



Review Article

PAST OUTLOOK AND CURRENT TAXONOMIC SCENARIO OF GENUS *CHROTOGONUS* (PYRGOMORPHIDAE: ORTHOPTERA): A REVIEW

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ABSTRACT

Species of genus *Chrotogonus* are known as surface grasshoppers which are polyphagous pest, multi-verses, terricolous and one of the common grasshopper species found in small grasses, bushes and often in crops (rice, maize, millet and cotton, etc.). Species belonging to genus *Chrotogonus* cover vast area in various countries of the old world (Africa and Asia) including India and Pakistan. This review provides lacks and benefits of previous research work along with distribution, biodiversity, biology, economic loss and current taxonomic status of genus *Chrotogonus*.

Keywords: *Chrotogonus*, Taxonomy, Biology, Distribution, Economic Loss, Orthoptera.

INTRODUCTION

Pyrgomorphidae family contains about 500 species and is the most colorful family of grasshopper families distributed World-wide. The genus *Chrotogonus* is from the most wide-ranged genera of pyrgomorphidae and contains about 19 species World-wide. Most of the species are found in Africa and Indian subcontinent (Table 1). Several species of *Chrotogonus* are known as important pest of agriculture (Haldhar *et al.*, 2007; Mahmood & Yousuf, 2000). Species of *Chrotogonus* are geophilous in nature (Jat, 2008). Species of genus *Chrotogonus* are harmful to many crops. They feed on plants during the germination stage of plants like wheat and cotton when plant emerges from the seed. Without knowing their systematic position it is impossible to solve the economic issues regarding the grasshopper's species. It has been reported that *Chrotogonus* persist in various habitats including gardens, bare soil, sandy soil, along with road sides and in many field crops in Africa and Asia. Wagan and Riffat observed that it has rough body including many tubercles with granules on surface of body (Wagan & Riffat, 2013). It has been described that *Chrotogonus trachypterus* (Indo Iranian species) basically has two forms *Chrotogonus trachypterus trachypterus* and *Chrotogonus trachypterus robertsi* which are two

subspecies and persist in the eastern and western sides of Indus plains, respectively. Further, Keven mentioned that *C. trachypterus robertsi* found in Baluchistan and Afghanistan in their arid zones along with eastern Palearctic Eremian. He described about *C. trachypterus trachypterus* as North Indian sub-species found in low arid regions hence persist in South of Himalayas from Baluchistan to India. He recorded its presence more abundant in oriental region as compare to Palearctic region. He also compared another species *Chrotogonus homalodemus homalodemus* with these two: *C. trachypterus trachypterus* and *C. trachypterus robertsi* by showing small differentiating character that is slightly slender and found in sandy regions of Baluchistan (Mekran) (Kevan, 1954). This attempt of review of various research papers concerned with genus *Chrotogonus* provides lacks and benefits of previous research work along with distribution, biodiversity, biology, economic loss and current taxonomic status of genus *Chrotogonus*.

Geographical look of *Chrotogonus*

Genus *Chrotogonus* found in the huge region of the old world together with Egypt, Africa and Asia including entire India and Pakistan (Table 1 and Figure 1) (Blackith &

McE, 1967). Species of *Chrotogonus* were commonly noticed in Africa and Orient regions while, *Chrotogonus trachypterus* and *Chrotogonus oxypterus* were common in the North and Southern regions of India, respectively (Jat, 2007). *Chrotogonus* species from Azad Jammu Kashmir, Pakistan reported with taxonomic keys for genera along

with additional characteristics, morphometry and habitats were also highlighted (Mahmood & Yousuf, 2000). In Orissa, serious cause of damage to many crops like sorghum, maize, ground-nut, tobacco and cotton has been recorded by *C. trachypterus* as minor pest (Haldhar *et al.*, 2007).

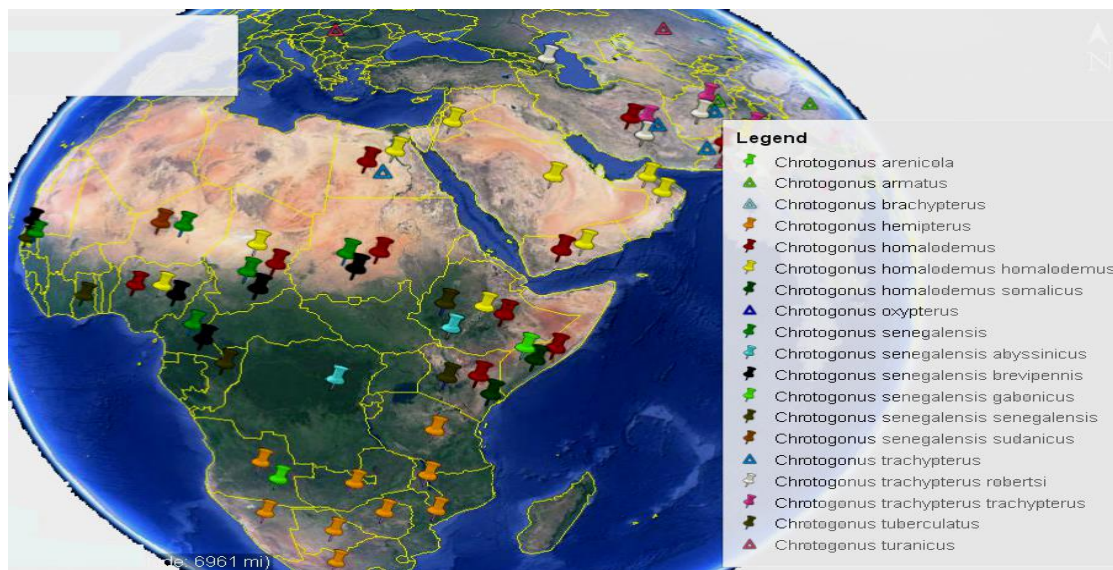


Figure 1. Global Geoposition of genus *Chrotogonus*.

Table 1. World-wide distribution of *Chrotogonus* species (Khan *et al.*, 2018 and Orthoptera Species File).

Species	Country
<i>Chrotogonus homalodemus homalodemus</i>	UAE, Oman, Eremian zone, NE-Africa, Egypt, Palestine, Jordan, Saudi Arabia, Chad, Arabian Peninsula, Yemen, Ethiopia, Nigeria and Pakistan
<i>Chrotogonus homalodemus</i>	Egypt, Iran, West Pakistan, Sudan, Chad, Ethiopia, Kenya, Nigeria, Somalia, Yemen and Pakistan
<i>Chrotogonus trachypterus trachypterus</i>	Afghanistan, India, Bangladesh, Iran, Nepal and Pakistan
<i>Chrotogonus trachypterus robertsi</i>	West Azerbaijan, Iran, Afghanistan, Indian Subcontinent, Pakistan
<i>Chrotogonus trachypterus</i>	Iran, India, Egypt, Afghanistan, and Pakistan
<i>Chrotogonus turanicus</i>	Kazakhstan, Hungary, India and in Pakistan
<i>Chrotogonus armatus</i>	China, Afghanistan, Bangladesh, India, Nepal and Pakistan
<i>Chrotogonus oxypterus</i>	Bangladesh, India and Sri Lanka
<i>Chrotogonus brachypterus</i>	India
<i>Chrotogonus hemipterus</i>	Tanzania, Zambia, Malawi, Mozambique, Zimbabwe, South Africa, Botswana, Namibia and Angola
<i>Chrotogonus homalodemus somalicus</i>	Somalia, Kenya
<i>Chrotogonus senegalensis</i>	Sudan, Niger, Senegal, Chad and Cameroon
<i>Chrotogonus senegalensis abyssinicus</i>	Ethiopia and Democratic Republic of the Congo
<i>Chrotogonus senegalensis brevipennis</i>	Sudan, Niger, Senegal, Chad and Cameroon
<i>Chrotogonus senegalensis gabonicus</i>	Angola
<i>Chrotogonus senegalensis senegalensis</i>	Senegal, Ghana, Congo, Zaire, Ivory Coast
<i>Chrotogonus senegalensis sudanicus</i>	Niger
<i>Chrotogonus arenicola</i>	Somalia
<i>Chrotogonus tuberculatus</i>	Kenya and Ethiopia

Note: Distribution of these species has been reviewed from Orthoptera species file (Online website) and from Khan *et al.*, 2018 (paper).

According to (Misari & Raheja, 1976) *Chrotogonus senegalensis* found in maximum number in paddy crops as compared to other crops. Further, Latif & Haq (1951) reported that surface grasshopper *C. trachypterus* which is terricolous and multivorous in nature was observed as one of the most commonly found species in Sindh, Pakistan, Whereas (Kevan, 1959) reported the presence of *C. trachypterus* in India, Bangladesh, Nepal, Iran, Pakistan and Afghanistan.

Taxonomical status of *Chrotogonus*

Taxonomic work regarding morphological keys on genus *Chrotogonus* done by many Taxonomists (Haldhar *et al.*, 2007; Khan *et al.*, 2018; Khare & Srivastava, 1975; Krauss, 1877; Mahmood & Yousuf, 2000; Poonia & Sunita, 2008;

Rahman, 2001; Ritchie & Mark, 1982; Sahebzadeh *et al.*, 2017; Sonkamble; Srivastava, 1954; Verma & Kanwar, 1998). Because of wide, short, depressed body form and small head, this genus is fairly different. Kevan (Kevan, 1954) described the wide-ranging modification of this genus in 1954. Further, it was also noticed that parts of genitalia were different morphometrically on species level viz. triangular shape was found in supra anal plate of male, tubular morphometry was noticed in the cerci and whereas sub-genital plate was absolutely conical shaped but these structures become change their shape and size in according to species of *Chrotogonus*. Genus *Chrotogonus* divided into three polytypic and seven monotypic species hence contains 10 species and 9 infraspecies (Orthoptera Species File, 2020) (Table 2).

Table 2. List of species/infraspecies found World-wide.

S.No.	Species/Infraspecies	Status	Source
1.	<i>Chrotogonus armatus</i>	Species	Orthoptera Species File
2.	<i>Chrotogonus brachypterus</i>	Species	Orthoptera Species File
3.	<i>Chrotogonus hemipterus</i>	Species	Orthoptera Species File
4.	<i>Chrotogonus homalodemus</i>	Species	Orthoptera Species File
5.	<i>Chrotogonus homalodemus homalodemus</i>	Infraspecies	Orthoptera Species File
6.	<i>Chrotogonus homalodemus somalicus</i>	Infraspecies	Orthoptera Species File
7.	<i>Chrotogonus oxypterus</i>	Species	Orthoptera Species File
8.	<i>Chrotogonus senegalensis</i>	Species	Orthoptera Species File
9.	<i>Chrotogonus senegalensis abyssinicus</i>	Infraspecies	Orthoptera Species File
10.	<i>Chrotogonus senegalensis brevipennis</i>	Infraspecies	Orthoptera Species File
11.	<i>Chrotogonus senegalensis gabonicus</i>	Infraspecies	Orthoptera Species File
12.	<i>Chrotogonus senegalensis senegalensis</i>	Infraspecies	Orthoptera Species File
13.	<i>Chrotogonus senegalensis sudanicus</i>	Infraspecies	Orthoptera Species File
14.	<i>Chrotogonus trachypterus</i>	Species	Orthoptera Species File
15.	<i>Chrotogonus trachypterus robertsi</i>	Infraspecies	Orthoptera Species File
16.	<i>Chrotogonus trachypterus trachypterus</i>	Infraspecies	Orthoptera Species File
17.	<i>Chrotogonus turanicus</i>	Species	Orthoptera Species File
18.	<i>Chrotogonus arenicola</i>	Species	Orthoptera Species File
19.	<i>Chrotogonus tuberculatus</i>	Species	Orthoptera Species File

Note: This list of species has been finalized from Orthoptera species file (Online website).

Chrotogonus is exceptionally variable even among Pyrgomorphidae and is typical than other members of this family in its broad and depressed body form and short head. *Chrotogonus* shows morphological plasticity, even within individual species so it is mystifying. The total range in variation in one species may apparently overlap most, or the whole, of the range in one or more other species: this is particularly true of wing development, but also of many other characters that make specific determination from individual specimens often extremely difficult without adequate geographical data (Kevan, 1959). It is mystifying that even different species of genus *Chrotogonus* showing the morphological flexibility (Blackith & McE, 1967). Furthermore, (Kumar *et al.*, 2014) reported in his work the taxonomic Importance of genitalia parts viz: supra anal

plate of male, sub-genital plate which is the external body part of the male genitalia and the cerci in the male during the classification of Indian pyrgomorphidae (Orthoptera: Pyrgomorphaidea). Besides this, it was noticed that size and shape of supra anal plate of male, sub-genital plate which is the external body part of the male genitalia and the cerci in the male are useful in distinguishing variation between different *Chrotogonus* species.

Morphological description of *Chrotogonus*

Generally size of body is smaller to medium and filiform antennae with 13 to 18 antennal segments. Eyes are paired and compound eyes with interocular space. Anterior margin of pronotum is more arisen as compare to posterior

(Haldhar *et al.*, 2007; Poonia & Sunita, 2008; Rahman, 2001; Ritchie & Mark, 1982; Verma & Kanwar, 1998). Tegmina are slightly larger than wings usually and looking sharp yellow in color including small veins on inner surface. Wings hyaline including veins on inner surface but yellow from the base and small than tegmina. Femur Large in size with robust/swollen muscles at base and becomes gradually narrower towards apex along with dark shade. Tibia slender but Small than femur, bears acute sharp spines in two rows and looks whitish yellow in color (Haldhar *et al.*, 2007; Mahmood & Yousuf, 2000). Cerci small in size, triangular shaped below the supra anal plate with dark shade in the midpoint. Ovipositor valves large, robust and smooth upper surface with small groove at the center. Looking brownish dark at the both ends slightly dark yellow at the center. Posterior part of the ovipositor valve is highly broad in width than segments (Haldhar *et al.*, 2007; Khan *et al.*, 2018). Supera anal plate small in size and greenish yellow in color present above the cerci to cover it entirely. Sub genital plate larger than supra anal plate with triangular shape looks like whitish yellow in color. Spines small spines are present on the tibiae that are very acute and sharp but often these are black tipped (Khan *et al.*, 2018; Rahman, 2001; Verma & Kanwar, 1998).

Biology of *Chrotogonus*

Detailed study on biology of surface grasshopper, *C. trachypterus* (Blanchard) has been carried out for two

successive Rabi seasons from Udaipur (Haldhar *et al.*, 2007; Jat, 2007). Surface grasshoppers are polyphagous in nature, considered as the pests of pastures throughout year while minor pest of agricultural crops. Furthermore, samples of surface grasshoppers which were collected from wheat and barley fields reared under laboratory conditions at the temperature: $28 \pm 2^\circ\text{C}$ which is room temperature along with the humidity: 60 ± 5 percent which is relative humidity under laboratory conditions. In addition to this, it was noted that moist soil is the most preferable for female to lay eggs and she lays eggs in the soil depth of 2-4 centimetre. Morphologically egg-pods look elongated and cylindrical with slight bend in the centre (Jat, 2007).

Various host plants attacked by *Chrotogonus*

Species of *Chrotogonus* like *C. trachypterus* occur as serious pest on the many crops (Table 3) e.g. Millet, Pearl, Cluster bean and Cowpea (Gupta, 1972) whereas *C. hemipterus* was found as pest before flowering stage on sunflower (Khaemba, 1979). Most of the species of Orthoptera are pest of paddy seedlings mostly in nurseries with abundant species *Oxya fuscovittata*, *Attractomorpha crenula* and *H. banian* and whereas *C. trachypterus* and *Acrida exalta* found moderately in number along with less abundant species *Teleogryllus occipitalis*, *Gryllotalpa* and *Catantops pinguis innotabilis*, (Thakre, 2020). *C. trachypterus* also recorded as pest of Cowpea, (Yadav & Yadav, 1983).

Table 3. Host plants attacked by genus *Chrotogonus*.

Host plant species		Source
Scientific name	Common name	
<i>Amaranthus viridis</i>	green amaranth	(Haldhar <i>et al.</i> , 2012)
<i>Arachis hypogea</i>	Groundnut	(Chandra and Mithal, 1983)
<i>Avena sativa</i>	Oat	(Haldhar <i>et al.</i> , 2012)
<i>Brassica campestris</i>	mustard	(Haldhar <i>et al.</i> , 2012)
<i>Brassica oleracea var. botrytis</i>	Cauliflower	(Chandra and Mithal, 1983)
<i>Brassica oleracea var. capitata</i>	Cabbage	(Meena and Singh, 2016)
<i>Cicer arietinum</i>	Gram	(Thippaiah and Kumar, 1999)
<i>Citrullus colocynthis</i>	bitter apple	(Chandra and Mithal, 1984)
<i>Cyamopsis tetragonoloba</i>	guar	(Gupta, 1972)
<i>Cynodon dactylon</i>	Grass	(Meena and Singh, 2016)
<i>Cyperus rotundus</i>	Nut grass	(Haldhar <i>et al.</i> , 2012)
<i>Gossypium hirsutum</i>	Cotton	(Haldhar <i>et al.</i> , 2012)
<i>Helianthus</i>	Sunflowers	(Khaemba, 1979)
<i>Hordeum vulgare</i>	Barley	(Haldhar <i>et al.</i> , 2012)
<i>Lycopersicon esculentum</i>	Tomato	(Meena and Singh, 2016)
<i>Medicago sativa</i>	Lucerne	(Haldhar <i>et al.</i> , 2012)
<i>Pennisetum typhoideum</i>	Bajara	(Gupta, 1972)
<i>Ricinus communis</i>	castor bean	(Chandra and Mithal, 1984)
<i>Solanum melongena</i>	Brinjal	(Chandra and Mithal, 1983)
<i>Spinacea oleracea</i>	Spinach	(Chandra and Mithal, 1983)
<i>Trifolium alexandrianum</i>	Egyptian clover	(Haldhar <i>et al.</i> , 2012)
<i>Triticum aestivum</i>	Wheat	(Meena and Singh, 2016)
<i>Vigna unguiculata</i>	Black-eyed pea	(Gupta, 1972)

The study has been done from Karachi Sindh Pakistan on eighty species of grasshoppers with forty seven genera regarding their seasonal incidence and abundance. *C. trachypterus* found on grasses, vegetables and maize (Perwin *et al.*, 1983) in Khyber Pakhtunkhwa, Pakistan as pest of sunflower, (Sattar *et al.*, 1984) and whereas species of *Chrotogonus* are also major pests of Chilli (*Capsicum annum*) (Reddy, 1984). From the attack of *C. trachypterus* few Indian varieties of cowpea were highly tolerant viz: IL 138, IL 118 and IL 148), (Ram *et al.*, 1984). It has been also reported that *C. trachypterus* creepers in the habitat of desert linked with tumba (*Citrullus colocynthis*) in Bikaner and Rajasthan (Chandra & Mital, 1983) whereas it is also reported that *C. trachypterus* pest of chickpea (*Cicer arietinum*) some times. Further (Thippaiah & Kumar, 1999) studied detail survey of grasshopper's fauna on field crops like soybean during the seasons of Kharif and summer and after that study, they reported *Chrotogonus* species as abundant in both seasons. In Jhansi eight species of grasshoppers: *H. nigrorepletus*, *Thisoicetrus pulcher*, *A.exaltata*, *A. crenulata*, *Oedaleus abruptus*, *Cyrtacantha cristartarica*, *Catantops pinguis*, *A. tumulus* and *C. t. trachypterus* were injurious to grasses but specimen's of *C. trachypterus* were found most abundant whereas first to appear in May was *C. trachypterus* (Saxena *et al.*, 2002). Ghani Lanjar *et al.* (2002) monitored the abundance and occurrence of surface grasshopper's *C. trachypterus* on paddy and reported species of grasshoppers infested paddy: *H. banian*, *C. trachypterus trachypterus*, *Oxyanitidula* and *A. tumulus* from which *C. trachypterus trachypterus* was abundant in number along with nymphs and adults/observation during July-October with 37.97°C temperature which is the mean temperature. *Chrotogonus* species: *C. trachypterus* and *C. oxypterus* found in abundant in cotton crops as compared to other species of grasshoppers (Elango *et al.*, 2019).

Negative photo tactic nature and feeding behaviors of *Chrotogonus*

Many germinating crops: wheat, cotton, kharif fodders, sugarcane and barley were consumed probably in whole Punjab but specifically in those districts where ratio of rainfall was less. Both nymphs and adults of *Chrotogonus* species damaged germinating plants and leaves of plants (Jat, 2007). Grasshoppers may not prefer to be mobile at night because of their negative phototactic nature hence feeding activity was not observed at night time but during day time *Chrotogonus* accepts various plants as food due to their polyphagous feeding behavior. To observe the feeding behavior the feeding activity of *C. trachypterus* was initiated during morning when temperature was low and preference able (Haldhar *et al.*, 2007). The peak feeding activity of *C. trachypterus* was recorded during morning time whereas 50% of insects remained busy in feeding with temperature 30°C at 11.00 am reported by Asad *et al.* (2001).

CONCLUSION

Previous surveys from Africa are evident that Africa is the main spot of the diversity of *Chrotogonus* but unfortunately, no recent survey study has been done from African countries (Angolo, Senegal, Gabon, Somalia and Nigeria) which indicate that there is immense need of survey in order to invent more new species of genus *Chrotogonus*. Genus *Chrotogonus* has very complex identification on the basis of morphological characteristics and illustration of various body parts because of phenotypic plasticity and cryptic species so morphological identification tools often become unable to differentiate *Chrotogonus* species. Unfortunately, molecular systematic work on the genus *Chrotogonus* is not available so that's why this study suggests strongly studying their systematic position in order to describe its appropriate phylogenetic status on the basis of their DNA sequence.

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REFERENCES

- Asad, R., Awan, M., Abro, G., & Shah, A. (2001). Studies on feeding, copulation, oviposition and defence behaviour of *Chrotogonus trachypterus* (Blanch) (Orthoptera: Pyrgomorphidae) under laboratory conditions. *Pakistan Journal of Zoology*, 33(2), 85-91.
- Blackith, R. E., & McE, D. K. (1967). A study of the genus *Chrotogonus* (Orthoptera). VIII. Patterns of variation in external morphology. *Evolution*, 76-84.
- Chandra, R., & Mital, V. (1983). Effect of food plants on the growth of *Chrotogonus trachypterus* Blanch (Orthoptera: Acrididae). *Plant Protection Bulletin*, 25(2), 147-150.
- Elango, K., Nelson, S. J., Srinivasan, M., Paranidharan, V., & Balakrishnan, S. (2019). Foraging potential of green lacewing *Chrysoperla zastrowi sillemi* (Esben-peterson) against a new invasive pest of india-coconut rugose spiralling whitefly *Aleurodicus Ugioperculatus martin*. *CTCSA-2019*, 44.
- Ghani Lanjar, A., Talpur, M. A., Khuhro, R. D., & Qureshi, K. H. (2002). Occurance and abundance of grasshopper species on rice. *Journal of Apic Science*, 2(7), 763-767.
- Gupta, J. (1972). Incidence of major insect pests of early summer fodders in Haryana, India. *Bulletin*, 20, 36-38.
- Haldhar, S., Swaminathan, R., & Rathore, P. S. (2007). Biological studies on the surface grasshopper, *Chrotogonus trachypterus* (Blanchard) at Udaipur. *International Journal of Tropical Agriculture*, 25(3), 681-688.

- Jat, S.L. *Eco-taxonomic studies on the surface grasshopper, Chrotogonus trachypterus (Blanchard) in south western Rajasthan*. MPUAT, Udaipur, India.
- Kevan, D. M. (1954). A study of the genus *Chrotogonus* Audinet-Serville, 1839 (Orthoptera-Acrididae). III, A review of available information on its economic importance, biology, etc. *Indian Journal of Entomology*, 16, 145-172.
- Kevan, O. (1959). A study of the genus *Chrotogonus* VI. History and biogeography of *Chrotogonini*. *Publication of Cielt. Comparative Diatom Angolag*, 43, 201-246.
- Khaemba, B. (1979). A survey of insect pest species associated with sunflower (*Helianthus annuus* L.) in Kenya. *Kenya Entomologist's Newsletter*, 9, 3-6.
- Khan, M. I., Usmani, M. K., Usmani, S., & Naz, H. (2018). Taxonomic studies on the gaudy grasshoppers (Orthoptera: Pyrgomorphaoidea: Pyrgomorphidae) from the northeastern states of India. *Journal of Threatened Taxa*, 10(15), 12953-12968.
- Khare, M., & Srivastava, U. (1975). Development of secondary malpighian tubules in *Chrotogonus trachypterus* Blanch (Orthoptera: Acrididae). *International Journal of Insect Morphology and Embryology*, 4(6), 539-548.
- Krauss, H. (1877). Orthopteren vom Senegal gesammelt von Dr. Franz Steindachner. *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Mathematischnatur Wissenschaftliche Klasse*, 76(1), 29-63.
- Kumar, H., Usmani, M. K., & Kumari, R. (2014). Taxonomic significance of male supra-anal plate, cerci and subgenital plate in the classification of Indian Pyrgomorphidae (Orthoptera: Pyrgomorphaoidea). *Journal of the Entomological Research Society*, 16(1), 21-26.
- Latif, A., & Haq, A. (1951). *Bionomics of Chrotogonus robertsii Kirby with special reference to temperature and food*. Paper presented at the Proceedings 3rd Pakistan Science Conference Daica.
- Mahmood, K., & Yousuf, M. (2000). Taxonomic study of some Pyrgomorphidae and Catantopinae (Acridoidea: Orthoptera) from Azad Jammu and Kashmir [Pakistan]. *Pakistan Journal of Biological Sciences (Pakistan)*, 3(11), 1914-1916.
- Misari, S., & Raheja, A. (1976). *Notes on field pests of groundnuts In northern Nigeria*. Paper presented at the International Symposium of Field Pests of Groundnuts and Millet, Kaolack, Senegal. 21-23 April 1976. Lagos, African Groundnut Council.
- Perwin, R., Ahmed, H., & Ahmed, M. (1983). Seasonal incidence of grasshoppers in Karachi (Pakistan) (on general vegetables). *Bulletin of Zoology*, 1, 66-77.
- Poonia, F., & Sunita, C. (2008). Life tables of *Chrotogonus trachypterus* Blanch. on three dietary regimes. *Journal of Applied Zoological Researches*, 19(1), 17-21.
- Rahman, K. A. (2001). Food consumption and utilisation of the grasshopper *Chrotogonus lugubris* Blanchard (orthoptera, acridoidea, pyrgomorphidae) and its effect on the egg deposition. *Journal of Central European Agriculture*, 2(3-4), 263-270.
- Ram, S., Patil, B., & Purohit, M. (1984). Cowpea varieties resistant to major insect pests. *Indian Journal of Agricultural Sciences*, 54(4), 307-311.
- Reddy, D. (1984). Pests infesting chilli (*Capsicum annum* L.) in the nursery. *Mysore Journal of Agricultural Sciences*, 18(2), 122-125.
- Ritchie, J., & Mark, R. J. (1982). A taxonomic revision of the genus *Gastrimargus* Saussure (Orthoptera: Acrididae). *Entomology*, 44, 239-329.
- Sahebzadeh, N., Ghaffari-Moghaddam, M., & Sabagh, S. K. (2017). Toxicity of N-alkyl Derivatives of Chitosan Obtained from Adult of *Chrotogonus trachypterus* (Orthoptera, Acrididae) against the Wheat, Cabbage and Oleander Aphid (Hemiptera: Aphididae) Species. *Jordan Journal of Biological Sciences*, 10(1).
- Sattar, A., Ullah, K., Ahad, A., & Yousaf, M. (1984). Insect pests of sunflower in NWFP, Pakistan. *Pakistan Journal of Agricultural Research*, 5(4), 239-240.
- Saxena, P., Shah, N., Hasan, N., Pandey, K., Faruqui, S., Bhaskar, R., Singh, J. (2002). Forage plant protection. *ICAR-IGFRI, Jhansi*.
- Sonkamble, M. M. *Evaluation of insecticidal properties of some botanical plants against Helicoverpa Armigera (Hubn) and Spodoptera litura (Fab)*. Vasantrao Naik Krishi Vidyapeeth, Parbhani.
- Srivastava, M. (1954). Studies on the structure of the chromosomes of *Chrotogonus incertus bolivar* (Acrididae). *Journal of Genetics*, 52(3), 480.
- Thakre, B. (2020). Biological Control of *Citrus Psylla (Diaphorina citri)* on Nagpur Mandarin. *Agriculture & Food: e-Newsletter*. 50, 337-340.
- Thippaiah, M., & Kumar, N. (1999). *Dysmicoccus* sp. *Pseudococcidae: Homoptera): a pest of soyabean in Karnataka*. *Insect Environment*, 5(2), 70.
- Verma, A., & Kanwar, K. (1998). Mineral profile of the cuticle of surface grasshopper *Chrotogonus trachypterus* (Orthoptera: Pyrgomorphidae). *Trace Elements and Electrolytes*, 15(1), 50-53.
- Wagan, M., & Riffat, S. (2013). *Biodiversity and distribution of the orthoptern insects of Pakistan*. Paper presented at the Proceedings of Pakistan Congress of Zoology, 24, 57-58.
- Yadav, L., & Yadav, P. (1983). Pest complex of cowpea (*Vigna sinensis* Savi) in Haryana. *Bulletin of Entomology*, 24(1), 57-58.