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A BIBLIOMETRIC OVERVIEW OF STUDIES ON ALIEN FISH SPECIES IN THE ORONTES RIVER

ABSTRACT

Freshwater fish native to the region face multiple threats, including climate change, habitat loss, pollution, excessive water use and invasive species. Rising temperatures and tropicalisation in the eastern Mediterranean are accelerating the spread of invasive species further and increasing pressure on native biodiversity. Endemic species in the Orontes River are affected by various threats, including human activities, water pollution, water abstraction, invasive species, drought, and dam construction. This study presents a bibliometric analysis of research on alien fish in the Orontes River, based on data from the Web of Science. A total of 100 articles published between 1982 and 2025 were analysed using VOSviewer. These publications received 1.756 citations (1.744 excluding self-citations), with an h-index of 22. The USA contributed the highest number of publications (n=25), while Türkiye ranked third (n=6). 'Marine Freshwater Biology' was the most active research area (n=39), Wiley was the leading publisher (n=22), and 'Aquatic Invasions' published the most articles (n=5). These findings provide an overview of research trends and highlight emerging directions in the understanding and management of alien fish in the Orontes River.

Keywords: Bibliometrics, Biodiversity, Alien Fishes, Threats, Orontes River

1. INTRODUCTION

The Orontes is the largest river to flow into the Levantine coast of the Mediterranean Sea. Of its total length of 380 kilometres, around 94 kilometres lie within Türkiye. The Afrin and Karasu streams join the Orontes in the Amik Valley. The river then flows northwards to the city of Antakya, emptying into the Mediterranean Sea just south of Samandağ in Türkiye [1 and 2]. The introduction and spread of alien and invasive species into a natural ecosystem is one of the main causes of biodiversity loss [3, 4 and 5]. To date, more than 50 fish species have been recorded in the Orontes River and its basin [6, 7, 8 and 9]. Along with the Mediterranean coast, the Orontes River and its basin (8–10 species) is the second-richest in terms of endemic freshwater fish species diversity, after the Po River Basin in Italy (11–17 species) [10]. Invasive species such as Prussian carp (*Carassius gibelio*), eastern mosquitofish (*Gambusia holbrooki*), redbelly tilapia (*Coptodon zillii*), goldfish (*Carassius auratus auratus*) and exotic sailfin catfish (*Pterygoplichthys disjunctivus*) have become established in the basin [8, 9, 11 and 12]. It is crucial

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to understand the potential for the spread of invasive fish species in the Orontes Basin, one of the most important endemic fish habitats in the Mediterranean, and their ecological impact, as well as the pressure they exert on local/endemic species. Given the international nature of the basin, integrating scientific knowledge produced in Lebanon, Syria and Türkiye and conducting bibliometric analyses to identify research gaps and geographical information deficiencies can significantly inform the determination of future research and conservation priorities. Xie et al. (2021) [13] present a quantitative overview of research trends concerning the discovery and characterisation of non-native fish species in the Orontes River in this bibliometric analysis.

2. RESEARCH SIGNIFICANCE

This study aims to identify key research areas, such as conservation and control, as well as significant contributions and trends, to inform future research and practical applications.

This research is a bibliometric analysis. It looks at studies on alien fish species in the Orontes River.

Highlights:

- A review of studies on alien fish conducted since 1982 has been conducted.
- The distribution of these studies in the basin by country, year and research topic has been presented.
- The potential for future research on alien fish has been evaluated.

3. MATERIALS AND METHODS

3.1. Research Design and Search Methodology

A bibliographic (retrospective) review was conducted using the bibliometric analysis method described by Zhang et al. (2021) [14]. The Web of Science Core Collection (WoSCC) electronic database was used to create the literature dataset because it provides comprehensive, consistent, exportable data and is widely used by scientists. The WoSCC was selected as the primary data source for this study due to its longstanding reputation as a reliable source for biological research, offering a robust foundation for further investigation. Its capacity to deliver extensive citation data was particularly emphasized.

3.2. Data Collection

The data search terms were 'Alien Fish' and 'Orontes River' (A Bibliometric Overview of Studies on Alien Fish Species in the Orontes River). To eliminate bias and account for frequent updates to the Web of Science Core Collection (WoSCC) database, the literature search was performed on a single day: 20 July 2026. The research covered the period between 1982 and 2025.

3.3. Standards for Study Selection

A comprehensive search in WoSCC using the terms "Alien Fish" and "Orontes River" (A Bibliometric Overview of Studies On Alien Fish Species in The Orontes River) resulted in the identification of a total of 100 studies. Subsequently, by selecting original articles from the document type tab, the search yielded 88 records.

3.4. Data Collection

The primary data points were publication titles, publication years, names of journals in which the research was published, author names, keywords, names of the institutions to which the authors were

affiliated and countries of origin and were extracted in plain text format. The analysis considered the total number of articles and total citations retrieved from the WoSCC database. WoS publications were saved as .txt files and subsequently exported to Microsoft Office Excel 2019 (Los Angeles, CA, USA) for further analysis.

3.5. Network Analytics

In this bibliometric study, VOSviewer (version 1.6.10, Leiden University, Netherlands) was used to import data and identify trends, collaborations, and key findings. The software was also used to collect and analyze data related to authorship, links, keywords, citations, and thematic words. The program aided in the analysis of keywords, concurrent uses, citations, co-authorship, and co-citations.

4. RESULTS

During the study period from 1982 to 2025, publications were produced in four languages. The most common language used was English (Table 1).

Table 1. The languages in which articles were published

Languages	Record Count	% of 88
English	85	96.59%
French	1	1.14%
German	1	1.14%
Spanish	1	1.14%

A total of 42 countries/regions have been published in the period from 1982 to 2025. The ten countries with the most publications are shown in Table 2.

Table 2. Most productive countries

Countries/Regions	Record Count	% of 88
USA	25	28.41%
Russia	6	6.82%
Türkiye	6	6.82%
Australia	5	5.68%
England	5	5.68%
France	5	5.68%
Germany	5	5.68%
Spain	4	4.55%
Armenia	3	3.41%
Canada	3	3.41%

Over the course of the study, which ranged from 1982 to 2025, 12 independent research areas were discovered. Table 3 shows the top 10 most extensively researched areas.

Tablo 3. Most active research areas

Research Areas	Record Count	% of 88
Marine Freshwater Biology	39	44.32%
Environmental Sciences Ecology	38	43.18%
Fisheries	21	23.86%
Zoology	17	19.32%
Water Resources	13	14.77%
Biodiversity Conservation	9	10.23%
Life Sciences Biomedicine Other Topics	2	2.27%
Oceanography	2	2.27%
Science Technology Other Topics	2	2.27%
Agriculture	1	1.14%
Showing first 10 out entries		

In the years between 1982 and 2025, a total of 230 affiliations have been published. Table 4 presents the affiliations of the ten journals with the highest number of publications.

Table 4. Most prolific affiliations

Affiliations	Record Count	% of 88
Russian Academy of Sciences	5	5682%
Bournemouth University	3	3409%
Centre National De La Recherche Scientifique Cnrs	3	3409%
Recep Tayyip Erdogan University	3	3409%
United States Department of Agriculture Usda	3	3409%
United States Department of The Interior	3	3409%
United States Forest Service	3	3409%
United States Geological Survey	3	3409%
Adelaide University	2	2273%
Canakkale Onsekiz Mart University	2	2273%

Between 1982 and 2025, ten entries were detected, representing 40 different publishers. Table 5 lists the most prolific publishers.

Tablo 5. Most prolific publishers

Publishers	Record Count	% of 88
Wiley	22	25.00%
Springer Nature	8	9.09%
Regional Euro-Asian Biological Invasions Centre-Reabic	6	6.82%
Taylor & Francis	6	6.82%
Pleiades Publishing LTD	4	4.55%
Elsevier	3	3.41%
Amer Soc Ichthyologists & Herpetologists	2	2.27%
Magnolia Press	2	2.27%
MDPI	2	2.27%
Pensoft Publishers	2	2.27%
Showing first 10 outentries		

A total of 71 journal articles have been published on this topic. Table 6 includes the top 10 journals with the most publications.

Tablo 6. Journals publishing the most articles

Journals	Record Count	% of 88
Aquatic Invasions	5	5682%
Journal of Applied Ichthyology	4	4545%
River Research And Applications	4	4545%
Journal of Fish Biology	3	3409%
Biological Invasions	2	2273%
Ecology of Freshwater Fish	2	2273%
Freshwater Biology	2	2273%
Hydrobiologia	2	2273%
Ichthyological Exploration of Freshwaters	2	2273%
Russian Journal Of Biological Invasions	2	2273%
Showing 10 Out of Entries		

The evaluated articles generated a total of 1.756 citations (1.744 of which were self-citations), with an average h-index of 22. The highest number of citations (162) and publications (5) were found in 2025 (Figure 1).

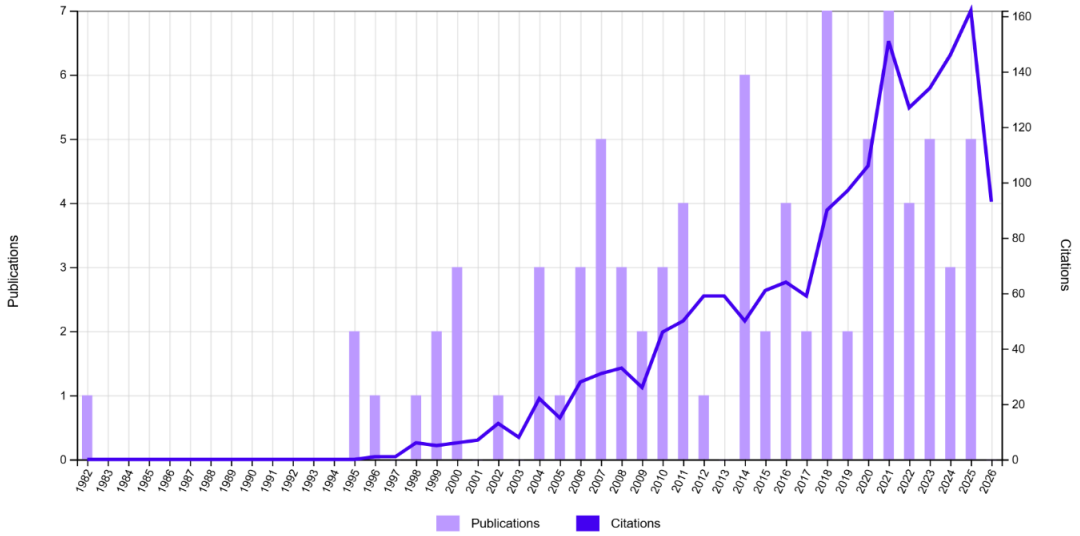


Figure 1. Publication and citation frequency

As shown in Figure 2, our bibliometric study has revealed the most frequently used keywords. It was found that the font size of the keywords was closely proportional to the frequency with which they were repeated in the articles.

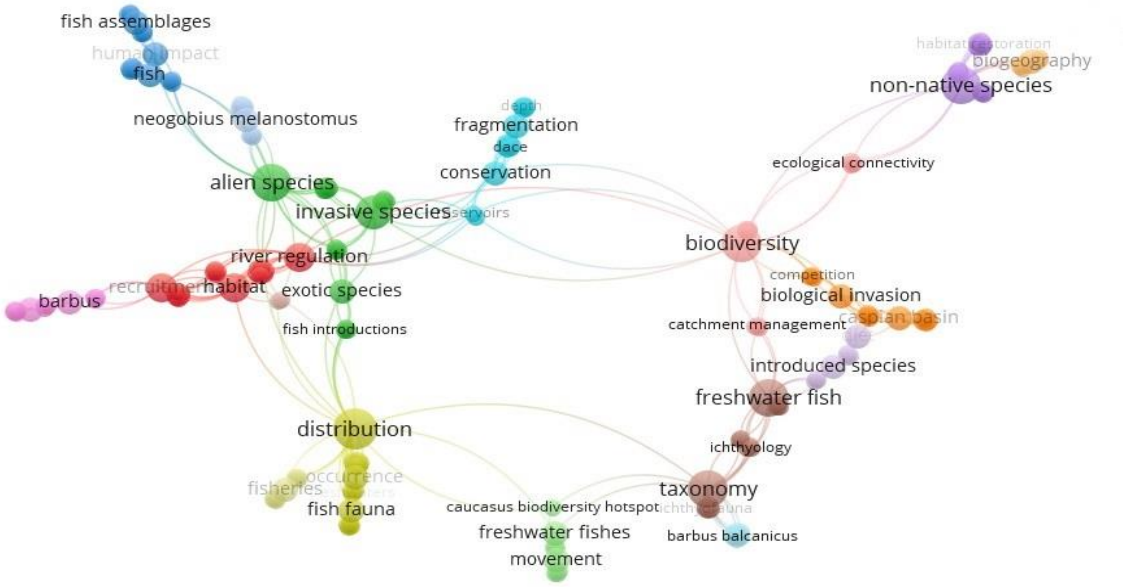


Figure 2. Keyword visualization map of articles

The size of the bubbles was proportional to the amount of research done in each country in the network representation of bibliographic coupling between nations. The width of the lines connecting the countries indicates the degree to which they are linked, while the colours of the lines indicate the cluster to which each country is assigned. For this study, we have included at least one document and one citation from each country (Figure 3).



Figure 3. Network visualisation of bibliographic coupling between countries

The relationship between authors with at least one publications and at least one citations is shown in Figure 4.

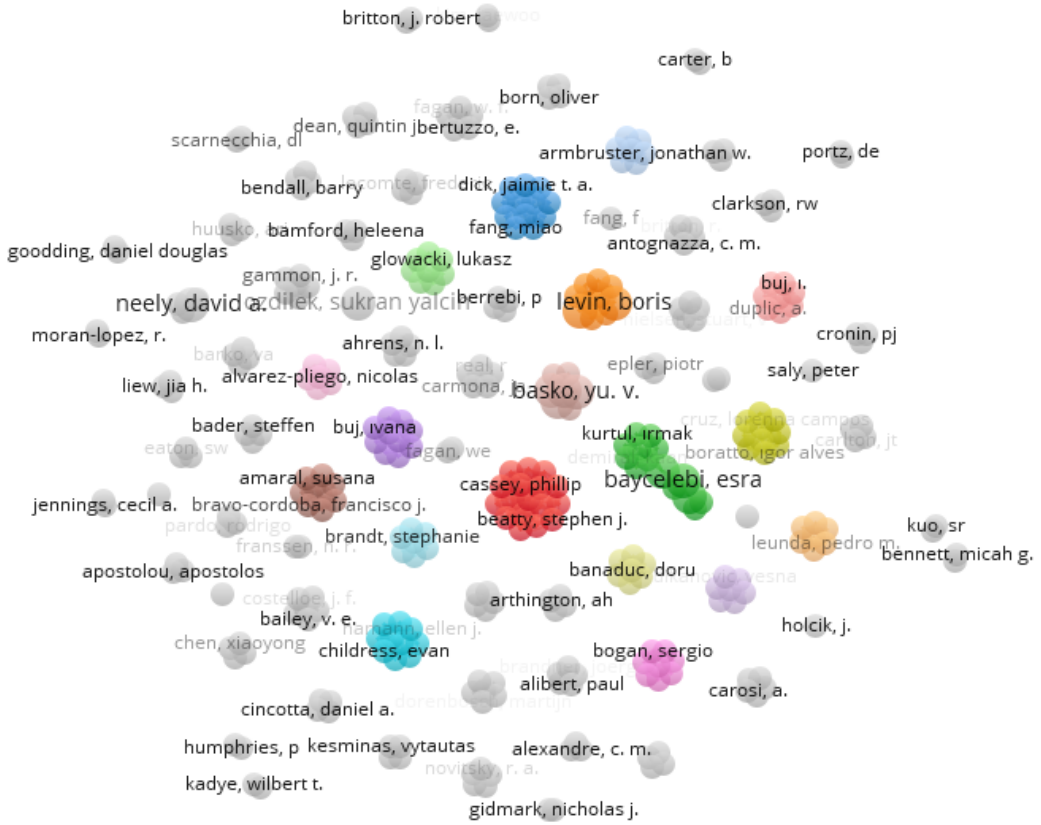


Figure 4. The relationships between authors

Universities that have published at least one article and received at least one citation are shown in Figure 5.

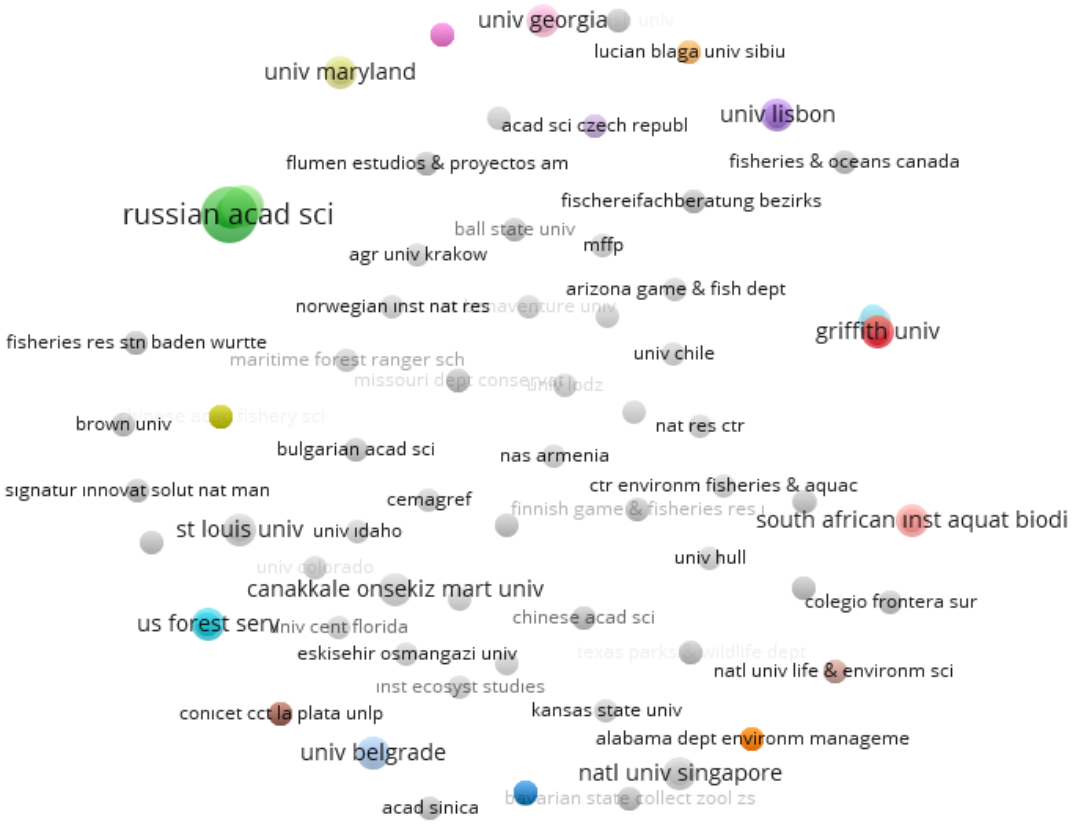


Figure 5. Universities with publications and citations

5. DISCUSSION

Freshwater fish native to a given region face multiple threats, including drought, extreme temperatures, water abstraction, habitat loss and degradation, pollution, eutrophication and the impact of non-native species [3 and 15]. Non-native species entering freshwater ecosystems can disrupt the balance of the ecosystem by negatively affecting native biodiversity and food webs. The number of non-native fish species in Türkiye's inland waters has steadily increased due to human activities such as aquaculture, recreational fishing, stock enhancement programmes, biological control and the ornamental fish trade [12]. To date, a total of 34 non-native species are known to have been introduced to Türkiye's inland waters, either intentionally or accidentally. Rising temperatures and tropicalisation in the Eastern Mediterranean are particularly facilitating the year-round survival of exotic species and their spread to river mouths and brackish water habitats. If *Pterygoplichthys disjunctivus*, which is native to South America, spreads into the Asi (Orontes) River, it is expected to negatively impact native species such as *Garra rufa*, which occupy the same trophic level, in terms of competition and habitat use. Therefore, *P. disjunctivus* poses a potential threat to the native fish fauna of the Asi (Orontes) River as an invasive species [8].

Monitoring the populations of non-native species is important for managing fisheries and developing prevention strategies. This study presents a comprehensive bibliometric summary of research on non-native species that have entered the Orontes River, the second most important freshwater system in the Mediterranean basin in terms

of biodiversity and endemic fish species, and summarises the basin's current taxonomic and ecological status.

The 71 research articles published between 1982 and 2025 spanned 12 different research areas. The evaluated articles received a total of 1.756 citations, with an average h-index of 22.

Russia and Türkiye were found to rank second and third, respectively, with the same number of studies (six), behind the United States, which leads in terms of the number of publications. Bibliometric analyses revealed that the most frequently used keywords were "distribution", "invasive species", "taxonomy", "biodiversity" and "invasive species". Network visualisation of bibliographic links between countries showed that, while some countries tended towards a single research cluster, many others were oriented towards various clusters.

The introduction of non-native species today poses a serious threat to many river basins. In basins rich in endemic species, such as the Asi (Orontes), future research should focus on interdisciplinary studies modelling the effects of global climate change and human-induced pressures on ecosystem resilience.

In recent years in particular, the proliferation of the invasive water hyacinth (*Eichhornia crassipes*) in the basin has placed significant pressure on aquatic ecosystems and biodiversity. Future research must therefore expand beyond fish diversity to encompass all components of biodiversity in the basin, taking a holistic approach to assess the ecological integrity of the Orontes River basin.

As a result, the Asi (Orontes) River is notable not only for its rich local and endemic freshwater fish fauna, but also for its critically endangered species. Ensuring the conservation and sustainability of the basin's fish biodiversity, which is rich in endemic species, and monitoring the impact of introduced species on local species and their ecological status and population dynamics will only be possible through the urgent implementation of national and international transboundary water protection policies.

AUTHOR DECLARATION

The author(s) declare that this study was not generated by artificial intelligence, that its scientific content and intellectual responsibility belong entirely to the authors, and that they accept full responsibility for all scientific, ethical, material, moral, and legal consequences arising from the work.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

FINANCIAL DISCLOSURE

The authors received no financial support for the research.

DECLARATION OF ETHICAL STANDARDS

The authors of the article declare that the materials and methods used in this study do not require ethics committee approval and/or legal special permission.

DATA AVAILABILITY

The data supporting the findings of this study were derived from the Web of Science Core Collection database. The bibliometric dataset

generated and analysed during the current study is available from the corresponding author upon reasonable request due to privacy reasons.

LIMITATIONS

One limitation of this study is its reliance on the Web of Science database. This database may have excluded some relevant articles from other databases or grey literature, thus overlooking important perspectives on the Discovery of Alien Fish Species in the Orontes River research. The exclusion of case reports and other document types may have led to underrepresentation of certain research trends or reviews that could complement the primary research findings. Furthermore, since the study only covers publications in English and a few other languages, significant contributions from non-English speaking regions may have been excluded. The use of citation counts and h-indexes as baseline measures may not fully reflect the qualitative impact of the research. These measures tend to favor older and more widely cited studies compared to newer and more innovative studies.

AUTHOR CONTRIBUTION

The authors conceived and designed the study, collected and analyzed the data, prepared the figures, wrote the manuscript, and approved the final version of the manuscript.

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