

## Dragonflies (Odonata) Reflect Climate Warming Driven Changes in High Mountain Invertebrates Populations

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**Abstract :** Much scientific research in the last 20 years has focused on the influence of global warming on the distribution and phenology of living organisms. Three potential responses to climate change are predicted: individual species may become extinct, adapt to new conditions in their existing range or change their range by migrating to places where climatic conditions are more favourable. It means not only migration to areas in other latitudes, but also different altitudes. In the case of dragonflies (Odonata), monitoring in Western Europe has shown that in response to global warming, dragonflies tend to change their range to a more northern one. The strongest response to global warming is observed in arctic and alpine species, as well as in species capable of migrating over long distances. The aim of the research was to assess whether the fauna of aquatic insects in high-mountain habitats has changed as a result of climate change and, if so, how big and what type these changes are. Dragonflies were chosen as a model organism because of their fast reaction to changes in the environment: they have high migration abilities and short life cycle. The state of the populations of boreal-mountain species and the extent to which lowland species entered high altitudes was assessed. The research was carried out on 20 sites in Western Sudetes, Southern Poland. They were located at an altitude of between 850 and 1250 m. The selected sites were representative of many types of valuable alpine habitats (subalpine raised bog, transitional spring bog, habitats associated with rivers and mountain streams). Several sites of anthropogenic origin were also selected. Thanks to this selection, a wide characterization of the fauna of the Karkonosze was made and it was compared whether the studied processes proceeded differently, depending on whether the habitat is primary or secondary. Both imagines and larvae were examined (by taking hydrobiological samples with a kick-net), and exuviae were also collected. Individual species dragonflies were characterized in terms of their reproductive, territorial and foraging behaviour. During each inspection, the basic physicochemical parameters of the water were measured. The population of the high-mountain dragonfly *Somatochlora alpestris* turned out to be in a good condition. This species was noted at several sites. Some of those sites were situated relatively low (995 m AMSL), which proves that the thermal conditions at the lower altitudes might be still optimal for this species. The protected by polish law species *Somatochlora arctica*, *Aeshna subarctica* and *Leucorrhinia albifrons*, as well as strongly associated with bogs *Leucorrhinia dubia* and *Aeshna juncea* bogs were observed. However, they were more frequent and more numerous in habitats of anthropogenic origin, which may suggest minor changes in the habitat preferences of dragonflies. The subject requires further research and observations over a longer time scale.

**Keywords :** alpine species, bioindication, global warming, habitat preferences, population dynamics

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