

### **Directions of studies in the Polish coccidology**

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**ABSTRACT.** The beginnings of Polish coccidology go back to distant times, but its full development begins in the 1960's thanks to the activity of the Cracow research centre with Professor JAN KOTEJA as its head. In that period the research problems concerning this group of insects became diversified and they comprised the following subject groups: faunistics and physiography, morphology, taxonomy and phylogenesis of scale insects, anatomy, embryology and development, fossil scale insects, parasites and predators of scale insects, the economic importance of scale insects. At present only studies on the morphology, fauna and the economic importance of scale insects are conducted.

**KEY WORDS:** Hemiptera, Coccoidea, Polish coccidology, directions of studies

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Scale insects (Hemiptera, Coccoidea) became the object of studies for the Polish entomologists as early as in the 16<sup>th</sup> century. Those interests were to a large extent related to the utilization of the Polish cochineal scale *Porphyrophora polonica* (L.) in order to obtain the natural dye-stuff. That is why the first papers were devoted mainly to this species. In the following periods the object of studies gradually shifted to other species as well; however, a broader interest in this insect group in Poland can be traced back only to the 20<sup>th</sup> century. In the beginning the attention of the entomologists focused on the species that were pests to plants; faunistic research was also conducted but only in a limited degree. It was only in the second half of the 20<sup>th</sup> century that the research problems concerning this insects group became more diversified and they comprised the following subject groups: faunistics and physiography, morphology, taxonomy and phylogenesis of scale insects, anatomy, embryology and development, fossil scale insects, parasites and predators of scale insects, the economic importance of scale insects. At present only studies on the morphology, fauna

and the economic importance of scale insects are conducted. The other directions of research were given up.

The total output of the Polish coccidologists comprises more than 1,000 papers. Hence, the bibliography of the present paper contains only the most important items. A complete list of the publications concerning the present paper can be found with the author. Bibliographic data of all Professor JAN KOTEJA's publications can be also found in WEGIEREK's work (WEGIEREK 2005).

#### FAUNISTIC-PHYSIOGRAPHIC RESEARCH

Faunistic research occupies a special place in Polish coccidology. Wünn's work (WÜNN 1919) is the oldest paper, where the author undertook an attempt to describe a geographical region in the aspect of the occurrence of scale insects. In successive years the papers which described the scale insects fauna of Wielkopolska, Upper Silesia and Lubuska District, appeared. The studies carried out by KAWECKI (1935, 1938, 1948, 1957) played an important role at that time. Totally, by the end of the 1950's 68 species were observed in Poland, including 54 Polish species, mostly pests of trees and fruit and ornamental shrubs. This outcome is the result of many years of research, which was only fragmentary and which was conducted in the area of a numbers of geographical regions in Poland.

A remarkable increase (nearly by 100%) of the number of scale insect species observed in Poland has been found out since 1961, when intensive studies conducted by the Cracow centre with Professor J. KOTEJA as the head began. In the years 1960-1980 faunistic studies were conducted in the Pieniny Mountains, the Ojcowski National Park, at the Baltic Coast as well as in the area of Kłodzko and Raciborz. In that same period faunistic research was also carried out by the workers of the Warsaw centre, who published a list of scale insects from the Nida Valley and the Kampinoski National Park. The fauna of armored scales occurring in the area of Poland was studied by KOMOSIŃSKA (1974). Besides, studies were conducted on the fauna of glasshouse scale insects (KOMOSIŃSKA 1961, 1965, 1968). Faunistic research conducted in the discussed period of twenty years resulted in pointing out 159 species from the area of Poland (along with the glasshouse species), including 32 species new to Poland or new to knowledge. Also, an increase of the number of species living on herbaceous plants was marked.

After 1980 papers concerning the scale insect fauna in the area of Krakowsko-Częstochowska Upland, Lower Silesia, West Beskid region, Świętokrzyskie Mountains and Roztocze district appeared. In that period a catalogue of the scale insects of Poland (KAWECKI 1985), which included the data up to the years 1980 was published. In the 1980's studies on the fauna of glasshouse scale insects were also continued. These problems are also dealt with in the papers by DZIEDZICKA (1988, 1989). The effect of inventory work done in the years 1980-2000 was finding out 12 species new to the Polish fauna and one species new to knowledge.

During the last fifteen years a planned many-years' research has been conducted only in the area of the Lublin Upland. The work on the scale insect fauna of the Sandomierska Forest has been finished and the results have not been published yet. Only a few faunistic papers are a result of field studies. Papers that describe the scale insect fauna of the Lublin Upland (ŁAGOWSKA & GOLAN 2002) and two species new to the Polish fauna (ŁAGOWSKA 2000, 2005) as well as papers confirming the presence of species (*Diaspidiotus alni* MARCHAL) and *Parthenolecanium persicae* (KAWECKI) in Poland so far considered to be doubtful have appeared. A collective work on the scale insects in Poland (ŁAGOWSKA 2004) should also be remarked. Besides, a paper giving new species in glasshouses has appeared (DZIEDZICKA & MADRO 1999). Three publications describing the fauna of the Roztocze region (ŁAGOWSKA & KOTEJA 1996), Pieniny (KOTEJA 2000a) and the Bieszczady Mountains (KOTEJA 2000b) also appeared in the analyzed period, but they refer to the studies conducted in earlier years.

A list of scale insects containing 185 species, including 141 Polish species and 44 glasshouse species (23.8% of the Polish fauna), is a result of the faunistic research so far. It should be emphasized that this is an open list and it still lacks in representatives of a number of genera occurring in the area inhabited by our eastern and western neighbours.

Despite many years of studies only three geographical regions are characterized by a satisfying state of knowledge about the scale insects fauna. These are: Krakowsko-Częstochowska Upland (KOTEJA & ŻAK-OGAZA 1983), Świętokrzyskie Mountains (KOTEJA & ŻAK-OGAZA 1989) and Roztocze district (ŁAGOWSKA & KOTEJA 1996). In those areas the number of the observed species constitutes from 61.7% to 68.1% of the Polish fauna. The number of the species observed at the Baltic Coast, the Lublin Upland, in the Western Beskidy Mountains and in the Pieniny Mountains ranges from 40% to 50%. 30-40% of the Polish fauna was found out in four geographical regions, while the number of species established in the Pomorskie Lake District, Mazurskie Lake District, Podlasie area, Trzebnickie Hills, the Eastern Sudety Mountains and the Tatra Mountains does not exceed even 10% of the Polish fauna.

At present faunistic research on the scale insects occurring in the Landscape Parks of Hawskie Lake District, Cistercian Landscape Compositions of Rudy Wielkie and Podlasie as well as inventory work on the Polish cochineal scale (*P. polonica*) are under way. It should be expected that after publishing the results from the Sandomierska Forest and Western Mazury district the picture of these regions will also change.

#### MORPHOLOGY, TAXONOMY AND PHYLOGENESIS OF THE SCALE INSECTS

Morphological and taxonomic studies are conducted parallel to the faunistic research. In the years 1950-2000 Polish coccidologists described 10 species new to knowledge (KAWECKI 1954; KOTEJA 1966, 1971, 1988; DZIEDZICKA & KOTEJA 1971; KOMOSIŃSKA 1980; KOTEJA & ŁAGOWSKA 1986) and they distinguished a few new genera (KOMOSIŃSKA

1965; KOTEJA & ŻAK-OGAZA 1981) and family groups (KOTEJA 1974). A revision was prepared of the genera *Eriopeltis*, *Poaspis*, *Luzulaspis*, *Exaeretopus*, *Parafairmairia*, *Asterodiaspis*, *Pulvinaria*. Studies on the male morphology constitute a separate group. These studies were initiated by Dr. KAJETAN BORATYŃSKI, who worked in London. In Poland modern research on males were conducted in the Cracow centre (KOTEJA 1986). Work on the morphological structures of scale insects and the possibilities of using it in the taxonomy of different groups of scale insects and on various levels are especially worthy of attention (KOTEJA 1976; KOTEJA & LINOWSKA 1976). Nowadays morphological studies (mainly on the larval stages) are continued by Professor E. PODSIADŁO in Warsaw (PODSIADŁO 2001, PODSIADŁO & LAMBDIN 2001, 2003). Besides, research on morphological variability of soft scale insects is also carried out, including *P. vitis*, *Coccus hesperidum* and the species from genus *Parthenolecanium* (ŁAGOWSKA 1996, 1997, 1999).

In Poland studies on the phylogenesis of scale insects were conducted only by Professor Jan KOTEJA, who explained the phylogenetic relationships of scale insects on various levels on the basis of morphological (KOTEJA 1974a, b, 1980), histological (KOTEJA et al. 2004) and paleontological (KOTEJA 1990, 1996) studies.

#### ANATOMY, EMBRYOLOGY AND DEVELOPMENT OF SCALE INSECTS

Studies on the anatomy and embryology of scale insects were and are still conducted to a limited extent not only in Poland but in the whole world as well. The few papers in this field have been published by the workers of the Cracow centre.

Peculiarities in the development of scale insects require the use of specific and laborious research methods, which are often different for particular species. That is the reason why studies concerning the biology of scale insects are undertaken by Polish entomologists rather rarely. Observations on the biology of harmful species have been performed to a broader extent (KAWECKI 1958a, b; DZIEDZICKA 1968, DZIEDZICKA & MARCHEWCZYK 1970; PODSIADŁO 1975, ŁAGOWSKA 1996), which is in a considerable degree connected with their greater availability. Outside this group the biology of only scarce species (e.g. *Steingelia gorodetskia* Nasonov, *Luzulaspis frontalis* Green) has been the objective of studies conducted by coccidologists in Poland (KOTEJA 1966, KOTEJA & ŻAK-OGAZA 1981a). In the meantime, the development of a number of species, especially those occurring more rarely, still remains unknown.

#### FOSSIL SCALE INSECTS

Palaeontological research is a relatively new domain in Polish coccidology. For more than 20 years it has been conducted with great dedication by Professor JAN KOTEJA, who engaged himself in collecting a lot of scale insect specimens in amber. He is the author of

a unique collection consisting of over 1,000 specimens. On the basis of the material that he collected and borrowed from all over the world he described 31 species new to knowledge and he distinguished 5 new families and 17 genera. He published the results of his studies, which are beyond any competition, in 120 works (KOTEJA 2000c). They include original creative works, popular articles, reports from symposia and exhibitions, polemics and theoretical research papers. He had a part of these works published in a periodical edited by himself entitled "Inclusion - Wrostek". Professor J. KOTEJA also initiated the Catalogue of the world collection of fossil scale insects.

#### PARASITES AND PREDATORS OF THE SCALE INSECTS

The studies conducted so far have neglected the problems concerning pathological microorganisms and their role in the regulation of the population of harmful scale insects. The parasitic and predatory fauna has also been treated rather marginally. At the turn of the 1950's and the 1960's three papers from this area published ŻAK-OGAZA (1957, 1958, 1961). In the 1980's PODSIADŁO (1981a, b, 1986) and ŁAGOWSKA (1987, 1994) dealt with the hymenoptera parasitic towards scale insects.

It should be emphasized that this branch of coccidology may bring interesting discoveries of the species of parasitic hymenoptera new to the Polish fauna. Extending the studies on the natural enemies of scale insects colonizing the plants grown in glasshouses may also contribute to the spread of the biological control of these burdensome pests in Poland.

#### THE ECONOMIC IMPORTANCE OF THE SCALE INSECTS

This is the oldest direction of studies in Polish coccidology. The first paper from this field was devoted to the Polish cochineal scale (*P. polonica*), which became popular as the source of the natural dye-stuff (MIECHOWITA 1521). Due to the role this species played in the economy and culture of old Poland it was also the object of research done by BREYNIUS (1731) and JAKUBSKI (1934). The scale insects living in Poland are also a source of honeydew. This problem was dealt with by KOTEJA (1981, 1996b), whereas nowadays these studies are continued by Dr. K. GOLAN (Agricultural University of Lublin).

The scale insect species that are pests to the cultivated plants arouse a much greater interest among the Polish entomologists. Professor Z. KAWECKI, who published several papers, was very active in this area. Some species belonging to the pests of shrubs and trees have been discussed in more detailed papers (KAWECKI 1958a, b, 1972). In the 1970's studies were begun on the harmfulness of scale insects on decorative and fruit plants considering the quality methods. They were carried out mainly in Warsaw (KOMOSIŃSKA 1986a, b, 1987) and in Lublin and its vicinities (ŁAGOWSKA 1987b, 1998).

The direction of research discussed here requires further continuation and the involve-

ment of a greater number of entomologists. A growing economic importance of those insects has been observed in recent years. This phenomenon is favoured by the import of decorative plants, which means that new scale insects are brought to Poland and these may become dangerous pests in the warming climate. In recent years a lot of popular-scientific papers have appeared on the harmfulness of scale insects on cultivated plants.

#### SUMMARY

Studies on the scale insects in Poland were conducted in few centers. In the pre-war period there existed a very strong centre of coccidology in Poznań (ANTONI JAKUBSKI, KAJETAN BORATYŃSKI, J.W. SZULCZEWSKI, ANDRZEJ RUSZKOWSKI and a few other researchers). That centre was not revived after the war. Then Polish coccidology began to develop thanks to the activity of Professor ZBIGNIEW KAWECKI. Following his initiative studies on the scale insects were undertaken by a group of scientists in Cracow (CZESŁAW JURA, ANNA KRZYSZTOFOWICZ, BARBARA WĘGLARSKA, IRENA BIELENIN, BARBARA ŻAKOGAZA, ANNA DZIEDZICKA, JAN KOTEJA) and in Warsaw (HALINA WERNERÓWNA, HALINA KOMOSIŃSKA, ELŻBIETA PODSIADŁO, MAREK SIEWNIAK). In the later period the scale insects became the subject of interest among the research workers in Białystok (BOŻENA ŁAGOWSKA, KRZYSZTOF STEPANIUK), Lublin (KATARZYNA GOLAN), and recently in Katowice (EWA SIMON).

The beginnings of Polish coccidology go back to distant times, but its full development began in the 1960's thanks to the activity of the Cracow research centre with Professor JAN KOTEJA as the head. Professor JAN KOTEJA was the initiator of new research directions in the Polish coccidology and his rich research output comprises almost all directions of studies. Thanks to his comprehensive studies the Polish coccidology began to be noticed on the international forum. The death of Professor JAN KOTEJA is a huge loss for the Polish coccidology. It should be also noticed that the studies on the scale insects in Cracow have already died out.

Scale insects are a very interesting group of insects. However, probably due to the fact that they are extremely time-consuming, they do not enjoy popularity among the young research workers. At present these insects are the only or the main object of studies for only five entomologists, including two working for a doctor's degree. Hence certain directions have been given up completely or the work in a given field is conducted only fragmentarily. The Polish coccidology urgently needs young research workers; otherwise, this branch of knowledge will disappear in our country.

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