PMDJAS
E-ISSN: 2789-2611
Pakistan's Multidisciplinary Journal for Arts & Science
ISSN 2789-2611
https://pmdjas.com
| January. 2023, VOL. 4 (No, 01) Page. 48 – 64 |

EFFECT OF SEASONAL VARIATIONS ON CRAB POPULATION DENSITY IN MOUNTAINOUS STREAMS OF DISTRICT BOLAN, BALOCHISTAN

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DOI: https://doi.org/10.5281/zenodo.7593050
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Received January: 06/2022. Accepted January: 25/2022. **Published January: 28/2023.**

Abstract

In this study we describe the seasonal effect of mountainous streams on crab's population that how crab population are affected from change in climate. Seasonal variations can have a significant impact on crab populations. Factors such as temperature, water levels, and food availability can all play a role in determining the size and health of a crab population. A survey was carried out in the Balochistan province's Kachhi (Bolan) district between May 2019 and February 2020. Fresh water crab's observations will be taken at the same site during (2019–2020) at the same time from around 12 AM to 02 PM on a monthly basis. One station is setup for sample collection for a period of one year, and once a week samples are collected. YSI 556 multi-probe sensors were used to measure the surface water quality parameters in-situ, such as pH, dissolved oxygen (DO), temperature (°C), and salinity (%) (mg $^{-1}$). Station S1 is the deepest station, with an average depth of 0.48 0.31 m. Despite this, Station S2 is the shallowest, with an estimated mean depth of 0.33 0.11 m. The study region includes the District Kachhi (Bolan) in Balochistan's mountains. Gecarcinucidae and Potamidae families dominated the stream that was sampled. The total number of specimens obtained includes two species from the family Gecarcinucidae and three species from the family Potamidae. There were 142 freshwater crabs total, with Maydelliatelphusa lugubris accounting for 64% of the total (n=91).

Keywords: Effect of seasonal variations on crab population density Kachi Bolan.

INTRODUCTION

Crabs are a diverse group of crustaceans that are found in a wide variety of habitats, including oceans, rivers, and freshwater bodies (Yeo et al.,2007). They are distinguished by their tough exoskeleton, which protects them from predators, and their potent claws, which they utilize for both defense and hunting. It is well recognized that a variety of environmental conditions, including water temperature, salinity, and food availability, have an impact on crab populations (Luppi et al.,2013). Additionally, human activities such as overfishing, pollution, and habitat destruction can also have a significant impact on crab populations. Crab populations are also known for their life cycles that include molting, where they shed their exoskeleton to grow. Some crabs also migrate for breeding, mating, and feeding. Crab populations are economically important, as they are harvested for food, bait, and other purposes, and have significant impacts on the ecosystem as well (Walls et al.,2002). Crabs are generally carnivorous, feeding on small invertebrates, fish, and sometimes plants. They are also known for their scavenging behavior. Some species, such as the ghost crab, are also known for their burrowing behavior, digging holes in the sand to create homes (Yosef et al.,2021). Crabs play an important role in marine ecosystems as both predators and prey. They are also of great economic importance as a food source for humans. Crabs procreate sexually by releasing eggs into the water that the males then fertilize (Rondeau & Sainte 2001). Crabs play an important role in marine ecosystems as both predators and prey.

Freshwater crabs come in over 1300 different species, including brachyuran crabs. Because they may complete their life cycle independently of their freshwater counterparts, marine habitats are preferred by freshwater crabs. Pseudothelphusidae (Australasia and Asia), Potamidae (Southern Europe, North Africa, and Asia), Platythelphusidae, and Deckeniidae (East Africa) are members of the families Platythelphusidae and Deckeniidae (Martin & Davis, 2001). A vast variety of freshwater ecosystems and habitats can be found in Bangladesh. Almost all types of aquatic environments are home to crabs. A valuable resource, crabs can be used for fishing, exported, and hidden (Rahman, 1991).

Seasonal variations can have a significant impact on crab populations. Factors such as temperature, water levels, and food availability can all play a role in determining the size and health of a crab population. For example, warmer water temperatures can lead to increased crab activity and breeding, while colder temperatures can slow down their metabolism and decrease their overall numbers (Azra et al.,2020). Similarly, changes in water levels, such as during the dry season, can lead to a decrease in the amount of available food and habitat for crabs, which can also affect their population numbers. Additionally, seasonal changes can also affect the timing of crab migrations and the availability of mating partners, which can have a further impact on population dynamics (Bopp et al.,2021). In marine ecosystems, increased temperatures have resulted in changing phenology and shifts in distribution for some species (Vitasse et al.,2021). Since disruptions can be connected to changes in recruitment, birth and mortality rates, maximum lengths, reproductive cycles, and even overall abundance, demographic studies are important for ecosystems (Carmen et al.,2015).

The effects of seasonal variations on crab populations would focus on how changes in temperature, rainfall, and other environmental factors associated with different seasons can impact the survival and reproduction of crab populations. Increased metabolic rates brought on by rising ocean temperatures will be followed by a drop in dissolved oxygen, which could limit organismal aerobic capacity (Seibel, 2011). The physiology of marine animals' tolerance to hypoxia and heat is well known (Deutsch et al.,2015). External threats to crabs include a large number of predators, habitat degradation, harm from invasive species, and pollution. In addition, because they act as parasites and invasive species in and of themselves, crabs themselves can harm other living things (Trathan et al.,2015). The waters of the world have many depleted fisheries (Pikitch 2012).

As autumn approaches, the abundance of crabs in local waters decreases (Zohar et al.,2008). The most significant effect is that during the breeding season (March-May), crab populations are high and can produce abundant numbers of eggs. This in turn can result in an increased catch rate (Zairion, Boer & Fahrudin 2015). One of the most ecologically significant macro-invertebrate groupings in tropical inland waters worldwide is the freshwater crab (Yeo et al., 2008). Some freshwater crab species are detritivores, which are crucial to the cycling of nutrients in tropical freshwater habitats (Dobson et al., 2007).

Tsang et al, (2014) stated this varied group of brachyuran crabs which includes members of the families Gecarcinucidae, Potamidae, Potamonautidae, Pseudothelphusidae, and Trichodactylidae is widely spread across the tropics. There have been more than 1300 species of crabs reported to date. Within their native habitat, they serve significant ecological and cultural roles throughout their entire life cycle without the aid of a marine phase (Cumberlidge et al., 2009). Particularly, in portions of Southeast Asia and Sri Lanka, agriculture and deforestation have been linked to dangers for a high number of vulnerable freshwater crab species (Bahir et al., 2005). Biological invasions are recognised to have significant ecological effects, particularly in freshwater ecosystems, according to Beisel (2001). Due to their restricted distribution, these effects are often more noticeable for species like freshwater crabs.

Rőszer (2014) reported that the metabolic rate may increase in response to global warming, and energy from the hepatopancreas may be transferred to the physiological functions and activities of crustaceans. By shortening the amount of time that prey is fed and handled, such as when breaking shells, an increase in temperature might change how animals forage (Wu et al.,2017).

The physiological susceptibility of organisms to temperature stress is related to the behavioral response to warming. Additionally, ectotherms can behaviorally modify body temperature in accordance with their tolerance (Payette & McGaw 2003). It is reported that freshwater crab species can receive water through food, they can meet their water needs without routinely submerging themselves in fresh water by consuming dew or the rare drop of water, or by capillary or osmotic uptake from moist substrates. Dobson (2004) investigated that Most crabs are foragers and scavengers. There are many different species, including herbivores, omnivores, and foragers. They eat fish faeces as well as flesh (fish, shrimp, mussels, and other shellfish). Daniels et al., (2002) suggested that the lack of marine planktonic larvae and their conduct in caring for their brood, which keeps the juveniles in the parental habitat, increase their philopatry.

According to Pati & Sharma, (2013) at night, Crabs that live in freshwater look for prey among fallen leaves and beechnuts. Diverse predators, such as marine organisms, gastropods, dead frogs, and snakes, prey on them. According to a survey this is among the most important worldwide fears to biodiversity is anthropogenic weather alteration, which is known to have both immediate and long-term effects on a range of ecosystems and taxonomic groups. Fang et al., (2013) reported that Some of the most threatened habitats on the globe include a number of freshwater settings and the creatures that depend on them. Every known species had elevated danger levels, it was found. From October 2017 to September 2018, Kour et al. (2019) conducted a study to assess the freshwater crab population in the Jammu region. Four investigation stations were used for the survey. The Jhajjar, Gho-Manhasan, Chakrali, and Chadwal streams in the Kathua and Jammu districts of the Jammu division (J&K State). The study's objectives included determining the current status of two common freshwater crabs that can be found in the waters off Jammu, Maydelliathelphus amasoniana and Himalayapotamon emphysetum, as well as taking into account various morphometric traits that can help with the systematic identification of native, unstudied freshwater crab fauna. In Marudu Bay, Sabah, Shareef et al., (2019) conducted research to learn more about the composition, dispersion, and catch per unit effort of mud crabs.

MATERIAL AND METHODS

Study Area / Study Design

In the Bolan river or streams in Balochistan, a species of freshwater crab has been discovered and studied. Kachhi district is another name for Bolan in Pakistan's Balochistan region. A survey was carried out in the Balochistan province's Kachhi (Bolan) district between May 2019 and February 2020.The locals were the ones who provided the full history of the Bolan water. Fresh water crab's observations will be taken at the same site during (2019–2020) at the same time from around 12 AM to 02 PM on a monthly basis. One station is setup for sample collection for a period of one year, and once a week samples are collected. The administrative hub for the region is Bolan. Mountains surround Bolan on all sides. The local wintertime temperature ranges from 2 to 20 degrees Celsius. By the end of April, temperatures might range from 20 to 48 degrees Celsius. Bolan is blessed with a pleasant wet season. Bolan experiences comfortable, warm winters. In Balochistan, Bolan is a lovely hamlet with numerous streams. For organic products and fresh produce, it is Balochistan's most productive region.

Sample Collections

Along a 500-meter section of the stream, an opportunistic hand-picking technique will be used to gather the crabs (Lara et al., 2013). A big boulder is hauled out of the way and a tunnel is dug (Shukla et al., 2013).

This study used only male crabs since female crabs are more solitary and more difficult todifferentiate from male crabs. For identification, every physical feature of the male freshwatercrab, including the G1 (gonopod 1), G2 (gonopod 2), and CL (carapace length), was painstakingly measured. Togopod 2 (Bahir 2007). Since freshwater crabs have a conservative external morphology, it is crucial to understand toxic morphology (Brandis& Sharma, 2005).

Figure: 2.2 Crab on the surface of mountainous stream's stone

Figure: 2.3 Crab swimming inside the mountainous stream

Habitat Parameters

GPS was used to map the species' whereabouts (Garmin etrex). The data sheet was used to record the habitat parameters, such as river or stream width and depth, elevation, and aspect. For the purpose of determining the freshwater crab's microhabitat, physio-chemical variables like temperature, PH, stream width, stream depth, and canopy coverage were noted (Lara et al., 2013).

Various meters were permitted to examine the various requirements, which are

- The temperature of the water will be measured using a Zeal mercury thermometer.
- Secchi disc is used to assess how hazy and murky the water is.
- Using pH paper and a pH meter, the pH values of the on-site water samples were calculated.
- Conductivity meters are used to measure the salinity (TDS), total dissolved solids (TDS), and electric conductivity of water.
- Use the formula to calculate alkalinity:

$$\text{Total Alkalinity (mg/L)} = \frac{\text{(mg's) of H2SO4 “50” 1000}}{\text{ml of sample taken}}$$

- Will compute dissolved oxygen using a dissolve oxygen meter (DO).
- The EPA's heavy metals approach is determined using Pakistani WHO (World Health Organization) strands.

WATER QUALITY

YSI 556 multi-probe sensors were used to measure the surface water quality parameters in-situ, such as pH, dissolved oxygen (DO), temperature (°C), and salinity (%) (mg -1). Yellow Springs, Ohio, USA-based YSI Inc. The (surface) water samples were collected from the surface (about 500 ml), put in plastic bottles, and then kept in the ice box for laboratory testing. Hydrogen chloride (HCl) was added to the bottles to stabilize the organic carbon (at pH 2). Every sample of water was put through a tiny glass filter paper in the lab before being analyzed for nutrients, S2, metals, and TOC using spectrophotometers (ICP-OES, Varian Vista-Pro, USA), TOC analyzers (Shimadzu, TOC-VCPH, Japan), and spectrophotometers (spectrophotometers). Chlorophyll-a (Chl-a) estimation was done using the filter paper.

Sediment Characteristics

In situ pH (DM-13 Takamura Electric Works, Japan) and soil temperature (lab thermometer, sensitivity: 0.2 °C) measurements were taken during the fieldwork. Using a transparent 30 PVC pipe of 1 m length, the depth above the anoxic sand layer (black in colour), which was driven into the soil, was calculated as the moisture depth at each location (pre-marked up to 50 cm). Additionally, a separate portion of the sediment (100 g) was taken (with a hand shovel) from each location for laboratory testing (e.g., grain size, metals, TOC). A set of sieves (63 mm were used) and ICP-OES analysis were then used to separate all of the samples into different fractions after they had been dried in an oven for 3 days (at 45 °C). The TOC was calculated using a TOC analyzer.

Preservation and Identification

Numerous male crabs were captured since they are necessary for the taxonomy of crabs. Samples were given numbers and stored in a 10% formalin solution for identification.

Then, in the laboratory, for long-term preservation, in 70–95 percent ethanol (Shukla et al.,2013). Used the identifying key created by Brandis and Sharma (2005) along with the identifying key created by to determine their identification (Alcock 1909).

Figure: 2.6 Preserved crabs inside Formalin

Diversity and physiochemical variable

The fresh water crab variety under the five places was determined by collecting the fresh water crabs from the streams beneath each location within the study area. In order to assess the diversity, the following metrics were used: species richness (the total number of species under each geog), abundance (the total number of individuals belonging to the same species), and the Shannon Diversity Index (H =-Pi*ln Pi) (McGinley, 2014).

Specimen Identification

Then, they were brought into the lab where a Varner calliper with a resolution of less than 0.05mm was used to measure them. A digital microscopic camera was used to take pictures of the specimen's early gonopods (G1) in order to determine the species of crab. The keys provided below were used to determine the crab's species.

Figure: 2.7 Measurement of preserved crab and specimen identification

STATISTICAL ANALYSES

The differences between the biological and environmental parameters evaluated were determined using One-Way ANOVA, and Principal Component Analysis (PCA) was performed to examine the percentage (%) fluctuation of the environmental parameters in connection to T. gigas egg counts (root-transformed data) (Clarke & Gorley, 2006). To understand how local environmental factors, affect T. gigas nesting sites, PRIMER v.6's BEST statistical approach, which combines BIO-ENV and BVSTEP procedures, was employed. In this case, the helpful environmental characteristics were determined using the global BEST match test (with a choice of 99 permutations).

RESULTS

Monthly C.P.U.E. data for the five study stations have been calculated (Table 1). The C.P.U.E values never remained constant; rather, they changed from station to station and throughout the course of the year. It is obvious that stations 1 and 4 recorded greater C.P.U.E values, whereas stations 2 and 3 reported lower values. Additionally, C.P.U.E. values change frequently. However, smaller ones were noted with a minimum value (C.P.U.E = 3) during the wet season (from February to July). In fact, higher values up to a maximum of C.P.U.E. 41.25—have been recorded during the dry season (from August to January).

Table 1 displays the values of the hydro morphometric variables collected from the five study stations.

Table: 1 *P. algeriense* catch values per unit effort were calculated at 5 locations along the Zegzel watercourse.

Period	Station 1	Station 2	Station 3	Station 4	Station 5
Wet period (February–July)	19.5	2.75	3	17.25	13
Dry period (August–January)	24.25	16.5	10.75	41.25	19

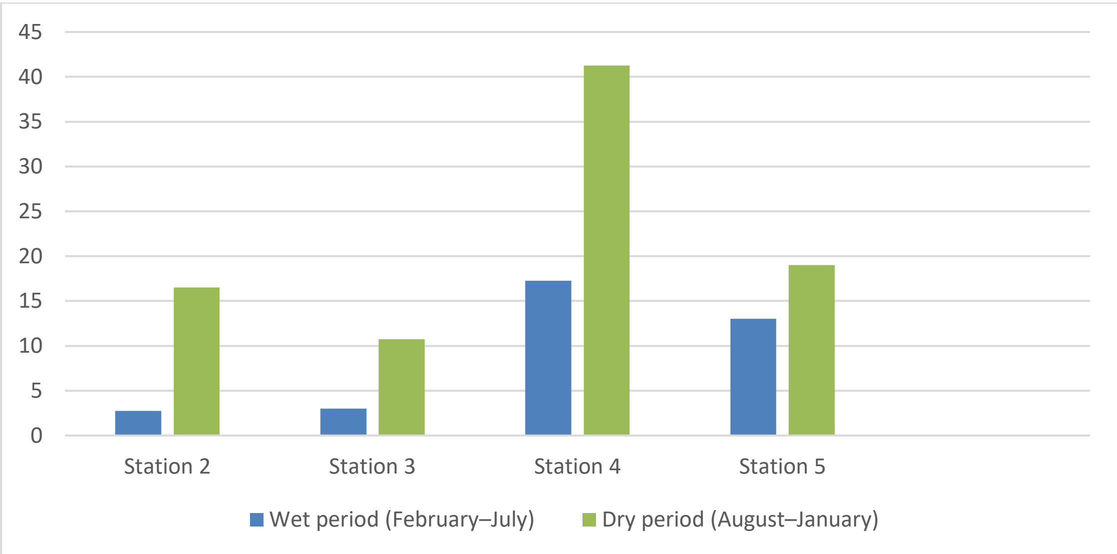

Figure: 4.1 *P. algeriense* catch values per unit effort were calculated at 5 locations along the Zegzel watercourse.

Station S1 is the deepest station, with an average depth of 0.48 0.31 m. Despite this, Station S2 is the shallowest, with an estimated mean depth of 0.33 0.11 m. The largest station is S4, which has an average width of 9.02 0.57 m, while the smallest station is S1, which has an average width of 3.45 0.14 m.) At station S3, the highest speed readings (1.06 to 1.08 m/s) were recorded. The slowest average speed was at station S1 (0.26 0.24 m/s), nevertheless. The mean streamflow varied significantly from station to station, with values ranging from 0.04 0.02 m3/s at station S1 to 0.36 0.44 m3/s at station S3.

The 13 physical and chemical factors were examined over the study period to determine how they affected the distribution and abundance of P. algeriense in the Zegzel watercourse. Abiotic factors may also affect the distribution of freshwater crab biodiversity in the past and future, additionally to the important controlling factor of global climate change. Physical and chemical aspects of the environment have a direct impact on variety, oxygen consumption, growth rates, metabolism, moulting frequencies, hormones, and crustacean survival.

Table: 2 Relationships between variables and streamflow, depth, width, or speed.

Stations	Variable			
	Width (m)	Depth (m)	Speed (m/s)	Streamflow (m3/s)
S1	3.45 ± 0.14	0.48 ± 0.31	0.26 ± 0.24	0.04 ± 0.02
S2	4.57 ± 0.26	0.33 ± 0.11	0.81 ± 0.91	0.22 ± 0.28
S3	6.24 ± 0.17	0.39 ± 0.15	1.06 ± 1.08	0.36 ± 0.44
S4	9.02 ± 0.57	0.42 ± 0.05	0.62 ± 0.63	0.25± 0.37
S5	5.62 ± 0.67	0.41 ± 0.09	0.43 ± 0.53	0.21 ± 0.34

They must also keep track of how other environmental variables affect them because environmental factors have an impact on the majority of aquatic life in some bodies of water. Table 3 displays the variation in mean environmental factors throughout the geogs of the study area. In cites 1 and 4, temperatures ranged from 22°C to 31°C, while pH values were between 8.3 and 8.6. Between 8% and 41% of the area was covered by canopies. The depth and width of the river were also measured as part of the research on crab diversity and habitat utilization. The width of the stream ranges from 3.3 to 4.2 meters.

Table: 3 Mean range of environmental variables of stream.

Parameters	Cite 1	Cite 2	Cite 3	Cite 4	Cite 5
Altitude (m)	518	348.8	357	342.6	265
Stream Width (m)	4.1	2.4	2.5	2.6	3.4
Stream Depth (cm)	16	14.25	14	16.52	7
Temperature (°C)	23	32	21.0	21.24	20
pH	7.3	7.6	8.5	8.6	8.6
Canopy Coverage %	26	7	31	37	41

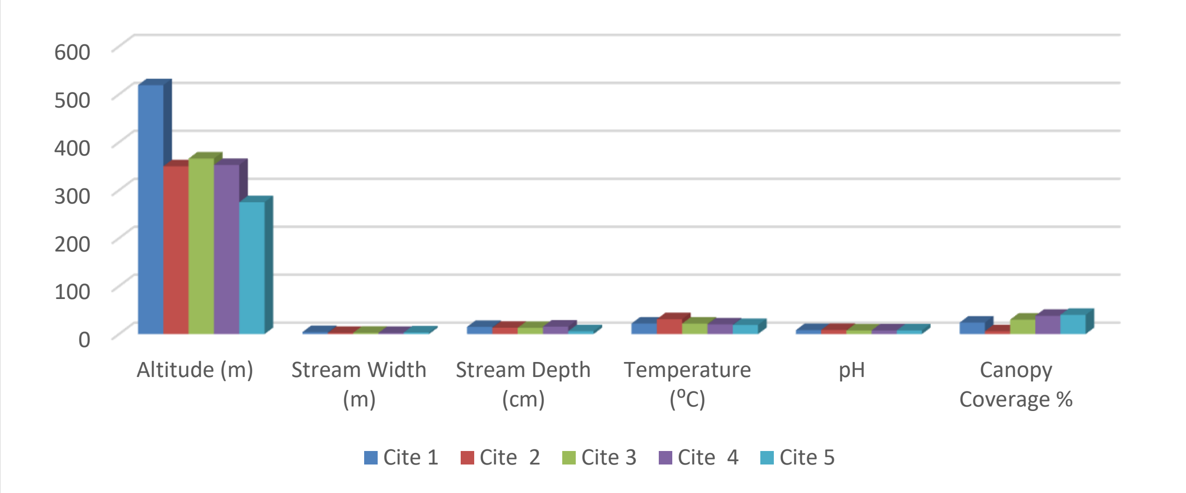

Figure: 4.2 Mean range of environmental variables of stream

DISCUSSION

The study region includes the District Kachhi (Bolan) in Balochistan's mountains. Gecarcinucidae and Potamidae families dominated the stream that was sampled. The total number of specimens obtained includes two species from the family Gecarcinucidae and three species from the family Potamidae. There were 142 freshwater crabs total, with Maydelliatelphusa lugubris accounting for 64% of the total (n=91). It is consistent with the discovery of that they were found at all five places between 142 and 780 meters above sea level (Brandis & Sharma 2005).

The least prevalent species (n=2) were Himalayapotamon atkinsonianum and Trichopotamon sikkimense, which combined for 2.11% of the species. The total number of specimens obtained includes two species from the family Gecarcinucidae and three species from the family Potamidae. Of the 142 fresh water crab samples, Maydelliatelphusa lugubris was found to be the most abundant 64% (n=91). The two species with the lowest prevalence, Himalayapotamon atkinsonianum and Trichopotamon sikkimense, made up 2.11% of the species (n = 2). In the current study, five species of freshwater crabs belonging to three genera were identified. The distribution of Maydelliatelphusa lugubris and Liotelphusa quadrata was discovered to be more widespread. At 456 MASL, Trichopotamon sikkimenses was discovered, below the range of its typical habitat as described by. It might represent a new habitat for this species. But more research is needed to corroborate this species' habitat range because it cannot be demonstrated by the current study alone.

Due to their environmental preferences—they prefer higher elevations given that they are a species with Eurasian origins—the Potamid crabs are less common than other species. However, because they came from Indian plates, gecarcinucid crabs are found at lower elevations (Klaus et al., 2014). The current study location doesn't have significantly higher elevation ranges, which may be why there are fewer Potamid fresh water crabs there than Gecarcinucids.

Due to the fact that Maydelliatelphusa lugubris and Liotelphusa quadrature were detected at every location within the study area, these two species were deemed to have the most diversified range. In locations 1, 2, 18, 15, 4, and 5 (n = 41), Maydelliatelphusa lugugubris was the most prevalent species, followed by Liotelphusa quadrata in spots 1, 2, 16, 3, 4, and 5 (n = 3). Only site 1 was visited throughout the study period, when Trichopotamon sikimneses (n = 2) and Himalayapotamon physetum (n = 5) were discovered. At position 4, a solitary male Himlayapotamon atkinsonium (n=1) was also found. According to the findings of a statistical test, the study region had the highest overall diversity of fresh water crabs in spot 1 and the lowest overall diversity in spot 5, but there was no obvious difference between the two.

The distribution of freshwater crabs will also be better understood with the use of the information provided by this study. Since Liotelphusa quadrata and Maydelliatelphusa lugubris were the most prevalent species and were found in nearly every stream sampled within the study area, this study's analysis of the fresh water crab distribution pattern shows that these two species, which belong to the Gecarcinucidae family, have a larger habitat range than other fresh water crabs. The results further support the notion that Gercarcinucid crabs are generally lowland species with widespread distribution.

Due to opportunistic foraging by some of the main predatory fishes, there is a significant geographical and temporal variation in blue crab intake. Fish stomach contents often include blue crabs, but the percentage that blue crabs comprise of stomach contents is often low and only occasionally high (Guillory & Elliot 2001).

Crabs and other crustaceans respond to variations in water temperature by altering the timing and frequency of moults, as well as their growth rates, size at maturity, spawning season, larval development, and survival. Productivity will be limited after these shifts approach their temperature thresholds because one or more environmental factors could make reproduction unsuccessful (Green et al., 2014).

CONCLUSIONS

The aim of this study was to collect baseline information for subsequent investigations into Pakistani freshwater crabs. Further research is required because the current study cannot confirm the habitat range of this species. No statistically significant changes in the region's diversity and richness were found, according to statistical research. This study will also help us better understand how freshwater crabs propagate. Environmental factors appear to have a negligible impact on the diversity and abundance of species, indicating that crabs do not. Additionally, it may be inferred that in addition to biotic factors like reproduction, food availability, and predation, numerous environmental factors may also have an impact on the population and distribution of freshwater crabs. The risk crab population can be significantly decreased by keeping oneself clean, restricting the discharge of industrial waste, using safe water, especially before handling food, and avoiding contaminated/unsafe drinking water.

ACKNOWLEDGMENT

We gratefully acknowledge and thankful to my supervisor Dr. Ghulam Dastagir and my friend Mr. Sana Ullah who helped me in my research work. Without their help it was impossible for me they supported me shoulder by shoulder in the whole research work.

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