



DOI: <https://doi.org/10.54692/lgujls.2024.0803xxx>

Paper Submission: 20th May 2024; Paper Acceptance: 7th Sep 2024; Paper Publication: 10th Sep 2024

Research Article

LGU J. Life. Sci

Vol 8 Issue 3 July- Sep 2024

ISSN 2519-9404

eISSN 2521-0130

Records of some Oxyinae (Orthoptera, Acrididae) from Sindh, Pakistan

Sadaf Soomro¹, Riffat Sultana¹

1. Department of Zoology, University of Sindh Jamshoro, Sindh, Pakistan

Corresponding Author's Email: Sadafsoomro137@gmail.com

ABSTRACT: *Sindh is in the Oriental region and makes a significant contribution to the agricultural sector, partly due to its widespread moderate climatic conditions. Oxyinae can easily survive in this region and various species of Oxyinae cause harm to crops, specifically paddy crops. An extensive survey of different cultivated and uncultivated areas of Sindh was planned to assess the identification and zoogeographical affinities of Oxyinae. A random survey of selected areas was conducted from 2021 to 2023. A total of 917 specimens were collected and sorted into four species of Oxyinae: *Oxya hyla* (Serville, 1831), *Oxya. velox* (Fabricius, 1787), *Oxya. fuscovittata* (Marschall, 1836), of the genus *Oxya*, and *Oxyina bidentata* (Willemse, 1925), of the genus *Oxyina*. Specimens were collected from various habitats, including rice fields, short, long, and thick grasses, semi-desert areas, vegetation, herbs, shrubs, and along roadsides. According to geological history, the eco-fauna of Oxyinae hoppers depends on their taxonomic composition.*

Keywords: Canal Harm, Crops, Taxonomy, Zoogeographical affinities, Sindh

INTRODUCTION

Oxyinae grasshoppers, belonging to the order Orthoptera (Acrididae), are zoogeographically distributed around the world, including Australia, Southeastern Russia, China, and Pakistan (Hollis, 1971). In Africa and Asia, they are abundant. Oxyinae is considered a major pest of various cultivated and valuable crops, damaging maize, sugar cane, wheat, fodder crops, and rice (Sultana et al., 2021). Due to their small size, capturing Oxyinae during data collection is very challenging. These grasshoppers are polyphagous, attacking and damaging a variety of valuable crops (Sultana et al., 2013). They are considered major pests of rice (*Oryza sativa*) fields (Karim and Riazuddin, 1999). Adult Oxyinae grasshoppers chew holes in leaves using their mandibles (Sultana et al., 2013). They also do so during their developmental stages (Uvarov, 1926). There are numerous publications on food preference, taxonomy, pest status, plant control, and distribution. The genus *Oxya* was established by Audinet-Serville in 1831 and revised multiple times by (Hollis 1971, 1975), and (Willemse 1925). Particularly important are Hollis's revision identifying 18 species based on quantitative analysis. Some cytological and morphological characteristics have helped establish the taxonomic position of Oxyinae grasshoppers

(Ma et al., 1994) and (Xu et al., 1997). (Mohan and Manoharan 1987), (Yusuf 1996), (Usmani and Nayeem 2012), and (Samejo and Sultana 2019), provided detailed descriptions of the taxonomic status of *Oxya* grasshoppers. (Dirsh 1956), introduced a comprehensive value of Acridoidea genera from Africa. (Hollis 1971, 1975), carried out significant work on revising many sub-families of Acrididae, including Oxyina, noting many revolutionary changes in this group. European fauna was discovered by (Harz, 1975). However, none of these studies fully covered the taxonomy of Oxyinae from Sindh. Although, a detailed account of the systematics of Oxyinae was given by Sultana et al. (2020a, 2020b, 2021), Kumar et al. (2013) and Soomro et al. (2015, 2016, 2017, 2018) no study had been carried out on the zoogeographical affinities of this group. Therefore, the present study was designed to assess the presence of Oxyinae hoppers and their geographical position. In the present study, we provide the taxonomy of four species from two genera (i.e., *Oxya* and *Oxyina*) of Oxyinae based on their variation and covariance with other variables. Beside this, zoogeographical distribution of Oxyinae was also discussed. Oxyinae are phytophagous insects damaging a variety of valuable crops e.g., sugarcane (*Saccharum*

officinarum), wheat (*Triticum aestivum*), rice (*Oryza sativa*) and other economically important crops. Additionally, these hoppers also attack and damage trees, herbs and shrubs (Sultana et al. 2012). Owing to their great reproductive potential and power of dispersal, these insects are considered major pests of valuable plants and crops. Their destructive impact on the leaves is evident at all developmental stages of the plants. According to the geographic distribution, Sindh has great importance with its relevance to Indomalayan, Ethiopian and Palearctic elements. The distribution of eco-fauna in each continent or area reflects a connecting link between the existing life forms and the types and patterns of herbiage in the area. Analogous fauna of different continents differs in their taxonomic composition, owing to the geological history of the general fauna. According to the zoogeographic position, Pakistan is unique in covering three major zoogeographic regions, i.e., Palearctic, Ethiopian and Indomalayan, among the world's six major zoogeographic regions. The Indomalayan region is bounded with the Indus River at the west, the Himalayas in the north, China, Indonesia and the Philippines in the southwest. Majority of the arid part, which is present in the west of the Indus River is included in the Palearctic

region, while the high deserts fall in the Ethiopian region.

Life forms and climatic biomes

The majority of Oxyinae are herbicoles and some species are gramnicoles. Herbaceous species are found in small trees or bushes. According to their habitat, their body structure is in relation to the thickness of the flora. These types of species live in open habitats and thick grasses, so according to their living style the freely living species mostly are broader and shorter in size and those inhabiting thickets are slightly longer and cylindrical in shape. While gramnicoles Oxyinae hoppers primarily live in the grasses, so their body structure is compressed, width and height are smaller than herbicoles species and face is oblique in shape. Recent survey and ecological data showed that the short, bodied grasshoppers occur in short and long grasses, while long bodied grasshoppers are restricted to long grasses only. Gramnicoles species are greenish, grey or straw-yellow in color, analogous with shades of the grasses.

Zoogeographically, Pakistan is divided into ten major zones, i.e., Temperate, Tundra, Taiga, Mixed and deciduous forests, Wooded meadow – steppe and steppe grassland and semi-desert, desert, hilly mountainous forests and tropical rain forests zone. Several Acrididae herbicoles species are found from mixed and deciduous

forests and gramnicoles from wooded meadow-steppe and steppe and genus *Oxya* from the desert of Sindh. Sindh is situated in subtropical region and according to the climatic condition Sindh is divided into three regions, i.e., upper region (center Jacobabad), middle region (center Hyderabad) and lower region (center Karachi), the climatic conditions of these regions are moderate, with the temperature frequently rising above the 46°C from May to August and 2°C recorded during the months of December to January. Average

rainfall in Sindh is 20 – 31 cm in a year.

MATERIAL AND METHODS

Sampling Sites

The data collection and sampling were done from the irrigated, non-irrigated area and grassland of different districts of Sindh, during the year 2021 to 2023, 17 study sites were selected for the determination, distribution and zoogeographic position of *Oxyinae* hoppers. A total of 917 specimens were randomly collected from the sites shown in table 1.

Table 1: Data of different study sites

Area name	Latitude	Longitude
Matiari	25.5922° N	68.444° E
Jamshoro	25.4303° N	68.2809° E
Hyderabad	25.3960° N	68.3578° E
Tando Allah yar	25.4570° N	68.7215° E
Tando. M. Khan	25.1256° N	68.5426° E
Badin	24.6459° N	68.8467° E
Saanghr	27.9570° N	68.6380° E
Shikarpur	26.0436° N	68.9480° E
Larkana	27.5570° N	68.2028° E
Mirpur Khas	25.5256° N	69.0136° E
Khairpur	27.5256° N	68.7551° E
Dadu	26.7341° N	67.7795° E
Thatta	24.7475° N	67.9106° E
Sukkar	27.7244° N	68.8228° E
Qambar Shahdadkot	27.5859° N	68.0060° E
Noushehro Feroze	26.8463° N	68.1253° E
Sujawal	24.6042° N	68.0776° E

Collection and preservation of specimens

All grasshoppers collected from distinct localities were captured using two methods: hand-picking and netting (net diameter 8.9 cm and length 51 cm). The collected specimens were placed in jars and killed using potassium cyanide (KCN) following standard entomological methods described by Vickery and Kevan (1983). After killing, the specimens were transferred from the cyanide bottles to preserving boxes containing 70% alcohol and a few drops of glycerin for further analysis. The identification of the specimens was carried out using a stereoscopic dissecting binocular microscopic (Olympus SZX7, SZ2- ILST), following the taxonomic keys and descriptions of Hollis (1971, 1975). Morphometric measurements were taken in millimeters using scales, ocular squares, reticules, and dividers. All collected material was preserved in preserving boxes with their ID number, genus, species name and the name of the host plant from which the Oxyinae hoppers were captured. The

specimens were stored in the Sindh Entomological Museum (SEM) at the Department of Zoology, University of Sindh, Jamshoro.

RESULTS AND DISCUSSION

***Oxya hyla* Serville, 1831**

Morphological Characteristics

Female specimens of this species are larger and stouter, while male species is moderate in size. The body is pale green or reddish brown in color. Antennae filiform, with 24 to 27 segments. Female antennae shorter in length and male antennae larger in size as compared to the combined length of head and pronotum. Eyes oval, fastigium of vertex short, broad, wide and obtusely angular. The pronotum sub cylindrical in shape, with white broad band lined and dorsally possess two black bands. Metazona is shorter than prozona. Tegmina is fully developed and larger in size than wings, few tegmina have short bristles on anteriorly. Wings are hyaline. Femur light green in color. Male cercus conical in shape (Table 2).

Table 2: Measurement of various body parts of *Oxya hyla*

Body parameters	Male (n=15)		Female (n=15)	
	Mean ±SD (mm)	Range	Mean ±SD (mm)	Range
Length of antenna	6.76 ± 0.31	6.3 -7.1	6.79 ± 0.51	5.59-7.29
Distance between eyes	0.50 ± 0.07	0.4-0.7	0.78 ±0.08	0.69-0.9
Length of head	2.76 ± 0.28	2.1-3.3	3.39 ±0.35	2.9-3.7.1
Length of pronotum	3.91 ± 0.30	3.5-4.5	5.04 ±0.61	4.3-5.02
Length of Tegmina	19.70 ± 0.81	19-22	24.3 ±2.12	19.7-30
Width of Tegmina	3.35 ± 0.80	3.0-5.0	4.31 ±0.63	3.001-5.2
Length of wings	18.5 ± 0.10	17-21	22.04 ±2.03	20-26.01
Width of wings	8.5 ± 0.7	7.0-9.0	9.97 ±0.83	9.02-11
Length of femur	12.34 ± 0.8	11-14	15.01 ±1.39	13.2-16.7
Width of femur	3.4 ± 0.45	3.0-4.0	3.75 ±0.41	3.02-04
Length of tibia	10.77 ± 0.61	10-12	12.72 ±1.32	11.03-15
Total body length	20.97 ±1.25	19-23	26.7 ±3.06	22.5-31

Material examined

PAKISTAN: Sindh province. 21♂, 32 ♀, Tando Muhammad Khan (25.1256° N, 68.5426° E), 17 June 2021, Sadaf. 7 ♂, 14 ♀, Badin (24.6459° N, 68.8467° E) 27 March 2021, Sadaf and Seema. 27 ♂, 42 ♀, Shikarpur (26.0436° N, 68.9480° E) 03 June 2022, Sadaf. 5♂, 7♀, Sukkar (27.7244° N, 68.8228° E), 14 July 2021, Sadaf. 18♂, 24♀, Matiari (25.5922° N, 68.444° E) 19 August 2022, Sadaf. 9♂, 19♀, Jamshoro (25.4303° N, 68.2809° E), 7 May 2022, Sadaf. 13♂, 16♀ Khairpur (27.5256° N, 68.7551° E), 22 April 2023, Sadaf. 17♂, 19♀, Thatta (24.7475° N, 67.9106° E), 11 March, 2023, Sadaf. 14♂, 25♀ Hyderabad (25.3960° N, 68.3578° E), 8 September 2022, Sadaf.

Habitat

The majority of *Oxyinae* species were found in thick grasses (*Cynodon dactylon*), in roadside vegetation and some other agricultural fields. It was observed that some specimens of this species were present in rice (*Oryza sativa*), maize (*Zea mays*) and jowar (*Sorghum vulgare*). *Oxyinae* are very harmful and damage economically important crops.

Geographical distribution

Oxya hyla grasshoppers have greater geographical range and coupled with this feature, which is excessively variable in its general size and morphological appearances. According to Sergeev (1995), *Oxya* species are terrestrial insects, they are found in Pakistan and some other countries i.e. Africa, Afghanistan, Bangladesh, India, Nepal, Sri Lanka and Kenya.

Zoogeographically Pakistan lies in the Indomalayan, this region connected with Sindh, Punjab and Khyber Pakhtunkhwa. The oriental fauna zone is bounded on the west by the river Indus, while Himalayas (north), China, Indonesia and Philippines with southeast, reported by Sultana and Wagan 2015. Their presence has been confirmed from Tando Muhammad Khan, Badin, Shikarpur, Sukkar, Matiari, Jamshoro, Khairpur, Thatta, Hyderabad and some other cultivated areas. At the present *Oxya hyla* was found abundantly from rice field and observed that the male and female specimens of this species are the major pest of many cultivated areas.

Species: *Oxya velox* (Fabricius, 1787)

Morphological Characteristics

Body medium to large, with pale to paler greenish color. Antennae and Tegmina both are fully developed. Antennae are wooden brown in color while tegmen with yellow brownish in color at basal parts. The edges of the vertex and eyes are dark brownish in color. Wings are hyaline. The inner and lower part of hind femur is yellowish green. Female is larger in length than male specimens. Fastigium of vertex short, weakly concave, less widened with apex obtusely parabolic and transverse furrows absent. Metazona flattened and weakly flattened prozona. Hind tibia with two rows, 39 dorsal black tipped spines, 09 external, while 11 internal (Table 3).

Table 3: Measurement of various body parts of *Oxya velox*

Body parameters	Male (n=15) mm		Female (n=15) mm	
	Mean ±SD	Range	Mean ±SD	Range
Length of antenna	6.65 ± 0.32	6.61-7.4	6.37 ± 0.70	5.5-7.4
Distance between eyes	0.39 ± 0.04	0.42-0.7	0.69 ± 0.06	0.7-0.9
Length of head	2.61 ± 0.20	2.41-2.1	3.30 ± 0.14	03-3.6
Length of pronotum	3.69 ± 0.20	3.4-4.3	4.74 ± 0.40	3.81-5.3
Length of Tegmina	18.75 ± 0.86	18.2-20	23.87 ± 1.16	22-25.1
Width of Tegmina	4.09 ± 0.60	3.02-5.1	4.39 ± 0.46	4.02-5.01
Length of wings	17.39 ± 1.36	16.1-20	22.15 ± 1.39	20-23.5
Width of wings	8.81 ± 0.74	8.49-10	10.15 ± 0.81	9.03-13
Length of femur	11.06 ± 0.80	10.2-11	13.89 ± 1.60	10.5-17
Width of femur	3.49 ± 0.60	3.01-4.2	3.70 ± 0.74	3.03-5.3
Length of tibia	10.38 ± 0.51	10.2-10	13.08 ± 1.30	11.0-14
Total body length	20.42 ± 0.86	21-23	26.17 ± 1.96	23-31

Material Examined

PAKISTAN: Sindh province. 36♂, 55 ♀, Tando Muhammad Khan (25.1256° N, 68.5426° E), 2 March, 2021, Sadaf. 28♂, 40♀, Matiari (25.5922° N, 68.444° E) 7 August 2023, Sadaf. 22♂, 31♀ Hyderabad (25.3960° N, 68.3578° E), 29 September 2023, Sadaf.

Habitat

Oxya velox is a rare species. During field survey specimens were collected from the rice field in abundant form and few specimens were captured from grasses.

Geographical Distribution

This herbivores species is distributed in Eastern and Western Pakistan, Burma, India and some irrigation fields of Himalayas. Ahmed (1980) and Baloach (1966) reported this species from the irrigated areas of Sindh, i.e., Thatta, Jacobabad and Larkana divisions.

Species: *Oxya fuscovittata* (Marschall, 1836)

Morphological Characteristics

Female specimens are larger and more robust than male. Antennae brown in color and filiform with 25 to 28 segments, in female antennae size is shorter than male specimens as compared to the combined size of head and pronotum. The wings are fully developed and hyaline. Fastigium of vertex concave with obtusely parabolic apex, wide and short. Transverse furrow totally absent. Tegmina fully developed, weakly spinose at interior margin, extending by abdomen, broad basally, hyaline, while in distal half it is narrowed. The hind tibia has two rows, these rows covered with the black tipped spines at dorsal, nine spines at dorso-external side while at dorso-internal side having ten spines. Body greenish in color. The head and pronotum both are light green color with dark green patches (Table 4).

Table. 4: Measurement of various body parts *O. fuscovittata*

Body parameters	Male (n=15) mm		Female (n=15) mm	
	Mean ±SD	Range	Mean ±SD	Range
Length of antenna	6.20±0.31	5.7-6.8	6.10±0.30	6.5-7.7
Distance between eyes	0.50±0.12	0.40-0.6	0.67±0.08	0.49-0.6
Length of head	2.79±0.29	2.41-2.79	3.18-0.47	03 -3.9
Length of pronotum	3.80±0.39	3.41-3.08	4.59±0.89	3.21-5.10
Length of Tegmina	19.70±1.10	18.5 -22.05	24.19±1.23	23.7-25.3
Width of Tegmina	3.51±0.49	3.01-4.03	4.49±0.61	4.02-6
Length of wings	18.38±0.69	16.9-18.2	23.40±1.19	22.2-24.9

Width of wings	8.51±0.57	8.01-9.02	10.6±0.59	10.7-10.5
Length of femur	12.49±0.1	11.4-14.98	14 ±1.37	12-15.9
Width of femur	3.39±0.49	3.1-4.3	4.50 ±0.49	4.03-6
Length of tibia	10.9±0.70	11-12.3	12.9±1.07	10.9-13.6
Total body length	21.50±1.50	20.5-24.9	24.08±0.80	23.8-25.9

Material Examined

PAKISTAN: Sindh province. 9♂, 13♀, Sukkar (27.7244° N, 68.8228° E), 22 July 2023, Sadaf. 16♂, 31♀, Jamshoro (25.4303° N, 68.2809° E), 28 August 2022, Sadaf. 29♂, 48♀, Thatta (24.7475° N, 67.9106° E), 11 March, 2021, Sadaf. 25♂, 27♀ Hyderabad (25.3960° N, 68.3578° E), 15 September, 20223, Sadaf.

Habitat

Oxya fuscovittata specimens were collected from the agricultural fields of Sindh, it is found abundantly in maize, rice and wheat crops of Sindh. This species is widely distributed in grass and is a major pest of paddy areas.

Geographical Distribution

Geographically, this species is distributed in Pakistan and India. Records from India by Usmani and Nayeem (2012), include only the females. During present attempt we found both male and female specimens abundantly from different cultivated areas of Sindh. These are herbivores and

included in the Indomalayan region zoogeographically, by Sultana and Wagan 2015.

Species: *Oxyina bidentata* (Willemse, 1925)

Morphological Characteristics

Female larger in size than male specimens. Antennae brown in color with 23 – 25 segments. In male, antennae longer in length than female as compared to the length of head and pronotum combined. Body green in color. Eyes and vertex ofadages brownish in color. Fastigium of vertex wide, short and concave with obtusely parabolic apex. Abdomen yellowish brown in color. The wings are fully developed and hyaline. Pronotum compressed, light greenish and dark green patches are present on dorsum. Tegmina is well developed. Hind tibia with two rows of black-tipped at dorsally and nine externally while internally with ten spines (Table 5).

Table 5: Measurement of various body parts of *O. bidentata*

Body parameters	Male (n=15) mm		Female (n=15) mm	
	Mean ±SD	Range	Mean ±SD	Range
Length of antenna	6.81±0.79	5.1-09	6.6±0.89	5.09-09
Distance between eyes	0.39±0.06	0.5-0.61	0.60±0.06	0.8-0.7.5
Length of head	2.79±0.19.7	2.43-3.10	3.07±0.16	2.78-3.19
Length of pronotum	3.90±0.21.9	3.7-4.7	4.60±0.67	3.9-6

Length of Tegmina	18.80±0.80	17.5-23	22.69±1.40	20.8-24.7
Width of Tegmina	3.49±0.58	3.06-4.03	4.06±0.90	3.10-6
Length of wings	17.7±0.10	16.1-20	20.50±1.40	19.75-29
Width of wings	8.3±0.80	7.01-9.02	9.6±0.77	9.02-10.9
Length of femur	11.7±0.80	10.7-12.9	12.30±1.41	10-13.8
Width of femur	2.10±0.09	2.10-3.17	3.69±0.69	3.02-5.07
Length of tibia	9.54±0.49	9.01-10.07	12.29±0.90	11.6-17
Total body length	20.40±0.79	19.4-19.9	23.7±0.90	21.9-24.7

Material Examined

PAKISTAN: Sindh province. 10♂, 12♀, Tando Allah Yar (25.4570° N, 68.7215° E), 6 March, 2022, Sadaf. 5 ♂, 9 ♀, Sanghar (27.9570° N, 68.6380° E) 27 September 2022, Sadaf and Seema. 7 ♂, 18 ♀, Larkana (27.5570° N, 68.2028° E) 03 June 2023, Sadaf. 13♂, 16♀, Noushahro Feroz, (26.8463° N, 68.1253° E), 23 June 2021, Sadaf. 26♂, 32♀, Sujawal (24.6042° N, 68.0776° E) 10 August 2023, Sadaf. 11♂, 28♀, Mirpur khas (25.5256° N, 69.0136° E), 17 May 2022, Sadaf.

Habitat

Ecological studies show that this species lives in a variety of habitats. Specimens of this species were collected from different agricultural fields and from herbs and shrubs.

Geographical Distribution

Oxyina bidentata widely distributed all around the Asia-tropical, Indian subcontinent, including Pakistan. This species was reported by Ahmed (1980) from the irrigated areas of Khyber Pakhtunkhwa and Punjab, from Sindh it was reported by Soomro at al. (2015). Recently, natural

habitat and interaction of related species was worked by Usmani and Nayeem (2012).

CONCLUSION

Extensive surveys in different localities of Sindh from 2021 to 2023 resulted in the collection of about 917 specimens. These surveys aimed to study the taxonomic composition, zoogeographical status, and distribution of *Oxyinae* in various agricultural fields. *Oxyinae* grasshoppers, observed in habitats such as herbs, shrubs, trees, and fields of maize, jowar, wheat, rice, and sugarcane, prefer rice as their primary diet. The specimens were sorted into four species: *Oxya hyla* (Serville), *O. velox* (Fabricius), *O. fuscovittata* (Marschall), and *Oxyina bidentata* (Willemse). *Oxya hyla* was the most dominant species, especially from May to July, while *Oxyina bidentata* was less common. The highest populations of *Oxyinae* hoppers were recorded during these months. This study, the first to examine the zoogeographical affinities of *Oxyinae* in this region, found these grasshoppers in both irrigated and non-irrigated areas of Sindh, where they

significantly damage economically important crops, particularly rice.

ACKNOWLEDGEMENT

The first author is highly thankful to the farmers and landlords who allowed and assisted me during the field visits. I am grateful to my parents for their support and motivation.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

REFERENCES

1. Ahmed FU (1980). Survey of grasshopper in arid and semi-arid region of Pakistan. Final Rep., Pl-480 No. P.K-ARS-20 (FG-Pa-21): 500.
2. Baloach HA (1966). Taxonomy of Pyrgomorphidae and sub-families Hemiacridinae, Oxyinae, Crytanthacridinae, Eyprepocnemidinae and Catantopinae of Acrididae of Hyderabad and its adjoining areas. M.Sc. Thesis, Uni. of Sindh. 1-66.
3. Dirsh VM (1956). The phallic complex in Acridoida (Orthoptera) in relation to taxonomy. Transactions of the Entomological Society, London. 108 (7): 223-356.
4. Harz K (1975). The Orthoptera of Europe, Series of Entomologia, The Hague. 11: viii+939.
5. Hollis D (1971). A preliminary revision of the genus *Oxya* (Orthoptera:Acridoidea). Bull. Brit. Mus. (Nat. His), Ent. 26 (7): 267-343.
6. Hollis D (1975). Review of the sub-family Oxyinae (Orthoptera: Acridoidea). Bull. Brit. Mus. (Nat. His), Ent. 31: 189- 234.
7. Karim S, Riazuddin S (1999). Rice insects' pests of Pakistan and this control: A lesson from past for suitable integrated pest management. Paki. J. Bot. 2 (2): 261-276.
8. Kumar S, Sultana R, Wagan MS (2013). Susceptibility of developmental stages of *Oxya velox* (Orthoptera: Acrididae) to *Aspergillus* species from Sindh. 33rd Pakistan Congress of Zoology (International) at Islamabad, 2nd - 4th April: 173.
9. Ma E, Guo Y, Zheng Z (1994). Cytotaxonomic study of *Oxya* species in China (Orthoptera: Acridoidea). Entomol. Sin. 1: 101 – 109.
10. Mohan N, Manoharan T (1987). Population distribution and control of small Rice grasshopper *Oxya nitidula*. Madras Agric J. 74: 328-329.
11. Sultana R, Soomro N, Kumar S, Samajo AA, Soomro S (2020a). A Comparative Study of the Egg-pod Morphology in two genera of Oxyinae (Acrididae: Orthoptera) Pak. J. Zool. 52(4):1327-1332.
12. Sultana R, Soomro N, Wagan MS (2020b). Description of new species with comparison to close allies (Oxyinae: Acrididae: Orthoptera). Paki. J. Zool. 1-6.
13. Sultana R, Soomro N, Kumar S, Samajo AA (2021). Comparison of Mating Behavior of four species of Oxyinae (Acrididae: Orthoptera). Paki. J. Zool. 53(3): 1181-1184.

14. Sultana R, Bughio AB, Waheed AP, Haji K (2012). Studies on the Immature Stages of *Oxya velox*. A rice grasshopper from district Jamshoro. FUUAST J. Biol. 2(1): 57-62
15. Sultana R, Wagan MS (2015). Grasshoppers and Locusts of Pakistan. Higher Education Commission of Pakistan. ISBN: 978-969-417-180-7: 1-180.
16. Sultana R, Abbas W, Bughio BA (2013). Preliminary studies on the occurrence of orthoptera from district Jamshoro. FUUAST J. Biol. 3 (2): 111.
17. Soomro N, Sultana R, Wagan MS, Abbasi AR, Solangi BK (2015). Occurrence of *Oxya* Species (Oxyinae: Acrididae: Orthoptera) from Sindh. Sindh Uni. Research J. 47 (2): 251-254
18. Soomro N, Sultana R, Wagan MS (2016). Biology of *Oxya* species (Oxyinae: Acrididae: Orthoptera) under laboratory conditions. 36th Pakistan Congress of Zoology (International) held at Uni. of Sindh, Jamshoro. Feb. 16-18: 133-34.
19. Soomro N, Sultana R, Wagan MS (2017). Comparative study on the immature stages of *oxya* (Oxyinae: Acrididae: Orthoptera). 37th Congress of Zoology (International) at Govt. Coll. Uni. Faisalabad. 210.
20. Soomro N, Sultana R, Wagan, MS (2018). Morphological and behavioral description of *Oxya hyla hyla* under laboratory conditions. 38th Pakistan Congress of Zoology (International) at University of the Punjab, Lahore, Feb. 27- March 1: 221.
21. Sergeev MG (1995). Biodiversity of insects of Arid and semi-arid lands of Eurasia Sino-Russian workshop on the study of Animal Biodiversity of major ecosystem of Eurasia held in Beijing: 57-66.
22. Samejo AA and Sultana R (2019). Morphology of immature stages of *Schistocerca gregaria* with special references to its size variations. Pak. J. Zool. 51: 1221 - 1226.
23. Usmani MK, Nayeem M (2012). Studies on taxonomy and distribution of Acridoidea (Orthoptera) of Bihar, India. J. Threat. Taxa. 4(13): 3190-3204.
24. Uvarov BP (1926). Notes on the *Oxya* (Orthoptera: Acridoidea). Bull. Ento. Res. 17: 45-48.
25. Vickery VR, Kevan DK McE (1983). A monograph of the Orthopteroid insects of the Canada and adjacent regions. Lyman Ent. Mus. Res. Lab. Mem. (13): 680-1462.
26. Willemse C (1925). Contribution a la faune des Orthopteres des Nouvelles Hebrides. Transactions of the Entomological Society of London. 3 (4): 513-525.
27. Xu S, Liu Z and Zheng Z (1997). A cladistics study on karyotype characters of some species of genus *Oxya* (Orthoptera: Acridoidea). J. Shaanxi Normal Univ. 25: 70-73.
28. Yusuf M (1996). Taxonomic studies on Grasshoppers and Locust (Acridoidea: Orthoptera) of Pakistan. Final Technical Report: Pakistan Sci. Foundation, Project S/Bio: 1-158.