Insecta Orthoptera: a bibliometric review of papers from the Scopus database published in English for the period of 1986-2021

Zamira Izbasarova[1*] and *Sherzod* Khalillaev[2]

[1]Research Institute of Environment and Nature Conservation Technologies, Tashkent 100043, Uzbekistan
[2]National University of Uzbekistan named after Mirzo Ulugbek, Tashkent 100174, Uzbekistan

Abstract. Today, climate change, an increase in anthropogenic factors, and changes in the natural environment have an adverse effect on insect diversity due to the changing climes around the world. There has been an increase in the number of pests of agricultural crops over the past few years because of the expansion of the cultivated areas in arid regions, including the number of insects of the Order *Orthoptera*. The formation of fauna in different regions of the globe needs to be identified in order to improve the methods of combating them, and therefore, it is necessary to identify their formation. A great deal of research on the class of insects has been conducted over the last 35 years, and most of those articles are published in English. However, the research work on *Insecta*: *Orthoptera* was carried out in different topics and ways during those 35 years. The scope of this article is to cover all articles that have been published about orthoptera between 1986 and 2021 in the Scopus database. Various categories were analyzed in order to determine the quality of this research, including the year of research, who was responsible for the research, and which of the major research institutes did the research. In the light of the analysis, it is possible to have a certain understanding of the current research problems that are being experienced in this area as a result of the analysis.

1 Introduction

A large proportion of the diversity of organisms on Earth can be attributed to insects and plants. The relationship between plants and insects is complex, and the interactions between them can be quite fascinating. Research on insect–plant interactions helps shape our understanding of ecology and coevolution (e.g. Crepet 1984, Grimaldi 1999, Novotny et al. 2006, Novotny and Miller 2014), resource management (e.g. Lundberg and Moberg 2003, Cardel and Koptur 2010, Hudewenz et al. 2012), and conservation (e.g. Kearns et al. 1998, Bale et al. 2002, Tscharntke and Brandl 2004, Tan et al., 2017)

In Northern Asian regions such as Russia, Mongolia, and China, the locust *Oedaleus asiaticus* (*Orthoptera, Acrididae*) is one of the most important grass-feeding insects. It is found in steppes and adjacent farmlands throughout the steppes of these nations. For many

* Corresponding author: z.izbasarova@eco.gov.uz

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

years, it has been reported that it is particularly abundant in the Inner Mongolia steppe region, and that it has caused great damage to the livestock industry as well as the environment. There are specific food preferences of *Asiaticus*, as it is the primary consumer of grasslands, and as a result of this extreme adaptation the productivity of grasslands has been dramatically reduced as well as competition between other native herbivores and farmed animals for food resources. It is important to note that these species represent a small part of the overall diversity of orthopterans. There are in fact a lot more species hiding in the pristine forests of Southeast Asia than can be found in the pristine forests of Europe.

According to a small set of observations, various cricket communities are flourishing along the gradient between maquis shrubland and rainforest in Southern New Caledonia as a result of the vegetation gradient. As a result of these cricket populations, it can be observed that specific differences are observed in habitat use and species replacement over time during forest regeneration (Anso 2016, Desutter-Grandcolas et al., 2016)

The superfamily *Hagloidea* (*Orthoptera*) *sensu* Gorochov 1995 was widespread from the Late Triassic to the Early Cretaceous and consists of the families *Haglidae, Tuphellidae, Prophalangopsidae, Hagloedischiidae* (Gorochov 1995). A cladistic analysis based on wing venation suggests that it is paraphyletic (Béthoux and Nel 2002, Gu et al., 2021). Anthropogenic action is significantly changing scenes over the globe and uncovering life forms to novel situations. Solid jolts in human-modified situations can provoke upgraded behavioral reactions, coming about in biological sinks where low-quality living space pulls in expansive numbers of people due to a jumble between common behaviors and adjusted situations (Tielens et al., 2021). Within the urban environment, the foundation of perennial blossom knolls rather than once in the past built-up structures or regularly mown gardens is one of the foremost vital measures to advance creepy crawlies. Less self-evident, but still important, is the change of other sorts of existing urban green spaces. In numerous cities, the green spaces, counting roadside plantings, are overwhelmed by presented (“exotic”) woody plants, which serve as “distance green” isolating diverse bunches of clients and may indeed have a few positive impacts on human prosperity, but less on creepy crawlies and insect-related forms (Mody et al., 2020). A surprising decay within the number of creepy crawly species and in their plenitude has been detailed from numerous places around the world in later a long time. Other than the significant misfortune of life forms that are important in their possess right, the misfortune of creepy crawlies has too been credited to hurting the interaction among species as well as biological system forms related with the misfortune of creepy crawlies (Mody et al., 2020).

Bibliometric investigation could be a writing survey strategy that factually and quantitatively investigations distributed considers (Broadus 1987). Bibliometric examination is valuable for analyzing the information structure and improvement of particular investigate areas (Ellegaard and Wallin 2015). As of late, this approach has empowered analysts to comprehensively measure and depict the foremost productive analysts, educate, since the approach is regarded to be more objective and dependable than other common strategies of writing audit strategies (Aria and Cuccurullo 2017).

Bibliometrics includes several descriptive statistics of citation data and network analysis of authors, journals, universities, countries, and keywords based on citations and frequency analysis techniques. Bibliometrics supports the identification of research clusters, provides insights into current research interests, and reveals trends for emerging topics in a field (Liao et al., 2018). Bibliometric analysis has several advantages. It allows the characterization of specific research areas by exploring word frequency, the timeline and development of the topic, and the geographical distribution, which helps draw useful conclusions about who is doing what. At present, this particular method is gaining interest as it contributes new insights into several fields such as economics (Homrich et al. 2018), library services (Coughlin and Jansen 2016; Welsh 2017), and information science (Merigó et al. 2018; Warriach and

Ahmad 2016). Bibliometric analysis has also been applied in several fields in the life sciences (Gondivkar et al. 2018; Iftikhar et al. 2019; Shuaib et al. 2015). In this context, VOS viewer is one of the most widely used software for constructing, exploring, and visualizing bibliometric networks and maps.

The purpose of this study is to analyze current topics and important areas of insect research, as well as to use historical bibliometric data to gain new insights into regional distribution and reproduction of insects [1-37].

2 Materials and methods

The search collects the English-language academic literature retrieved from the Scopus database for the period 1986-2021. The analysis was carried out in September 2022. A total of 914 publications were downloaded with the keyword "*Insecta Orthoptera*". In the next step, articles were categorized according to year of publication. A database of all peer-reviewed papers was then created, including the year of publication, authors' names, countries, publication type, journal name, number of citations per paper, the number of citations per journal, the percentage of publications by the topic cluster name and subject area. The analysis was performed using programs like Microsoft Excel, VOS viewer and Map chart. Figure 1 shows the flow of the selected methodology for the research. The year of publication of the articles was then verified with the information in the articles. The database was expanded for all reviewed articles, including year and type of publication, author's name, country of affiliation, journal name. The reasons why we utilize the strategies we did prior are due to the reality that Scopus is one of the foremost well-known databases that collects definitive writing from around the world in one put, particularly within the case of chemistry. English could be a widespread dialect, hence, the writing in English is more standard and important than writing in other dialects.

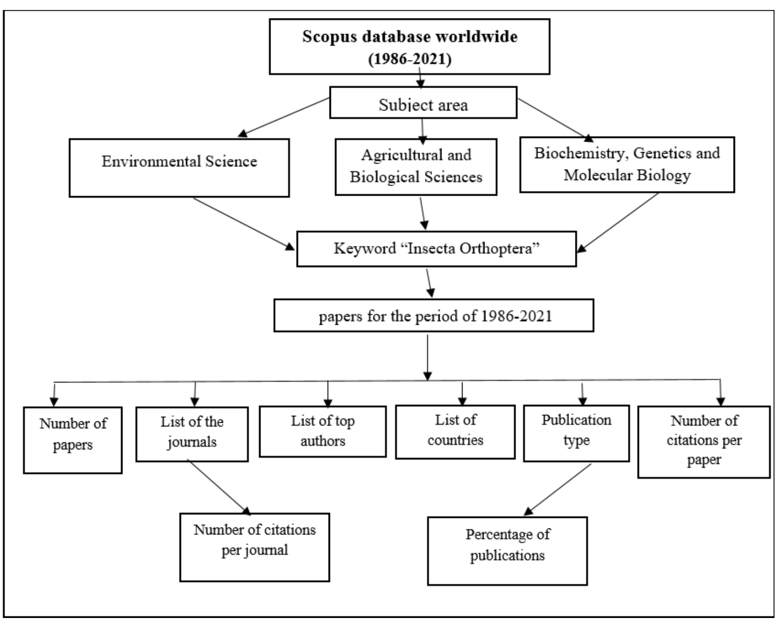

Fig. 1. Flowchart of the methodology.

3 Results and discussion

3.1 Trend of publications on *Insecta Orthoptera*

In general, what stands out is that the number of published papers on a particular issue studied for the first time in the world. Total of 914 papers published between 1986 and 2021 on *Insecta Orthoptera* issue. The number of records started to grow between 1986 and 2021 from 16 to 75 publications (Figure 2).

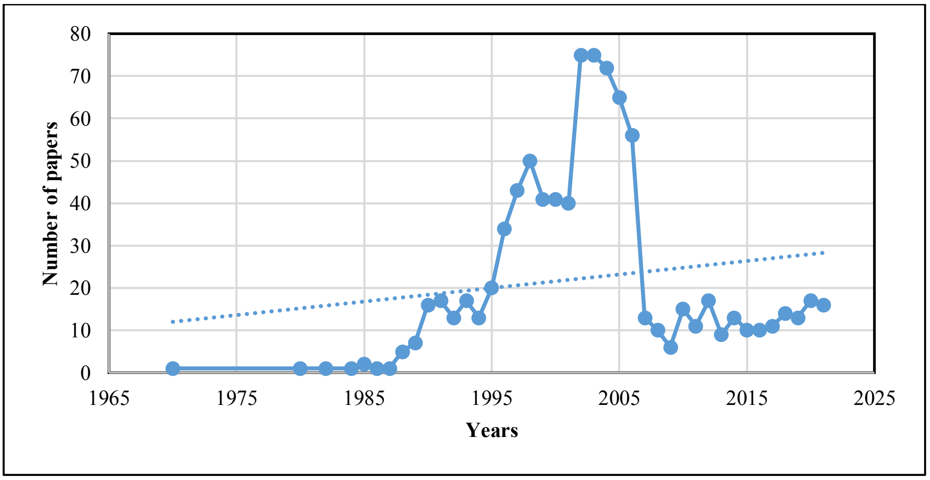

Fig. 2. Number of papers on insecta orthoptera by the year of publication issues in the world.

Papers on *Insecta Orthoptera* issue in the world published in 4 different publication types in the given period of time (1986-2021). The 6 publication types are article, review, conference, letter, book chapter and note (Figure 3). The table shows that most of the publications were in the article (840). The number of papers published in review and conference are 42 and 24 respectively. The rates of publications as letter and book chapter are 5 and 2 respectively. Also, only 1 publication was as the note.

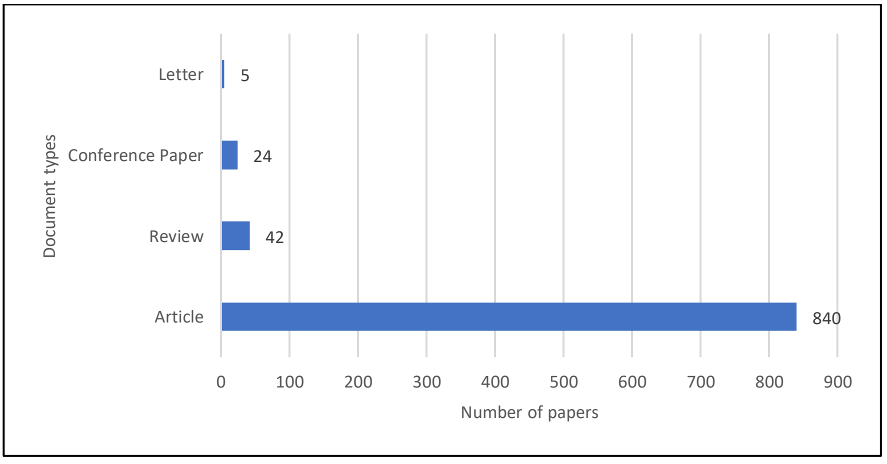

Fig. 3. Publication type on insecta orthoptera in the world.

3.2 Journals on *insecta orthoptera*

Scientists use variety of journals in different countries in order to publish their research. There are 43 different journals published in the world during the period of the study, which shows a total of 426 papers about *Insecta Orthoptera* during the period of study. The Zootaxa journal is leading top journal which published 34 papers (Table 1). The top journals illustrating *Insecta Orthoptera* issue in the world are Journal of Experimental Biology, Proceeding of The Royal Society Biological Sciences and Journal of Insect Physiology.

Table 1. List of the journals on *Insecta Orthoptera* in the world

Scopus Source title	Number	Scopus Source title	Number
Zootaxa	34	Molecular Phylogenetics and Evolution	9
Journal of experimental Biology	31	Archives of insect Biochemistry and Physiology	8
Proceeding of the royal society biological sciences	22	Biocontrol Science and Technology	8
Journal of insect physiology	20	Florida Entomologist	8
Environmental Entomology	19	Heredity	8
Journal of insect Conservation	18	Journal of Evolutionary Biology	8
Cell and Tissue Reseach	15	Applied Entomology and Zoology	7
Evolution	14	Canadian Journal of Zoology	7
Insect Biochemistry and Molecular Biology	14	Ecological Entomology	7
Peptides	14	Entomologia Experimentalis et Applicata	7
Journal of Chemical Ecology	13	Oecologia	7
Physiological Entomology	13	Zoosystema	7
European Journal of Entomology	11	Genome	6
Animal Behaviour	10	Insect Molecular Biology	6
Development	10		
Journal of Invertebrate Pathology	10	Journal Of Economic Entomology	6
Annals Of The Entomological Society Of America	5	Journal Of Insect Science	4
Annual Review Of Entomology	5	Tropical Zoology	1
Chromosome Research	5	Australian Journal Of Zoology	
Ecology	5	Bioacoustics	3
Zoologischer Anzeiger	5	Brazilian Journal Of Biology	3
Ecology Letters	4	Journal Of Thermal Biology	3
		Zookeys	3

3.3 Top authors on *Insecta Orthoptera*

Authors must be professionals in order to gain an effective and successful research in a particular field. The given diagram shows the names of 18 authors who published 177 papers in total. De Loof, Simpson S.J. and Nel.A are authors with 18 publications each of them. Johnson D.L., Massa B. and Schoofs L. published by 9 papers each of them in given period starting from 1986 year (Table 2). In addition, Lockwood. J.A. and Breuer. M. published 8 and 7 papers respectively, according to the statistics. De Loof. A. and Simpson, S.J. are leading the list of top publications with 21 and 18 respectively which shows their positions as the experts in the *Insecta Orthoptera* field.

Table 2. Top productive authors according to publishing papers about *Insecta Orthoptera*

	Rank	Authors	Occurrence	Total Link Strength
Authors	1	De Loof.A.	21	39
	2	Simpson S.J.	18	22
	3	Nel.A	13	7
	4	Hollier. J.	10	0
	5	Robillard. T	10	6
	6	Johnson. D.L	9	0
	7	Massa. B	9	6
	8	Schoofs. L.	9	15
	9	Lockwood. J.A.	8	1
	10	Simmons. L.W.	8	1
	11	Breuer. M..	7	12
	12	Claeys. I.	7	20
	13	Heller K.G	7	1
	14	Raubenheimer, D	7	8
	15	Simonet, G	7	20
	16	Buzzetti, F.M.	6	7
	17	Andersen, S.O	5	0
	18	Burrows, M.	5	5

The institutions are ranked accordingly to the quality of papers that its researchers publish. In statistics, there 160 different institutions worked in order to publish 1028 papers on *Insecta Orthoptera* around the world starting from 1986 to 2021 years. Figure 4 shows that University of Oxford and Museum National d'Histoire Naturelle are the top influencer institutions who published more papers with 28 each of them on insect orthoptera comparing with other institutions. CNRS Centre National de la Recherche Scientifique and KU Leuven are ranked as second productive institutions with 25 publications each of them. Those 4 top institutions published 10.3% of the total publications. Also, only 12 institutions showed at least 10 publications according to the data in table.

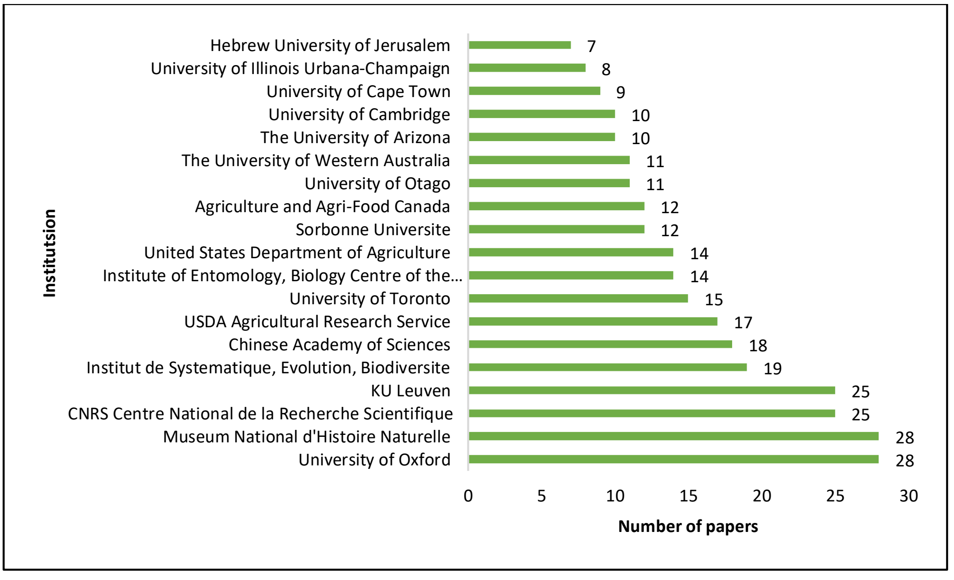

Fig. 4. List of top institutions on *Insecta Orthoptera* in the world

3.4 Top countries on *Insecta Orthoptera*

According to statistics, more than 86 different countries jointly worked on *Insecta Orthoptera* issues in the world starting from 1986. The table illustrates the geographical location of the top 15 countries took a participation in publication of 43 and more papers. United States are the dominant with 217 research documents on insect orthoptera among those top 15 countries around the world. Then, United Kingdom and Germany are leading the list with 137 and 101 publications respectively (Figure 5). The Canada and France showed 71 and 57 publications in order. The top five countries' researchers participated in almost 53% of total publications (Table 3).

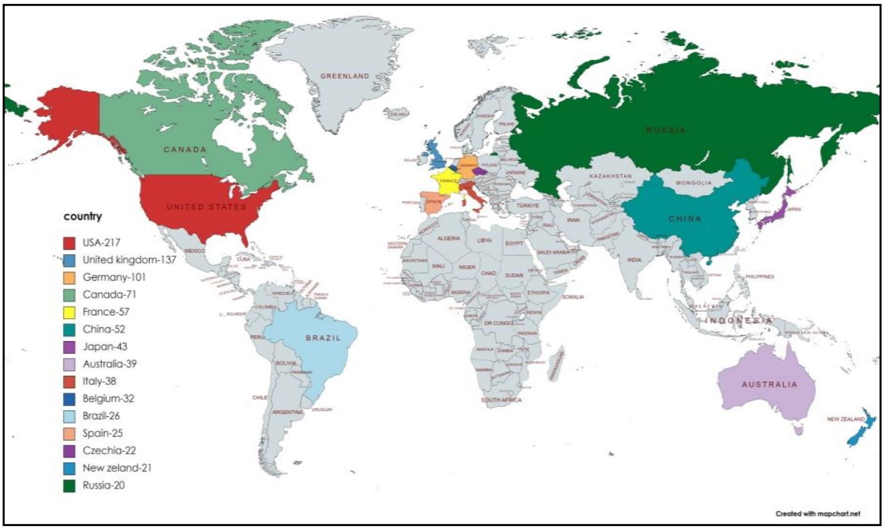

Fig. 5. List of top countries on *Insecta Orthoptera* in the world

Table 3. List of top cited publications on *Insecta Orthoptera* in the world

Insecta Orthoptera				Insecta Orthoptera			
Journals	**TNP**	**Publishing country**	**IF**	**Journals**	**TNP**	**Publishing country**	**IF**
Zootaxa	13	New Zealand	1.02	Plos ONE	43	United States.	3.5
Zoological Science	25	Japan	0.87	Molecular Phylogenetics and Evolution	69	United states	4.49
Alcheringa	8	United Kingdom	1.29	Entomological Review	9	Russian	0.46
Journal of Insect Conservation	11	Netherlands	2.52	Biodiversitas	20	Indonesia	1.32
International Journal of Biological Macromolecules	6	Netherlands	7.71	Revue Suisse de Zoologie	19	Switzerland	0.65
Turkish Journal of Zoology	6	Turkey	0.93	Zoosystema	7	France	1.27
Italian Journal of Zoology	24	Italy	2.43	ZooKeys	8	Bulgaria	1.45

Biological Research	4	United Kingdom	6.70	Systematic Biology	74	United Kingdom	8.0

* PC – Published country, * IF – impact factor

3.5 Top cited journals on *Insecta Orthoptera*

In this subsection, we analyzed top journals which published the greatest number of papers. Taking into consideration this factor we decided to investigate top-cited journals on *Insecta Orthoptera*. Firstly, we sorted source names alphabetically of excel extension file of 862 documents. Then step by step total papers` citations are summarized by each journal. Interestingly, at the result we got updating list with potential journal names. Three journals: Environmental Science, Agricultural and Biological Sciences, Biochemistry Genetics and Molecular Biology (Figure 6).

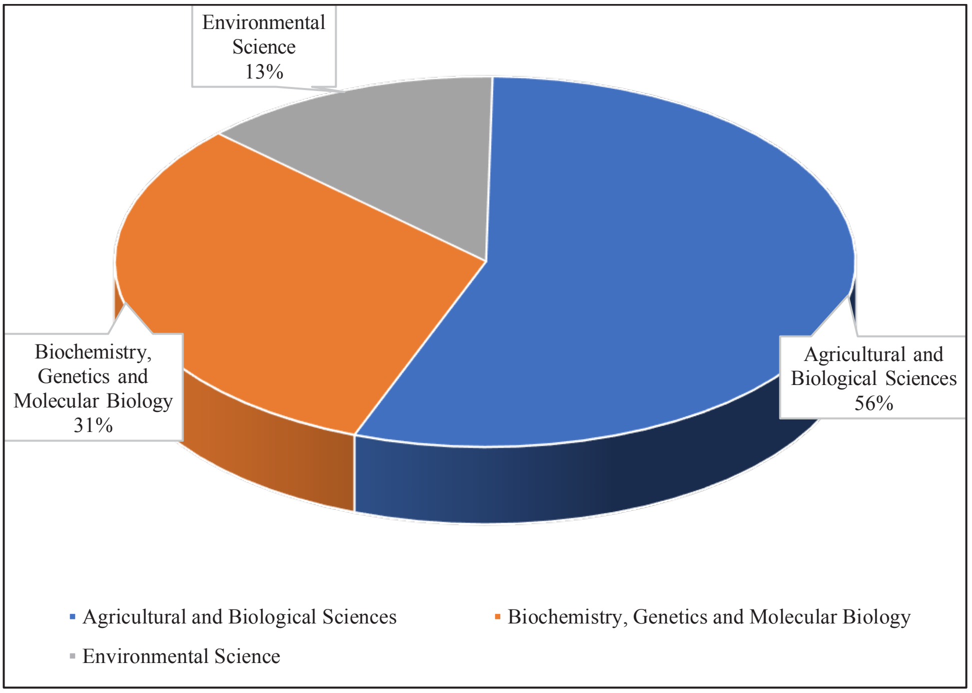

Fig. 6. Top topic cluster name on *Insecta Orthoptera* in the world

3.6. Top funding sponsors on *Insecta Orthoptera*

Funding sponsor plays an important role in achieving successful research. According to statistics, there are 159 funding sponsors who financially helped to make the research on insect orthoptera more thorough and effective. National Science Foundation and Deutsche Forschungsgemeinschaft are the top sponsors who helped with 24 and 23 publications respectively (Figure 7). The funding sponsor "National Natural Science Foundation of China" helped in 20 publications on insect orthoptera, according to data.

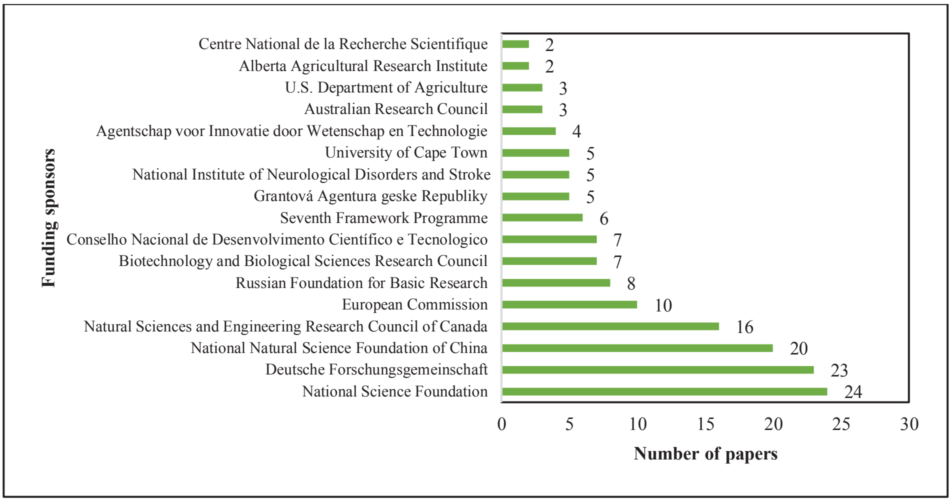

Fig. 7. List of top funding sponsors on *Insecta Orthoptera* in the world

3.7. Publications by keywords on *Insecta Orthoptera*

Co-authorship, keyword co-occurrences, citations, bibliographic coupling, and co-citation maps can be generated using VOSviewer based on bibliographic data. File formats supported include .txt, .ris, and .csv from databases such as Web of Science, Scopus (Samir Kumar Jalal, 2019). VOSviewer program identified 143 authors who published at least 3 articles out of 2103s authors during 1986-2022. Separated authors form 24 clusters: *De Loof* group, *Simpson S* group, and *Schoofs I* group, *Hollier J* group. As a result, it was found that De Loof published 21 Simpson S-18 Roff D-11 Hollier J-10 Schoofs I-9 and Simmons I-8 articles.

There are 24 items distributed over seven clusters: cluster 5, links-82, Total link strength-194.

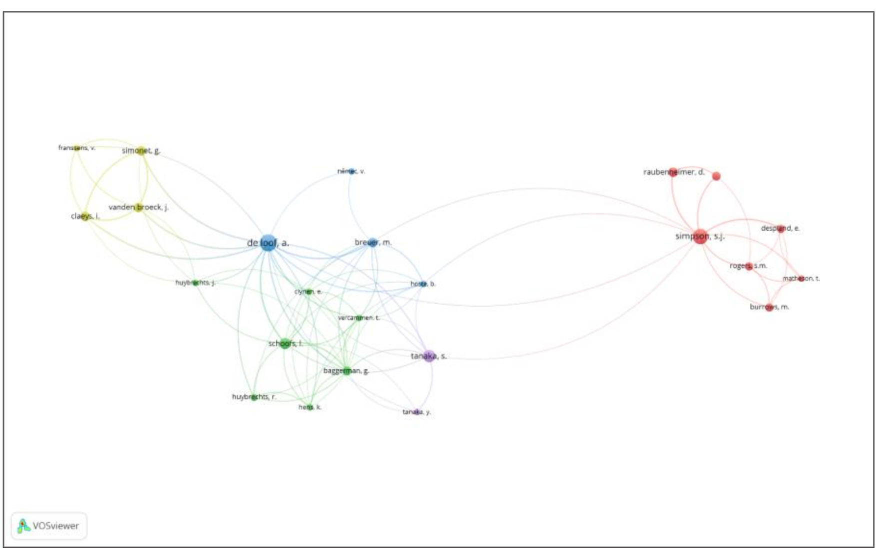

Fig. 8. Network map of top co-authorships based on the total link strength

The analysis yielded 6830 keywords. After excluding the general keywords with a low relevance score and those with low occurrence (by default, a minimum of five occurrences of a keyword is selected, to strengthen the co-occurrence results), 24 items were finally identified. Based on the total link strength, each resulting keyword is sketched in a node, creating a network map of all keywords. Figure 8 shows the network map of the top 30 authors' keyword co-occurrence. The size of the node reflects the keyword's degree of importance.

Table 4. List of top 15 author keywords used in publications on the topic of *Insecta Orthoptera*

	Rank	Keywords	Occurrence	Total Link Strength
Keywords	1	orthoptera	885	6156
	2	insecta	857	6013
	3	hexapoda	362	2952
	4	animals	289	3710
	5	acrididae	157	1008
	6	grasshopper	151	1346
	7	gryllidae	127	875
	8	female	112	1274
	9	lepidoptera	111	1176
	10	coleoptera	109	1009
	11	locusta migratoria	107	1041
	12	priority journal	125	1335
	13	arthropoda	102	890
	14	cricket	43	246
	15	animal experiment	44	503

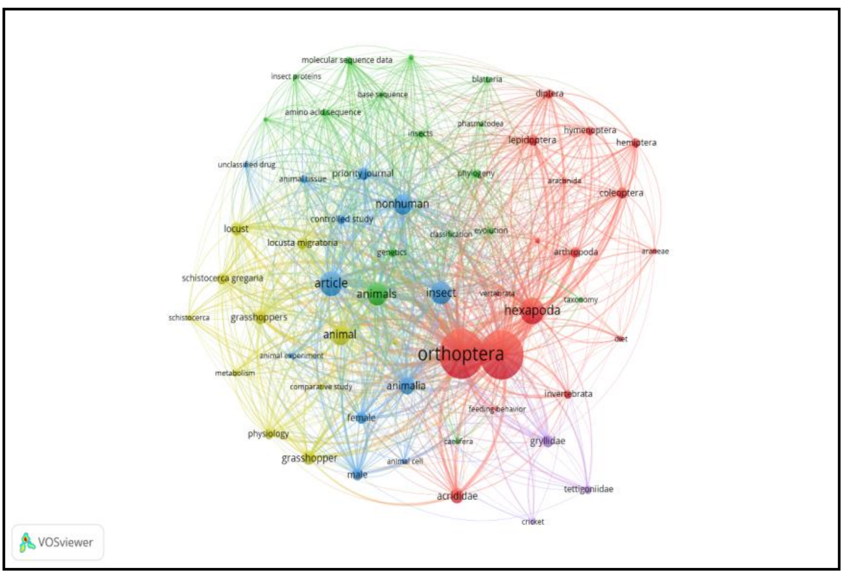

Fig. 9. Network map of top keywords based on the total link strength.

The list of top 15 author keywords which are used in publications on the topic of Insecta Orthoptera in Table 4. Also, Figure 9 shows the map of top keywords on the total link strength.

4 Conclusions

According to the results of the research conducted between 1986-2021 on insecta orthoptera, there was a slight acceleration. The following are the names of the main journals that published research materials based on the obtained results: Zootaxa, Journal of experimental Biology, Proceeding of the royal society biological sciences, Journal of insect physiology, Environmental Entomology, Journal of Insecta Conservation. The top 10 institutions conducting research on *Insecta Orthoptera* are located in the United States, Great Britain, Germany, Canada, France, China, Japan, Australia, Italy, and Belgium. The main part of published research results (84%) belongs to journal articles. According to statistics, there are 159 funding sponsors that have provided financial support to make research more thorough and effective. The main field which funds is research projects on agriculture and biological sciences. The negative impact of changes in global climate and inter-landscape processes on agricultural production is increasing year by year. The expansion of the cultivated areas in arid regions has led to a sharp increase in the number of pests of agricultural crops, including the number of orthoptera in the recent years. Accordingly, it is important to know and study the researches being done by scientists around the world, the main publications which publish scientific research results, the countries and institutions that are doing the main research, and the funding sectors.

Acknowledgements

The author expresses their appreciation to the project "English for Science", implemented by the Ministry of Innovative Development of the Republic of Uzbekistan for the direction and inspiration for carrying out this reaserch. In addition, the authors are grateful to the anonymous reviewers of earlier drafts for constructive comments that helped to improve the manuscript.

References

1. Ahn, M.Y., Kim, B.J., Kim, H.J., Jin, J.M., Yoon, H.J., Hwang, J.S., Lee, B.M., 2019. Glycosaminoglycan Derived from Field Cricket and Its Inhibition Activity of Diabetes Based on Anti-Oxidative Action (preprint). MEDICINE & PHARMACOLOGY. https://doi.org/10.20944/preprints201903.0136.v1
2. Dawwrueng, P., Tan, M.K., Artchawakom, T., Waengsothorn, S., 2017. Species checklist of Orthoptera (Insecta) from Sakaerat Environmental Research Station, Thailand (Southeast Asia). Zootaxa 4306, 301. https://doi.org/10.11646/zootaxa.4306.3.1
3. Desutter-Grandcolas, L., Anso, J., Jourdan, H., 2016. Crickets of New Caledonia (Insecta, Orthoptera, Grylloidea): a key to genera, with diagnoses of extant genera and descriptions of new taxa. Zoosystema 38, 405–452. https://doi.org/10.5252/z2016n4a1
4. Fiesler, E., Drake, T., 2016. Macro-invertebrate Biodiversity of a Coastal Prairie with Vernal Pool Habitat. Biodivers. Data J. 4, e6732. https://doi.org/10.3897/BDJ.4.e6732
5. Gahukar, R.T., 2018. Entomophagy for Nutritional Security in India:Potential and Promotion. Curr. Sci. 115, 1078. https://doi.org/10.18520/cs/v115/i6/1078-1084
6. Gu, J.-J., Yang, X., Huang, R., Yang, G., Yue, Y., Ren, D., 2021. New species and material of Hagloidea (Insecta, Ensifera) from the Yanliao biota of China. ZooKeys 1033, 183–190. https://doi.org/10.3897/zookeys.1033.63571

7. Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., Zeng, X.-J., 2018. A Bibliometric Analysis and Visualization of Medical Big Data Research. Sustainability 10, 166. https://doi.org/10.3390/su10010166
8. Mody, K., Lerch, D., Müller, A.-K., Simons, N.K., Blüthgen, N., Harnisch, M., 2020. Flower power in the city: Replacing roadside shrubs by wildflower meadows increases insect numbers and reduces maintenance costs. PLOS ONE 15, e0234327. https://doi.org/10.1371/journal.pone.0234327
9. Samir Kumar Jalal, 2019. Co-authorship and co-occurrences analysis using BibliometrixR package: a case study of India and Bangladesh. Ann. Libr. Inf. Stud. 2, 57–64.
10. Tan, M.K., Artchwakom, T., Abdul Wahab, R., Lee, C.-Y., Belabut, D.M., Wah Tan, H.T., 2017. Overlooked flower-visiting Orthoptera in Southeast Asia. J. Orthoptera Res. 26, 143–153. https://doi.org/10.3897/jor.26.15021
11. Tielens, E.K., Cimprich, P.M., Clark, B.A., DiPilla, A.M., Kelly, J.F., Mirkovic, D., Strand, A.I., Zhai, M., Stepanian, P.M., 2021. Nocturnal city lighting elicits a macroscale response from an insect outbreak population. Biol. Lett. 17, rsbl.2020.0808, 20200808. https://doi.org/10.1098/rsbl.2020.0808
12. Uehara-Prado, M., Bello, A. de M., Fernandes, J. de O., Santos, A.J., Silva, I.A., Cianciaruso, M.V., 2010. Abundance of epigaeic arthropods in a Brazilian savanna under different fire frequencies. Zool. Curitiba 27, 718–724. https://doi.org/10.1590/S1984-46702010000500008
13. Walters, R.J., Hassall, M., Telfer, M.G., Hewitt, G.M., Palutikof, J.P., 2006. Modelling dispersal of a temperate insect in a changing climate. Proc. R. Soc. B Biol. Sci. 273, 2017–2023. https://doi.org/10.1098/rspb.2006.3542
14. Zhang, W., Ren, H., Sun, F., Shen, T., Yuan, S., Gao, X., Tan, Y., 2022. Evaluation of the Toxicity of Chemical and Biogenic Insecticides to Three Outbreaking Insects in Desert Steppes of Northern China. Toxins 14, 546. https://doi.org/10.3390/toxins14080546
15. Penalver, E. & Grimaldi, D.A. (2010) Latest occurrences of the Mesozoic family Elcanidae (Insecta: Orthoptera), in Cretaceous amber from Myanmar and Spain. Annales de la Societe Entomologique de France, 46, 88–99. https://doi.org/10.1080/00379271.2010.10697641
16. Olivier, G.A. (1789) Encyclopédie méthodique. Dictionnaire des insectes. Vol. 4. Pankouke, Paris, 331 pp.
17. Poinar, G., Gorochov, A.V. & Buckley, R. (2007) Longioculus burmensis n gen., n. sp. (Orthoptera: Elcanidae) in Burmese amber. Proceedings of the Entomological Society of Washington, 109, 649–455.
18. Ragge, D.R. (1955) The wing-venation of the Orthoptera Saltatoria with notes on dictyopteran wing-venation. British Museum of Natural History, London, 159 pp.
19. Sharov, A.G. (1968) Phylogeny of orthopteroid insects. Proceedings of the Paleontological Institute, Russian Academy of Sciences, 118, 1–217.
20. Zeuner, F.E. (1939) Fossil Orthoptera Ensifera. British Museum of Natural History, London, 321 pp.
21. Zeuner, F.E. (1942) The Locustopsidae and the phylogeny of the Acridoidea (Orthoptera). Proceedings of the Royal Entomological Society of London (B), 11, 1–19

22. Agea JG, Biryomumaisho D, Buyinza M, Nabanoga GN (2008) Commercialization of Ruspolia nitidula (nsenene grasshoppers) in central Uganda. African J Food Agric Nutr Dev 8(3):319–332
23. Ahn MY, Hwang JS, Kim M-J, Park K-K (2016) Antilipidemic efects and gene expression profling of the glycosaminoglycans from cricket in rats on a high fat diet. Arch Pharm Res 39:926–936. https://doi.org/10.1007/s12272-016-0749-1
24. Ahn MY, Kim BJ, Kim HJ, Jin JM, Yoon HJ, Hwang JS, Lee BM (2019) Glycosaminoglycan derived from feld cricket and its inhibition activity of diabetes based on anti-oxidative action. Preprints. https://doi.org/10.20944/preprints201903.0136.v1
25. Airyalat SAS, Malkawi LW, Momani SM (2019) Comparing bibliometric analysis using PubMed, Scopus, and Web of Science databases. J Vis Exp e58494. https://doi.org/10.3791/58494
26. Ayieko M, Oriaro V, Nyambuga I (2010) Processed products of termites and lake fies: improving entomophagy for food security within the Lake Victoria region. African J Food Agric Nutr Dev 10:2085–2098. https://doi.org/10.4314/ajfand.v10i2.53352
27. Belluco S, Losasso C, Maggioletti M, Alonzi CC, Paoletti MG, Ricci A (2013) Edible insects in a food safety and nutritional perspective: a critical review. Compr Rev Food Sci Food Saf 12:296–313. https://doi.org/10.1111/1541-4337.12014
28. Bodenheimer FS (1951) Insects as human food. In Insects as Human Food. Springer, pp 7–38 Bristowe WS (1953) Insects as food. Proceedings of the Nutrition Society 12(1):44–48. https://doi.org/10.1079/PNS19530012 Chantawannakul P (2020) From entomophagy to entomotherapy. Front Biosci 25:179–200. https://doi.org/10.2741/480
29. Gorochov, A.V. (1986) Insects in Early Cretaceous ecosystems of western Mongolia. Descriptions of fossil Gryllida (Orthoptera). Trudy Sovmestnaya Sovetsko-Mongol'skaya Paleontologicheskaya Ekspeditsiya, 28, 171–174.
30. Gorochov, A.V. (1990) Orthoptera. Gryllida. In: Rasnitsyn, A.P. (ed.) Late Mesozoic insects of Eastern Transbaikalia. Trudy Zoologitscheskogo Institute, Akademiia Nauk SSSR, 239, 210–214.
31. Fang, Y., Muscente, A.D., Heads, S.W., Wang, B. & Xiao, S. (2018a) The earliest Elcanidae (Insecta, Orthoptera) from the Upper Triassic of North America. Journal of Paleontology, 92 (6), 1028–1034. https://doi.org/10.1017/jpa.2018.20
32. Bthoux, O. & Nel, A. (2001) Venation pattern of the Orthoptera. Journal of Orthoptera Research, 10, 195–198. https://doi.org/10.1665/1082-6467(2001)010[0195:VPOO]2.0.CO;2
33. Fang, Y., Wang, B., Zhang, H.C., Wang, H., Jarzembowski, E.A., Zheng, D.R., Zhang, Q., Li, S. & Liu, Q. (2015) New Cretaceous Elcanidae from China and Myanmar (Insecta, Orthoptera). Cretaceous Research, 52, 323–328. https://doi.org/10.1016/j.cretres.2014.05.004
34. Gorochov, A.V., Jarzembowski, E.A. & Coram, R.A. (2006) Grasshoppers and crickets (Insecta: Orthoptera) from the Lower Cretaceous of southern England. Cretaceous Research, 27, 641–662. https://doi.org/10.1016/j.cretres.2006.03.007
35. Gahukar RT (2018) Entomophagy for nutritional security in India: potential and promotion. Curr Sci 115:1078–1084. https://doi. org/10.18520/cs/v115/i6/1078-1084
36. Gasco L, Finke M, Van Huis A (2018) Can diets containing insects promote animal health? J Insects Food Feed 4:1–4. https://doi. org/10.3920/JIFF2018.x001

37. Accessed 26 Jun 2021 Jantzen DSLA, Menegon de Oliveira L, da Rocha M and Prentice C (2020) Edible insects: An alternative of nutritional, functional and bioactive compounds. Food Chem 311:126022. https://doi. org/10.1016/j.foodchem.2019.126022