The narcotic nectar of *Epipactis* orchids

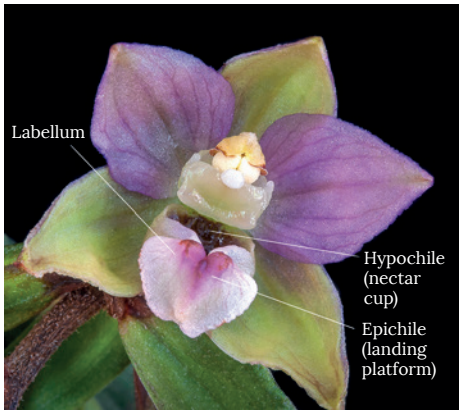
Nora De Angelli describes the unusual nectar produced by some species of helleborine

Photos by Nora De Angelli

Epipactis is a well-known orchid genus, represented by approximately 72 species and nothospecies (species of hybrid origin) distributed across Europe, eastward through Asia to Japan, and southward to tropical Africa. In North America, the genus has only one endemic representative, *Epcts. gigantea*. *Epipactis* species grow in very diverse habitats, from sandy beaches to open spaces, in deciduous or coniferous forests, on roadsides, in meadows, on moist soils and even in flooded habitats. Some species are so invasive that they are considered weeds.

Some *Epipactis* species are robust and may be over 1m tall (for example, *Epcts. africana*), while others are tiny, their flowering stem reaching only a few centimetres in height. Their leaves are dark green, both long and broad. The inflorescences consist of many small, variously coloured flowers, which secrete vanillin and eugenol and emit a nice vanilla-lavender scent (Jakubska et al., 2005). The labellum consists of two parts; the base, known as the hypochile, is cup-shaped and full of nectar, and the terminal part, the epichile, is heart-shaped, adorned with various calli and keels on its surface. *Epipactis* are rewarding species that attract and recompense pollinating insects with their abundant, nourishing nectar, secreted in the hypochile (sometimes called the nectar cup). The most important purpose of nectar is to attract pollinators and, since insects love sugary foods that give lots of energy, its main ingredient is sugar (in the form of glucose, fructose and saccharose). Apart from sugars, nectar also contains amino acids, lipids and organic acids, as well as various vitamins, enzymes, antioxidants and minerals.

However, the nectar of some species of *Epipactis* is unusual. In 1988, Müller analysed the nectar of *Epcts. helleborine* and discovered that it contained an ethanol concentration as high as 0.02%. In addition, he found hyphae-like structures in the nectar and suggested that, during hot summer days, yeasts might cause fermentation of the nectar sugars and produce ethanol. Probably these microorganisms were carried by wind and insects that frequently visit the flowers (Kevan et al., 1988). Previously in 1971, Bell had suggested that the plants secrete hallucinogenic or narcotic substances, causing an addiction in their pollinators,



Epipactis helleborine – labellum structure

which become visibly disorientated in flight. He coined the phrase “drunken insects” to describe them. After numerous detailed studies, Ehler & Olsen confirmed in 1996 that, besides ethanol, the nectar of *Epipactis* also contains certain quantities of other narcotic substances, such as derivatives of indole, morphinans (oxycodone) and derivatives of phenol. After feeding on this toxic nectar, the insects become sluggish and drowsy, spending a prolonged time on the inflorescences, thus increasing the chance of pollinating the orchid (Jakubska et al., 2005).

Epipactis helleborine (broad-leaved helleborine) is mainly pollinated by eusocial and solitary wasps (Schremmer, 1961) and, to a lesser extent, by bees and bumblebees. In order to increase its chances of getting pollinated, the orchid has synchronised the peak of its anthesis (flowering period) with the mating periods of various genera of wasps (Claessens & Kleynen, 2011). Both males and females usually feed on nectar. As long as the female wasps do not have a brood, they feed almost exclusively on nectar. Once they have to feed their larvae with animal nourishment, they become less interested in nectar.

Many insects that pollinate *Epipactis*, especially wasps and bees, are efficient groomers (Brantjes, 1981; Müller, 1988). Once they realise that a large load of pollen is stuck on their heads, they display

Epipactis atrorubens pollinated by *Apis mellifera* (right) and *Bombus campestris* (left).
The common honey-bee and the bumblebees are very efficient day-time pollinators of this orchid. Bees, though, groom less than wasps. This increases the chances of pollinia getting transported to the next flower and accomplishing pollination. Bumblebees are strong insects, able to carry the heavy load of pollinia. Their short proboscis allows them to easily rob the orchids’ nectar on which they feed but, at the same time, it brings their heads closer to the anther and the pair of friable pollinia that usually get stuck on their foreheads.

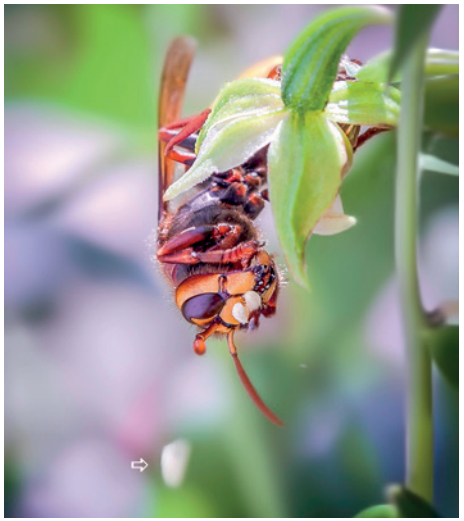




Vespa crabro pollinating *Epipactis helleborine*
The European hornet is the largest eusocial wasp native to Europe. European hornets are mainly carnivorous and hunt large insects such as beetles, wasps, large moths, dragonflies and mantises, but they also feed on fallen fruit and other sources of sugary food such as nectar. They apparently learned to exploit *Epipactis* as a food source.



intense grooming behaviour, trying to get rid of the heavy pollinia. This high pollen waste is detrimental to the orchids. However, after sipping from several nectar cups and eventually picking up many pairs of pollinia, the sluggish, drowsy wasps lose the necessary strength to groom their heads. As a result, the pollinia remain intact and will be carried to the next flower to be visited, thus accomplishing the pollination and successful reproduction of the orchids. Perhaps the toxic nectar is an ingenious solution found by the orchids to overcome the grooming problem.



Vespa crabro grooming and removing the pollinia fixed on its head
During the day, when ethanol concentrations are low, the narcotic effect of the nectar is not strong enough to cause intoxication in wasps. As a result, the powerful insects display intense grooming behaviour trying to get rid of the pollinia (arrow) fixed on their heads.



Two pairs of pollinia removed by the wasp and dropped onto the ground. These pairs represent the entire pollen-load of two separate flowers. Now they are wasted.

Nevertheless, one might argue that the flowering period of *Epipactis* species occurs at the end of July and beginning of August, a period when, in Romania, air temperatures during the day often exceed 25–30°C. Consequently, the ethanol evaporates and the nectar becomes less intoxicating to the insects. Since bees do not tolerate alcohol, this is the best time for bees and bumblebees to pollinate the freshly opened flowers of these orchids. In the evenings, the ethanol concentrations gradually increase and the orchid attracts mainly wasps, which better tolerate alcohol. Confirming this, in studying *Epcts. helleborine* and *Epcts. atrorubens* (dark red helleborine) we also noticed that during the day, especially at noon, the wasps were very energetic and did not seem to be much affected after drinking the nectar. On the contrary, in late afternoon when temperatures decreased, the wasps seemed to be drunker and more sluggish, giving the impression of intoxicated behaviour. They stayed on the same flower for longer and crawled from one flower to another, rather than flying from one to the next, like they normally do. Sometimes, they even fell off the orchid flowers onto neighbouring plants or the ground (De Angelli & Anghelescu, 2020). The narcotic effect of the nectar usually causes addiction and the wasps soon become the orchid's most loyal visitors and consequently also its most efficient pollinators. It is still unclear how much the insects benefit from the narcotic nectar, apart from getting a good meal from time to time, but orchids definitely do.

A list of references is available from the Editor.

The narcotic nectar of *Epipactis* orchids







A male wasp, *Dolichovespula saxonica*, pollinates several flowers
The male wasp spent almost 30 minutes on the inflorescence, sticking his head deep into several nectar cups and dragging himself very slowly from one flower to the next. Eventually, with the pollinia still attached to his head, the tipsy fellow completely lost his balance and fell off, clinging helplessly to some nearby blades of grass.