

Location, Evolution and Importance of *Cephalcia* spp. (Hym: Pamphiliidae) Populations in Polish Carpathian Mountains

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The web-spinning sawflies (*Cephalcia* Panz.) are members of the *Symphyla* that are of economic significance, and which constitutes an integral part of the spruce forest environment. Spruce, which is the dominant component of Western Carpathian forest stands, is the only known host plant for all the species of *Cephalcia*. Species in this genus occasionally appear in high densities at which time they become a major threat to coniferous forest stands especially in the mountains. Gradations develop very slowly but may persist for several years. Defoliation by these insects causes a reduction in radial increment and weakens trees so that they are susceptible to attack by secondary organisms and by drought. This may result in extensive tree mortality over large areas. Monolithic spruce forest stands of artificial origin are attacked, as are stands of natural origin in middle and older age classes that are located at altitudes of 800-1200m.

C. alpina (Klug) (= *fallenii* Dalm) was found for the first time in the Gorce Mountains of Poland; this also represented the first mass appearance of this species in Europe. *C. alpina* occurred in Gorce spruce forest stands at altitudes of from ca. 900 to 1200 m. The insect finds optimum conditions for its development and survival in monolithic spruce forest stands in the upper mountain regions associated with the plant community characterized by *Piceetum excelsae carpaticum*. During the only gradation recorded so far, traces of feeding damage were noticed before the 1979 growing season on the mountain sides of Kudłoń, Mostownica and Jaworzyna Kamienicka. In the summer of 1979, the feeding damage expanded around these original foci, including artificially established spruce stands of middle and older age classes. The forest stands located there were damaged significantly (60-90%) and moderately (30-60%) in an area of ca. 580 ha. Forest stands on 1600 ha located around these foci were lightly damaged (>30%). Despite extensive swarming in 1980, the population declined and remained at low levels until 1982. In subsequent years, the population declined even further and, beginning in 1985, *C. alpina* was not considered to be a threat to forest stands. One may conclude from this description of the gradation that populations probably increased for several years prior to 1979. It is probable that its onset was synchronized with a gradation that occurred in the Radziejowa massif, where light feeding damage first appeared in 1976; at that time, the population of the insect, initially called *C. abietis* (L.), and the area of its incidence were definitely smaller than in Gorce. The gradation period was therefore 10 years (1976-1985). As a result of several years of defoliation of spruce growing at high altitudes, resistance thresholds of natural spruce stands were exceeded. Weakened trees were killed by *Armillaria* spp. and species of bark beetles in areas above 850 m. Spruce trees were drying out in large numbers so that during the period from 1984 to 1990, a forested area of 140 ha was salvaged. Over another 266 ha, tree mortality varied from 21-100%.

After the *C. alpina* gradation in Gorce disappeared, a sudden increase in population was detected in Beskid Śląski in an area near the summit at Skrzyczne at an altitude of 1000-1200 m. Populations of this pest persisted there from 1982 to 1986. Analysis of entomological material collected from the areas of mass incidence of *C. alpina*, Beskid Śląski, in an area near the summit at Skrzyczne at the altitude of 1000-1200 asl. Populations of this pest persisted there from 1982 to 1986. Analysis of entomological materials collected from the areas of mass incidence of *C. alpina*, (Beskid Śląski from the 1976-84 gradation period, the Gorczański National Park (1978-85), the Sudety mountains (1982-84) and Gdańsk (1993-1996) allowed us to conclude that a large percentage of web-spinning sawflies identified as *C. alpina*, possessed morphological features of *C. annulicornis* (Hartig). Both species appeared together in the gradation areas, but their ratio varied considerably from area to area without any apparent relationship to environmental aspects, type of forest stands, altitude, and local climate. This species has been known to occur in the Beskidy region since the 1980s. Observations of the major swarming in the Skrzyczne massif during those years indicated that possibly several

variations of *C. alpina* might exist. Research to identify the characteristics of the two web-spinning sawflies was conducted in Italy from 1990-1995. Entomological materials used for research on the biology of these species were obtained from the Czech Republic, Poland and Italy. The role of each species in high-density populations was determined based on analyses of insects in entomological collections from the Czech Republic, Germany, Poland and Italy, and on examination of published literature.

Since 1980, *C. arvensis* (Panz) has been recorded along with these species. Since 1978, in the lower elevations a new species appeared, *C. abietis* (L.), which has displaced the other species of this group over the past twenty years. The gradation has been spreading towards the south along the mountain ridge and towards the valleys on the western and eastern sides of the mountain ridges at an altitude of 600-800 m.

A detailed analysis of the data available on *Cephalcia* spp. incidence in the last 20 years indicate that there is a lack of permanent outbreak foci of these insects at a micro-geographical scale. The incidence of web-spinning sawflies resembles a mosaic overlaid on a background of spruce forest stands. Individual 2- and 4-year cycles are apparent for particular species on small areas, as is the expansion of populations and their appearance in new locations. The replacement of existing populations by other species has also been noticed: initially, *C. arvensis* was the dominant species, then *C. alpina*, and ultimately *C. abietis*.

Currently, the incidence of web-spinning sawflies in the Carpathian Mountains is common but at low populations. However, an increase in the population of *C. alpina* has been noticed, associated with *C. erythrogaster* (HTG). Monolithic spruce forest stands located at an altitude of 600-1200 m in the western part of the Carpathian mountains in Beskid Śląski and Żywiecki, at their summit and along mountain ridges, will continue to be the most affected.

Gradations of *Cephalcia* spp. have persisted in spruce forest ecosystems in mountainous regions because of disturbances caused by forest management activities and exacerbated by atmospheric soil and water pollution, which in turn are related to poor economic conditions.

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