Check for updates

RESEARCH ARTICLE

The evolution of knowledge in sericultural research as observed through a science mapping approach [version 1; referees: 1 approved with reservations]

Giselle Zambrano-Gonzalez [ID] [1], Gustavo Ramirez-Gonzalez [ID] [2],

Martha I. Almanza-P [3]

[1]Biology Department, Geology, Ecology and Conservation Research Group (GECO), University of Cauca, Popayán, Cauca, Colombia
[2]Telematic Engineering Department, Telematic Engineering Research Group (GIT), University of Cauca, Popayán, Cauca, Colombia
[3]Agropecuary Sciences Department, Production Integrated Systems Research Group (SISINPRO), University of Cauca, Popayán, Cauca, Colombia

Abstract

Background: Sericulture, since its discovery in China, has spread to become a valued activity in a range of other countries. China remains the leading producer of silk, followed by India and other Asian countries, Europe, Brazil and Colombia. This article examines the evolution of sericultural research between 1892 and 2016, identifying the main themes and applications.
Methods: The SciMat software tool and the Bibliometrix R package were used as tools for data analysis in this study, based on records from the Clarivate Analytics Web of Science and SCOPUS databases.
Results: The results show that research has been growing, both in number of publications from the 1990s onwards, and in the emergence of topics closely related to the sericulture research field, a field that proves to be multi-disciplinary, exhibiting expansion and vitality.
Conclusions: The information gathered will contribute greatly to the definition of relevant research strands, bearing in mind a number of significant gaps in information in this field. It will furthermore provide a better insight into the development of sericulture research over time.

Open Peer Review

Referee Status: ?

	Invited Referees
	1
version 1 published 30 Nov 2017	? report

1   **Manuel Jesus Cobo** [ID] , University of Cádiz, Spain

Discuss this article

Comments (0)

GODAN
Global Open Data
for Agriculture e Nutrition

This article is included in the Global Open Data for Agriculture and Nutrition gateway.

Corresponding author: Giselle Zambrano-Gonzalez (gzambranog@unicauca.edu.co)

Author roles: Zambrano-Gonzalez G: Conceptualization, Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing;
Ramirez-Gonzalez G: Methodology, Resources, Writing – Original Draft Preparation, Writing – Review & Editing; **Almanza-P MI**: Formal Analysis,
Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Introduction

Sericulture is an agro-industrial activity that involves mulberry (*Morus* spp) cultivation, silkworm rearing, and the collection of silk thread for the textile industry. The latter aspect has been highly exploited[1,2]. Sericulture is carried out mainly in rural and suburban zones. Since it is limited by the supply of mulberry leaves, a lot of plants are required near the breeding site. It is environmentally friendly because it does not generate any pollutant waste, smell or sound and can therefore coexist happily with already populated areas. Silkworm rearing is not recommended however for industrial or intensely agricultural zones that use agrochemicals, given that silkworms are seriously affected by the presence of toxic product[3,4].

Silkworms feed on fresh mulberry leaves (leaves and young sprouts) in which they find the nutrients and water necessary to grow and develop. While artificial diets do exist, they are used only in native breeding silkworm countries, such as Japan, because of their high cost[3,5,6].

Mulberry was first cultivated for sericulture in Asiatic countries approximately 4,500 years ago. The practice of sericulture prompted the movement of species and varieties of mulberry plant across the continents, distributing these woody plants everywhere from temperate to tropical and subtropical climates[2,7]. Consequently, they do not have a precise origin. Many authors agree however that the main sites of origin include regions of China, Japan and the Himalayas[8,9]. Mulberries can grow on non-fertile ground, but when cultivated on rich ground, with regular irrigation, they produce a large quantity of high quality leaves.

In the textile industry, no natural product surpasses the quality of silk thread, because it possesses unique characteristics in resistance, elasticity, durability, and refinement. Silk thread can also preserve heat, absorb water, gases, and colorants[3,10,11]; these are characteristics appreciated by the international market due to a rising tendency to use natural products, meaning that silk is increasingly welcomed and in demand.

Sericulture is an enterprise in which family members can work at a handcraft level so it requires low initial investment and less staff. Likewise, sub-products derived from thread production such as silkworm chrysalis and mulberry leaf residues can be used as feed for livestock, generating additional income for families.

China is considered to be the first country where spinning and knitting of silk thread took place, according to 7,000 year old archaeological findings in Yuyao city[12]. The trading of silk thread permitted an extensive, permanent and active economic interchange between China and other countries in ancient times, with the "Silk Road" connecting China, Mongolia, India, Persia, Arabia, Syria, Turkey, Europe and Africa[12]. Nowadays, spinning and knitting of silk thread is carried out in 30 countries, generally by small farmers. The main producers are China and India, who possess more than 50% of worldwide production, followed by Japan, Korea, and Thailand. The main producers in Europe are Italy and Spain, Zambia and Uganda in Africa, while in Latin America,

Brazil is the largest producer, with Bolivia and Colombia as smaller producers[13,14]. Main consumer countries are the United States, Italy, Japan, India, France, China, United Kingdom, Switzerland, Germany, the United Arab Emirates, South Korea, and Vietnam, mainly for use in the production of clothing and home decor pieces[15].

Besides in the production of silk for use in textiles, it is foreseen that sericultural research will be involved in using mulberry as a bioactive substance, able to function as medicine or food, where the silkworm is studied as a "bio-factory insect" for producing protein, thanks to transformation of the mulberry. The silk itself, due to its proteic nature, could be used to manufacture membranes, as a foodstuff, in cosmetics, or for medical and bioengineering purposes.

We sought to carry out a bibliometric analysis of research into sericulture in order to identify the principal topics related to sericulture research and their applications.

Methods

General methodology and description of the software tools used

We followed four main steps to carry out the bibliometric analysis:

1. Datasets from different sources were extracted;

2. The data was cleaned up;

3. A particular analysis of the data was carried out, depending on the software tool used;

4. Lastly, the results were analyzed and discussed.

SciMAT[20] and the Bibliometrix[21] R package (version 3.3.3) were used as tools for data analysis in this study. Both are used widely for bibliometric analysis studies. SciMAT is widely used for management and organization[22,23], virtual and remote labs[24], knowledge-based systems[25], marketing, and[26,27] in the field of social work. Bibliometrix is commonly used in businesses, healthcare, and public administration[28,29].

SciMAT is based on the science mapping analysis approach presented in 20, and allows us to carry out science mapping studies within a longitudinal framework[30,31]. The SciMAT approach establishes four steps for analysis[20]:

1. Detection of substructures, especially clusters of words, by means of co-word analysis over specific time periods

2. Generation of cluster diagrams based on results of the first step.

3. Generation and interpretation of evolution diagrams based on clusters and periods. This reveals the general evolution of the research field.

4. Analysis of the different time periods, clusters, and subject areas that have evolved using the various measures of density and centrality generated by the tool.

A strategic diagram represents the themes of the research field. Classification into four groups is achieved using the method proposed in 32 and 33 for equivalence index, normalized for a co-word network of keyword co-occurrence. The Simple Centres algorithm is based on 34 and the values of cluster centrality and density rank are based on 32. Based on centrality and density, the clusters can be classified into four groups:

1) motor

2) basic and transversal

3) emerging or declining

4) highly developed and isolated.

An analysis of the evolution of research themes was also undertaken to detect the general areas of evolution, based on a map.

Bibliometrix is an R package (version 1.8) that comes with options to import bibliographic data from SCOPUS databases. The user can perform a science mapping analysis and build data matrices for co-citation, coupling, scientific collaboration analysis, and co-word analysis.

Datasets and search methodology
This study made use of two of the most important databases for scientific literature, i.e. the core collections of Scopus and Web of Science (Web of Science).

The analysis was performed using SciMAT version 1.1.03, configured with the following parameters: Unit of analysis, Words (authorRole=true, sourceRole=true, addedRole=true); Kind of network, Co-occurrence; Normalization measure, Association strength; Cluster algorithm, Simple Centres (Max cluster size: 7, Min

cluster size: 3); Evolution measure, Association strength; Overlapping measure, Association strength.

Some 1,883 records were obtained by Scopus and a further 312 by Web of Science, related to journal articles, notes, books, book chapters, reviews, and conferences. Following the deletion of duplicated records, the total of 2,195 was reduced to a final 1,930 records to be analyzed. On preliminary analysis, 91% of these were found to be for journals, with others totalling just 9%. We adopted a generalized definition of "Sericulture" which includes several different types of work on the silkworm (*B. mori*), mulberry (*Morus* spp), silk, and its industry. Some meaningless keywords that were too general, such as study or paper, were removed.

Using Bibliometrix as an R package does not require any special configuration. However, some steps based on R commands are needed:

1. Upload to R the download file in a character vector.

2. Convert the object to a data frame.

3. Apply the "biblioAnalysis" function that returns an object of class "bibliometrix".

4. Apply the "biblioNetwork" function with the "collaboration" parameter for the "analysis" and the "countries" parameter for the "network" variable. This creates a collaboration network that is then plotted.

Results
Data extraction
Figure 1 shows the amount of articles published on sericulture over time, from 1892 to 2016 (plus seven documents from 2017), for Scopus and Web of Science. The information covers a 124 year
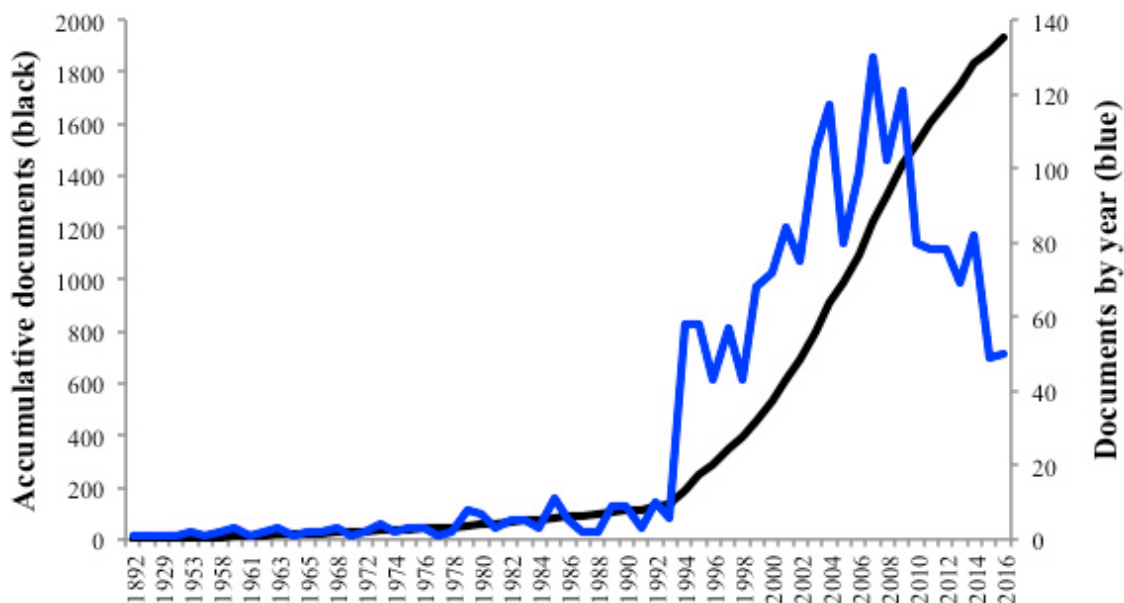

Figure 1. Documents on sericulture published over time, as found in Scopus and Web of Science.

period, but 93% of records were from 1990 onwards. According to these results, it could be inferred that sericulture is an increasing area of research. Of the 1,930 records found, 531 were from the years 1892 to 2000, and 1,399 from the years 2001 to 2016.

The most representative and influential journals that published on sericulture were mostly concentrated in Japan and India, except for *Biomacromolecules*, which is owned by the American Chemical Society.

The *Journal of Sericultural Science of Japan* and *Japanese Journal of Human Geography* are also listed, but to date these journals are not found in internationally indexed databases (Table 1).

Ten authors published 21.7% of the total research articles found, touching on various topics such as mulberry cropping, silkworm rearing, silk thread collection for the textile industry, and development of sericulture in different countries (Table 2). These ten authors have an affiliation from institutions located in India.

Table 1. List of journals that were found to publish articles on sericulture.

Journal	Coverage	Number of documents	Area	Impact Factor (2015 JCR)	Impact Factor (2015 SJR)
Indian Silk	1993	705	Agricultural and biological science Business and international Management Industrial and manufacturing engineering		0.1
Indian Journal of Sericulture	1992	314	Agricultural and biological science Business and international Management		0.101
Journal of Insect Biotechnology and Sericology	2001	45	Agricultural and biological science Applied Microbiology and Biotechnology Business, Management and accounting Industrial and manufacturing engineering Insect science		0.227
Asian Textile Journal	1992	44	Agricultural and biological science Business and international Management Business, Management and accounting Industrial and manufacturing engineering		0.1
The Journal of Sericultural Science of Japan[1]	1930 – 2005	40			
Biomacromolecules	2000	17	Bioengineering Biomaterials Materials chemistry Polymers and plastics Biochemistry & molecular biology[2] Chemistry, organic[2] Polymer science[2]	5.583	2.209
Man-Made Textiles in India	1989	9	Chemistry Geotechnical engineering and engineering geology Industrial and Manufacturing engineering Polymers and plastics		0.104
Japan Agricultural Research Quarterly	1973	8	Agronomy and crop science Animal science and zoology Biotechnology[2] Ecology[2] Agriculture, multidisciplinary[2]	0.453	0.278
Journal of Rural Development	1982	8	Development		0.101
Indian Journal of Agricultural Economics	1978	8	Development Geography, planning and Development		0.113
Japanese Journal of Human Geography[1]	1948–2005	8			

[1]Journals that are not categorized in JCR and SJR

[2] Area JCR

The country with the largest research output was India, with 1,242 records, much higher than the next two, Japan with 185 and China with 182. These three countries published 81.9% of the sericulture records found, and the ten most active countries produced 90% of the research (Figure 2).

Thirty-one countries gave meaningful contributions to sericulture from all over the globe. By continent, Asia is represented by 14 countries, Europe by 9, America by 5, Africa by 2, and Oceania by one. There are isolated publications from 19 countries, including

Brazil, Italy, Turkey, Iran, Spain, and Colombia (Figure 3). Other nations with a minimal number of records found in Web of Science include Croatia, Indonesia, Madagascar, Nepal, Pakistan, Paraguay, Romania and Russia.

Once the download references were uploaded in SciMat, a total of 2,518 keywords were extracted. Table 3 presents the top ten keywords identified. These keywords represent topics related to the concepts presented in Figure 4. This figure is based on the conceptual relationship between the keywords extracted, presented in clusters.

Evolution and expansion of topics related to sericulture

Publications were divided into five consecutive time periods: 1892–2000; 2001–2005; 2006–2010; 2011–2013; 2014–2016. These time periods had 531, 461, 532, 225, and 181 publications, respectively (Figure 5) and we found 557, 844, 1,120, 853 and 852 keywords, respectively (Figure 6). It is important to note that the first time period covers 109 years, the largest amount of research was published in the 1990s (68%).

For the 1892–2000 time period 557 keywords were found. Between 2001–2005, 261 keywords did not reappear, 296 keywords migrated and 548 new keywords were mentioned. Between 2006–2010, 401 keywords did not reappear, 443 keywords migrated and 677 new keywords were mentioned. Then, between 2011–2013, 684 keywords did not reappear, 436 keywords migrated and 417 new keywords were mentioned. Finally, between 2014–2016, 499 keywords did not reappear, 354 keywords migrated and 498 new keywords were mentioned.
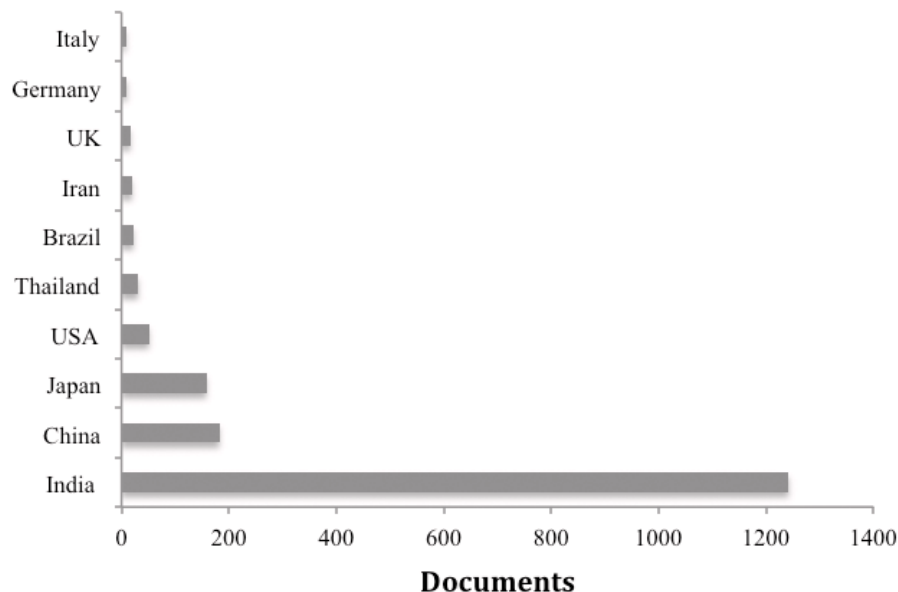
Table 2. Most productive authors in sericulture research.

Author	Number of documents	Periods Publication
Dandin, S.B.	76	1990 – 2014
Qadri, S.M.H.	56	1999 – 2014
Datta, R.K.	47	1994 – 2013
Kamble, C.K.	41	1994 – 2010
Geetha, D.	40	1995 – 2014
Sinha, R.K.	36	1994 – 2014
Basavaraja, H.K.	34	1990 – 2011
Kumaresan, P.	31	1994 – 2015
Khan, M.A.	30	1972 – 2012
Bindroo, B.B.	29	1996 – 2014

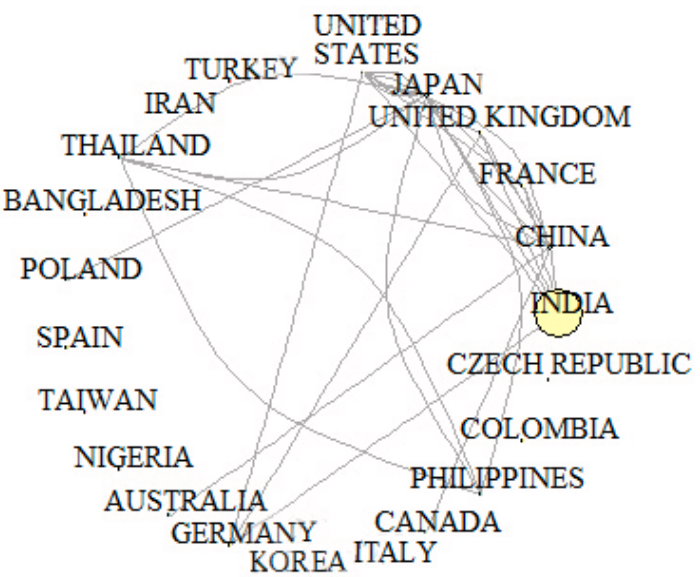**Figure 2.** The top 10 most active countries in sericulture research, between 1892 and 2016.

Figure 3. Collaboration between countries, from 1892 to 2016.

Table 3. Top keywords used in sericulture research, as identified by the present study.

Keywords	Number of documents
Silk	740
Silkworm	572
Bombyx mori	481
Mulberry	401
Cocoon	288
India	230
Breeds BM	187
Economic-Conditions	177
Genetic	167
Developing	152

The number of keywords added in each of the four later time periods (64.9%, 60.5%, 48.8% and 58.5%, respectively) shows the vitality and expansion of the research field. Meanwhile, unchanged keywords between 38.9 and 53.1% (53.1%, 52.5%, 38.9% and 41.5%, respectively) point to the existence of certain base research topics (Figure 6).

The conceptual evolution of sericultural research (Figure 7) is represented by green, red and blue colours, denoting mulberry cultivation, worm breeding, and silk, respectively. There are no gaps in the evolution of most of the topics. Seven topics (Protein, Larva

BM, Silk, Silkworm, Genetic, India) have been present in the field across the five time periods analysed and may thus be considered classic themes.

The topics (mulberry cultivation, worm breeding, and silk) exhibit a positive pattern of development because of the increasing number of subtopics within them. For instance, in the case of Fiber, it diversifies into Sericin, Genetic, and Stress in the second period (Per2). Similarly, Cocoon (Per2) comes from BM larvae (Per1) and diversifies into Preservation, India, Parasite, and Economic-Conditions. Some topics sustain the number of topics from previous periods
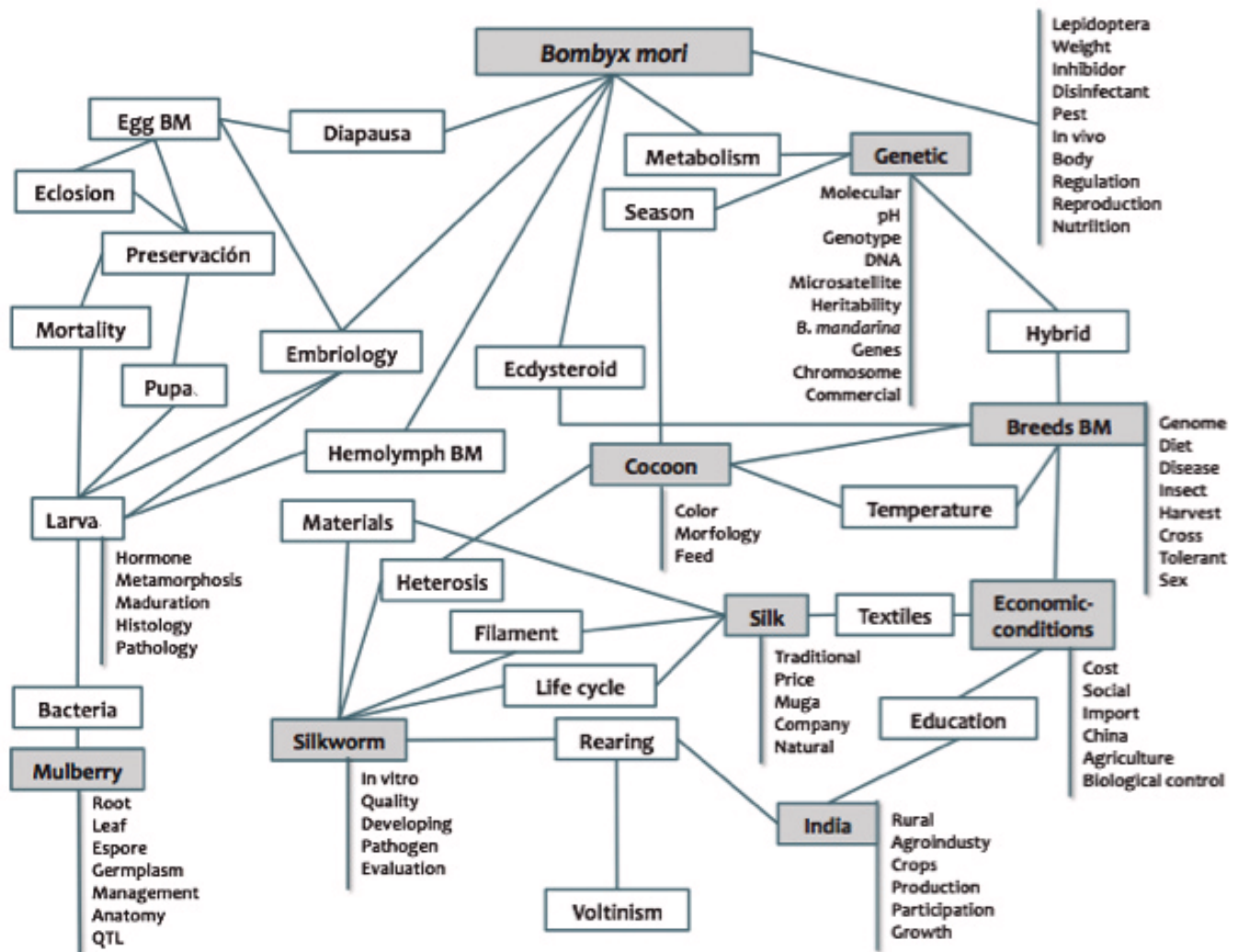
Figure 4. Relationship between the topics surrounding sericultural research mentioned in publications between 1892 and 2016.
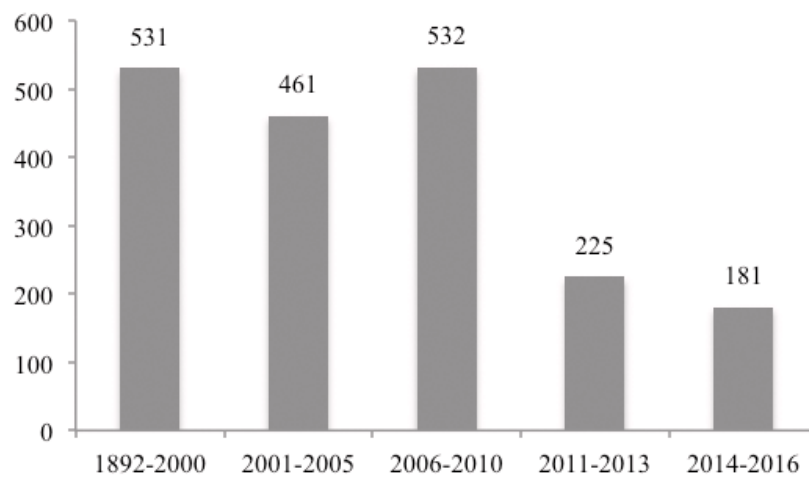

Figure 5. Documents published on sericulture from1892 to 2016 (1892–2000, 2001–2005, 2006–2010, 2011–2013 and 2014–2016).
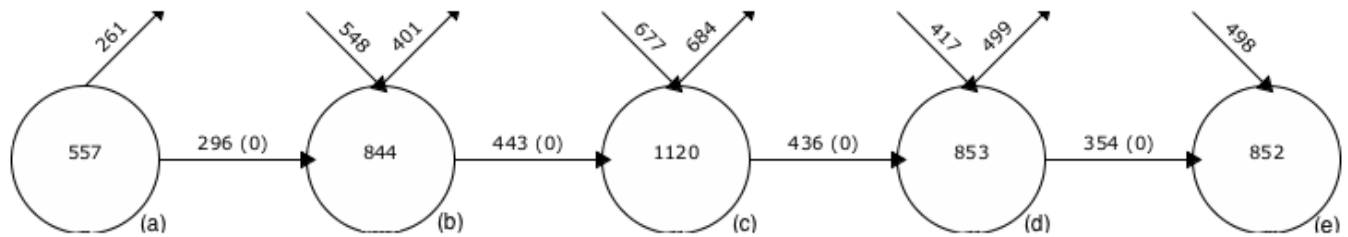
Figure 6. Keywords overlapping in the map of publications on sericulture: (**a**) 1892–2000, (**b**) 2001–2005, (**c**) 2006–2010, (**d**) 2011–2013 and (**e**) 2014–2016.

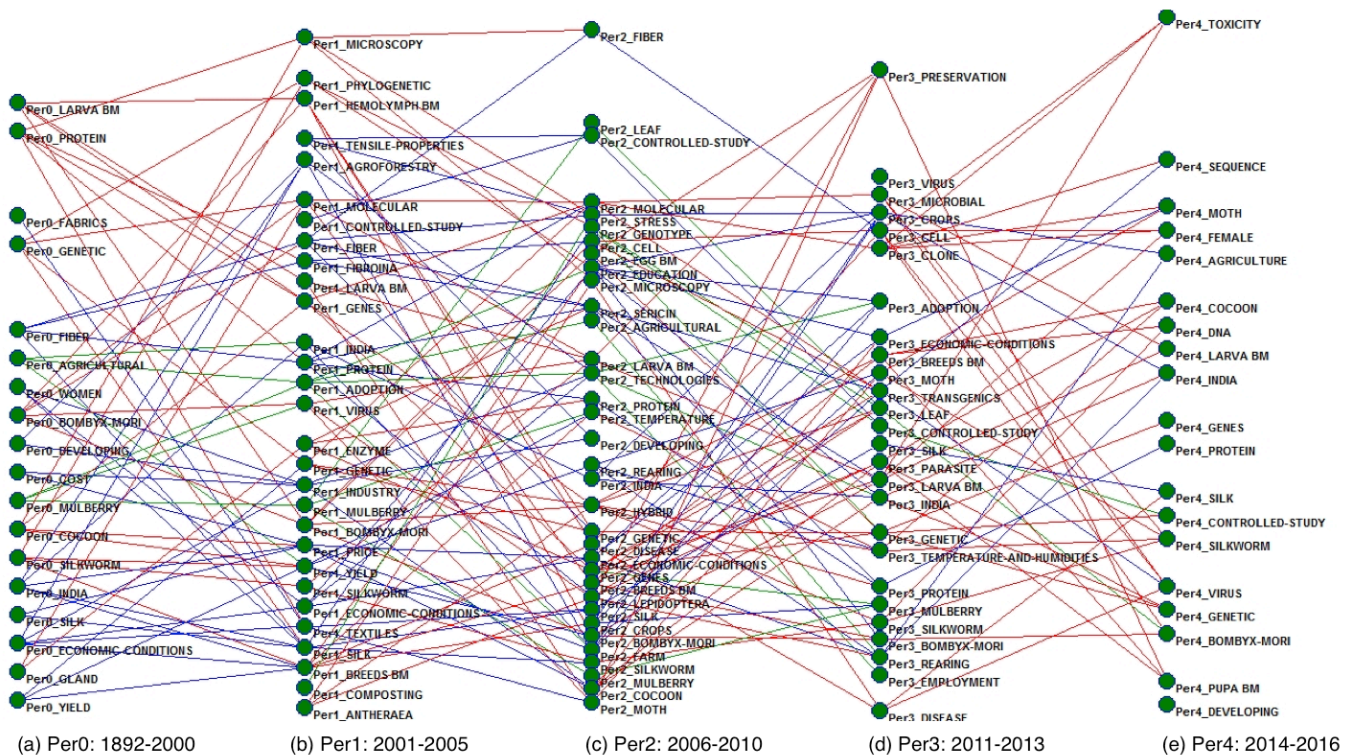**Figure 7. Conceptual evolution map separated into time periods.** Shows the most important elements and their development. (**a**) Per0:1892–2000, (**b**) Per1:2001–2005, (**c**) Per2:2006–2010, (**d**) Per3:2011–2013 and (**e**) Per4:2014–2016.

and diversify into the next; this is the case for Microscopy (Per1) that comes from the initial period (Per0) of Cocoon and Protein and changes to Fiber and Stress in the following period (Per2) (Figure 7).
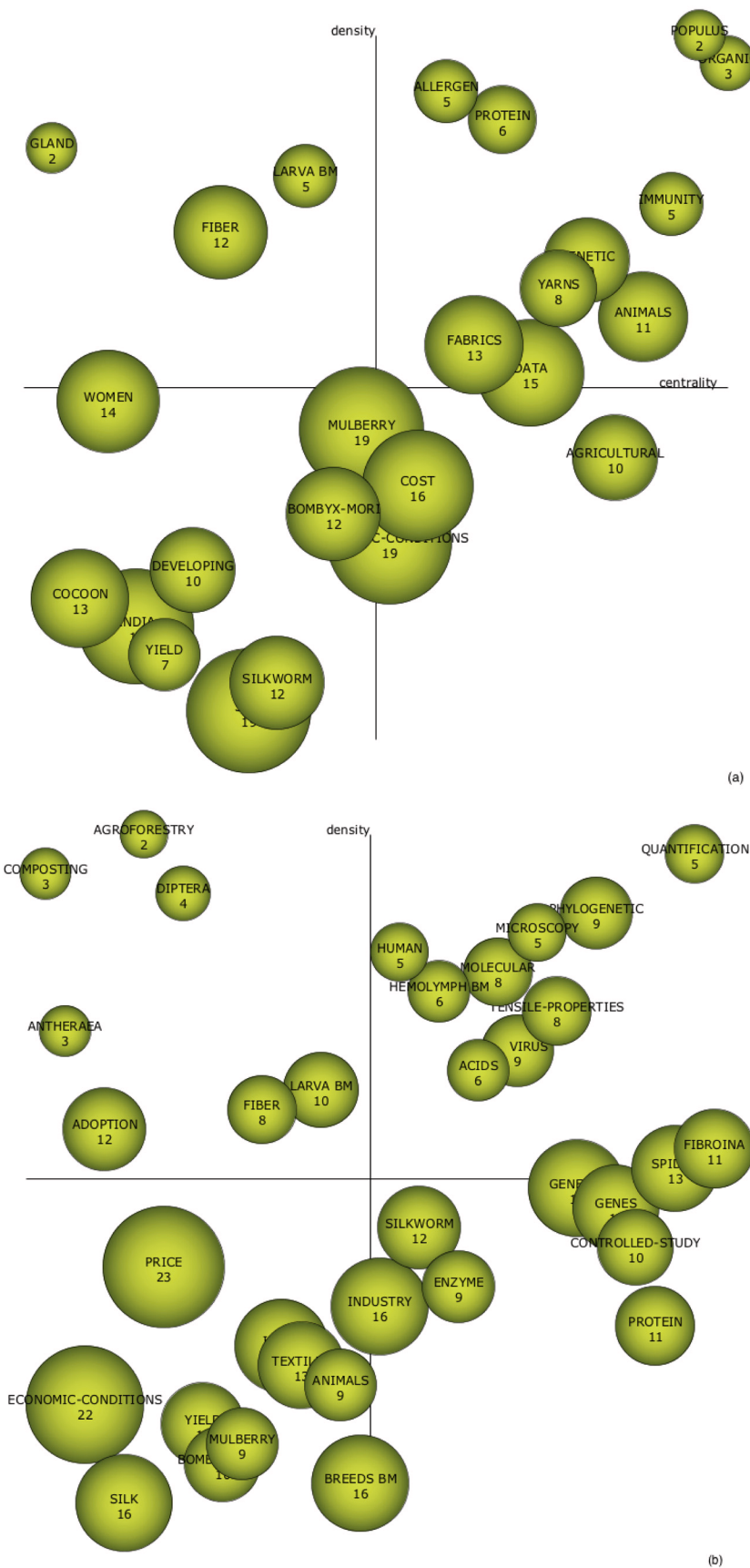
Research themes

To analyze the most prominent themes in the field of sericulture research for each time period, a strategic diagram is provided (Figure 8). In each diagram, sphere size is proportional to the number of records associated with each research theme.

Evolution of keywords related to sericulture over the last five years (2012–2016)

The evolution of keywords in the last 5 years is depicted in Figure 9 and Figure 10. The relationships between research themes are presented in Figure 11.

2012 begins with 405 keywords. In 2013, 224 keywords did not reappear, 181 keywords migrated and 278 new keywords were mentioned. In 2014, 279 keywords did not reappear, 180 keywords migrated and 299 new keywords were mentioned. In 2015, 301 keywords did not reappear, 178 keywords migrated and 238 new keywords were mentioned. Finally in 2016, 296 keywords did not reappear, 120 keywords migrated and 177 new keywords were mentioned. The addition of more than half the number of keywords in each period (60.5%, 62.4%, 57.2%, and 59.6%, respectively) and the fact that less than 45% of keywords remained the same (44.7%, 39.2%, 37.2%, and 28.8%, respectively) shows the vitality and expansion of this research field in the last five years (Figure 10).

The conceptual evolution of the field of sericulture research in the last five years (Figure 12), in which the theoretical evolution
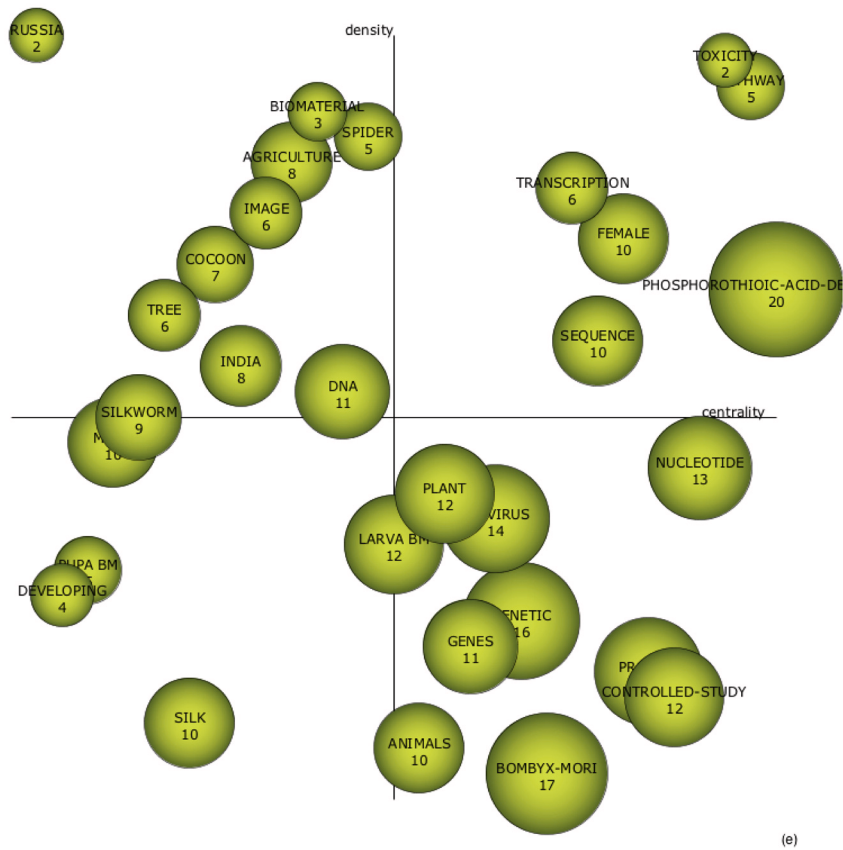
(a)

(b)

(c)

(d)

Figure 8. Research themes at different time periods according to the strategic diagrams (**a**) 1892–2000, (**b**) 2001–2005, (**c**) 2006–2010, (**d**) 2011–2013 and (**e**) 2014–2016.
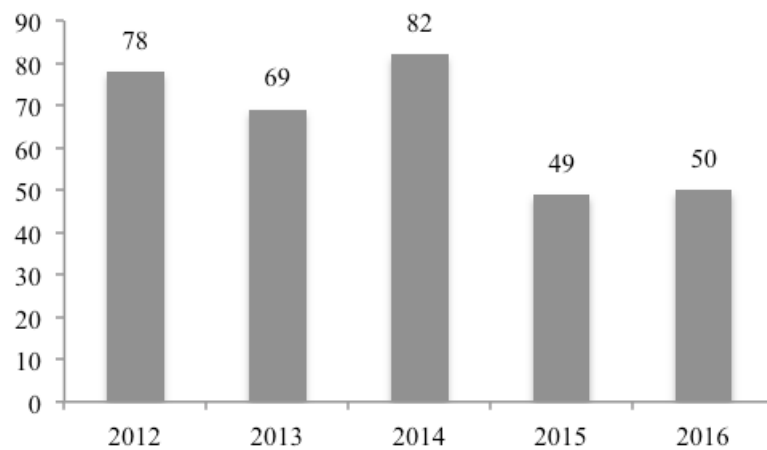

Figure 9. Documents published on sericulture in the last five years (2012–2016).
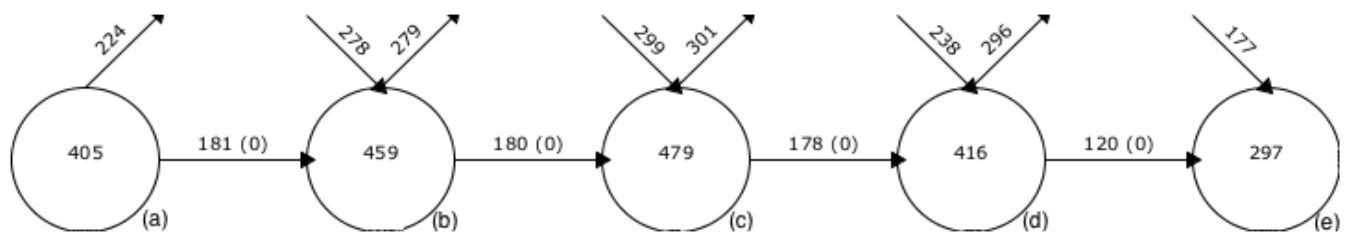
Figure 10. Keywords overlapping map of sericulture publications in the last five years: (**a**) 2012, (**b**) 2013, (**c**) 2014, (**d**) 2015 and (**e**) 2016.
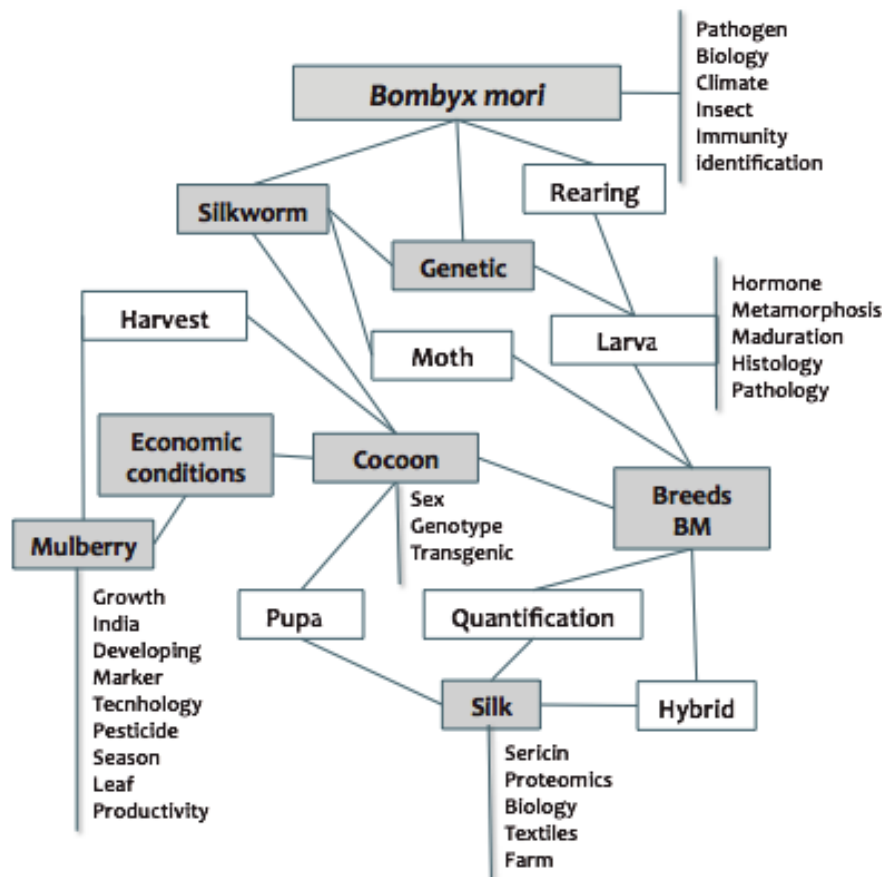

Figure 11. Relationship between the topics surrounding sericultural research in the last five years (2012 to 2016).

since 1892–2016 is represented by three colours exhibits cohesion; furthermore, there are no gaps in the evolution of the majority of thematic areas. Protein is the thematic area that is present across the five analyzed time periods, and is thus considered an established topic in sericultural research.

In the last five years, topics such as SILKWORM, *Bombyx mori* (Supplementary Figure S1a), MULBERRY (Supplementary Figure S1b) and SILK are mentioned. Even though in one or two time periods (in the case of Silkworm, for example) they are not

found as nodes that are evidenced in the clusters, these topics have been permanent and predominant. In the case of SILK, it finishes up as a motor topic. With ECONOMIC-CONDITIONS, there are not enough registers in 2012 and 2013 for it to appear as a node, but it does appear in the Cocoon and Mulberry clusters (Supplementary Figure S2); over the last three years, there is no evidence of work on this topic. For DEVELOPING, in 2012, 2013, 2014 and 2016 there are not enough registers for it to appear as a node, but it appears in the Cocoon, Larva BM, Agriculture, and Silk clusters (Supplementary Figure S3).
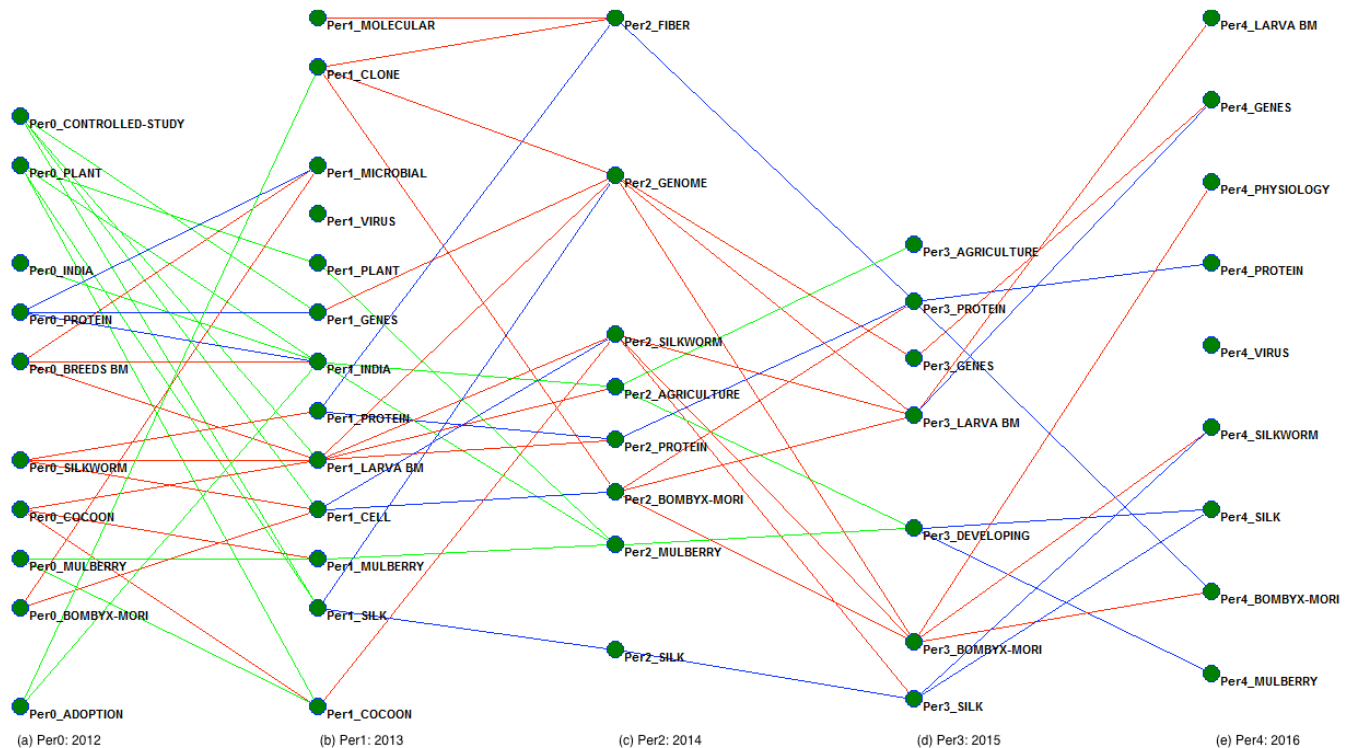
Figure 12. Conceptual evolution map for the last five years. Shows the most important elements and their development. (**a**) Per0:2012, (**b**) Per1:2013, (**c**) Per2:2014, (**d**) Per3:2015 and (**e**) Per4:2016.

COCOON (Supplementary Figure S4), INDIA (Supplementary Figure S5a) and BREEDS BM (Supplementary Figure S5b) are topics that appear in a diversity of clusters: for example COCOON appears in both Silkworm and Silk, BREEDS BM appears in Silkworm and Larva BM, and INDIA appears with Mulberry. With GENETIC, there is no evidence of nodes at any time period, but it is found within the Drug, Larva BM, Animals, *Bombyx mori*, and Physiology clusters (Supplementary Figure S6).

Research themes in the last five years

To analyze the most prominent themes in the field of sericulture in the last five years, a strategic diagram is provided (Figure 13).

Dataset 1. Data obtained from Web of Science in May 2017

http://dx.doi.org/10.5256/f1000research.12649.d184837

Dataset 2. Data obtained from Scopus files in ris format in May 2017

http://dx.doi.org/10.5256/f1000research.12649.d184838

Dataset 3. Data obtained from Scopus files in BibTex format in May 2017, to be used with Bibliometrix

http://dx.doi.org/10.5256/f1000research.12649.d184839

Dataset 4. SCIMAT project file, to be opened in SciMAT with the processed files

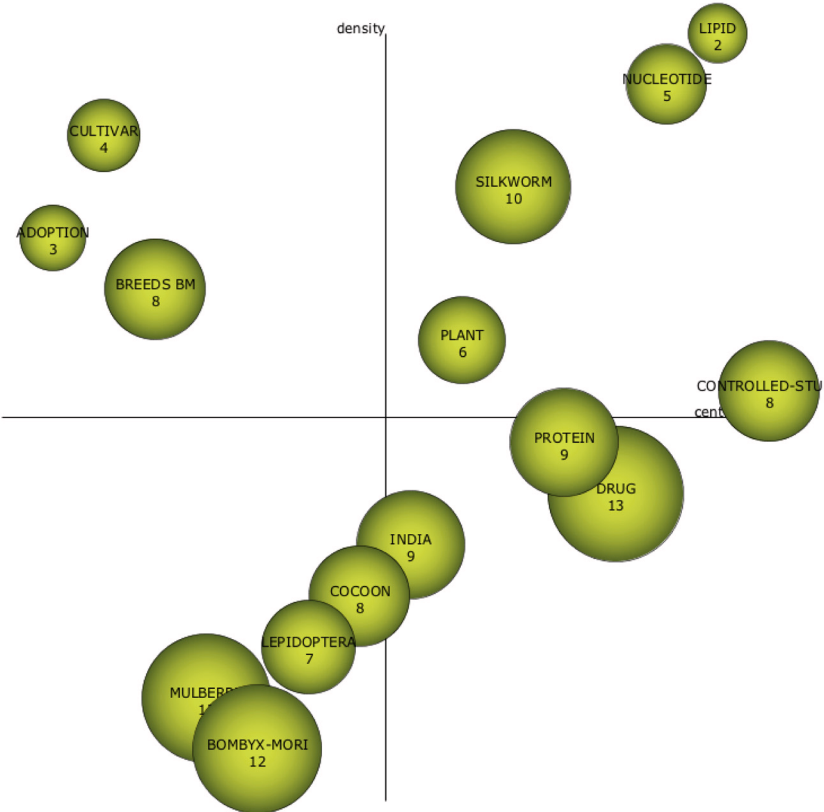http://dx.doi.org/10.5256/f1000research.12649.d185218

Discussion

Distribution of records in Scopus and Web of Science

Three general time periods were identified for publications:

(1) Pre-1990s. Only 104 publications found, possibly because over that period publishing in annexed databases wasn't common, and the priority was other kinds of documents such as technical reports from the centres dedicated to sericulture research and journals with no annexed databases;

(2) 1990s. Publications on sericulture begin to increase and specialized journals are created;

(3) Post-2000s. More than 76% of publications are from this time period, with strong growth in 2003, 2004, 2007, 2008 and 2009.

The publication dynamics in sericulture appear to be related to the history of fibres. Ever since the appearance of synthetic fibres (early XX century)[16], the market has evolved thanks to the cost, ease

density

LIPID
2

NUCLEOTIDE
5

CULTIVAR
4

SILKWORM
10

ADOPTION
3

BREEDS BM
8

PLANT
6

CONTROLLED-STUDY
8

centrality

PROTEIN
9

DRUG
13

INDIA
9

COCOON
8

LEPIDOPTERA
7

MULBERRY
1

BOMBYX-MORI
12

(a)

density

IMAGE
7

CLONE
5

MULBERRY
8

MICROBIAL
6

PROTEIN
8

MOLECULAR
7

GENES
7

PARTICLE
5

centrality

VIRUS
5

LARVA BM
9

INDIA
7

PLANT
6

CELL
18

SILK
10

COCOON
4

(b)

(c)
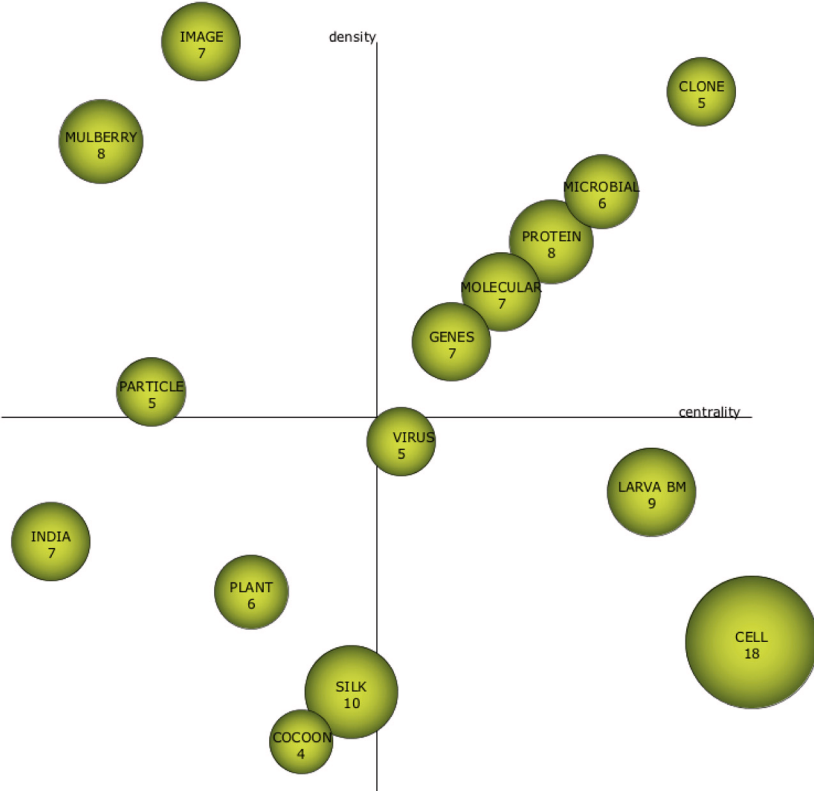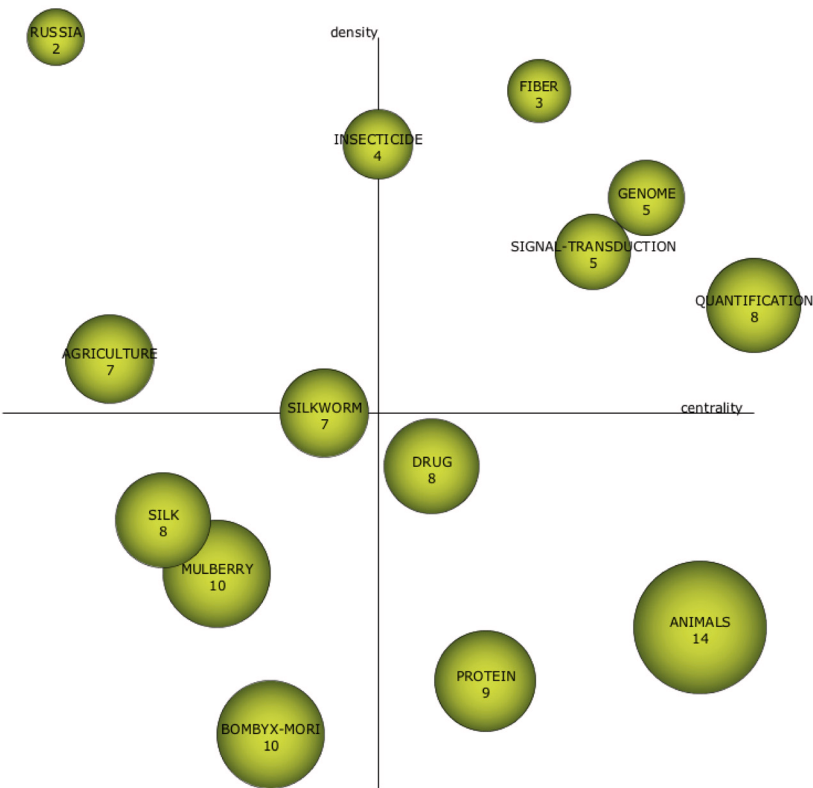
(d)

Figure 13. Sericulture research themes in the last five years according to the strategic diagrams (**a**) 2012, (**b**) 2013, (**c**) 2014, (**d**) 2015 and (**e**) 2016.

of production, greater uniformity,[17], such that they tended to push natural fibers out of the marker. However, in the last few years, natural fibres have been viewed as a sustainable option, 100% biodegradable, environmentally friendly, this has caused their use to diversify and increase[18].
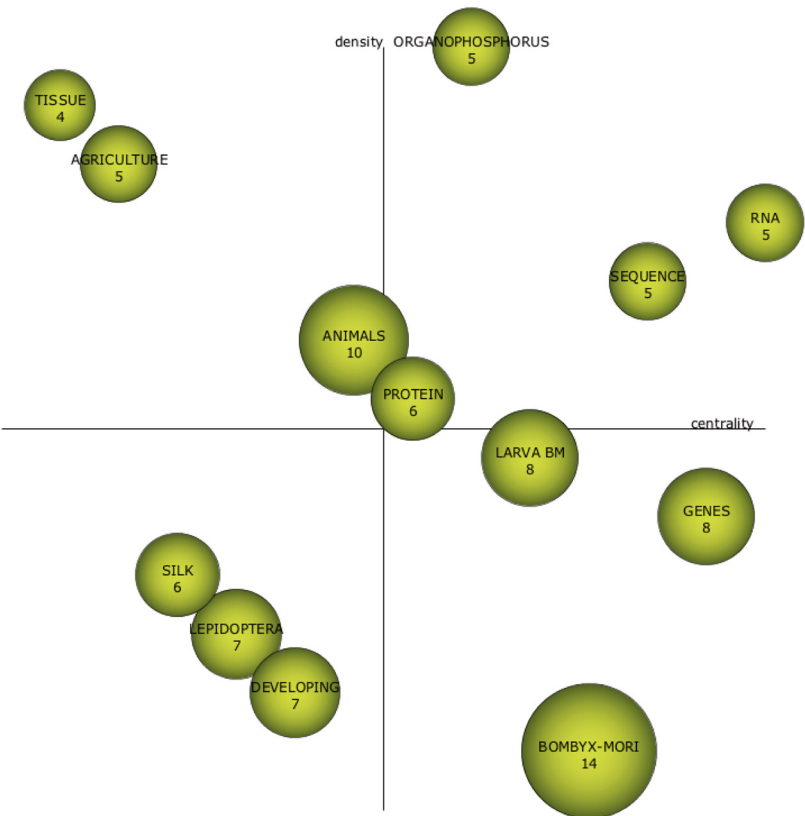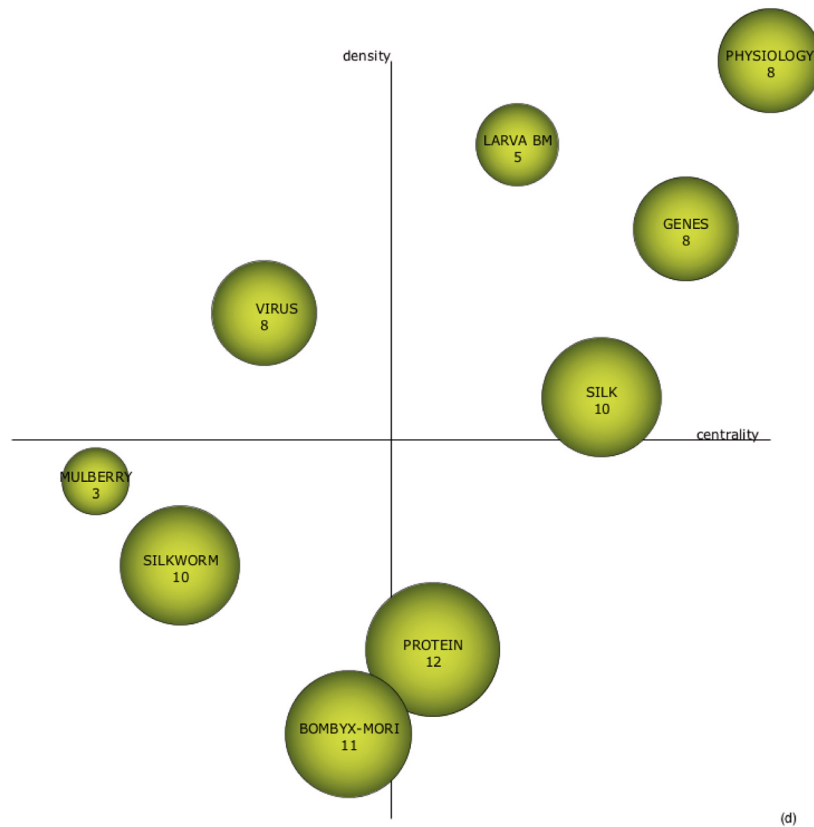
Core sericulture journals
The journals that have published the most on the topic of sericulture have a low impact factor that can be attributed to their specialization. The appearance and indexing of specialized journals such as *Silk and India Journal of Sericulture* in the 1990s lead to an increase in publication output. The total number of journals that have published sericulture related topics is 528. The top 10 journals account for 62.4% of the total contributions (1,206).

Most productive authors
Publications in the last 20 years have been led by authors from India. Notably, the Central Sericultural Research and Training Institute, founded in 1961 and directed by the Ministry of Textiles of the Government of India, is actively developing the silk industry in the country, and its researchers represent the most productive authors. From the total number of authors (3,058), ten have published 21.7%

of the research output (420 documents) and 83.5% (2,555) have published one or more documents.

Most productive countries
The importance of India in the production of sericulture documents worldwide may lie in the investment the country makes in developing the silk industry, including silk centres, research institutes, specialized journals, and organized events. Publications with collaborations are evident; Japan has the most publications in collaboration with authors from other nations with 12 country links, followed by China with 10 and India with 6 links. This might suggest that collaborative work is missing between countries with an established research output and those looking at sericulture as an option for diversification and economic development, as is the case with Colombia and Brazil in South America[19].

Evolution of topics related to sericulture
Generally, the keywords found were not linked just to one area of sericulture (mulberry cultivation, worm breeding, silk), showing that sericulture is multidisciplinary. It is worth mentioning that this research has shown that sericulture is dynamic and has faced new challenges created by environmental needs and scientific progress,

as shown by keywords such as molecular, transgenic, genomic, sequence, and phylogenetic.

Conclusions

A bibliometric analysis of publications between 1892 and 2016, was carried out for the field of sericulture research. It was found that most research is published in journals in China and Japan, while the most representative authors were affiliated to research centres in India. As a result, India produces 64% of publications. The research field is centred on topics related to silk, silkworm, *Bombyx mori*, mulberry, cocoon, India, BM breeds, economic conditions, genetic, and development. As proposed by 35, *B. mori* is excellent as an experimental animal for genetic and biological research, and was present in several clusters in the course of the analysis. The field is multi-disciplinary and exhibits expansion and vitality. In future work, this type of bibliometric analysis gives researchers a broader view of the research field, to better identify potential interplay of topics in future work.

Data availability

Dataset 1: Data obtained from Web of Science in May 2017. DOI, 10.5256/f1000research.12649.d184837[36]

Dataset 2: Data obtained from Scopus files in ris format in May 2017. DOI, 10.5256/f1000research.12649.d184838[37]

Dataset 3: Data obtained from Scopus files in BibTex format in May 2017, to be used with Bibliometrix. DOI, 10.5256/f1000research.12649.d184839[38]

Dataset 4: SCIMAT project file, to be opened in SciMAT with the processed files. DOI, 10.5256/f1000research.12649.d185218[39]

Supplementary material

Figure S1. Present topics inside the clusters of the last five years.

Click here to access the data.

Figure S2. The keyword Economic-conditions is present in some clusters of the last five years (a) initial period (Per0: 2012), (b) second period (Per1: 2013).

Click here to access the data.

Figure S3. The keyword Developing is present inside the clusters of the last five years (a) initial period (Per0: 2012), (b) second period (Per1: 2013), (c) third period (Per2: 2014), (d) fifth period (Per4: 2016).

Click here to access the data.

Figure S4. The keyword Cocoon is present inside the clusters of the last five years (a) third period (Per2: 2014), (b) fourth period (Per3: 2015), (c) fifth period (Per4: 2016).

Click here to access the data.

Figure S5. Present topics in some clusters of the last five years. Topics that appear in a number of clusters include India in (a) for the second period (Per1: 2013), and Breed BM in (b) for the third period (Per2: 2014).

Click here to access the data.

Figure S6. The keyword Genetic present inside clusters of the last five years (a) initial period (Per0: 2012), (b) second period (Per1: 2013), (c) third period (Per2: 2014), (d) fourth period (Per3: 2015), (e) fifth period (Per4: 2016).

Click here to access the data.

References

1. Cifuentes C, Sohn KW: **Manual técnico de sericultura: Cultivo de la morera y cría del gusano de seda en el trópico).** SENA-CDTS, 1998.

2. Aruga H: **Principles of Sericulture.** CRC Press, 1994.
   Reference Source

3. Pescio F, Zunini H, Pedro BC, *et al.*: **Sericultura: Manual para la produccion.** Instituto Nacional de Tecnologia Industrial (INTI), 2006.
   Reference Source

4. Munhoz REF, Bignotto TS, Pereira NC, *et al.*: **Evaluation of the toxic effect of insecticide chlorantraniliprole on the silkworm *Bombyx mori* (Lepidoptera: Bombycidae).** *Open J Anim Sci.* 2013; **3**(4): 343–353.
   Publisher Full Text

5. Shah SIA, Khan IA, Hussain Z, *et al.*: **The effect of three different mulberry varieties on performance of three different *Bombyx mori* L. races.** *Sarhad J Agric.* 2007; **23**(4): 1085.
   Reference Source

6. Zah C, Marghita L: **Nutrition research on silkworms *Bombyx mori* L.** Analele Universitatii din Oradea, Fascicula: Ecotoxicologie, Zootehnie si Tehnologii de Industrie Alimentara. 2011; **10**: 399–402.
   Reference Source

7. Rodríguez A, Vargas J, Ventura A, *et al.*: **Manual de sericultura en Hidalgo: Principios básicos.** Instituto Nacional de Tecnologia Industrial (INTI), 2012.
   Reference Source

8. Castro A, Orozco E: **Cultivo de morera (*Morus spp*) y su uso en la alimentación animal.** INTA, 2010.
   Reference Source

9. Awasthi AK, Nagaraja GM, Naik GV, *et al.*: **Genetic diversity and relationships in mulberry (genus *Morus*) as revealed by RAPD and ISSR marker assays.** *BMC Genet.* 2004; **5**: 1.
   PubMed Abstract | **Publisher Full Text** | **Free Full Text**

10. Mondal M: **The silk proteins, sericin and fibroin in silkworm, *Bombyx mori* Linn.,-a review.** *Caspian J Env Sci.* 2007; **5**(2): 63–76.
    Reference Source

11. Teulé F, Miao YG, Sohn BH, *et al.*: **Silkworms transformed with chimeric silkworm/spider silk genes spin composite silk fibers with improved mechanical properties.** *Proc Natl Acad Sci U S A.* 2012; **109**(3): 923–928.
    PubMed Abstract | **Publisher Full Text** | **Free Full Text**

12. Shuobin Y: **La cultura de la seda en la china antigua.** *Revista Instituto Confucio.* 2015; **VI**: 62–76.
    Reference Source

13. Medina MG, García DE, Moratinos P, *et al.*: **La morera (*Morus* spp.) como recurso forrajero: Avances y consideraciones de investigación.** *Zootecnia Tropical.* 2009; **27**(4): 343–362.
    Reference Source

14. Singhal BK, Khan MA, Dhar A, *et al.*: **Approaches to industrial exploitation of mulberry (*Morus* sp.) fruits.** *J Fruit Ornam Plant Res.* 2010; **18**; 83–99.
    Reference Source

15. Hyvrinen A: **La seda en el mercado mundial.** Technical report, Centro de Comercio Internacional, 1999.
    Reference Source

16. Richards AF: **Nylon Fibres.** In *Synthetic Fibres: Nylon, Polyester, Acrylic, Polyolefin (Woodhead Publishing Series in Textiles)*; Woodhead Publishing, 2004; 20–88.
    Publisher Full Text

17. McIntyre JE: **Historical background.** In *Synthetic Fibres: Nylon, Polyester, Acrylic, Polyolefin (Woodhead Publishing Series in Textiles)*; Woodhead Publishing, 2004; 1–15.
    Publisher Full Text

18. Hänninen T, Hughes M: **Historical, contemporary and future applications**. In *Industrial Applications of Natural Fibres: Structure, Properties and Technical Applications*; Wiley, 2010; 385–396.
    Reference Source

19. Pademer: **La influencia de la integración de productores y artesanos en el desarrollo de la corporación para el desarrollo de la sericultura del Cauca**. Sistematización de experiencias locales proyecto de apoyo al desarrollo de la microempresa rural. Technical report, Pademer, 2003.
    Reference Source

20. Cobo M, López-Herrera A, Herrera-Viedma E, *et al.*: **An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field.** *J Informetr.* 2011; **5**(1): 146–166.
    Publisher Full Text

21. Aria M, Cuccurullo C: **bibliometrix: an R tool for comprehensive bibliometric analysis of scientific literature.** University of Naples Federico II Naples, Italy, 2016.

22. Zupic I, Cater T: **Bibliometric Methods in Management and Organization.** *Organ Res Methods.* 2015; **18**(3): 429–472.
    Publisher Full Text

23. Heradio R, de la Torre L, Galan D, *et al.*: **Virtual and remote labs in education: A bibliometric analysis.** *Comput Educ.* 2016; **98**: 14–38.
    Publisher Full Text

24. Cobo M, Martínez M, Gutiérrez-Salcedo M, *et al.*: **25years at Knowledge-Based Systems: A bibliometric analysis**. *Knowl Based Syst.* 25th anniversary of Knowledge-Based Systems. 2015; **80**: 3–13.
    Publisher Full Text

25. Murgado-Armenteros EM, Gutiérrez-Salcedo M, Torres-Ruiz FJ, *et al.*: **Analysing the conceptual evolution of qualitative marketing research through science mapping analysis.** *Scientometrics.* 2015; **102**(1): 519–557.
    Publisher Full Text

26. Martínez MA, Herrera M, Contreras E, *et al.*: **Characterizing highly cited papers in Social Work through H-Classics.** *Scientometrics.* 2015; **102**(2): 1713–1729.
    Publisher Full Text

27. Martínez MA, Cobo MJ, Herrera M, *et al.*: **Analyzing the Scientific Evolution of Social Work Using Science Mapping.** *Res Soc Work Pract.* 2015; **25**(2): 257–277.
    Publisher Full Text

28. Cuccurullo C, Aria M, Sarto F: **Foundations and trends in performance management. A twenty-five years bibliometric analysis in business and public administration domains.** *Scientometrics.* 2016; **108**(2): 595–611.
    Publisher Full Text

29. Aria M, Cuccurullo C, Sarto F: **Exploring healthcare governance literature: systematic review and paths for future research.** MECOSAN. 2015; 61–80.
    Publisher Full Text

30. Garfield E: **Scientography: Mapping the tracks of science.** Current Contents: Social & Behavioural Sciences. 1994; **7**: 5–10.
    Reference Source

31. de Solla Price D, Gürsey S: **Studies in Scientometrics I Transience and Continuance in Scientific Authorship.** *Ciência da Informação.* 1975; **4**(1).
    Reference Source

32. Callon M, Courtial JP, Laville F: **Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemsitry.** *Scientometrics.* 1991; **22**(1): 155–205.
    Publisher Full Text

33. Courtial JP, Callon M: **Indicators for the identification of strategic themes within a research programme.** *Scientometrics.* 1991; **21**(3): 447–457.
    Publisher Full Text

34. Coulter N, Monarch I, Konda S: **Software engineering as seen through its research literature: A study in co-word analysis.** *J Am Soc Inf Sci.* 1998; **49**(13): 1206–1223.
    Publisher Full Text

35. Petkov N, Tzenov P, Petkov Z, *et al.*: **Silkworm, *Bombyx mori* L. germplasm resources in Bulgaria.** Technical report, National Centre for Agrarian Sciences–Sofia, Sericiltural Experiment Station–Vratza, 2006.
    Reference Source

36. Ramirez-Gonzalez G, Zambrano-Gonzalez G, Almanza-P MI: **Dataset 1 in: The Evolution of knowledge in Sericultural Research through a science mapping approach.** *F1000Research.* 2017.
    Data Source

37. Ramirez-Gonzalez G, Zambrano-Gonzalez G, Almanza-P MI: **Dataset 2 in: The Evolution of knowledge in Sericultural Research through a science mapping approach.** *F1000Research.* 2017.
    Data Source

38. Ramirez-Gonzalez G, Zambrano-Gonzalez G, Almanza-P MI: **Dataset 3 in: The Evolution of knowledge in Sericultural Research through a science mapping approach.** *F1000Research.* 2017.
    Data Source

39. Ramirez-Gonzalez G, Zambrano-Gonzalez G, Almanza-P MI: **Dataset 4 in: The Evolution of knowledge in Sericultural Research through a science mapping approach.** *F1000Research.* 2017.
    Data Source

Open Peer Review

Current Referee Status: ?

Version 1

Referee Report 20 December 2017

? **Manuel Jesus Cobo** (iD)

Department of Computer Science and Engineering, University of Cádiz, Cádiz, Spain

In this paper, a bibliometric analysis of the Sericulture field has been carried out by means of science mapping analysis. To do that, SciMAT and Bibliometrix was employed.

Although the paper is interesting, it must be further improved. In general, it is not well organized and it is difficult to read, and therefore, understand.

Regarding the methodology, authors must to clarify the use of two software. And also, authors must to read carefully the methodology used since some concepts seem not clear.

Moreover, the contribution of the paper to the field is very little. Authors do not extract relevant conclusion from the results. They just describe the figure and tables. Also, the objectives are not clear.

In what follows, some comments and suggestion are listed.

- The introduction describes the sericulture research field deeply, but the objective and research questions of the paper are missing. Authors must to clarify if there are other bibliometric analyses focused on that topic, and the importance of this research.

- Two software tools are used in this study: SciMAT and Bibliometrix. But, they are not properly cited. Both software have associated a publication published in important journals. For example, SciMAT is published in JASIST in 2012[1] and Bibliometrix is published in JOI in 2017[2]. Authors should cite correctly the software used. Moreover, there is a reference to SciMAT, but authors confused the methodology used by SciMAT with the paper describing SciMAT. Both paper should be cited.

- Why authors use SciMAT and Bibliometrix?

- What is the query used to retrieve the data?

- Authors should clarify why they used two different databases to retrieve the data. If two databases are used, authors should not take into account the citations, since may vary in WoS and Scopus.

- Authors perform a deduplication step over the keywords?

- How Figure 4 was created?

- Why the conceptual evolution is shown before the strategic diagrams? It does not make sense. Thus, Figure 8 (strategic diagrams) must be place before Figure 7 (evolution).

- Last paragraph of page 6 does not provide nothing interesting, since it is just describing the overlapping figure in a textual way. Authors should make an effort to show the knowledge learned.

- Regarding the strategic diagrams, authors just put them but any comment is added. This is the most important part of the papers, and there is any comment describing them. Also, the strategic diagrams are difficult to understand since they have a lot of themes. I recommend to set a higher threshold for the data and network in SciMAT.

- Why authors make a complementary analysis of the last five years in five different periods? In this subanalysis, authors made the same errors than in the analysis of the other periods. That is, no comments (or just a few) describing the results.

- Finally, the discussion and conclusion must be further improved. Authors must make a great effort extracting knowledge from their results. That is, authors should not just mention the results shown in Tables and Figures, but describe and interpret the results.

References

1. Cobo M, López-Herrera A, Herrera-Viedma E, Herrera F: SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*. 2012; **63** (8): 1609-1630 Publisher Full Text

2. Aria M, Cuccurullo C: bibliometrix : An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*. 2017; **11** (4): 959-975 Publisher Full Text

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
No

Competing Interests: No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias

- You can publish traditional articles, null/negative results, case reports, data notes and more

- The peer review process is transparent and collaborative

- Your article is indexed in PubMed after passing peer review

- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research