



The role of the journal *Periodicum biologorum* in representing the development of biological sciences in Croatia

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Abstract

Background and Purpose: The journal *Periodicum biologorum* is the first Croatian journal in the field of biological sciences which has been published regularly since 1886 and which has had the leading role in conveying scientific information in the field of biology in Croatia. The bibliometric analysis of the content of this journal in time span 1886–2010 provided an insight into the structure of scientific communication in the field of biology in Croatia with a purpose to present trends and development of specific biological disciplines.

Materials and Methods: The analysed sample consists of 1,347 articles classified into eight biological disciplines and 40 subdisciplines over a 122-year period, 1886–2010. In order to provide easier assessment of the development of biological sciences and presenting results, the publishing period of journal has been divided into functional periods.

Results and Conclusion: Since the beginning of its publication until the 1950s, the fields of study predominant in the journal involved classic biological disciplines of zoology and botany, i.e. their mostly descriptive subdisciplines. From the 1970s onwards, biological disciplines and subdisciplines in the journal have been developed in accordance to global trends, with domination of experimental fields of molecular biology, immunology, physiology etc. Despite the fact that research was conducted only with a purpose to enhance the development of biological sciences in Croatia, this journal also presents an important communication media in biomedical disciplines and subdisciplines. A detailed scientometric analysis might help the journal editorial board to reach decisions concerning journal's future development more easily.

INTRODUCTION

A journal, as the primary medium in scientific communication in the field of natural sciences, is one of the most commonly used sources in bibliometric research. Those types of research based on the form and contents of scientific articles may provide an insight into various aspects of scientific activity in a particular field. Through different parameters used to define a journal it is also possible to assess the development and influence of particular scientific discipline or a field. The assessment of development trends in certain scientific disciplines and of constant changes in the research environment may aid the

scientists to reach decisions regarding the direction of their future research activities, while, on the other side, it facilitates the creation of scientific policy and more efficient distribution of financial resources for research.

Following scientific developments in the world, since the mid 19th century ever more attention has been devoted to the development of natural sciences in Croatia. In 1885, the Croatian natural scientists gathered around Spiridon Brusina, the first professor of zoology at the Zagreb University, founded the *Croatian Society of Natural Sciences (Hrvatsko prirodoslovno društvo)* aimed at promotion of natural sciences in this part of Europe. As one of the most important activities of the *Society* was publishing of scientific research results, in 1886 the *Herald of the Croatian Society of Natural Sciences (Glasnik Hrvatskoga prirodoslovnog društva)* was launched, as the first scientific journal in the field of natural sciences in Croatia. In the course of its long term publishing the journal changed its names depending on the development of natural sciences or the problem issue presented. Within the first period of its publishing, until 1938, the *Herald (Glasnik)* used to publish original scientific articles in all fields of natural sciences. Since 1947, under the name the *Herald of the Biological Section (Glasnik Biološke sekcije)*, and from 1953 as the *Biology Herald (Biološki glasnik)* the journal published primarily articles dealing with biological problem issues. The journal has been published under its present name *Periodicum biologorum* since 1970. Despite changes of its name since 1886 until the present day, this journal has been the representative channel of the development of biological sciences in Croatia.

Until now, the research of the journal *Periodicum biologorum* has been partly conducted from historical perspective (1), or in relation to its role within the scope of activities of the *Croatian Society of Natural Sciences* (2). Partial bibliometric research of the journal has been conducted on several occasions by the editorial board (3, 4, 5) and within the research of Croatian scientific journals in *ISI* databases (*Institute for Scientific Information*) (6, 7). This research is the first systematic bibliometric research of the journal *Periodicum biologorum* since the beginning of its publishing in 1886, with a purpose to present the directions in the development of certain scientific fields of biological sciences in Croatia.

In order to obtain an overall insight into the significance of the journal under its present name *Periodicum biologorum*, as the main communication medium for the field of biological sciences in Croatia, the bibliometric research of the journal in time span 1886–2010 was conducted. A more coherent picture of the development of biological sciences would be obtained by carrying out a complex research on the overall productivity (including the papers in other Croatian and international journals, scientific books, course books, handbooks and other types of publications) and its reception in the relevant international community.

Despite the fact that *Periodicum biologorum* is the oldest Croatian journal which assesses the development

of biological sciences in the small scientific environment, it is by no means the only representative of the development of biological sciences in Croatia. A more coherent picture of the development of biological sciences would be obtained by carrying out a complex research on the overall productivity (including the works in other Croatian and international journals, scientific books, course books, handbooks and other types of publications) and its reception in the relevant international community.

MATERIAL AND METHODS

Although this journal published various document types, in its, for Croatian circumstances long history, only scientific articles were encompassed by this research. The analyzed sample consists of 1,347 articles pertaining to biological sciences published in the journal *Periodicum biologorum* over a period of 122 years, i.e. from 1886 until 2010. The articles are classified according to their content into eight biological disciplines and forty subdisciplines. Due to the fact that numerous articles are multidisciplinary or interdisciplinary it was almost impossible to make a consistent classification. Therefore, certain subjectivity was inevitable, which should be taken into account during the interpretation of data, or while reaching the conclusions. The representation of biological disciplines and corresponding subdisciplines is reflected in the number of articles per certain period, or through the number of years of their publication.

In order to facilitate the assessment of the development and transparency of results, publishing period of journal has been divided into logical and functional intervals. The first period took place since the establishment of journal in 1886 until 1938 which was also the last year of its publishing under the name the *Herald of the Croatian Society of Natural Sciences*. Considering the fact that the journal was not published during and immediately after the World War II, in conceptual terms that marked the end of the period in which the journal served as a herald for a broader area of natural sciences in Croatia. The second period covered in the analyses took place in the period between 1947 and 1969 in which the journal, upon the foundation of *Biological Section of the Croatian Society of Natural Sciences* was published under the name the *Herald of the Biological Section* i.e. *Biological Herald*. The third period which lasted from 1970 until 2010, with another change of name into *Periodicum biologorum*, was in conceptual terms more oriented towards the expansion and development of biomedical disciplines and subdisciplines. Due to the predefined goal of this research, namely the assessment of the development of biological disciplines in Croatia, the articles from the field of biomedicine and other scientific fields have not been taken into consideration, neither the volumes of the journal only with published conference abstracts and extended abstracts.

RESULTS AND DISCUSSION

The journal under the present name *Periodicum biologorum* is the first and the oldest Croatian journal in the

field of biological sciences which has been published continuously since 1886 and which has a leading role as the representative conveyor of scientific information for all fields of biological sciences in Croatia. The analyses confirmed the thesis of the essential role of editors and editorial board for the contents and concept of the journal.

In the first period of its publishing until 1938, when the journal used to publish articles from all fields of natural sciences, the editors were prominent Croatian natural scientists, botanists, zoologists, geologists, mathematician and chemists. It is particularly important to emphasize the role of exceptional and versatile Croatian natural Scientist, Spiridion Brusina, the founder of the journal and its editor over the period of 18 years. Through his efforts, the journal was successfully following the world scientific trends which also included the need to publish the articles in foreign languages in order to ensure the availability of researches acquired by the Croatian natural scientists, to the relevant international scholarly community. Apart from Brusina, it is also important to mention the following editors in the above mentioned period: Antun Heinz, botanist, Oton Kučera, physicist, Ferdo Koch, geologist and so forth.

In the post-war period, since 1947 and especially since the late 1950s, biomedical and medical scientists became editors which resulted in incorporation of articles from biological and medical branches and disciplines into the journal. The fact that in the period from 1947 until 1969 the editors were Ivo Ehrlich and Teodor Varačak, veterinarians, and Nikša Allegretti, physiologist at the *Faculty of Medicine* in Zagreb goes in favour of mentioned information.

Since the 1970s the profile of the journal and its editorial board changed significantly and the emphasis was put on the publishing of papers and articles in biomedical disciplines and subdisciplines which were undergoing an intense development and were primarily rooted in biological sciences, such as immunology, genetics and so forth. Since 1975 and over the next twenty years the editor was Vlatko Silobričić, physician/immunologist.

Due to the quality of its articles and their compatibility with global standards of quality scientific publishing, in 1972 the journal *Periodicum biologorum* was included in the most selective bibliographic database *CC (Current Contents)*, the core of the world knowledge at that time. Due to the loss of features of a quality world scientific journal, after 20 years, in 1992, that database ceased to index the journal. The reason should be partially sought in publishing of a large number of abstracts and extended abstracts from scientific symposia, congresses and conferences which had a negative impact both on the quality of the journal and formally on *IF (Impact Factor)*. In addition to that, the negative impact on the journal's development and its future status was caused by the Croatian *Regulations on the scientific promotion*. According to that *Regulations*, the key "quality" criterion was journal's indexed in the *CC* database which resulted in the absence of the best works of Croatian biologists.

The development of biological sciences in Croatia according to disciplines

In the research of developmental trends of particular scientific disciplines various approaches have been applied. In order to determine the new foci in the researched areas, Chen (8) and Small (9) proposed a method based on the "co-citation" analysis of articles. By applying the method of "co-word" analysis, Lee (10) conducted the research based on the frequency of occurrence of pairs of words or phrases which enables a profound insight into the contents of the research topic. Further to Price's (11) hypothesis according to which the number of articles in a certain scientific field increases significantly after that field becomes prominent and begins to attract more scientists attention, Nyons (12) and associates were testing the frequency of the activities and the establishment of new scientific trends by assessing the change in the number of articles in the researched areas.

In this research, the trends in the development of certain biological disciplines and subdisciplines in Croatia were assessed on the basis of 1,347 articles published in the journal *Periodicum biologorum* over the period between 1886 and 2010.

In order to obtain an insight into the status of biological disciplines in relation to other natural sciences disciplines covered by this journal, in the initial period between 1886 and 1938 under the name the *Herald of the Croatian Society of Natural Sciences*, this analysis has been conducted as well.

In the overall sample, the biological sciences represented in the journal were classified into eight disciplines. The most represented disciplines according to the number of articles were zoology (28%), physiology (18%), molecular biology (15%) and botany (14%), whereas marine biology (5%), microbiology (4%), general biology (3%) and ecology (3%) were less represented (Figure 1).

The development of particular biological disciplines followed by the number of articles per functional periods is presented in Figure 2.

In the first period of journal's publishing from 1886 until 1938, the most represented biological disciplines were zoology with 46.5% and botany with 15.5% articles.

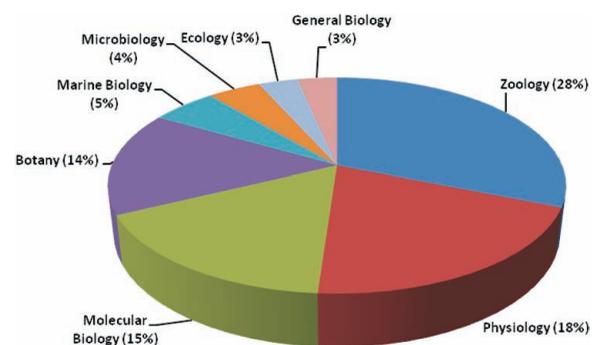


Figure 1. Biological disciplines represented in the journal *Periodicum biologorum* in time span 1886–2010.

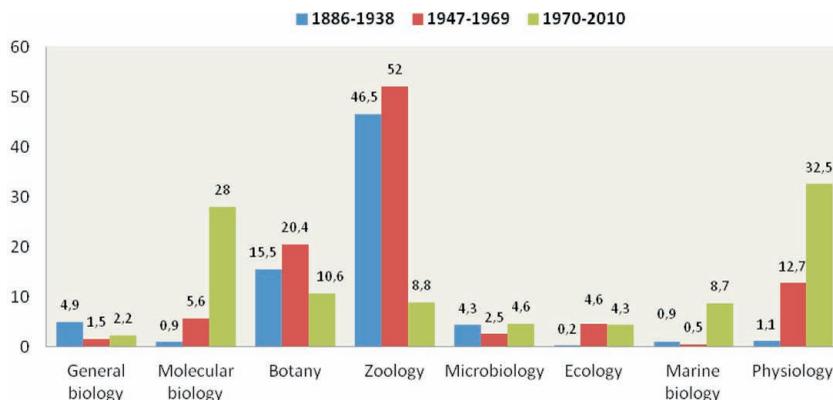


Figure 2. Biological disciplines in the journal *Periodicum biologorum* given in percentage by periods.

The explanation for the data presented above may be found in scientists' desire to study and carry out a more comprehensive research of Croatian flora and fauna in the second half of the 19th century. Additionally, those were the first scientific disciplines in which, upon the establishment of the *Department of Zoology* and *Department of Botany and Physiology* of the University in 1874, a systematic and organised scientific work began and which marked the beginning of higher education in the field of biology in Croatia.

In the period from 1947 until 1968, classical disciplines such as zoology (52%) and botany (20.4%) prevailed in the journal, whereas a significant increase of scientific activities compared to the previous period was recorded in physiology (12.7%), ecology (4.6%) and molecular biology (5.6%). The development of experimental disciplines in the above mentioned period enabled primarily the redirection of biology study programme which, until 1946 belonged to the *Faculty of Humanities and Social Sciences*, to the newly established *Faculty of Science* in Zagreb. Some specialized biological disciplines were studied at the other newly established university and scientific institutes and departments. The establishment of the *Ruđer Bošković Institute* in 1950, and its *Department of Biology* in 1958, was particularly important for the development of biological sciences, especially molecular biology.

The prevalence of experimental biological disciplines in the journal is visible in the last assessed period of its publishing, i.e. from 1970 until 2010. The largest scientific activity measured by the share of articles was recorded in physiology (32.5%) and molecular biology (28%), whereas a significant increase was recorded in marine biology (8.7%), microbiology (4.6%) and ecology (4.3%).

The classification system of certain biological disciplines and subdisciplines encompassed by the research in relation to the percentage of articles and the period of publishing is presented in Table 1.

Classical biological disciplines are represented with the largest number of subdisciplines, botany with 10 subdisciplines and zoology with 14 subdisciplines, as a result of a relatively large number of articles in the journal

dedicated to various aspects of botanical and zoological research in certain periods of journal's publishing. The second reason lies in the fact that due to the specific qualities and structural differences, certain subdisciplines such as anatomy, morphology, ecology and physiology were assessed separately in both categories of organisms. Entomology as an active zoological subdiscipline with a relatively high share of articles has been singled out in relation to other invertebrates.

Most articles were published in the following subdisciplines: molecular biology and biochemistry (11.8%), immunology (9.9%), flora and vegetation (7.2%) and entomology (6.4%).

Classical biological disciplines such as zoology and botany were published over the largest period of time. This is understandable due to the fact that the earliest biological research in Croatia was targeted at the research of domestic flora and fauna. As the result of development of numerous subdisciplines many of which are interdisciplinary and experimental, those disciplines have also remained in the focus of interest of authors in the journal even in the recent times. The longest researched zoological subdiscipline is entomology with articles published in the period from 1887 until 2010. Over a 120-year period of journal's publishing, from 1886 until 2006, articles in botanical subdisciplines of anatomy and morphology as well as flora and vegetation were published. It is important to notice the long term period of publication of experimental biological fields in the journal, namely general physiology (1886–2001) and immunology (1904–2004), which points to the development of those disciplines in Croatia since the first years of journal's publishing. Additionally, cell biology and genetics were represented in the journal with a relatively long period of publication.

Particularly interesting is the long term presence of marine biology which, as the researched discipline, appeared in the journal from 1892 until the end of this research in 2010. The research of the Adriatic Sea was intensified at the end of the 19th century after the establishment of first stations for marine studies at the Adriatic coast in Trieste, Rovinj and Rijeka. It is hereby necessary to emphasize the crucial role of Spiridion Brusina who was

TABLE 1

Representation of biological disciplines and subdisciplines in the journal Periodicum biologorum.

Biological disciplines and subdisciplines	Percentage of articles	Period of publishing
GENERAL BIOLOGY	3	1886-2004
Evolution/ Paleoanthropology	1,2	1889-2006
General/Theoretical biology	1	1887-1998
History/Philosophy of biology	0,8	1886-2004
MOLECULAR BIOLOGY	15	1904-2008
Bioinformatics	1,3	1979-2006
Genetics	1	1904-1993
Molecular Biology /Biochemistry	11,8	1961-2008
Cell Biology	0,9	1913-2006
BOTANY	14	1886-2008
Anatomy/Morphology	0,7	1886-2006
Plant Virology/Phytochemistry	0,9	1947-2008
Plant Ecology/Geobotany	0,8	1910-2008
Plant Physiology	1,7	1889-2006
Flora/Vegetation	7,2	1886-2006
Horticulture	0,3	1886-1963
Palinology	0,1	2005-2006
Sistematics	0,1	1894-1997
Ultrastructure/Tissue culture	1,7	1977-2008
ZOOLOGY	28	1886-2008
Anatomy/Morphology	0,6	1953-1999
Invertebrates	3,1	1886-2006
Animal Ecology	1,1	1917-2006
Embriology	1,9	1888-2006
Entomology	6,4	1887-2008
Fauna	1,8	1886-2006
Animal Physiology	2,2	1947-2006
Herpetology	0,9	1896-2006
Ichthyology	2,7	1887-2003
Mammalogy	0,4	1903-1974
Ornithology	3,9	1887-1947
Parasitology	0,9	1887-1960
Paleozoology	1,9	1886-1938
Protists	0,8	1896-2005
MICROBIOLOGY	4	1886-2006
Bacteriology	0,7	1888-1995
Micology	1,4	1886-2005
Virology	1,3	1963-2006
ECOLOGY	3	1938-2006
General ecology/Biodiversity	0,4	1938-2006
Terrestrial ecology	0,4	2005-2006
Freshwater ecology	2	1956-2005
MARINE BIOLOGY	5	1892-2008
PHYSIOLOGY	18	1886-2008
General Physiology	5,6	1886-2001
Immunology	9,9	1904-2004
Neurobiology	1,3	1972-2006
Toxicology	1,5	1980-2008

TABLE 2

Other natural science disciplines in the first period of journal's publishing (1886-1938).

Scientific disciplines	Percentage of articles	Period of publishing
EARTH SCIENCES	6	1887-1938
Geology	3,3	1889-1938
Geophysics/Meteorology	1	1887-1936
Geography	2,2	1888-1922
CHEMISTRY	0,6	1888-1910
ASTRONOMY, PHYSICS, MATHEMATICS	1,8	1896-1938

very aware of the importance of versatile scientific research of the Adriatic Sea for Croatia, carried out an intense work on organisation and realisation of such research.

A somewhat more complete picture of the condition of biological sciences in relation to other natural science disciplines in the first period of journal's publishing from 1886 until 1938, indicates that after biological sciences, the most represented were geosciences (Table 2).

The reasons for that may be interpreted in terms of professional orientation of editors who were predominantly biologists yet also geologists, and by the fact that at that time most natural scientists in Croatia were engaged exactly in those fields. The afore mentioned reasons may partly justify the fact that this journal offered a relatively few articles in physics, chemistry or mathematics. In the field of geosciences, geology were represented with most articles (3.3%), geography (2.2%) as well as geophysics and meteorology (1%). In the field of astronomy, physics and mathematics the total of 1.8% articles were published in the journal. The largest share of articles was from the field of astronomy (1%), whereas physics and mathematics were less researched. The presence of a larger number of articles in astronomy in the first year of journal's publication may also be related to the activities of our renowned astronomer Oton Kučera who edited the journal in the period from 1902 until 1910.

Developmental trends of biological subdisciplines according to periods

Period from 1886 until 1938

The first period of journal's publishing, from 1886 until 1938, was characterised by the articles of the renowned Croatian natural scientists. As a result of the interest and intense work in the research of flora and fauna in the second half of the 19th century carried out by domestic scientists, the most represented were classical biological disciplines zoology and botany, or their predominantly descriptive subdisciplines flora and vegetation, entomology, ornithology, faunistics etc. Of the total of 29 subdisciplines researched in the above mentioned period, the most represented subdisciplines are shown in Figure 3.

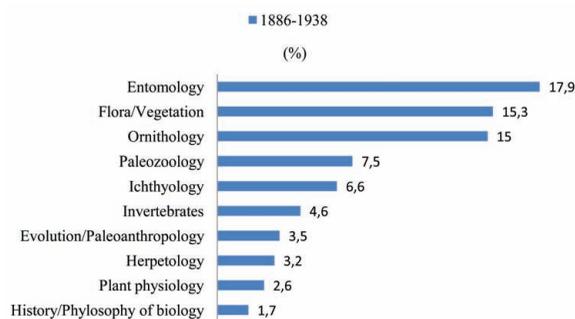


Figure 3. The most represented biological subdisciplines in the period 1886–1938.

In the analysed period, the zoological subdiscipline entomology was prevailing with the largest number of articles, 17.9%. According to authors' geographical representation, that subdiscipline was researched in different parts of Croatia: A. Korlević (Rijeka), M. Katurić (Zadar), Gj. Koča (Vinkovci), N. Damin (Senj), A. Langhoffer, and Z. Lorković (Zagreb) etc. It was followed by ornithology with a high share of 15% articles, as a result of the activities of the *Croatian Ornithological Station* which has been carrying out and coordinating bird ringing in Croatia since 1910. It is interesting to point out that one of the first ornithological articles was written by S. Brusina in 1888.

Paleozoology was represented by 7.5% articles, primarily due to the research of Croatian palaeontologist, geologist and archaeologist Dragutin Gorjanović Kramberger. Kramberger was a versatile person in the field of geosciences in Europe, and the importance of his paleoanthropological and paleozoological discoveries places him among the best paleontologists of his time, even from the present point of view (13). Apart from Kramberger, the authors of paleozoological articles were F. Koch, J. Poljak, K. Babić, S. Brusina etc. The influence of Kramberger's significant paleoanthropological discoveries in Krapina is also reflected in the journal with 3.5% articles from the field of evolution and paleoanthropology.

Among botanical subdisciplines present in the researched period the most represented were flora and vegetation (15.3%), which, at that time, was predominantly descriptive. Among the authors engaged in the study of Croatian flora, the most represented in the journal were D. Hirc, L. Adamović, Lj. Rossi, A. Forenbacher, F. Koščec, S. Gjurašin etc. The share of 2.6% articles in plant physiology mostly results from Professor V. Vouk's activities and his role in the establishment of physiological laboratory at the *Department of Botany of the University of Zagreb* in 1928, which was at that time equipped for modern physiological and microbiological research. In connection with the representation of articles in history and philosophy of biology (1.7%), it might be interesting to mention the fact that the first article in the journal dealt exactly with philosophical subject matter. The fact is that on the occasion of journal's publication, the editorial board asked Oton Kučera to write an article on "Man and Natural Science" (14) which presented the

state of natural sciences in the world at that time, but which also reflected the attitude of the members of the *Croatian Society of Natural Sciences* towards philosophical problems of natural science.

Period from 1947 until 1969

The second researched period in the history of journal's publishing, from 1947 until 1969 is characterised by the fact that in the researched articles the classical biological disciplines of zoology and botany were still prevalent, and that within them a significant move towards experimental subdisciplines (animal physiology, embryology, plant virology) could be observed. Among the total of 28 researched subdisciplines, the most represented in that period were flora and vegetation with 13.3% articles (Figure 4).

The appearance of general physiology, the second represented subdiscipline which was at that time present with 12.8% articles, may be related to indications of the change in journal's direction. When the journal changed its name into *Biological Herald (Biološki glasnik)* in 1956, its subtitle indicated that it was also the herald of the *Society for Experimental Medicine*. The increase in the number of articles in general physiology may also be related to the establishment of the *Department of Physiology at the Division of Biology of the Faculty of Science* in Zagreb in 1963, which for the first time enabled the development of physiology as a subdiscipline within natural sciences. That created the prerequisites for systematic scientific work in the field of physiology but also in other subdisciplines such as immunology, transplantation immunology, toxicology etc. as new biological subdisciplines which shall be taken over by medicine in course of time, primarily for pragmatic purposes.

As important information related to the researched period, it is necessary to emphasize the appearance of the first articles in the field of molecular biology and biochemistry (4.1%). The research results in that field have been present in the journal since 1961, almost since the very beginning of the development of that discipline in our country. The systematic research in the field of molecular biology in Croatia began upon the establishment of the *Ruđer Bošković Institute*, i.e. *Department of Biology* in 1958. The radiobiologist Banimir Miletić, Ph.D. is considered the initiator of that field in Croatia. With a group of associates, he began the research related to the in-

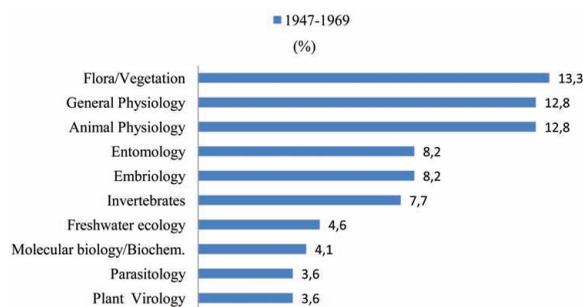


Figure 4. The most represented biological subdisciplines in the period 1947–1969.

fluence of radiation on DNA metabolism of simple life forms, bacteria, bacterial viruses and animal cell in tissue culture (15). Miletić and his associates published the results of their observations in world-renowned journals, amongst which was *Nature*. In the 1960s, Miletić and his associates published 4 articles in the field of molecular biology and biochemistry in the journal *Periodicum biologorum*. This information is very important for the journal and the state of scientific awareness of Croatian scientists of that time.

The presence of ecological research, namely freshwater ecology, in the afore mentioned period with 4.6% articles, was mostly related to the activities of the *Department of Zoology of the Faculty of Science* in Zagreb. The first course in ecology at that *Department* named the *Ecology of Terrestrial Animals* was introduced by Professor Nikola Fink as early as 1934. Following the development of ecology as an interdisciplinary science which tends to incorporate the knowledge of other professions, the chemists, climatologists, hydrologists etc., new ecological courses were introduced in the study programme, hence scientific research of employees of the *Department of Zoology* was aimed at that direction.

The significant development of plant virology as a new botanical subdiscipline in Croatia was reflected in the journal with 3.6% of published articles as a result of the establishment of *Laboratory for Virology* at the *Department of Botany of the Faculty of Science* in Zagreb in the 1960s, as well as scientific productivity of laboratory founder, Professor Davor Miličić and his associates.

Period from 1970 until 2010

In the last observed period from 1970 until 2010, the journal *Periodicum biologorum* became an attractive medium for a large number of biological subdisciplines as the result of its international character, regular publishing and the fact that in 1972 it entered the prestigious database of that time, *CC (Current Contents)*. This fact is supported by contemporary research topics which were covered in articles in the period in question. Experimental subdisciplines prevailed and they were based on modern scientific technologies which were also prevalent in classical disciplines zoology and botany (Figure 5).

Among the total of 38 subdisciplines, the most represented subdisciplines at that time were molecular biology and biochemistry with 22% articles. It is hereby necessary to emphasize the activities of the scientists from the *Ruder Bošković Institute* who acquired a new impetus in the 1980s when new laboratories for molecular research were opened and with the establishment of the *Department for Molecular Genetics*, later to change its name into the *Department for Molecular Biology*. This is substantiated by the fact that in the period from 1990 until 1992, 53% of the total number of articles in the field of molecular biology and biochemistry in Croatia were published by the scientists from the *Ruder Bošković Institute*.

The recognition of the research in the field of molecular biology in Croatia was supported by the initiation of

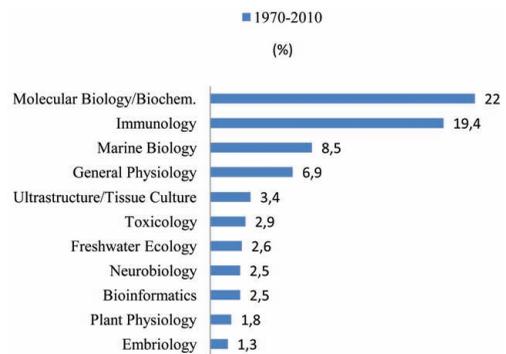


Figure 5. The most represented biological subdisciplines in the period 1970–2010.

the first university courses in the 1970s, at the study programme at that time known as *Experimental Biology* at the *Division of Biology of the Faculty of Science of the University of Zagreb*, followed by the establishment of the *Department of Molecular Biology* at the same Division. Thus, within the faculty and the newly established *Department*, the prerequisites were met to carry out a more systematic research of molecular basis of plant, animal and human biology. Aside from that, the research of molecular basis of life was also carried out in other scientific and educational institutions in the country. It is furthermore important to point out to the occurrence of bioinformatics, as a relatively young subdiscipline created at the crossing of computer technologies and molecular biology which flourished at the end of 1980s. A relatively large involvement of bioinformatics with 2.5% articles in the afore mentioned period resulted mostly from thematic journal issues dedicated to the research of proteins, bioinformatics and computer biology (16).

Among physiology subdisciplines, immunology was represented with most articles (19.4%), followed by general physiology (6.9%), toxicology (2.9%) and neurobiology (2.5%), which were undergoing intense development in the world at that time as well. Due to the fact that at that time the journal *Periodicum biologorum* belonged to prestigious international journals and that it was the only Yugoslav journal of that kind, it was logically attracting an increasingly large number of experts from the field of biomedical sciences both in Croatia and in the former country. The editorial board explained the large share of articles in immunology as a "reflection of the fact that in our environment, immunologists represent a very active group of researchers in the field of biomedicine" (17).

A relatively high percentage of 8.5% of articles in interdisciplinary field of marine biology in the period from 1970 until 2010 is mostly the result of two thematic issues dedicated to that subject matter (18), but also of the growing presence of that discipline in scientific research in Croatia. Although scientific research of the Adriatic Sea was systematically carried out even in the previous period in the research centres in Rovinj, Split and Dubrovnik, in 1997 the Croatian government initiated the "*Adriatic Project*" (18) as a reflection of the need to design a national strategy for sustainable development

of the Adriatic Sea and the use of its resources. The research results related to that project were partly published in the journal *Periodicum biologorum*, although a specialised Croatian journal *Acta Adriatica* has been continuously published for 80 years, and until 1991 the journal *Thalassia Yugoslavica* was published covering oceanographic and geophysical aspects of the sea.

Botanical subdisciplines, ultrastructure and tissue culture are present in the journal with 3.4% articles, mostly in the issue dedicated to the 50th anniversary of the modern plant biology in Croatia (20). The crucial role for the development of that subdiscipline in Croatia was the establishment of the *Laboratory for Electron Microscopy of the Ruđer Bošković Institute*, as the research centre for ultrastructure and physiology of plant cells. It is also necessary to emphasize the role of Professor Z. Devidé and his associates, particularly Professor S. Jelaska at the *Faculty of Science* in Zagreb to whom the credit goes for the fact that in the 1980s Zagreb became the regional centre for the culture of plant cells.

The extent to which the journal *Periodicum biologorum* shall continue to reflect the state of development of biological sciences in Croatia shall largely depend on national scientific policy and the editorial board itself.

CONCLUSION

The journal *Periodicum biologorum* has had a leading role as a mediator of scientific information in the field of biology in Croatia since 1886, whereby it proved to be the relevant source for the assessment of development of biological sciences. The bibliometric analysis of journal's content in time span 1886–2010 provided an insight into the structure of scientific communication in the field of biology in Croatia and it presented the trends and development of specific biological disciplines.

The analyzed sample comprises 1,347 articles which have been classified in terms of their content into 8 biological disciplines and 40 subdisciplines. In the first period of its publication from 1886 until 1938, classical biological disciplines zoology and botany prevailed in the journal, namely their predominantly descriptive subdisciplines such as entomology, ornithology, flora and vegetation and so forth. In the 1950s and 1960s, within zoology and botany a step forward was visible towards new subdisciplines which require laboratory research (animal physiology, embryology, plant virology etc.). The increase of the activities in the journal was also recorded in experimental subdisciplines such as general physiology as well as molecular biology and biochemistry. Since the 1970s, the development of biological disciplines and subdisciplines has resembled the world trends. Experimental subdisciplines prevail such as molecular biology and biochemistry, immunology, physiology, as well as interdisciplinary fields such as marine biology and freshwater ecology. The experimental subdisciplines (embryology ultrastructure and plant tissue culture, plant physiology) also prevail in the research conducted in classical disciplines zoology and botany.

In order to obtain a more comprehensive insight into the role of the journal *Periodicum biologorum* as a mediator of scientific information in the broad field of biological sciences, it is necessary to carry out the analysis of all of published documents and its visibility through the obtained results, which is a very demanding task. In these turbulent times in which survival, of the tentatively called national journals, becomes ever more questionable, this type of research should help the editorial board to direct the journal towards preserving the role of the relevant medium in scientific communication. On the one side, its title and contents provide it with a broadness which opens towards interdisciplinarity, whereas on the other side it loses its recognisability in the ever growing specialisation of biological disciplines and specialties. It is not irrelevant to mention the indeterminacy of scientific policy towards "national" journals, primarily in the field of natural sciences, which reluctantly acknowledge the adjective "national".

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