Shifts in European bee populations over the past century

100 Years of Bees

WALDEMAR CELARY
Institute of Systematics and Evolution of Animals, Kraków
Polish Academy of Sciences
celary@isez.pan.krakow.pl

Dr. Waldemar Celary studies the biology of aculeates, especially bees. He works to protect wild species and investigates their behavior, nesting strategy and lifecycle. He has authored many research publications, books, and monographs

Central European bee species numbers have seen dynamic changes over the past century. Painstaking study and research by entomologists is now seeking to identify the causes for the observed trends and to help rescue unique species of these extraordinary insects

Bees (*Anthophila*) are one of the most numerous groups of *Hymenoptera*, the membranous-winged insects. So far some 20,000 bee species have been identified in the world, with several dozen more discovered each year. The shifts observed in the diversity of known Central European bee species over the course of the past century have been heading in two opposing directions: on the one hand the known number of bee species has been systematically on the rise, yet on the other hand species numbers are decreasing...

Bands and patches

Overall, bee species are characterized by very broad morphological variation. Although their bodies are most frequently of stocky shape, certain species, such as the parasitic bees of the tribe *Nomadini*, are slender and appear more like wasps than bees. The smallest species are only 1.6 mm long, while the largest range up to nearly 40 mm. Body color likewise varies greatly: most species are black or brown, but there are some whose cuticle is red, blue, or green (sometimes with a metallic sheen), or whose body is covered by bright markings (white, yellow, or red). Aside from a few cases, bees as a rule have pronounced hair cover, at least a portion of which consists of the small feathery hairs typical only for them, which may cover the whole body or form various sorts of bands or "patches."

Only nectar and pollen

Bees feed on the pollen and nectar of angiosperm plants. Pollen is their source of protein, while nectar (honey) is a source of sugar and water. Bees are the only membranous-winged insects whose larva feed off the same sort of food as the adults. Although bees have a very close bond with flowering plants, there is wide diversity among species in terms of feeding preferences. Bee species can be classified as *monolectic*, only feeding on the pollen of a single species or genus of plant, *oligolectic*, harnessing the pollen of plants from several closely related species or genera from a single family, or *polylectic*, visiting the blossoms of nearly all flowering plants. Refined feeding tastes of the former sort sometimes have adverse consequences: the fate of many monolectic or oligolectic bee species hinges on the fate of individual plant species, and shrinking

Waldemar Celary

A female *Chelostoma campanularum* in a peach-leaved bellflower

Waldemar Celary

A female *Dasypoda argentata* digging a nest. The present author has tracked down a dwindling population of this rare species and established five new nesting sites

food sources will pose a great threat to those species dependent upon them.

Solitary, communal, and eusocial

Contrary to popular opinion, the most numerous type of bees are *solitary* bees, whose females build their own nests and supply their own offspring with food. In *communal* species, several females build a single complex nest with only a main corridor in common, where each female has its own larval chambers. The nests of the most social or *eusocial* bee species are only initially built and supplied by a female often called the "queen." Although it is she who feeds the first larvae, she subsequently turns the job over to her offspring (workers). There are also certain bee species, called *parasitic*, whose females ensure the development of their own offspring by making use of other species' nests.

Ground, plants, and crevasses

Certain species build nests alongside one another, in huge clusters. Cases have been reported of clusters encompassing nearly 12 million nests! Non-parasitic species are extremely flexible in choosing where to locate their nests and how to build them. They also employ a surprisingly diverse range of materials. Most bees build their nests in the ground, and various species prefer various sorts of medium: some sand, others clay, loess, or sandstone. Many other species build a home by eating away the insides of plants, such as rotting or dry wood, grass blades, or the soft-cored stems of herbaceous plants and bushes. Quite a few other species make use of existing holes, inhabiting the corridors left behind by xylophageous beetles, empty galls and snail shells, the abandoned hollows of small mammals, the nests of birds or other aculeates, or crevasses in rocks and walls. Interestingly, there is a fairly numerous group of bees that build their nests on open surfaces, e.g. on the ground, stones, walls, or plants. They then have to employ materials that can withstand the worst weather conditions, most often using clay, "cement," resin, wax, or ground-up plant material. Certain species build nests in highly specialized locales, such as termite nests, anthills or spider's webs and burrows.

Species diversity

A great majority of bees are highly xerothermophilic, meaning that they demonstrate a strong preference for our globe's dry and warm (sometimes even semiarid) areas. That is why Central Europe generally does not have rich biodiversity of bees. Nearly 750 species have been identified in this part of Europe to date, although we can state that their numbers increase as one proceeds from north to south. The least diverse bee fauna is seen in Denmark (239 species), Belgium (376), Holland (320), and Luxembourg (274), while the richest diversity is to be found in Austria

(647), Czech Republic / Slovakia (together 640), and Switzerland (580). The species composition of Central Europe's bee fauna is constantly changing, although most of those changes only become visible after an extended period.

Expansion and DNA

Increases in species numbers most often stem from more precise knowledge gained about the existing fauna and from studies of as-yet unexplored terrain. Yet such growth in the numbers sometimes also results from the expansion of species that had previously not occurred in Central Europe. An example here is to be found in *Bombus semenoviellus* SKORIKOV, or the eastern bumblebee, whose western frontier shifted over just 30 years from the western portion of southern Siberia to Germany. Its pace of expansion was truly impressive: the first *Bombus semenoviellus* specimen was found in Poland in 1988, and another was identified not far from Lübeck in eastern Germany in 1998.

Growth in known species diversity can likewise result when twin species are identified, i.e. species whose similarity makes them very hard to distinguish, but can be told apart via comparative DNA analysis or deeper research into the biology of individual species. For example, the bees *Andrena rosae* PANZER and *A. stragulata* ILLIGER were previously thought to be two generations of the same species, yet were later identified as being separate species.

Particularly rapid growth in the number of known Central European bee species has been seen over the past 100 years: in the early 20th century there were somewhat more than 500 species, at mid-century there were 650, and by the 1990s there were nearly 750. Nonetheless, it seems that the 21st century will see few new additions to the species list.

Sounding the "Alarm" for Europe

A second, opposing trend seen in Central European bee fauna involves a downturn in population numbers and the disappearance of some previously attested species. This phenomenon, particularly evident in the latter half of the 20th century, is chiefly caused by rising anthropopressure and climactic change, although frequently it is impossible to tell which of these factors is decisive. The narrow food specialization and selective nesting requirements of some species mean that the disappearance of certain plants or nesting sites will entail the immediate extinction of an entire bee species. Germany saw the extinction of as many as 29 bee species by the end of the 20th century (5.3% of the country's fauna), while 21 (3.8%) are dying out, as many as 88 species (16.1%) are gravely endangered, and 79 (14.4%) are endangered. The situation in Poland is not as tragic, but here too anthropopressure has made its mark: "only" 18 species (3.8% of Poland's fauna) are presently considered extinct, while 8 (1.7%) have been classified as facing extinction, 8 more (1.9%) are endangered, and 76 (16.2%) are threatened with extinction.

The PAN Institute of Systematics and Evolution of Animals strives to research the biodiversity and biology of aculeates,

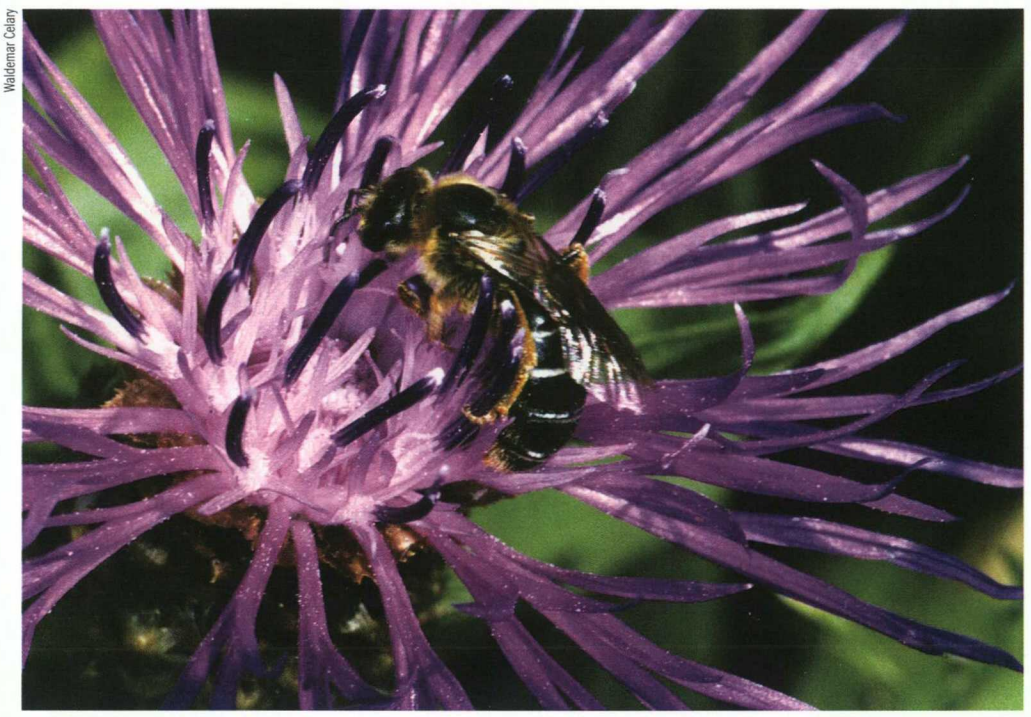
Waldemar Celary

Certain bee species feed on the pollen and nectar of only a single plant species – such as this female *Andrena hattorfiana*, which only feeds on field scabious (*Knautia arvenis*)

Waldemar Celary, private records

The eastern bumblebee (*Bombus semenoviellus*) is expanding its terrain at an impressive rate, progressing over the course of 30 years from western Siberia all the way to Western Germany

Waldemar Celary



A female *Halictus rubicundus* visiting a brownray knapweed (*Centaurea jacea*)

especially bees. The present author's own research work, which concerns protecting bee species and analyzing the threats they face, has in recent years concentrated on small melittid bees. They hold a special place among all the bees species because they combine traits of primitive, "short-tongued" bees and evolutionarily advanced, "long-tongued" bees. A vast majority of *Melittidae* species are very highly specialized in terms of food sources (being oligo- or monolectic), which makes them highly sensitive to changes in their food base. My research on the distribution of individual bee species in Poland has shown that more than half (55%) of domestic species are rare, while as many as 36.4% are faced with extinction and 18.2% are gravely endangered.

My research on the biology of *Melittidae* species has also allowed me to trace the lifecycle of one of the rarest species, *Dasypoda argentata*, which has long been "in retreat." As recently as in the early 19th century it was present even in southern Sweden, yet now it is absent from not just Sweden but also Germany's Brandenburg province and Poland's Pomeranian and Masurian districts. In Poland I managed to track down a shrinking population of the species and to rescue it from disappearance, by transporting fertilized females to new locations and "encouraging" them to build nests there. These efforts successfully established 5 new nesting sites for the species and each year I take the appropriate protective measures to keep the populations in proper "shape."

Unfortunately, the phenomenon of successively disappearing bee species is known to be affecting nearly the entire European continent. The gravity of the problem led several years ago to the inception of project "Alarm," aimed at pinpointing the causes at work. This project involves 21 EU countries plus 5 others (including Israel and Switzerland). Let us hope that joining forces will help us to at least curb the unfavorable trends and to sustain our continent's unique species of fauna. ■

Further reading:

Banaszak J. (2000). A checklist of the bee species (*Hymenoptera, Apoidea*) of Poland, with remarks on their taxonomy and zoogeography: revised version. *Fragmenta faunistica, 43*, 135-193.

Banaszak J. (2002). *Apoidea* - bees [in Polish]. In: Głowaciński Z. (ed.), *Czerwona Lista Zwierząt Ginących i Zagrożonych w Polsce* (s. 69-75). Kraków: Instytut Ochrony Przyrody PAN.

Warncke K. (1986). Die Wildbienen Mitteleuropas ihre gültigen Namen und ihre Verbreitung (*Insecta: Hymenoptera*). *Entomofauna*, supplement 3, 128.