Variation in susceptibility to bee diseases among European races of honey bees

Report on the 2nd lecture of Dr. Robert Paxton to the BIBBA AGM on 19th April 2009 at Stoneleigh, England.

Following his 1st lecture to BIBBA which was a repeat of his lecture to the BBKA spring convention the previous day on Nosema ceranae, Dr. Paxton's 2nd lecture to the BIBBA AGM on 19th April addressed variation among European honey bee races in disease susceptibility. His lecture was based upon recent research of the European Union funded research project Bee Shop (FOOD-CT-2006-022568), of which he is one of 10 partners (coordinator: Prof. Robin Moritz, University of Halle, Germany, see www2.biologie.uni-halle.de/bee-shop). Bee Shop has four departments: pathology, honey quality, genetics and behaviour, and extension; research has been organised into a series of "work packages". Dr Paxton's group, comprising himself with Dr Joachim de Miranda and PhD student Orlando Yañez, are within the "pathology department", focusing specifically on viral diseases; additional funding for Orlando has been provided by the CB Dennis Trust, for which Dr Paxton was most grateful. Full details of Bee Shop research will be presented at the Apimondia conference in Montpellier, France, this September 2009 in a special session devoted to Bee Shop.

Dr Paxton's lecture was entitled: Bee Shop: an ongoing EU research project. This project, the EU's major commitment to honey bee research over the past 3 years, comes to its natural close with Apimondia 2009. Its rationale is to reduce contaminants in the hive and thereby ensure high honey quality. One major source of such contaminants is the range of chemicals employed by beekeepers to control bee diseases, and so the project has sought to identify variation among honey bees in disease susceptibility and then to identify those genetic markers (variants or alleles as specific loci) responsible for reduced susceptibility. The prospect is that honey bee breeding can then use marker-based selection to generate the less disease-susceptible bees. Variation among bee races in disease susceptibility is obviously of central interest to BIBBA members, so Dr Paxton concentrated on ongoing Bee Shop research addressing this point.

As diseases, the Bee Shop has focused on AFB (American foulbrood), *Varroa destructor* (herefter "varroa") and viruses transmitted by varroa, particularly DWV (deformed wing virus), the most widely distributed virus associated with and transmitted by varroa. In all three cases, the approach has been to investigate variation among individual larvae/pupae or among individual adults in disease susceptibility, so as to facilitate the molecular genetic research to identify disease susceptibility genes. For AFB and viruses, this has entailed in vitro rearing of 100s of larvae from egg through to adult on artificial diets, so that their exposure to disease organisms and their response to those diseases can be accurately monitored.

The research on AFF susceptibility, undertaken by Prof. Ingemar Fries and his team at the Swedish Agricultural University, examined LC50 values (lethal concentration of spores that lead to 50% mortality of larvae when fed one variant of AFB: Eric I) of individual larvae of the honey bee subspecies/variants *Apis mellifera carnica, A. mellifera ligustica, A. mellifera mellifera* and Buckfast bees. Results demonstrate surprising variation in susceptibility among colonies in larval LC50 values; larvae from some colonies were consistently very susceptible to AFB spores (low LC50 values) whereas larvae from others were not. Most significantly, there was no average between-subspecies/strain differences in disease susceptibility; there were good and bad colonies (with respect to AFB susceptibility) in all subspecies/strains. The genetic research by the teams of Prof. Moritz (Halle) and Prof. Solignac (Paris) have already identified a number of candidate loci that are responsible for reduced AFB susceptibility.

Research on varroa has been lead by Dr Peter Rosenkranz of the State Bee Research Institute of Baden Württemberg at Hohenheim University, Germany. He and his team examined varroa fertility (% mites that reproduce) and fecundity (number

of offspring per reproducing mother mite) in individual pupae, and investigated the honey bee subspecies/variants: *A. mellifera carnica, A. mellifera ligustica, A. mellifera mellifera* and Gotland bees. (The last-named are part of the Gotland experiment of Prof. Fries in which 150 colonies were turned out on Gotland and left without varroa control; after 9 years, some 15 colonies still survive, indicating they have a degree of reduced susceptibility to varroa). There were only subtle between-colony differences in "varroa susceptibility" i.e. varroa fertility and fecundity was similar across all colonies, irrespective of honey bee subspecies/variant. Hence the Gotland bees seem to be no different from other bees with respect to varroa fertility and fecundity. How they have survived so long without varroa control is still not yet resolved.

Dr Paxton's research on viruses is not yet complete, so final results will have to await the Apimondia congress in Montpellier, September 2009. He did, however, mention the other research on viruses that he and his team (Dr Joachim de Miranda and Orlando Yañez) have undertaken within the Bee Shop project. Firstly, reanalysis of a large French survey of colonies in 2002 has demonstrated the presence of IAPV (Israeli acute paralysis virus) in a considerable number of apparently healthy colonies. You may recall that Diana Cox-Foster and colleagues first suggested there was a link between IAPV and CCD in the USA in an influential paper published in the leading journal *Science* in 2007. The results from the French apiaries indicate that IAPV does not cause CCD. Secondly, his team have been investigating the relative importance of different transmission routes for DWV: horizontal transmission via trophallaxis between adult workers, via larval feeding, via varroa, via sperm (i.e. from drone to queen) and vertical transmission from queen to offspring. Surprisingly, they find most drones at DCAs (drone congregation areas) to be packed with DWV, and carefully controlled experiments have demonstrated that queens often pass DWV from drones on to their offspring via eggs (called "transovarial tranmission"). It is therefore hardly surprising that, in a locality harbouring DWV, all colonies soon become infected.

What do all these results mean for bee breeding, and BIBBA in particular? Dr. Paxton summed up by suggesting that the Bee Shop results indicate that all races harboured genes for reduced disease susceptibility. Therefore, given that importation of honey bees carries with it the risk of disease importation, it would be prudent to breed from local stock. Those that claim non-native stock has lower disease susceptibility are wrong. The onus is on them to demonstrate scientifically their claims. If not, they risk disease spread to all beekeepers. He applauded the approach taken by BIBBA, and we applauded him for an interesting and informative presentation of his and colleagues' very latest and, in part, not yet published results.

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