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DIVERSITY AND DISTRIBUTION OF TERRESTRIAL GASTROPOD FAUNA (SNAILS AND SLUGS) OF LORALAI DIVISION, BALOCHISTAN PROVINCE, PAKISTAN

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Abstract

In this study we describe the Diversity and Distribution of Terrestrial Gastropod Fauna (Snails and Slugs) of Loralai Division, Balochistan Province, Pakistan, that how Diversity and Distribution of Terrestrial Gastropod Fauna (Snails and Slugs) are affected from change in climate or what is the present status. As native terrestrial snails and slugs are poorly studied and understood in Balochistan Province. The study was conducted during the period of March 2022 to March 2023 from the Loralai divisions. Specimens will be collected and preserved randomly from the soil, vegetation, gardens, humid and shaded places of each selected sites and will preserve in 70-80% ethyl alcohol in specimen bottles. A total 592 individuals of snails and slugs (Gastropods) "were sampled and examined. The gastropods were dominant in all" areas of the Loralai divisions. A total of five species were recorded from eight sampling sites during the study period which are B. similaris, M. sequax, Z. insularis, A. gracile, Z. detrita. These taxa were represented by a class Gastropoda; two orders viz., Stylommatophora and Pulmonata; five families and five genera. Seasonally, the species richness showed its highest value during Summer, followed by Spring, then Autumn, whereas the least catch was recorded in Winter in all studied sites. "The high value of soil pH was reported by in September to which present finding showed dissimilarity. Soil organic carbon and soil organic matter ranged (0.94 - 1.88) % and (1.70 - 3.24) % with maximum content of Soil Organic Carbon (SOC) and Soil Organic Matter (SOM) in site-5 and minimum in site-8". It was Concluded that among the ten sites, Given the number and diversity of gastropods, it is clear from this study that there is an important suggestion between the distribution of gastropods and sediment quality.

Keywords: Diversity, Gastropod Fauna, Snails, Slugs, Loralai, Balochistan.

Introduction

Fish Gastropods are a group of invertebrate animals that include snails, slugs, of phylum Mollusca (Gerdol *et al*.,2018). They are found in almost every habitat, from terrestrial to freshwater and marine environments. A variety of ecosystems, including woods, grasslands, deserts, and wetlands, are home to terrestrial gastropods, also referred to as land snails and slugs (Nekola *et al*.,2018). There are over 40,000 known species of terrestrial gastropods, making them one of the most diverse groups of animals on land (Proios *et al*.,2021). They vary greatly in size, shape, and color, and exhibit a range of behaviors, from herbivores to predators, and from burrowers to climbers. Numerous elements, such as climate, soil, vegetation, and human activities, have an impact on the distribution of terrestrial gastropods. In general, they are more abundant in moist environments, such as rainforests and wetlands, than in dry environments, such as deserts and arid grasslands (Neubert *et al*.,2019).

Many gastropod species are threatened by habitat loss, climate change, and other human activities. Invasive species, habitat degradation, and climate change all pose serious risks to the terrestrial gastropod fauna, which is causing population sizes and biodiversity to fall (Dhiman *et al*.,2020). The distribution of gastropods is likewise anticipated to be significantly impacted by climate change, as changing temperature and precipitation patterns alter their habitat suitability. Terrestrial snails and slugs can cause major damages to soft vegetables, fruits, and flowers indicated by contact and as ingesting roots, seeds and tubers during growing or after sowing (Sallam, 2012).

Slugs, on the other hand, do not have a shell, and their bodies are generally more streamlined and elongated than those of snails (Stanisic 2022). Another interesting feature of young slugs is their ability to regenerate body parts. They can regrow lost body parts, tentacles, and even their entire body if necessary. This ability has been studied extensively by scientists, who hope to learn more about the mechanisms of regeneration and apply this knowledge to human medicine (Fellowes 2020).

Both snails and slugs are gastropod mollusks that can be found in a range of settings, such as forests, fields, gardens, and aquatic areas (Nurinsiyah *et al*.,2016). Snails and slugs are crucial members of the ecosystem because they breakdown dead organic materials and recycle nutrients (Bagyaraj *et al*.,2016). They also serve as a food source for other animals, such as birds, rodents, and snakes. Additionally, some types of slugs and snails are herbivores that eat plants and regulate plant growth. Snails are also consumed as food in many cultures and are considered a delicacy in some countries. In some areas, snail farming is a profitable industry (Ghosh *et al*.,2016).

The gastropods are a group of animals that can crawl through their muscular foot, welldeveloped heads with tentacles, and eyes. Members of this class include slugs, snails, and limpets (Cuezzo *et al*., 2020). Within the Phylum Mollusca, members of Class Gastropoda are the

most diversified and, possibly, most successful group (Kocot et al., 2022). The rainy summer season are favourable for the richness of snails (Hailegebriel *et al*.,2022). The variety of factors, including the vegetation type, quantity of soil humidity involves in the attraction of snails (Sikder & Vestergård 2020). The extensive existence of terrestrial gastropods is clear indication of their successful adaptation to diverse surroundings. They inhabited most terrestrial environment extending from low lands to highlands, humid to arid environment of warm and cold areas (Magnin *et al*.,2022).

Terrestrial snail occurrence and distribution are significantly influenced by temperature and moisture. They play an important role in the disintegration of litter, the uptake of soil calcium concentration, and as a source of food for other animals, but they also tend to have short lifespans (a few months to a few years), which makes them excellent bio indicators (Altaf *et al*., 2017).

Staley et al., (2017) reported that about 35,000 species are currently known to exist worldwide, and they have almost taken over all land-based habitats. According to Nurhayati *et al.*, (2021) that the diversity and abundance of terrestrial snail species found on the Mount ArjunaWelirang, East Java slopes of Indonesia. Olusi *et al.*, (2021) collected 70 giant African land snails (*Archachatina marginata*) from different sites of Akure metropolitan area of Nigeria. Sharmin *et al., (*2019) introduced that Snails and slugs are effective bio-filters that clean water because they eat algae, zooplankton, and diatoms and recycle nutrients and energy by dissolving organic materials.

Khanam *et al.*, (2020) found *Zootecus insularis*, a terrestrial land snail in the marshland areas of Karachi, Pakistan and presented this species as the first locality record in the selected areas. Pokryszko *et al*., (2009) reported that there are 51 pupilloid species (Pupilloidea sensu lato, i.e. including the Enidae) on the checklist of Pakistan's snails, with the ends accounting for the majority of the fauna with an estimated 32 species. Kakar *et al*., (2020) were surveyed fourteen different sites of Balochistan province for the search of terrestrial snail fauna and found five land species including the *A. gracile,B similaris, M. sequax, Z. insularis*and *Z.detrita*. Though, the *Z. insularis* was revealed a wide spread dispersal among them while the *Zebrina detrita* was showed least distribution and recorded from only site.

Materials and Methods

Study Area/ Study Design

The study was carried out from the Loralai divisions between March 2022 and March 2023. Although, the study area of terrestrial gastropod fauna comprises of Loralai, Musakhail, Barkhan and Duki districts of Loralai division respectively.

Figure 1: Map of Loralai division Province Balochistan

Collection and Preservation of Gastropod fauna

Samples will be randomly taken from the soil, vegetation, gardens, humid, and shaded areas of each chosen site and preserved in specimen bottles with 70–80% ethyl alcohol. Each site will have between 500 and 592 samples collected. Additionally, the habitat and other ecological traits will be noted. On the same day or the following day, the collected specimens will be delivered to the zoology department's central laboratory for full description.

Figure 2a: Collection of terrestrial Snails fauna

Figure 2b: Collection of terrestrial Slugs fauna

Figure 3: Preservation of Gastropod fauna in Laboratory Collection of five land Snails fauna

the five land Snails species which are *B. similaris, M. sequax, Z. insularis, A. gracile* and

Z. detrita and their number were mentioned in (Table 1 and figure 4) from different regions of the Loralai division's such as (Pathankot, Loralai City, Sagar, Mekhtar, Old Duki, Rabat, Luni, Kingri, Rarasham, Barkhan, Bughawo and Rakhni) which includes the *B. similaris* (09) species, *M. sequax (07)* species, *Z. insularis (06)* species, *A. gracile (05)* species and *Z. detrita (06)* species.

Table 1: Distribution of terrestrial snails in different sampling regions of Loralai division

Regions	***B. similaris***	***M. sequax***	***Z. insularis***	***A. gracile***	***Z. detrita***
Pathankot	+	_	_	_	+
Loralai City	_	+	_	+	_
Sagar	+	+	+	_	+
Mekhtar	+	_	+	+	_
Old Duki	_	+	+	+	+
Rabat	+	_	_	_	_
Luni	+	+	+	_	+
Kingri	+	+	+	+	_
Rarasham	+	_	_	_	+
Barkhan	_	+	_	+	_
Bughawo	+	_	+	_	_
Rakhni	+	+	_	_	+
Total	**09**	**07**	**06**	**05**	**06**

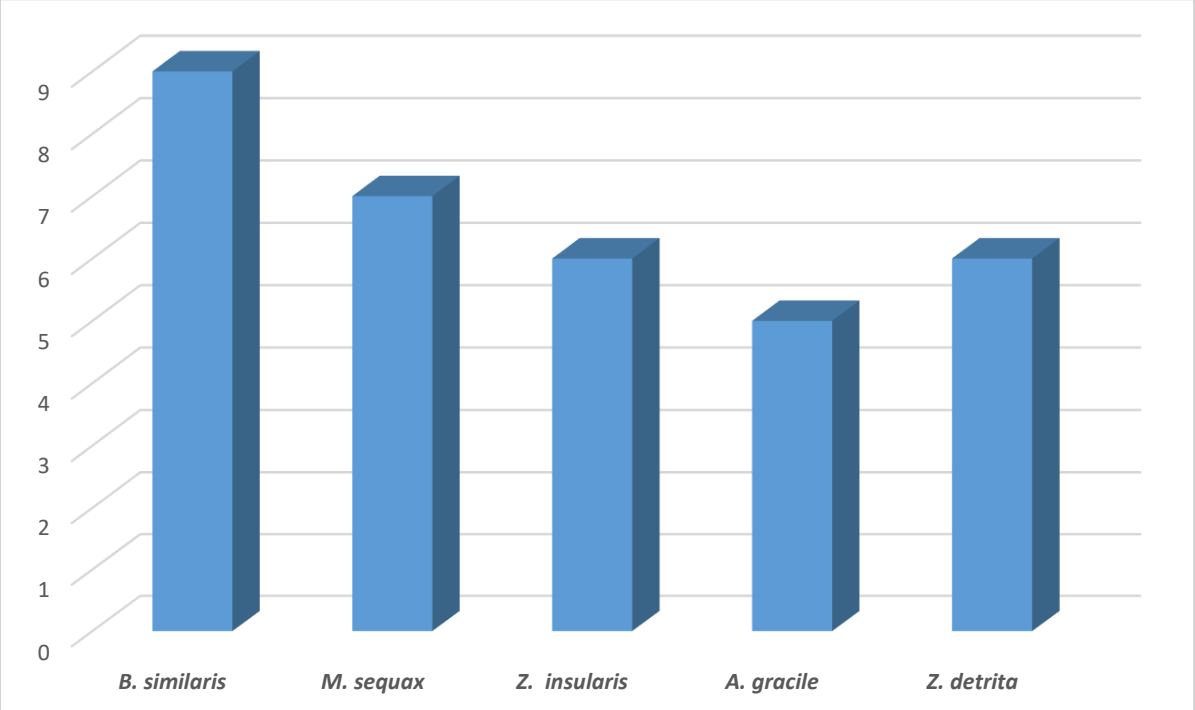

Figure 4: Distribution of terrestrial snails in different sampling regions of Loralai division

Identification of terrestrial gastropod Fauna

The properties of a land snail's shell, including its size, shape, color, decoration, and coiling, will be used to identify it (figure 5a and figure 5b). The size and shape of the umbilicus, the number of whorls, and the size and shape of the aperture (Sinistral /dextral) further distinguish them from one another. The whorls may also be rounded, angular, or keeled. Moreover, the Spire's dimension, size, and shape. the Opercula's (trap doors) presence or absence, as well as their design. Apex size, form, and narrowness or depth of the suture. Position, form, and perforation of the columella. Periostracum-coloured, patterned (ridged, striated) outer coating. A morphometric parameter will be taken together with the tentacles' position relative to the eye.

Visual identification involves examining the physical characteristics of the gastropod, such as shell shape, size, and colour, to determine its species. A field guide or identification key specific to the region or habitat can be useful.

- Dissection of the gastropod can reveal internal structures and characteristics that can aid in identification.
- DNA analysis can provide more accurate identification of gastropod species, especially when distinguishing between closely related species.
- Expert consultation and consulting with a specialist or expert in gastropod taxonomy can be helpful in identifying difficult-to-identify species.

Species will be recognized using a stereo binocular microscope. Vernier calipers will be used to take measurements, while digital cameras will be used to take pictures.

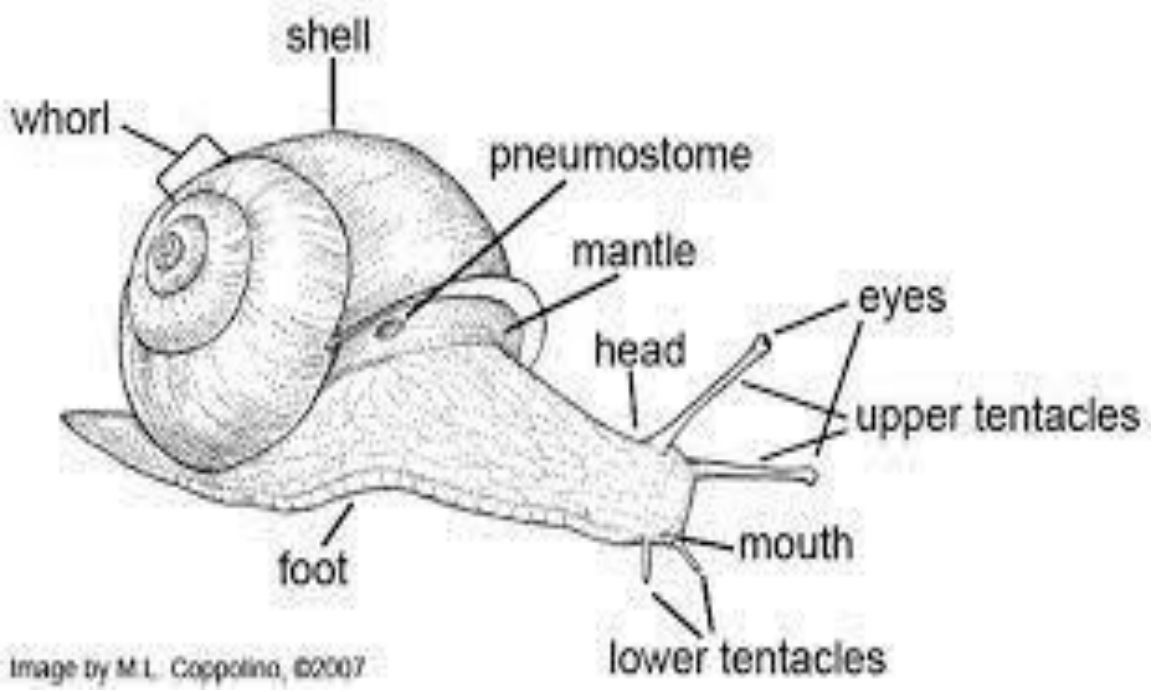

Figure 5a: Identification of terrestrial snails

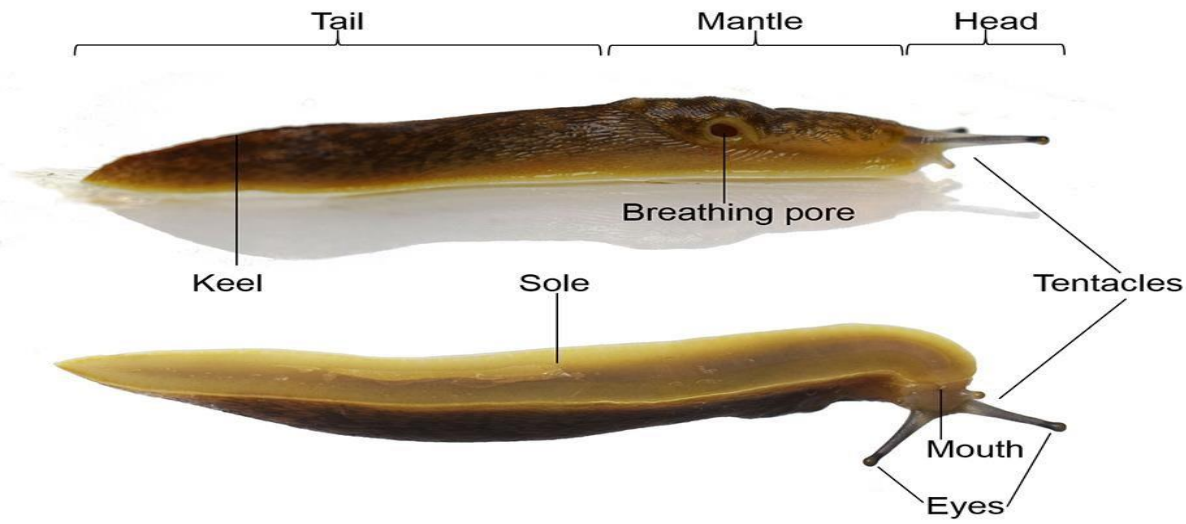

Figure 5b: Identification of terrestrial slugs

Data analysis

The diversity and distribution of gastropods will be recorded for each species of snail and slug's location. Data will be analyzed by applying one-way ANOVA and P-Value< 0.05 using the computer programmed SPSS version.19.

To determine distribution ranges (D) of Gastropod species, Equation will be used.

$$D = \frac{n}{N} \times 100$$

Where in this Equation, "n" is the locations number where a specific category will present, whereas "N" is the total number of all investigated stations.

Result

A total 592 individuals of snails and slugs (Gastropods) were sampled and examined. In every area of the Lorelai, the gastropods dominated. During the study period, a total of five species *B. similaris, M. sequax, Z. insularis, A. gracile*, and *Z. detrita* were discovered at eight sample sites. Gastropoda, a class, two orders (Stylommatophora and Pulmonata), five families. Seasonally, the species richness showed its highest value during Summer, followed by Spring, then Autumn, whereas the least catch was recorded in Winter in all studied sites.

Quantitative analysis of land snails and slugs (Gastropods)

It involves measuring and analysing their population sizes, distributions, and other characteristics in a systematic and quantitative way. This type of analysis can help scientists and conservationists better understand the ecology and conservation status of these important organisms.

Sediment quality

Seasonal and regional variations in soil characteristics were barely apparent. The percentages of sand, silt, and clay were respectively 18.65-42.16, 36.15-49.25, and 21.59-34.8%. Sand particle percentage was highest in sites 5 and 6 and lowest in sites 1 and 2, while silt concentration was highest in site 3 and lowest in site 4, and clay concentration was highest in site 5 and lowest in site 7. During the winter, the pH of the soil fluctuated from (6.3-7.3), with the minimum pH being at site-2 and the maximum pH being at site-4. In September, it was stated that the pH of the soil was high, and the current finding differed from that. In terms of SOC and SOM content, sites 5 and 8 had the highest and lowest values, respectively, ranging from 0.94 to 1.88 and 1.70 to 3.24 percent. The results were partially corroborated by the spatial distribution of soil attributes in the current investigation (Table 2 and figure 6).

Table 2: Relationships Between Various Sediment Parameters with The Abundance of Gastropods Species

Gastropod species	Soil pH	Soil Organic Carbon (SOC)	Soil Organic Matter (SOM)	Sand (%)	Silt (%)	Clay (%)
B. similaris	0.39	0.63	0.64	0.38	-0.48	-0.44
M. sequax	-0.26	-0.72	-0.72	-0.29	0.43	0.41
Z. insularis	0.59	0.79	0.79	0.66	-0.51	-0.56
A.gracile	0.44	0.46	0.48	0.82	-0.58	-0.55
Z.detrita	-0.49	-0.27	-0.48	-0.71	0.48	0. 59

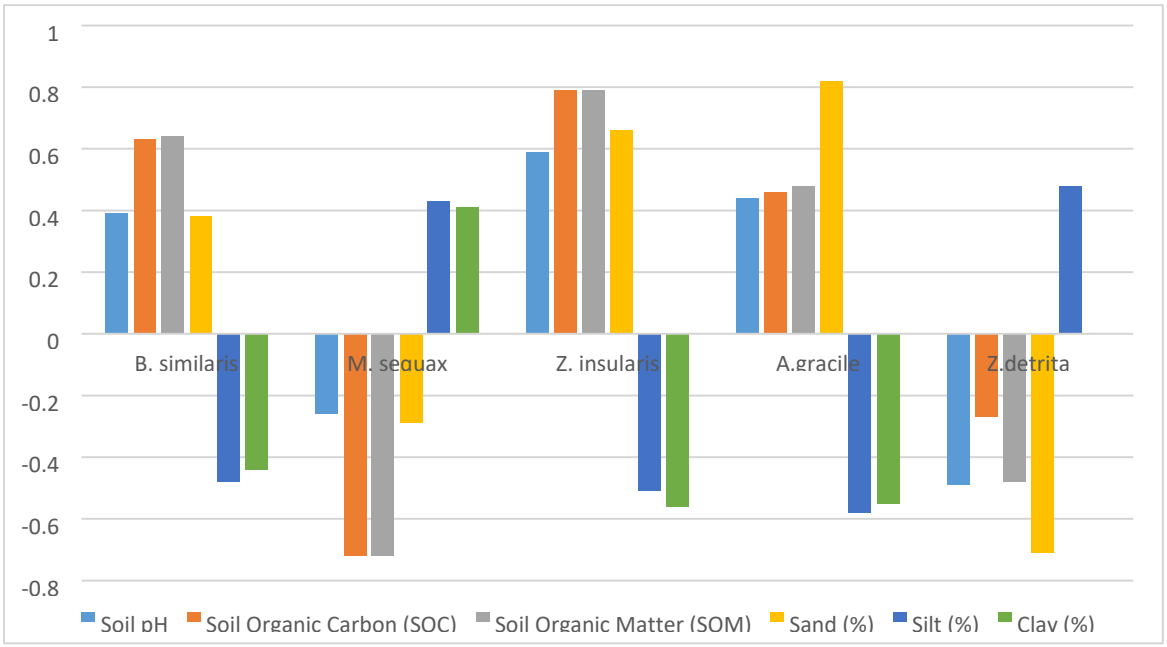

Figure 6: Relationships Between Various Sediment Parameters with The Abundance of Gastropods Specie

Distribution of snails in different months

The monthly distribution of the (Table 3 and figure 7) shows that the highest number of *B. similaris*, 39, was found in the month of July, and the lowest number, 6, was discovered in the month of March. There were 26 cases of *M. sequax* discovered in July, 27 in June, 11 in April, and 8 in March. The average maximum temperature and average minimum temperature were highest in August, followed by July, when the relative abundance of snails and slugs peaked at 19%. By contrast, in May, when these temperatures were lowest, the relative abundance of snails and slugs was only 9%.

Table 3: Distribution of Gastropod (Snails) In Different Months

Species/Habitats	March	April	May	June	July	August	Total
B. similaris	6	12	20	25	39	37	139
M. sequax	8	11	22	27	26	30	124
Z. insularis	4	9	18	8	30	29	98
A.gracile	12	8	11	7	33	23	94
Z.detrita	7	20	17	24	39	30	137

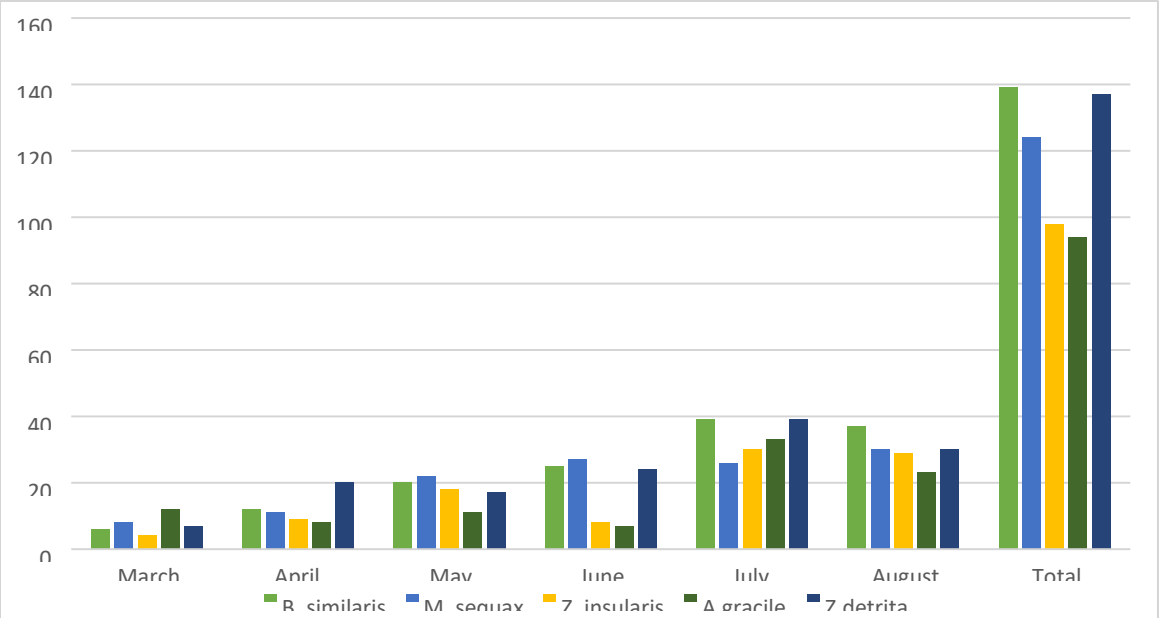

Figure 7: Distribution of Gastropod (Snails) In Different Months

Discussions

The findings showed significant differences in the ecological indices (constancy index, relative abundance, specific and mean richness) between the chosen study locations and an important diversity of the malacological fauna in the Loralai divisions, particularly in the city of Loralai. Furthermore, it was discovered that the soil at the Loralai division site had low porosity and permeability, high organic content, and a large field capacity. The findings point to the importance

of these characteristics in influencing the diversity of terrestrial gastropods in Loralai divisions, however we cannot completely rule out the possibility that other environmental factors are equally significant. Land snail and slug biodiversity and distribution are influenced by a number of variables, including soil properties, climate variables, anthropogenic disturbances, and vegetation.

Global protection of the biodiversity of gastropods is required, according to numerous research (Dedov *et al*., 2018). Recently, some inventories of terrestrial gastropods in various biotopes were conducted in Algeria (Ramdini *et al*., 2021). There are over 100 species of terrestrial gastropods (snails and slugs) recorded in Balochistan. These species can be found in a range of settings, such as mountains, woodlands, and deserts. (Budha *et al*.,2015). According to Coppolino (2010) that terrestrial snails and slugs are often overlooked as a subject of study, despite being important components of many ecosystems. Snails and slugs are often nocturnal or hide during the day, making them difficult to observe in the wild (Glaeser & Abed-Navandi 2023). Schilthuizen *et al*., (2003) reported that since it is generally known that land snails require a large amount of calcium for the development of their shells and eggs, it follows that soil calcium content and snail abundance are correlated.

Conclusions

According to the associations found in this study, it is evident that there is a close concord between the distribution of gastropods and sediment quality at the eight sites where the density and diversity of gastropods were examined. The ecological status of water bodies may be significantly impacted by the low snail population. Therefore, continuous abundance, variety, and conservation of these locations for migratory birds require long-term gastropod monitoring. By keeping oneself clean, the risk of the terrestrial gastropod (snails and slugs) population can be considerably reduced, restricting the discharge of industrial waste, using safe water, especially before handling food, and avoiding contaminated/unsafe drinking water.

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