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Faunistic studies in Poland – historiography and stages of development*

Abstract: Five stages of faunistic studies in Poland can be distinguished, differing in tasks, principles and methods applied. In Stage One [from the annalists to the Commission of National Education (1773)] faunistic information was collected in order to describe the resources and wealth of the country. In Stage Two (1773–1855) the ideas of Enlightenment put into practice resulted in the preparation of new textbooks based on verified information on faunal resources. In Stage Three (1855–1918) faunistic research became an integral part of the physiographic studies of the old ethnic Polish territory. In Stage Four (1918–1945) a detailed programme of regional faunistic studies was developed on the territory under Polish rule. It was based on new methodology of faunistic research. In Stage Five (1945 till now) quantitative methods were incorporated into faunistic research. Fauna is examined as an important national resource and the investigations are carried out mostly in defined ecosystems such as forests, agrocoenoses, meadows and towns.

Key words: faunistic, historiography, periods, Poland.

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INTRODUCTION

Accounts describing fauna inhabiting the territory of a country, district or region are as old as the earliest written records. In ancient times information of this kind could be found in philosophical papers, alongside cooking recipes (CARUS, 1872). In mediaeval Europe real and imaginary animals provided a natural background for descriptions of countries (KARŁOWSKA-KAMZOWA, 1997). It was only towards the end of this era that first physiographic works were written, including separate chapters or volumes on animal life.

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Faunistic studies emerged as a separate type of scientific activity in the 18th and 19th centuries. Since that time more and more of such studies have been undertaken by researchers with an appropriate knowledge of fauna, owing to the development of animal taxonomy, which became a mature science employing a hierarchical system in the 18th century. Mastering this system required a special professional background. Furthermore, the tasks, needs and public expectations regarding studies of local faunas, and the requirements that such studies should comply with were also articulated in this period (DAHL, 1909).

Thus, contemporary faunistics can be viewed as a result of the development of the natural sciences or the accumulation of knowledge about the world and the environment in which we live. However, its position in relation to other sciences remains unclear. On the one hand faunistic investigations constitute an important component of physiography and have been seen as such by students of animal life and historians alike for more than a century (FEDOROWICZ, 1963). However, faunistics is also considered a constituent of and an auxiliary science to zoogeography (de LATTIN, 1967; UDVARDY, 1978). Another question that arises is whether faunistics, while aiding physiography and zoogeography as well as other branches of science, remains a research-oriented independent subdiscipline of zoology. For faunistics does possess a well-defined object of study – the animals, or fauna, inhabiting a given area, its composition, structure and the changes that it undergoes.

Broadly defined practical needs have always been an important motive and incentive for faunistic research. Chronicles included information about animals to document the wealth of the countries or lands they described. Inventories of zoological peculiarities that could be found there were actually an editorial technique designed to win greater readership. Faunal descriptions in physiographic works are closely associated with the subject of natural resources of economic importance. Hence, one can frequently encounter there accurate descriptions of fish, chase game, bees and breeding animals (e.g. K. KLUK, 1795–1802). Such accounts may also contain information about parasites of man and animals used by people. There is an abundance of descriptions of crop pests and the catastrophic outcome of their mass appearance. Some 19th century physiographic papers were also concerned with the protection of animals threatened with extinction, mostly mammals and birds.

Thus, tendencies in faunistic research are affected on the one hand by the general civilisational development of the country, which, in turn, weighs upon the questions formulated with regard to the study of fauna. The other factor that has stimulated faunistics is the development of animal taxonomy and methods of faunistic explorations which determine the accuracy of faunistic estimations.

It must, nevertheless, be stressed that when the practical needs were especially urgent, faunal explorations could attain a high standard years before parallel developments in zoology took place, as is illustrated by the case of *Porphyrophora polonica* (L.), a tiny insect leading a covert life-style which has by now practically become extinct in Europe. A monograph on this insect with

precise information about its development and biology was published by J. P. BREYN from Gdańsk in 1731. His work has been considered the best achievement in entomology of the pre-Linnaeus era (BODENHEIMER, 1929). 80 years earlier, D. ZWIKER (1650) had published a map of the distribution of this insect in the Polesie region, probably the first zoogeographical map showing the distribution of an animal (KAWECKI & WERNERÓWNA, 1975). Both papers deal with a tiny insect whose biology is associated with the roots of *Scleranthus perennis* (L.) and *Polygonum minus* HUDS., and which is never seen on the surface. That insect, however, was the source of a crimson dye much sought-for by the Gdańsk merchants, who exported it. The practical need underlying the research was the competition from the Mexican cochineal insect, which had been storming the European market since the late 16th century. This need was answered with a scientific study of the existing resources of *Porphyrophora polonica* (L.) on a scale that was not to be repeated in relation to any other animal species for more than a century.

THE HISTORY OF STUDIES OF THE FAUNA OF POLAND

Studies on the progress of explorations of animal life in Poland can basically be divided into two trends. One comprises papers written by historians of science, who analyse the topic from a historical viewpoint – historiographical papers dealing with zoological studies conducted at individual scientific centres and works published by organizations promoting faunal research, mostly biographies of zoologists credited for their contribution to faunistic studies. The other group consists of papers presenting the state of research on the fauna of a particular regions of Poland, especially these rich in valuable natural reserves or an animal group, as well as bibliographical inventories listing faunistic papers published in a given period.

Studies on the historiography of zoological sciences on the territory of Poland have been undertaken by KOŻUCHOWSKI (1963). In his work he set out to analyse the history of zoology in Poland from the viewpoint of completeness of the exploration. A peculiarity of studies of the fauna of Poland is the fact that the country was partitioned and under foreign occupation in the past, owing to which faunal research in different parts of the country could not develop at the same rate and many researchers were forced to publish the results of their work in foreign journals and carry out their studies abroad. Work on the fauna of our country was also conducted by numerous foreign scientists. A detailed portrayal of this situation still remains to be provided by historians of zoology.

J. KOŻUCHOWSKI (op. cit.) included in his book a list of papers attempting to embrace the entire history of zoological studies in Poland. Particularly valuable among these are newer works, published in the 20th century and making use of contemporary methods of historical analysis, such as papers by BŁĘDOWSKI (1912) on the 19th century, by GROCHMALICKI (1931), who concentrated on faunistical studies in the years 1875–1925, by HOYER (1948), who

wrote an outline of the history of Polish zoology, and two items of particular importance: "A history of zoology in Poland" by G. BRZĘK (1947) and "An outline of the history of zoology" by Z. FEDOROWICZ (1962). The list should be supplemented with yet another book by Z. FEDOROWICZ (1963) "An outline of the history of the development of physiography in Poland, with special emphasis on faunistic research (from the earliest times until 1918)".

On the other hand the conclusions drawn by J. KOŻUCHOWSKI (1963: 96) are difficult to accept: the author confines himself to enumerating deficiencies precluding comprehensive analysis of the history of zoology in Poland, but the list he presents is far from complete.

The book by Z. FEDOROWICZ (1963), concerned with the history of physiography, presents a review of studies carried out at individual centres until the end of World War I. A number of less general papers have also been written on this topic. Physiographic work, including faunistic research, at the Warsaw centre, has ben described by SZWEYKOWSKI (1932), NAWROCZYŃSKI (1950) and BRZĘK (1955). The output of scientists from the Wielkopolska region has been presented by BRZĘK (1938), who also wrote about the work of the Vilnius centre (BRZĘK 1947). A work on the history of zoological studies at Jagiellonian University (FEDOROWICZ 1962) includes some information about the development of faunistics since the times of M. SIŁA-NOWICKI. This issue is dealt with in a much more comprehensive manner in another paper by FEDOROWICZ (1971), concerned solely with faunistical research, which was an important element of the activity of the Physiographical Committee of the Polish Academy of Skills. From 1865 on this institution played a crucial role in initiating faunistic studies in that part of the Polish territory which was under Austrian rule. A paper on the development of zoological studies at the Gdańsk centre (FEDOROWICZ 1963) focusses only on the 17th and 18th centuries.

Most of the above papers deal with the times before Poland regained independence in 1919. Faunistic studies in the years 1919–1939 have not been the subject of historiographic investigation so far. GROCHMALICKI'S conference presentation (1931) gave a rather general treatment of the years 1919–1925, due to the lack of historical perspective, and failed to analyse the range of issues dealt with in those papers. Now after over 50 years that have passed since that time we are in a position to come up with a realistic evaluation of the development of faunistic studies on the territory of Poland.

Biographies or monographs documenting the work of individual researchers are the essential source of information about the history of faunistic studies. However, this area shows the largest amount of information gaps. An especially painful problem is the lack of a bibiliography of biographies of Polish zoologists. KOŻUCHOWSKI (1963) wrote about it as the most acute problem in the summary of his paper. The recently published "Dictionary of Polish biologists" (FELIKSIAK 1987) has only partly filled this gap. Biographical papers are of crucial importance when it comes to evaluating the role of individual researchers in the development of faunistic studies. The most important work in this group is a monograph dedicated to the life, activity and works of M. SIŁA-NOWICKI (FEDOROWICZ & KAWECKI 1962), Another significant paper deals

with descriptions of Polish animals found in papers by G. RZĄCZYŃSKI (FEDOROWICZ 1966). An excellent picture of K. KLUK'S activities in the field of faunal studies is given by BRZĘK (1977). Other, equally important students of the Polish fauna, particularly those active in the inter-war period, still wait for their monographs.

The output of the first period of physiographic research is mostly papers aiming to describe the Polish fauna in its entirety, attempts that were as inevitably fragmentary as they were inaccurate. It was only in the second half of the 19th century that genuine faunistic papers, concerned with individual regions or even towns and villages appeared. Poland being partitioned, it was virtually impossible to combine faunistical studies into a system that would embrace the entire Polish territory. Nevertheless these efforts led to a much better recognition of the unique features of local faunal resources. The essential inventory of papers concerned with the fauna of Poland (JAKUBSKI and DYRDOWSKA 1927–1928) comprises papers published until 1880, thus failing to include the last 34 years before World War I, during which period scientists from the existing centres contributed so richly to Polish faunistics.

Due to the difficulties associated with processing the vast material connected with the fauna of the entire territory of Poland, much greater importance should be attached to papers concerned with a particular region, such as those concerned with the Ziemia Lubuska and the Western Pomerania region (URBAŃSKI 1958). Also important are bibliographic papers dealing with individual objects, written after World War II. Here, the "Białowieża Bibliography" stands out as the most significant series in this group (KARPIŃSKI & OKOŁÓW 1969; OKOŁÓW 1976, 1983, 1991), providing in its successive volumes lists of papers concerned with the Białowieża Primaeval Forest. It also contains a complete bibliography of papers concerned with the fauna of this forest area. A similar bibliography has also been compiled for papers concerned with the Holy Cross Mountains (LIANA & PRÓSZYŃSKA 1984), and the fauna of Roztocze (LIANA, 1994). Faunistic papers are also catalogued and analysed when bibliographies concerned with the study of larger natural objects, such as national parks are published.

Catalogues and inventories of papers in faunistics concerned with individual groups of animals are of crucial importance for analyses of the state of studies on Polish fauna. The most complete in this group of bibliographic works is the "Catalogue of Polish fauna" published since 1960 and "The Fauna of Poland" (since 1973) and "Monographs of the Fauna of Poland" (since 1973)., though these works are still far from complete. An attempt to assess the species composition of Polish fauna is „Checklist of Animals of Poland" compiled by a team of zoologists and published by J. RAZOWSKI since 1960. Most of these works have appeared after 1945. They provide a more accurate picture of the fauna of Poland than did earlier papers.

Another important group of papers consists of bibliographies of faunistic papers focussing on individual research centres and organizations that carry out faunistic studies as part of their statutory duties. The most prominent among these organizations was the Physiographic Commission of the Polish

Academy of Skills. A complete catalogue of faunal papers published under the auspices of the Academy from 1865 to 1939 has been compiled by FEDOROWICZ (1971).

STAGES OF DEVELOPMENT OF FAUNISTICS IN POLAND

The question of stages that can be distinguished in the history of faunistic studies in Poland has rarely been dealt with in papers concerned with the history of zoology in Poland. Regarded as a subdivision of physiography, faunistics is believed to fit in well with the staging of the history of its mother discipline. FEDOROWICZ (1963) expressed this view in the following way "Works by Jan Długosz, Stanisław Staszic and Wincenty Pol divide the history of physiography in Poland into three periods: I – from Jan Długosz to Stanisław Staszic, II – from Staszic to Wincenty Pol, III – the period of contemporary physiographic studies." The importance of these authors, and especially of their works, for the development of physiography, is obvious. However, none of them engaged in faunistic observations. Therefore the question arises whether the development of faunistics follows the same criteria of chronological division as the development of physiography. The development of the former could actually have been accelerated or delayed in certain periods in relation to the latter. Which events gave rise to critical changes in faunistic studies on Polish animals? A rational answer to this question must account for the requirements that studies carried out in a given period were supposed to meet, study techniques and the contents of the publications. These issues are not discussed with respect to physiography in the paper by FEDOROWICZ (1963) quoted above, nor are they dealt with by GROCHMALICKI (1931) in his paper on the history of faunistics in the years 1875–1925. Another question that arises is whether a single researcher can bring about a revolution in "his or her" field on his own or whether the success of such revolutionary changes depends of the work of institutions attempting to live up to newly emerging tasks or advocating a new approach to existing tasks. There have been two periods in the history of Poland when such institutions existed and exerted a considerable influence. These were: 1) the Committee for National Education (1773–1794), the first Ministry of Education in Europe, acting in the period just before the partitioning; and 2) in the era of partinioned Poland (1794–1918), or more exactly in the second half of the 19th century, commissions which were established at that time to carry out or support physiographic research on the fauna of Poland.

The decisive role which the Commission for National Education was to perform as regards studies of the fauna of Poland stemmed from the following premises. First, new textbooks had to be supplied to fit the new system of education, based on reformed curricula. Two natural science textbooks were to be prepared (KOŁODZIEJCZYK, 1936; WIERZBOWSKI, 1908):

1. "An elementary book about natural history shall include short descriptions of animals, birds and fishes, particularly those that are found in

Poland. This part of natural history shall be taught to first- and second-graders. The natural history syllabus for third graders shall contain the most necessary information about minerals found in our country."

2. "An elementary book on farming shall first deal with all gardening activities comprising herbs, vegetables and trees, especially fruit-bearing. Besides, it shall also be a source of useful information on herbs that benefit the health, always focussing in the first place on those found in our country. It shall also deal with field farming, or agriculture, providing only tested, useful and practical information applicable to Polish conditions... The first part shall be taught in grade 4, the second, in grade 5."

These stipulations reflect the empirism and practicalism peculiar to the Enlightenment, the major theoretical and methodical paradigm of this period. What it meant for faunistic research was the necessity of verification of all information about the animals of Poland found in earlier works, and the determination of the actual composition of the fauna of Poland. This issue was addressed in clear terms in a project by DUBOIS and CAROSI (1777), the authors of an outline for the natural history textbook, submitted to the Elementary Books' Society. They demanded that information be accumulated about "minerals and other components of natural history" found in the country. The Society sent out letters to school headmasters all over the country, "obligating them to collect information about their environs connected with natural history". Apart from collecting information on the minerals, plants and animals occurring in the area, headmasters were also obliged to deliver specimens to the Society's headquarters which were to form the core of "a cabinet, or store, of our country's natural history; such a collection is indispensable for acquiring this science".

These projects also reflected the ideas of the era of Enlightenment formulated in Western and Northern Europe. In that period, natural science cabinets and collections were set up at universities and nobility households in the West. This trend was also imported to Poland and heralded the establishment of the Zoological Cabinet in Warsaw. In 1784 another project was undertaken by the Government when a questionnaire which included questions concerned with fauna was sent to all parishes in the country. The answers submitted in response to that questionnaire have never been published and are available as a manuscript at the National Library in Warsaw (FEDOROWICZ 1963). The work of the Commission for National Education and the Elementary Books' Society did not result in the publication of a modern textbook of natural history that was so much needed in those times. It was written later, when Poland had already been partitioned. Nevertheless, the requirements that the book was supposed to comply with led to the establishment of a new style and methodology of physiographic work, with expertise and direct observation relentlessly verifying the information and opinions contained in works by annalists that used to be reproduced verbatim over centuries. Of great importance for further development of faunistics were Vilnius and Cracow as the Supreme

Schools established there were bound to carry out physiographic studies by their statutes.

During the 18th century Gdańsk was a centre of zoological studies (FEDOROWICZ, 1968). The anatomy of animals was the main aim of these investigations. Parallelly, such researchers as P. BRENIUS, J. Ch. HANOW, I. D. TITIUS, J. T. KLEIN and J. C. EICHHORN carried out their studies on animal taxonomy, faunistics and zoogeography of land, marine and freshwater fauna using a new tool – the microscope. Their achievements were known and broadly recognized in the world and many of them were distinguished by membership of scientific societies of Europe.

The mid-19th century saw the birth of the concept of geo- and ethnographical uniqueness and unity of the historical Polish land. It was also a political statement that countered anti-Polish theses forwarded by the invaders, who strove to turn the ethnic Polish territory into German- or Russian-speaking lands. This idea, formulated by Wincenty POL and documented and developed by Wacław NAŁKOWSKI, represented an excellent extension of the concept advocated by Stanisław STASZIC in "The Geology of the Carpathians...". The new formulation of the tasks of physiography harmonized well with public demands. Scientists from Warsaw and Galicia set out to formulate guidelines for physiographic studies of the Polish territory. Because in the Russian partition the authorities effectively blocked the project to set up a Physiographic Museum, and its tasks were subsequently realized by other institutions, including the Zoological Cabinet of the University of Warsaw. The Austrian authorities, on the other hand, accepted plans for the establishment of the Physiographic Committee with a zoological section.

The Physiographic Committee left behind immense scientific output (FEDOROWICZ 1971). Its legally approved activities in the field of the study of nature established it as an organization that directed and supported the efforts of individual collaborators. Guidelines for physiographic explorations were also developed alongside with the objectives and principles of such studies. All those guidelines were deeply pragmatic and aimed at identification of natural resources in order to utilize them for practical purposes. The standard of the studies was additionally enhanced by increasing specialisation of the scientists, which made it possible to design and conduct more exhaustive studies.

The period after regaining the independence in 1918 is characterized by two directions of faunistic investigations. The first one summed up the results of previous stages and prepared the basis of faunistic studies of the country. Its achievements included a faunistic bibliography of Polish territory (JAKUBSKI & DYRDOWSKA, 1928–1929), the first periodization of faunistic studies (GROCHMALICKI, 1931) and the first methodical manual for the collection and conservation of animals (POLIŃSKI [ed.] 1921–1929). The second direction focused on faunistic investigation of several regions of Poland, and was associated with universities and scientific societies. The Poznań centre was carrying out the investigations on the fauna of Great Poland, the western part of the country. The scientific staff of the State Natural Museum and of the Warsaw U-

niversity was exploring the fauna of Mazovia and some more interesting areas of south and south-east Poland. In this period were also initiated investigations of the fauna of the Białowieża Old Forest, a future Reserve of Biosphere. Researches on the fauna of east Poland, including the pest bogs of Polesie, were conducted in Vilnius. In Lwów, a programme of investigations included the problem of the boundary of steppe and Black Sea fauna, which cuts across the Podole. In Kraków the tradition of faunistic studies of the Małopolska region was continued under the auspices of Physiographic Commission. Investigations of the freshwater fauna of Poland were stimulated by the Wigry Hydrobiological Station and the magazine "Archiwum Hydrobiologii i Rybactwa", founded by A. LITYŃSKI.

The 2nd World War brought faunistic studies in Poland to a halt and took a substantial toll on the scientific community. After the war Polish science has been reconstructed and developed further, and numerous new university centres have been set up all around the country. As a result the scope of faunistic research could be expanded and new techniques of study could be developed. Quantitative techniques for the collection and processing of study material have come into wider use, first in ornithological studies, then in teriology and finally, in the 1970s, in entomological studies.The quantitative methods make it possible to study fauna in terms of its structure, stability and changes. The results of faunistical studies contribute to increasingly detailed descriptions of individual types of habitats and phytocenoses as well as changes in faunal systems brought on by transformation of the environment, primarily degradation. The investigations were carried out by teams of experienced taxonomists so that the results obtained were of importance for identification of the nature and processes occurring in faunal assemblages.

The above outline of the current trends in faunistic research in Poland has demonstrated that additional stages encompassing more recent times can be distinguished in the history of faunistics. The history of studies of the fauna of Poland can thus be divided into 5 distinct stages, characterized by different objectives, principles and methods of study:

Stage One. From the annalists to the Commission for National Education, that is from the origins of Poland as a country to the year 1773. This period was marked by the gathering of elementary information about Poland's natural resources, including fauna. The information was collected in order to describe the country, its resources and wealth. Nature-related information was also compiled in this period but the validity of the sources was hardly ever verified.

Stage Two (1773–1855). From the Commission for national Education to the initiation of organized physiographic exploration in Warsaw and Galicia. In this period the ideas of the era of Enlightenment were put into practice in Poland. Its origins were associated with the planned reform of the schooling system and the resulting need to prepare new textbooks which were supposed to rely on verified information about the natural resources of our country, including wild and domesticated animals.

Stage Three (1855–1918) From the formation of modern physiography to the end of World War I. Often referred to as the period of modern physiogra-

phy (Fedorowicz 1963). In this period faunistic research became an integral part of the physiographic study of the ethnic Polish territory. The studies were usually conducted by qualified professionals, well-equipped to study domestic fauna. The results of studies carried out in this period permanently enriched Polish faunistics and helped to record the occurrence of numerous animal groups in Poland.

Stage four (1918–1945) comprises studies of the fauna of the territory under Polish rule after Poland regained independence. Faunistics still being part of physiography, it nevertheless developed its own programme, defined its tasks and implemented a series of detailed studies of the fauna of Poland. The methodology of faunistic research and guidelines for gathering information about fauna were developed in this period.

Stage Five. From 1945 until present. At the beginning it was a continuation of studies carried out before the war, based on physiographic concepts. However, faunistics is no longer formally related to physiography. Research objectives and topics are now defined by scientific societies and committees whose statutes oblige them to conduct faunal research. State-run programmes of zoological studies also play an important role in shaping the trends in zoological research. This period has seen the gradual incorporation of quantitative methods of study into faunistic research, making it possible to address such issues as the comparison of species composition of fauna in different areas and habitats and the study of changes in the fauna, particularly those brought on by the destruction of the environment by man and economic management. Computer software packages enabling collection and processing of faunal data have also come into wider use, allowing faunal mapping and analysis of the structures of taxocoenes and their diversity.

The above division of the history of faunistical studies in Poland complies with that proposed by FEDOROWICZ (1963) as far as the first two periods are concerned. However, the period of "contemporary physiographic research" distinguished by Fedorowicz, would now necessarily comprise a century and a half of most intensive development of science, including faunistics. In this paper, that period has been divided into three parts, with the two world wars representing distinct dividing lines between them. It should be also stressed that each of these three periods brought new approaches, tasks and methods, thus contributing to better recognition and understanding of the faunal resources of our country. In each of these periods Polish faunistics sought answers to questions posed in response to certain public needs, or dictated by politics, economic practice, or the fate of the natural environment subject to changes taking place globally as well as factors adversely influencing the condition of the environment and the resources of nature.

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ZWICKER D. 1650. Nova, et nunc primum edita, Paludum Polesiae Tabula, qua eas (secus ac geographorum vulgus sentit) satis habitatis, cultas, et pervias esse ostenditus. Gedani, map 1.

STRESZCZENIE

[Tytuł: Historiografia i periodyzacja badań faunistycznych w Polsce]

W badaniach faunistycznych w Polsce można wyodrębnić pięć wyraźnych okresów, w każdym z nich dominują odmienne zadania, zasady i metody pracy.

1. Okres pierwszy od kronikarzy do Komisji Edukacji Narodowej (1773), w którym informacje o zwierzętach stanowią element charakterystyki środowiska kraju, jego zasobów i bogactwa.
2. Okres drugi (1773–1855) od Komisji Edukacji Narodowej do powstania ośrodków badań fizjograficznych w Warszawie i Krakowie jest związany z reformą i unowocześnieniem oświaty, w tym przyrodniczej, opartej na zweryfikowanych informacjach o faunie.
3. Okres trzeci (1855–1918) od powstania nowoczesnej fizjografii do końca I. Wojny Światowej. Badania faunistyczne stają się wtedy istotną częścią fizjografii historycznych ziem polskich.
4. Okres czwarty (1918–1945) obejmuje badania fauny na terytorium Polski uformowanym po odzyskaniu niepodległości. Opracowano wtedy podstawy metodyczne prac faunistycznych oraz zbudowano system badań regionalnych.
5. Okres piąty (1945 do dziś) obejmuje badania po II. Wojnie Światowej. Charakteryzuje go stopniowe wprowadzanie metod ilościowych do badań faunistycznych oraz komputerowe gromadzenie i przetwarzanie danych. Fauna jest ujmowana jako zasób przyrody podlegający różnym uwarunkowaniom, szczególnie w związku z działalnością gospodarczą.

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