustacea: Ocypodidae) in a tropical mangrove from Northeast Brazil. *Acta Oecologica* 31:251–258. DOI: https://doi.org/10.1016/j.actao.2006.10.003.

Bhat M, Trivedi J. 2021. New record of the Sesarmid crab *Episesarma versicolor* (Tweedie, 1940) (Crustacea: Decapoda: Sesarmidae) from the West Coast of India. *Journal of Biological Studies* 3:165–170.

Chopra BN, Das KN. Further notes on Crustacea Decapoda in the Indian Museum. IX. On three collections of crabs from Tavoy and Mergui Archipelago. *Records of the Indian Museum* 39:377–434.

Chou C-C, Head ML, Backwell PRY. 2019. Effects of temperature on reproductive timing and hatching success in a tropical fiddler crab. *Biological Journal of the Linnean Society* 128. DOI: https://doi.org/10.1093/biolinnean/blz157.

Copatti CE, Legramanti RP, Trevisan A, Santos S. 2016. Growth, sexual maturity and sexual dimorphism of *Aegla georginae* (Decapoda: Anomura: Aeglidae) in a tributary of the Ibicuí River in southern Brazil. *Zoologia (Curitiba)* 33. DOI: https://doi.org/10.1590/s1984-4689zool-20160010.

Crowley CE, Shea CP, Gandy RL, Daly KL. 2019. Fecundity Assessment of Stone Crabs in the Eastern Gulf of Mexico. *Marine and Coastal Fisheries* 11:32–47. DOI: https://doi.org/10.1002/mcf2.10059.

de Arruda Leme MH, Negreiros-Fransozo ML. 1998. Reproductive patterns of *Aratus pisonii* (Decapoda: Grapsidae) from an estuarine area of São Paulo Northern Coast, Brazil. *Revista de Biología Tropical* 46:673–678.

Díaz H, Conde JE. 1989. Population Dynamics and Life History of the Mangrove Crab *Aratus Pisonii* (Brachyura, Grapsidae) in a Marine Environment. *Bulletin of Marine Science* 45:148–163.

Fiielder DR, Greenwood JG, Jone MM. 1979. Larval development of crab Leptodius exaratus (Decapoda, Xanthidae), reared in the laboratory. *Proceedings of Royal Society of Queensland* 90:117–127.

Flores A, Negreiros-Fransozo ML. 1999. Allometry of the secondary sexual characters of the shore crab *Pachygrapsus transversus* (Gibbes, 1850) (Brachyura, Grapsidae). *Crustaceana* 72:1051–1066. DOI: https://doi.org/10.1163/156854099504013.

Flores AAV, Paula J. 2002. Population dynamics of the shore crab *Pachygrapsus marmoratus* (Brachyura: Grapsidae) in the central Portuguese coast. *Journal of the Marine Biological Association of the United Kingdom* 82:229–241. DOI: https://doi.org/10.1017/s0025315402005404.

Fransozo A, Bertini G, Correa M. 2000. Population biology and habitat utilization of the stone crab Menippe nodifrons in the Ubatuba region, São Paulo, Brazil. *Biodiversity Crisis and Crustacea* 12:275–281.

Fransozo A, Mantelatto FLM. 1998. Population structure and reproductive period of the tropical hermit crab Calcinus tibicen (Decapoda: Diogenidae) in the region of Ubatuba, São Paulo, Brazil. *Journal of Crustacean Biology* 18:738–745.

Gherardi F, Nardone F. 1997. The question of coexistence in hermit crabs: population ecology of a tropical intertidal assemblage. *Crustaceana* 70:608–629.

Goodbody I. 1965. Continuous Breeding in Populations of Two Tropical Crustaceans, *Mysidium Columbiae* (Zimmer) and Emerita Portoricensis Schmidt. *Ecology* 46:195–197. DOI: https://doi.org/10.2307/1935274.

Gosavi S, Purohit B, Mitra S, Patel K, Vachhrajani K, Trivedi J. 2021. Annotated checklist of marine decapods (Crustacea: Decapoda) of Gujarat state with three new records. *Proceedings of the "Marine Biology Research Symposium – MBRS 2021*:45–66.

Gosavi S, Trivedi J, Trivedi D, Vachhrajani K. 2017a. First record of *Leucisca squalina* MacLeay, 1838 (Decapoda: Leucosiidae) from Gujarat state, India. *Journal of Entomology and Zoology Studies* 5:400–402.

Gosavi S, Trivedi J, Trivedi D, Vachhrajani K. 2017b. New records of Anomuran crabs (Crustacea: Decapoda: Anomura) from Gujarat, India. *Journal of Entomology and Zoology Studies* 5:658–662.

Hamasaki K, Ishii M, Dan S. 2021. Seasonal variability in fecundity and egg size in the porcellanid crab *Petrolisthes japonicus* (Decapoda: Anomura: Porcellanidae). *Crustacean Research* 50:17–27. DOI: https://doi.org/10.18353/crustacea.50.0_17.

Hamilton WD. 1967. Extraordinary sex ratios. *Science.* 156:477–488.

Hammer Ø, Harper DAT, Ryan PD. 2001. PAST-palaeontological statistics. *Palaeontol. Electron* 4:1–9.

Hu MPK, Kwan B, Wang Y, Cheung S, Shin P. 2015. Population Structure and Growth of Juvenile Horseshoe Crabs *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*

(Xiphosura) in Southern China. In: Carmichael R, Botton M, Shin P, Cheung S eds. *Changing global perspectives on horseshoe crab biology, conservation and management*. 167–180.

Huang X, He L, Tan R, Feng G, Geng Z, Zhao F, Zhang T, Zhuang P. 2022. Effects of salinity on reproductive characteristics and embryo quality of *Eriocheir sinensis*. *Aquaculture Research* 53:4970–4979. DOI: https://doi.org/10.1111/are.15983.

Johnson P. 2003. Biased sex ratios in fiddler crabs (Brachyura, Ocypodidae): a review and evaluation of the influence of sampling method, size class, and sex-specific mortality. *Crustaceana* 76:559–580. DOI: https://doi.org/10.1163/156854003322316209.

Kneib RT, Weeks CA. 1990. Intertidal distribution and feeding habits of the mud crab. *Eurytium limosum. Estuaries* 13:462–468.

Kobayashi M, Wong YH, OguroOkano M, Dreyer N, Høeg, Jens T, Yoshida R, Okano K. 2018. Identification, characterization, and larval biology of a rhizocephalan barnacle, Sacculina yatsui Boschma, 1936, from northwestern Japan (Cirripedia: Sacculinidae). *Journal of Crustacean Biology* 38:329–340.

Litulo C. 2004. Fecundity of the pantropical fiddler crab *Uca annulipes* (H. Milne Edwards, 1837) (Brachyura: Ocypodidae) at Costa do Sol mangrove, Maputo bay, Southern Mozambique. *Western Indian Ocean Journal of Marine Science* 3:87–91.

Litulo C. 2005. Population structure and breeding biology of the hairy crab *Pilumnus vespertilio* (Fabricius, 1793) (Crustacea: Brachyura: Pilumnidae) in southern Mozambique. *Journal of Natural History* 39:1359–1366. DOI: https://doi.org/10.1080/00222930400010070.

López Abellán LJ, BalgueríasE, Fernández-Vergaz V. 2002. Life history characteristics of the deep-sea crab *Chaceon affinis* population off Tenerife (Canary Islands). *Fisheries Research* 58:231–239. DOI: https://doi.org/10.1016/s0165-7836(01)00384-8.

Lwin TT, Doi W, Yokota M, STRÜSSMANN CA, Watanabe S. 2007. Juvenile morphology of the xanthid crab *Leptodius exaratus* (H. MilneEdwards, 1834) (Decapoda: Brachyura), with notes on the appearance of sexual dimorphism. *Invertebrate Reproduction & Development* 50:191–201.

Lycett KA, Shields JD, Chung JS, Pitula JS. 2020. Population Structure of the Blue Crab Callinectes sapidus in the Maryland Coastal Bays. *Journal of Shellfish Research* 39. DOI: https://doi.org/10.2983/035.039.0316.

Mantelatto FLM, Fransozo A. 1997. Fecundity of the Crab *Callinectes ornatus* Ordway, 1863 (Decapoda, Brachyura, Portunidae) from the Ubatuba Region, SãO Paulo, Brazil.. *Crustaceana* 70:214–226.

Mantelatto FLM, Sousa LM. 2000. Population biology of the hermit crab *Paguristes tortugae* Schmitt, 1933 (Anomura, Diogenidae) from Anchieta Island. *Nauplius* 8:185–193.

Manzoor R, Haider S, Fatima M, Qari R. 2016. Study on Abundance, Breeding and Growth of the Ocypodide Crab *Dotilla Blanfordi* in Karachi Coast, Pakistan. *International Journal of Marine Science* 6. DOI: https://doi.org/10.5376/ijms.2016.06.0022.

Matias D, Joaquim S, Matias AM, Leitão A. 2016. Reproductive effort of the European clam *Ruditapes decussatus* (Linnaeus, 1758): influence of different diets and temperatures.

Invertebrate Reproduction & Development 60:49–58. DOI: https://doi.org/10.1080/07924259.2015.1126537.

Mishima S, Henmi Y. 2008. Reproduction and embryonic diapause in the hermit crab *Pagurus nigrofascia*. *Crustacean Research* 37:26–34. DOI: https://doi.org/10.18353/crustacea.37.0_26.

Mustaquim J, Khatoon S, Rashid S. 2022. A note on sex ratio, size at maturity, fecundity and breeding season of the portunid crab, *Thranita crenata* (Rüppell, 1830) from the Pakistani coast. *Crustaceana* 95:127–136. DOI: https://doi.org/10.1163/15685403-bja10179.

Naderloo R. 2017. *Atlas of Crabs of the Persian Gulf*. Switzerland: Springer Cham. DOI: https://doi.org/10.1007/978-3-319-49374-9.

Negreiros-Fransozo ML, Costa TM, Colpo KD. 2003. Allometric Growth in the Fiddler Crab *Uca Thayeri* (Brachyura, Ocypodidae) from a Subtropical Mangrove. *Journal of Crustacean Biology* 23:273–279. DOI: https://doi.org/10.1163/20021975-99990337.

Oh I-K, Lee S. 2020. Effects of Temperature on the Survival and Larval Development of *Deiratonotus Japonicus* (Brachyura, Camptandriidae) as a Biological Indicator. *Journal of Marine Science and Engineering* 8:213–213. DOI: https://doi.org/10.3390/jmse8030213.

Padate VP, Patel KJ, Rivonker CU, Trivedi JN. 2022. On Indian species of *Nanosesarma* Tweedie, 1950 (Decapoda: Brachyura: Sesarmidae). *Nauplius* 30:e2022031. DOI: https://doi.org/10.1590/2358-2936e2022031.

Patel D, Patel K, Patel P, Trivedi J. 2020. Shell utilization pattern by the hermit crab Diogenes custos (Fabricius, 1798) along Gulf of Kachchh, Gujarat, India. *Journal of Biological Studies* 3(2):79–95.

Patel H, Patel K, Trivedi J. 2021b. Study of colour variation in intertidal crab Leptodius exaratus (H. Milne Edwards, 1834) inhabiting rocky shores of Saurashtra coast, Gujarat, India. In: *Marine Biology Research Symposium (MBRS 2021)*. 67–80.

Patel K, Patel P, Trivedi J. 2021a. First record of Manningis arabicum (Jones and Clayton, 1983) (Decapoda, Brachyura, Camptandriidae) from India. *Nauplius* 29:e2021017. DOI: https://doi.org/10.1590/2358-2936e2021017.

Patel KJ, Vachhrajani KD, Trivedi J. 2023. Population structure and reproductive biology of *Clibanarius rhabdodactylus* Forest, 1953 (Crustacea: Anomura: Diogenidae) in Gujarat state, India. *Regional Studies in Marine Science* 63:103033–103033. DOI: https://doi.org/10.1016/j.rsma.2023.103033.

Patel KJ, Vachhrajani KD, Trivedi JN. 2022. Study on Shell Utilization Pattern of Two Sympatric Hermit Crab Species on the Rocky Intertidal Region of Veraval, Gujarat, India. *Thalassas: An International Journal of Marine Sciences* 39. DOI: https://doi.org/10.1007/s41208-022-00487-5.

Patel P, Patel K, Trivedi J. 2020. First record of Hermit crab *Clibanarius ransoni* Forest, 1953 (Crustacea: Anomura: Diogenidae) from India. *Journal of Biological Studies* 3:19–23.

Qureshi NA, Saher NU. 2012. Density, Distribution and Population Biology of *Macrophthalmus* (*Venitus*) *dentipes* Lucas, 1836, From Mangrove Areas of Pakistan. *Pakistan Journal of Zoology* 44:615–623.

Reese ES. 1968. Annual breeding seasons of three sympatric species of tropical intertidal hermit crabs, with a discussion of factors controlling breeding. *Journal of Experimental Marine Biology and Ecology* 2:308–318. DOI: https://doi.org/10.1016/0022-0981(68)90022-1.

Rouf MA, Shahriar SIM, Antu A-H, Siddiqui MN. 2021. Population parameters of the orange mud crab *Scylla olivacea* (Herbst, 1796) from the Sundarban mangrove forest in Bangladesh. *Heliyon* 7:e06223. DOI: https://doi.org/10.1016/j.heliyon.2021.e06223.

Saher NU, Amanat Z, Gondal MA, Qureshi NA. 2017. Distribution, Abundance and Population Ecology of *Ashtoret lunaris* (Forskel, 1775) and *Matuta planipes* Fabricius, 1798 from the Sonmiani Bay (Lagoon), Pakistan. *Pakistan Journal of Zoology* 49:425–434. DOI: https://doi.org/10.17582/journal.pjz/2017.49.2.425.434.

Saher NU, Qureshi NA. 2010. Zonal distribution and population biology of *Ilyoplax frater* (Brachyura: Ocypodoidea: Dotillidae) in a coastal mudflat of Pakistan. *Current Zoology* 56:244–251. DOI: https://doi.org/10.1093/czoolo/56.2.244.

Saher NU, Qureshi NA. 2011. Density, distribution and population structure of *Opusia indica* (Ocypodoidae: Camptandriidae) in a coastal mangrove creek in Pakistan. *Biologia* 66:138–145. DOI: https://doi.org/10.2478/s11756-010-0142-3.

Santos S, Negreiros-Fransozo ML, Padovani CR. 1995. Relação do peso em função da largura da carapaça do siri candeias Portunus spinimanus Latreille, 1819 (Decapoda Portunidae). *Arquivos de Biologia e Tecnologia* 38(3):715–724.

Sastry A, Vernberg FJ, Vernberg W. 1983. Ecological aspects of reproduction. In: Vernberg FJ ed. *Environmental Adaptations*. New York, UK: Academic Press, 1–410.

Siegel V, Damm U, Neudecker T. 2008. Sex-ratio, seasonality and long-term variation in maturation and spawning of the brown shrimp Crangon crangon (L.) in the German Bight (North Sea). *Helgoland Marine Research* 62:339.

Silk JB. 1983. Local resource competition and the evolution of male-biased sex ratios. *Journal of Theoretical Biology* 108 (2):203–213. DOI: https://doi.org/10.1016/S0022-5193(84)80066-1.

Smith DR, Pooler PS, Swan BL, Michels SF, Hall WR, Himchak PJ, Millard MJ. 2002. Spatial and temporal distribution of horseshoe crab (*Limulus polyphemus*) spawning in Delaware Bay: Implications for monitoring. *Estuaries* 25:115–125. DOI: https://doi.org/10.1007/bf02696055.

Swanson BO, George MN, Anderson SP, Christy JH. 2013. Evolutionary variation in the mechanics of fiddler crab claws. *BMC Evolutionary Biology* 13:1–11.

Taddei FG, Davanso TM, Castiglioni L, Herrera DR, Fransozo A, Caetano R. 2015. Population structure, recruitment, and mortality of the freshwater crab *Dilocarcinus pagei* Stimpson, 1861 (Brachyura, Trichodactylidae) in Southeastern Brazil. *Invertebrate Reproduction & Development* 59:189–199. DOI: https://doi.org/10.1080/07924259.2015.1081638.

Takween W, Qureshi N. 2005. Population structure and reproductive biology of four species of swimming crabs (Crustacea: Brachyura: Portunidae) from coastal area of Karachi, Pakistan. *Pakistan Journal of Marine Sciences* 14:107–121.

Thurman CL. 1985. Reproductive biology and population structure of the fiddler crab *Uca subcylindrical* (stimpson). *The Biological Bulletin* 169:215–229. DOI: https://doi.org/10.2307/1541399.

Tina FW, Jaroensutasinee M, Sutthakiet O, Jaroensutasinee K. 2015. The fiddler crab, *Uca bengali* Crane, 1975: population biology and burrow characteristics on a riverbank in southern Thailand. *Crustaceana* 88:791–807. DOI: https://doi.org/10.1163/15685403-00003450.

Touchon JC, Gomez-Mestre I, Warkentin KM. 2006. Hatching plasticity in two temperate anurans: responses to a pathogen and predation cues. *Canadian Journal of Zoology* 84:556–563. DOI: https://doi.org/10.1139/z06-058.

Trivedi J, Gosavi S, Vachhrajani K. 2020. First record of three species of spider crabs from west coast of India (Crustacea: Decapoda: Brachyura). *Journal of Biological Studies* 3:24–29.

Trivedi J, Mitra S, Patel P, Gosavi S, Vachhrajani K. 2020. Four New Records of Brachyuran Crabs (Crustacea: Decapoda: Brachyura) from India. *Thalassas: An International Journal of Marine Sciences* 37:235–242. DOI: https://doi.org/10.1007/s41208-020-00252-6.

Trivedi J, Mitra S, Patel P, Maheta N, Patel K, Ng PKL. 2021. On the Indian species of Eurycarcinus A. Milne-Edwards, 1867, Heteropanope Stimpson, 1858, and Pilumnopeus

A. Milne-Edwards, 1867 (Decapoda: Brachyura: Pilumnidae). *Nauplius* 29:e2021004. DOI: https://doi.org/10.1590/2358-2936e2021004.

Trivedi J, Trivedi, D, Soni, G, Purohit B, Vachhrajani. KD. 2015a. On new records of hermit crabs (Anomura: Paguroidea: Diogenidae) from Gujarat state of India. *Electronic Journal of Environmental Science* 8:33–42.

Trivedi J, Vachhrajani K. 2016b. On new record of *Pagurus kulkarni* Sankolli, 1962 (Crustacea: Anomura: Paguridae) from Gujarat, India. *International Journal of fisheries and Aquatic Studies* 4:183–185.

Trivedi JN, Osawa M, Vachhrajani KD. 2016. A new species of the genus *Diogenes* Dana, 1851 (Crustacea: Decapoda: Anomura: Diogenidae) from Gujarat, northwestern India. *Zootaxa* 4208:189–197. DOI: https://doi.org/10.11646/zootaxa.4208.2.6.

Trivedi JN, Soni GM, Trivedi DJ, Vachhrajani KD. 2015b. A new species of *Ilyoplax* (Decapoda, Brachyura, Dotillidae) from Gujarat, India. *Journal of Asia-Pacific Biodiversity* 8:173–177. DOI: https://doi.org/10.1016/j.japb.2015.02.005.

Trivedi JN, Soni GM, Vachhrajani KD. 2016. A new species of *Lyphira* Galil, 2009 (Crustacea, Decapoda, Leucosiidae) from Gujarat, India. *Tropical Zoology* 29:148–154. DOI: https://doi.org/10.1080/03946975.2016.1181954.

Trivedi JN, Trivedi DJ, Vachhrajani KD, Ng PKL. 2018. An annotated checklist of the marine brachyuran crabs (Crustacea: Decapoda: Brachyura) of India. *Zootaxa* 4502:1–83. DOI: https://doi.org/10.11646/zootaxa.4502.1.1.

Trivedi JN, Vachhrajani KD. 2013a. Taxonomic account of genus *Scylla* (de Haan, 1833) from Gujarat State, India with two new records of species. *Arthropods* 2:159–171.

Trivedi JN, Vachhrajani KD. 2013b. First record of two porcellanid crabs from Gujarat state, India (Crustacea: Decapoda: Porcellanidae). *Journal of the Marine Biological Association of India* 55:55–58. DOI: https://doi.org/10.6024/jmbai.2013.55.1.01756-09.

Trivedi JN, Vachhrajani KD. 2015. First record of brachyuran crab *Leptodius affinis* (De Haan, 1835) (Crustacea: Decapoda: Xanthidae) from the western coast of India. *Marine Biodiversity Records* 8:1–5. DOI: https://doi.org/10.1017/s175526721400133x.

Trivedi JN, Vachhrajani KD. 2016a. On burrow morphology of the ghost crab, *Ocypode ceratophthalmus* (Decapoda: Brachyura: Ocypodidae) from sandy shore of Gujarat, India. *International Journal of Marine Science* 6:1–10. DOI: https://doi.org/10.5376/ijms.2016.06.0015.

Trivedi JN, Vachhrajani KD. 2017. Seasonal Burrow Distribution of the Ghost Crab, *Ocypode ceratophthalmus* (Pallas, 1772), on Sandy Shores of Gujarat, India. *International Journal of Marine Science* 7. DOI: https://doi.org/10.5376/ijms.2017.07.0034.

Trivedi JN, Vachhrajani KD. 2018. On new record of brachyuran crab *Scopimera crabicauda* Alcock, 1900 (Crustacea: Decapoda) from India. *Journal of the Marine Biological Association of India* 60:105–107. DOI: https://doi.org/10.6024/jmbai.2018.60.1.1945-17.

Viña-Trillos N, Brante A, Urzúa Á. 2023. Intraspecific variation in reproductive traits and embryo elemental composition of the crab *Hemigrapsus crenulatus* (Milne Edwards, 1837) across fluctuating coastal environments along Chilean coasts. *Marine*

Environmental Research 188:106023–106023. DOI: https://doi.org/10.1016/j.marenvres.2023.106023.

Wada S, Kitaoka H, Goshima S. 2000. Reproduction of the hermit crab Pagurus lanuginosus and comparison of reproductive traits among sympatric species. *Journal of Crustacean Biology* 20:474–478.

Waiho K, Ikhwanuddin M, Abualreesh MH, Shu-Chien AC, Ishak SD, Jalilah M, Azmie G, Fazhan H. 2021. Intra- and Interspecific Variation in Sexual Dimorphism Patterns of Mud Crab Genus *Scylla* Along the Equatorial Region. *Frontiers in Marine Science* 8. DOI: https://doi.org/10.3389/fmars.2021.690836.

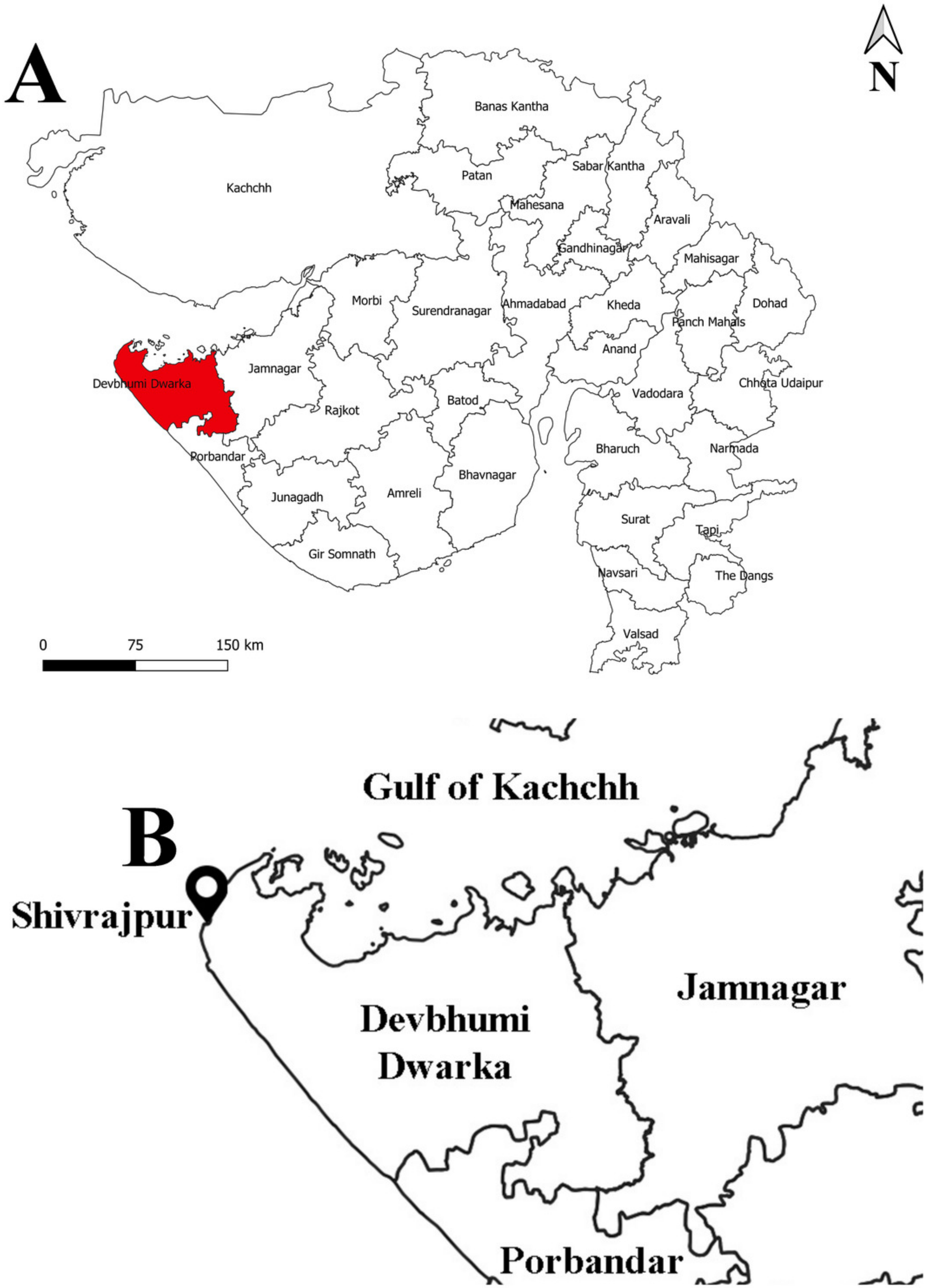
Wenner AM. 1972. Sex Ratio as a Function of Size in Marine Crustacea. *The American Naturalist* 106:321–350. DOI: https://doi.org/10.1086/282774.

Zhang B, Yu C, Xu Y, Huang Z, Cai Y, Li Y. 2023. Hepatopancreas immune response during different photoperiods in the Chinese mitten crab, *Eriocheir sinensis*. *Fish & Shellfish Immunology* 132:108482–108482. DOI: https://doi.org/10.1016/j.fsi.2022.108482.

Zimmerman TL, Felder DL. 1991. Reproductive Ecology of an Intertidal Brachyuran Crab, *Sesarma* sp. (nr. reticulatum), from the Gulf of Mexico. *The Biological Bulletin* 181:387–401. DOI: https://doi.org/10.2307/1542359.

Figure 1

Figure 1 . Map of study area: A. Gujarat state; B. Shivrajpur ,Gujarat state, India.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Rajkot
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Figure 2

Figure 2. Overall size frequency distribution of *Leptodius exaratus* collected from Shivrajpur Beach.

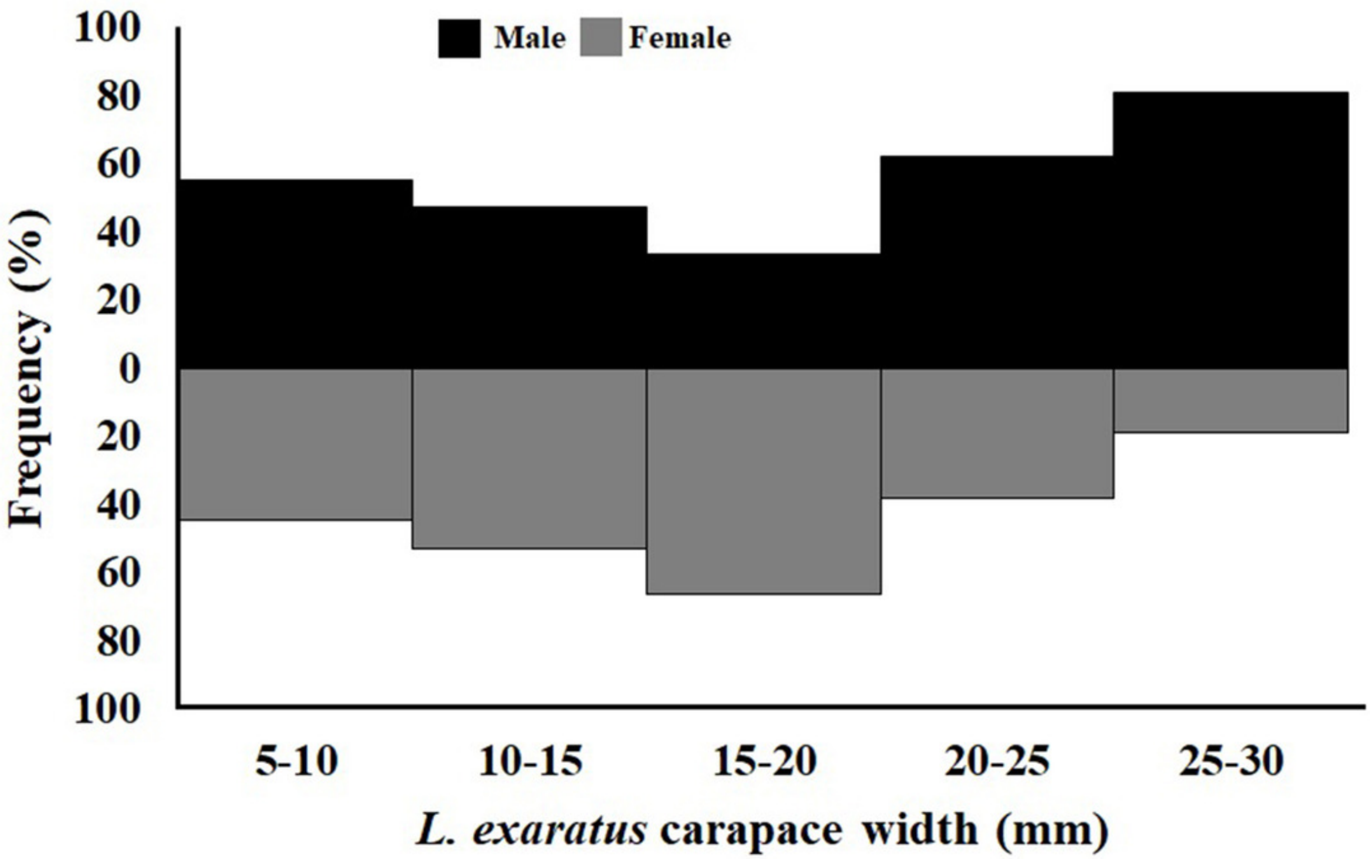

Figure 3

Figure 3. Percentage of different demographic categories of *Leptodius exaratus* at Shivrajpur Beach during the 12 months of study period. (OF: Ovigerous females; A: Adults; J: Juveniles)

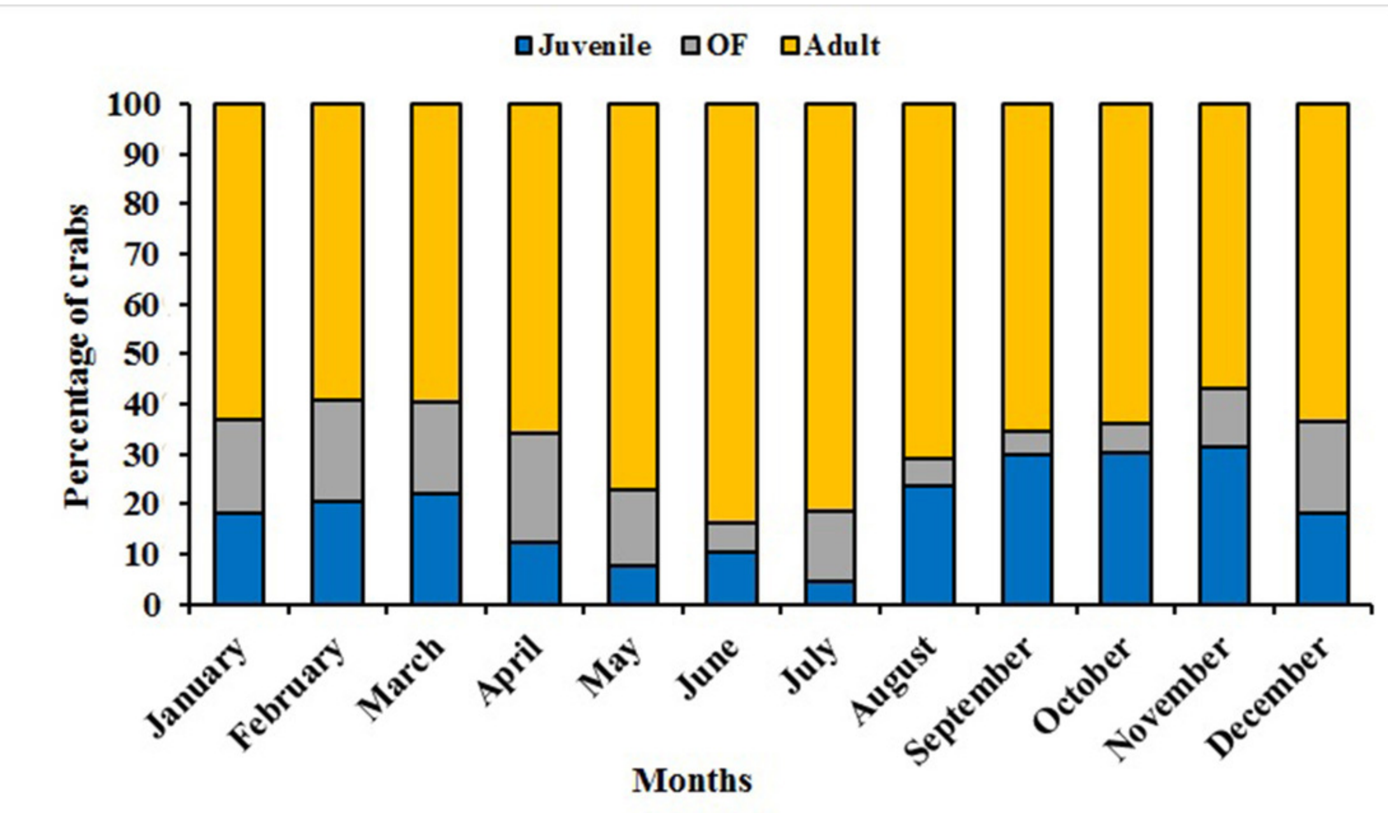

Figure 4

Figure 4. Monthly size frequency distribution of *Leptodius exaratus* from January to December.

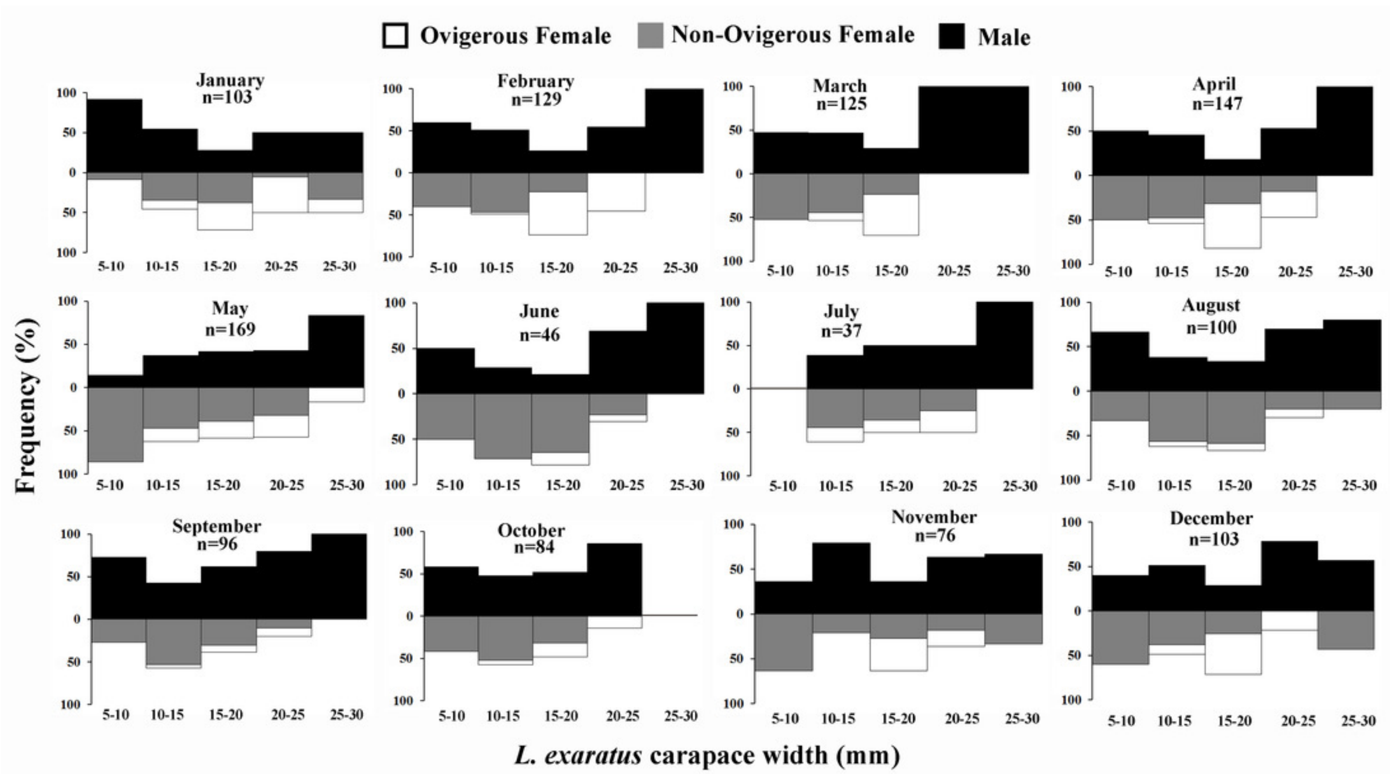

Figure 5

Figure 5. Association between the juveniles (of both sexes) and ovigerous female occurrence of *Leptodius exaratus* with monthly ambient and water temperatures at Shivrajpur Beach.

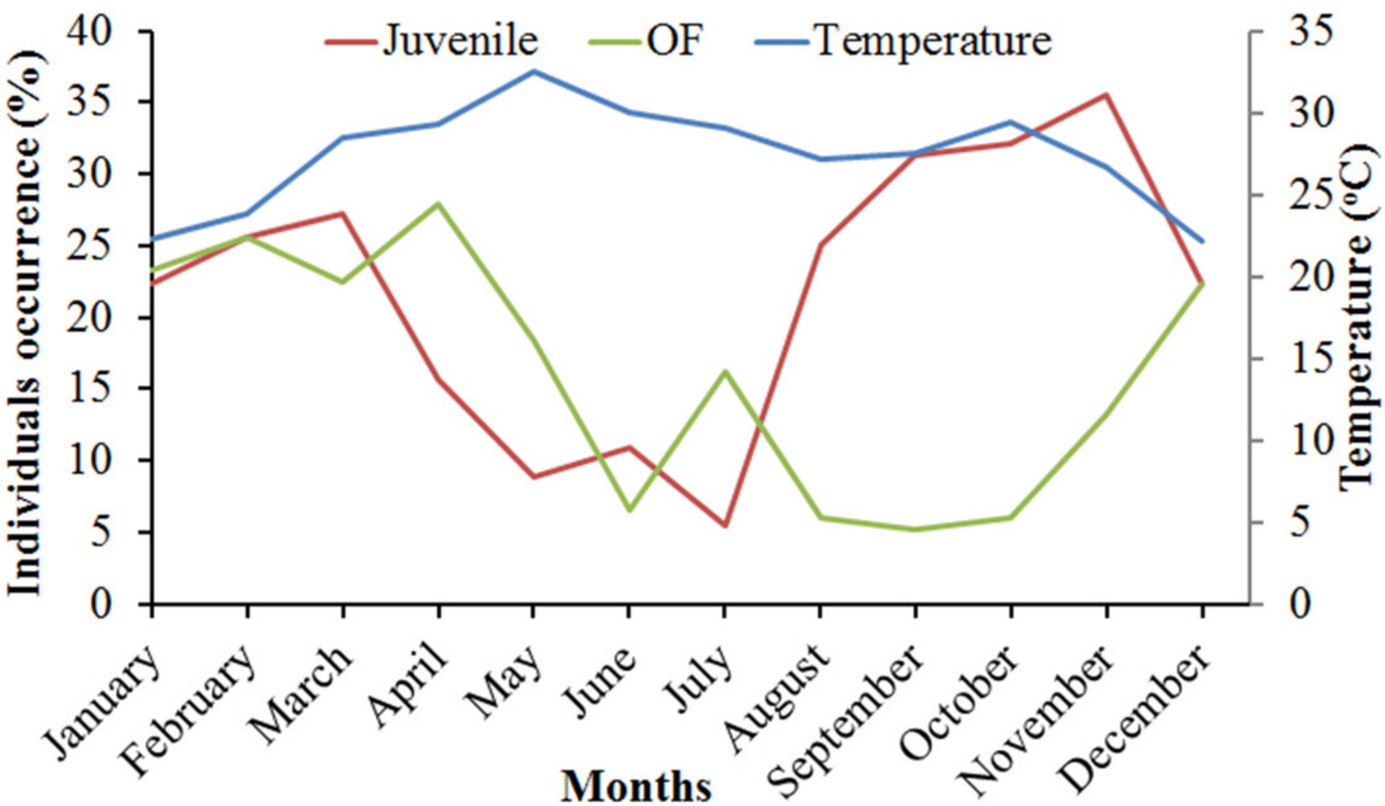

Figure 6

Figure 6. Relationship of *Leptodius exaratus* carapace width with A. total number of eggs; B. egg weight; and C. average egg size; and crab weight with D. total number of eggs; E. egg weight; and F. average egg size.

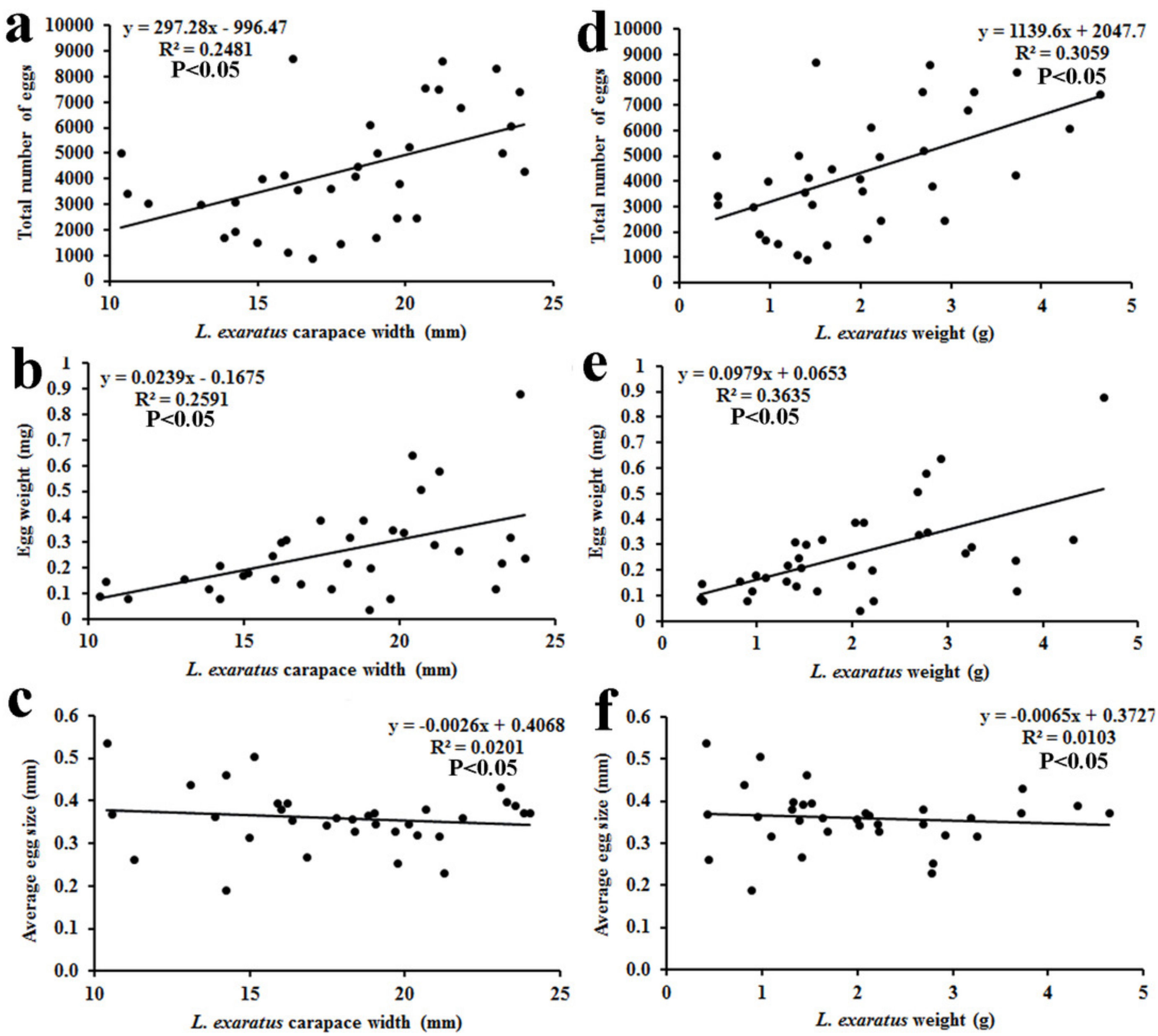

Table 1(on next page)

Table 1 . Carapace width values of male and female individuals of *Leptodius exaratus*. (n= total number of individuals, CW= carapace width).

Table 1. Carapace width values of male and female individuals of *Leptodius exaratus*. (n= total number of individuals, CW= carapace width).

Sex	n	Min. CW (mm)	Max. CW (mm)	Mean ± SD
Male	559	5.15	31.3	15.99 ± 5.30***
Female	657	5.26	28.63	15.48 ± 3.77***

Table 2(on next page)

Table 2. Total number of *Leptodius exaratus* specimens collected at rocky intertidal region of Veraval. (M: Male; NOF: Non-ovigerous female; OF: Ovigerous female)

Table 2. Total number of *Leptodius exaratus* specimens collected at rocky intertidal region of Veraval. (M: Male; NOF: Non-ovigerous female; OF: Ovigerous female)

Month	M	%	NOF	%	OF	%	NOF+ OF	%	Male: Female
January	51	49.51	28	27.18	24	23.30	52	50.49	1:1.02
February	56	43.41	40	31.01	33	25.58	73	56.59	1:1.3
March	55	44.00	42	33.60	28	22.40	70	56.00	1:1.3
April	55	37.41	51	34.69	41	27.89	92	62.59	1:1.7
May	69	40.83	69	40.83	31	18.34	100	59.17	1:1.4
June	20	43.48	23	50.00	3	6.52	26	56.52	1:1.3
July	17	45.95	14	37.84	6	16.22	20	54.05	1:1.2
August	44	44.00	50	50.00	6	6.00	56	56.00	1:1.3
September	54	56.25	37	38.54	5	5.21	42	43.75	1:0.8
October	45	53.57	34	40.48	5	5.95	39	46.43	1:0.9
November	44	57.89	22	28.95	10	13.16	32	42.11	1:0.7
December	48	46.60	32	31.07	23	22.33	55	53.40	1:1.1
Total	558	45.93	442	36.38	215	17.70	657	54.07	1:1.2

Table 3 (on next page)

Table 3. Summary of different morphological parameters of *Leptodius exaratus* ovigerous females and eggs. (n= total individuals; SD= standard deviation).

Table 3. Summary of different morphological parameters of *Leptodius exaratus* ovigerous females and eggs. (n= total individuals; SD= standard deviation).

Variables	n	Mean ± SD	Min.	Max.
Crab weight (g)	34	2.04 ± 1.2	0.41	4.64
Weight of egg mass (g)	34	0.29 ± 0.18	0.04	0.88
Carapace length (mm)	34	12.14 ± 2.4	6.92	15.88
Carapace width (mm)	34	18.1 ± 3.8	10.38	24.02
Egg number	34	4529 ± 2003	920	8730
Egg size (mm)	34	0.36 ± 0.07	0.19	0.54