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Exploration of Caeliferans' Diversity in the Eastern Regions of District Kohat, Khyber Pakhtunkhwa, Pakistan

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Abstract

Biodiversity greatly impacts the functioning of ecosystems as our society depends on natural resources. Man is dependent on various life forms such as animals for meat and milk while on plants for medicines and nutritional needs. Sub-order caelifera within the kingdom Animalia is a diverse group of insects comprising about 11,000 described species worldwide. They are phytophagous animals and are important pests to agricultural crops. The present study was conducted in the Khushal Garh area, District Kohat, to find out the diversity of Caeliferans fauna. A sampling of Caeliferans fauna was done from July 2020 to July 2021. After collection, identification of all the specimens was made up to the species level. During this study, a total of 2 families of the Caeliferans were recorded, which collectively comprised of 10 species. The identified Caeliferans species were *Chrotogonus trachypterus*, *Sphingonotus caeruleans*, *Acrida exaltata*, *Schistocerca nitens*, *Trimertropis pallidipennis*, *Acorypha glaucopsiss*, *Anacridium aegyptium*, *Coryphistes ruricola*, *Heteracris littoralis* and *Poekelocerus pictus*. The species consist of 7 subfamilies, which were Acridinae, Oedipodinae, Calliptaminae, Cyrtacanthacridae, Catantopinae, Eyprepocnemidinae, and Pyrgomorphinae, respectively. Since Caeliferans are a valuable group for bio indication, it is significant to get information on their multiplicity in ecological circumstances.

Keywords Biodiversity, Arthropods, Caelinfera, Acrididae, Pyrgomorphidae, Identification protocol.

1. Introduction

There is great variability among animals, from the microorganisms to giant ones, called biodiversity (1). The animal kingdom consists of 34 phyla which constitute approximately 1.5 million animal species, identified to date that constitute less than 20% of living organisms. Phylum Arthropoda represents the largest part among animals, which is crucial and vital in all ecosystems on earth. In phylum Arthropoda, Class Insecta is one of the most diverse and largest groups of organisms in the world (2), which make up an estimated 90% of the terrestrial animals (1). It includes approximately 1.1 million described species which counts about three-fourths of all species of animals on Earth. But experts estimate that almost 30 million species may exist (3). Order Orthoptera of class Insecta is comparatively a very large order, comprising 22,500 identified species worldwide (4). Suborder Caelifera is the group of Short-horned grasshoppers (Caeliferans and locusts), while suborder Ensifera is the group of long-horned grasshoppers (katydids and crickets) (5). Classification is a basic need for understanding biodiversity easily. Caeliferans are placed in 28 different families with a total of 1400 genera. The most diverse among all the families is Acrididae (6). Grasshoppers are classified on their morphological features

such as the shape and size of the Pronotum, absence or presence of tympanic organ, absence or presence of arolium, and type of antennae present on the head (1).

Caeliferans are oviparous insects commonly found in temperate zones. They lay eggs during the spring and summer and exhibit incomplete metamorphosis during the life cycle (7). Mostly they have well-developed ovipositor for safe positioning of eggs. During the winter season, they hibernate until the favorable environmental conditions are experienced back (4).

Caeliferans have great useful significance as essential customers, supplement recyclers and prey for an extensive variety of animals. They are phytophagous insects and are found all over the world in all type of ecological systems (8). Caeliferans are also an efficient food source for mammals, birds, reptiles, and amphibians. They also make plant litter for soil, stimulating plant growth and nutrients and recycling important elements (9). Caeliferans cause great damage to a variety of crops and forests (8). Caelifera can be a major pest for plants that can severely damage the growth of crops, and forests, so that damage and decline their nutritional values and production rate.

Kohat region has great biodiversity mainly due to its rich vegetation and favorable climate (temperature, humidity

etc.) that made it an extremely suitable region for breeding different groups of insects. Amongst all insects, the order Orthoptera is a relatively well-studied insect order throughout the world and Pakistan, too(4). The purpose of this research is to explore the biodiversity of Order Orthoptera at Khushal Garh and its vicinities, district Kohat, Khyber Pakhtunkhwa. Until now, in Pakistan as no such type of research exploration work has been done in the selected area insofar. This study will provide a baseline for researchers in the future.

2. Material and Method

2.1 Study Area

District Kohat is at an altitude of 489 meters, on the western bank of the Indus River and on the left bank of the Toi River, which also drops into the Indus River. Its coordinates are 33°-35° North and 71°-26° East. The city has a subtropical and semi-arid climate. Large biodiversity exists in this geographically variable region (10).

This study was conducted in Eastern Regions of district Kohat (Khushal Garh, Dhok Munir, Parshai and Resi Banda, Khyber Pakhtunkhwa, Pakistan. Khushal Garh is situated near the western bank of the mighty Indus River, where there is a moderate climate, and all seasonal changes occur occasionally.

2.2 Equipments Used

Table 1: The following materials were used in the entire research:

Name	Usage
Hand Net	To capture the Caeliferans
Formalin	To kill the Caeliferans
Plastic Bottles	To put the specimens for killing
Foam	Foam was soaked in Formalin and put in plastic bottles.
Small Wooden Box	The killed specimens were pinned in temporarily for later observations.
Insect Pins	To pin and mount the specimens.
Stretching Board	To stretch the wings, tagmen and legs of Caeliferans.
Naphthalene Tablets	The prevent specimens from the attack of insectivorous insects.
Insect Showcase	To mount and deposit the collected and identified Caeliferans.

2.3 Sample Collection

The adult member species of Caeliferans were collected from various agricultural fields, including wheat, grams, hilly area, semi-desert, trees, shrubs, herbs, and grasses, by using traditional insect hand-net as well as by hand-catching. The collection was done during 2020-2021 from the Eastern Regions of district Kohat, Khyber Pakhtunkhwa, Pakistan.

2.4 Preservation and Identification of Specimens

The specimens were collected using a hand net and hand capturing method. They were put immediately into the plastic bottles containing foam soaked in Formalin (11). Specimen collection was done eight times in the total time duration. The killed specimens were transferred to the small wooden boxes to avoid any damage. Then they were brought to the laboratory and identified to species level by using the available Identification Keys described in “Fauna of British India by Kirby 1914”, by Vickery and Kevan (1983) and Sultana and Wagan (11). The identified Caeliferans were tagged with super- family, family, sub-family, and genus to which they belong. Their specific names were also mentioned on the tags. They were finally mounted in the Insect Showcase for depository in the College Laboratory.

2.5 Compilation and Use of Identification Keys

Identification keys were first compiled from different research articles and especially a book named “Caeliferans and Locusts of Pakistan” written by Riffat Sultana and Saeed Wagan. The keys were for morphological characters of the Caeliferans. Classification focused on the pronotum, arolium, antennae, prosternal process, and tympanum. For instance, to classify the Caeliferans into their super-families, the following key was applied:

2.6 Keys for identification of super-families of Caeliferns of Pakistan

1. Size is small to very small; hind appendages are modified for digging, all tarsi have less than three segments; ovipositor is often absent.....**Tridactyloidea**.

Size varies but mostly medium; appendages are not or little adapted for digging; tarsi are usually all three segmented; ovipositor is well developed.....2

2. Pronotum is large and extended to the apex of the abdomen, tarsi have no arolium..... **Tetrigoidea**.

Pronotum is short enough that it does not cover the back of the abdomen, tarsi have arolium, which is weakly pronounced 3

3. Antenna shorter than fore femora, if longer than fore femora then they contain dorsally serrated the first segment of it. The body is entirely apterous, bases of antennae are spaced more than lateral ocelli, the tympanum is absent.....**Eumastacoidea**

---. If not as above 4

4. Upper lobe of the hind femora is smaller than the basal lobe, slanting frons with a conical head, notched vertex..... **Pyrgomorphaeidea**

---. The upper lobe of the hind femora is larger than the basal lobe, the vertex is not entirely notched; if notched, then weakly**Acridoidea** (11).

3. Depository

All the collected and identified specimens are deposited in the lab of the Zoology Department, Govt. Post Graduate College, Kohat, Khyber Pakhtunkhwa, Pakistan.

4. Results

Three hundred forty-eight specimens were captured from Khushal Garh, district Kohat and were identified using the Identification Keys protocol used by Riffat Sultana and Saeed Wagan 2012. Total of 10 species identified, belonging to 2 superfamilies, 2 families, 7 subfamilies, and 10 genera. Family Acrididae was found most prevalent, consisting of 8 species (80%), while Pyrgomorphae was found less prevalent, consisting of only 2 species (20%). Both the families (Acrididae and Pyrgomorphae) were found at Khushal Garh and Dhok Munir while a single-family (Acrididae) was found at Parshai and Resi Banda, the species *Poekelocerus pictus* was absent in these areas. At Khushal Garh and Dhok Munir, 7 sub families and 10 genera with 10 species were found, while at Parshai and Resi Banda, 6 subfamilies and 9 genera with 9 species were detected (Table 2).

Table 2: Overall prevalence of more common Caeliferans in Kohat

Taxon	Kushal Garh	Parshai	Dhok Munir	Resi Banda
Family	2	1	2	1
Sub Family	7	6	7	6
Genus	10	9	10	9
Species	10	9	10	9

In the current study, 10 caeliferans species were identified that were dominated by *Chrotogonus trachypterus* (19.54%), followed by *Sphingonotus caeruleans* (12.07%), *Acrida exaltata* (10.92%), *Schistocerca niten* (10.92), *Trimertropis pallidipennis* (10.06%), *Acorypha glaucopsis* (9.20%),

Anacridium aegyptium (8.91%), *Coryphistes ruricola*, (8.62%) and *Heteracris lithorali* (7.47%). The rarest species detected was *Poekelocerus pictus* (2.30%). The first eight belonged to the family Acrididae, while the last two belonged to Pyrgomorphae (Table 3).

Table 3: Hierarchical classification of Identified Caeliferans at Species Level in district Kohat.

Family	Sub Family	Genus	Species	
Pyrgomorphidae	Pyrgomorphae	Chrotogonus	<i>Chrotogonus trachypterus</i>	
	Oedipodinae	Sphingonotus	<i>Sphingonotus caerulans</i>	
	Acridinae	Acrida	<i>Acrida exaltata</i>	
	Cyrtacanthacrididae	Schistocerca	<i>Schistocerca nitens</i>	
	Oedipodinae	Trimertropis	<i>Trimertropis pallidipennis</i>	
	Acrididae	Calliptaminae	Acorypha	<i>Acorypha glaucopsis</i>
		Cyrtacanthacrididae	Anacridium	<i>Anacridium aegyptium</i>
		Catantopinae	Coryphistes	<i>Coryphistes ruricola</i>
		Eyreprocnemidinae	Heteracris	<i>Heteracris littoralis</i>
	Pyrgomorphidae	Pyrgomorphae	Poekelocerus	<i>Poekelocerus pictus</i>

5. Discussion

In the present study, which was conducted from July 2020 to July 2021, 10 species of sub-order Caelifera were detected in at Khushal area, district Kohat. *Chrotogonus trachypterus* was found to be the most abundant species from all the four spots viz. Khushal Garh, Dhok Munir, Resi Banda, and Parshai with approximately 20% in total. *Poekelocerus pictus* was rarely found, with only 2.29% out of 348 specimens. All the identified species of Caeliferans belonged to the two closely related families, Acrididae and Pyrgomorphidae, both of which had well-developed wings, tagmen, and flat pronotum. All the species had medium-sized bodies, on average. The species *Poekelocerus pictus* was not found at Resi Banda and Parshai because of a shortage of its host plant. It feeds only on the Milkweed plant.

A similar study was conducted in Hazara Division by Shoaib Ali and Waheed Ali Panhwa from 2016 to 2017 to find Caeliferans' fauna of district Hazara. During an inspection, they collected 402 species of Caeliferans and Locusts and

found 7 species pertaining to 5 sub-families and 7 genera. Besides this, grasshoppers of the subfamily Acridinae identified here were most abundant with 20.82%, then Oedipodinae, Gomphocerinae, and Oxyinae with 17.61%, 17.47%, and 14.40%, respectively. Cyrtacanthacridinae was observed with the lowest population of 3.06% (8).

Similarly, another study was conducted in Toordand district Karak, Khyber Pakhtunkhwa by Khalid Usman, Hameed Ur Rehman, Ruqia Nazir, Muslim Khan, Abdur Rab, Muhammad Idrees Khan, Sehrish Khudadad, and Khalid Pervaiz, in the year 2016-2017. Seven species of Caeliferans belonging to five subfamilies, Oedipodinae, Acridinae, Gomphocerinae, Cyrtacanthacridinae, and Eyreprocnemidinae, were identified during the survey, namely *Scintharis tanotabilis*, *Sphingonotus rubescens*, *Aiolopus thalassinus*, *Acrotylus humbertianus*, *Acrida exaltata*, *Schistocerca gregaria* and *Heteracris illustris* respectively. In this research, Sub Family Oedipodinae was found to be the largest one of all the families consisting of four Species (12).

This study concluded that only two families of Caeliferans exist in the Khushal Garh area of district Kohat. All the

common species of Caeliferans are almost equally distributed in this area except *Poekelocerus pictus* which is restricted to the areas that contain milkweed plants. All other species that are not milkweed feeders are therefore distributed in the whole of the specified region. The most diverse family of Caeliferans is Acrididae with 8 species in this region, while the family Pyrgomorphidae is rarely found with only two species.

The further explorative study is recommended at other sites of Khyber Pakhtunkhwa to find out the complete biodiversity of insects. It is also recommended that the host plant of all the identified species be identified so that any crop pest grasshopper may be pointed out. In addition, further such studies are recommended in other regions of district Kohat to explore all the Caeliferans fauna of the district and report pests Caeliferans, if any.

6. Identification keys

6.1. Keys for the Identification of Super-Families of Sub-Order Caelifera of Pakistan

1. Body size is small; hind legs are adapted to digging, their tarsi have less than three segments; ovipositor is usually absent **Tridactyloidea**
 --. body size varies, usually with medium size; ovipositor is present, tarsi are three segments and hind legs are little modified for digging 2
2. Large pronotum that extends to the abdomen, no arolium of tarsi **Tetrigoidea**
 ---. Pronotum short, not covering the abdomen from above; tarsi usually with distinct arolium, more seldom weakly pronounced.....3
3. Antenna shorter than fore femora, if longer than the first segment of the hind tarsus is serrated dorsally, and the body entirely apterous, bases of antennae spaced at least a little more than lateral ocelli, first abdominal segment without tympanic organ **Eumastacoidea**
 --- Not as above.....4
4. Lower basal lobe of hind femora longer than upper lobe, head conical with strongly slanting frons, vertex anteriorly notched, strongly protruding anteriorly, with paired apical area in profile forming an acute angle with frons.....**Pyrgomorphoidea**
 ---. Lower basal lobe of hind femora shorter or longer than upper lobe, rarely as long as above, vertex anteriorly not notched or weakly notched **Acridoidea**

6.2. Super-Family Acridoidea:

Keys for identification of super family Acridoidea:

1. pronotum is notched on the frontal half and raised above, flattened from behind, wings are lacking **Dericorythidae**
 --. Flat pronotum, upper lobe of hind femora is smaller than the lower basal lobe, vertex is notched often inclined from anterior and vertically, usually forming a right or even obtuse angle with frons..... **Pamphagidae**
2. Body is robust in appearance, thorax is curved with short femur than tibia, usually called as groundhoppers pygmy grasshoppers or grouse locusts **Tritiridae**

6.2.1. Keys for the identification of genera of Acridinae (Macleay, 1821)

1. hind femur is without stridulatory files from inner side.....*Truxalis* (Fabricius, 1775)
2. elongated head, hind femur is very long and slender..... *Acrida* (Linnaeus, 1758)
3. head is smaller in size; hind femur short and not slender..... *Phlaeoba* (Stal, 1861)

6.2.2. Keys for the identification of species of *Acrida* (Linnaeus, 1758)

1. Body colour green, tegmina have no distinct colours; round apex of spermatheca *A. exaltata* (Walker, 1859)
2. Body colour is dry grassy; lateral carina of pronotum edges have black lines; apical diverticulum of spermatheca has truncated apex..... *A. gigantea* (Herbst, 1786)

6.3. Subfamily Calliptaminae:

Hind femur is short never reaching the apex of abdomen and is much robust; lophi absent; cercus of males is large, strong, curved and toothed apically.....Calliptaminae Brunner, 1893

6.4. Subfamily Catantopinae:

- Face is considerably slanting back; antennae are sword-shaped; body is very slender; weak, spine inserted between front legs.

6.4.1. Keys for the identification of the genera:

1. pronotum has no lateral carina.....2
- pronotum has lateral carina.....*Choroedocus* (Bolivar, 1914)

2. Pronotum is constricted near prozona
Xenocatantops (Dirsh, 1953)

Pronotum has no constriction in prozona
Diabolocatantops Jago, 1984

6.5 Subfamily Eyprepocnemidinae:

pronotum with lateral carina well developed.

Keys for identification of Indian species of Heteracris Walker, 1870

1. Prosternal process is antero-posteriorly compressed
-**H. littoralis** (Rambur, 1838)

Prosternal process sub-cylindrical with obtused apex.....
H. pulcher (Bolivar, 1902)

6.6 Subfamily Oedipodinae:

Prosternal process is absent, if it is present then antenna will be ensiform type.

6.6.1 Keys for identification of genera of Oedipodinae (Walker, 1871)

1. Pronotum has no X-shaped pattern on dorsum 2

Pronotum has X-shaped patterns on dorsum
Oedaleus Fieber, 1853

2. Median carina on pronotum is crossed by more than one transverse sulci.....3

Median carina on pronotum is crossed by only one transverse sulcus or not crossed at all7

3. Pronotum alongwith median carina is raised equally in prozona and metazoan and not forming tooth like structure 4

Media carina is strongly raised and forms two tooth like structures with the pronotum, metazoan is sharp.....
Trilophidia Stal, 1873

4. Body size is large and robust; tegmina with broad apex; pronotum is slightly convex.....5

Body size ranges from medium to small; tegmina is with narrow apex; pronotum saddle shaped, apex is rounded.....
Bryodema Fieber, 1853

5. Pronotum is longer than its width, with median carina linear, lateral carinae not present.....6

pronotum has same length and width, with median carina well-developed, lateral carinae irregular
Acrotylus Fieber, 1853

6. Pronotum slightly rugulose, frontal ridge is flat, metazoan is longer than Prozona, mesosternal intrspace wider than length; hind femora isslender
Sphingonotus Fieber, 1852

Pronotum is very rugulose, metazoan is much larger than prozona, posterior margin elongated and angular; mesosternal interspace much wider than length; hind femora very broad with the upper carina particularly expanded and suddenly depressed near the apex.....
Chondronotulus Uvarov, 1956

7. Pronotum has weak media carina
Aiolopus Fieber, 1853

Pronotum has well developed media carina
Locusta Linnaeus, 1758

7. Conclusion

The present study concluded that only two families of Caeliferans exist in the Khushal Garh area of district Kohat. All the common species of Caeliferans are almost equally distributed in this area except Poekelocerus pictus, which is restricted to the areas that contain milkweed plants. All other species that are not milkweed feeders are therefore distributed in the whole of the specified region. The most diverse family of Caeliferans is Acrididae with 8 species in this region, while the family Pyrgomorphidae is rarely found with only two species.

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