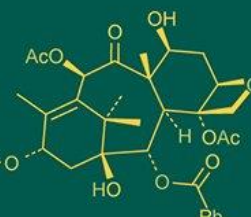
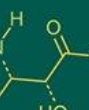
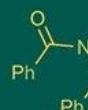


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2023; SP-7(2): 438-441
www.biochemjournal.com
Received: 10-08-2023
Accepted: 16-09-2023

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Comparative morphometric analysis of short-horned grasshoppers (Orthoptera: Acrididae and Pyrgomorphidae) recorded from Telangana, India

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DOI: <https://www.doi.org/10.33545/26174693.2023.v7.i2Sf.9195>

Abstract

Morphometric analysis is an important component of insect taxonomy and provides reliable characters for species identification and comparison among related taxa. The present study was conducted to compare the morphometric characteristics of 21 species of short-horned grasshoppers belonging to the families Acrididae and Pyrgomorphidae collected from different agro-climatic zones of Telangana, India. Standard morphometric characters including body length, antennal length, head length, pronotum length, tegmina length, hind femur length and hind tibia length were recorded from male and female specimens. A total of 21 species representing 18 genera were examined. The results revealed considerable interspecific variation in all morphometric characters. Females were generally larger than males in almost all species, indicating pronounced sexual dimorphism. *Poecillocerus pictus* exhibited the largest average body length among the pyrgomorphids (62.84 mm in females), whereas *Acrotylus humbertianus* was the smallest acridid species (13.70 mm in males). Among Acrididae, *Cyrtacanthacris tatarica tatarica* possessed the greatest average body length (57.54 mm in females), while *Spathosternum prasiniferum prasiniferum* exhibited comparatively smaller body dimensions. Hind femur and hind tibia measurements varied proportionally with body size and reflected adaptations for locomotion. Tegmina length also showed considerable variation among species and was absent in *Neorthacris acuticeps acuticeps* because of wing reduction. The study demonstrates that morphometric measurements provide dependable diagnostic characters for distinguishing closely related species and support traditional taxonomic classification of short-horned grasshoppers. The generated baseline data will be valuable for future systematic, ecological and biodiversity studies on Orthoptera in India.

Keywords: Acrididae, Pyrgomorphidae, morphometrics, taxonomy, grasshopper, Telangana

Introduction

Short-horned grasshoppers (Orthoptera: Caelifera) constitute one of the most diverse groups of phytophagous insects and play important ecological and agricultural roles. The family Acrididae alone comprises over 6,500 described species worldwide and represents the largest family of Orthoptera (Dirsh, 1975) [2]. Several grasshopper species are economically important because they feed on cereals, pulses, oilseeds, vegetables, fodder crops and natural grasses. Outbreaks of certain acridid species can cause severe economic losses by reducing crop productivity and forage availability. Conversely, many species contribute significantly to ecosystem functioning by regulating plant biomass, participating in nutrient cycling and serving as food for birds, reptiles and predatory arthropods. Therefore, accurate identification of grasshopper species is fundamental for biodiversity assessment, ecological studies, pest surveillance and integrated pest management programmes.

India possesses a rich diversity of Orthopteran fauna owing to its varied climatic conditions and heterogeneous vegetation. Telangana situated on the Deccan Plateau encompasses multiple agro-climatic zones ranging from irrigated agricultural landscapes to dry deciduous forests and natural grasslands. These diverse habitats support a rich assemblage of short-horned grasshoppers. However, despite the ecological and agricultural importance of these insects, comprehensive morphometric information on the grasshopper fauna of Telangana remains limited. Most available studies focus primarily on species inventories or taxonomic descriptions whereas quantitative comparisons of morphometric characters among different

species are relatively scarce (Dinesh Waghmare, 2013; Mayya *et al.*, 2005; Paulraj *et al.*, 2009) ^[1, 6, 7].

Morphological and morphometric characters remain fundamental tools for species identification of grasshoppers despite advances in molecular taxonomy. Measurements of body length, antennal length, head, pronotum, tegmina and hind legs have long been used for species diagnosis, evaluation of sexual dimorphism and comparative taxonomy Kirby, W.F. (1914) ^[5]; Uvarov, 1966 ^[11]; Dirsh, (1975) ^[2]. Such measurements provide quantitative evidence supporting traditional morphological descriptions and facilitate discrimination among closely related taxa. (Grunshaw, 1988; Husemann *et al.*, 2012; Song, 2010; Shishodia *et al.*, 2010; Song *et al.*, 2018) ^[3, 4, 9, 8, 10]

The state of Telangana supports diverse grasshopper fauna owing to its varied agro-climatic conditions, cropping systems and natural vegetation. However, comprehensive morphometric information on the short-horned grasshoppers occurring in the state remains scarce. The present investigation was therefore undertaken to compare the morphometric characteristics of twenty species belonging to the families Acrididae and Pyrgomorphidae recorded from different agro-climatic regions of Telangana. The study aims to generate baseline morphometric data useful for species identification, comparative taxonomy, biodiversity documentation and future systematic studies on Indian Orthoptera.

Materials and Methods

Study Area

Adult grasshopper specimens were collected from three different agro-climatic zones of Telangana, India representing agricultural fields, grasslands, fallow lands and natural vegetation. Collections were made during systematic field surveys covering multiple locations to represent the diversity of short-horned grasshoppers occurring in the state.

Collection and Preservation of Specimens

Adult grasshoppers were collected using sweep nets and hand picking during active field surveys. Collected specimens were euthanized using ethyl acetate and preserved following standard entomological procedures. The specimens were stretched, pinned, labelled and deposited for further taxonomic examination.

Identification of Species

Species identification was carried out using standard taxonomic keys and diagnostic descriptions provided by Dirsh (1975) ^[2], Uvarov (1966) ^[11], Kirby (1914) ^[5] and Shishodia *et al.* (2010) ^[8]. Identification was confirmed by comparing external morphological characters and diagnostic taxonomic features.

Morphometric Measurements

Morphometric observations were recorded using a digital Vernier caliper with an accuracy of 0.01 mm. Seven external morphological characters were measured:

- Body length
- Antennal length
- Head length
- Pronotum length
- Tegmina length
- Hind femur length

- Hind tibia length

Measurements were recorded separately for male and female specimens wherever both sexes were available. Mean values were calculated from five adult specimens of each sex for each species.

Results and Discussion

Morphometric Variation among Short-horned Grasshopper Species

Morphometric analysis of 21 species of short-horned grasshoppers belonging to the families Acrididae and Pyrgomorphidae revealed considerable interspecific variation in all seven measured morphological characters, namely body length, antennal length, head length, pronotum length, tegmina length, hind femur length and hind tibia length (Table 1). Distinct differences in body size and appendage dimensions were observed among species, reflecting their taxonomic diversity and ecological adaptations.

Body Length

Body length varied markedly among the recorded species. Among the Pyrgomorphidae, *Poekilocerus pictus* exhibited the greatest average body length, measuring 51.52 mm in males and 62.84 mm in females. Within the family Acrididae, *Cyrtacanthacris tatarica tatarica* was the largest species, with an average body length of 43.42 mm in males and 57.54 mm in females. In contrast, *Acrotylus humbertianus* was the smallest species examined, recording an average body length of 13.70 mm in males and 18.76 mm in females. Relatively smaller body dimensions were also observed in *Spathosternum prasiniferum prasiniferum*, *Atractomorpha crenulata crenulata* and *Chrotogonus trachypterus trachypterus* (Table 1). Overall, females possessed greater body length than males in almost all species, indicating pronounced sexual dimorphism.

Antennal Length

Considerable variation was observed in antennal length among the species studied. The longest antennae were recorded in *Poekilocerus pictus* (20.83 mm in males and 18.51 mm in females) and *Cyrtacanthacris tatarica tatarica* (13.59 mm in males and 20.55 mm in females), whereas the shortest antennae were observed in *Acrotylus humbertianus* (3.32 mm in males and 4.94 mm in females) (Table 1). Species belonging to the genera *Hieroglyphus*, *Acrida* and *Gastrimargus* also exhibited relatively long antennae, reflecting their characteristic head morphology and sensory adaptations.

Head and Pronotum Length

Head length and pronotum length showed moderate interspecific variation. The greatest head length was observed in female *Acrida exaltata* (10.62 mm), followed by female *Acrida turrita* (9.61 mm), while the smallest head length was recorded in male *Acrotylus humbertianus* (2.40 mm). Similarly, pronotum length ranged from 1.52 mm in male *Acrotylus humbertianus* to 13.59 mm in female *Cyrtacanthacris tatarica tatarica* (Table 1). Larger-bodied species generally possessed longer pronota, suggesting proportional growth of thoracic structures with increasing body size.

Tegmina Length

Tegmina length exhibited substantial variation among species. The longest tegmina were observed in female *Cyrtacanthacris tatarica tatarica* (53.42 mm), followed by female *Acrida exaltata* (43.35 mm), female *Acrida turrita* (42.43 mm) and *Poekilocerus pictus* (42.18 mm) (Table 1). In contrast, *Neorthacris acuticeps acuticeps* lacked tegmina in both sexes, confirming its brachypterous condition. Smaller species, including *Acrotylus humbertianus* and *Spathosternum prasiniferum prasiniferum*, possessed comparatively shorter tegmina.

Hind Femur and Hind Tibia Length

Measurements of the hind femur and hind tibia demonstrated a strong positive relationship with body size. The longest hind femur was recorded in female *Cyrtacanthacris tatarica tatarica* (33.46 mm), followed by female *Acrida exaltata* (31.29 mm) and female *Poekilocerus pictus* (25.38 mm). Likewise, hind tibia length was greatest in female *Cyrtacanthacris tatarica tatarica* (30.28 mm), followed by female *Acrida exaltata* (30.16 mm). In contrast, *Acrotylus humbertianus* exhibited the shortest hind femur (8.09 mm in males) and hind tibia (6.61 mm in males). These observations indicate that larger grasshopper species possess proportionally longer hind legs, facilitating efficient jumping and locomotion.

Sexual Dimorphism

Sexual dimorphism was consistently observed among the recorded species. Females generally exceeded males in body length, pronotum length, tegmina length, hind femur length and hind tibia length. The difference was particularly evident in *Poekilocerus pictus*, *Acrida exaltata*, *Cyrtacanthacris tatarica tatarica*, *Hieroglyphus banian* and *Euprepocnemis alacris alacris*. The larger body size of females is likely associated with greater reproductive capacity and egg production. Although antennal length varied between sexes, the pattern was not consistent across all species.

Overall Morphometric Comparison

The present investigation demonstrates substantial interspecific variation in morphometric characters among the twenty short-horned grasshopper species recorded from Telangana. Body length, tegmina length and hind leg measurements were the most variable parameters, whereas head and pronotum length exhibited comparatively lower variability. The observed morphometric differences provide reliable quantitative characters for species discrimination and support conventional taxonomic identification based on external morphology.

Table 1: Consolidated Morphometric Table of Short-horned Grasshoppers Recorded from Telangana (Average values in mm)

S. No	Species	Sex	Body length	Antenna	Head length	Pronotum	Tegmina	Hind femur	Hind tibia
1.	<i>Atractomorpha crenulata crenulata</i>	♂	18.26	4.95	4.27	2.88	15.31	8.43	7.46
		♀	26.02	5.30	4.30	3.39	18.59	9.24	9.08
2.	<i>Chrotogonus trachypterus trachypterus</i>	♀	21.07	7.45	4.80	3.30	11.05	11.94	10.49
3.	<i>Poekilocerus pictus</i>	♂	51.52	20.83	6.33	5.89	42.36	23.61	23.30
		♀	62.84	18.51	5.97	7.15	42.18	25.38	25.19
4.	<i>Neorthacris acuticeps acuticeps</i>	♂	18.73	7.30	2.58	2.14	-	7.25	6.89
		♀	23.49	6.29	3.69	2.64	-	8.40	7.97
5.	<i>Acrida exaltata</i>	♂	32.45	10.54	6.90	4.84	26.55	20.45	20.41
		♀	53.48	12.99	10.62	8.23	43.35	31.29	30.16
6.	<i>Acrida turrita</i>	♀	51.59	10.87	9.61	6.15	42.43	29.92	28.08
7.	<i>Phlaeoba infumata</i>	♂	19.85	7.21	3.33	2.01	16.75	12.08	11.51
		♀	30.26	6.96	4.65	3.78	24.87	16.97	15.11
8.	<i>Diabolocatanotops pinguis</i>	♂	24.91	8.26	2.78	2.85	23.24	13.63	11.44
		♀	34.52	8.55	3.70	4.01	30.60	17.25	14.29
9.	<i>Xenocatanotops karnyi</i>	♂	18.53	4.97	3.09	2.15	16.24	10.38	8.61
		♀	21.95	7.19	4.44	3.31	20.04	12.76	10.91
10.	<i>Acorypha glaucopsis</i>	♀	27.97	9.10	5.93	4.92	19.56	14.88	11.79
11.	<i>Cyrtacanthacris tatarica tatarica</i>	♂	43.42	13.59	4.72	9.95	40.86	23.59	21.46
		♀	57.54	20.55	5.89	13.59	53.42	33.46	30.28
12.	<i>Cataloipus indicus</i>	♂	33.71	5.70	6.08	4.87	33.07	20.04	18.75
13.	<i>Euprepocnemis alacris alacris</i>	♂	22.65	7.70	2.51	3.03	17.41	12.87	10.85
		♀	41.44	9.31	6.35	5.07	35.36	28.43	25.08
14.	<i>Hieroglyphus banian</i>	♂	35.27	16.14	4.61	5.55	25.63	18.07	17.04
		♀	46.56	17.92	6.59	6.26	31.89	24.52	21.91
15.	<i>Hieroglyphus nigrorepletus</i>	♂	37.06	13.52	5.01	5.49	33.28	21.16	20.34
		♀	43.52	10.42	4.80	5.90	39.53	20.71	20.38
16.	<i>Acrotylus humbertianus</i>	♂	13.70	3.32	2.40	1.52	14.06	8.09	6.61
		♀	18.76	4.94	2.73	1.88	18.31	10.13	9.25
17.	<i>Aiolopus thalassinus thalassinus</i>	♀	31.06	9.42	4.59	2.88	32.51	18.06	16.47
18.	<i>Gastrimargus africanus africanus</i>	♂	24.26	8.74	5.70	5.21	26.67	16.22	14.10
		♀	32.91	9.23	6.21	8.17	35.75	20.38	19.32
19.	<i>Oxya hyla hyla</i>	♂	21.25	5.14	3.67	4.17	18.20	11.28	10.11
		♀	24.37	7.06	4.94	4.55	21.26	14.42	11.87
20.	<i>Oxya nitidula</i>	♂	20.16	4.77	2.62	1.60	19.47	10.92	10.32
		♀	25.33	5.94	3.32	2.07	21.95	14.90	12.74
21.	<i>Spathosternum prasiniferum prasiniferum</i>	♂	15.41	4.50	2.36	2.01	13.92	8.90	7.87
		♀	21.15	5.97	3.79	2.78	16.07	10.92	9.61

Discussion

The present study revealed considerable interspecific variation in the morphometric characters of 21 species of short-horned grasshoppers belonging to the families Acrididae and Pyrgomorphidae recorded from Telangana. Body length, tegmina length and hind leg measurements exhibited the greatest variation among the species studied. Females were generally larger than males, indicating pronounced sexual dimorphism, which is consistent with the observations of Dirsh (1975) ^[2] and Uvarov (1966) ^[11], who reported that female grasshoppers are typically larger because of their reproductive role.

Among the species examined, *Poecillocerus pictus* and *Cyrtacanthacris tatarica tatarica* exhibited the largest body dimensions, whereas *Acrotylus humbertianus* was the smallest. The proportional increase in hind femur and hind tibia length with body size reflects adaptations for jumping and locomotion. The absence of tegmina in *Neorthacris acuticeps acuticeps* further demonstrates species-specific morphological adaptations. Similar findings have been reported by Song (2010) ^[9] and Husemann *et al.* (2012) ^[4], who emphasized the taxonomic and evolutionary significance of morphometric variation in grasshoppers.

Overall, the morphometric characters examined in the present study provide reliable diagnostic features for species identification and support traditional morphological taxonomy. The baseline morphometric data generated will be valuable for future taxonomic revisions, biodiversity assessments, and systematic studies of Indian Orthoptera.

Conclusion

The present investigation provides a comprehensive comparison of morphometric characters of 21 short-horned grasshopper species from Telangana. Significant interspecific variation and clear sexual dimorphism were observed for all measured characters. Body size, tegmina length and hind leg dimensions were the most variable parameters among species. These morphometric data provide reliable diagnostic information for species identification and constitute valuable baseline information for taxonomic revision, biodiversity documentation and future systematic studies on Indian Orthoptera.

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