Diversity of Praying Mantises (Insecta: Mantodea) in Buner Pakistan

Khalid Khan[1], Kausar Saeed[1] , Zain Ali[1], Sajjad Ali[1],Khan Niaz khan[2],Fawad Ali[3]
Khushnuma Azim[4], Israr Alam[1]

[1]Department of Zoology University of Buner, Pakistan
[2]Department of Biology, Edwardes College Peshawar, Pakistan
[3]Institute of Biotechnology and Microbiology Bacha Khan Unversity Charsadda, Pakistan
[4]Department of Zoology, Qurtaba University Peshawar, Pakistan

Corresponding Author: Kausar Saeed

Abstract

Mantids are one of the top predatory insects groups due to their ability to camouflage and specialized raptorial fore legs. Current study was conducted on diversity of mantids by using visual encounter and light trapping method. Seven different habitats were searched and 17 species under 15 genera and 6 families were reported. Some of the species were widely distributed in studied habitat while few species preferred to a specialized habitat. Highest species richness were recorded in maize crop and shrub layers while the lowest were recorded in canopy layer and wheat crops. In addition to the Mantodean fauna of Pakistan, we reported 03 new families to the Mantodean fauna of Pakistan. Among Mantodea, the family Mantidae dominated with (09 genera and 10 species) followed by Hymenopodidae (2 genera and 2 species).

Keywords: Specie Richness, Diversity indices, Mantids, KPK, Pakistan.

Introduction

Praying mantises belongs to most fascinating and colorful group of insects and are well known to mankind. About 2400 praying mantis species were discovered globally, under the 25 families while 1261 species were described from Indo-subcontinent (Otte &

Spearman 2012; Panhwar *et al*., 2020). Additionally, they play vital role in ecosystem; act as predator of numbers of prey and used as biological control agents to control pest populations (Shar and Panhwar, 2020). Mantids are one of the top predator groups due to their camouflage and mimicry (Pashaie Rad, 2017) and having highly specialized raptorial forelegs. The species are globally distributed in warm, tropical, subtropical and temperate regions (Hurd 1999; Rivera 2010). Although continental endemism is common while certain groups; such as the bark mantises (Liturgusidae), had wide distributions (Svenson & Whiting, 2009).Study on mantids got less attention however some taxonomic studies were reported by Rivera et al., 2011; Roy and Stiewe, 2011; Menezes abd Bravo, 2012, 2013, 2015; Roy, 2015; Lambardo et al., 2015Agudelo and Rafael, 2016). Mantids fauna of India were reported with 174 species under 11 families (Chandra, 2011; Chand and Das, 2018; Ahmed et al., 2021; Patel and Singh, 2016; Chhapekar et al., 2021). Primary studies and some species addition from Pakistan were reported by Murray (1880), Uvarov (1931; 1992) and Wagan et al. (1995). Khokhar (2017) reported five species from KPK, Pakistan.

Pakistan have a wide range of habitats and diverse ecological niches to support mantids populations but however the complete checklist and diversity of mantodae in the country are still unexplored and this area of study required attention to draw the complete checklist and to initiate community awareness toward pest biological control instead of pesticides. The current study was designed to study the diversity, species richness and habitat preference of prey mantids in District Bunere, KPK, Pakistan.

MATERIALS AND METHODS

3.1 Study area

Buner is the district of Malakand division (Khyber Pakhtunkhwa) which is mostly hilly areas. It is surrounded by Swat in north, Malakand agency in west, Shangla in east and Swabi and Mardan in south. Buner lies between 34-09 and 34-43° N latitude and 72-10 and 72-47° E longitude (Saeed *et al*., 2013).The district comprises a mountainous valley, having an area of 1865 m^2. Altitude of the area varies from 400 m at Totalai in south to 3500 m, at Dosaray peak in the north at Swat border (Rahman *et al.*, 2022). Study area is divided into six tehsils named Tehsil Daggar, Tehsil Gadezi Tehsil Mandanr, Tehsil Khadukhel, Tehsil Gagra and Tehsil Chagharzi. The areas of District are plain, undulating land and mountain slopes. The plain and undulating areas are lying on the lower elevation and mountain slopes with barren rocks are on higher elevation the hydrology of the district Buner is covered by seasonal streams (Ali, 2020).

Study Design

The study was design at all six tehsils of District Buner, from first week of March 2022 to last week of October 2022. Day and night surveys were conducted to collect specimens. Visual encounter surveys were conducted in three different habitats; agricultural lands, urbanized areas and natural sites at each tehsils. The vegetation of natural sites were divided into three layers; under story, shrubs layer and trees or canopy layer. Two main crops were cultivated; Wheat and maize while some areas have Orchard Plantation. During day time surveys, visual encounter method were used in all habitat niches(Khokhar, 2017) while light trapping method were used in agriculture sites and

natural sites during night time surveys(Helmkampf *et al*., 2007; Ling, 2011; Musi, 2017). All surveys were time constrain and search total 158 locations for one hour. Stop watch were used to calculate time and during handling specimens and data writing the stop watch were stop to minimize the error. The light traps were design from a torch and white inverted umbrella. The light traps were set in total 48 locations for 2 hours. All the specimens attracted to light traps were captured, identified and put in a bucket. After two hours the light traps were remove and the specimens were release back, however the few specimens were preserved in jar that did not identified during field.

The collected specimens were killed by means of potassium cyanide or ethanol 70/90% in standard entomological bottles after pinning the specimens they stretched on the stretching board and the attention was paid to the position of antenna, wings and legs in order to display important taxonomic characters. The fully dried specimen removed from the stretching boards and stored in the insect boxes with the labels showing locality, date and collector's name. Further, live samples collected from field were kept isolated in order to avoid their cannibalistic behavior (Fatima *et al*., 2016). Mounting and preservation of specimens were carefully done. Specimens were kept into specific wooden insect boxes and labeled as per standard procedure. Naphthalene balls were used to protect and preserve insects from predators (ants) and fungus (Shar & Panhwar, 2020).

The species were identified by using different keys we. Most of the identification key was taken from (published literature) and Ph.D. Thesis (Khokhar, (2017).Identification was carried by regional taxonomic keys present in the literature.(Fatima *et al*., 2016, Soomro, 2000, Soomro *et al*., 2012, Soomro *et al*., 2002, Shar & Panhwar, 2020,

Battiston *et al*., 2014, Ghahari & nasser, 2014, Pashaie Rad, & Mirzaee, 2017 and Khokhar, 2017).

Statistical Analysis

Data were analyzed by various diversity indices, species richness, Shannon index, evenness and Simpson index.

Shannon Diversity Index:

(H') = - Σ (pi ln pi)

Where pi = proportional frequency of the ith species (Magurran, 1988).

Simpson index:

$D= 1/ \Sigma^{s}_{i-1}pi^{2}$

Evenness Index (E):

E= H/ ln (S)

Where H' is the Shannon Diversity Index and S is the number of species. The data were analyzed by statistical software (Past 3.24). Non parametric test (Mann- whitney test) were used to due to compare both study method.

RESULT

During this research 17 species of Mantids under 15 Genera, 06 families and 05 sub family were reported.Among Mantodea, the family Mantidae dominated with 09 Genera and 10 Species. Family Hymenopodidae dominated with 02 genera and 02 species, family Gonyptidae dominated with 01 genus and 02 species, the other rare families, Amelidae, Liturgusidae, Angelidae contains 01 genera and 01 species respectively. The 03 new families Amelidae, Angelidae, Gonyptidae and 12 species; *Psedumantis*

albofimbriata (Stoll, 1860), *Tenodera sinensis* (Saussure,1871), *Brunneria borealis* (Scudder,1896), *Yersinia mexicana* (Sassure,1859), *Pnigomantis medioconstricta* (Westwood,1889), *Apteromantis aptera* (Fuente,1894), *Gonatista grisea*(Fabricius,1793), *Creobroter pictipanis* (Wood-Mason,1878), *Theopropus elegans* (Westwood,1832), *Angela guianenesis* (Rhen,1906), *Amantis reticulata* (Giglio-Tos, 1915), *Amantis nawai* (Shiraki, 1908) for the first time recorded from Pakistan.

Under stories in natural sites were the most diverse sites in specie richness (Margalef index = 1.726), while lowest values of specie richness were recorded from canopy layer and wheat crops. Highest Shannon-Winner index and Simpson index were record in Shrub layers (H= 2.132) and (1-D= 0.875). When we excluded the canopy layer the highest evenness values were recorded in wheat crop (E= 0.968) while the lowest value were recorded at Orchards plantation (E= 0.623) (Table 3.1). The individual rarefaction curves show the perfect specie curve line in Shrubs layer, maize crops and wheat crops while Orchard plantation have much diverse expectations (Fig 3.1). The samples collected by two methods were analyze by using Mann-Whitney U test, realized that the sum of ranking in the groups were not different (U=0.017, p= 0.98).

DISCUSSION

The current study was conducted on the diversity of Mantodean fauna of district Buner. During this research 17 species of Mantids under 15 Genera, 06 families and 05 sub family were reported. Ten species were reported from agriculture fields at district Howrah, West Bangal, India (Dwari & Amal, 2018). Family Mantidae is dominant family at agriculture areas (Dwari & Amal, 2018; Khokhar *et al*., 2022). The same result found during the current study. Mustaffa, (2019) and Shukla et al. (2018)reported 19 species and 21 species respectively, with dominant family mantidae, accounting for about 53% of total species. The same results were found during this study with 59% species belonging to mantidae of total species.

According to Mukherjee et al. (1995), India has a diverse fauna of Mantids with about 162 species under 68 genera and six families, however due to recent synonymization of some genera like Cimantis Giglio-Tos (with Amantis Giglio-Tos) and Parhierodula Giglio-Tos (with Hierodula Burmeister) and some species like Mantis nobilis Brunner von Wattenwyl [now Statilia nemoralis (Saussure)] the total number of genera and species in India has changed (see Ehrmann, 2002). In addition, recently one more genus, namely Euchomenella Giglio-Tos was added to the fauna of India when a new species, namely E. indica Ghate & Mukherjee, was described (Ghate & Mukherjee, 2004), however 2300 species of Mantids under 434 genera reported globally (Ehrmann, 2002; Zhang, 2013). Specie richness and diversity indices were different in different habitat.

The pitch sizes do not have an effect on population size of mantids (Greyvenstein et al., 2021). We do not search any comparison but however we found that moderate height vegetation have diverse and high population of mantids. Some of the species that were almost widely distributed in studied habitat such as *Tenodera aridifolia* and *Tenodera sinensis* while *Amantis nawai, Theopropus elegans, Statilia maculata* and *Amantis reticulate* distributed in a specific habitats. Most of mantids fauna were captured by visual encounter while some species and mostly males can be capture by light traps method. The current study was conducted for a short time period and we did not collect any data about environmental parameters to find relation of population. Area constrain method is best method to calculate population density and population size but due to short time period we preferred time constrain method.

CONCLUSION

In this research, a total of 480 specimens of Mantodea belonging to 17 species under 15 genera and 6 families reported from district Buner. The Mantodea families are Mantidae, Gonyptidae, Liturgusidae, Angelidae, Amelidae and Hymenopodidae. In addition to the Mantodean fauna of Pakistan, we reported 03 new families to the Mantodean fauna of Pakistan. Mantids are the important component of ecosystem as it act as predator and can widely use as biological control agent for pest population. Pakistan have diverse fauna of predatory insect but due to using of different pesticides and herbicides, populations of biological control agents declining on daily bases. We highly recommended minimizing use of insecticides and chemicals and ensuring the conservation of important fauna of an ecosystem. We also recommend studying the predatory insects and ensuring their use for pest control.

Figures legends:

Figure 2.1. Map of District Buner, KPK, Pakistan.

Figure 3.1 Box plots of Species richness and diversity indices in varies habitats, Wheat crops (WC), Maize crops (MC), Orchard plantations (OP), Understories (US), Shrub layer (SL), Canopy layer (CL) and Urban areas (Ur); (A) Simpson index (1-D), (B) Shannon Winner index (H), (C) Evenness index (E) and (D) Species richness index (Margalef index).

Figure 3.2 Individuals rarefaction curve plot for collected specimens and identified Species (Taxa S) at varies habitats; Wheat crops (WC), Maize crops (MC), Orchard plantations (OP), Understories (US), Shrub layer (SL), Canopy layer (CL) and Urban areas (Ur).

References

Abu-Dannoun, O. and A. Katbeh-Bader (2007)."Mantodea of Jordan." *Zootaxa* 1617(1): 43-56.

Agudelo A. L. Chica (2003) Mántidos de la Orinoquia colombiana: contribución al conocimiento de su diversidad genérica y algunos aspectos bioecológicos (Insecta: Mantodea) Revista Colombiana de Entomología 29(2): 127-136

Agudelo, A. A. and J. A. Rafael (2014). "Genus M antillica W estwood, 1889:rediscovery and review of the A mazonian "ant-mantis"(M antodea: T hespidae: O ligonicinae)." *Entomological Science* 17(4): 400-40

Ahmed, I., Chandra, K., & Gupta, D. (2021). Insecta: Mantodea. *Faunal Diversity of Biogeographic Zones of India: North-East*, 243-247.

Ahmed, J.(2017) "Biodiversity and Biogeography of Mantodea in Pakistan" Mphil and Phd thesis, Department of Zoology University of Sindh, Jamshoro, Pakistan, Pp 1-148.

Akhtar,N. (2018)."Distribution of wild mammalian fauna of Mahaban and Malka Valley District Buner." *Pakistan Journal of Zoology* 50.2.

Ali, B. (2020). "Exploring the Biodiversity of Herpeto Fauna of District Buner."MSc thesis, Department of Zoology, University of Buner. P13.

Barry, K. L., Holwell, G. I., & Herberstein, M. E. (2008). Female praying mantids use sexual cannibalism as a foraging strategy to increase fecundity. *Behavioral Ecology*, *19*(4), 710-715.

Battiston, R., Ortego, J., Correas, J. R., & Cordero, P. J. (2014). A revision of Apteromantis (Mantodea: Mantidae, Amelinae): A comprehensive approach to manage old taxonomic and conservation problems. *Zootaxa*, *3797*(1), 65-77.

Battiston, R., Picciau, L., Fontana, P., & Marshall, J. (2010). *Mantids of the Euro-Mediterranean area*. Verona: *World Biodiversity Association*, 1973-7815(2), 978-88-903323-1-9.

Battiston, R., Picciau, L., Fontana, P., & Marshall, J. (2010). *Mantids of the Euro-Mediterranean area*. Verona: World Biodiversity Association.

Buskirk RE, Frohlich C, Ross KG. 1984. The natural selection of sexual cannibalism. AmNat. 123:612–625.

Cassar, T. (2020). The praying mantises of the Maltese Islands: distribution and ecology (Mantodea). *Fragmenta entomologica*, *52*(2), 341-348.

Chandra, K. (2011). Insect fauna of states and union territories in India. *ENVIS Bulletin Wildlife & Protected Areas*, *14*(1), 189-218.

Chhapekar, S. D., Kolangath, S. M., Sawant, D. S., Chinchkhede, K. H., Pawshe, M. D., & Shalini, A. S. (2021). Diversity and habitat preferences of mantids in Gorewada reserve forest, Nagpur, Maharashtra, 9(5), 302-308.

Dwari, S., & Amal, K. M. (2018). Diversity of mantids (Insecta: Mantodea) of Howrah District, West Bengal, India. *Journal of Entomology and Zoology Studies*, *6*(2), 1038-1042.

Enan, R., GadAllah, S., Okely, M., & Nasser, M. (2017). Historical review of Mantodea occurrence in Egypt with notes about Eremiaphila spp. in the Middle East and North Africa. *Eur J Zool Res*, *5*(2), 25-33.

Fatimah, S., Sultana, R., & Wagan, M. S. (2016). Study on the gender identification of praying mantids (Dictyoptera: Mantodea). *Journal of Entomology and Zoology Studies*, *4*(5), 529- 531.

Fatimah, S., Sultana, R., Khatri, I., Larik, S. A., & Chandio, A. October 2018- September 2021 A review of the Gonypetidae Westwood, 1889 (Dictyoptera: Mantodea) with two new records from Sindh, Pakistan.

Ferro, M. L. (2018). It's the End of the Wood as We Know It: Insects in Veteris (Highly Decomposed) Wood. In *Saproxylic Insects* (pp. 729-795).Springer, Cham.

Ghahari. , M.G. El-Den nasser. , 2014. A contribution to the knowledge of the Mantodea (Insecta) fauna of Iran.Linzer biologische Beiträge; 46, 665-673.

Grimaldi D. 2003: A revision of Cretaceous mantises and their relationships, including new taxa (Insecta: Dictyoptera: Mantodea). Amer. Mus. Novitates 3412, 1—47.

Gul, S. U., Rehman, H. A., Ahmad, N., Din, A., Jawad, M. S., Noureen, S., ... & Ashfaq, M. A. (2017). Medicinal plants feeding insect fauna of district Karak, KP. *Pakistan. Journal of Entomology and Zoology Studies*, *5*(6), 2563-2566.

Handal, E., Al Wahsh, A., Ehrmann, R., Amr, Z., Battiston, R., & Qumsiyeh, M. (2018). Mantids (Dictyoptera: Mantodea) from the Palestinian Territories with an updated list, 33, 91–105.

Hasan, Z., Afridi, R., Rahman, L., Qureshi, N. A., Saeed, K., & Afridi, H. (2018).A preliminary survey on prevalence and knowledge about different aspects of somnambulism in Buner District of Khyber Pakhtunkhwa, Pakistan. *Sleep and Breathing*, 22(4), 973-979.

Helmkampf, M. E., Schwarz, C. J., & Beck, J. (2007). A first look at the biodiversity of praying mantids (Insecta: Mantodea) in Sabah, Borneo. *Sepilok Bulletin*, *7*, 1-13.

Hira, F. S., Asad, A., Farrah, Z., Basit, R. S., Mehreen, F., & Muhammad, K. (2018). Patterns of occurrence of dengue and chikungunya, and spatial distribution of mosquito vector Aedes albopictus in Swabi district, Pakistan. *Tropical Medicine & International Health*, *23*(9), 1002-1013.

Hiral, P., Shukla, A., & Pratik, S. (2018). Biodiversity of praying mantids (Insecta: Mantodea) in Gujarat, India.-ISSN: 2320-7078 -2349-6800 JEZS 2018; 6(4) : 455-459.

Iqbal, J., & Ahmed, M. (2014). Vegetation Description Of Some Pine Forests Of Shangla District Of Khyber Pakhtunkhwa Pakistan. A Preliminary Study. *Fuuast Journal Of Biology*, *4*(1), 83-88.

Jadhav, S. S., Sureshan, P. M., & Ghate, H. V. (2006). Additions to the mantid fauna (Insecta: Mantodea) of Pench National Park, Maharashtra, India. *ZOOS'PRINT JOURNAL*, *21*(5), 2261-2262.

Jaskuła, R. (2014). "First Record of Geomantis larvoides Pantel, 1896 (Mantidae) from Albania with an updated checklist of Albanian Mantodea." *Acta zoologica Bulgarica* 66(1): 125-126.

Kausar, S., Abbas, M. N., Mahmood-ul-Hassan, M., Rana, S. A., Rana, N., Maqsood, I., & Gul, I. (2017). Diversity and Dynamics of Macro-Invertebrates in Sugarcane Agro-Ecosystem of Punjab (Pakistan). *American-Eurasian Journal of Agricultural and Environmental Sciences*, 128-142.

Khokhar, J. A., Naheed, M., Soomro, T. J. U., & Samina Malik, N. (2016).Description of new characterized specie Microthespis oderai (Rivetinae, Mantidae Mantodea) from Sindh Province of Pakistan. *European Academic Research*, *3*, 12116-12123.

Khokhar, J. A., Ursani, T. J., Memon, F., Malik, S., Soomro, A., & Shah, F. (2022). Diversity and Morphometric of Oothecae of Mantids in District Mirpurkhas, Sindh.

Khokhar, Jawaid A. (2022). "Diversity and Morphometric of Oothecae of Mantids in District Mirpurkhas, Sindh." 72(2):223-279.

Kranjcev, R. (2013). "Fauna bogomoljki (Dictyoptera: Mantodea) *u Hrvatskoj."* *Entomologia Croatica* 17(1-4): 41-52.

Lanna, L. M. (2021). "First record of non-carnivore feeding behavior in a wild praying mantis (Mantodea: Mantidae*)." Entomological Communications*3: 2675-1305.

Lee, S. W. (2014). New lower cretaceous basal mantodean (Insecta) from the Crato Formation (NE Brazil). *Geol. Carpath*, *65*(4), 285-292.

Liu, Q.-P. (2021). "A new species and two new species records of Hierodulinae from China, with a revision of Hierodula chinensis (Mantodea: Mantidae)." *Oriental Insects* 55(1): 99-118.

Martinović, M., Ćato, S., Lengar, M., & Skejo, J. (2022). First records of three exotic giant mantid species on the Croatian coast. *Journal of Orthoptera Research*, *31*(1), 55-61.

Mukherjee, T. K., Ghosh, A. K., & Hazra, A. K. (1995). The mantid fauna of India (Insecta: Mantodea). *Oriental Insects*, *29*(1), 185-358.

Murray, J. A. (1880). *A Hand-book to the Geology, Botany, and Zoology of Sind*. Beacon P..

Mustaffa, N. (2019). Diversity of praying mantises (Insecta: Mantodea) in Bukit Piton Forest Reserve, Lahad Datu, Sabah. *Journal of Tropical Biology & Conservation (JTBC)*, 185â-196.

Naeem, M. and Yousuf, M., (1996). Mantodea (Dictyoptera) from the Punjab Province of Pakistan. Entomologist's Monthly Magazine, 132(1588/91), 281-284.

Obertegger, U., & Agabiti, B. (2012).On the usefulness of ratios for the identification of some Mediterranean species of the genus Ameles Burmeister, 1838 (Insecta, Mantodea). *Zootaxa*, *3259*(1), 34-50.

Otte D., Spearman L., 2005. Mantida- species file. Catalog of the Mantids of the World. Insect Diversity Association Publication; 1, 1- 489.

Panhwar, W. A., Tasleem, S., Asif, M., Alam, M., Anwar, F., Nisa, Z. U., ... & Bhatti, W. A. (2020). Praying mantis (Mantodea: Dictyoptera) of Pakistan: A Review Based study. *Bulletin of Environment, Pharmacology and Life Sciences*, *9*, 180-183.

Pashaie Rad, S., & Mirzaee, Z. (2017). Seven new records of Mantids (Insecta: Mantodea) for Alborz Mountain,(Tehran Province) Iran. *Iranian Journal of Animal Biosystematics*, *13*(2)

Patel, H. N., Shukla, A., & Prajapati, J. N. (2018). Diversity of praying Mantids (Insecta: Mantodea) from various ecosystems of south Gujarat, India: 2320-7078 - 2349- 6800 JEZS 2018; 6(4): 167-169.

Patel, S., Singh, G., & Singh, R. (2016). A checklist of global distribution of Liturgusidae and Thespidae (Mantodea: Dictyoptera). *Journal of Entomology and Zoology Studies*, *4*(6), 793-803.

Patel, Shveta, and Rajendra Singh. (2016). "Updated checklist and distribution of Mantidae (Mantodea: Insecta) of the World." *International Journal of Research Studies in Zoology* 2, no. 4: 17-54.

Prete FR, Wells H, Wells PH, Hurd LE (eds) (1999) The praying mantids. The Johns Hopkins University Press, London

Qasim, M., Hubacek, K., Termansen, M., & Fleskens, L. (2013).Modelling land use change across elevation gradients in district Swat, Pakistan. *Regional environmental change*, *13*(3), 567-581.

Rahman, S. U., Ullah, Z., Ali, A., Aziz, M. A., Alam, N., Sher, H., & Ali, I. (2022). Traditional knowledge of medicinal flora among tribal communities of Buner Pakistan. *Phytomedicine Plus*, *2*(3), 100277.

Rivera, J. and C. Vergara-Cobián (2017). "A checklist of the praying mantises of Peru: new records, one new genus (Piscomantis gen. n.) and biogeographic remarks (Insecta, Mantodea)." *Zootaxa* 4337(3): 361-389.

Rivera, J. and G. J. Svenson (2014). "A revived focus on the praying mantises (Insecta: Mantodea)." *Zootaxa*3797(1): 5-6.

Rondón A.A.A., Lombardo F. & Jantsch L.J. 2007: Checklist of the Neotropical (Insecta, Dictyoptera, Mantodea). Biota Colombiana 8, 2, 105—158

Saeed, K., Khan, S., & Haq, F. (2013). Diversity and population status of fish fauna of river Barandu district Buner Khyber Pakhtunkhwa Province Pakistan. *Journal of Biodiversity and Environmental Sciences*, *3*(4), 83-88.

Samin, N. A. J. M. E. H., Ghahari, H. A. S. S. A. N., & Katbeh-Badr, A. H. M. A. D.(2016). A faunistic study on the Mantodea (Insecta) from western Iran. *Norwegian Journal of Entomology*, *63*, 116-119.

Shah, A. H., Khan, S. M., Shah, A. H., Mehmood, A., Rahman, I. U., & Ahmad, H. (2015). Cultural uses of plants among Basikhel tribe of district Tor Ghar, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot*, *47*, 23-41.

Shar, K. A., & Panhwar, W. A. (2020). Rhomboderella scutata, Boliver, 1889 (Mantidae: Mantinae): A new record from Sindh Pakistan. *Journal of Entomology and Zoology Studies*, *8*(2), 470- 473.

Shcherbakov, E., & Govorov, V. (2020, May).Statilia maculata (Thunberg, 1784)–the first invasive praying mantis (Mantodea, Mantidae) in the fauna of Russia.

In *Annales de la Société entomologique de France (NS)* (Vol. 56, No. 3, pp. 189-202).Taylor & Francis.

Soomro N, Khokhar J, Jabeen T, Soomro M. A Comparative Description of Mouthparts in Praying Mantids from Sindh. Sindh Univer. Res.Jour. -SURJ (Science Series). 2012; 44(4):741-744

Soomro N. The taxonomic study of Praying Mantids (Mantodea) of Sindh. Ph.D thesis University of Sindh. 2000, 1-140.

Soomro N.M, Soomro M.H, Wagan MS. Key to the identification of Praying mantids occurring in Sindh,. Sindh Univer. Res. Jour -SURJ (Science Series).2002; 34(1):57-62.

Sugiarto, A. (2018). "Inventory of Praying Mantis (Mantodea) in Serdang Menang Village, Sirah Pulau Padang Sub-district, Ogan Komering Ilir District, 29(2), 243-351.

Sureshan, P. M., Samanta, T., & Radhakrishnan, C. (2006). Mantid (Insecta: Mantodea) fauna of Orissa with some new records for the state. *Zoo's print journal*, *22*(1), 2539-2543.

Svenson, G. J. and M. F. Whiting (2009). "Reconstructing the origins of praying mantises (Dictyoptera, Mantodea): the roles of Gondwanan vicariance and morphological convergence." *Cladistics*25(5): 468-514.

Tariq, U. S., Abdul, A., Taj, A. K., & Haleema, A. (2012). Application of geographical information system (GIS) to groundwater quality investigation: A case study of Mardan district, Pakistan. *International Journal of Physical Sciences*, *7*(37),

5421-5448.

Tyagi, B. K., & Veer, V. (2016). Entomology in the Doon Valley (Garhwal Himalaya) a stronghold for insect research.*Scientific Publishers*, 978-93-86102, 75-1 978- 87307-63-6.

Ursani, T. J., Khokhar, J. A., Dhiloo, K. H., Malik, S., Yaseen, M., Chandio, J. I., & Chandio, W. A. (2017). Biology of a praying mantid Tenodera attenuata (Stoll, 1937)(Mantodea: Mantidae: Mantinae) from Sindh. *Journal of Entomology and Zoology Studies*, *5*(6), 2620-2624.

Uvarov, B.P., (1931). A new mantid from Baluchistan. Ann. Mag. Nat.Hist. (10) 8: 418-419.

Vermeersch, X. H., Stiewe, M. B., & Shcherbakov, E. O. (2019). A new genus of praying mantis, Chlorocalis n. gen., with two new species from the Greater Mekong region (Mantodea: Mantidae). In *Annales de la Société entomologique de France (NS)* (Vol. 55, No. 2, pp. 197-210).

Vidal-Garcia, M., O'Hanlon, J. C., Svenson, G. J., & Umbers, K. D. (2020). The evolution of startle displays: a case study in praying mantises. *Proceedings of the Royal Society* B, 287(1934), 20201016.

Vujic, M., & Zlatic, L. (2021). The first confirmed record of Mediterranean mantis, Iris oratoria (Mantodea: Eremiaphilidae) in Montenegro. *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa", 64*, 97.

Wagan, M. S., Soomro, N. M., & Soomro, M. H. (1995).Praying Mantids (Mantodea) of Sindh Province, Pakistan. *Journal of Orthoptera Research,* 161-162.

Yamasaki, K., Schütte, K., & Nawa, T. (2022).New record of Chinese Reddish Mantis, Hierodula chinensis Werner, 1929 (Mantodea, Mantidae) from Japan. *Check List*, *18*(1), 147-150.

Zherikhin V.V. 2002: Order Mantida Latreille, 1802. The mantises (=Mantodea Burmeister, 1838). In: Rasnitsyn A.P. & Quicke D.L.J. (Eds.): History of Insects. Kluwer, Dodrecht, 273— 276.

Table 3.1. Diversity indices values, number of species (S), Simpson index (1-D), Shannon Winner index (H), Evenness index (E) and Specie richness (Margalef index).

S.No	Study Habitats	S	1-D	H	E	Margalef index
1	Wheat crops	3	0.646	1.066	0.968	0.522
2	Maize Crops	8	0.843	1.93	0.861	1.478
3	Orchards	7	0.668	1.473	0.623	1.329
4	Understories	9	0.867	2.097	0.904	1.726
5	Shrub layer	9	0.875	2.132	0.936	1.695
6	Trees layer/ Canopy layer	1	0	0	1	0
7	Urban Areas	5	0.721	1.392	0.804	1.022