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Taxonomic Studies of Gaudy Grasshoppers (*Pyrgomorphinae*: *Pyrgomorphidae*: *Orthoptera*) in Bihar, India

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Abstract

The subfamily Pyrgomorphinae belongs to the family Pyrgomorphidae. Members of this subfamily have brightly colored bodies, owing to which they are commonly known as "gaudy grasshoppers". It had been an extensive survey for grasshoppers that consisted of diversified and rich flora as well as different ecological conditions, rainfall, humidity, and temperature. Surveys in various seasons in important agricultural areas in different regions of Patna district for the collection of grasshoppers during survey observations have been made on their geographical distribution, diversity, host range, and pest incidence. Insects belonging to this subfamily are generally found in tropical and subtropical regions. They've a short, stout body with a kind, angular appearance. There are pictorial colors and patterns present on the body, which include spots, stripes, and other patterns to serve as a warning to bloodsuckers. The head is broad and may be slightly conical or rounded, containing well-developed emulsion eyes. The face is generally perpendicular or slightly slanted. Antennae are short and thick, having a conjoined or slightly expanded appearance at the tips. The abdomen is covered by a rearward plate called the pronotum, which is stretched and extends over part of the tummy and bears a median suture. The hind legs have strong femora and are adapted for jumping, while the tibiae retain backbones that help the insects move. The forewings, or the tegmina, are tough and contain bright colors and patterns. The hind bodies are membranous and brightly colored. The mouth corridor is adapted to biting different types of food and their corridor.

Keywords: *Pyrgomorphidae*, Patna, grasshoppers, distribution, diversity, colours

INTRODUCTION

z segments. These insects represent an economically significant category of Orthopteran pests that infest various cultivated and wild crops.

The subfamily *Pyrgomorphinae* is part of the family *Pyrgomorphidae*. These insects are often referred to as "gaudy grasshoppers" due to their bright colors. Typically found in tropical and subtropical regions, members of this subfamily possess a short and robust body with a somewhat angular shape. Their bodies showcase vivid colors and patterns, such as spots and stripes, which serve as warnings to potential predators. While they are spread across the globe, they thrive best in tropical and subtropical areas. Generally, the population of locusts and grasshoppers diminishes as one moves further from the equator, with their numbers increasing closer to it. They are polyphagous feeders, consuming a variety of unrelated plant species [1, 2]. Habitat differences are largely influenced by various abiotic factors, including

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ecosystem type, altitude, latitude, and rainfall. These insects are regarded as effective indicators of threatened habitats, contributing to the conservation and protection of vital areas. Grasshoppers serve as primary consumers in grasslands worldwide [3]. They are crucial for energy transfer within trophic levels, functioning as primary consumers in the food chain and as prey for other animals, which helps maintain ecological balance. This dynamic keeps their populations in check, but their defense mechanisms create intense competition for predators and parasites. Recently, these insects have displayed a tendency to migrate toward natural vegetation, such as crop fields, demonstrating their potential as significant pests, including species like *Phlaeoba infumata, Atractomorpha crenulata,* and *Oxya fuscovittata*.

These insects will be watched closely in their natural environments, allowing for the observation of interactions between pests and plants as well as plant relationships with pests. The research will initially cover the entire area, focusing on the Patna district and nearby agricultural zones, riverbanks with fertile soil, and rural regions rich in forests and vegetation. This study is crucial for taxonomists and applied entomologists, setting a standard for other interdisciplinary fields. Numerous economically significant grasshopper species, such as *Hieroglyphus, Oxya, Atractomorpha, Pyrgomorpha, Spathosternum, Phlaeoba, Truxalis, and Acrida*, have displayed a noticeable impact on agricultural regions like the one being studied.

REVIEW OF LITERATURE

Initially, [4]. established the family group name *Acrididae* based on the genus *Acrida* [5]. Subsequently, [6–7] suggested the family names *Truxalidae and Oedipodidae*, respectively. In the *Horae Entomologica, Macleay* introduced *Acridina and Locustina* as sections within Orthoptera [8]. Formally assigned the family name *Acrididae,* further dividing it into three subfamilies: *Acridiinae, Tettiginae, and Proscopiinae.* He then categorized the subfamily Acridiinae into three tribes: *Truxalini, Oedipodini, and Acridini* [9]. Identified *Oedipodii and Tryxalii as tribes within Oedipodidae* [10]. Recognized several subfamilies within *Acrididae, including Acrydiinae, Eumastacinae, Tryxalinae, Pyrgomorphinae, Pamphaginae, Catantopinae, Pneumorinae, and Proscopiinae* [11]. Continued this classification [12]. Arranged the family Acrididae into nine subfamilies: *Tetriginae, Pneumoninae, Mastacinae, Proscopinae, Tryxalinae, Oedipodinae, Pyrgomorphinae, Pamphaginae, and Acridinae* [13]. Elevated the family Acrididae was elevated to the rank of sub-order *Acridoidea,* consolidating the subfamilies classified by [12] into family status as *Tetrigidae, Pneumoridae, Mastacidae, Proscopidae, Truxalidae, Oedipodidae, Pyrgomorphidae, Pamphagidae, and Acrididae* [14]. Later designated *Acridinae, Oedipodinae, Catantopinae, and Pyrgomorphinae* as subfamilies of Acrididae, eventually adding a fifth subfamily, Pamphaginae, to the family.

Thirty-three locust and grasshopper species have been studied by [15] in Western Uttar Pradesh. The taxonomic significance of the female genitalia in Indian *Acridoidea* has been examined by [16, 17]. Documented twenty-six grasshopper species from the rice-growing regions of Uttar Pradesh, while [18] reported thirty-four grasshopper species from the pulses and paddy fields in Bihar and Jharkhand, India [19]. Identified forty-one grasshopper species in Jharkhand, and they also noted thirty-seven species from Bihar in the same year [20]. Reported fourteen species from pulses, and another twenty-six species were noted from the Aligarh Fort area of Uttar Pradesh. Additionally, [21] compiled data on the ecological habitats of grasshopper fauna in Aligarh, where [22] recorded thirty-two grasshopper species. The male genitalia were categorized by [23].

The increasing population of grasshoppers has resulted in significant crop damage, as these insects are considered pests in agricultural lands. According to [24, 25] identified four grasshopper species are responsible for 90% of the crop destruction [26]. Highlighted the link between feeding habits and migratory traits in Mongolian locusts [27]. Discovered two new slant-faced grasshopper species in central India, while [28] researched the abundance and diversity of grasshoppers and their ectoparasitic mites in Dakota. The *Acrididae* family represents a diverse group within the Orthoptera order, as noted

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by [29]. Approximately 360 species of short-horn grasshoppers have been documented [30]. Attractomorpha [9]: Insects belonging to this genus possess slender, elongated bodies and pointed heads. Typically, their bodies are green or brown, which helps them blend into their environment. They are predominantly found across Asia and Australia.

MATERIALS AND METHODS

About 57 samples of grasshoppers were collected from colorful agrarian pastoral areas of Bihar and timber territories. This served as the basis for the present critical study. A complete record was also maintained, indicating the reference number, position, date of collection, and name of host shops, etc.

Collection of Adult Grasshoppers

The authors surveyed colorful agrarian areas of Bihar during the period 2022–2023 for the collection of grasshoppers and locusts. They were caught by hand, by forceps, and by the ordinary upstanding nonentity net. The net was used for catching insects collectively or by sweeping over meadows, backwoods, and other vegetation. Since some acridoids live on trees, it is occasionally satisfying to probe the branches of trees. Attempts were made to collect the samples from their host shops as well as those attracted to light during the night. They were captured on different dates in different months from colorful crops. Different corridors of crops were examined. The collected samples were killed in cyanide bottles.

Preparations for Morphological Studies

Sot mounts were also prepared for a better understanding of certain characters like size, color, texture, etc. For this purpose, the samples were first relaxed, stretched, and later they were projected and labeled duly. Endless collections of projected samples were kept in store boxes and closed for further studies on their morphological structures.

Preparations for Genitalic Studies

For a detailed study of the colorful factors of genitalia, endless slides were prepared and examined under a microscope to conduct a detailed study of the genital structures.

RESULT

The subfamily *Pyrgomorphinae* belongs to the family *Pyrgomorphidae.* Members of this subfamily have brightly-colored bodies, owing to which they are generally known as “garish grasshoppers”. Insects belonging to this subfamily are generally found in tropical and subtropical regions. They’ve a short, stout body with a kindly angular appearance. There are pictorial colors and patterns present on the body, which include spots, stripes, and other patterns to serve as a warning to bloodsuckers. The head is broad and may be slightly conical or rounded, containing well-developed emulsion eyes. The face is generally perpendicular or slightly slanted. Antennae are short and thick, having a conjoined or slightly expanded appearance at the tips. The abdomen is covered by a rearward plate called the pronotum, which is stretched extending over part of the tummy and bears a median ship. The hind legs have strong femora and are acclimated to jumping, while the tibia retain backbones that help the insects move. The forewings, or the tegmina, are tough and contain bright colors and patterns. The hind bodies are membranous and brightly colored. The mouth corridor is adapted to biting different types of food and their corridor.

Genus – Atractomorpha

Members of this genus have stretched, slender bodies and refocused heads, and are generally found in tropical and subtropical regions of Asia, Africa, and Australia. The colors of these insects allow them to blend in with their natural territories, which include meadows and foliage. Their bodies are smooth and streamlined and are generally 20 to 50 mm in length. The head is sprucely pointed and triangular. The eyes are large and prominent, positioned directly on the head. The antennae are short and thick, generally about half the length of the body, tapering towards the end and appearing slightly conjoined. The pronotum is stretched, narrow, smooth, and contributes to the streamlined appearance of the insects.

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The hind legs have strong muscular femora. The legs and mid-legs are slender and help insects in movement. The bodies of most species are completely developed, but some species may have reduced bodies. The forewings are narrow and tough, while the hind wings are membranous and clear or mildly colored. Some species have long bodies covering the entire tummy, while other species have short bodies. The nonentity bodies are generally green or brown in color, and some species may have light-colored stripes or spots. The mouth corridor is acclimated for biting a variety of meadows.

The behavioural, visual, and morphological features of each of these species are described below.

Atractomorpha psittacina psittacina (Haan, 1842)

External morphology: Body-slender and elongated, length ranges from 25 to 50 mm, streamlined shape, bright green color with faint unheroic or brown markings; head – conical and sprucely refocused; face – slightly slanted; eyes – large, indirectly placed emulsion eyes; antennae – short and thick, tapering towards the ends, half the length of the body; pronotum – stretched and narrow, covering the abdomen and part of the tummy, smooth, contributes to streamlined body shape hind legs – well- developed and muscular; femora – slender and strong; tibiae – bear small backbones; legs and mid-legs – slender, warrant heavy backbones; bodies – completely developed, long covering the entire tummy; forewings – narrow, tough, green; hind bodies – membranous, clear or mildly colored. Table 1 provides the morphometric measures of the insects.

Internal morphology: Digestive system – comprises of foregut with crop and gizzard, midgut, and hindgut; manly reproductive system – comprises of a brace of testes, vas deferens, appurtenant glands; womanish reproductive system – comprises of a brace of ovaries, oviducts, spermatheca, well-developed ovipositor; respiratory system – comprises of a series of spiracles along the side of the body, spiracles connect to a network of tracheae; nervous system – comprises of central brain, frontal whim-whams cord, supplemental jitters.

Behavior Feeding – herbivorous, primarily feeds on meadows and other soft foliage, uses strong bills to bite leaves and stems; locomotion – well-developed jumping capability, escapes pitfalls snappily, also uses flight for escape over long distances; avoiding bloodsuckers – bright green body color provides disguise in a grassy niche, remains still under trouble, escapes by jumping or flying; lovemaking – occurs in warmer months, males give visual signals to attract ladies, ladies lay eggs in soil or in factory stems where they door; seasonal gesteactive during warmer months, population growth seen in late spring and summer, less active or dormant during colder months.

Table 1. Morphometric measurements of *Atractomorpha psittacina psittacina* (Haan, 1842).

S.N.	Body Part	Male (mm)	Female (mm)
1	Body length	30–35	40–50
2	Hind femur length	15–18	20–25
3	Hind femur width	3–4	5–6
4	Hind tibia length	12–14	18–20
5	Pronotum (length/width)	6–7/2.5	7–8/3
6	Head length	5–6	6–7
7	Head width	4–5	5–6
8	Average diameter of the head capsule	3–4	4–5
9	Maximum diameter of the eye	2–2.5	2.5–3
10	Minimum diameter of the eye	1–1.5	1.5–2
11	Average diameter of the eye	1.5–2	2–2.5
12	Interocular space	2–2.5	2.5–3

Atractomorpha sinensis sinensis (Bolivar, 1905)

External morphology: Body – slender and elongated, length ranges from 20 to 40 mm, streamlined body shape, green color; head – conical, sprucely refocused; eyes – large, indirectly deposited; antennae

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– short, thick, tapering towards the ends; pronotum – stretched, narrow, extending over the abdomen, incompletely covering the tummy, smooth, contributes to streamlined body shape hind legs – strong and muscular femora; tibiae – retain small backbones; legs and mid-legs – slender; bodies – completely developed, cover the entire tummy; forewings – narrow, tough, green; hind bodies – membranous. Table 2 provides the morphometric measures of insects.

Internal morphology: Digestive system – comprises of foregut, midgut, and hindgut, foregut comprises of crop and gizzard; manly reproductive system – comprises of a brace of testes connected to the vas deferens, which further connects to the aedeagus; womanish reproductive system – comprises of a brace of ovaries connected to oviducts, spermatheca, ovipositor; respiratory system – comprises of spiracles on the side of the body, which connect to a network of tracheae; nervous system – comprises of central brain, frontal whim-whams cord, supplemental jitters.

Behavior Feeding – herbivorous, primarily feeds on meadows and herbaceous shops, strong bills enable biting factory material; locomotion – well-developed jumping capability, primary means of locomotion for escaping pitfalls is jumping, can also fly; avoiding bloodsuckers – green body color provides disguise, remain still under trouble, escapes pitfalls by jumping or flying; lovemaking – occurs during warmer months, males give courting displays, ladies lay eggs in soil or in factory stems where they door; seasonal gesteactive during warmer months, population growth seen during late spring and summer, dropped exertion or dormant during colder months.

Table 2. Morphometric measurements of *Atractomorpha sinensis sinensis* (Bolivar, 1905).

S.N.	Body Part	Male (mm)	Female (mm)
1	Body length	25–30	35–40
2	Hind femur length	12–15	18–22
3	Hind femur width	3–3.5	4–5
4	Hind tibia length	10–12	15–18
5	Pronotum (length/width)	5–6/2.5	6–7 / 3
6	Head length	4–5	5–6
7	Head width	3–4	4–5
8	Average diameter of the head capsule	2.5–3	3–4
9	Maximum diameter of the eye	1.5–2	2–2.5
10	Minimum diameter of the eye	1–1.5	1.5–2
11	Average diameter of the eye	1.25–1.75	1.75–2.25
12	Interocular space	1.5–2	2–2.5

CONCLUSIONS

During the check, about 57 samples of grasshoppers were collected from colourful territories and colourful fields. The detailed study of species reveals that the species of grasshoppers belong to the *Pyrgomorphidae* family. An extensive check of colorful crop territories to collect grasshoppers from different agrarian areas had been conducted. An attempt has been made to collect the samples from their host plant. It had been an expansive check for grasshoppers corresponding of diversified and rich foliage as well as different ecological conditions, downfall, moisture, and temperature.

The calculation work forms an important element of the study. The computer has been used for the management of a data matrix. The result consists of tables and morphometric measurements of the *Atractomorpha psittacina psittacine*, *Atractomorpha sinensis sinensis* species. Surveys in colorful seasons to important agrarian areas in different regions of Patna quarter for the collection of grasshoppers during check compliances have been made on their geographical distribution, diversity, host range, and pest prevalence.

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