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Research Article

Dormitator latifrons (Richardson, 1844) a Pacific fat sleeper, but skinny in research: a scientometric study

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ABSTRACT. In order to provide information on the current knowledge about the native fish *Dormitator latifrons* and identify the gaps that must be filled to achieve correct resource management, a scientometric study was carried out using different scientific databases. A total of 103 publications were registered between the years 1972 and 2021. Results indicate that the species has been addressed since 2001 with less than one publication per year, with 2008 being the year with the highest number of publications (10). The main topics addressed were ecology, physiology, and parasitology of fish. The available knowledge generated about the species is concentrated in 68 journals, with Mexico as the most productive country, followed by USA and Ecuador, and the most productive research centers about this fish were Mexico's Instituto Politécnico Nacional and Universidad de Guadalajara. A total of 285 authors were detected contributing knowledge to the species, with Violante-González in the top with ten publications. The co-authorship co-occurrence maps suggest there is no solid collaborative relationship between the scientific community and that the information generated is insufficient for conserving and exploiting this fish. It is essential to increase the study of thematic areas that allow their comprehensive management in the medium term; topics like reproduction in captivity, aquaculture, and nutrition must be addressed in the future to assure a sustainable use of this resource.

Keywords: *Dormitator latifrons*; native fish; amphidromous; worldwide database; regional database; co-occurrence maps

INTRODUCTION

The biodiversity of the American continent is one of the largest on the planet, including freshwater species, some of which are commercial or fishery important at a local or regional market. Therefore, multiple research programs on culture technology for native species have been developed (Flores-Nava & Brown 2010) in rural and private sectors. However, most of the research on native species is still in the early stages of technological development (Flores-Nava & Brown 2010) compared with the well-positioned exotic species throughout the continent. According to the United Nations Environment Program (UNEP), exotic species production represents the second most serious threat to biodiversity and an important social and economic risk (Curiel 2012).

Fish species of the *Dormitator* genus (Gill, 1861) are known as "sleepers." They are representative of freshwater amphydromic fish that inhabit the tropical

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and subtropical coastal environments of America and West Africa (Galván-Quesada et al. 2016). In the Pacific, *Dormitator latifrons* (Richardson, 1844), commonly known as the Pacific fat sleeper, inhabit continental waters from California (USA) to Ecuador, with regional names like fat sleeper, chame, puyeque, popoyote, poplar, chococo, chopopo or chalaco. Its amphydromic characteristic allows it to migrate and occupy different bodies of water, freshwater, estuaries, and coastal lagoons. So, its presence can be usual and abundant in these aquatic systems due to its wide environmental tolerance with different physiological survival and adaptation strategies (Vega-Villasante et al. 2021). Although there are no official data on its fisheries and aquaculture production, this species has a commercial interest since it is part of the gastronomy in several coastal communities in Ecuador (Flores Nava & Brown 2010) and southern Mexico, mainly in the states of Guerrero and Oaxaca (Larumbe 2002). In Ecuador, *D. latifrons* is considered a resource for aquaculture and a fishery resource (Arriaga & Martinez 2002, Schwarz 2007) since there is already information generated from the empirical practice for cultivation through the collection of wild fingerlings (Vega-Villasante et al. 2021).

The published research on *D. latifrons* covers ecology, parasitology, and physiology. It is a species with commercial importance and is classified as having a high potential for aquaculture (Arriaga & Martinez 2002, EcoCostas 2006, Schwarz 2007, Basto-Rosales et al. 2019). At the same time, the information generated on aquaculture aspects is found mainly in gray literature, such as graduate thesis and others of technical nature, not published (Vega-Villasante et al. 2021). Therefore, the knowledge generated about *D. latifrons* would be essential to analyze it from a scientometric perspective. A scientometric study includes the quantitative analysis of scientific production, which addresses its statistical aspects, areas, frequency of citation, and keywords, among other indices (Macías-Chapula 2001). The same author refers that the analysis of scientometric data makes it possible to identify and represent scientific networks, highlight the links between countries, institutions, and researchers, and know the impact of the main programs and organizations. The most concrete way to explain a scientometric study is through scientometric indicators, which are standards used to measure, quantify and evaluate the scientific performance of an individual, group, institution, nation, or region (Álvarez-López & Michán-Aguirre 2018). The most commonly used are production, impact, citation, content, and collaboration. Within these, some elements of scientometric analysis of scientific articles known as metadata can be mentioned: title, abstract, keywords, author, institution, author's country, journal name, year of publication, references, and citations (Álvarez-López & Michan-Aguirre, 2018).

The present study aims to order and analyze the available knowledge about *D. latifrons* based on the scientific literature published and deposited in commercial databases to detect the gaps that must be filled to achieve correct management of the *D. latifrons* resource.

MATERIALS AND METHODS

The study was carried out according to the methodology used by Chong-Carrillo et al. (2015). The bibliometric review included Latin American databases (SciELO, Redalyc, and Periodica) that are not compiled in international commercial databases but include high-quality scientific and editorial publications from the region in their indexes. The registered publications were made in the following databases: Web of Science, Scopus, Bio-one, Springer, Science Direct, Scielo, Redalyc, and Periodica.

All the records containing the term "*Dormitator latifrons*" in the title, abstract, and keywords fields were collected from 1968 to 2021. The records were systematized into a single matrix that concatenated all the records from all the databases. The data matrix generated included: authors, the title of the publication, journal, language, keywords, abstract, country, year of publication, research area, and the authors' institution. The mentioned indicators were organized, computed, and graphed with the WPS Spreadsheet® software.

VOSviewer is a software tool for creating maps based on network data visualizing and exploring these maps. A map can be created based on a network already available, but it is also possible to construct a network first. VOSviewer can be used to construct metadata: networks of scientific publications, scientific journals, researchers, research organizations, countries, keywords, or terms (Van Eck & Waltman 2020). This software-generated co-authors co-occurrence maps and keywords networks from the articles from Scopus and Web of Science. In the map display, the elements are represented by their label in a circle. The weight of publications determines the size of the label and the circle. The higher the weight of the posts, the bigger the label and the circle. Therefore, the label may not be displayed for some items to avoid overlap. The color of an item is determined by the group or cluster to which the item belongs. The lines between elements represent links or collaborations (Van Eck & Waltman 2010). The conditions computed in VOSviwer® software under test

were the following: a maximum number of thirteen authors per document; full counting like counting method; at least two documents per author; with association strength method; and a layout with default values. The analysis was projected on a network visualization for both co-authorship and keywords with Scopus and Web of Science.

RESULTS

In a period of 49 years, from 1972 to 2021, a total of 103 publications were registered. There are years when publications are not recorded. However, since 2001, at least one document has been published. The year with the highest number of publications (10) is 2008 (Fig. 1), and the highest subjet record was ecology (35%), followed by physiology (15%), parasitology (13%), and aquaculture (10%). Ecology studies represent 35% of the studies related to the species of *Dormitator latifrons*. Many of these ichthyology works aim to study community ecology in estuaries and freshwater systems at both the population and community levels, addressing basic issues such as richness, composition, diversity, abundance, distribution (space-time), and structure. Physiology studies refer above all to work on the acoustic sensory system and, to a lesser extent, to studies on the reproductive physiology and environmental tolerance of the species under culture conditions. Parasitology addresses issues of parasite identification, distribution, and variation in fish communities (where *D. latifrons* is found as its host). Aquaculture deals mainly with work on nutrition (protein and lipid requirements) in experimental systems. Other areas with a lower appearance percentage are archeology, microbiology, food, and histology (Fig. 2).

Available knowledge about *D. latifrons* is concentrated in 68 journals (Fig. 3a). In the first place, with seven publications, is the Revista de Biología Tropical, followed by the Revista Mexicana de Biodiversidad with six publications, the Journal of Comparative Physiology and Parasitology Research with five publications each, and the Latin American Journal of Aquatic Research, with four publications. Other journals, such as Copeia, Ecosistemas y Recursos Agropecuarios, Journal of Parasitology, and Molecular Phylogenetics and Evolution, register three publications each.

A total of 285 authors were detected contributing knowledge to the species *D. latifrons*. Violante-Gonzalez is the author with the highest number of publications (10), followed by Badillo-Zapata and Vega-Villasante (9), and Lu with eight publications (Fig. 3b). The following authors registered five publications: Aguirre-Macedo, González-Acosta, Monks and Rojas-Herrera; and with four publications: Castro-Aguirre, Franco-Gordo, Godínez-Domínguez, Rodríguez-Montes de Oca, Ruiz-Campos, Velázquez-Velázquez and Xu (Fig. 3b).

The co-authorship co-occurrence maps revealed the existence of eight clusters for the Scopus database and nine for Web of Science (Figs. 4a-b). It is important to note that both co-authorship co-occurrence maps express independent groups where there is no connection between them. Of these, four clusters coincide for both maps, corresponding to the group of i) Violante-Gonzalez, ii) Badillo-Zapata and Vega-Villasante, iii) Lu, and iv) Barba. Violante-Gonzalez addresses issues about parasitology, where *D. latifrons* appears as the host wild habitat: richness and species composition of helminth community, seasonal patterns in metazoan parasite community, to mention. Badillo-Zapata addresses nutritional aspects of the species: under different densities, meat protein quality, and soy, among other aquaculture issues. Lu et al. study on sensory and acoustic physiology of *D. latifrons*. Barba et al. present population studies of native species, including *D. latifrons*. The keyword co-occurrence maps for both databases indicated that "*Dormitator latifrons*" is the dominant word in scientific publications. On the part of Scopus (Fig. 4c), the co-occurrence density for *D. latifrons* is 13, followed by fish (8), Mexico (7), hearing (6), ear, and otolithic organ (5). Five groups are detected, separated from the rest, the keywords related to the sensory physiology of the center *dormitator latifrons*. There are groups related to taxonomy (phylogeny, Eleotridae, taxonomy), those of parasitology (parasite and Nematoda), and ecology (ecology, assemblages, fishes), and a little more separated the aquaculture group. For Web of Science (Fig. 4d), *Dormitator latifrons* (23), fish (15), Mexico (12), hearing (8), saccular efferent (7), sleeper goby (7), sensitivity (6), and ear (5). Like Scopus, in Web of Science, it appears as a *Dormitator latifrons* center. It is possible to detect the group of sensory physiology (ear and hearing), and new words appear, such as DNA sequences, typical of genetic and phylogenetic studies.

DISCUSSION

Several scientometric studies address issues in biological sciences, although these cannot be comparable since they handle different bibliometric approaches. In addition, few specific studies on aquatic organisms make it even more difficult to conduct in-depth analyses on these issues. For example, Singh et al. (2019) analyze scientific productivity and collaborative networks of authorship in fisheries and aquaculture

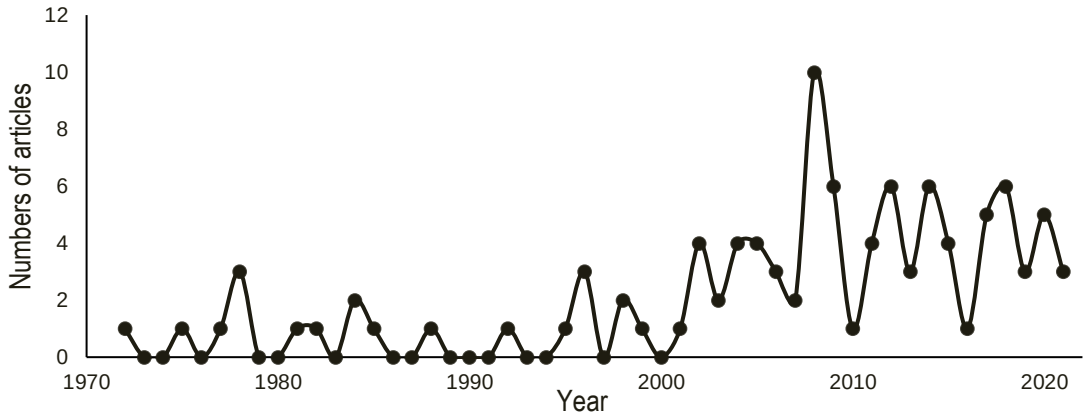


Figure 1. The number of articles on *Dormitator latifrons* from 1972 to 2021.

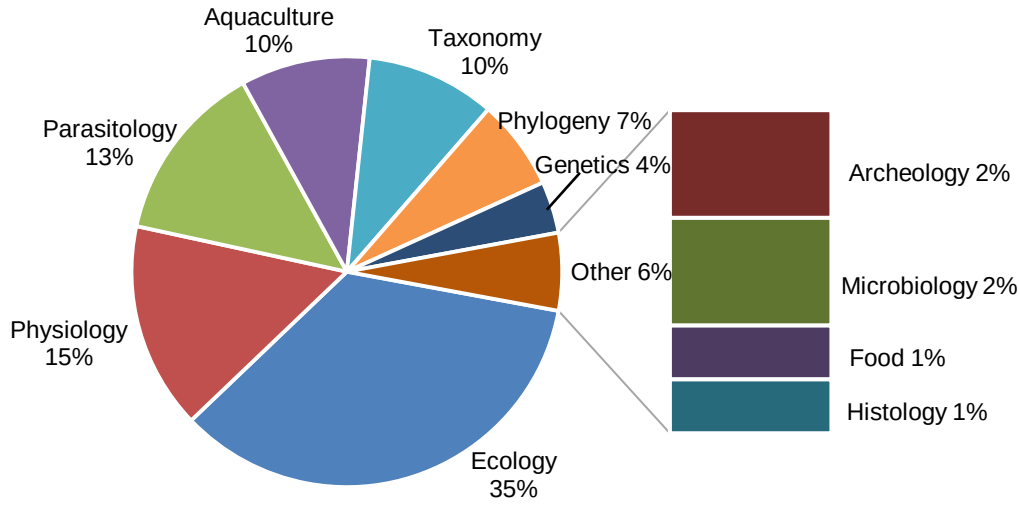


Figure 2. Themes in the scientific publications on *Dormitator latifrons*.

research in India. Nikolic et al. (2011) perform a bibliometric analysis of the evolution of scientific productivity in seven diadromous fish; they analyze the total number of research (articles, books, and conferences) in all countries in the function of each main field of knowledge. In general, these studies show where there is greater intensity of research, the economic impact by species, and in turn, help to generate a support framework for the management of the species conservation plan.

The species of the genus *Macrobrachium* share socioeconomic characteristics very similar to *Dormitator latifrons*. A particular case happens with Chong-Carrillo et al. (2015, 2016, 2018a,b,c), which report different scientometric approaches in prawns from the *Macrobrachium* genus. Some species are already cultivated on an industrial scale, such as *M. rosenbergii*, and others, such as *M. tenellum*, are in stages of technological development (Chong-Carrillo et al. 2015, 2016, 2018a,b,c). Prawns of the *M. tenellum* species, like the *D. latifrons* fish, occasionally appear in local and regional markets and tourist centers, are consumed fresh or cooked, and can even be used as bait (Vega-Villasante et al. 2011). It is a product that can be grown in freshwater; its fishing and culture are of great importance especially in areas far from the coast, where saltwater is not readily available to rural communities (García-Guerrero et al. 2013). While such attributes can be almost completely transferred to *D. latifrons*, research directed at the genus *Macrobrachium* is undoubtedly far superior to research. The above even when we restricted only to the native species of Mexico. However, and leaving aside the biological importance, despite the economic and social importance that it represents at the regional level, the scientific production of the species *D. latifrons* is scarce, with only 103 publications.

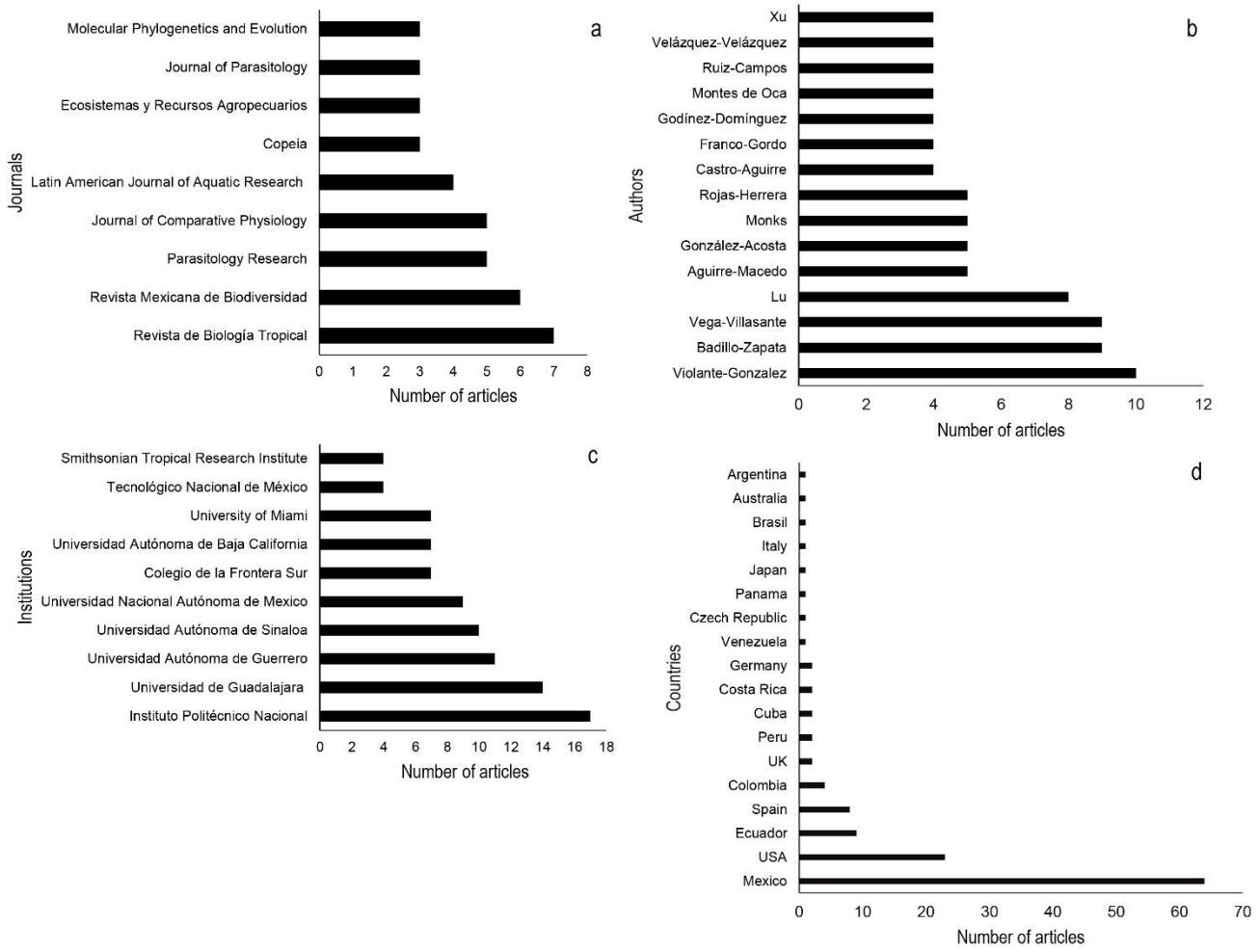
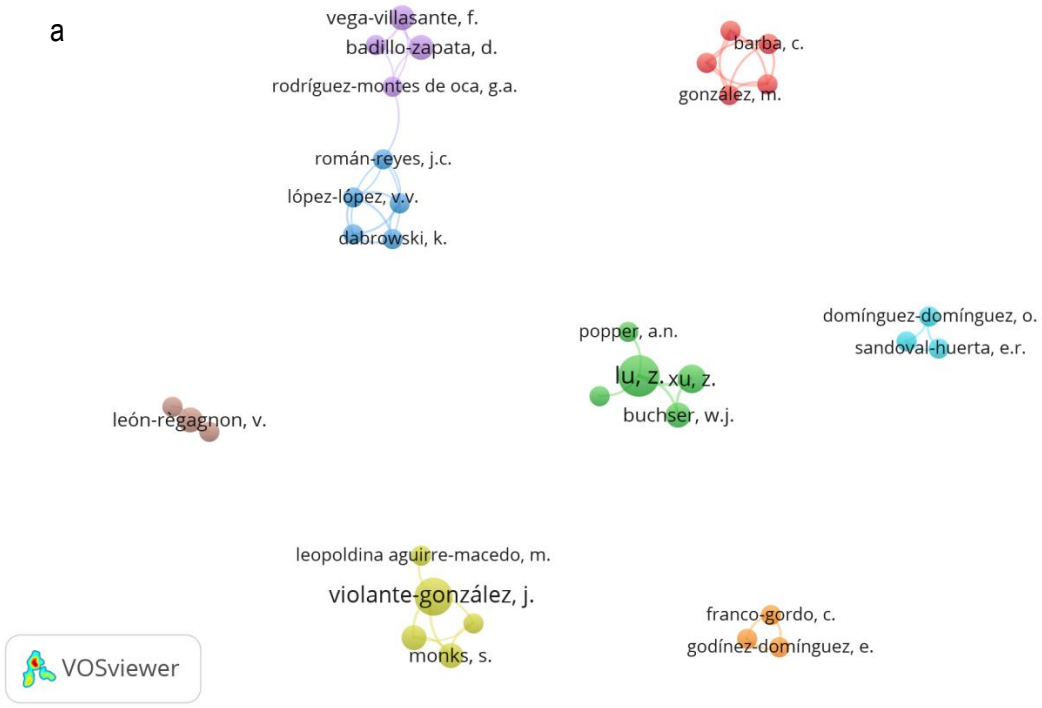


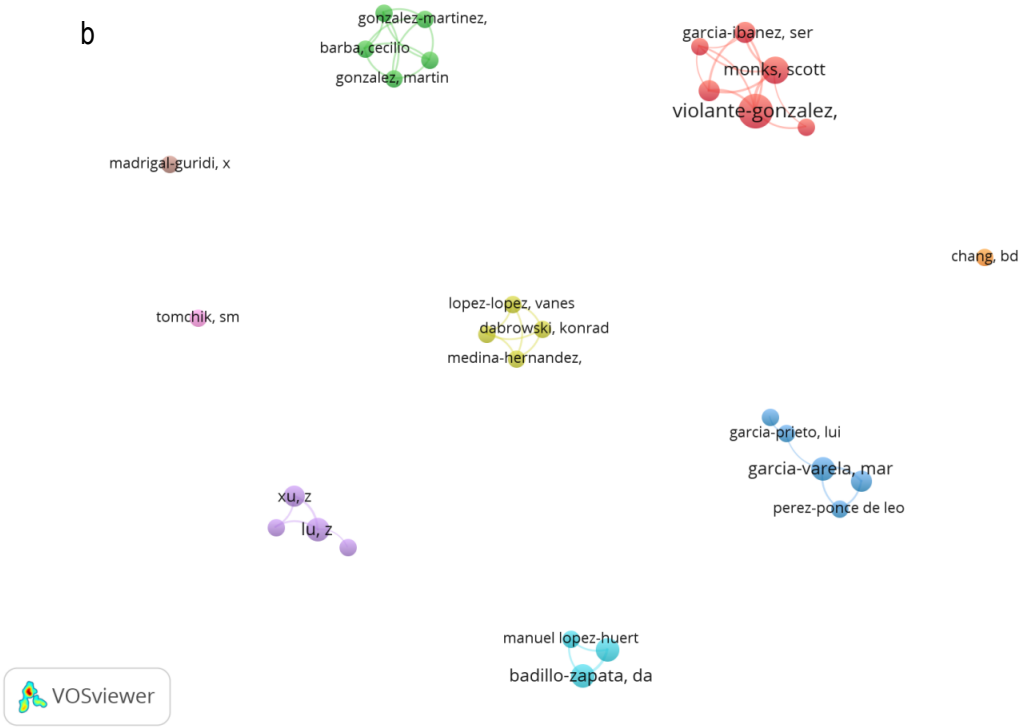
Figure 3. a) Main journals that contribute the greatest number of publications to the knowledge of the species *Dormitator latifrons*, b) main authors who contribute the most to the knowledge of the species, c) institutions that contribute to the knowledge of the species, d) countries that contribute to the knowledge of the species.

Scientific research on the species *D. latifrons* registered in the databases corresponds to almost half a century. There has been an increase in scientific production from 2000, with a tendency to increase, denoting a new interest in the species, perhaps from new generations of scientists. Ecology and parasitology are the scientific areas that contribute the most information to the knowledge of the species. Although these areas can support the management plans of the species, information on *D. latifrons* is scarce since no study or government report refers to the current situation of its fishery.

The studies on aquatic species are fundamental to solving some of the current global problems (FAO 2020). In Latin American countries, hunger affected 47.7 million people; if this continues, the forecasts for the year 2030 would be around 67 million people, 20 million more than in 2019 (FAO 2020). Consequently, government institutions and organizations have emphasized including them in global decisions. The Food and Agriculture Organization of the United Nations (FAO) already incorporates aquaculture as a fundamental axis to solve poverty and hunger in developing countries; this implies, within its guidelines, the study of aquatic species (FAO 2020). *D. latifrons* possess the characteristics that position them as an excellent candidate to be integrated into a species with the potential to contribute to solving the regional hunger problems. In this sense, Basto-Rosales et al. (2019) showed that *D. latifrons* have the protein requirements necessary for a human diet. In turn, argue the exploitation of this resource for rural communities.

Concerning the above, there is not enough information to allow a comprehensive advance in developing cultivation technology for the species. There are wide gaps to fill in practically all areas related


a
vega-villasante, f.
badillo-zapata, d.
rodríguez-montes de oca, g.a.
román-reyes, j.c.
lópez-lópez, v.v.
dabrowski, k.
barba, c.
gonzález, m.
domínguez-domínguez, o.
sandoval-huerta, e.r.
popper, a.n.
lu, z. xu, z.
buchser, w.j.
león-regagnon, v.
leopoldina aguirre-macedo, m.
violante-gonzález, j.
monks, s.
franco-gordo, c.
godínez-domínguez, e.
VOSviewer


b
gonzalez-martinez,
barba, cecilio
gonzalez, martin
garcia-ibanez, ser
monks, scott
violante-gonzalez,
madrigal-guridi, x
chang, bd
tomchik, sm
lopez-lopez, vanes
dabrowski, konrad
medina-hernandez,
garcia-prieto, lui
garcia-varela, mar
perez-ponce de leo
xu, z
lu, z
manuel lopez-huert
badillo-zapata, da
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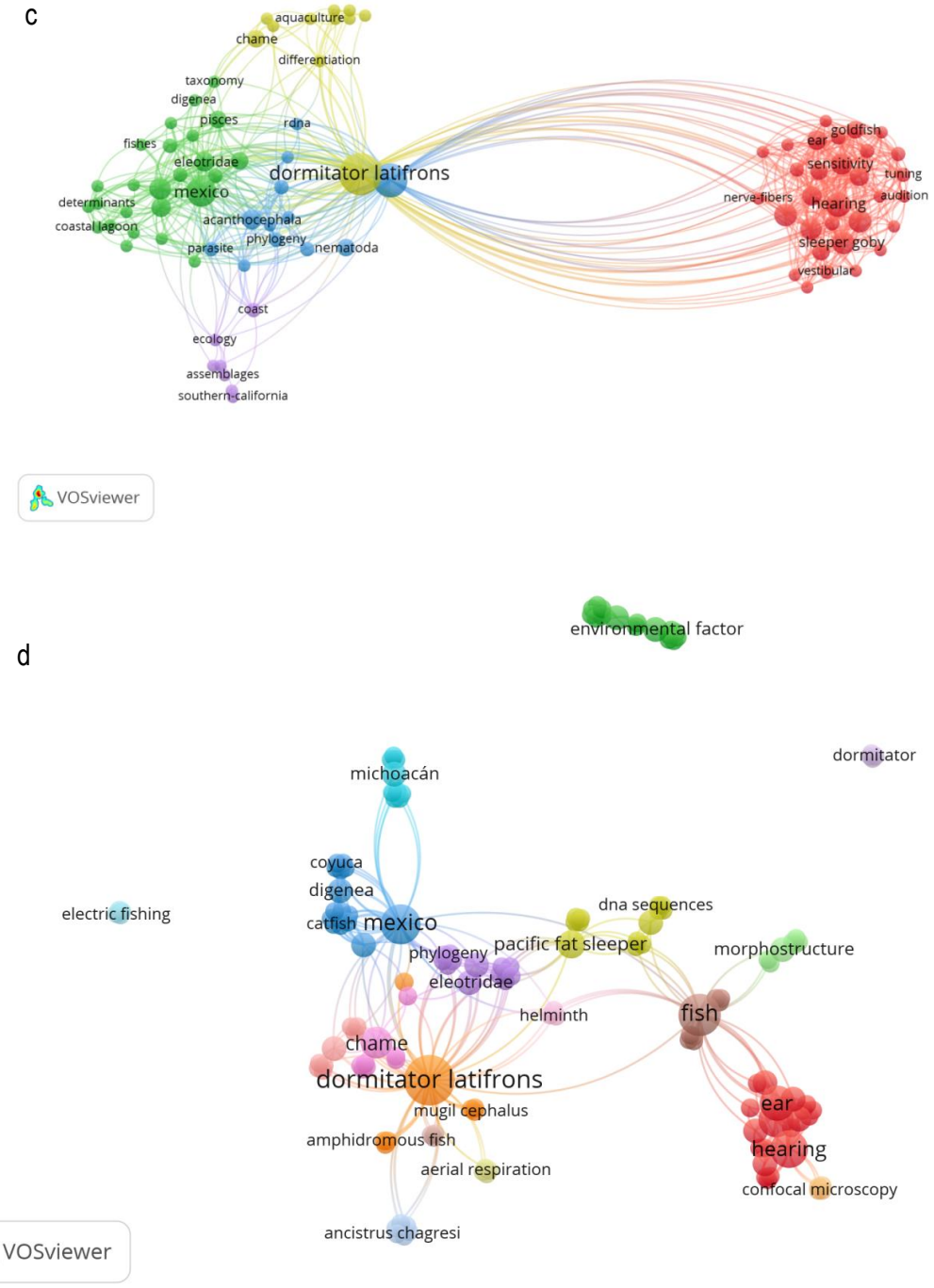

Figure 4. Co-author co-occurrence maps, with the database provided by a) Scopus and b) Web of Science, and keyword co-occurrence maps with c) Scopus and d) Web of Science.

to the aquaculture of the species. The aquaculture area only represents 10% of the information generated and corresponds to nutrition, growth, and reproduction topics. Published works on the elaboration of diets (Badillo-Zapata et al. 2018, 2021), stocking densities (Basto-Rosales et al. 2019), and aspects of spawning

and assisted reproduction (Rodríguez-Montes de Oca et al. 2012), are among the few that can be mentioned. Along with the present work, Vega-Villasante et al. (2021) have presented a review that systematizes the existing scientific knowledge about this species. It is comparable to this work since the authors show that epistemological gaps must be filled to efficiently manage *D. latifrons*' wild populations and conserve and cultivate them successfully (Vega-Villasante et al. 2021).

Parasitology topics support developing experimental designs that allow combating parasites associated with the species and can be presented in a cultivation system. Such as the example of the work of Vega-Villasante et al. (2017) that reports the presence of the ectoparasite *Argulus* sp. in *D. latifrons* during a culture, in general, his study addresses mortality and treatment against this parasite. In general, there is a basis of the state of the art of the species, giving basic guidelines that help aquaculture grow juveniles. The knowledge generated to date helps define the ideal density for a species culture (Basto-Rosales et al. 2019) and the protein and lipid requirements for designing juvenile diets (Badillo-Zapata et al. 2018, 2021). In their study, there are small advances in the reproduction of the species. Rodríguez-Montes de Oca et al. (2012) obtained gametes and larvae under laboratory conditions and determined the optimal condition for reproduction under certain parameters.

Ecology studies refer to it being an abundant species, diadromous of the amphydromic group, which spawns in freshwater, where the larvae migrate to the sea, to later return to freshwater to complete its development (Milton 2009). *D. latifrons* can occupy different bodies of water. Therefore, it makes it susceptible to being exposed to pollutants products of human activity. Rodríguez-Amador et al. (2012) report high levels of heavy metals in *D. latifrons* fish collected in a lagoon system in Mexico. In addition to the problem of environmental contamination, there is a potential human health problem, which is why it is necessary to undertake ecotoxicology studies in regions where there is the possibility of exploitation for human consumption.

The results obtained show that the co-authorships have been established with Europe (Spain, UK, Germany, Czech Republic, and Italy), Asia (Japan), and Oceania (Australia) (Fig. 3d). However, there are no strong connections between the groups or authors (Figs. 4c-d). The preceding suggests sporadic, circumstantial but not constant, and systematic collaborations between groups of experts, making the advancement of knowledge in specific areas more complicated.

Co-authorship co-occurrence maps revealed the existence of 8-9 clusters related to *D. latifrons*. These can be considered the only representative; since the analysis projected from the commercial databases (Scopus and Web of Science) represent only 70% of all the information generated on the species (Figs. 4a-b). The co-authorship clusters are well established by subject area, i) Violante-Gonzalez, which focuses on community ecology studies; ii) Badillo-Zapata and Vega-Villasante, in aquaculture, with nutrition and growth; iii) Lu and Xu, with studies in auditory physiology; and iv) Barba and González-Martínez, who study some aspects of population ecology. It is evident in both co-authorship maps (Figs. 4a-b) that there are no bridges or connections between these research groups. However, in that order, there is a collaboration between authors from Latin American institutions with those of the USA, Spain, England, and Germany (Fig. 3d).

The keyword co-occurrence maps project that the most prominent terminological nucleus is "*Dormitator latifrons*" since the bibliometric search starts from this, so here it is convenient to analyze the strongest lexical bridges of the rest of the keywords that exist in Scientometrics of the species. For both databases, strong densities appear for words such as fish and Mexico, typical of ecology studies; and words such as hearing, ear, otolithic organ, and saccular efferent, for the works that correspond to the auditory physiology of the species (Figs. 4c-d). There are other convenient words to mention, such as those for the common names of the species: chame, pacific fat sleeper, and sleeper goby, or words that would allow a better search to be filtered, such as Eleotridae, amphidromous fish, and electric fishing. In the parasitology section, words such as parasite, helminth, and Nematoda are projected (new species of parasites have been identified in this fish). Words such as phylogeny and DNA sequences appear in lower density, related to recent genetics studies, specifically works on phylogeny and molecular biology, respectively.

The current panorama of the study of *D. latifrons* presented in this work leaves three points exposed: i) the main topics addressed are related to ecology, ii) there is no solid collaborative relationship between the scientific community, and iii) the information generated is insufficient for the conservation and exploitation of the resource. Given the scenario presented, it is essential to increase the study of thematic areas that allow their comprehensive management in the medium term. Knowing the status of their populations is essential as a fishing resource. Addressing its reproduction under laboratory conditions, including the larviculture cycle to produce juveniles, as well as beha-

vior, food and nutrition, cultivation systems, and meat processing, are aspects that must be addressed to achieve its proposal as a food alternative for unprotected sectors. Promoting and reinforcing collaboration between countries and institutions involved in the scientific production of *D. latifrons* will undoubtedly help promote knowledge about this species, which, in the future, will allow the development of technologies that enable its cultivation and conservation.

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