

Abstract of the doctoral thesis

The influence of the selected microclimate elements on the mortality rate of the particular developmental stages of *Pityogenes chalcographus* (L.) in wintertime

Pityogenes chalcographus (L.) is one of the most important cambiofagous insects connected with spruce stands. Current knowledge about this beetle focuses mainly on issues related to its feeding, economic importance and methods of eradication. However, the aspects of *P. chalcographus* wintering and its resistance to the microclimate conditions during winter, which are the subject of this thesis, have not been practically known so far.

The literature review and the conducted pilot studies helped to establish the following research hypotheses: (1) extreme microclimate conditions during winter increase the mortality rate of *P. chalcographus* specimens wintering in its feeding grounds; (2) immature stages of *P. chalcographus*, that are wintering on spruce branches, show higher mortality in relation to the fully developed specimens; (3) mortality rate of each developmental stage of *P. chalcographus*, wintering on spruce branches lying on the forest floor, which are protected from extremely low temperatures by a thick snow cover, is lower than on the branches found in the treetops.

Derived from the above hypotheses the following aims of the study were set: (1) determination of number and structure of the developmental stages of *P. chalcographus* wintering on spruce branches; (2) determination of lethal sub-zero temperatures for particular developmental stages of *P. chalcographus* in laboratory conditions, at a given relative air humidity; (3) determination of winter mortality rate of *P. chalcographus* hibernating on branches lying on the forest floor, which depends on the temperature, relative air humidity and the thickness of the snow cover.

Field studies were conducted on selected spruce stands, situated between 600 m and 1250 m a.s.l., in the Silesian and Żywiec Beskids area. Data was collected periodically during the autumn and winter seasons between 2010 and 2014. Spruce branches with active feeding grounds of *P. chalcographus* were located in two places that differed in the prevailing microclimate, i.e. in the treetops and on the forest floor near those trees. The analysis of the mortality rate of the particular developmental stages of *P. chalcographus* was conducted maximum four times each year: in late autumn, twice during the wintertime and after spring snowmelt. At the same time, the basic microclimate parameters were measured – temperature, relative air humidity and thickness of the snow cover.

The subject of the research was also the mortality rate of individual developmental stages of *P. chalcographus* in various ranges of sub-zero temperatures, which were established in laboratory

conditions using a low-temperature chamber. Wintering insects removed from the feeding grounds were exposed to a certain temperature for a pre-set time.

The results of the study show that during autumn and winters season the old imagoes of *P. chalcographus* appear on spruce stands with the highest frequency (over 99%), followed by the young imagoes (about 90%). The larvae forms were observed with a remarkably lower frequency (depending on the location between 47% and 51%), while the lowest values were determined for the pupae stage (amid 9% and 16%). Such a frequency distribution did not correspond neither with the size nor the share of each developmental stage of *P. chalcographus* population. This species predominantly hibernates at the stage of a young beetle (about 42%) and an old insect (between 35% and 41%). Larvae can be found less often (from 15% to 20%), and only a small percentage of specimens were found during this period in their pupae stage (between 1% and 2%).

The larvae form was found to be the most resistant, to thermal and moisture conditions in wintertime, developmental stage of *P. chalcographus* (the mortality rate was depended on the location and fluctuated from 32% to 48%), while the pupae stage appears to be most vulnerable to these circumstances (its mortality rate was estimated between 48% and 74%). Therefore, the hypothesis stating a higher mortality of immature stages compared to imagoes during the wintering season has been confirmed only in the case of the pupae, and rejected in relation to the larvae.

Statistics also shown, that the mortality rate of specimens wintering on branches lying on the forest floor is significantly lower than those found in the treetops. Thus, the hypothesis about the positive influence of snow cover – that creates favorable thermal and moisture conditions – on the survival rate of *P. chalcographus* different developmental stages wintering on branches lying on forest floor has been confirmed.

Laboratory tests confirmed that the lowering of temperature led to increase in mortality rate for all the developmental stages of *P. chalcographus*. It was shown that the lethal temperature point for the examined developmental stages is around -35°C. Such a temperature led, within 2 hours, to an increase in the mortality rate of the tested specimens to a level of over 95%. It was also found that *P. chalcographus* shows a high resistance to rapid temperature fluctuations. The laboratory tests proved that around 10% of the young imagoes were able to survive up to 20 cycles of sudden thermal changes.

Due to the fact that during the research time no lethal (for *P. chalcographus* specimens) drops in temperature or relative air humidity could be observed in the Silesian and Żywiec Beskids area, the results obtained in the laboratory should be verified by further research. The results of the

conducted field study show that the climate conditions throughout the 2010-2014 autumn and winter seasons were not able to increase the mortality rate among the wintering on treetop branches particular developmental stages of *P. chalcographus*, which would result in a significant reduction of their population. Thus, the hypothesis stating that the microclimate conditions prevailing in the winter period cause a very high mortality rate among particular developmental stages of the wintering in the treetops *P. chalcographus*, could not be definitively confirmed.

Key words: *Pityogenes chalcographus*, wintering, lethal temperatures, mortality, thermal and moisture conditions