**ЛІСІВНИЦТВО І АГРОЛІСОМЕЛІОРАЦІЯ**
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# METHODS OF RESTRICTIONS IN THE NUMBER OF COCKCHAFER POPULATION IN THE FORESTRY OF POLAND AND UKRAINE

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Analysis of intensity of cockchafer distribution in Ukraine and Poland is carried out. Methods and ways of pest control are evaluated. Complex approaches to application of means and methods of forest stands protection are presented. Attention is paid to wider introduction of forestry methods for the restriction of pest distribution.
K e y w o r d s : cockchafer, methods and means of forest protection.

**Introduction.** Problem of forest protection from pests and diseases and issues of forest pathology are growing in importance for forestry and forest regeneration. In many countries of the world the forestry can observe big damages from various diseases. Only in the last decades the areas of damaged forest stands have increased in tens and hundreds times. Intensive distribution of diseases and forest pests demands development and introduction of the most effective methods of their control.

As a result of the alliance of many European countries of the European Union, general European standards concerning methods and ways of plant protection are applied more and more often. They demand coordinated approach from the EU member countries. At the same time, the new states which have acceded to EU have a number of complications. These complications are connected with unification of the legal statuses concerning application of the means of protection and restrictions in application of chemical control methods. In this case new EU members appeared not to be ready for the change of rules and principles of application of plant protection means. Some uncertainty concerning application of preparations of plant protection has led to intensive distribution of pests and diseases in the environment. New normative and legal regulations of the EU stipulate essential reduction of the list of chemical preparations that can be applied and development of biological control methods.

In the last decades much attention have been paid to biological control methods. The application of biological means of protection demands significant time for their testing. It is caused by the fact that their introduction in environment can lead to unexpected consequences in ecosystems. To coordinate efforts of researchers from different countries as well as to exchange experience in the development and application of biological methods, the International organization on biological control has been created. In 2001, at the 8-th session of General Assembly in Poznan (Poland) a new structure of the constant commissions, including biological protection of forests has been formed [5].

Integration of new countries into the structures of the European Community demands acceptance of certain measures on development and introduction of new methods of pest control. These questions are equally urgent for countries which strive for integration into EU, and Ukraine is one of them.

Today in Poland only one chemical preparation which can be applied in natural habitat against harmful insects control is registered. Forests in Poland are certified under the program FSC. Regulations of FSC forbid application of chemical means of protection in forests. In Ukraine the list of preparations which can be applied in forest protection remains very short in spite of long-term researches carried out by scientists. Chemical preparations which reduce damage of roots by Cockchafer grubs in forest plantations are not included as well. Today in Ukraine there are no registered preparations for Cockchafer control. Therefore, preventive maintenance and protection of pine stands from Cockchafer is possible on the basis of knowledge of biological features of the pest [26].

Essential reduction of applied chemical preparations in forestry has led to mass development of forest pests. The latter is represented by Cockchafer, which distribution is of great danger. Today the fifth part of the general area of the damaged forest stands consists of forest stands damaged by Cockchafer. In Europe Cockchafer is the most dangerous pest of forest ecosystems. Cockchafer is distributed in the most parts of Europe and Asia. The most frequent are the Common Cockchafer (*Melolontha melolontha* L.), and Forest Cockchafer (*Melolontha hippocastani* F.).

The Common Cockchafer (*Melolontha melolontha*) can be found almost everywhere in Europe: Albany, Austria, Belgium, Bulgaria, the Czech Republic, France, Germany, Macedonia, Poland, Romania, Slovakia, Switzerland, Serbia and Montenegro, Hungary, Ukraine, Belarus, Latvia, Lithuania, Estonia. It can be found also in Portugal, Spain, Italy and Greece. In the north it is distributed up to the south of Sweden. In Poland it is widely distributed in the lowland and at lower elevations in the mountains. It occurs in the forests and fields, most abundantly in the South and West of the country. In Poland it is as common as *M. melolontha* although not as frequent. It is more abundant in the forested areas than in the agricultural lands, mainly in the North and Southeast of the country [4, 32].

Forest Cockchafer (*Melolontha hippocastani*) is distributed in central and northern Europe, and in Siberia and Manchuria. Ecology of Forest Cockchafer is quite difficult due to wide diversity of climatic and soil zones constituting wide natural habitat of the beetle. The boundary of intensive distribution of Forest Cockchafer during the last years has moved further to the north. It can be found even in the northern areas of the Arkhangelsk region [4].

Expansion of an area of Cockchafer distribution is caused by global climatic changes. The rise in temperature leads to increase in territories having optimum climatic conditions for this pest. Another reason of Cockchafer area expansion is connected with intensive forest management. Continuous deforestation in large areas has led to intensive population by Cockchafer grubs. In the southern and middle taiga Cockchafer grubs significantly damage the growth of young trees and plantations in the areas of continuous forest cutting and fire-sites in pine forests and other types of forests. Even in middle taiga there are areas having 8 – 10 or more Cockchafer grubs per 1 $m^2$. In some areas in water basin of the river Northern Dvina Cockchafer grubs damage not only roots of a pine (*Pinus*), but of *Populus tremula*, a heather and some other plants as well [2, 4].

The adult feed most willingly on the leaves of *Quercus*, especially *Q. robur* which develops earlier. Besides, they may be found on the leaves of *Salix caprea*, *Betula verrucosa*, *Sorbus aucuparia*, *Fagus sylvatica*, *Carpinus betulus*, *Acer platanoides*, *Populus tremula*, some other species of *Populus*, and *Aesculus hippocastanum*. The leaves of *Tilia*, *Alnus*, *Caragana*, *Euonymus*, *Padus racemosa*, *Prunus communis*, *Viburnum*, *Fraxinus*, *Sambucus nigra*, and other species of broadleaf trees and shrubs are fed upon only in the exceptional cases. The adults readily feed on the needles of *Larix* and occasionally on the flowers of *Pinus sylvestris*, *Picea abies*, and *Abies alba*. The white grubs of *Melolontha melolontha* and *Melolontha hippocastani* during their first year of life consume humus and small tender roots, mainly of grasses. The older grubs injure the roots of seedlings and young saplings of almost all species of trees and shrubs [4].

Common Cockchafer and Forest Cockchafer are widely distributed in Ukraine too. Forest stands are mostly damaged by Common Cockchafer. Forest in the western part of Ukraine is damaged the most intensively. The areas of intensive forest stand damages by Forest Cockchafer are much smaller, but its distribution over the territory is wider. The center of forest damage by Forest Cockchafer are concentrated mainly in central and eastern parts of Ukraine (Fig. 1).

Common Cockchafer is the most dangerous one out of 29 species of insects that damage roots in Ukraine. Due to researches carried out in Ukraine, the increase of Cockchafer role in damage of young pine plantations is caused by extension of non-forested lands, existence of deserted fields which are located near large forests, weather conditions (especially dry and hot weather during vegetative period which occurred in Ukraine during last years) [3].

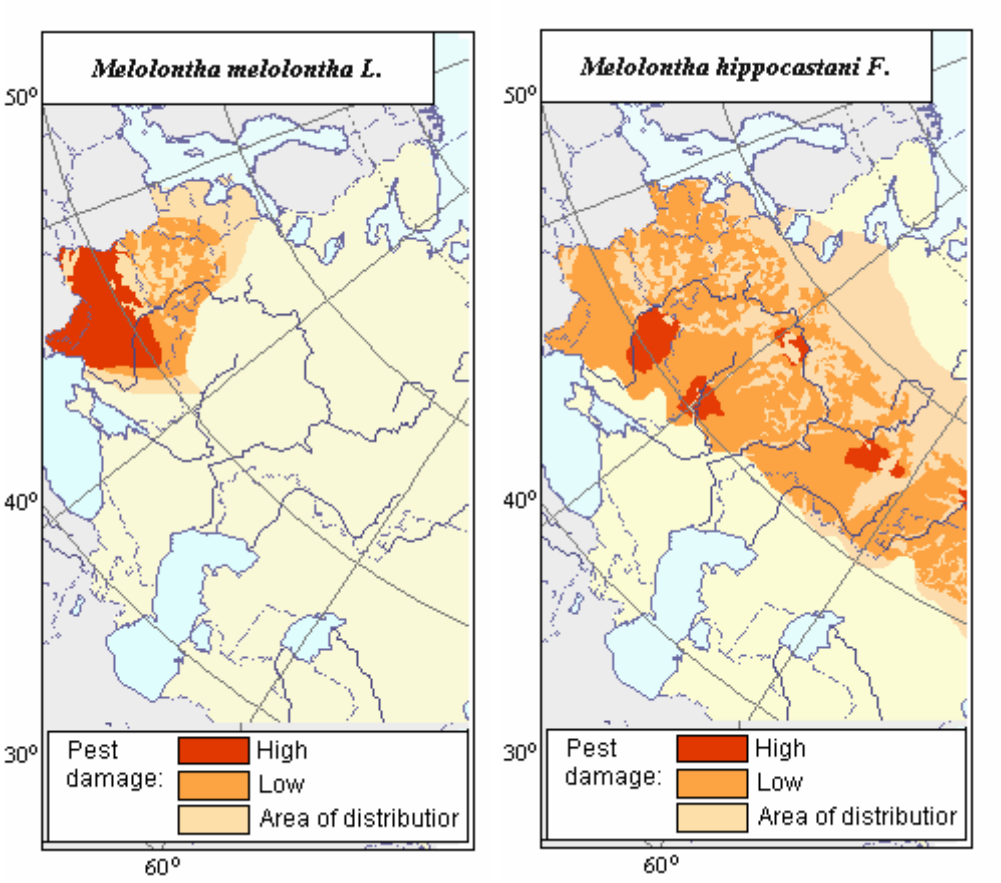


**Fig. 1 – Intensity of forest damages caused by Common Cockchafer and Forest Cockchafer in Ukraine [35]**

The most dangerous pest insects of Polish forests are the same two species as in Ukraine: the common cockchafer (*Melolontha melolontha*) and the forest cockchafer (*Melolontha hippocastani*). In spite of the fact that the issue of mass incidence of scarab beetles (Coleoptera, Scarabaidae) has been broadly discussed in Polish and European literature for a long time, no effective methods have yet been developed to reduce their number.

The area of mass incidence of cockchafers increases with every next swarming of imagines. A particularly strong race swarmed in the years 1991, 1995, 1999, 2003, 2007 increasing its area of occurrence in Poland by hundred times for less than 17 years (Fig. 2). The pest affected not only tree seedlings in forest nurseries, but also seedlings in plantations and even young stands. The restocking of the failed areas such as fill planting or underplanting carried out by foresters do no bring the anticipated results. In consequence, the complete feeding by imagines causes the weakening of mature stands.

With the increasing threat to forest sustainability, temporary actions are being undertaken aimed to reduce the risk of cockchafer spreading. During the recent big swarm of cockchafers in 2007, the State Forests National Forest Holding decided to mechanically collect adult insects in the territory of four Regional Directorates of the State Forests (Fig. 3). As a result, 24.1 tonnes of cockchafers were collected which cost the State Forest administration PLN 358,000. The expenses for aircraft sprays containing the mixture of insecticides Mospilan 20SP and Decis 2.5EC conducted during the same swarming period were still higher. The permission to carry out a one-time treatment covered a total area of 52,200 hectares (in the territory of the Łódź, Radom and Krosno Regional Directorates). However the conditions of use of a mixture of insecticides included in the permission provided additional restrictions causing a reduction in the area of aerial control treatment. The cost of the carried out treatment totalled PLN 3.75 million of which 78 percent was covered by the Łódź Regional Directorate [27].

In addition, Forest Districts which every year report damage from grubs spend much more money on restocking the failed areas. On a national scale, the total costs incurred by the State Forests in 2006 amounted to PLN 300 million (after Sukovata, unpublished; the estimates made by the State Forests were based on the results of the inventories of the failed and damaged stands using the methodology resulting from the Ordinance of the Minister of the Environment of 20 June 2002, Dz.U. no. 99, item 905).

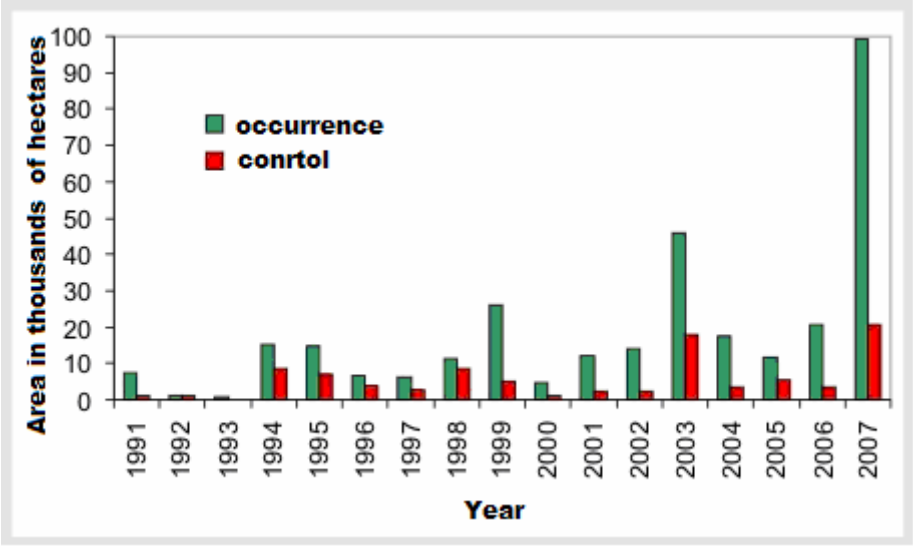


**Fig. 2 – The area of occurrence and control of cockchafer adults in the years 1991 – 2007 in Poland [11]**


**Fig. 3 – A map of areas with the highest threat from scarab beetles in Poland on which mechanical and aerial treatments against cockchafer adults were performed in 2007**

The causes of insect outbreak which currently has its peak in Poland, are to be sought in the past land management. In fact, the present numerous occurrences of cockchafers are observed in the same areas which a hundred years ago reported losses of economic nature. This situation may have been caused by the abandoning of the use of plant protection agents, as well as by the increased, by the end of the 1980s and at the beginning of the 1990s, area of wastelands becoming a favourable habitat for depositing eggs by cockchafers females. Therefore, it should be of no surprise that today, like hundred years ago, efforts are made to solve the problem of the damage caused by cockchafers.

The first records on biology of cockchafers and methods of reducing their number date back to the 19th century, when the idea of planned forest management was introduced. As early as in the eighties and the nineties of the 19th century, the Galician Forest Society called for preparing a draft act on the management of common cockchafers to be presented at a Parliamentary Session. (the act never came into force) [28]. After Poland had gained independence (in 1918), this issue was tackled by Kozikowski and Nunberg [20 – 23]. The methods of combating the pest at that time consisted of hand collection of adult insects during the swarming season and of grubs during field tillage. Attention was drawn to the need for protecting birds and mammals as natural enemies of the pest. In 1951, M. Nunberg [23] prepared the characteristic of races of both cockchafer species in Poland and determined the years of their swarming.

The 1950s saw a large-scale use of pesticides (DDT and HCH). At first, the application of plant protection agents brought positive results [6, 33]. The pest management process was effective, with a relatively low labour input involved. However with the passing of time, there were increasingly more doubts, mainly in connection with the non-selective activity of pesticides, their long disintegration time in the environment and accumulation in the living organisms. The public protests and opposition from ecological organizations finally led to the withdrawal of these chemicals from use.

Parallel to the strong protests of ecological organizations, attempts were made to develop a new concept of integrated plant protection. First, the term integrated protection was meant as a concurrent use of chemical and biological methods with the emphasis on selective pesticides and use of other protection agents in such a way as not to destroy the natural enemies of pests [14]. The studies on selective plant protection agents are still continued in Poland. Although the UE Commission withdrew the selective preparations such as Diazinon 10 GR, Furadan 5 GR and Marshal Suscon 10 CG from use in forest protection and the only preparation placed at the disposal of the Polish foresters is Dursban 480 EC, the demand for preparations of this type is still high. Therefore studies are being carried out on new preparations based on active substances that will be acceptable in the EU countries. The research conducted by the Forest Research Institute in Warsaw [15] shows their high effectiveness. A few-minute dipping of seedling roots in water emulsions containing insecticides Regent 200 S.C., Apacz 50 WG and Mospilan 20 SP efficiently protect seedlings from even the most voracious third (L3) instar grubs [15].

Studies on the introduction of biological preparations to forest protection have recently intensified. The preparations are based on the spores of the fungi of the genus *Beauveria* although the history of research concerning their use in cockchafer control is very long [13]. Under natural conditions, this fungus attacks cockchafers in all larval stages. The *Beauveria brongniartii*-based preparations are already applied in countries like Austria, Switzerland, Italy, Belgium and France [7]. However, the effectiveness of this fungus depends on a number of abiotic and biotic factors. The major ones are soil temperature and moisture, as well as soil pH, dispersal of the fungus in soil and antagonistic activity of certain soil microorganisms (mycorrhizal fungi and possibly *Trichoderma spp*. producing secondary metabolites with fungistatic activity). Unlike soils in Europe to which *B. brongniartii* has been applied, most forest soils in Poland are acidic, with a pH ranging between 3.5 – 5.5 [8]. Besides, no fungi which are typical for forest habitats occur in these soils (or occur in amounts which are insignificant to its activity).

Parasitic nematodes of genera *Steinernema* and *Heterorhabditis* [9] and bacteria *Riketsiella melolonhae* and *Bacillus thuringiensis* can also be used in the biological control of cockchafers. In

this group of methods which reduce the pest population rather than completely destroy it, the age of grubs and their physiological condition is of great importance. Unlike in the case of chemical agents for plant protection, the use of entomopathogenic nematodes has better effects on older grubs [10]. The most negative feature of nematode preparations is the low survival of nematodes which are particularly susceptible to temperature and soil type. In turn, the use of pathogenic bacteria against cockchafer grubs causes the so-called milky disease. Regrettably, the infectivity of these types of bacteria in field conditions has so far proved insignificant [34]. Active biological substances obtained from the seeds of plants of the family Meliaceae showing antifeedant activity are also used in the control of cockchafers [34]. Experiments in respect of silviculture were few. One of the few studies was carried out by Satkowski (1899), Różyński (1926) and Ulatowski (1932) [25] who used buckwheat in forest nurseries. Sawing buckwheat was also applied with various results in forest plantation ([14] Niemczyk, unpublished), agriculturally utilised areas and horticulture. There are no methodological studies related to stand tending. Some silvicultural observations were described in 1938 by Puster who for 25 years was the Manager of a Forest District where grub colonisation of soil was high. He recommended avoiding thinning of stands, promoted high planting density (25,000 pine seedlings per hectares) in order to obtain quick crown closure and shadowing of soil surface. He recommended interplanting in the fourth year of grub's life because the 4-year-old grub feeding is shortest, dense underplanting of beech or beech with spruce in oak and pine poletimber stands. In timber and pre-commercial stands, especially in the stands with loose structure, he proposed to carry out underplanting with species such as beech, fir and spruce. In his opinion, the precondition to enter with tending treatments should be only when the planted species ensured necessary protection of soil. Puster also paid much attention to production of sufficient number of pine, spruce, fir and other tree species seedlings in forest nurseries to have them at hand when needed.

The recommendations included in the silvicultural-protection programs prepared for those Forest Districts which are colonised by *Melolontha*, are almost identical to those proposed by Puster in 1938 [24]. In addition to hand grub collection in forest nursery soils, buckwheat sowing and chemical protection, he promoted narrow planting density, correction of species composition, restocking of failed areas to reach satisfactory results or shifting the restocking time from spring to autumn in the years when the main race is in the third (L3) larvae instar [1].

In scientific studies, the main focus is on the experiments with biological methods of reducing pest population. It seems, however, that only an integrated method combining silvicultural and forest protection methods can both increase the natural resistance of the forest environment and reduce the population of this dangerous pest to a level which the economy can withstand.

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МЕТОДИ ОБМЕЖЕННЯ ЧИСЕЛЬНОСТІ ПОПУЛЯЦІЙ ТРАВНЕВОГО ХРУЩА У ЛІСОВОМУ ГОСПОДАРСТВІ ПОЛЬЩІ ТА УКРАЇНИ

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Наведено аналіз інтенсивності поширення травневого хруща в Україні та Польщі. Оцінено методи та способи його контролювання. Запропоновані комплексні підходи до застосування засобів і методів захисту лісових насаджень. Акцентовано увагу на ширшому запровадженні біологічних і лісівничих методів обмеження поширення шкідника.

К л ю ч о в і  с л о в а : травневий хрущ, методи та способи захисту лісу.

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МЕТОДЫ ОГРАНИЧЕНИЯ ЧИСЛЕННОСТИ ПОПУЛЯЦИЙ МАЙСКОГО ХРУЩА В ЛЕСНОМ ХОЗЯЙСТВЕ ПОЛЬШИ И УКРАИНЫ

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Приведен анализ интенсивности распространения майского хруща в Украине и Польше. Оценены методы и способы борьбы с вредителем. Предложены комплексные подходы к применению средств и методов защиты лесных насаждений. Акцентировано внимание на более широком внедрении биологических и лесоводственных методов ограничения распространения вредителя.

К л ю ч е в ы е  с л о в а : майский хрущ, методы и средства защиты леса.

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