

A BIBLIOMETRIC ANALYSIS OF PUBLICATIONS IN STUDIES OF THE BIOINDICATOR SPECIES OF HUMAN IMPACTS *Emerita brasiliensis* SCHMITT, 1935 (DECAPODA: HIPPIDAE) IN 20 YEARS

ANÁLISE BIBLIOMÉTRICA DE PUBLICAÇÕES EM ESTUDOS DA ESPÉCIE BIOINDICADORA DE IMPACTOS HUMANOS *Emerita brasiliensis* SCHMITT, 1935 (DECAPODA: HIPPIDAE) EM 20 ANOS

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Abstract

This work corresponds to an analysis of the scientific production on the species *Emerita brasiliensis* Schmitt, 1935 through bibliometric indicators. *Emerita brasiliensis* is a decapod crustacean belonging to the Hippidae family. This species inhabits the intertidal benthic zone of beaches and, despite being distributed in great abundance along the Brazilian coast, has been suffering anthropic impacts on its habitat. The research object was chosen due to the need to understand the level of knowledge about the characteristics of this organism, which point to it as a potential bioindicator, in addition to having great ecological importance on sandy beaches and having considerable relevance in marine food chains. Bibliometric research is a method of quantitative analysis on a given subject. Through this method, it was possible to detect different lines of research on the subject, recognize limitations and determine patterns to research on this species. The collected data expose the contribution of the scientific community to that area of study. Thus, the objective of this study is to evaluate the scientific production on the species *Emerita brasiliensis* based on the analysis of articles published in journals or conference proceedings indexed in the Scopus database. The amount of information collected corresponds to a search of articles published over the 20 years (1981-2021).

Palavras-chave: Tatuí. Biological Indicator. Behavioral Ecology. Literature Review.

Resumo

Este trabalho corresponde a uma análise da produção científica sobre a espécie *Emerita brasiliensis* Schmitt, 1935 através de indicadores bibliométricos. O *Emerita brasiliensis* é um crustáceo decápode pertencente à família Hippidae. Esta espécie habita a zona bentônica entremarés de praias e, apesar de estar distribuída em grande abundância ao longo da costa

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brasileira, vem sofrendo impactos antrópicos em seu habitat. A escolha do objeto de pesquisa ocorreu pela necessidade de compreender o nível de conhecimento sobre as características deste organismo, que o apontam como potencial bioindicador, além de possuir grande importância ecológica nas praias arenosas e ter considerável relevância nas cadeias alimentares marinhas. A pesquisa bibliométrica é um método de análise quantitativa sobre um determinado assunto. Através deste método foi possível detectar diferentes linhas de pesquisa sobre o tema, reconhecer limitações e determinar padrões de pesquisa nesta espécie. Os dados recolhidos expõem a contribuição da comunidade científica para aquela área de estudo. Assim, o objetivo deste estudo é avaliar a produção científica sobre a espécie *Emerita brasiliensis* a partir da análise de artigos publicados em periódicos ou anais de congressos indexados na base de dados Scopus. A quantidade de informação recolhida corresponde a uma pesquisa de artigos publicados ao longo de 20 anos (1981-2021).

Keywords: Tatuí. Indicador biológico. Ecologia Comportamental. Revisão da literatura.

1. INTRODUCTION

The sandy beaches constitute one of the largest landscapes in Brazil, being an environment that runs along the entire coast and among all the coastal environments present in the world, the beaches are the most frequented and occupied by man. As transitional ecosystems between continents and oceans, beaches have a great ecological and economic importance, being the habitat of dense benthic biodiversity. Thus, they constitute dynamic ecosystems located at the interface between land and sea and comprise most of the coastline of tropical and temperate regions (MALFATTI, 2016).

Among the ecosystem services provided by the beaches, regulation and/or support services stand out - such as the natural retention of sediments, recharge of aquifers, control and storage of water, assimilation and recycling of pollutants, dissipation of wave energy and the protection in the natural shore area -; provision services - such as natural food production, food production in cultivated areas, water resources, ornamental resources and genetic/medicinal resources; and information and culture services - such as ecotourism, cultural and/or historical tourism, recreation and leisure, and scenic attractiveness (SILVA; PAULA, 2017).

The population density of coastal cities has been growing more and more and the occupation of coastal cities in Brazil has intensified in recent decades around three development priorities: urbanization, industrialization and tourist exploitation (MORAES, 2007). The growing real estate speculation, mining with removal of sand from beaches and dunes, and the explosive and disorderly growth of tourism without any environmental planning and investments in infrastructure (AMARAL *et al.*, 2002) set the tone of strong environmental degradation to this habitat.

Brazil has one of the longest coastlines in the world - about 8,000 km -, along which are found the most varied types of beaches. Due to rapid economic growth and real estate speculation, Brazilian beaches are constantly impacted, resulting in a high risk of biodiversity loss and environmental imbalance (ROSA FILHO *et al.*, 2015).

Many crustacean species that live in this habitat are reliable indicators of ecosystem stability (PETERSON; HICKERSON; JHONSON, 2000), and the researchers' studies can be used as biological indicators of beach stability, aiding in coastal management and planning processes. Thus, possible changes in the structure and population dynamics of benthic fauna can help to



assess the ecological status of beaches, in addition to contributing to the planning, management and environmental monitoring of coastal regions (COUTINHO, 2013).

Among the crustaceans that live on sandy beaches, *Emerita brasiliensis* stands out. It is a common mole crab called "tatuira" or "tatuí" in Brazil. They are organisms of the genus *Emerita* belonging to the group of decapods. They are abundantly distributed on most of the sandy beaches of Rio de Janeiro, being one of the most abundant species of macrofauna on the beaches of the state. (VELOSO; CARDOSO, 2001). But they are also distributed throughout the Brazilian coast, also being found in long stretches of the coast of South America and North America. Located between the mean level of low tide and the mean level of high tide, the intertidal zone of exposed sandy beaches is home to this organism, which is among the important species in structuring macrofaunistic communities.

The use of this organism as a bioindicator allows an integrated assessment of the ecological effects caused by different means of pollution. Thus, its use as a biological indicator is as efficient as instantaneous measurements of physical and chemical parameters that are normally measured in the field and used to assess water quality (CALLISTO; GOULART, 2003). Spritzer, Barbosa and Batista-da-Silva (2015), conducted a study at Praia do Leblon, located in Rio de Janeiro, surveying three different points. It is important to point out that this beach has free access and many visitors, producing great anthropic pressure on this environment, especially in summer. At point 1 there was a negative disparity of *Emerita brasiliensis* individuals in relation to the other two points. The mentioned point is close to a rocky shore and has a strong occurrence of domestic pollutants disposed of in the open on the sand (SPRITZER; BARBOSA; BATISTA-DA-SILVA, 2015). Point 2 has a greater abundance of individuals compared to point 3 - which also has a sewage dump. Therefore, point 2 was the one with the highest abundance of *Emerita brasiliensis*, possibly due to the greater distance from the sewage discharge points (SPRITZER; BARBOSA; BATISTA-DA-SILVA, 2015).

The available knowledge about coastal biodiversity is still limited. The consequent lack of scientific dissemination and surveys of faunal information not only hinders the research of environmentalists, but also causes distance between bathers and the species that inhabit there (AMARAL *et al.*, 2002). Through this research, it was possible to show that there is still a long way to go for environmental scientists to establish a better relationship between coastal biodiversity and environmental preservation policies. Thus, the need arises to research these species and their relationship with the environment in order to subsidize and generate theoretical support for policies for the preservation of these organisms.

2 DEVELOPMENT

2.1 The bibliometric method

Bibliometrics was systematized as a scientific method based on the efforts of Hulme (1923) and Lotka (1926) and was initially called statistical bibliography because it is a set of techniques whose objective is to quantify the process of written communication (SILVA *et al.*, 2016). The method has been used by scientists to verify the contribution of the main authors in a given area, detect currents of thought and even the main journals. Thus, bibliometric studies focus on examining the production of articles in a given field of knowledge, mapping academic communities and identifying networks of researchers and their motivations (CHUEKE; AMATUCCI, 2015).



This type of study enables the development of systematic work that facilitates pointing out paths for research in certain areas, understanding their strengths and weaknesses. Silva *et al.*, (2016) indicates that this type of study has become popular among academics due to the large amount of bibliographic material that is currently produced and available. develop a particular scientific sector. Thus, it is worth noting that the creation of measures and indicators of scientific and technological production also become part of the government's agenda as part of the process of elaborating the countries' development policies (CHUEKE; AMATUCCI, 2015).

Bibliometric studies can collaborate in the task of systematizing research carried out in a given field of knowledge and addressing problems to be investigated in future research (CHUEKE; AMATUCCI, 2015). We see that systemic literature reviews, as in the case of bibliometrics, serve as cartography to map the origins of existing concepts, point out the main theoretical lenses used to investigate a subject and raise the methodological tools used in previous works (CHUEKE; AMATUCCI, 2015). (CHUEKE; AMATUCCI, 2015) suggests that the collection period for evaluating a particular field of study is between 15 and 20 years. Thus, the present work will use the time frame of 20 years in its collection of information.

2.2 Sandy beaches

The coastal zones of temperate and tropical zones are mostly composed of sandy beaches and, although these places are conceived by the popular imagination as leisure spaces or spaces of economic value - especially of real estate capital -, these places are responsible for providing a range of ecosystem services such as fishing and coastal harvesting or coastal protection. Part of this population carries out activities, directly or indirectly, linked to tourism, oil and natural gas production, fishing and services that meet the economic dynamics generated by these municipalities and others nearby (IBGE, 2012).

Associated with sandy beaches, there are other ecosystems of extreme importance for the maintenance of coastal biodiversity, such as restingas, mangroves, deltas, lagoons, rivers and rocky shores. Therefore, beaches constitute dynamic ecosystems located at the interface between land and sea and comprise most of the coastline of tropical and temperate regions (MALFATTI, 2016). Possessing a great diversity of species, beaches are dynamic ecosystems located at the interface between land and sea and cover most of the coast of tropical and temperate regions (MALFATTI, 2016), however, the false impression of a desert environment comes from the fact that many of these species are reduced in size and live buried, in some cases among the tiny grains of sand, throughout their life or part of it (ROSA FILHO *et al.*, 2015).

The population's lack of knowledge about this biota increases the impression of a desert location. However, representatives of different phyla can be found in the sand of beaches, such as cnidarians, turbellarians, nemertes, nematodes, annelids, molluscs, equiurids, sipunculids, arthropods, pycnogonids, brachiopods, echinoderms, hemicordates and vertebrates (ROSA FILHO *et al.*, 2015).

Due to historical factors of occupation of the territory, Brazil follows the same trend as many other countries in relation to population density in locations close to the coast. According to surveys carried out by the IBGE (2012), around 26.6% of the Brazilian population lived in municipalities classified as coastal in 2010, that is, this represented a total of 50.7 million inhabitants close to the coast. . Therefore, sandy beaches constitute one of the largest ecosystems on the entire Brazilian coast (ROSA FILHO *et al.*, 2015).

2.3 Bioindicator organisms and behavioral ecology



The environmental impact and anthropic actions since the industrial revolution have been modifying and destroying ecological chains and bringing countless damages to nature, today lacking information and biomonitoring tools for environmental analysis, being difficult to obtain and evaluate the effects of environmental degradation, showing a great challenge for current science (SILVA *et al.*, 2007). Ecology can be understood as the study of the relationships between living organisms and the environment. Understanding these relationships as having a double meaning, that is, organisms affect and are affected by each other, as well as affect the environment and are affected by it (DEL-CLARO, 2010).

Hence, behavioral ecology is a type of approach that reveals the ecological and evolutionary bases of behavior, experimentally demonstrating the action of a given act on the adaptive value of an individual (DEL-CLARO, 2010). Thus, an indicator is a characteristic of the environment that, when measured, quantifies the magnitude of stress, characteristics of the habitat, degree of exposure to the stressor, or even the degree of ecological response to exposure (PRESTES; VICENCI, 2019). Species that have this ability to respond positively or negatively to environmental impacts are classified as bioindicators (HOLT; MILLER, 2010).

Living beings known as bioindicators usually have the ability to infer about environmental quality, as their punctual responses according to their presence or absence in a given area are easy to perceive (CALLISTO; GONÇALVES-JÚNIOR; MORENO, 2005). Thus, the term “bioindicator” is a generic term used to designate living beings that have these characteristics, and can be found in different environments around the world, and in the most diverse types of habitats (CONTI, 2008).

The use of a given taxon as a bioindicator must verify a list of characteristics such as the reproductive behavior in its environment, its sensitivity to habitat changes and its wide distribution. The organism must have four basic characteristics: feasibility, economic sampling, easy and reliable identification, functionality and respond to disturbances in a consistent manner (PRESTES; VICENCI, 2019). Hence, It is very important that a sensitive biological indicator is used to monitor and detect signs of stress in populations, before they suffer changes in their “fitness” and irreversible demographic damage (MICHAELSEN; SCHAEFER; PETERSON, 2015).

From this perspective, the advantages of using biological indicators over conventional methods - such as the analysis of physical and chemical parameters in the field - provide speed and accuracy in obtaining low-cost data and results (QUEIROZ; TRIVINHO-STRIXINO; NASCIMENTO, 2000). The study, monitoring and behavioral assessment of these organisms can be considered efficient methods of contributing to improving the quality of life and maintaining the environment, as their knowledge can generate mobilization and immediate intervention (CONTI; CECCHETTI, 2001). Therefore, organisms used as bioindicators are usually sensitive to environmental changes, which can affect the physiology, morphology and behavior of individuals, population density or even the richness, diversity and composition of biological communities (ARIAS *et al.*, 2007).

2.4 *Emerita brasiliensis*

Many crustacean species are reliable indicators of ecosystem stability (PETERSON; HICKERSON; JHONSON, 2000), and researchers' studies can be used as biological indicators of beach stability, aiding in coastal management and planning processes. In this sense, crustaceans have been well used as bioindicators of anthropogenic impacts on sandy beaches, as they allow a short-term assessment of responses to environmental stress (WENNER, 1988).



In the intertidal zones it is common to find the decapod crustacean of the infraorder anomura of the species *Emerita brasiliensis* which, despite having great ecological plasticity, suffers impacts on its reproduction due to anthropic factors at medium and long term scales, and may present changes in its distribution and structure populational. The *Emerita brasiliensis* are frequently and abundantly distributed in their habitat along the southwest coast of the Atlantic Ocean, especially on subtropical and temperate beaches with dissipative characteristics (NAKAGAKI; PINHEIRO, 1999).

The *Emerita brasiliensis* is of great importance in marine food chains, especially in the intertidal and benthic zones, being an important food component of predators such as gastropods of the genus *Olivancillaria* and *Buccinanops* - such as marine snails and molluscs -, and marine birds of the genus *Calidris*, *Zonibix* and *Larus* (GIANUCA, 1983).

The cycle of life of the species of genus *Emerita* gives the group a great capacity to act as bioindicators, as they live in close association with the environment (LERCARI; DEFEO, 1999). The presence of *Emerita brasiliensis* is also an indicator of the environmental quality of the beaches, because when polluted, they usually present this species.

Lercari and Defeo (2003) states that *Emerita brasiliensis* populations suffer long-term anthropogenic impacts on beaches, responding with a change in their population structure and distribution. So, these characteristics allow this species to carry out an environmental assessment of the level of ecological stress in its habitat (CALLISTO; GOULART, 2003).

Its reproductive cycle is seasonal, starting in spring and continuing until late summer (GIANUCA, 1983). Females generally do not spawn in winter, but Veloso *et al.* (1995) detected the presence of females spawned continuously during all seasons of the year, at Praia de Fora, in Rio de Janeiro. Through complementary studies (VELOSO *et al.*, 1995) - based on data previously obtained by Gianuca (1983) - it was possible to see a continuous pattern from the presence of ovated females and megalopae during all seasons of the year - for Praia de Fora, in the neighborhood of Urca, in Rio de Janeiro.

In 2015, Spritzer, Barbosa and Batista-da-Silva (2015) found that at “Praia do Leblon” (RJ) the largest population increase of the species occurred in winter and not in summer. Therefore, it was possible to verify that this species is able to adopt a differentiated reproductive strategy in regions with large temperature variations, interrupting the reproductive cycle when conditions are unfavorable (MALFATTI, 2016). Even showing resilience to climate variability to extend their reproduction period, the number of individuals of *Emerita brasiliensis* has been increasingly reduced on the most urbanized beaches of the Brazilian coast, not being able to resist the various anthropic impacts on their habitat (SPRITZER *et al.*, 2015).

In 2011, a survey of the biomass of benthic macroinvertebrates was carried out on Tramandaí beach, Rio Grande do Sul (LUIZ; OZORIO, 2011). In this study, researchers compared two environments with different degrees of urbanization. From this study, it was possible to verify that the lowest biomass values were associated with places of greater occupation when compared to places with less anthropogenic pressure.

These results indicate a relationship between population structure, reproductive behavior and distribution patterns of macroinvertebrates that inhabit the intertidal zone and the urban phenomenon present on the beaches. The amount of changes in morphological characteristics can be considered a way to assess the environmental quality and instability of individuals' development in a given environment (WELLER; GANZHORN, 2004).

Through urbanization parameters it is verified that these influence the population descriptors of this species (MALFATTI, 2016). Human impacts generate stressful conditions for organisms that reside in benthic zones and reduce the environmental quality of beaches



(CARDOSO *et al.*, 2016). From this perspective, studies have demonstrated the relevance of using benthic communities in the assessment of environmental quality (VAN LOON *et al.*, 2015). Hence, the *Emerita brasiliensis* can reach high productivity values and Benke (1993) emphasizes the importance of studies on the secondary production of invertebrates.

3. MATERIAL AND METHODS

To carry out the bibliometric survey, the VosViewer program was used. It is a software that creates maps of thematic relevance from the proximity between conceptual approaches, keywords, grouping of citations and references, journals and countries.

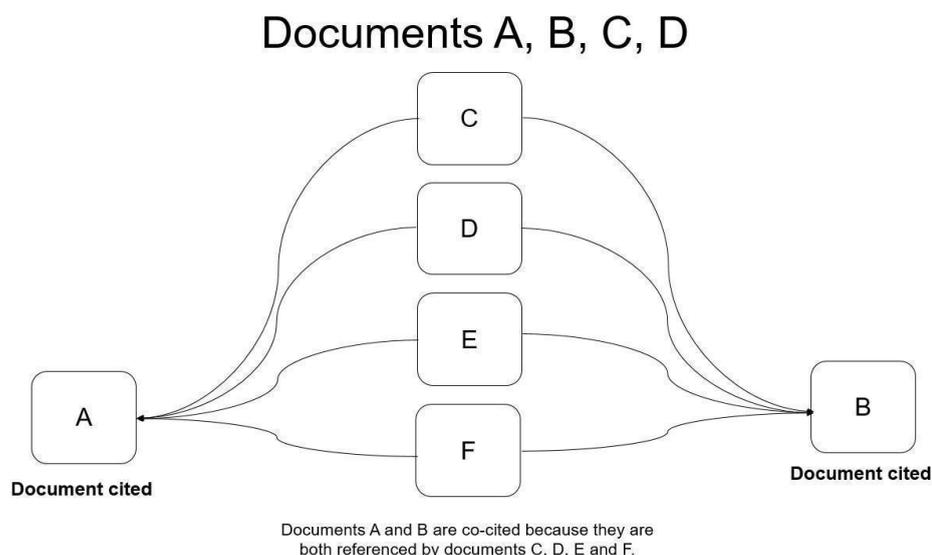
In this way, networks of co-citations were created through the analysis of articles. For this, a bibliographic survey of the Scopus database was carried out due to its relevance of publications of academic works. Grácio (2016) states that co-citation identifies the link / similarity of two cited documents through their frequency of occurrence together in a reference list of citing authors. Thus, the intensity of co-citation between two articles is determined by the number of publications in which the two articles are cited together. Initially, the compared articles may seem distant, but their connections appear from the moment they are cited together. In the present work, a general selection of articles was made using the keyword "*Emerita brasiliensis*". Selection filters were not used for the research, such as grouping by areas of knowledge, but a temporal filter was used (such as selection of years).

Before carrying out the bibliometric evaluation, it is necessary to have knowledge about the topic to be analyzed. From this, it is necessary to determine the keywords for your search, as they must be related to the research topic. Next, it is necessary to define the parameters used in the search, such as: area and subarea of the research, year of publication, type of journal in which the work was published, among others. It is possible to carry out this type of research in other journals, such as Web Of Science. (SILVA *et al.*, 2016). Both databases are already prepared for bibliometric research with information on the number of citations of each article, relevance of journals, among others.

In the present work, a general selection of articles was made using the keyword "*Emerita brasiliensis*". The search focused on articles published over 20 years, during the years 1981 to 2021.

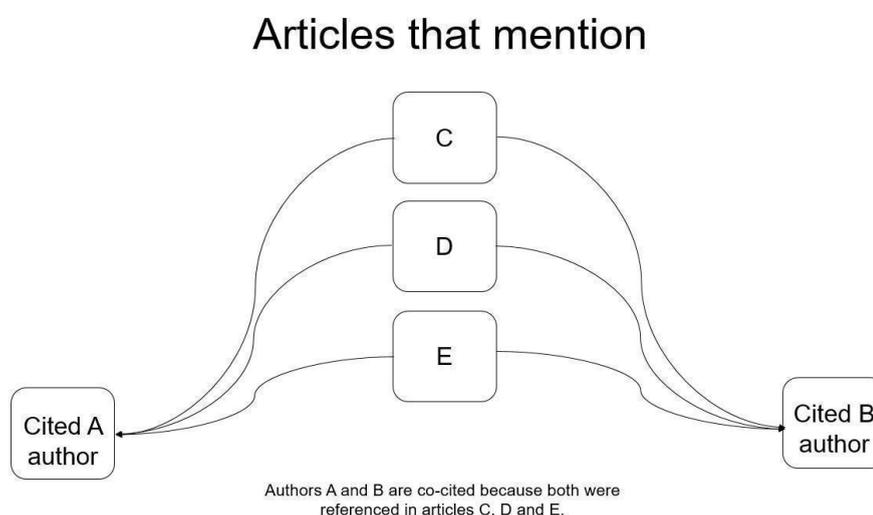
A CSV file was generated and imported into the VosViewer software and maps were generated in it. Manipulating the software, tools were used that work with the following variables: works with a greater number of co-citations, keywords and the most used main authors, mapping and dividing the results into clusters of different colors - which represent different ideas and currents of thought about the topic analyzed. The clusters were divided by red, green and blue colors. The maps were generated in the following variables: co-citation of articles; co-citation of authors; most cited keywords; Countries that publish the most in studies.



Figure 1: Co-citation of articles scheme

Source: Adapted from Mattos and Dias (2010)

In the co-citation of articles scheme, the more works are cited together, the greater the chances that their content and methodology are related. It may be that at the time of publication both articles do not appear to be methodologically and conceptually connected, but their links may appear and grow over time as these articles are jointly cited in the scientific literature.

Figure 2: Authors' co-citation scheme

Source: Adapted from Mattos and Dias (2010)

The method of analyzing the author's co-citation, on the other hand, identifies the link between one author and another. This variable is not intended to specify the works in which the compared authors are cited, but rather to identify the joint citation of both authors.

4. RESULTS AND DISCUSSION

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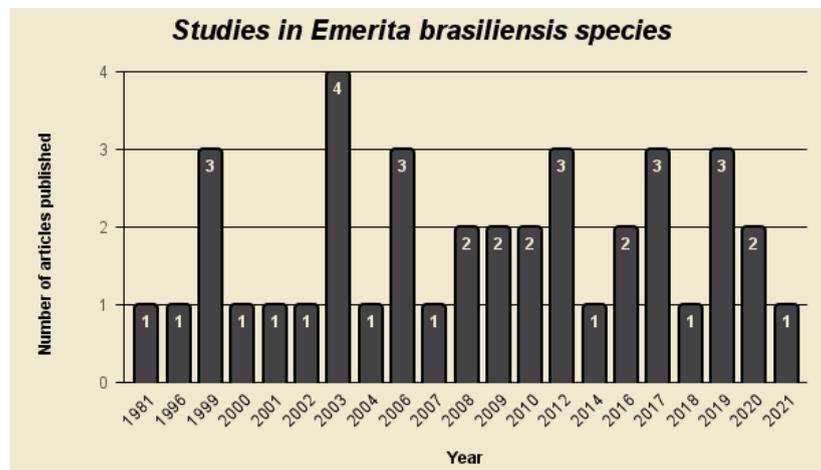
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Through this research, it was possible to detect 39 articles published by Scopus between 1981 and 2021. Of these 39, it was possible to divide them into 3 lines of research.

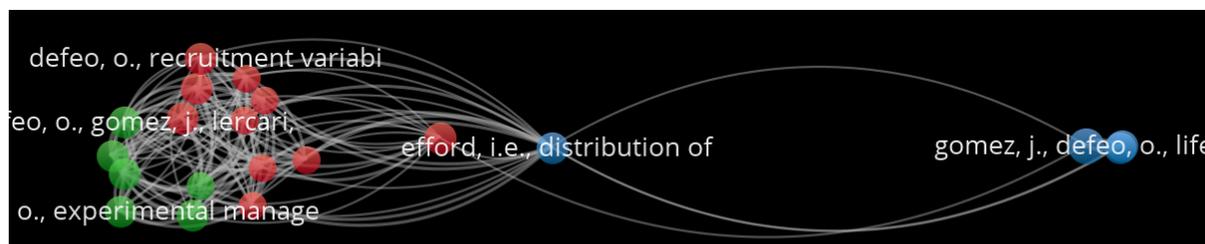
Graphic 1: Chronology of publications on the species *Emerita brasiliensis* between the Years 1981 and 2021



Source: SCOPUS Base

The chart above shows the chronological evolution of published works on the species *Emerita brasiliensis*.

Figure 3: Co-citation map of works on the species *Emerita brasiliensis*



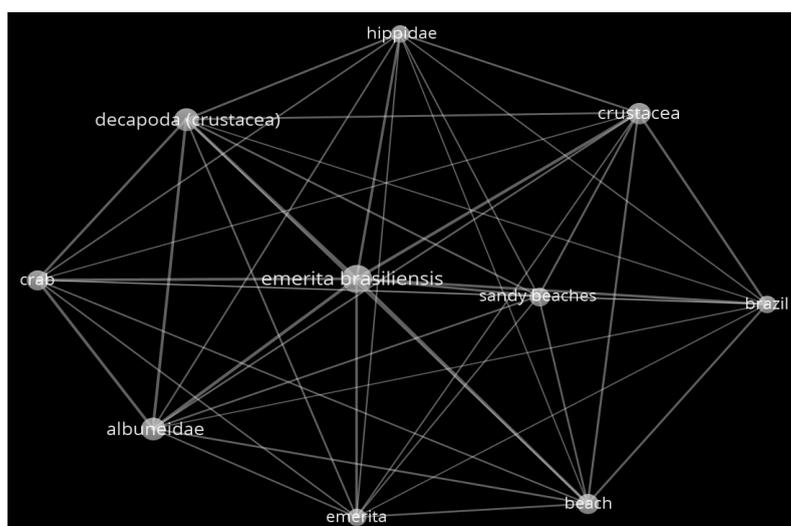
Source: developed from the SCOPUS Base using VosViewer software

The map above shows the 20 works with the highest number of co-citations in articles on the species *Emerita brasiliensis* in the last 20 years. It is important to highlight that 50% of the works in the blue cluster are also present in the red cluster and 25% are present in the green cluster, indicating that it is a cluster that mixes research lines and methods from both clusters.

Chart 1: referring to the clusters of the co-citation map of works on the species *Emerita brasiliensis*

Cluster	Main Contributions	Main concepts studied
Red	This cluster groups articles that aim to deepen concepts and values such as abundance, distribution, biomass and population structure, relating these variables to external elements - such as anthropogenic influence -, or physical - such as the climate itself and the morphological characteristics of the beach, to assess the reproductive development of marine species.	Population dynamics; Detection of distribution patterns associated with fishing activities; Relationship between species population variations and edamorphoclimatic conditions.
Green	This cluster grouped works that indicate the interactions of marine biota with the environment, evaluating the natural fluctuations in the influence of the population structure of macrofauna and infauna species.	Variation of spatiotemporal scales, biotic interdependence and long-term monitoring; Food strategy and potential for adaptation and ecological plasticity; Biomass; Size and weight
Blue	The blue cluster has similarities to the red cluster, sharing 75% of its work with the red cluster. This cluster indicates the elements that influence the reproduction and distribution of benthic organisms.	Distribution and characteristics of the genus <i>Emerita</i> ; Length-weight ratio; Physical characteristics of the beach.

Source: Prepared by the author

Figure 4: Map of the most cited keywords in studies on the species *Emerita brasiliensis*

Source: developed from the SCOPUS Base using VosViewer software

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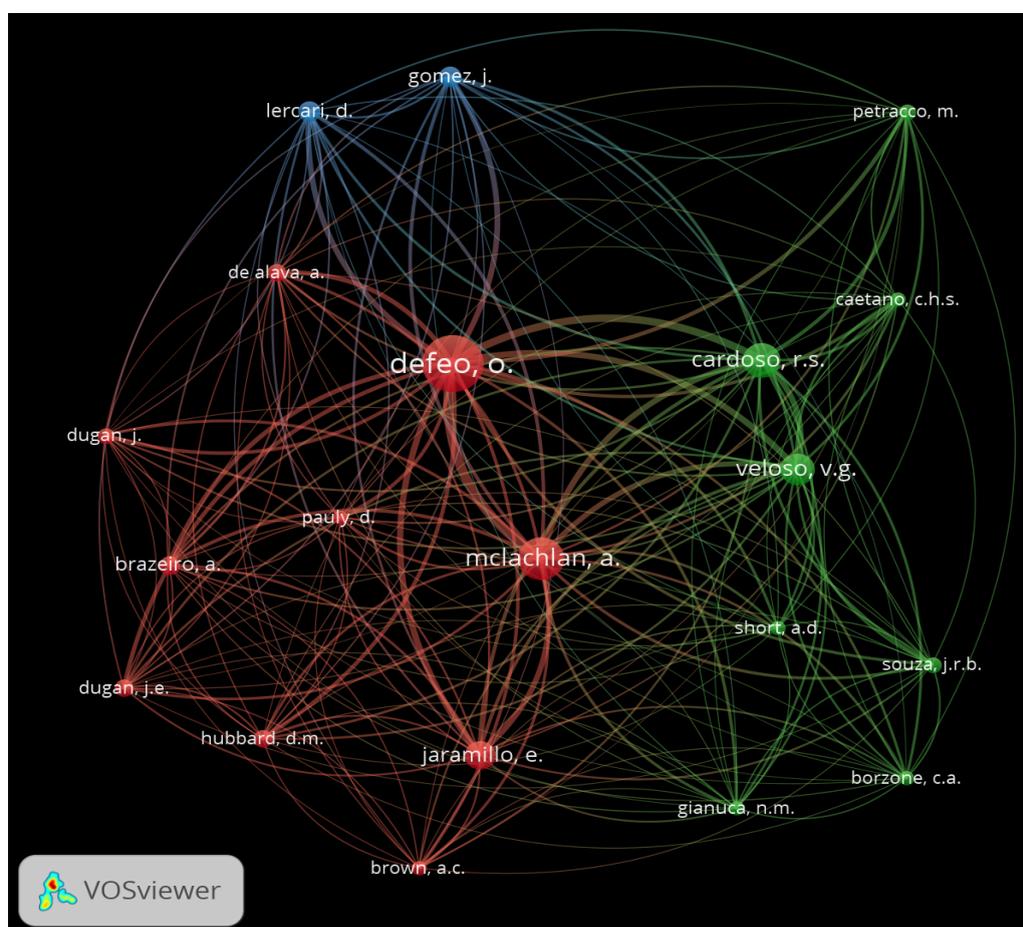
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The map above represents the analysis of the ten keywords with the highest co-occurrence in articles from the Scopus database in works on the species *Emerita brasiliensis*. In word co-occurrence analysis, it is identified when certain terms and keywords appear together in a group of documents (MATTOS; DIAS, 2010).

In descending order the words are: *Emerita*; Brazil; Hippidae; Sandy Beaches; Crab; Beach; Crustacea; Decapoda (crustacea); *Emerita brasiliensis*. Therefore, these are the keywords most used in studies on *Emerita brasiliensis* species.

The intention of the map is to show the ten most used keywords in works of this type. Thus, there was no formation of clusters and, for this figure, the information was represented and standardized in a single grayish color.

Figure 5: Co-citation map of the most cited authors in studies on the species *Emerita brasiliensis*



Source: developed from the SCOPUS Base using VosViewer software

This map represents the analysis of the most cited authors in articles from the base of Scopus in works on the species *Emerita brasiliensis*. For this variable, Grácio and Oliveira (2014) indicate the importance of co-citation data for better visualization and understanding of the underlying structures of a scientific community.

Thus, the authors were grouped into 3 different clusters to propose the analysis of this variable. Some authors have published works together despite being in different clusters, such as Defeo, O (red cluster), Cardoso, R (green cluster) and Lercari, D (blue cluster).

In this variable, the authors Defeo (with 307 citations) and McLachlan (with 174 citations) stand out.

Chart 2: referring to the co-citation map of the most cited authors in studies on the species *Emerita brasiliensis*

Cluster	Main Contributions	Main concepts studied
Red	The authors cited in the red cluster prioritize studies on the reproductive behavior of benthic organisms and the measurement of their characters, such as antenna length and telson.	Biotic interdependence, feeding strategy, life history, population structure, sex, size, weight, fecundity and maturity patterns.
Green	The authors mentioned that the green cluster presents in their work a greater concern with eating habits and the production of macrofauna. They also show relationships between species abundance and richness with physical factors.	Biomass, abundance, macrofauna production, population dynamics, detection of distribution patterns, characteristics of the genus <i>Emerita</i> .
Blue	The blue cluster presents articles with similar characteristics to the articles in the red cluster, however, the works in this cluster are not freely available in the Scopus database.	Size, individual growth, natural mortality, fecundity, maturity and weight-length ratio.

Source: Prepared by the author

Table 1. Referring to the co-citation map of the most cited authors in works on the species *Emerita brasiliensis*

ID	Author	Documents	Citations	Total Link Strength
1	Araújo F.G.	2	22	0
2	Cabrini T.M.B.	2	33	2
3	Caetano C.H.S.	2	83	4
4	Cardoso R.S.	13	392	21
5	Celentano E.	5	70	12
6	Combes V.	1	2	7
7	Defeo O.	13	434	14
8	Franco B.C.	1	2	7
9	Martinelli Filho J.E.	2	2	6
10	Matano R.P.	1	2	7

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11	Meerhoff E.	2	2	9
12	Petracco M.	4	19	10
13	Piola A.R.	1	2	7
14	Radetski C.M.	1	0	3
15	Rezende C.E.	1	0	3
16	Rocha P.F.P.	1	0	3
17	Turra A.	3	9	8
18	Vaca F.H.	1	2	7
19	Veloso V.G.	6	239	9
20	Zalmon I.R.	2	5	3

Source: Prepared by the author

Figure 6: Countries map of that publish the most in studies on the species *Emerita brasiliensis*



Source: developed from the SCOPUS Base using VosViewer software

This map shows the countries that published the most on the subject. Highlight for Brazil and Uruguay.

Table 2: referring to the countries map of that publish the most in studies on the species *Emerita brasiliensis*

ID	Country	Documents	Citations	Total Link Strength
1	Brazil	24	388	1592
2	Chile	3	65	264
3	Mexico	6	276	1319
4	United states	3	85	559
5	Uruguay	13	408	1982

Source: Prepared by the author

This work aimed to understand the development of studies on the species *Emerita brasiliensis*. This process was carried out through the analysis of articles through research carried out in the Scopus database. The search was performed with the keyword '*Emerita brasiliensis*'.

With the result of this search, it was possible to generate co-citation maps using the VosViewer software. Through this exercise it was possible to understand the development of research on this species of crustacean in the last 20 years (1981 - 2021). Thus, it is possible to notice a considerable inconsistency of studies directed to macrobenthos.

Among the 39 articles available in the Scopus database, it is possible to notice that the distribution of publications from the last 20 years (1981 - 2021) totaled an average of 2 publications per year, reaching its peak in the 2000s, with 17 publications. For Edgar (1990), this lack of studies related to benthic communities and their secondary production comes from methodological obstacles, such as: measuring the individuals collected; estimates of growth rates, among other variables.

This bibliometric exercise allows us to point out research patterns related to marine ecology and biodiversity. Therefore, the co-citation networks of the 39 works published in Scopus indicate the parameters used to understand the characteristics of the macrofauna and its relationship with the environment. Thus, the division between two streams of benthic studies is notorious: works that aim to use the ontogenetic development and reproductive characteristics of macrofauna species to understand the patterns of their natural fluctuations and population structure; and works that seek to deepen external elements, such as physical and anthropic influence, to understand the levels of abundance and distribution patterns of benthic organisms.

However, such methods are not antagonistic or even less so, on the contrary. The data and indicators indicated by the two streams sometimes complement hypotheses addressed in different works.

5. CONCLUSION

Through this article it is possible to highlight the need to apply new methodologies in macrofauna studies. Traditionally, biology and ecology use methods that do not take into account the microecosystems present on beaches. In 2010, Choi *et al.* (2011) published a paper called "Potential mapping of crustacean habitat in a tidal flat using remote sensing and GIS". The work articulated remote sensing and GIS techniques to model the physiographic features that influence the abundance, frequency and distribution of crustaceans, generating maps of potential habitats. There has been little methodological evolution in studies of this nature in the last 20 years.

Despite the contribution, VosViewer still has limitations. It has little content that indicates the use of the tools and the results are subjective, requiring interpretation of the results by the researcher.

Finally, this work exposes the need to expand studies of this nature - not only on the organism *Emerita brasiliensis*, but on the entire marine macrofauna, developing a faunal inventory with more in-depth and abundant knowledge.

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