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RESEARCH ARTICLE

Bibliometric and scientometric analysis of acarological publications in Türkiye between the years 1992-2023

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ASBTRACT: A bibliometric and scientometric analysis of acarological studies conducted in Türkiye between 1992 and 2023 were performed by searching the Clarivate Thomson Reuters WoS database using 525 keywords. The first publication from Türkiye appeared in WoS in 1992. A total of 1,344 articles, 52 reviews, 30 progress reports, eight letters, eight early access documents, seven editorials, three conference abstracts and one note were found. The 1,453 articles written by Turkish scientists were published in 420 different sources (books, journals, etc.) with an annual growth rate of 16.3% and an average number of references of 10.39. Overall, 149 (10.25%) of the publications were written by a single author, while the remaining 1,304 articles had an average of 4.36 authors and 23.47% of them were written in collaboration with international experts. With some slight fluctuations, the number of publications increased over the years, with the highest number of publications being recorded in 2021 and 2023. Again, a steady increase in total and annual citations was observed, with some slight fluctuations. Systematic and Applied Acarology and International Journal of Acarology were the journals with the highest number of publications, while Experimental and Applied Acarology (n=1,202) was the journal with the highest number of citations to Turkish publications. Experimental and Applied Acarology and Veterinary Parasitology were the journals with the highest H-index. The most prolific authors were Salih Doğan (n=77), İsmail Döker (n=67) and Sultan Çobanoğlu (n=64), while the most cited publications were those of Salih Doğan, Nusret Ayyıldız and Adem Keskin. Münir Aktaş, Salih Doğan and Adem Keskin were the authors with the highest H-index. With 199 publications, Ankara University was the institution with the highest number of publications. The 1,453 publications were produced in collaboration with researchers from 87 countries. The highest number of collaborative publications was with researchers from the United States of America (n=89). The Scientific and Technological Research Council of Türkiye was the institution that founded the highest number of studies.

Keywords: Bibliometric analysis, scientometric analysis, acarology, Türkiye
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INTRODUCTION

Acarology, the study of mites and ticks, is a scientific field of growing interest in Türkiye due to the country's diverse ecosystems and the significant impact of mites and ticks on human and animal health, agriculture, and the environment. Over the years, Turkish researchers have contributed significantly to acarology through their studies on the taxonomy, biology, ecology, and control of mites and ticks. This paper provides an overview of acarology research and publication trends in Türkiye, highlighting key contributions and future directions in the field.

Several factors have influenced public health awareness of mites and ticks. The first one is the epidemic of Crimean-Congo haemorrhagic fever in Türkiye which started at the beginning of the 2000s. The disease is transmitted by ticks mainly and the fatality rate of it is approximately 4-5% (Karti et al., 2004; İnci et al., 2016; HSGM-MoH Türkiye, 2024). Another factor is the dramatically increased prevalence of allergic diseases due to house dust mites which is a global problem in developed countries (Aydin et al., 2009; Gökce et al., 2010; Zeytun et al., 2017; Mumcuoğlu and Taylan-Özkan, 2020; Türkiye Ulusal Alerji ve Klinik İmmünoloji Derneği, 2024). Developments in agricultural and livestock policies are another factor that increases interest in acarology. Such as precision agriculture envisages ensuring the economy by using inputs effectively (in the required amount) and thus reducing their impact on the environment. This can also contribute to ensuring uniformity in product quality. In these respects, some of the goals of precision agriculture related to acarology are: Reducing chemical input expenses such as fertilizer and pesticides, reducing environmental pollution, and providing high quality products in high quantities (Yaldız et al., 2005; Kılıç and Alkan, 2018; Akıllı Tarım Platformu, 2019).

Scientometric analysis and bibliometric analysis are two similar, but different methods used to measure, evaluate

and analyze scientific publications and research activities. Bibliometric analysis is the collection, analysis, and interpretation of numerical data about scientific publications. This analysis specifically aims to examine the sources of scientific publications (authors, institutions, and journals), publication numbers, citations, and circulation of publications. It is used for purposes such as determining which fields, which topics, and which methodologies scientific publications deal with, analyzing research trends on a particular subject, and monitoring developments in a field of science. It can especially help the researcher in finding funds and grants (Aria and Cuccurullo, 2017; Şenel et al., 2020; Koç and Gürler, 2022). On the other hand, scientometric analysis takes an overall measure of scientific activities, it can also include citation networks, scientific collaborations, and scientific interactions in addition to bibliometric analysis. Accordingly, scientometric analysis is determined as the measurement, quantitative analysis, and interpretation of scientific activities (publications, citations, patents). This analysis is used to understand the overall growth, interactions, diversity, and innovations in a field of science. It can also be used to identify important researchers, institutions, and research trends in a particular field of science (Aria and Cuccurullo, 2017; Koç and Gürler, 2022; Mumcuoglu et al., 2023).

This study aimed to list the publications done in acarology in Türkiye between the years 1992-2023, the trends of the publications during the years, the journals in which the most number of publications in acarology were done, the collaboration between Turkish and foreign acarologists, the most cited articles, their impact to our knowledge, the most prolific authors, those who were most cited in other publications, the authors with the highest H-indexes and the institutions in which they are working.

MATERIALS AND METHODS

Bibliometric and scientometric analysis

Data were collected by searching the Clarivate Thomson Reuters WoS Database (Thomson Reuters, New York, USA) using 525 keywords (Supplementary Table 1). The search was filtered by country, i.e., "Turkey" and "Türkiye" and by year, specifically between 1992 and 2023. Only publications authored by Turkish scholars were included. Even if the materials were collected from Türkiye, if the scientist who conducted the research was affiliated with an organization outside Türkiye, he/she was excluded from the list.

Visualization

The data were analyzed and visualized using the R-based Bibliometrix 4.1 Analysis Program (Aria and Cuccurullo, 2017) and the web interface provider Biblioshiny and the VOSviewer software.

RESULTS

The search yielded a total of 1,344 articles, 52 reviews, 30 progress reports, eight letters, eight early access documents, seven editorials, three conference abstracts and one note.

Table 1 shows the types of publications, their total and average number, and whether they were single- or multi-authored. The 1,453 articles written by Turkish scientists were published in 420 different sources (books, journals, etc) when the annual growth rate was 16.3%, and the average number of references was 10.39. The majority of the publications (1,344) were journal articles written by 3,774 authors with 3,426 keywords (whose number was reduced to 2,757 by the WOS system). Of the 1,453 publications, 149 (10.25%) were written by a single author, while the remaining 1,304 articles had an average of 4.36 authors and 23.47% of them were written in collaboration with international experts.

As can be seen in Figure 1, the highest number of publications took place in 2021 and 2023. Although an overall increase was observed over the years, a gradual decrease in the number of publications was still observed during 2010-2014 and 2016-2018, as compared to 2010 and 2016, respectively.

The average ratio of total and yearly citations is shown in Figure 2, where with some slight fluctuations a steady increase in the ratio of total and yearly citations can be seen.

Figure 3 shows the top 20 journals in which most of the studies originating from Türkiye were published. Systematic and Applied Acarology and International Journal of Acarology are the journals with the most publications, followed by the Turkish Journal of Entomology, Zootaxa, and Turkish Journal of Zoology.

The journals in which the most cited Turkish publications appear are shown in Figure 4. Accordingly, Experimental and Applied Acarology, followed by Veterinary Parasitology, and Zootaxa were the journals in which the highest number of citations to Turkish publications were observed.

The list of journals with the highest H-index in which Turkish publications were cited is shown in Figure 5. Accordingly, Experimental and Applied Acarology and Veterinary Parasitology were the journals with the highest H-index.

Figure 6 shows the 20 most prolific authors. Accordingly, S. Doğan (n=77), İ. Döker (n=67) and S. Çobanoğlu (n=64) were the authors who published the most papers in acarology. The publications of S. Doğan, N. Ayyıldız, and A. Keskin were the most cited papers (Fig. 7).

The productivity of the seven authors with the most publications over time is shown in Figure 8. Overall, the authors were either consistently productive or their productivity increased over time.

Table 2 shows the 20 most locally and internationally cited articles published by Turkish acarologists between the years 1992-2023. Accordingly, the papers of Erman et al. (2007), Aktaş et al. (2014), Bursalı et al. (2012), and Doğan (2007) were the most cited publications.

Table 1. Details of publications on acarology in Türkiye, between the years 1992-2023.

Description	Results	Description	Results
PUBLICATIONS		**AUTHORS AND COLLABORATIONS**	
Timespan	1992-2023	Single-authored publications	149
Sources (Journals, Books, etc.)	420	Average number of co-authors per publications	4.36
Documents	1,453	International co-authorships %	23.47
Annual Growth Rate %	16.3	**DOCUMENT TYPES**	
Document Average Age of the Publication (years)	9.22	Article	1,344
Average citations per doc	10.39	Article: Early access	8
References	31,626	Article: Proceedings paper	30
DOCUMENT CONTENTS		Editorial	7
Keywords Plus (ID)	2,757	Letter	8
Author's Keywords (DE)	3,426	Meeting abstract	3
AUTHORS		Note	1
Authors	3,774	Review article	52
Authors of single-authored publications	84		

Table 2. List of the 20 most locally and internationally cited articles published by Turkish acarologists between the years 1992-2023.

Publication	Local and International Citations
Erman et al. (2007), Zootaxa	149
Aktas et al. (2014), Veterinary Parasitology	121
Bursalı et al. (2012), Experimental and Applied Acarology	112
Doğan (2007), Zootaxa	82
Aktas et al.(2012), Veterinary Parasitology	74
Faraji et al. (2011), International Journal of Acarolology	70
Ay and Gürkan (2005), Phytoparasitica	64
Doğan (2003), Archives des Sciences	63
Altay et al. (2008), Research in Veterinary Science	61
Kaya et al. (2008), New Microbiologica	60
Seyhan et al. (2004), Journal of International Medical Research	59
Sen et al. (2011), Ticks and Tick-borne Diseases	54
Bursalı et al. (2011), Journal of Medical Entomology	53
Doğan (2006), International Journal of Acarology	52
Erman et al. (2010), Zootaxa	51
Karaer et al. (2011), Experimental and Applied Acarology	48
Keskin et al. (2014), Journal of Medical Entomology	42
Urhan (2002), Journal of Natural History	29
Koç and Akyol (2004), Annales Zoologici	28
Urhan (2008), Turkish Journal of Zoology	27

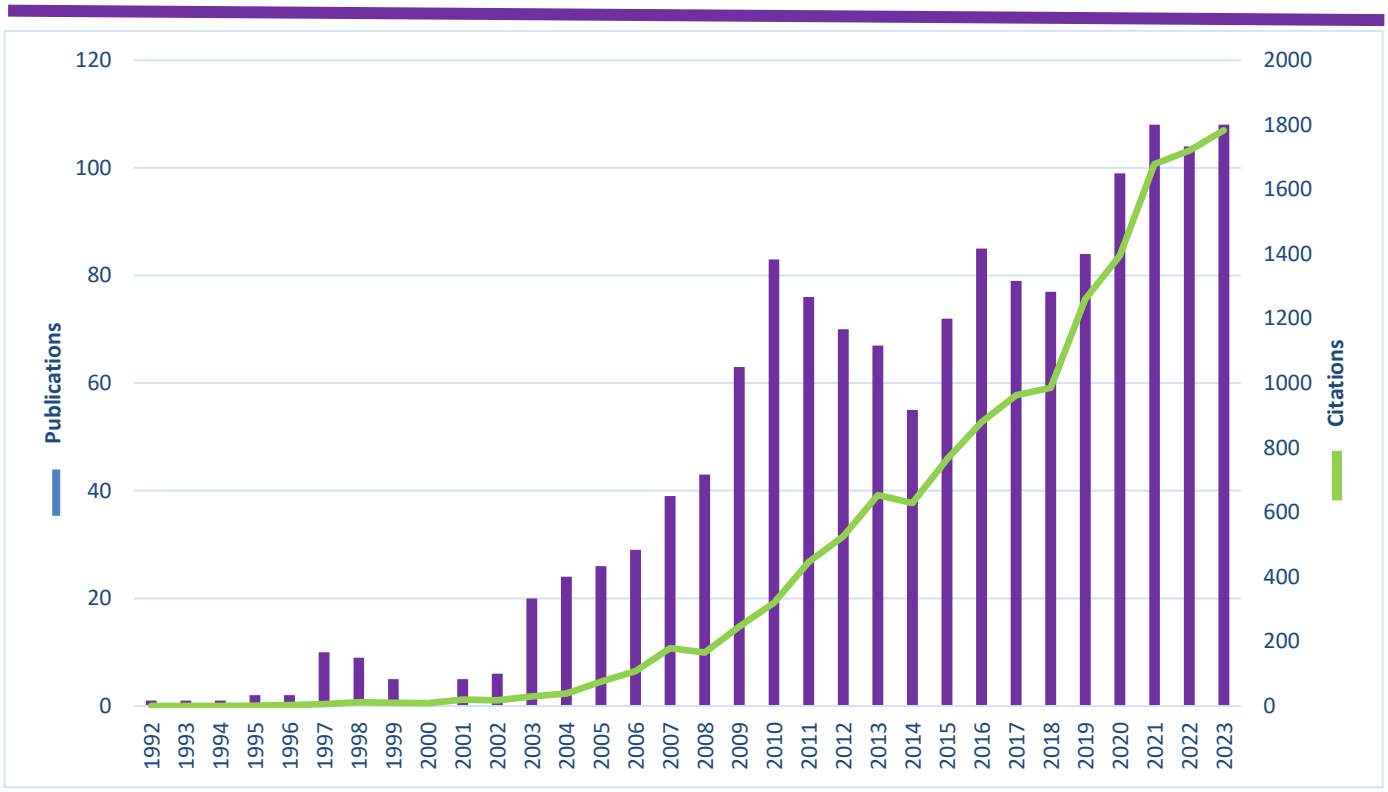

Figure 1. Distribution of published studies on acarology by years and number of citations (1992-2023).

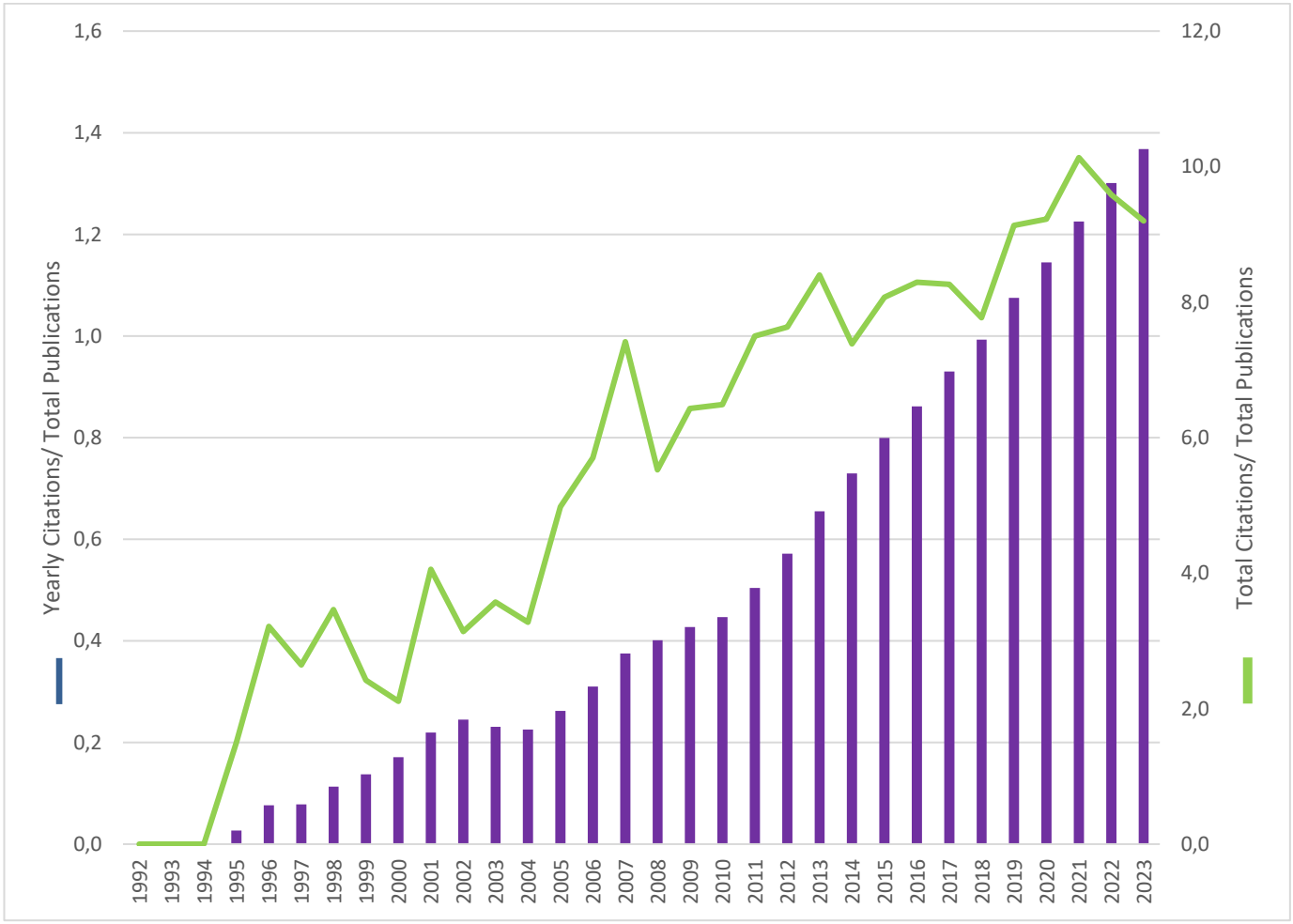

Figure 2. Average annual citation rate of acarological publications in Türkiye between the years 1992-2023.

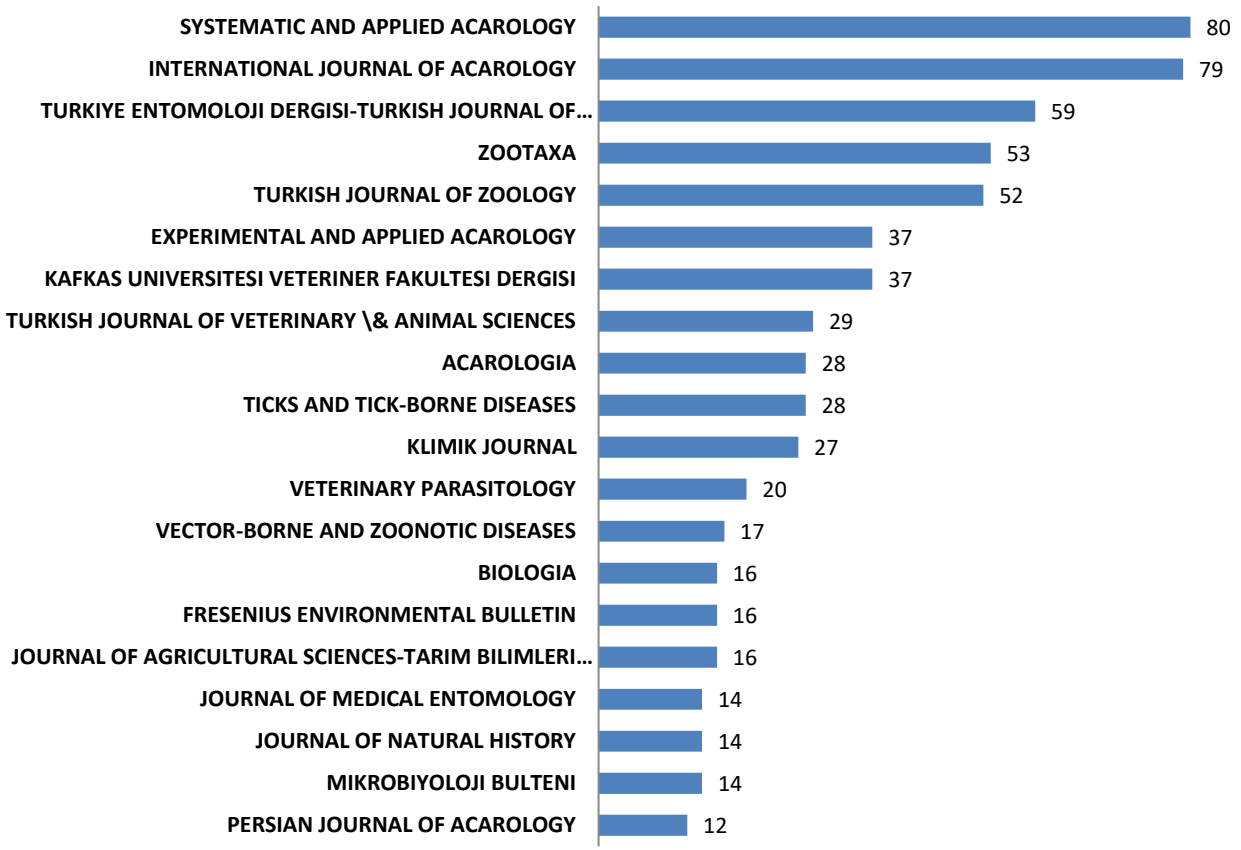

Figure 3. Academic journals in which most of the acarological studies originating from Türkiye were published (1992-2023).

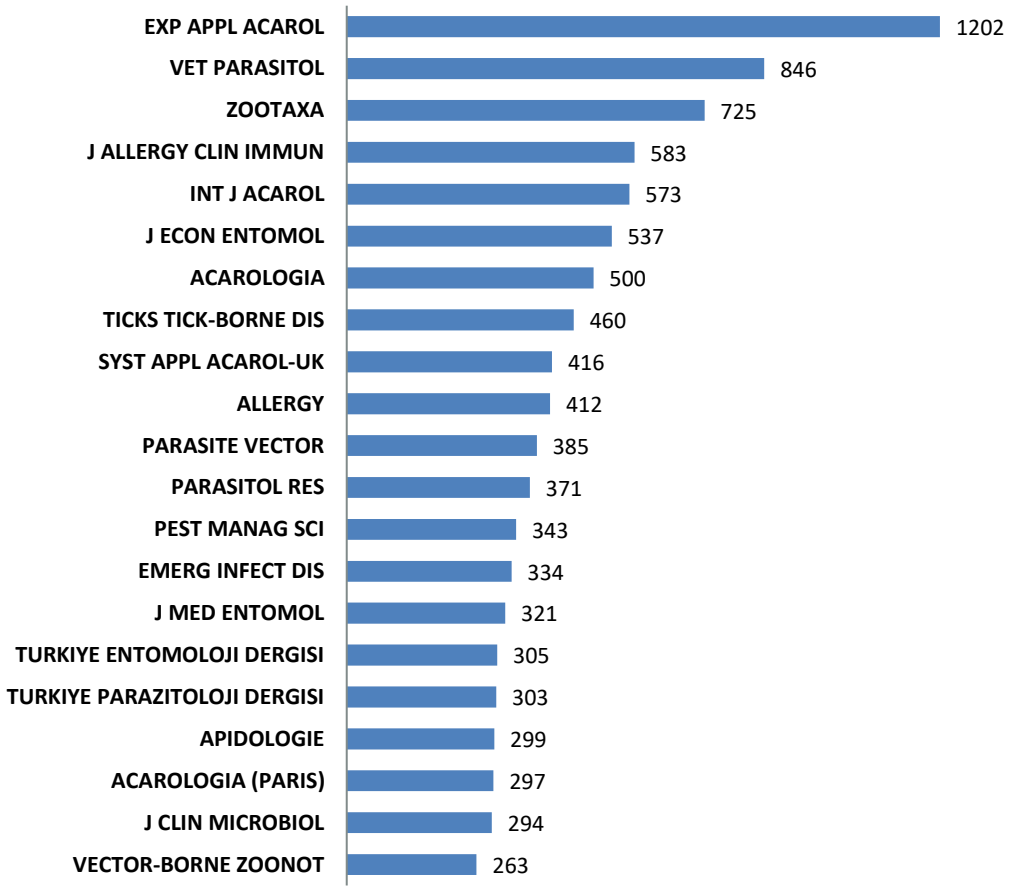

Figure 4. Journal in which the highest number of citations regarding Turkish acarological publications were recorded between the years 1992-2023.

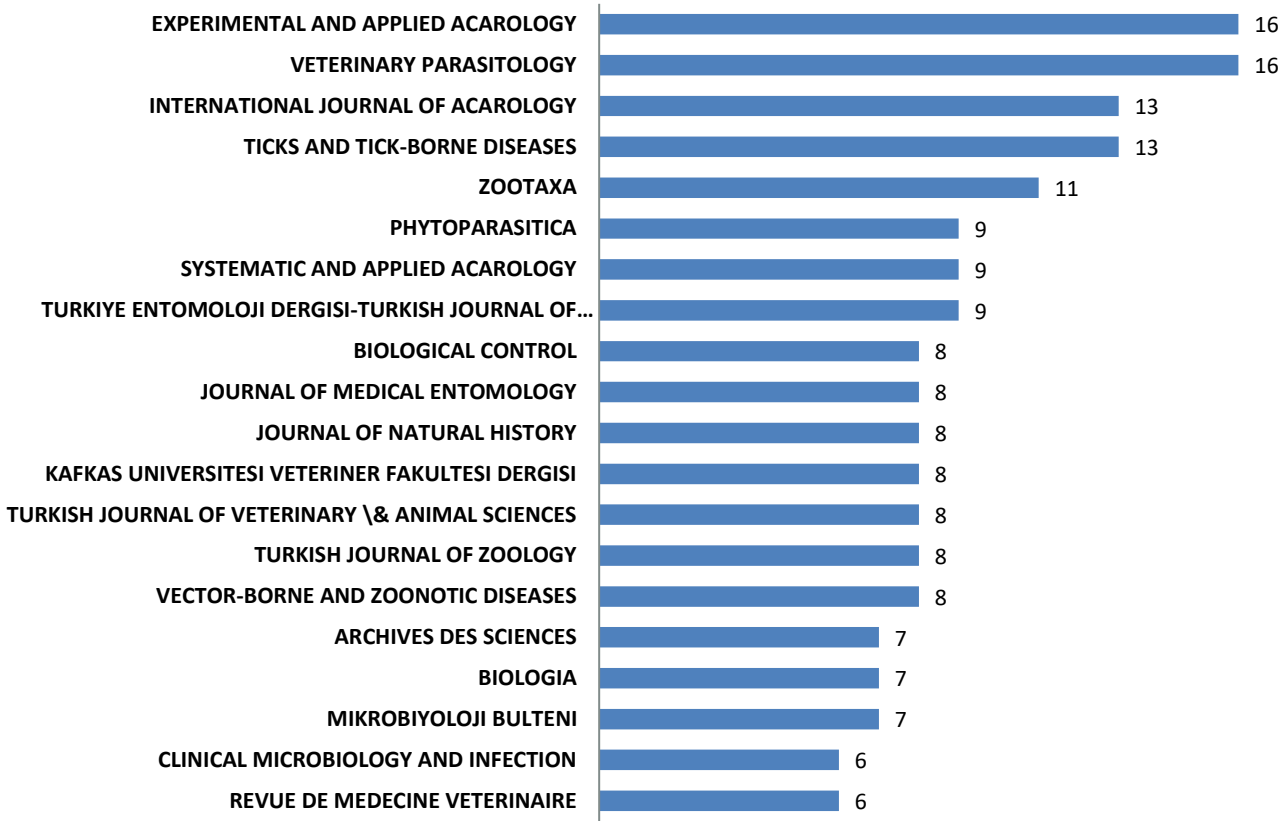

Figure 5. Journals with the highest H-index in which acarological publications from Türkiye between the years 1992-2023 were included.

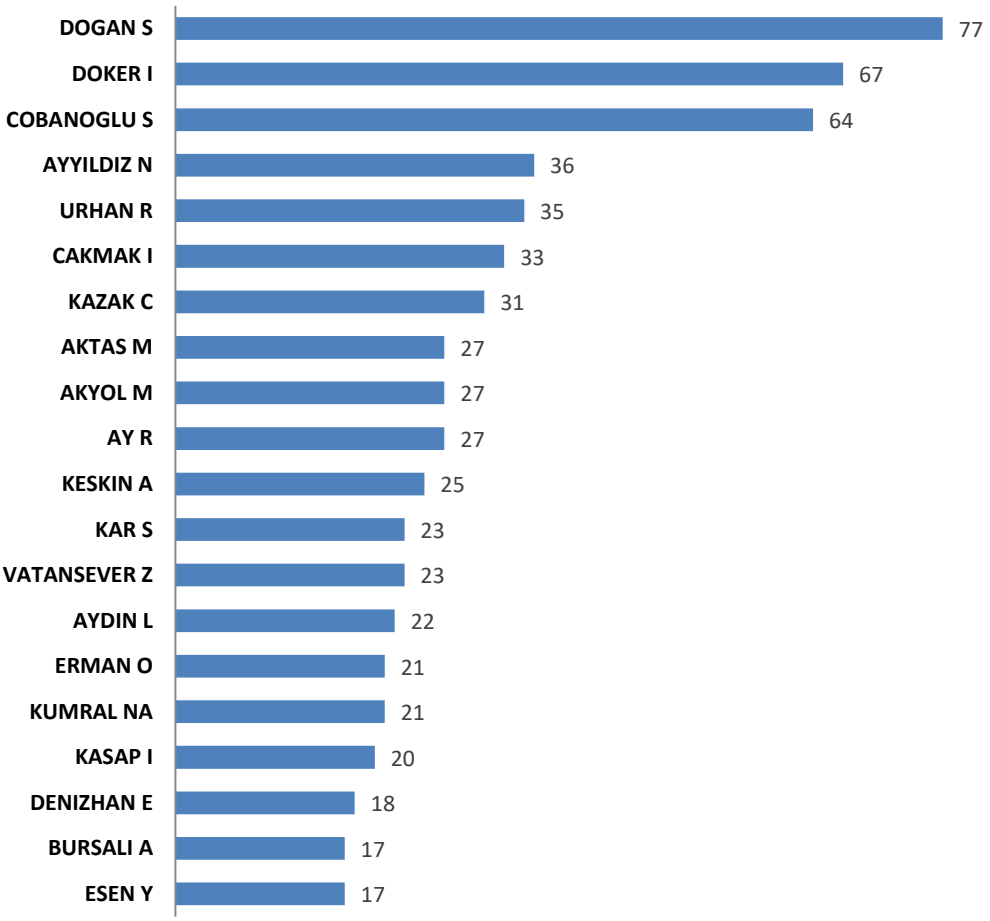

Figure 6. List of the 20 most prolific authors on the subject of acarology in Türkiye between the years 1992-2023.

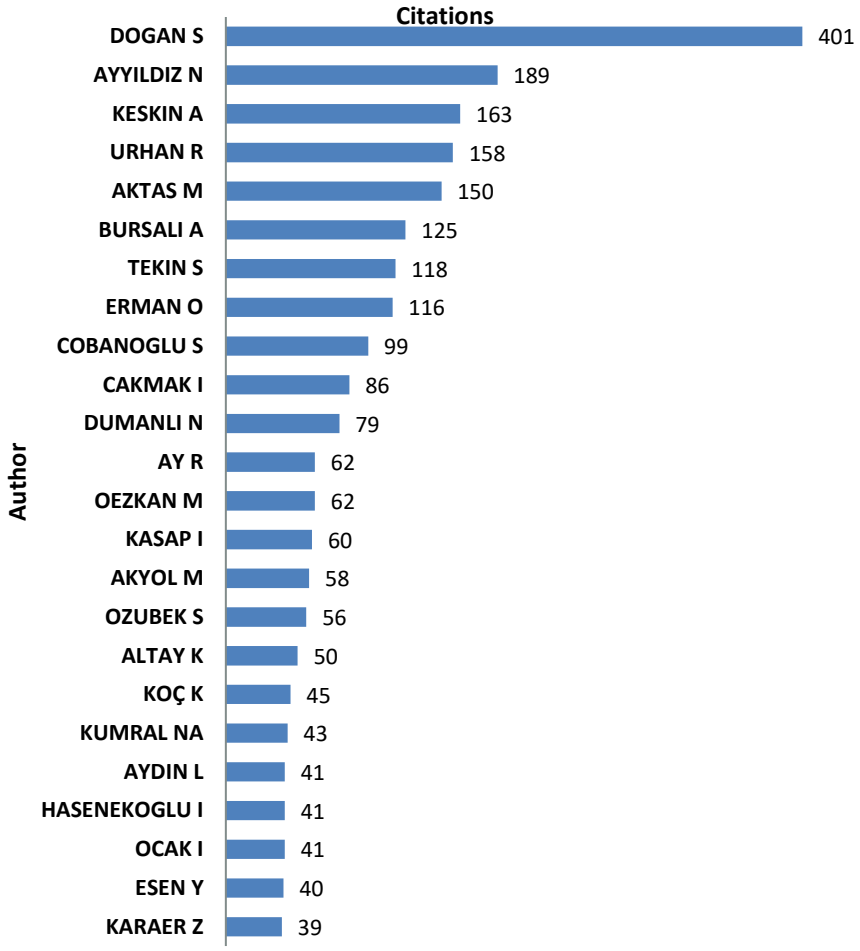

Figure 7. List of the most cited 20 Turkish authors with acarological publications between the years 1992-2023.

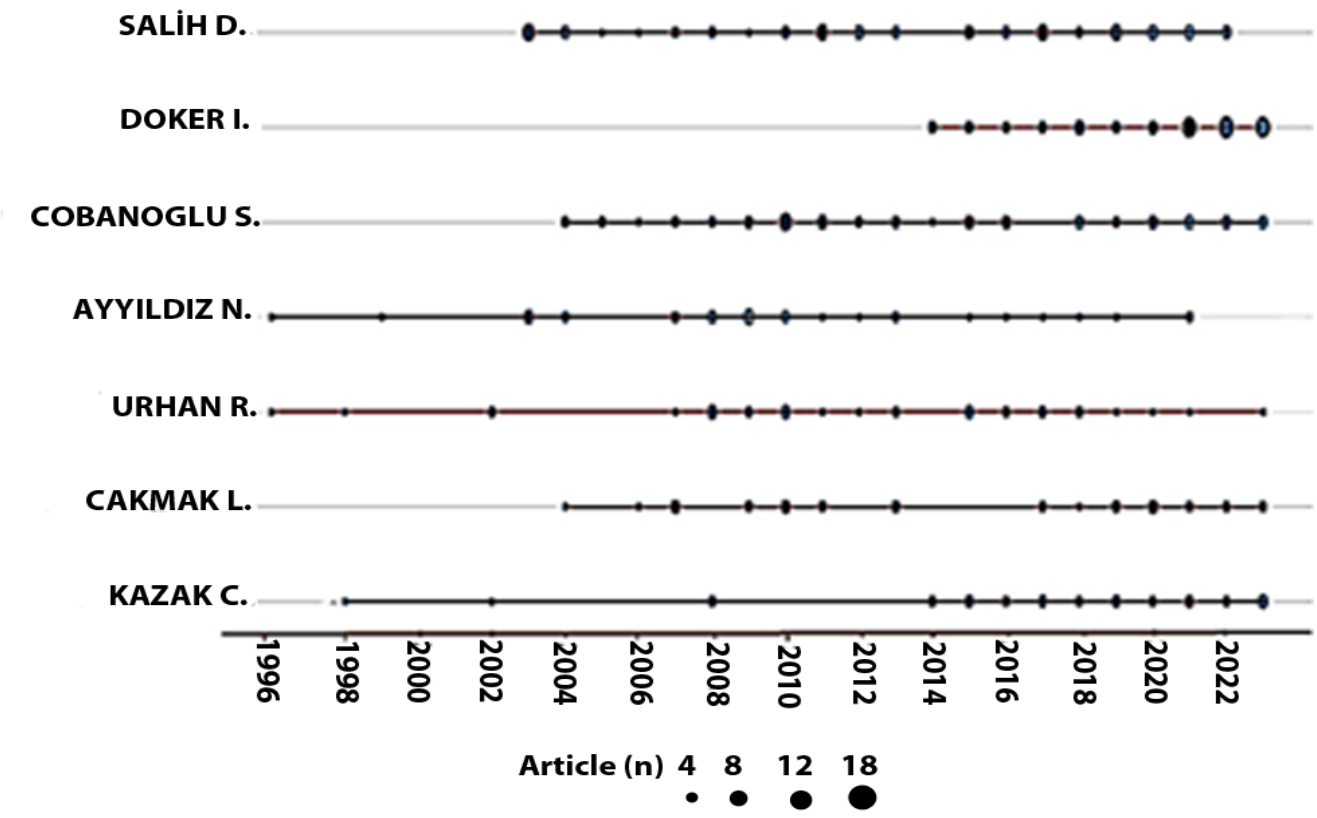

Figure 8. Author's productivity between the years 1992-2023.

Figure 9 shows the 20 most influential authors according to the H-index. Hence, M. Aktaş, S. Doğan, İ. Çakmak, S. Çobanoğlu, and A. Keskin were the authors with the highest H-index.

Figure 10 shows the names of the 20 universities with the highest number of publications in acarology. Accordingly, Ankara University (n=199), Çukurova University (n=154), and Atatürk University (n=150) were the institutions that produced the highest number of publications.

The number of publications in acarology of the five most productive universities over the years can be seen in Figure 11. With some slight fluctuations, there is a steady increase in the number of publications between 2002 and 2023 in all five universities.

Table 3 shows the countries of the scientists with whom at least five collaborative studies were conducted. The 1,453 publications mentioned in the present study were done with scientists from 87 countries. The highest number of collaborative publications was done with scientists from the USA (n=89), followed by Iran (n=42), and Russia (n=39).

The WordCloud created in proportion to the frequency of the 200 keywords used is shown in Figure 12. The most frequently used keywords were "mites", "Acari", "prevalence", "infection", "two-spotted spider mite", "resistance", "identification", and "Mesostigmata".

The trend of keywords used over the years is shown in Figure 13. The terms "*Neoseiulus californicus*" and "predatory mites" were the most recently used keywords, while "*Tetranychus urticae*" and "cross-resistance" were used the longest duration.

The funding sources for the research studies are shown in Figure 14. Accordingly, The Scientific and Technological Research Council of Türkiye (TÜBİTAK) (f=125), Erzincan Binali Yıldırım University (f=23), and the Russian Science Foundation (f=19) were the institutions which founded the highest number of studies.

The fields of acarology research conducted in Türkiye are shown in Table 4. According to this, "Entomology" (n=413, 28.4%), "Veterinary Sciences" (201, 13.8%), and "Zoology" (169, 11.6%) were the research fields in which the majority of studies were conducted.

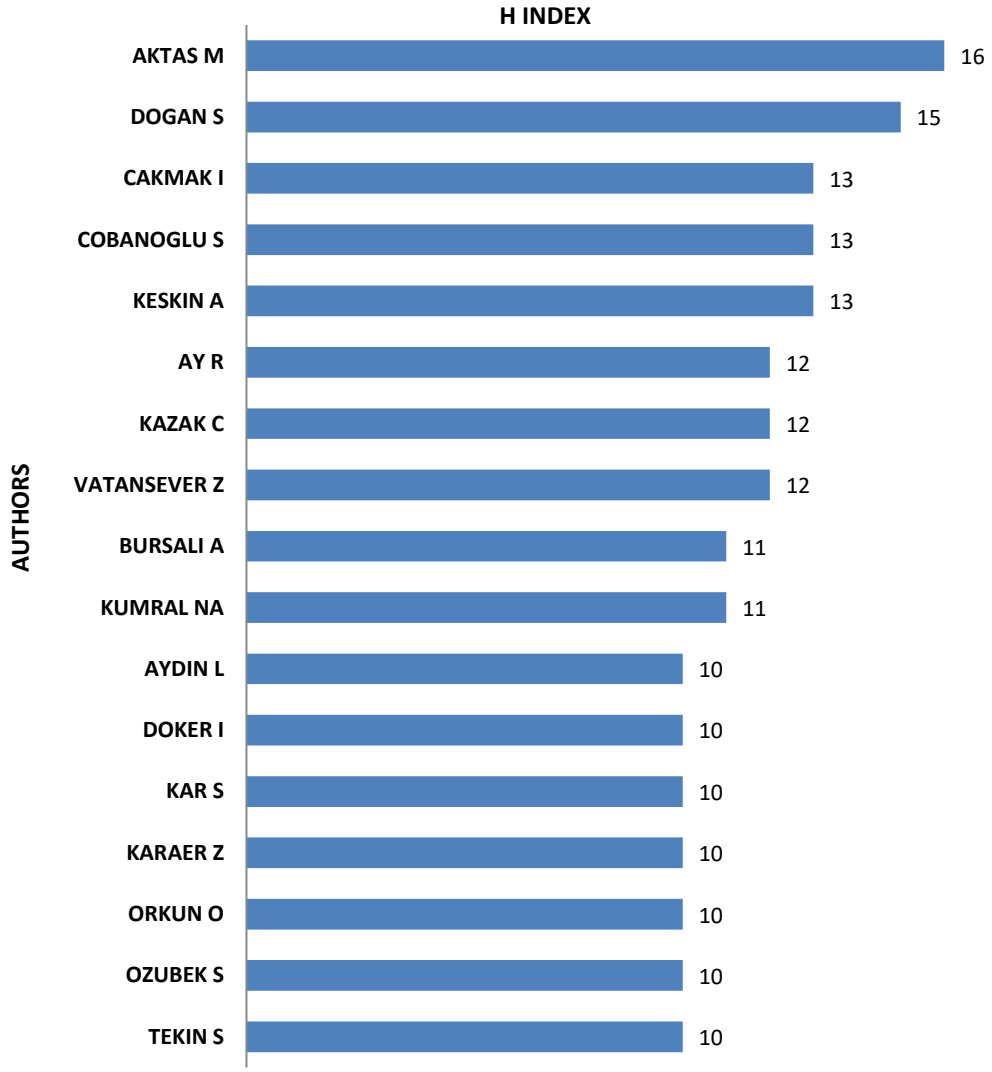

Figure 9. List of 20 authors with the highest H-index with acarological publications in Türkiye between the years 1992-2023.

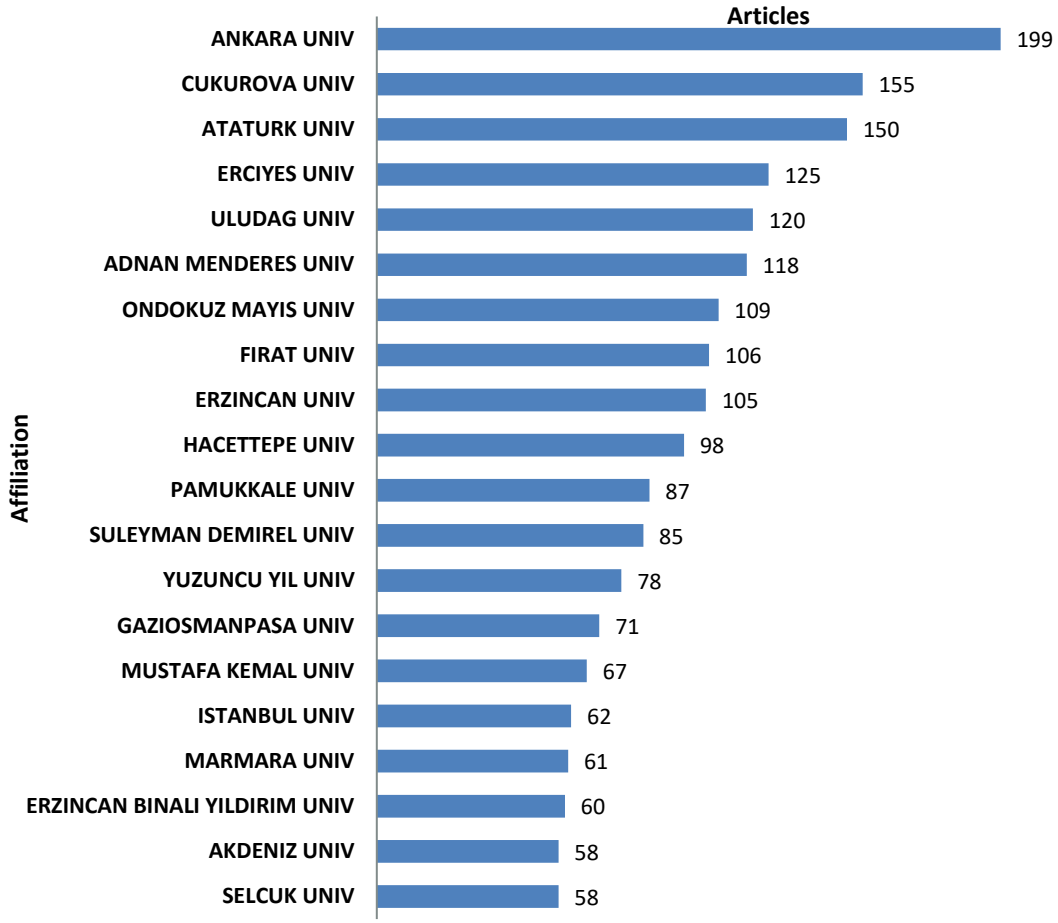

Figure 10. Turkish universities with the highest number of publications in acarology (1992-2023).

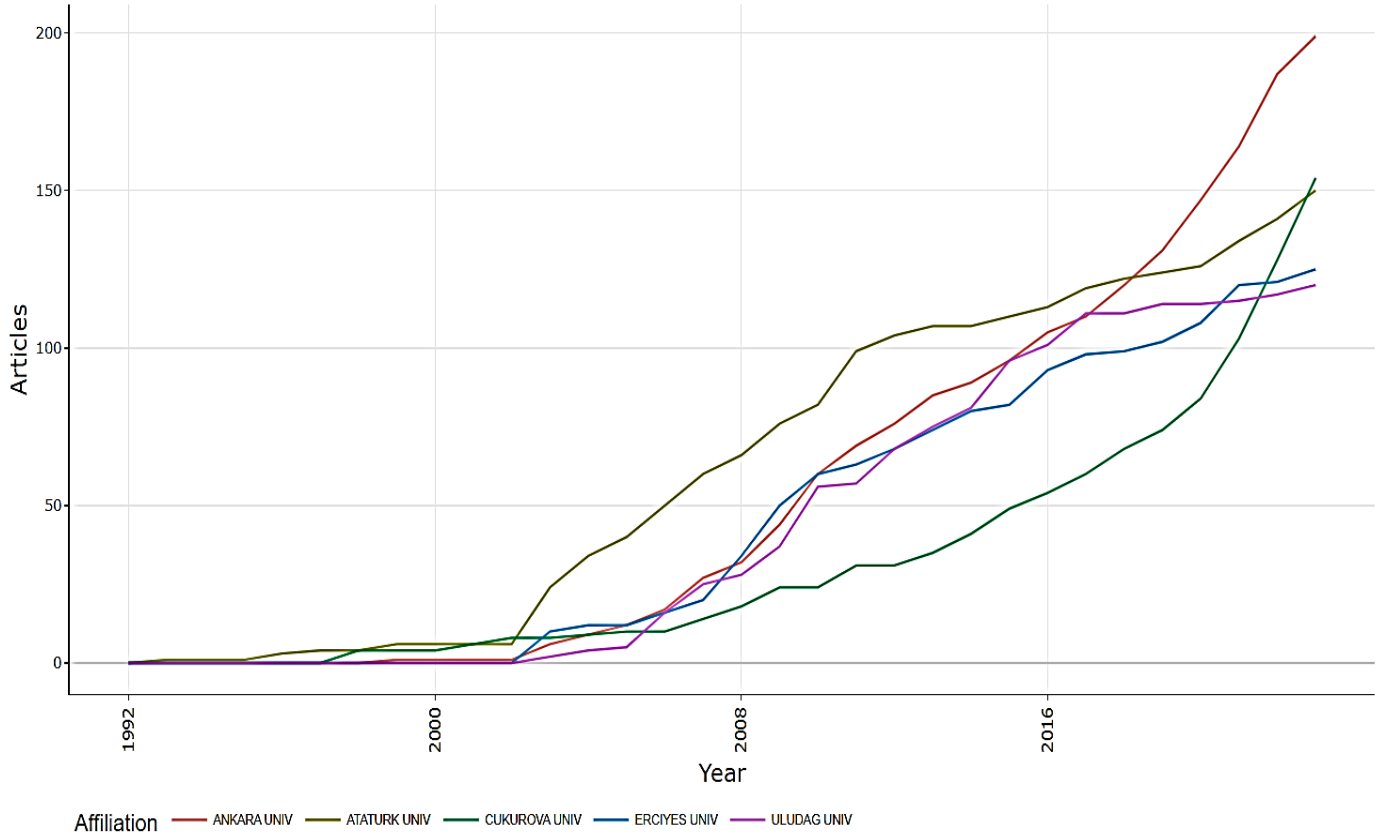

Figure 11. Number of acarology publications over time in the five most productive universities in Türkiye between the years 1992-2023.

Figure 12. WordCloud for the first 200 words used in the publications on acarology in Türkiye between the years 1992-2023.

Figure 13. Topic trends over the last 10 years of acarological publications in Türkiye between the years 1992-2023.

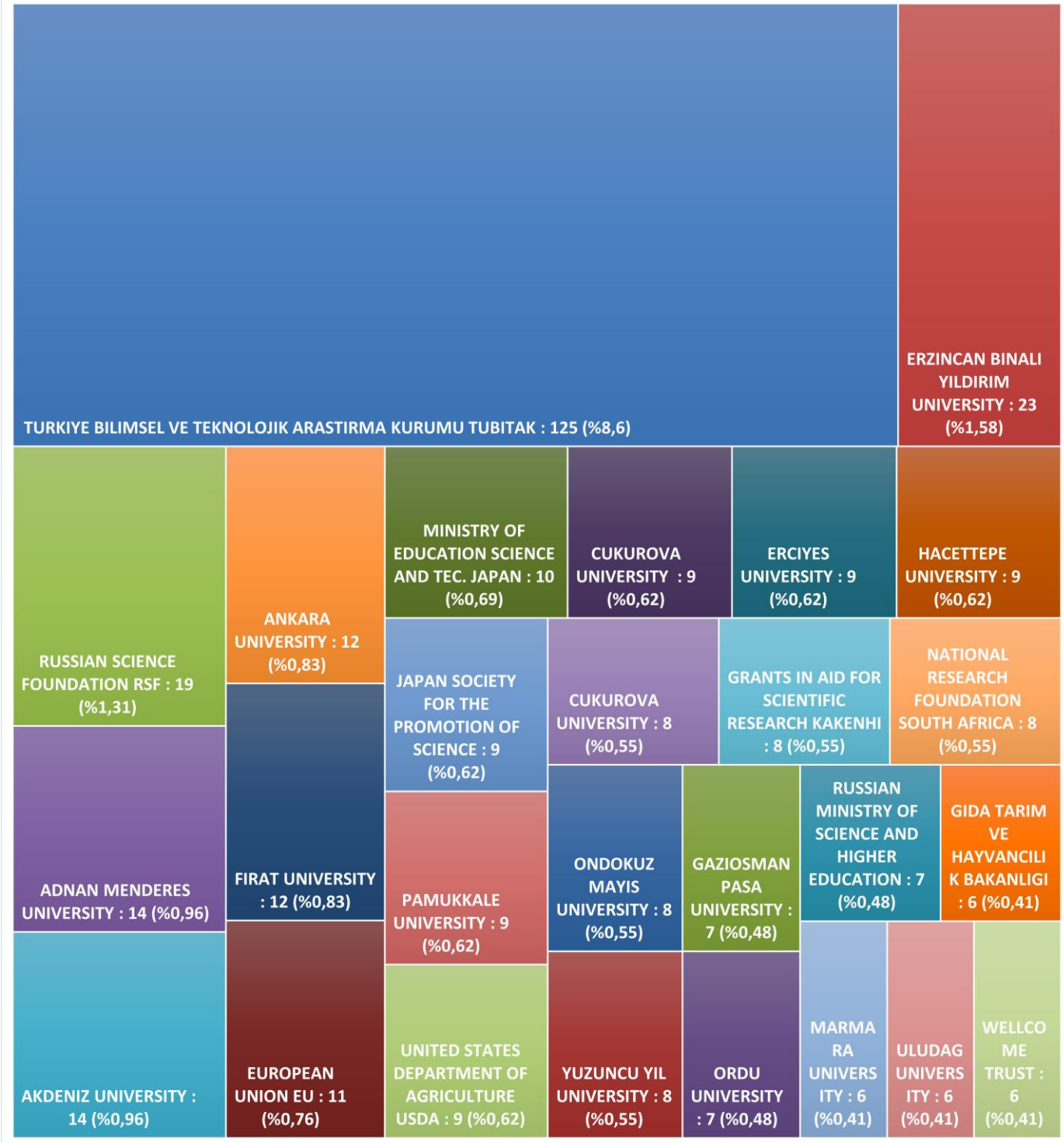

Figure 14. Funding agencies for acarological studies in Türkiye between the years 1992-2023.

DISCUSSION

In Türkiye, the first acarological studies were conducted in the veterinary medicine and mainly on ticks and tick-borne diseases (Doğan and Ecevit, 2023). The first books in this field were written by Hakkı (1929), Oytun (1947), Kurtpınar (1954), Merdivenci (1969), Özkan (1978), and Ecevit (1981), while those in agricultural acarology by Bodenheimer (1951) and Düzgüneş (1954) (Doğan and Ecevit, 2023). The faunistic and taxonomic studies of Özkan (1978) contributed to the discovery of hundreds of new species to the scientific community (Doğan and Ecevit, 2023). Lists of mites and ticks reported from Türkiye have been published by Özkan et al. (1988, 1994), Doğan (2007, 2019, 2022), Erman et al. (2007, 2010, 2019, 2024), Çakmak et al. (2011), Faraji et al. (2011), Bursalı et al. (2012), Denizhan et al. (2015), Sevsay (2017), and Baran et al. (2018). A bibliometric analysis of postgraduate theses prepared on the ticks and mites in Türkiye between 1977 and 2021 and archived in the YÖKTEZ database revealed that a total of 449 theses on acarology were conducted, with 278 being master's and 171 doctoral theses (Doğan and Ecevit, 2023;Karaer et al., 2023).

Acarology research in Türkiye has been influenced by the country's geographical location, which serves as a bridge between Europe, Asia, and Africa, resulting in a rich diversity of mite and tick species (Inci et al., 2016). Turkish researchers have conducted studies on a wide range of mite species, including economically important pests, vectors of human and animal diseases, and beneficial mites used in biological control. One of the significant research trends in Turkish acarology is the study of ticks and tick-borne diseases. Researchers have focused on identifying tick species, their distribution, and the pathogens they transmit to humans and animals. Studies have also investigated the ecology of ticks, including their host preferences, seasonal dynamics, and habitat requirements. The number of publications on ticks have increased sharply after 2002, which could be related to the discovery of the presence of Crimean-Congo haemorrhagic fever (CCHF) in Türkiye. The disease first attracted attention in 2002 and was definitively diagnosed in 2003. Cases of CCHF, which first attracted attention in and around Tokat province, today are mostly concentrated in the north of Central Anatolia, the Central Black Sea and the north of Eastern Anatolia, while the main tick species that transmit the disease is *Hyalomma marginatum*.

Another important area of research in Turkish acarology is the study of mites in agricultural systems. Researchers have studied mite pests that affect crops such as citrus, cotton, and greenhouse vegetables, as well as beneficial mites used in integrated pest management programs. These studies have contributed to the development of sustainable pest management practices in Turkish agriculture. WordCloud and the trend of keywords such as "two-spotted spider mite", "*Neoseiulus californicus*", "predatory mites" and "*Tetranychus urticae*" show that agricultural acarology is getting very important in the country.

Turkish researchers have published their findings in a variety of national and international journals, contributing to the global body of knowledge in acarology. Some of the prominent journals that have published acarology research from Türkiye include Experimental and Applied Acarology, Turkish Journal of Veterinary and Animal Sciences, and Turkish Journal of Zoology.

Overall, there are few bibliometric studies on ticks and some tick-borne diseases (Klingelhöfer et al., 2022). To the best of our knowledge, the present study is the first reported scientometric or bibliometric analysis of acarological publications that covers both mites and ticks in a given country.

Mites of medical importance include *Scabies, Demodex,* and house dust mites. In Türkiye, Tosun (2022) found 1,924 publications on the scabies mite, *Sarcoptes scabiei* worldwide, most of which were published in dermatology journals, with the USA and Australia being the most productive countries. Mumcuoglu et al. (2023) conducted a scientometric evaluation of the itch mite and reported 2,933 articles on this topic worldwide, of which 66.3% were original articles and 663 were published by US scientists. The journal with the highest number of publications on scabies was the International Journal of Dermatology. Using the Web of Science database and the words "house dust mite" and "*Dermatophagoides*" Demir et al. (2020) reported 4,742 publications on house dust mites between 1980 and 2018. The USA was the country that contributed most to the literature, with most papers published in the journal Clinical and Experimental Allergy. In India, Singh et al. (2020) searched the literature on scabies published from 2009 to 2018 using the Scopus database and reported 2,268 publications by 8,639 authors. In addition to research articles, Turkish acarologists have also published books, book chapters, and review articles on various aspects of acarology. These publications have helped disseminate knowledge and raise awareness about the importance of acarology in Türkiye. Lately, an excellent book on acarology has been published, summarizing our knowledge of the systematic, biology, and epidemiology of mites and ticks and their significance in medical and veterinary medicine as well as in agriculture (Doğan and Özman-Sullivan, 2023).

WoS metadata was chosen to analyse acarological publications in Türkiye due to universal acceptance of this data source. However, due to the fact that WOS database contains mainly English language articles and high H-index journals, many of the acarological publications in Türkiye were not included in this study. Using local databases such as Tr Index and DergiPark 1322 additional publications were found mainly in the journals Acarological Studies (94), the Turkish Journal of Entomology (46), and the Plant Protection Bulletin (41), however, these data were not included in the present analysis. It is planned that the remaining publications will be collected by searching local databases and references of published articles in Türkiye.

Looking ahead, acarology research in Türkiye is expected to continue to grow, driven by advances in technology, changes in land use and climate, and emerging issues related to mite pests and diseases. Future research directions in Turkish acarology may include:

- Using molecular techniques to study the genetic diversity and evolution of mites and ticks.
- Investigating the impact of climate change on the distribution and abundance of mite species.
- Developing novel control strategies for mite pests, including the use of biological control agents and acaricides with reduced environmental impact.

In conclusion, acarology research and publications in Türkiye have made significant contributions to our understanding of mites and ticks and their impact on human and animal health, agriculture**,** and the environment. With continued research and collaboration, Turkish acarologists are well-positioned to address emerging challenges in acarology and contribute to global efforts to reduce the negative impact of mites and ticks on the environment and health.

Table 3. Countries of scientists with whom cooperative studies in acarology were conducted in Türkiye between the years 1992-2023.

Country	N	%	Country	N	%	Country	N	%
USA	89	6.13	Israel	13	0.89	South Korea	7	0.48
Iran	42	2.89	Australia	12	0.83	Georgia	6	0.41
Russia	39	2.68	Belgium	11	0.76	Romania	6	0.41
Germany	29	2.00	Egypt	11	0.76	Scotland	6	0.41
Spain	23	1.58	Greece	11	0.76	Slovakia	6	0.41
Netherlands	22	1.51	Italy	11	0.76	Brazil	5	0.34
England	20	1.38	Montenegro	11	0.76	Hungary	5	0.34
South Africa	19	1.31	Cyprus	10	0.69	Saudi Arabia	5	0.34
France	18	1.24	Canada	9	0.62	Serbia	5	0.34
Japan	18	1.24	Czech Republic	9	0.62	Slovenia	5	0.34
Poland	18	1.24	Pakistan	9	0.62	Switzerland	5	0.34
India	13	0.89	China	9	0.62	Taiwan	5	0.34

Table 4. Research areas of the acarological studies between the years 1992-2023.

Research Areas	n	%	Research Areas	n	%
Entomology	413	28.4	Biodiversity Conservation	15	1.0
Veterinary Sciences	201	13.8	Engineering	14	1.0
Zoology	169	11.6	Science Technology Other Topics	13	0.9
Microbiology	112	7.7	Virology	13	0.9
Agriculture	104	7.2	Materials Science	11	0.8
Parasitology	97	6.7	Emergency Medicine	9	0.6
Infectious Diseases	92	6.3	Research Experimental Medicine	9	0.6
General Internal Medicine	79	5.4	Forestry	8	0.6
Dermatology	62	4.3	Fisheries	7	0.5
Environmental Sciences Ecology	53	3.6	Marine Freshwater Biology	6	0.4
Immunology	48	3.3	Otorhinolaryngology	6	0.4
Allergy	39	2.7	Rheumatology	6	0.4
Public Environmental Occupational Health	39	2.7	Geology	5	0.3
Pediatrics	36	2.5	Neurosciences Neurology	5	0.3
Plant Sciences	29	2.0	Physics	5	0.3
Chemistry	23	16	Physiology	5	0.3
Ophthalmology	20	1.4	Respiratory System	5	0.3
Tropical Medicine	20	1.4	Endocrinology Metabolism	4	0.3
Biotechnology Applied Microbiology	19	1.3	Genetics Heredity	4	0.3
Life Sciences Biomedicine Other Topics	19	1.3	Obstetrics Gynecology	4	0.3
Pharmacology Pharmacy	18	1.2	Surgery	4	0.3
Biochemistry Molecular Biology	15	1.0	Telecommunications	4	0.3

Authors' contributions

Kosta Mumcuoğlu: Conceptualization, data curation, formal analysis, supervision writing-original draft, writing-review & editing. **Naci Bayrak:** Conceptualization, data curation, formal analysis, methodology, software, writing-original draft, writing-review & editing. **Engin Şenel:** Conceptualization, data curation, formal analysis, methodology, software, validation, writing-original draft, writing-review & editing. **Adem Keskin:** Data curation, formal analysis, validation, writing-original draft, writing - review & editing. **Abdulkadir Taşdemir:** Data curation, formal analysis, validation, writing-original draft, writing-review & editing. **Ayşegül Taylan-Özkan:** Data curation, formal analysis, supervision, validation, writing-original draft, writing-review & editing.

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