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Research Trends and Scientific Progress in *Culicoides* spp. (Diptera: Ceratopogonidae) Studies

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ABSTRACT *Culicoides* species are important in public health and veterinary medicine as biological vectors of various pathogens. These species play a role in the epidemiology of certain viral infections, particularly in farm animals, and cause economic losses. Additionally, they can trigger hypersensitivity reactions related to their blood-feeding activities. Therefore, monitoring the distribution, diversity, and population dynamics of *Culicoides* species is a critical component of vector control and surveillance efforts. This study subjected 290 scientific publications on *Culicoides* spp. from 1975 to 2025 to bibliometric analysis using VOSviewer software. Using text mining and data visualization techniques, global research trends and thematic focuses related to these parasitic vectors were revealed. Research on *Culicoides* has demonstrated a strong growth trend that became apparent after 2009. While the main focus areas of the studies are Veterinary Sciences (34.8%) and Entomology (20.0%), the United States (28.3%) and various European countries dominate global research output. The field stands out for its publications in journals with high standards in terms of methodological rigor and academic impact, with an analysis of 290 articles receiving a total of 5849 citations supporting these findings. This study is the first comprehensive bibliometric analysis conducted on *Culicoides* spp. The most frequently used keyword is "Bluetongue virus," the most researched field is veterinary science, and the most productive country is the United States. This analysis reveals global trends in *Culicoides* research, providing an important guide for future research directions.

Keywords: *Bibliometric analysis, Culicoides spp., Vector-borne diseases.*

ÖZ

Culicoides spp. (Diptera: Ceratopogonidae) Çalışmalarında Araştırma Eğilimleri ve Bilimsel Gelişmeler

Culicoides türleri, çeşitli patojenlerin biyolojik vektörü olarak halk sağlığı ve veteriner hekimlikte önemlidir. Bu türler, özellikle çiftlik hayvanlarında bazı viral enfeksiyonların epidemiyolojisinde rol oynar ve ekonomik kayıplara neden olur. Ayrıca, kan emme aktivitelerine bağlı aşırı duyarlılık reaksiyonları oluşturabilirler. Bu nedenle, *Culicoides* türlerinin dağılımı, çeşitliliği ve popülasyon dinamiğinin izlenmesi, vektör kontrolü ve sürveyans çalışmalarının önemli bir bileşenidir. Bu çalışmada, 1975'ten 2025'e kadar *Culicoides* spp. ile ilgili 290 bilimsel yayın, VOSviewer yazılımı kullanılarak bibliyometrik analize tabi tutulmuştur. Metin madenciliği ve veri görselleştirme teknikleri kullanılarak, bu parazitik vektörlerle ilgili küresel araştırma eğilimleri ve tematik odak noktaları ortaya çıkarılmıştır. *Culicoides* üzerine yapılan araştırmalar, 2009'dan sonra belirginleşen güçlü bir büyüme eğilimi göstermiştir. Çalışmaların ana odak alanları Veteriner Bilimleri (%34,8) ve Entomoloji (%20,0) olmakla birlikte, küresel araştırma çıktıları ABD (%28,3) ve çeşitli Avrupa ülkeleri tarafından domine edilmektedir. Bu alan, metodolojik titizlik ve akademik etki açısından yüksek standartlara sahip dergilerde yayınlanan makalelerle öne çıkmaktadır. Bu bulguları destekleyen 290 makalenin analizi, toplam 5849 atıf almıştır. Bu çalışma, *Culicoides* spp. üzerine yapılan ilk kapsamlı bibliyometrik analizdir. En sık kullanılan anahtar kelime "Bluetongue virüsü", en çok araştırılan alan veterinerlik bilimi ve en üretken ülke Amerika Birleşik Devletleri'dir. Bu analiz, *Culicoides* araştırmalarındaki küresel eğilimleri ortaya koyarak, gelecekteki araştırma yönelimleri için önemli bir kılavuz sunmaktadır.

Anahtar Kelimeler: *Bibliyometrik analiz, Culicoides spp., Vektör kaynaklı hastalıklar.*

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INTRODUCTION

Culicoides (Diptera: Ceratopogonidae) species are hematophagous Diptera members measuring 1-3 mm in size and serve as biological vectors for important viral pathogens such as Bluetongue and African horse sickness (Harrup et al. 2015; Yeşilöz et al. 2025). The primary current economic importance of *Culicoides* species (Diptera: Ceratopogonidae) currently have major economic importance due to their role as biological vectors of pathogenic arboviruses such as the Bluetongue virus (BTV), Epizootic hemorrhagic disease virus (EHDV), Schmallenberg virus (SBV) and African horse sickness virus (AHSV). These viruses cause serious diseases in ruminants, deer, and other ungulates and are listed as notifiable epizootic animal diseases by the World Organization for Animal Health (OIE) (Elbers et al. 2013; Yeşilöz et al. 2025).

The genus *Culicoides* is commonly known as biting midges and no-see-ums and taxonomically includes over 1,400 identified species. A significant portion of these species are hematophagous and feed on the blood of humans and various animals; many also serve as biological vectors for animal pathogens, causing significant allergic and pathological reactions (Borkent 2016). Although the first records of the *Culicoides* fauna in Türkiye are attributed to Kieffer, he has also described numerous species found in Türkiye. Systematic research on *Culicoides* in Türkiye has progressed adding many new records. Subsequently, Yılmaz's study in the Elazığ region identified 42 species, expanding the species inventory adding many new records. A study compiled by Dik reported this number as 61 species, and subsequently, Korkmaz et al. increased this number to 72 by recording additional species in a comprehensive field study across 51 provinces (Kieffer 1918; Dik 1989; Yılmaz 1994; Korkmaz et al. 2021).

Culicoides species cause allergic skin reactions (culicoidosis) in humans and animals, characterized by severe itching, leading to significant disturbances in host behavior, such as displacement and escape to indoor environments. Since females feed by sucking blood from animals and humans, *Culicoides* biting midges appear to be important vectors from both veterinary and medical perspectives. However, the most critical role of these species in public health is their ability to transmit the Oropouche virus (OROV), the causative agent of Oropouche fever, a febrile illness in humans (Turgut et al. 2022; Deniz et al. 2023).

The primary objective of this study is to present a comprehensive bibliometric analysis that quantitatively evaluates scientific publications on *Culicoides* spp. on a global scale. The research aims to reveal current research trends, intellectual structure, and scientific productivity dynamics by examining the metric data of the relevant literature. Bibliometric studies on vector-borne diseases and *Culicoides* spp. in the current literature have demonstrated that such analyses enable the systematic mapping of knowledge accumulation, research gaps, and academic orientations in the field. This study also aims to provide insights into global research trends by evaluating the scientific production profiles of developed and developing countries from a comparative perspective.

MATERIAL AND METHODS

Search Strategy and Data Collection

This bibliometric study aims to conduct a comprehensive analysis of scientific publications on the *Culicoides* taxon published globally between 1975 and 2025. A search using the keyword "*Culicoides* spp." in the Web of Science (WoS) database yielded a total of 290 records. Publications prior to 1975, studies not directly related to the topic, and publication types other than research articles (case reports, editorial articles, letters, etc.) were excluded from the analysis. Only original research articles published in peer-reviewed journals were included in the evaluation, and the final analysis was conducted on 290 eligible articles.

Bibliographic information such as titles, author names, publication years, journal names, and numbers of citations for articles retrieved, has been systematically recorded. The entire dataset has been exported in plain text (TXT) format and archived under the file name "downloadable text." Van Yuzuncu Yil University's online library systems and digital resources were used in the data collection process. Literature review and data analysis were conducted exclusively in English.

Data Analyses

In this bibliometric analysis, VOSviewer software (version 1.6.20, Leiden University, Netherlands) was used to determine global trends, collaboration networks, thematic focuses, and emerging research directions related to *Culicoides* studies (Van Eck and Waltman 2022). VOSviewer is an effective tool specifically developed for network visualization of large-scale bibliometric data sets. During the systematic data collection phase, the WoS database was used as the basis, and the bibliographic data of all articles included in the final analysis were transferred into VOSviewer and evaluated using the software's calculation and mapping algorithms. The results were interpreted from an integrated perspective.

Within the scope of this study, collaborations at the country/region and institutional levels, author contributions, and keyword analyses were conducted. Microsoft Office Excel 2019 software was used to evaluate temporal trends, while text mining and data visualization techniques (including bubble maps and multiple graph types) were utilized to support the validity and reliability of the findings.

RESULTS

This study analyzed 290 scientific articles compiled from the WoS database and 5849 citations attributed to these articles. The analysis revealed an average number of citations per article of 20.17 and an H-index of 39. A significant increase was observed in both the annual number of publications and the number of citations, particularly after 2009. This continuous increase in publication and citation numbers is considered an indicator of the field's increasing bibliometric momentum. These annual distributions and trends are visualized in Figure 1.

The disciplinary distribution of the analyzed publications reveals a clear concentration of scientific production around specific thematic areas. The five main research areas that stand out in terms of publication volume are Veterinary Sciences (34.8%), Entomology (20.0%), Parasitology (11.4%), Tropical Medicine (5.9%), and Infectious Diseases (5.2%). This distribution indicates that these five disciplines, which account for approximately three-quarters of the total articles (77.3%), constitute the fundamental backbone of the literature in question (Table 1).

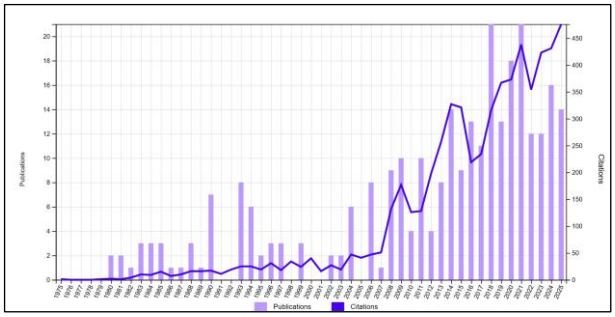

Figure 1: Annual Number of Publications and Citations in *Culicoides* Research Worldwide, Based on the Web of Science Database (1975–2025).

Table 1: Categorization of publications on *Culicoides* spp. according to global research areas, based on Web of Science Data (1975-2025).

Research Areas	Record Count	% of 290
Veterinary Sciences	174	34.828
Entomology	101	20.000
Parasitology	58	11.379
Tropical Medicine	33	5.862
Infectious Diseases	17	5.172
Immunology	15	3.103
Microbiology	9	3.103
Virology	9	2.759
Public Environmental Occupational Health	8	2.414
Agriculture	7	2.414
Science Technology Other Topics	7	1.724
Dermatology	5	1.724
Zoology	5	1.379
Biotechnology Applied Microbiology	4	1.379
Environmental Sciences Ecology	4	0.690
Allergy	2	0.345
Biochemistry Molecular Biology	1	0.345
General Internal Medicine	1	0.345
Genetics Heredity	1	0.345
History	1	0.345
Life Sciences Biomedicine Other Topics	1	0.345
Research Experimental Medicine	1	0.345

The top 22 research areas with the highest rates.

A bibliometric profile analysis of publication frequency by country indicates a significant geographic concentration in global research output. The data show that the United States contributed the largest volume, with 82 articles, accounting for 28.3% of total publications. This finding confirms the United States' leading position in scientific production in this field. The top-ranked country is followed by strong participation from Europe, with Germany (n=42; 14.5%), the England (n=38; 13.1%), Switzerland (n=23; 7.9%), and Spain (n=19; 6.5%) among the top five countries. The combined contributions of these five countries form the fundamental backbone of the global research network. The full list and numerical distribution of the top 25 countries are detailed in Table 2 (Figure 2).

Bibliometric analysis of institutional publication productivity revealed significant institutional concentration in research output. The institutions with the highest publication volumes were the United States Department of Agriculture (USDA) (8.3%), the Florida State University System (7.9%), the Biotechnology and Biological Sciences Research Council (BBSRC) (7.6%), the Pirbright Institute (7.6%), and the UK Institute for Research and Innovation (7.6%). Remarkably, the top five institutions contribute approximately 39% of total publications, suggesting that the research agenda in this field is largely shaped by these leading institutions. A comprehensive analysis of the top 25 institutions, detailing the network mapping of institutional collaborations and their publication productivity, is presented in Table 3 (Figure 3).

Table 2: According to Web of Science (WoS) data, the top 25 countries publishing on *Culicoides* between 1975 and 2025.

Countries/Regions	Record Count	% of 290
USA	82	28.276
England	38	14.483
Germany	42	13.103
Switzerland	23	7.931
Spain	19	6.552
France	18	6.207
Netherlands	14	4.828
South Africa	14	4.828
Australia	13	4.483
Austria	13	4.483
Brazil	11	3.793
Iceland	11	3.793
India	11	3.793
Italy	11	3.793
Poland	11	3.793
Belgium	10	3.448
Israel	10	3.448
Thailand	10	3.448
Peoples R China	9	3.103
Ireland	8	2.759
Japan	8	2.759
Romania	8	2.759
Scotland	8	2.759
Türkiye	8	2.759
Czech Republic	5	1.724

The top 25 Countries/Regions with the highest rates.

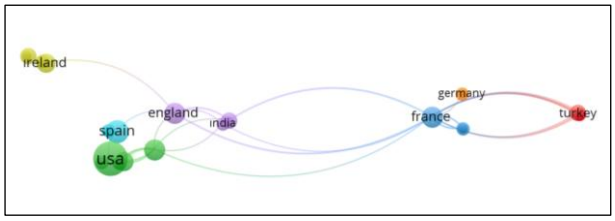

Figure 2: Global Collaborative Network of Countries in *Culicoides* Research (1975–2025).
Data Source: Web of Science. Note: It visualizes the global network of collaborations in *Culicoides* research spanning the period 1975–2025. The visual reveals a dense cluster of collaborations, with Ireland exhibiting strong connections primarily with Spain, the United States (US), and the England. This centralized structure suggests a high level of collaborative research projects and knowledge exchange between these countries.

Indexing analysis based on the WoS database revealed a distinct trend in the distribution of the reviewed publications. The overwhelming majority of articles (96.2%) were indexed in the Science Citation Index Expanded (SCI-Expanded) category, which encompasses high-impact journals. Other indexes that fall well behind this main category are the Emerging Sources Citation Index (ESCI) (3.8%) and the Conference Proceedings Citation Index – Science (CPCI-S) (1.0%). The inclusion of almost all of the existing literature in SCI-Expanded indicates that the research is conducted on platforms with high quality standards in terms of methodological soundness and academic impact (Table 4, Figure 4).

Table 3: Leading institutions in *Culicoides* research by publication output: Top 25 rankings based on Web of Science data (1975–2025).

Affiliations	Record Count	% of 290
United States Department of Agriculture USD	24	8.276
State University System of Florida	23	7.931
Biotechnology And Biological Sciences Research Council BBSRC	22	7.586
Pirbright Institute	22	7.586
Uk Research Innovation UKR	22	7.586
University of Florida	22	7.586
University of Bern	13	4.483
Utrecht University	13	4.483
University of California System	11	3.793
University of Veterinary Medicine Hannover	11	3.793
Cirad	10	3.448
University of Iceland	10	3.448
University System of Georgia	10	3.448
Wageningen University Research	10	3.448
Friedrich Loeffler Institute	9	3.103
Kimron Veterinary Institute	9	3.103
Leibniz Association	9	3.103
National Veterinary Institute National Research Institute	9	3.103
University of California Davis	9	3.103
University of Pretoria	9	3.103
University of Veterinary Medicine Vienna	9	3.103
University of Zurich	9	3.103
Inrae	8	2.759
Universite De Strasbourg	8	2.759
Universitas De Strasbourg Establishments Associes	8	2.759

The top 25 institutions with the highest rates.

Table 4: Web of Science categories used to identify global publications on *Culicoides* (1975–2025).

WEB OF SCİENCE INDEX	Record Count	% of 290
Science Citation Index Expanded (SCI-EXPANDED)	279	96.207
Emerging Sources Citation Index (ESCI)	11	3.793
Conference Proceedings Citation Index – Science (CPCI-S)	3	1.034

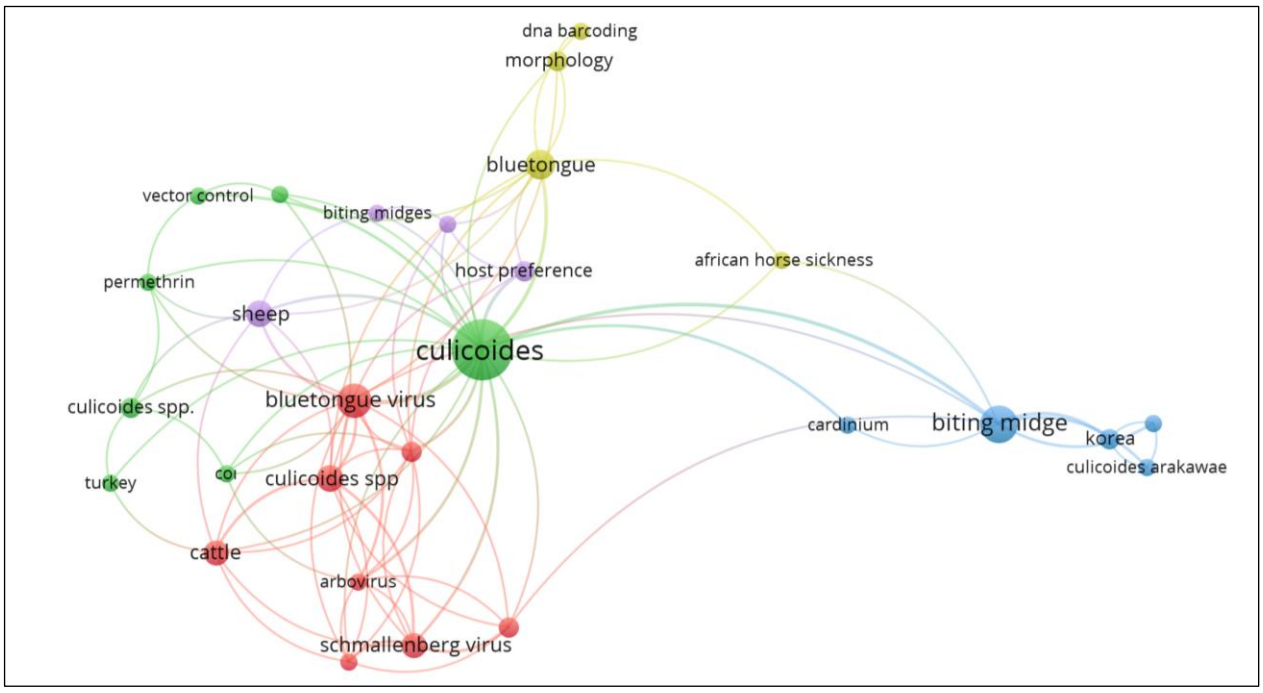

Figure 3: Bibliometric mapping of institutional productivity and collaboration in *Culicoides* research (1975–2025).
Note: A word cloud or concept map showing the results of a bibliometric analysis of *Culicoides* research. The distribution and size of the keywords in the image reflect research trends, focuses, and scientific collaborations in this field between 1975 and 2025.

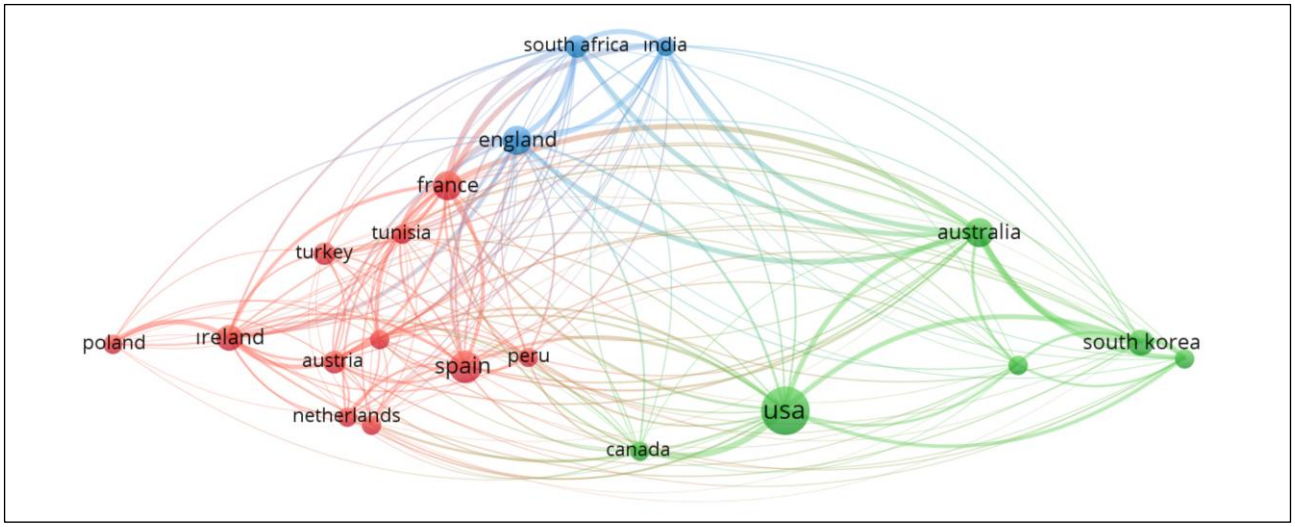

Figure 4. Mapping intellectual alliances: A bibliographic coupling analysis of countries in *Culicoides* research (1975–2025).
Note: presents a bibliographic coupling analysis, which delineates the intellectual alliances among countries based on shared reference lists within the *Culicoides* research domain from 1975 to 2025. This methodology effectively maps the underlying intellectual structure and knowledge base of the field, revealing distinct thematic clusters where countries are investigating closely related topics.

DISCUSSION AND CONCLUSION

Bibliometric analysis serves as a quantitative data analysis methodology that facilitates the assessment of scientific publications, theses, and academic productivity within a given field. In recent decades, these approaches have gained prominence in medical literature, allowing for systematic evaluation of scholarly output. Such analyses are typically performed using specialized databases and are often enhanced through data visualization tools, thereby offering novel insights and perspectives to researchers in the discipline. A growing body of literature has employed major indexing databases such as Web of Science Core Collection (WoSCC), Scopus, PubMed, and MEDLINE to conduct comprehensive bibliometric assessments (Dahdi et al. 2018; Alıravcı 2022; Afşar et al. 2024; Yıldız et al. 2024). The role of bibliometric analysis in medical research continues to expand in both scope and significance. Academic journals function as fundamental communication channels, enabling researchers to disseminate their work to the global scientific community. Consequently, a journal's academic standing is closely tied to the scientific impact and performance of the studies it publishes (Maciver et al. 2020; Durgun 2021; Yıldız 2022; Afşar et al. 2025).

Although there are many valuable studies on *Culicoides* spp. in the academic literature, integrative analyses that provide a systematic map of existing studies and identify future research directions using quantitative data remain limited (Kieffer 1918; Dik 1989; Yılmaz 1994; Elbers et al. 2013; Harrup et al. 2015; Borkent 2016; Korkmaz et al. 2021; Turgut et al. 2022; Deniz et al. 2023; Yeşilöz et al. 2025). The current literature provides critical data on the epidemiology, pathogenesis, clinical course, and prevention strategies of the disease in question and establishes a conceptual framework for future research in the field. This study has revealed a significant global increase in scientific publications related to *Culicoides* spp. in recent years. The main objectives of the research are to systematically map global trends in *Culicoides* spp.-focused studies, emerging research clusters, thematic focal points, and geographical distribution patterns. Furthermore, through the analysis of leading journals, influential authors, and fundamental studies in the field, gaps in the existing literature have been identified, and priority directions for future research have been proposed.

A search using the keyword *Culicoides* in the WoS database identified 310 articles, of which 290 were included in the final analysis. When examining the chronological distribution of the studies, it was observed that there were a very limited number of publications before 1975, but interest in the subject increased significantly from 2009 onwards. The number of publications peaked in 2018 and 2021, indicating that scientific productivity in this field has increased significantly in recent years. When examining the distribution of research areas, it was observed that (34.8%) of the studies were concentrated in the field of Veterinary Sciences. This was followed by Entomology with (20%) and Parasitology with (11.4%). Other important research areas include Tropical Medicine (5.9%), Infectious Diseases (5.2%), and Immunology (3.1%). This distribution shows that *Culicoides* research is primarily focused on veterinary medicine and vector biology, while the human health dimension has been less studied. This focus in the current literature indicates significant research gaps, particularly in areas such as public health, clinical management, and advanced molecular pathogenesis studies. This thematic profile reflects a multidisciplinary approach centered on the “One Health” concept, which is directly linked to public health and global food security, including the transmission dynamics of zoonotic pathogens, vector-borne diseases, and parasitological threats. The full disciplinary distribution of publications is detailed in Table 1.

When analyzing international collaboration networks and national contributions, Türkiye's position in *Culicoides* research is noteworthy. In terms of publication count, Türkiye has a contribution rate of 2.759% with 8 articles, placing it behind countries such as the USA (28.276%), the UK (14.483%), and Germany (13.103%), but on par with countries like Ireland, Japan, and Scotland in terms of publication performance. However, when examining the collaboration map, Türkiye is seen to play a central role in the international co-author network. Its collaborations with countries with different geographical and scientific profiles, such as Spain, France, South Africa, Tunisia, Poland, and South Korea, have made Türkiye an important hub in the global *Culicoides* research ecosystem. This situation highlights Türkiye's strategic importance in the

field, not only through its quantitative contribution but also through its integration into interdisciplinary and multinational research networks (Table 2, Figure 2). The network map also shows that other important international partners, such as France, Germany, Türkiye, and India, are integrated into this global research ecosystem. Given the global threat of vector-borne pathogens associated with *Culicoides* (such as Bluetongue and African Horse Sickness), this structure reflects the transboundary nature of the issue and the vital importance of interdisciplinary collaboration for research progress in this field.

This bibliometric analysis reveals institutional productivity and collaboration networks in *Culicoides* research. Institutions such as the United States Department of Agriculture (USDA), the Florida State University System, and the UK-based Biotechnology and Biological Sciences Research Council (BBSRC) stand out as the most productive organizations in the field, with publication rates of 8.3%, 7.9%, and 7.6%, respectively. Keyword analysis shows that research focuses are shaped around thematic clusters such as "DNA barcoding," "vector control," "Bluetongue virus," and "host preference." When examining geographical distribution, the US and European countries play a central role, but Türkiye, South Korea, and South Africa also make strong contributions. It is particularly noteworthy that Türkiye has become an important hub in the global research network with its studies on regional vector-borne pathogens. These findings demonstrate that *Culicoides* research has an interdisciplinary and multi-centered structure and that global collaborations are vital for progress in the field (Table 3, Figure 3). This bibliometric map demonstrates that *Culicoides* research has a multidimensional and interdisciplinary structure. Studies range from basic species identification to the epidemiology of vector-borne diseases and control strategies. Furthermore, global collaborations and regional focuses balance the universal and local dimensions of the research. This type of analysis provides a valuable guide for determining future research priorities and strengthening collaborations.

Scientific research conducted on *Culicoides* species is highly regarded in academic literature and largely published in prestigious international indexes due to the critical importance of these vectors in public health and veterinary medicine. Analyses conducted using the WoS database reveal that a remarkably high percentage (96.2%) of the articles examined were published in journals included in the Science Citation Index Expanded (SCI-Expanded). This dominant category is followed by other indexes such as the Emerging Sources Citation Index (ESCI) (3.8%) and the Conference Proceedings Citation Index–Science (CPCI-S) (1%). This distribution demonstrates that almost all scientific production related to *Culicoide*s is concentrated in high-impact, peer-reviewed science and health science journals, clearly reflecting the importance given to the field (Table 4, Figure 4).

The analyzed bibliographic data revealed that the term *Culicoides* forms a central node in co-word analysis network maps and constitutes the fundamental axis of the research field in question. The keywords most frequently associated with "*Culicoides*" include pathogen and disease themes such as "vector," "Bluetongue virus," "bovine ephemeral fever," "Schmallenberg virus," and "Orbivirus." These findings indicate that the research focus is predominantly focused on the epidemiology and transmission dynamics of vector-borne viral pathogens. The network analysis also observed that geographical regions such as "Türkiye," "Iran," "Australia," and "North America" form significant clustering areas. Keyword time trend analysis indicates a clear shift towards genetic and phylogenetic themes such as molecular identification, phylogeography, and species complexes after 2010. This trend indicates that the research paradigm in the field has evolved from morphological identification to molecular systematics.

This study systematically evaluates global trends, collaborations, and thematic focuses in *Culicoides* research using bibliometric analysis methods. The findings are expected to guide researchers, particularly those working in the fields of parasitology and veterinary entomology, in identifying gaps in the existing literature and planning future research directions. The data used in the study were obtained from the WoS database, which is widely accepted in bibliometric research. However, it should be noted that, as a limitation of the study, some studies included in other large databases such as Scopus or PubMed may not have been included in the analysis because it is based solely on the WoS index. This situation may limit the generalizability of the results, and the integrated use of multiple databases may be recommended in future studies. It is important to increase *Culicoides* research in our country and improve molecular methods for better epidemic control and diagnosis.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

Idea/Concept: SE, MA
Supervision/Consultancy: SE, HY
Data Collection and/or Processing: SE, MA, MY
Analysis and/or Interpretation: SE, MA
Writing the Article: MA
Critical Review: HY

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