Research Article

The Status of Ornamental Fish in Scientific Research: Trends and Themes

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Abstract | The species of ornamental fish kept in aquariums mainly for aesthetic reasons are part of the pet and aquaculture industries, forming a multibillion-dollar global business. Based on 2015 Scopus-indexed core collection documents from 1,679 journals authored by 6,979 writers from 54 countries, with an annual growth rate of 4.02% over the past decade (2014–2024), this study examined the intellectual structure of current research on ornamental fish. The basic scientometric profile of these fields was analyzed through this bibliometric research, conducted using the bibliometrix R package. The results showed that the most productive authors in this area were Bampidis, V., Kouba, M., and Mayo, B., each with 38 publications during the same period and closeness values of 0.25. Conversely, Assefa A. had a higher overall citation count (347). However, Aquaculture (ISSN 0044-8486) had the highest number of publications (n = 101). India was identified as having the strongest collaboration network and being the most prolific country, with 319 genuine papers. Along with providing detailed insights into the research environment and intellectual landscape of ornamental fish, this bibliometric study highlights the growing interest in this field and related disciplines.

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Introduction

The pet market, often considered a multibillion-dollar industry valued between $15 billion and $30 billion, includes the ornamental fish sector (Tarihoran *et al*., 2023). In 2021, the global export value of ornamental fish was $379.1 million, comprising $99.5 million in marine ornamental fish (MOF) exports and $279.6 million in freshwater ornamental fish (FOF) exports, according to UN-Comtrade data. The trade in ornamental fish is one of the fastest-growing sectors of the economy, with over 5,300 species exported annually to international markets (Tarihoran *et al*., 2023; Novák *et al*., 2011). Known as living jewels, ornamental fish are kept in gardens or aquariums for their aesthetic appeal and entertainment, thanks to their vibrant colors, unique shapes, and intriguing behaviors. Recently, they have gained a significant role in commercial trade, especially in earning foreign exchange (Kar, 2015; Kumar *et al*.,

2015). As a result, caring for these fish has become a popular and lasting hobby worldwide, valued for their visual beauty and ability to enhance the ambiance of their surroundings. Additionally, their stress-relieving properties have contributed to their crucial role in the global fish trade (Sharma and Dhanze, 2018). The breeding of animals for the aquarium hobbyist market is a rapidly expanding part of the aquaculture industry, and its importance is expected to grow as regulations on wild collection become more stringent. Currently, more than 50% of the world's ornamental fish are supplied from Asia, with 60% of these fish coming from developing countries (Bartley, 2000; Tlusty, 2002; Olivier, 2003).

The domestication of goldfish in China over a thousand years ago marked the start of ornamental fish breeding. Today, many fish species are appreciated for their distinctive markings, such as koi carp. Research shows that about 10% of households in the United Kingdom keep pet fish (Balon, 2004; Sneddon *et al.*, 2016). Estimates indicate that around 20–25 million fish are kept in aquariums and roughly 20 million in ponds throughout the country. Additionally, about 4000 freshwater and marine species are maintained as pets or displayed (Davenport, 1996; Sneddon *et al.*, 2016).

In 1976, the export market for ornamental fish expanded to 28 countries. Only later, in 2004, did it grow to about 105 countries. Now, approximately 120 countries are involved in the industry. Singapore leads as the top hub of the ornamental fish trade worldwide, accounting for 12.7% of all exports. Furthermore, the USA is the largest single importer in the industry, contributing 19.7%. Asian countries alone make up around 60% of the global export trade (Raja *et al.*, 2019).

International commerce in these pets has grown significantly in recent decades. According to Chen *et al.* (2020), who recently reviewed MOF larviculture, it is estimated that more than 20 million marine ornamental fish are collected from the wild and sold to over 2 million aquarium hobbyists worldwide each year." This highlights the urgent need to expand this industry by including more ornamental species. In Africa, South America, and Southeast Asia, the ornamental fish trade and related sectors are economically important, serving as a major source of foreign income (Ukaonu *et al.*, 2011). Its market was valued at USD 5.4 billion in 2021 and is expected to grow at an annual rate of 8.5% from 2022 to 2030. The tropical FOF category, which made up 51.7% of the global market in 2021, dominates the industry. Guppies (*Poecilia reticulata*), mollies (*P. sphenops*), and zebrafish (*Danio rerio*) are among the most popular tropical freshwater fish for beginners; most of these fish are affordable, typically costing between $1 and $6. Marine ornamental species, known for their vibrant colors and captivating behaviors, account for over 15% of all traded fish (Raja *et al.*, 2014).

With $339 million in commerce in 2022, ornamental fish ranked 3,297th worldwide (Figure 1). Exports decreased by 13.1%, from $390 million to $339 million, between 2021 and 2022. Their trade makes up 0.0014% of global commerce. In 2022, Indonesia ($44.6M), Singapore ($38.2M), Japan ($37.6M), the Netherlands ($25.8M), and Sri Lanka ($23.3M) were the top exporters. The United States ($66.9M), China ($27.9M), Germany ($21.9M), the United Kingdom ($20.5M), and France ($18.6M) were the leading importers of ornamental fish in 2022 (OEC, 2024).

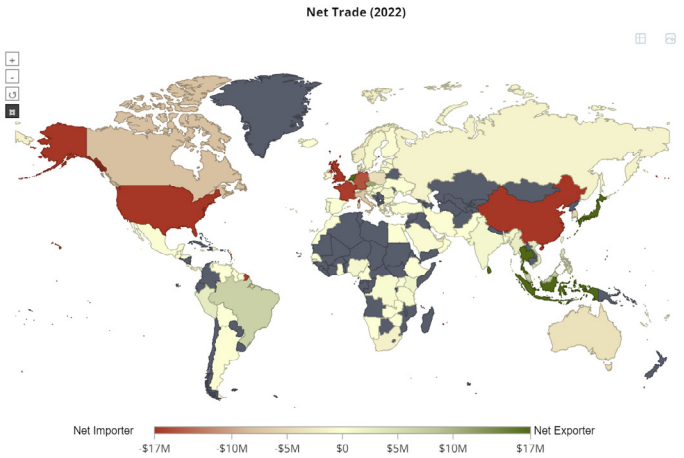

Figure 1: *Which nations import or export more ornamental fish. Each country is colored according to the difference between its imports and exports in 2022.*

Compared to FOF equivalents, MOF commands a significantly higher premium per unit. In the United States, far fewer farms produce MOF than FOF, despite the latter's higher value. Only 28 marine ornamental fish farms were estimated to exist in the US in 2018, with 15 of these farms located in Florida. A total of 204 freshwater ornamental farms were established in 2014 (USDA-NASS, 2014).

Invasive species, pests, and diseases are among the many risks that MOF trade can pose to ecosystems

and species. Overharvesting and poor management practices can harm conservation efforts, especially for endangered and rare species (Conant, 2015; Lockwood *et al*., 2019; Molnar *et al*., 2008; Vagelli, 2011; WOAH, 2022). Concerns about animal welfare have also been raised due to high death rates in some supply chains (Militz *et al*., 2016; Stevens *et al*., 2017). Furthermore, coral reef species from tropical regions delicate ecosystems (Eddy *et al*., 2021; Hughes *et al*., 2017) are the main source of the marine ornamental fish trade (Biondo and Burki, 2020; Rhyne *et al*., 2012).

Most MOFs are wild-caught, but over 90% of freshwater aquarium fish are bred in captivity, making FOF aquaculture the market leader (Dawes, 1999). However, in recent years, this small part of the aquaculture industry has experienced significant growth. The only captive-bred animals that were commercially available were gobies, clownfish, and dottybacks. Since 2019, approximately 398 marine ornamental fish species have been successfully bred in captivity, with about 46 of these species being considered regularly accessible, according to Coral Magazine's Captive-Bred MOF Species List (Groover *et al*., 2020). To better understand the development, trends, patterns, and thematic evolution of author productivity, as well as the key keywords in scientific writing within this field, this study was conducted. This will provide researchers with a reliable source to help them understand the current focus on ornamental fish and related bibliometric data.

Materials and Methods

Research design

This study performed a bibliometric analysis of ornamental fish in scientific publications. Bibliometric analysis is a quantitative method used to evaluate the impact and development of research by examining publication and citation patterns (Van Eck and Waltman, 2010). This approach aimed to identify the scope and trends of ornamental fish research as documented in the Scopus database over a specified period (2014-2024).

Selection standards for the study's articles

This study analyzed ornamental fish using a bibliometric approach. Following specific inclusion and exclusion criteria, a PRISMA flowchart was used to guide the selection process. Only articles published in English were included. Moreover, the analysis focused solely on publications from 2014 to October 2024. The literature search was streamlined by applying meta-analysis and adhering to the "Preferred Reporting Items for Systematic Reviews" (PRISMA) guidelines (Figure 2) (Punnakitikashem and Hallinger, 2019).

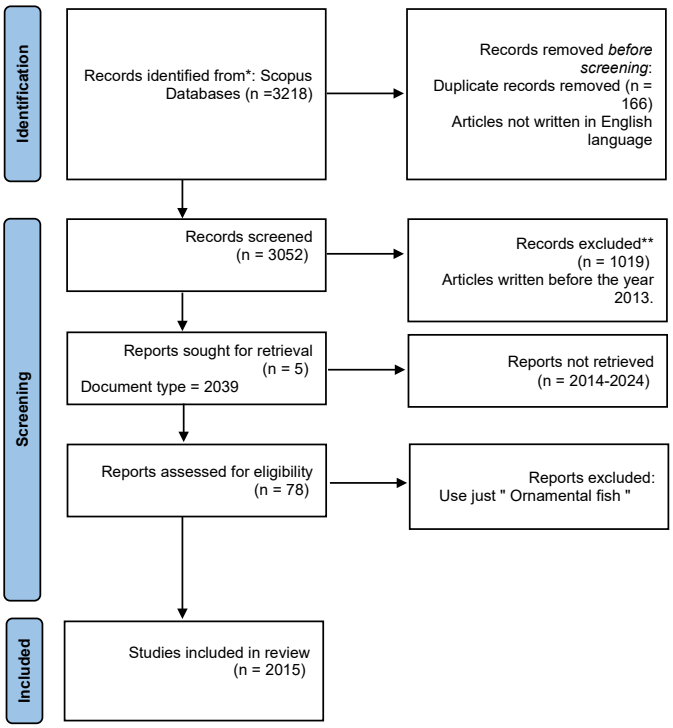

Figure 2: *A literature search using the PRISMA procedure.*

Literature searching

The main data source for this study was the Scopus database, a comprehensive and widely recognized bibliographical resource covering multiple disciplines, including ecology, fisheries, and aquaculture. Scopus was chosen for its extensive coverage of peer-reviewed literature, such as articles, conference papers, and reviews related to biodiversity research. The search terms used were ornamental fish. These keywords had to appear in the titles, abstracts, and keywords of the indexed documents. This method aimed to find publications specifically focused on ornamental fish, ensuring relevant results for the study. Bibliometric data, including titles, abstracts, keywords, and references, were extracted from the selected publications. The extraction involved downloading the metadata for each publication, which was then imported into VOSviewer (version 1.6.20; 2009–2023, van Eck and Waltman, Leiden University, The Netherlands), a specialized software for creating and visualizing bibliometric networks (van Eck and

Waltman, 2010). The Biblioshiny tool, available within the R package at https://www.bibliometrix.org/home/, was used to further analyze and interpret the data. Bibliometrics software, based on R for scientific computation, provides various tools for quantitative scientometric and bibliometric research, including advanced statistical algorithms, integrated data visualization options, and high-quality numerical routine analyses (Aria and Cuccurullo, 2017).

Inclusion and exclusion criteria

Only peer-reviewed journal articles, conference papers, review articles, and book chapters were included in the search results (Table 1). This ensured that the study focused on high-quality, credible sources of information. Documents such as notes, articles, conference papers, reviews, books, and book chapters were used to maintain the academic rigor of the study.

Table 1: *Number of document types of ornamental fish.*

Rank	Document type	Number
1	Article	1583
2	Conference paper	152
3	Review	164
4	Book chapter	94
5	Book	22

The study methodology has some limitations. Relying only on the Scopus database may have excluded relevant articles indexed in other databases like Web of Science or Google Scholar. The search terms might have missed studies on the relationship between fish and floristic diversity that use different terminology or are part of broader ecological contexts. Also, excluding non-English publications could introduce language bias and overlook important research from countries where English is not the primary language.

Results and Discussion

The annual number of Scopus articles on ornamental fish is shown in Figure 3. The number of publications increased from 2014 to 2024. Phase I spans 2014–2015, Phase II covers 2016–2019, and Phase III encompasses the period from 2020 to the present. These three phases make up the study period. Surprisingly, in 2014, there were 120 publications (in the first phase); however, the number decreased to 104 the following year. This marked the starting point, as evidenced by the roughly two-fold growth in the number of articles and publications from 2016 to 2019. The most prolific publications occurred in the third phase, during which the number of articles related to ornamental fish increased significantly. However, there was a decrease in publications in 2024 (178 publications), which may be attributed to the remaining time in the year and journal policies regarding the publication of special issues. Nonetheless, recent advances in fish husbandry and aquarium equipment technology have further supported the hobby (Livengood and Chapman, 2007). This trend reflects ongoing scientific progress in the field.

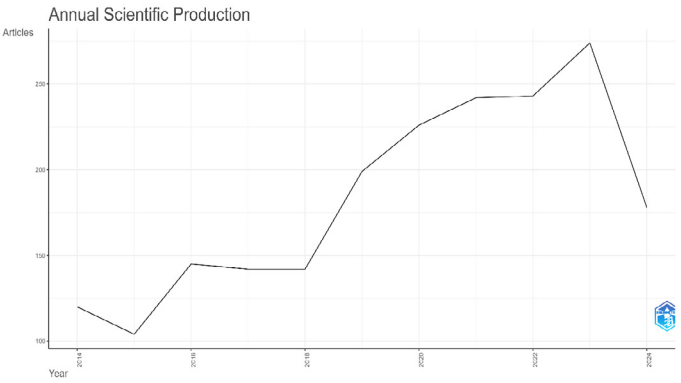

Figure 3: *The number of related scientific papers published on ornamental fish from 2014 to 2024.*

Additionally, the increasing number of authors (Table 2 and Figure 4), the number of countries involved (Figure 5), the citations per article (Figure 6), journal productivity (Table 3), and the sources used (Figure 7) all reflect the overall growth of the scientific literature on ornamental fish. An author influence map was used to evaluate changes over time in author impact on publications, with the results shown in Table 3. Between 2014 and 2024, 38 publications reveal that the most prolific authors are Bampidis, V., Kouba, M., Mayo, B., and Ramos, F. (Figure 4). Regarding ornamental fish research, Figure 5 highlights the most cited articles, with Assefa A (n = 347), Love DC (n= 286), Shinn AP (n= 204), and Lieke T (n= 202) leading. As Wang *et al.* (2019) noted, prominent authors with more citations tend to produce more influential work that significantly impacts the field. Since 2014, the Scopus database shows that 72 countries have published papers on ornamental fish. India leads with 336 papers, making up 13.2% of the total, followed by Brazil with 309 papers or 12.9%. The United States and Indonesia are also key contributors, with 220 and 205 publications, respectively. In terms of publication volume, most of

the top 10 contributing countries are in Asia or the United States (Figure 6).

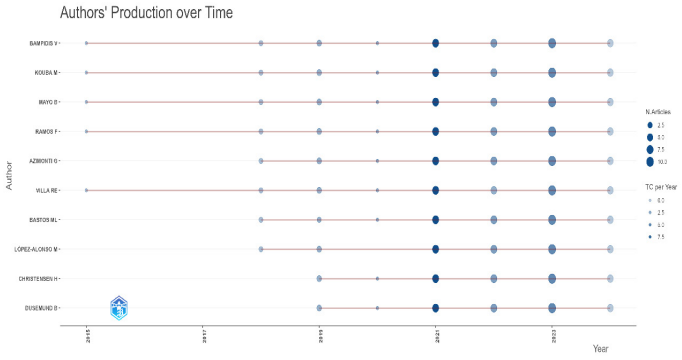

Figure 4: *The top 20 authors from 2014 to 2024.*

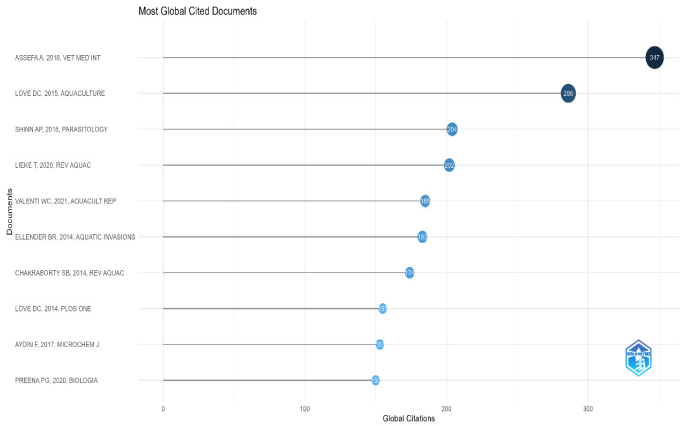

Figure 5: *The top 20 most cited documents from 2014 to 2024.*

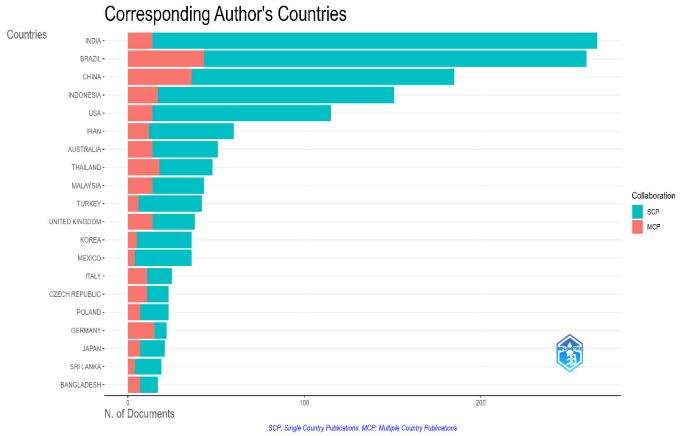

Figure 6: *Lists the top 20 nations in terms of scientific output from 2019 to 2022. SCP = Country Publications; MCP = Multiple Country Publications.*

Based on how often their relevant peers cite their scholarly publications, important writers with high citation counts are believed to have a significant impact on the academic research field (Docampo and Cram, 2019). Nowadays, as professional researchers, authors especially in aquaculture sciences conduct their scientific work in a complex manner that involves registering and commercializing their patents, copyrights, inventions, and innovations, as well as contacting different research sponsors, collaborators, publishers, institutions, industries, and other colleagues (Perkmann *et al.*, 2013; Joffre *et al.*, 2017; Kosmützky *et al.*, 2021; Neema and Chandrashekar, 2021).

Table 2: *Top ten authors on total publications in the ornamental fish fields.*

Author	Articles	Articles fractionalized	Country
Bampidis V	38	1.73	Greece
Kouba M	38	1.73	
Mayo B	38	1.73	Spain
Ramos F	38	1.73	
Azimonti G	37	1.68	
Villa Re	37	1.68	Italy
Bastos Ml	36	1.63	Portugal
López-Alonso M	36	1.63	Spain
Christensen H	35	1.59	
Dusemund B	35	1.59	Germany
Marcon F	35	1.59	Italy
Petkova M	35	1.59	Bulgaria
Woutersen R	35	1.59	Netherlands
Pechová A	34	1.55	Czech Republic
López Puente S	30	1.38	Spain
Chesson A	29	1.32	United Kingdom
Manini P	26	1.19	Italy
Westendorf J	26	1.19	
Brantom P	24	1.11	United Kingdom
Pizzo F	21	0.95	Italy

On the other hand, Aquaculture (ISSN 0044-8486) had 101 publications, making it the most prolific journal over the ten-year period analyzed, as shown in Table 3. This journal covers a wide range of topics related to fish. However, the Aquaculture Journal is a peer-reviewed, open-access publication that aims to provide a new platform for publishing reviews, original research articles, and special issues focused on aquaculture-related topics. These broad-ranging issues include subjects such as nutrition, physiology, reproduction, endocrinology, genetics, pathology, immunology, microbiology, husbandry, production techniques, and the aquatic environment.

In bibliometric scientometrics studies, consistency, uniformity, stability, and focus on an author's output in the field are essential for enhancing their scientific

Table 3: *The top ten journals are based on the number of documents on ornamental fish.*

Journal title	SJR * 2024	ND	Cite score (2024)	Publisher
Aquaculture	Q1	101	8.6	Elsevier
IOP conference series: Earth and environmental science	Q3	78	1	IOP Publishing Ltd.
Aquaculture Research	Q2		4.6	Hindawi
EFSA Journal	Q1	44	5.2	John Wiley and Sons
AACL Bioflux	Q4	39	1.4	Bioflux Publishing House
Aquaculture International	Q1	37	5.1	Springer Nature
Journal of Fish Diseases	Q1	35	4.6	John Wiley and Sons
Diseases of Aquatic Organisms	Q3	28	3.1	Inter-Research
Aquaculture Reports	Q1	23	5.9	Elsevier
PLoS ONE	Q1	22	6.2	Public Library of Science

*TP=Total Publications; TC= Total Citation; ND= Number of documents, * SJR= Scimago Journal and Country Rank.*

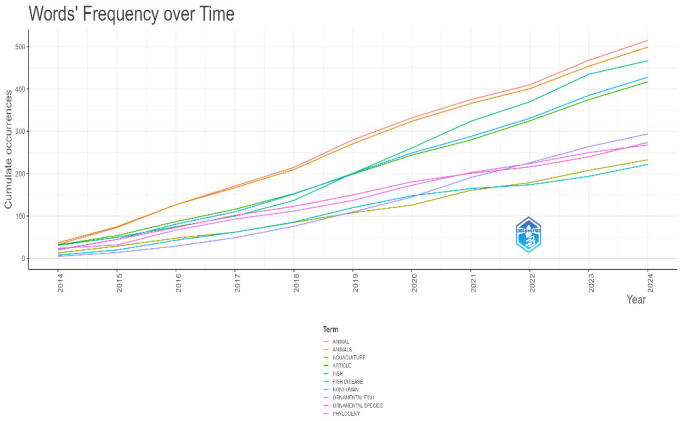

Figure 7: *The dynamics of the top 20 sources from 2014 to 2024.*

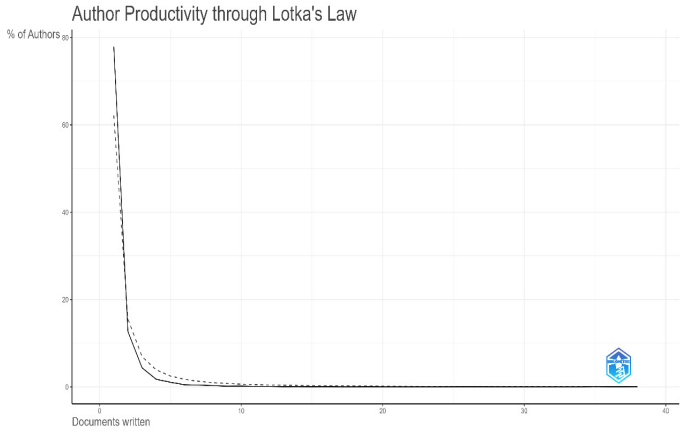

Figure 8: *The productivity of authors and the distribution of research literature about Lotka's law.*

impact and influence over time (Rejeb et al., 2022; Mostafa, 2020). The factors of scientific productivity and their frequency distribution can be quantitatively analyzed using statistical models such as Lotka's law and Shannon's entropy principle. Lotka's law has been particularly applied in fields such as fisheries, aquaculture, and marine studies. Examples include aquaculture research (Kanakaraj, 2016), limnology (Gunaseelan, 2023), endemic catadromous fish species (Copeland et al., 2023), water security (Huai and Chai, 2016), and the production of self-sufficient fish feed from agri-food waste (Prabakusuma et al., 2023). For this study, a total of 2036 legitimate documents from 4420 authors and co-authors across 73 countries were collected. Each author was credited once to evaluate their contribution and productivity. Lotka's law (Figure 8) aligns with the current data, as most authors (5439; 77.9%) submitted only one article. Furthermore, the beta coefficients and goodness-of-fit analysis suggest that more productive research on ornamental fish may be possible in the future.

The geographic distribution of the ornamental fish scientific landscape is shown in Figure 9. The map displays the total number of citations using proportional dark blue gradient shades, and a red line with varying widths indicates the strength of publishing agreements. The most significant publishing partnerships are between the USA and Thailand (10 collaborations), the USA and Brazil (15 collaborations), Indonesia and Malaysia (12 collaborations), and the United Kingdom and Canada. China and the USA (19 collaborations) rank second and third, respectively.

On the other hand, Figure 10 shows the distribution of papers by institutions. The University of Florida has the highest number of papers (162), followed by Universidade Federal do Pará (n = 88) and Shanghai Ocean University (n = 112). The USA has likely made the most significant progress in the field of ornamental fish publications. Florida is a major global supplier of live ornamental aquatic species, which are captured in the wild and bred. With over 200 farms raising

more than 800 freshwater fish strains, it leads the production of freshwater ornamental fish (Monticini, 2010).

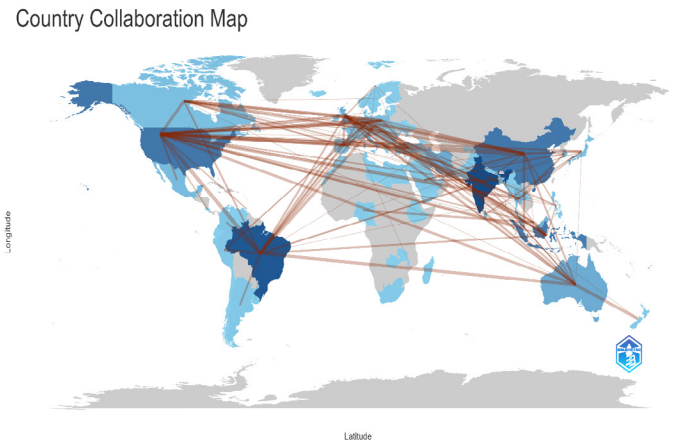

Figure 9: *Map showing global collaboration by author location, quantity of scientific publications, and strength of networking links.*

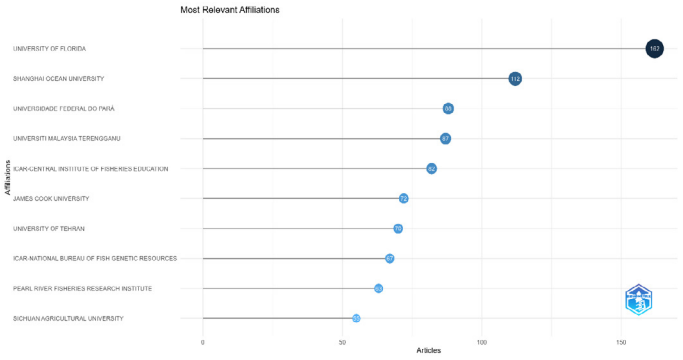

Figure 10: *Top ten academic institutions in ornamental fish publications.*

A network map showing individuals who collaborated or shared co-authorship on the ornamental fish research is displayed in Figure 11. The co-authorship network consists of three clusters, based on the countries of the authors as determined by the Walktrap clustering algorithm. Among the relevant countries, the USA has the highest betweenness (155), and the UK has the highest betweenness (199). Egypt and Iraq, on the other hand, have the lowest betweenness (1) (Figure 11A).

The graph can be interpreted in several ways, including this: Bampidis, V., Kouba, M., Mayo, B., and Ramos, F. are regarded as the four most influential writers in this field of study (Figure 11B). Because of their significant contributions, high citation counts, and wide connections with other authors, these individuals have the largest node sizes in the co-authorship network. Citation counts, along with peer review assessments, are probably the main methods used to evaluate the importance and relevance of academic research. Based on the number of citations their work receives from peers, influential writers with high citation numbers have a major impact on the academic research area (Docampo and Cram, 2014, 2019).

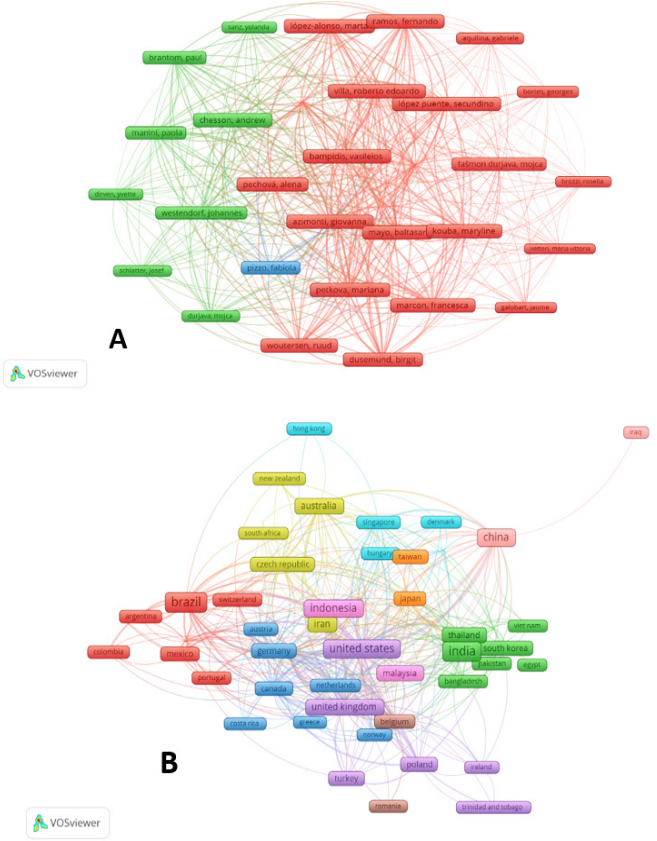

Figure 11: *A global map of co-authorship collaborations based on the number of scientific publications, the location of the authors, and the strength of the networking links.*

However, Figure 12 presents a word cloud of the keywords identified in the abstract of the academic paper on ornamental fish. The size of its word represents a term's frequency in an article in the visual graph; the larger the word, the more often it appears in the examined papers, and vice versa. 'Animal' (515 times), 'fish' (499 times), 'nonhuman' (428 times), 'article' (417 times), 'ornamental fish' (294 times), 'phylogeny' (274 times), 'ornamental species' (268 times), 'aquaculture' (233 times), and 'fish disease' (46 times) were the most frequently occurring keywords. Using a word cloud to analyze the most common terms in bibliometric studies indicates that most research concentrates on these topics. Additionally, smaller words suggest potential directions for further investigation (Mulay et al., 2020). A word cloud transforms text into tags or words, where relative importance is indicated by

size and color, as claimed by Mulay *et al.* (2020). By examining the keywords authors use in their publications, researchers can identify popular topics (Song *et al.*, 2019). Hence, the purpose of this research is to demonstrate that publishing keywords facilitates the rapid identification of a publication's main topic and focus.

Figure 12: *A word cloud of the authors' frequently used keywords in Scopus-indexed works, with the size of the cloud indicating how frequently the keywords are used.*

The thematic map of ornamental fish is another analysis conducted for this study. Its goal is to understand the current state and potential for sustainability in this field by creating a thematic map. Researchers and stakeholders can benefit from this study by exploring opportunities for future growth in thematic research within the area (Agbo *et al.*, 2021). As shown in Figure 13 the author's keywords were used to develop four themes on the thematic map: niche (top left), motor (top right), emerging or declining (bottom left), and basic themes (bottom right). The top right area, labeled as motor themes, includes well-developed study themes like Cluster 1: animal, nonhuman, and fish, and Cluster 2: aquarium, perciform, and survival. Concepts such as aquarium, perciform, and survival appear in Cluster 1 under emerging or declining themes. Diet, Pisces, decorative species, and embodiment are the three topics in Cluster 2. Microbiology, antibiotic resistance, and anti-infective agents have a significant impact on both niche and driving themes. Aquaculture is the only subject that overlaps between motor and basic themes. According to Esfahani *et al.* (2019), centrality indicates the degree of interconnection among different themes, while density measures the cohesion among nodes. These two metrics evaluate the importance or development of a particular issue. A node's centrality and relevance increase with the number of relationships it has with other nodes in the theme network; it also occupies a key position within the network. Similarly, a node's cohesiveness, which reflects the density of a research area, defines its capacity to grow and sustain itself (Agbo *et al.*, 2021).

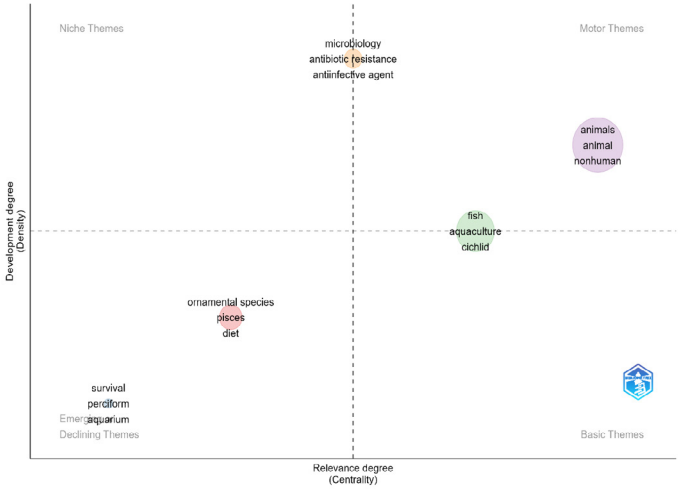

Figure 13: *Thematic map, source: R Studio.*

As commonly seen in studies on ornamental fish, this research further breaks down each word's conceptual or contextual structure map via area mapping, showing the relationship between two words. Two main clusters of 45 keywords, identified in dimension 1 (81.94%) and dimension 2 (7.27%), were clearly separated through factorial analysis (Figure 14A, B).

However, several terms such as isolation and purification, classification, DNA, microbiology, phylogeny, nucleotide sequences, parasitology, sequence analysis, genetics, and fish disease are closely related. The keyword cluster that includes animal experiment, male, and female appears more distant from the other keywords in the same group, indicating a weaker connection. This correspondence analysis helps clarify the topic structure of the vocabulary study.

The subject dendrogram in Figure 5B displays the hierarchical order and relationships among the keywords generated by hierarchical clustering. The cuts in the graphics and the vertical lines assist in analyzing and understanding the different groupings. According to Andrews (2003), Figure 14B is intended to estimate the approximate number of clusters to support further discussion rather than to determine the ideal number of linkages between clusters.

On the other hand, Figure 15 displays the types of documents in the relevant research area, showing that

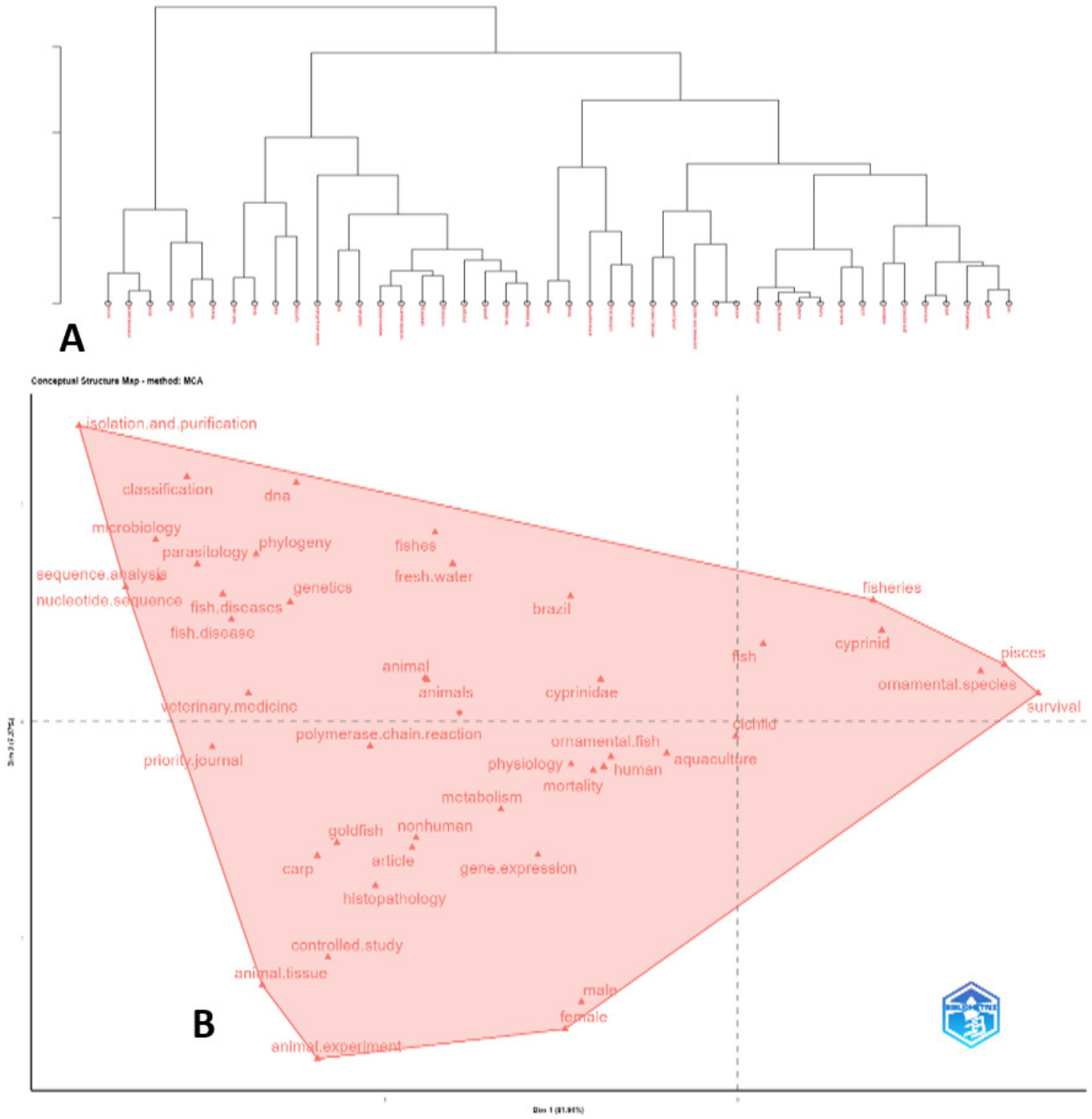

Figure 14: *The percentages of publications on the subject of ornamental fish.*

Agricultural and Biological Sciences accounted for the highest percentage, 38% (n= 1339), followed by Environmental Science at 15% (n= 507), while the other specializations had the smallest share. Each original research publication generally offers new perspectives, research results, methodological insights, and improved understanding (Dutta, 2019). However, the large volume of information generated worldwide every day has increasingly made it difficult to find relevant, current facts and insights (Bahishti, 2021).

Conclusion

This study aims to document the numerous advancements in ornamental fish research. The production of ornamental fish, a vital part of the aquaculture industry, often begins with technical procedures. Besides creating jobs, the ornamental fish trade significantly contributes to the economies of both developed and developing countries by generating foreign exchange (Thomas, 2008). As a result, several countries in Asia and Europe have started capturing and breeding vibrant, fantastical,

and intriguing fish varieties. An increasing number of freshwater, brackish, and marine fish have been domesticated and gained popularity for commercial use. To understand the current state of the field, research contexts, and knowledge areas such as leading scholars, core journals, significant trends, and research hotspots worldwide this study initially uses bibliometric methods with VOS Viewer and Biblioshiny in the R-package for Bibliometrics. Next, the research explores the growing interest and notable advancements in ornamental fish research in more detail. Additionally, it emphasizes that the main drivers of growth in this field are originality, timeliness, and consistent publication.

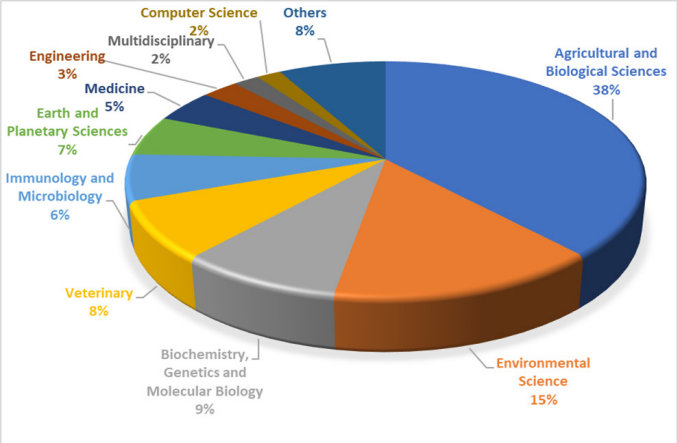

Figure 15: *The proportions of types of documents about ornamental fish.*

Major upstream and downstream activities in the value and supply chains involved in the production of ornamental fish could be the focus of future bibliometric research. Additionally, it is strongly recommended that the bibliometric methodology used in this study be applied to other topics. A collection of abstracts, publications, and citations can provide comprehensive information and bibliometric profiles, illustrating the intellectual landscape. One significant limitation that may have contributed to the exclusion of some literature was the reliance solely on articles from the Scopus database. Future studies might include other scientific databases, such as the Web of Science, PubMed, and Dimensions. These databases can complement and broaden the evaluation results by uncovering new concepts, insights, study perspectives, and trends.

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Novelty Statement

Ornamental fish have become both an economic asset for breeders and the corporate sector, and a psychological one for enthusiasts of these species. However, research on them provides a clear picture and highlights the importance of commercial species.

Author's Contribution

Sayed-Lafi R.M.: Study design, data collection, drafting the paper.
Al-Shammari, N.A.H.: Writing original draft and editing.

Generative AI and AI-assisted technology statement

The authors used the Grammarly tool in order to improve the language used in the text. After using this tool/service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

Conflict of interest

The authors have declared no conflict of interest.

References

Agbo, F.J., Oyelere, S.S., Suhonen, J. and Tukiainen, M., 2021. Scientific production and thematic breakthroughs in smart learning environments: a bibliometric analysis. Smart Learn. Environ., 8: 1-25. https://doi.org/10.1186/s40561-020-00145-4

Andrews, J.E., 2003. An author co-citation analysis of medical informatics. J. Med. Library Assoc., 91(1): 47.

Aria, M. and Cuccurullo, C., 2017. Bibliometrix: An R-tool for comprehensive science mapping analysis. J. Inf., 11(4): 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Bahishti, A.A., 2021. The importance of review articles and its prospects in scholarly literature. Exten. Rev., 1(1): 1-6. https://doi.org/10.21467/exr.1.1.4293

Balon, E.K., 2004. About the oldest domesticates among fishes. J. Fish Biol., 65: 1-27. https://doi.org/10.1111/j.0022-1112.2004.00563.x

Bartley, D.M., 2000. Responsible ornamental fisheries. FAO Aquacult. Newsl., 24: 10-14. http://icsfarchives.net/id/eprint/11410

Biondo, M.V. and Burki, R.P., 2020. A systematic review of the ornamental fish trade with emphasis on coral reef fishes an impossible task. Animals, 10(11): 2014. https://doi.org/10.3390/ani10112014

Chen, J.Y., Zeng, C., Jerry, D.R., Cobcroft, J.M., 2020. Recent advances of marine ornamental fish larviculture: broodstock reproduction, live prey and feeding regimes, and comparison between demersal and pelagic spawners. Rev. Aquacult., 12(3): 1518-1541. https://doi.org/10.1111/raq.12394

Conant, T.A., 2015. Endangered species act status review report: Banggai Cardinalfish, Pterapogon kauderni, pp. 1-36. https://repository.library.noaa.gov/view/noaa/16289

Copeland, L.K., Stockwell, B.L. and Piovano, S., 2023. Exploring the research landscape of endemic Catadromous fishes: A comprehensive bibliometric study and PRISMA review. Diversity, 15(7): 825. https://doi.org/10.3390/d15070825

Davenport, K.E. 1996. Characteristics of the current international trade in ornamental fish, with special reference to the European Union. Rev. Sci. Tech. (Int. Off. Epizoot.), 15(2): 435-443. https://doi.org/10.20506/rst.15.2.936

Dawes, J., 1999. International experience in ornamental marine species management Part 2: Some resource management strategies. Ornamental Fish Int. J., 27: 10–12.

Docampo, D. and Cram, L., 2014. On the internal dynamics of the Shanghai ranking. Scientometrics, 98: 1347-1366. https://doi.org/10.1007/s11192-013-1143-0

Docampo, D. and Cram, L., 2019. Highly cited researchers: A moving target. Scientometrics, 118(3): 1011-1025. https://doi.org/10.1007/s11192-018-2993-2

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N. and Lim, W.M. 2021. How to conduct a bibliometric analysis: An overview and guidelines. J. Bus. Res., 133: 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Dutta, M. 2019. The importance of scholarly reviews in medical literature. Ear, Nose & Throat Journal, 98(5), 251-252. https://doi.org/10.1177/0145561319827725

Eddy, T.D., Lam, V.W., Reygondeau, G., Cisneros-Montemayor, A.M., Greer, K., Palomares, M.L.D. and Cheung, W.W., 2021. Global decline in capacity of coral reefs to provide ecosystem services. One Earth, 4(9): 1278-1285. https://doi.org/10.1016/j.oneear.2021.08.016

Ellegaard, O. and Wallin, J.A., 2015. The bibliometric analysis of scholarly production: How great is the impact? Scientometrics, 105: 1809-1831. https://doi.org/10.1007/s11192-015-1645-z

Esfahani, H., Tavasoli, K. and Jabbarzadeh, A., 2019. Big data and social media: A scientometrics analysis. Int. J. Data Netw. Sci., 3(3): 145-164. https://doi.org/10.5267/j.ijdns.2019.2.007

Fox, C.W., Paine, C.T. and Sauterey, B., 2016. Citations increase with manuscript length, author number, and references cited in ecology journals. Ecol. Evol., 6(21): 7717-7726. https://doi.org/10.1002/ece3.2505

Groover, E.M., DiMaggio, M. and Cassiano, E.J., 2020. Overview of commonly cultured marine ornamental fish: FA224, 4/2020. EDIS, 2020(3): 1-7. https://doi.org/10.32473/edis-fa224-2020

Gunaseelan, S., 2023. Application of bibliometric laws in global limnology research publications: A scientometric analysis based on web of science 1989-2020. Kelpro Bull., 27(1): 93-111.

Huai, C. and Chai, L., 2016. A bibliometric analysis on the performance and underlying dynamic patterns of water security research. Scientometrics, 108: 1531-1551. https://doi.org/10.1007/s11192-016-2019-x

Hughes, T.P., Barnes, M.L., Bellwood, D.R., Cinner, J.E., Cumming, G.S. and Scheffer, M., 2017. Coral reefs in the Anthropocene. Nature, 546(7656): 82–90. https://doi.org/10.1038/nature22901

Joffre, O.M., Klerkx, L., Dickson, M. and Verdegem, M., 2017. How is innovation in aquaculture conceptualized and managed? A systematic literature review and reflection framework to inform analysis and action. Aquaculture, 470: 129-148. https://doi.org/10.1016/j.aquaculture.2016.12.020

Kanakaraj, S., 2016. Aquaculture research outputs from Scopus database: A bibliometric analysis. Indian J. Inf. Sour. Ser., 6(1): 20-29. https://doi.org/10.51983/ijiss.2016.6.1.440

Kar, D., 2015. Epizootic ulcerative fish disease

syndrome. Acad. Press,

Kosmützky, A. and Wöhlert, R., 2021. Varieties of collaboration: On the influence of funding schemes on forms and characteristics of international collaborative research projects (ICRPs). Eur. J. Educ., 56(2): 182-199. https://doi.org/10.1111/ejed.12452

Kumar, T.A., Gunasundari, V. and Prakash, S., 2015. Breeding and rearing of marine ornamentals. In: Advances in marine and brackishwater aquaculture, pp. 101-107. https://doi.org/10.1007/978-81-322-2271-2_11

Livengood, E.J. and Chapman, F.A., 2007. The ornamental fish trade: An Introduction with perspectives for responsible aquarium fish ownership: FA124/FA124, 5/2007. Edis, 2007(16): 1-8. https://doi.org/10.32473/edis-fa124-2007

Lockwood, J.L., Welbourne, D.J., Romagosa, C.M., Cassey, P., Mandrak, N.E., Strecker, A. and Keller, R., 2019. When pets become pests: The role of the exotic pet trade in producing invasive vertebrate animals. Front. Ecol. Environ., 17(6): 323-330. https://doi.org/10.1002/fee.2059

Militz, T.A., Kinch, J., Foale, S. and Southgate, P.C., 2016. Fish rejections in the marine aquarium trade: An initial case study raises concern for village-based fisheries. PLoS One, 11(3): e0151624. https://doi.org/10.1371/journal.pone.0151624

Molnar, J.L., Gamboa, R.L., Revenga, C. and Spalding, M.D., 2008. Assessing the global threat of invasive species to marine biodiversity. Front. Ecol. Environ., 6(9): 485-492. https://doi.org/10.1890/070064

Monticini, P., 2010. The ornamental fish trade: Production and commerce of ornamental fish: Technical-managerial and legislative aspects (Vol. 102). Rome, Italy: Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/handle/20.500.14283/bb206e

Mostafa, M.M., 2020. A knowledge domain visualization review of thirty years of halal food research: Themes, trends and knowledge structure. Trends Food Sci. Technol., 99: 660-677. https://doi.org/10.1016/j.tifs.2020.03.022

Mukherjee, D., Lim, W.M., Kumar, S. and Donthu, N., 2022. Guidelines for advancing theory and practice through bibliometric research. J. Bus. Res., 148: 101-115. https://doi.org/10.1016/j.jbusres.2022.04.042

Mulay, P., Joshi, R. and Chaudhari, A., 2020. Distributed incremental clustering algorithms: A bibliometric and word-cloud review analysis. Sci. Technol. Lib., 39(3): 289-306. https://doi.org/10.1080/0194262X.2020.1775163

Neema, S. and Chandrashekar, L., 2021. Research funding why, when, and how? Indian Dermatol. Online J., 12(1): 134-138. https://doi.org/10.4103/idoj.IDOJ_684_20

Novák, J., Kalous, L. and Patoka, J., 2020. Modern ornamental aquaculture in Europe: Early history of freshwater fish imports. Rev. Aquacult., 12(4): 2042-2060. https://doi.org/10.1111/raq.12421

OEC, The Observatory of Economic Complexity 2024. Ornamental fish. Available: https://oec.world/en/profile/hs/ornamental-fish?countryComparisonGeoSelector=as

Olivier, K., 2003. World trade in ornamental species. Marine ornamental species–Collection, culture and conservation, pp. 49-63. https://doi.org/10.1002/9780470752722.ch4

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'este, P. and Sobrero, M., 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. Res. Policy, 422: 423-442. https://doi.org/10.1016/j.respol.2012.09.007

Prabakusuma, A.S., Wardono, B., Fahlevi, M., Zulham, A., Sunarno, M.T.D., Syukur, M. and Pramoda, R., 2023. A bibliometric approach to understanding the recent development of self-sufficient fish feed production utilizing agri-food wastes and by-products towards sustainable aquaculture. Heliyon, 9(7). https://doi.org/10.1016/j.heliyon.2023.e17573

Punnakitikashem, P., and Hallinger, P., 2019. Bibliometric review of the knowledge base on healthcare management for sustainability, 1994–2018. Sustainability, 12(1): 205. https://doi.org/10.3390/su12010205

Raja, K., Aanand, P., Padmavathy, S. and Sampathkumar, J.S., 2019. Present and future market trends of Indian ornamental fish sector. Int. J. Fish. Aquat. Stud., 7(2): 6-15. https://www.fisheriesjournal.com/archives/2019/vol7issue2/PartA/7-1-48-550.pdf

Raja, S., Babu, T.D., Nammalwar, P., Jacob, C.T. and Dinesh, K.P.B., 2014. Potential of ornamental

fish culture and marketing strategies for future prospects in India. Int. J. Biosci. Nanosci., 1(5): 119-125.

Rejeb, A., Rejeb, K., Abdollahi, A. and Treiblmaier, H., 2022. The big picture on Instagram research: Insights from a bibliometric analysis. Telemat. Inf., 73: 101876. https://doi.org/10.1016/j.tele.2022.101876

Rhyne, A.L., Tlusty, M.F., Schofield, P.J., Kaufman, L.E.S., Morris Jr, J.A. and Bruckner, A.W., 2012. Revealing the appetite of the marine aquarium fish trade: the volume and biodiversity of fish imported into the United States. PLoS One, 7(5): e35808. https://doi.org/10.1371/journal.pone.0035808

Sayed-Lafi, R.M. and Sultan, F.A.M., 2024. A bibliometric approach to understanding the recent development of publication about the silver carp Hypophthalmichthys molitrix Between 2003 and 2023. Egypt. J. Aquat. Biol. Fish., 28(6): 645-662. https://doi.org/10.21608/ejabf.2024.392434

Sharma, I. and Dhanze, R., 2018. A checklist of the ornamental fishes of Himachal Pradesh, the western Himalaya, India. J. Threat. Taxa, 10(8): 12108-12116. https://doi.org/10.11609/jott.3716.10.8.12108-12116

Sneddon, L.U., Wolfenden, D.C. and Thomson, J.S., 2016. Stress management and welfare. Fish Physiol., 35: 463-539. https://doi.org/10.1016/B978-0-12-802728-8.00012-6

Song, Y., Chen, X., Hao, T., Liu, Z. and Lan, Z., 2019. Exploring two decades of research on classroom dialogue by using bibliometric analysis. Comput. Educ., 137: 12-31. https://doi.org/10.1016/j.compedu.2019.04.002

Stevens, C.H., Croft, D.P., Paull, G.C. and Tyler, C.R., 2017. Stress and welfare in ornamental fishes: What can be learned from aquaculture? J. Fish Biol., 91(2): 409-428. https://doi.org/10.1111/jfb.13377

Tan, H., Li, J., He, M., Li, J., Zhi, D., Qin, F. and Zhang, C., 2021. Global evolution of research on green energy and environmental technologies: A bibliometric study. J. Environ. Manage., 297: 113382. https://doi.org/10.1016/j.jenvman.2021.113382

Tarihoran, A.D.B., Hubeis, M., Jahroh, S. and Zulbainarni, N., 2023. Competitiveness of and barriers to Indonesia's exports of ornamental fish. Sustainability, 15(11): 8711. https://doi.org/10.3390/su15118711

Thomas, K., 2008. Status of ornamental fish trade in India with special reference to investment and trade opportunities. Abstract, International seminar on ornamental fish breeding, farming and trade, Cochin, India. pp. 7.

Tlusty, M., 2002. The benefits and risks of aquacultural production for the aquarium trade. Aquaculture, (2053-4): 203-219. https://doi.org/10.1016/S0044-8486(01)00683-4

Ukaonu, S.U., Mbawuike, B.C., Oluwajoba, E.O., Williams, A.B., Ajuonu, N., Omogoriola, H.O. and Myade, E.F., 2011. Volume and value of ornamental fishes in the Nigerian export trade. Agric. Biol. J. N. Am., 24: 661-664. https://doi.org/10.5251/abjna.2011.2.4.661.664

USDA, (United States Department of Agriculture)-NASS National Agricultural Statistics Service) 2019. Census of agriculture 2017, Census of Aquaculture 2018. Volume 3, Special Studies, Part 2.

Vagelli, A.A., 2011. The Banggai cardinalfish: Natural history, conservation, and culture of Pterapogon kauderni. John Wiley and Sons Ltd, Chichester, UK. https://doi.org/10.1002/9781119950387

Van Eck, N. and Waltman, L., 2010. Software survey: VOS viewer, a computer program for bibliometric mapping. Scientometrics, 842: 523-538. https://doi.org/10.1007/s11192-009-0146-3

Wang, M., Zhang, J., Jiao, S. and Zhang, T., 2019. Evaluating the impact of citations of articles based on knowledge flow patterns hidden in the citations. PLoS One, 1411: e0225276. https://doi.org/10.1371/journal.pone.0225276

WOAH, World Organization for Animal Health 2022. Aquatic Animal Health Code. Available: https://www.woah.org/en/what-wedo/standards/codes-and-manuals/aquatic-code-online-access