Chalkbrood

By Sally Ponting and Kirsty Stainton, National Bee Unit

The appearance of chalkbrood, with the characteristic signs of either spongy, white larvae or older, dried, hard, white larvae in uncapped cells, signals the need for urgent action. Sally Ponting and Kirsty Stainton help us understand more about this larval disease and how we can best mitigate it.

A brief history of chalkbrood

Chalkbrood is what we call the manifestation of the fungal disease caused by *Ascosphaera apis*, which affects developing honey bee brood. The first reports of chalkbrood disease date back to the early 1900s in Europe. In 1916, the first scientific reference to 'chalkbrood' appeared in a German article by Maassen who described a well-known disease in Europe that affects honey bee larvae; he named it *Pericystis apis*.[1] It was not until 1955 that the taxonomic nomenclature was reclassified as *Ascophaera apis* by the mycologists Charles F Spiltoir and Linday S Olive.[2]

At that time, the disease had never been observed outside of Europe, but it spread to North and South America, the middle east, Asia, Australasia[3] and Africa[4] during the latter part of the 1900s. It spread rapidly across the globe due to movement of bees and hive products. For example, the source of infection for Turkey was tracked back to imports of contaminated beeswax, and migratory beekeeping was implicated in the fast spread of chalkbrood across North America and Australia.[3]

What causes chalkbrood?

The developing larvae acquire the infection through their gut when it is fed to them through contaminated food; the fungus cannot penetrate the cuticle (skin) of a larva.[5] When ingested by a larva, the fungal spores germinate in the midgut and produce mycelia. Mycelia (singular: mycelium) is the collective term for groups of hyphae; a network of fungal threads produced by fungi, which it uses for feeding. You may have observed this on, for example, a rotten tomato that has white, fluffy fungus growing on it; the fluff is the network of hyphae. The mycelium is also responsible for reproduction and forms 'fruiting bodies', which will generate more spores. The spores that germinate in the larval gut produce enzymes that damage the larva, causing it to die. The mycelia then break through the cuticle and the larva turns spongy and white, at first, then becomes hard and chalk-like. The larvae may then turn grey, black or brownish green[5] when the fruiting bodies of the fungi produce infectious spores on the surface of the larva.

In 1991, Bailey and Ball stated that the fungus germinates in the larval gut when the colony temperature falls below its optimal level of 32°C to 35°C for more than two hours.[6] Chalkbrood is most prevalent during the spring and early summer, and this is the time that growth will be favoured due to cool and humid conditions, particularly in poorly ventilated hives.[3] Also, during this time, colonies are growing quickly so this is when the larvae are most likely to become chilled, making them more susceptible to infection. Leslie Bailey observed that drone brood may appear to suffer more from chalkbrood as they are at the periphery of the brood nest and more likely to become chilled.[6]

Each chalkbrood 'mummy' can produce millions of infective spores that stick to the brood cells, hive components and adult bees. Chalkbrood is considered highly infectious and spores can be spread through robbing and drifting of worker bees, and via contaminated equipment.

Chalkbrood spores are very resistant in the environment and may persist for at least fifteen years.[7] While adult honey bees are not susceptible to infection, they can transmit the pathogen within the hive and to other colonies. Food sharing between adult bees allows fungal spores to be carried by foraging bees and subsequently passed to susceptible larvae.

A chalkbrood-like disease can occur in other bee species, including bumblebees, leaf cutting bees, mason bees and sweat bees, which is caused by other species in the genus *Ascosphaera*.[7] However, it is not clear whether chalkbrood can be spread between species.

Recognising chalkbrood

Chalkbrood is very easy to recognise. As described above, larvae can be seen to be covered by white fungus and later, they begin to dry out and shrink down forming their distinctive 'mummified' chalk-like appearance. Although the larvae become

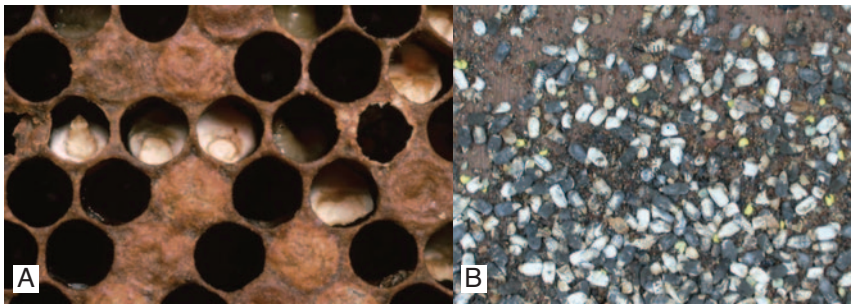

Figure 1. (A) Larvae infected with chalkbrood and (B) a mixture of white and grey/black chalkbrood mummies outside a colony. The dark mummies contain the spore form of the chalkbrood fungus. Images courtesy Crown copyright.

infected during early stages of life, they will not exhibit symptoms until just before, or up to two days after capping.[7]

Workers will uncap and remove the majority of infected chalkbrood cells so the beekeeper will only see a small proportion of the infection in the hive. Figure 1a shows chalkbrood-infected larvae in their cells. The bees eject these mummies from the hive and they can be seen on the hive floor or outside the hive, as shown in Figure 1b. However, if mummies are still contained in capped cells, when a comb is shaken gently, they may be heard rattling.[7]

In 1912, the English apiculturist, Annie D Betts, identified and classified a pollen-mould she observed to be common in UK beehives; you will probably have seen it growing on stored pollen. She named it *Pericystis alvei* and beautifully describes it as being *"... undoubtedly a normal inmate of the healthy bee-hive ..."*.[8] Annie D Betts provides some images of this fungus in her 1912 publication: A Bee-hive Fungus, *Pericystis alvei*, Gen. et Sp. Nov.,[8] and in Figure 2, you can see that this fungus has a fluffier presentation on the comb, but the cell contents can look a bit like chalkbrood. Chalkbrood mummies are fairly distinctive but could feasibly be confused with this mould, however, when rubbed between two fingers the mouldy pollen will break up easily, whereas a mummified chalkbrood larva will not and is hard to crush between the fingers.

Can I prevent chalkbrood?

Chalkbrood is fatal to infected larvae and can result in a decline in bee numbers and honey production, but it does not typically cause the demise of a colony.[3] However, it can be problematic and the most common treatment for recurring chalkbrood is to re-queen the colony from a hygienic stock, as some strains of honey bee are naturally more resistant to chalkbrood than others.

Management techniques to reduce infection with chalkbrood include keeping hives clean, replacing storage and brood combs regularly, and keeping hives well ventilated and dry.[3] Spores are very persistent in the environment, so it is important to use clean equipment and to not transfer material between colonies if infection is present. Chalkbrood spores may be contained in pollen, honey and wax and can therefore be transmitted to other colonies by transfer of these products.

In an experiment, two infected pollen combs were removed from chalkbrood-infected colonies and placed into healthy colonies. The result was that the healthy colonies began to suffer from an increase in chalkbrood-infected larvae, while in the infected colonies chalkbrood levels began to decline.[9] This shows that material should not be transferred from a sick colony to a healthy one, but also suggests that removal of stored pollen from infected hives and provision of a protein substitute could help reduce infection levels in an affected colony. This same study demonstrated that placing pollen traps on colonies increased chalkbrood infection and suggested that a pollen/protein deficit could aggravate the condition.[9]

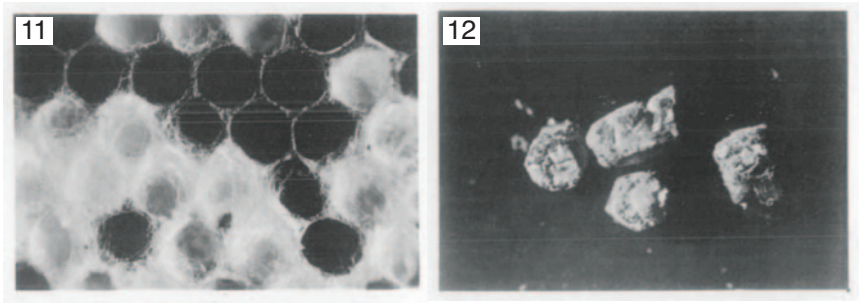

Figure 2. Plates 11 and 12 from a publication by Annie D. Betts (1912)[8] demonstrating the presentation of the pollen mould *Pericystis alvei*.

Are there any treatments for chalkbrood?

Unfortunately, there are no products registered for treatment of chalkbrood in the UK. Some researchers have tested various essential oils against chalkbrood and there is some success reported in laboratory experiments, but field data indicating any potential treatments is yet to materialise. So, for now, good husbandry is the best treatment.

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