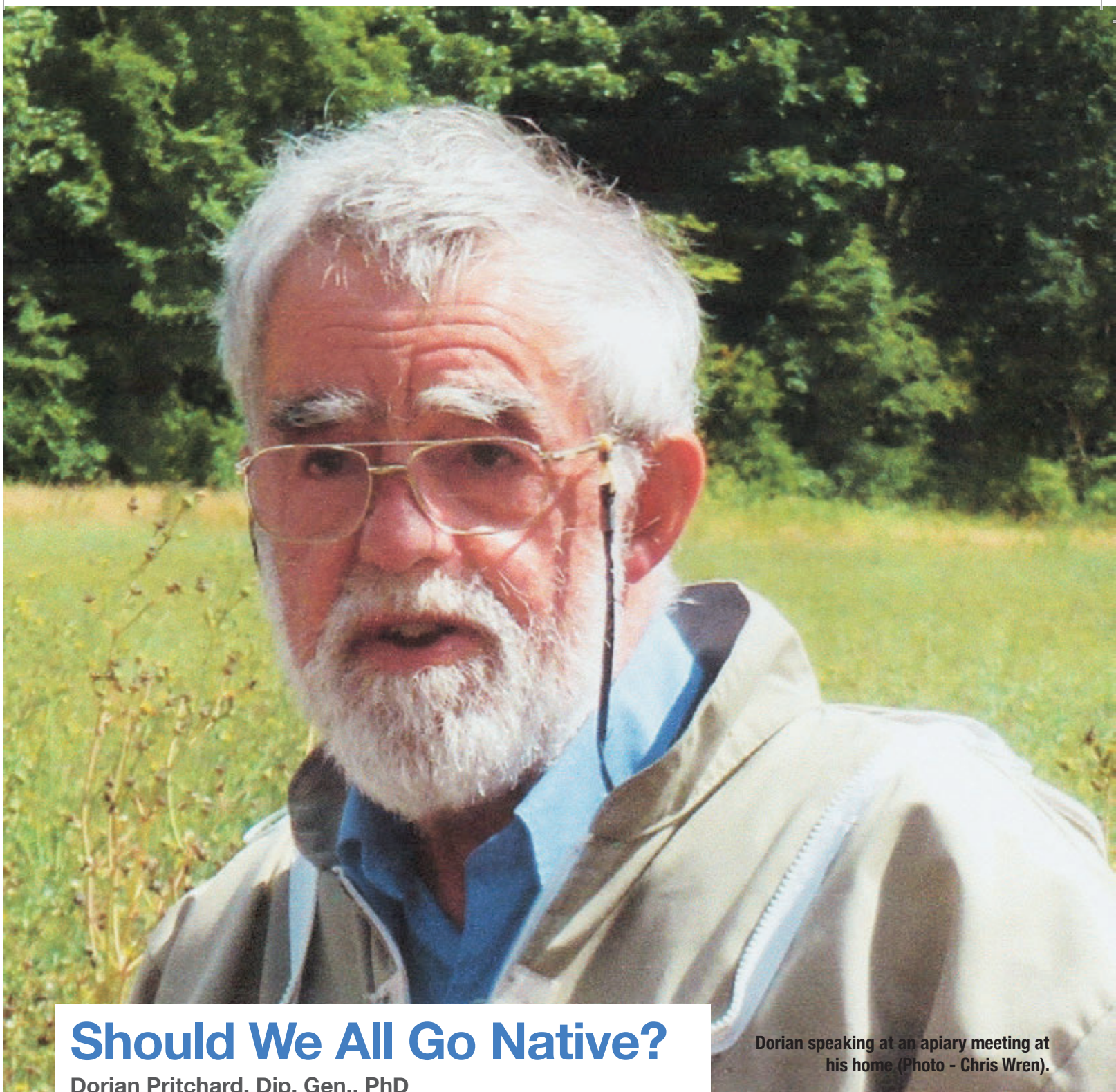




Should We All Go Native?

Dorian Pritchard, Dip. Gen., PhD

Dorian speaking at an apiary meeting at his home (Photo - Chris Wren).

Part One

All across Europe most honey bees now survive apparently only with human help and the noxious produce of the pharmaceutical industry! The recent COLOSS survey found that of 597 colonies of 5 subspecies and 16 genetic origins established in 20 professionally-run apiaries, only 94 (15.7%) managed to survive a mere 30 months without a chemical fix! (see Büchler, et al, 2014) Each location contained bees of local strains together with at least two others of foreign origins (see Meixner et al, 2010;

2014). The enemy that brought most of them low was Varroa destructor.

This is a truly shocking finding, to me perhaps more than most, because, despite varroa being all around me, I have not treated my bees with any anti-varroa chemical, or relevant biotechnical procedure, since 2002. During those 14 years, of a total of several hundred colonies, I have lost no more than 3 for which the cause could be considered to be varroa or its associated viruses. For many years I have hardly seen a mite in my hives, nor

a bee with signs of deformed wing virus. This year (2016) in my 30+ hives I've seen just one worker with shrivelled wings, and not a single varroa mite. No doubt there are some, but you'd have to look hard to find them.

I think a strong clue to the health of my bees lies in the finding of the COLOSS scientists that at every test location it was the local strain of bee that fought its corner with greatest success (Büchler, et al, 2014). Indeed, colonies with local queens survived on average 83 (+/-23) days



The author's Northumberland strain of *Apis mellifera mellifera*.

($p < 0.001$) longer than those with non-local queens. I have selected and bred from local bees for nearly 40 years now, with a view to strengthening representation of the local variant of the North European Dark Bee, *Apis mellifera mellifera* L. in my area of Northumberland. In the survey it was not necessarily the *mellifera* subspecies that was most successful, but only so where *A. m. m.* was native to that locality. The important point is that independent survival of honey bees everywhere against this new pathogen turned out to be highest in stocks that were already naturally selected to dwell at that specific location.

To biologists this should cause little surprise, as we are brought up in the Darwinian mind. This teaches that all species are the outcome of repeated rounds of genetic selection by a host of environmental factors and traditional pathogens, which must perforce act locally. Wherever they are, local wild species whose ancestors have survived there for thousands of generations without human supervision must, of necessity, be well adapted to the environmental factors that define the home locations of those ancestors. These adaptations are specified by the genes inherited through generation after generation of well adapted survivors. True, environments change, but adaptability has also been selected, like

our ability to tan or go pale depending on the intensity of ambient sunlight, both skin shades having survival value in the appropriate regime. So changes in agricultural practices and environmental fluctuations, like global warming and cooling, are also accommodated within the native bees' behavioural and physiological repertoire, provided those changes are not too profound in kind, too major in degree, or too extended in time. Imported honey bees similarly well adapted to climatically very different locales are already under adaptive stress in their new homes, so their chances of success when other things go wrong can be expected to be relatively slim.

A term sometimes used in this connection is "antagonistic pleiotropy" (Fry, 1993). Pleiotropy refers to a gene which controls more than one aspect of phenotype. Coupled with "antagonistic" it implies opposite effects on fitness in different habitats, so that no single genotype is universally superior (Büchler, et al, 2014). Bienefeld and Pirchner (1991) considered most colony traits to be expressed in both workers and queens, although often with opposite selective value.

In relation to the COLOSS finding, the most likely parameters of success or failure were thought to include aspects of colony development, behaviour and dis-

ease susceptibility (Meixner, et al, 2014; Hatzina et al, 2014; Uzunov et al, 2014).

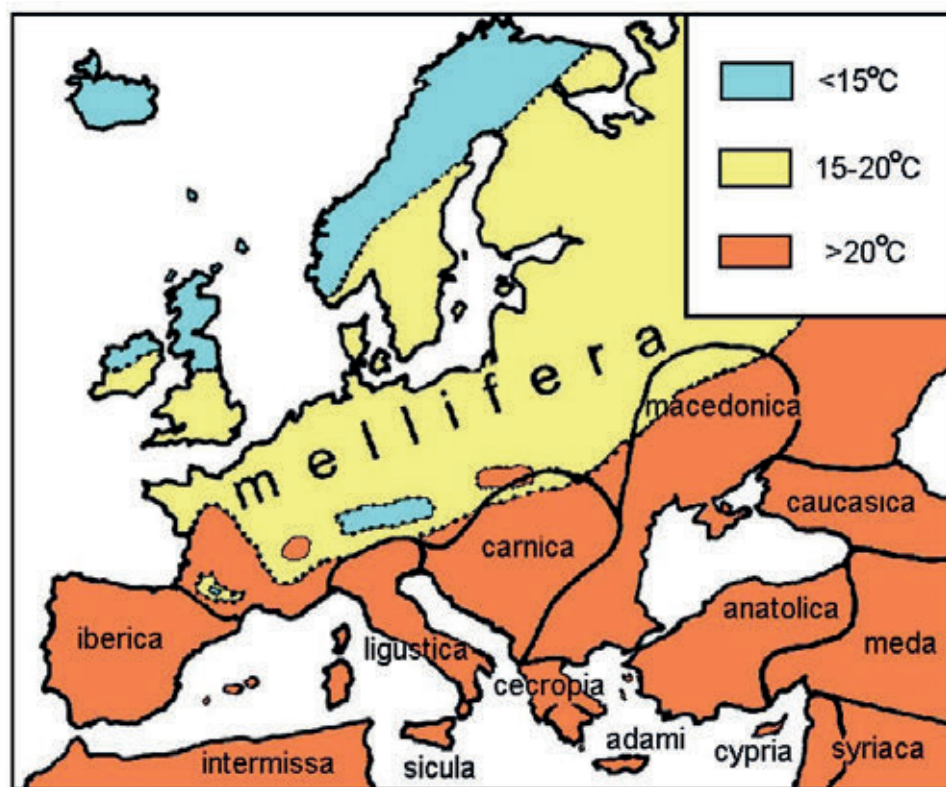
The state of mature adaptation to one, albeit somewhat variable, climatic environment, is at the core of the resilience of native stocks. Underlying this is a balanced genome which has been held in isolation for thousands of generations and within which re-assortment of the genes takes place without creation of physiological disharmony. When foreign genomes are spliced in, that harmony is disrupted and chaos can, and frequently does, ensue.

So, in the case of honey bees, what are the inherited features of say, the North European Dark Bee that on its home ground in Northern Europe give it a selective advantage over the other races? Comparative attributes of the European native honey bees are reviewed by Ruttner (1988).

Coping with the cold. One of the most important, indeed death-dealing, hazards of the North is low environmental temperatures, and northern native bees have several defences they use against them. First, their large size helps conserve body heat when outside the nest. This is because the surface area of a rounded body is proportional to the square of its radius, while its volume is a function of its radius cubed. Heat loss is proportional to surface area, while heat retention depends on body volume. The ratio of loss to gain is therefore smaller for large bodies than small ones and large individuals find it easier to keep warm in cold environments.

Although dark bodies radiate heat more than light coloured ones, they also absorb heat better and on balance the Northern bee's dark coloration aids in absorbing warmth from the sun. Cooper (1986) suggested that this for the Northern bee is most important in aiding drones to fly in cool air for mating. He suggests this gives them a competitive advantage of around 5-10% over drones of lighter colours. So drone-laying queens are less likely in native apiaries than in those of exotic bees.

Unsurprisingly, Northern natives can fly at lower temperatures than their Mediterranean cousins for both foraging and mating, but unlike those cousins, they do not risk chilling by emergence at dawn to collect dew, as rain water is rarely in short supply in the north. Northern bees are also less likely than their hot country cousins to be tempted out by the bright light reflected from snow, when no bee can survive that exposure for long.



Natural home ranges of subspecies of *Apis mellifera* (Ruttner, 1988) in relation to July average peak temperatures. The *A. m. mellifera* subspecies was originally confined to the region north of the Alps and Carpathian mountains and south of latitude 60°N, where average temperatures rarely exceed 20°C, but can go below 15°. All other honey bee subspecies are naturally adapted to July temperatures in excess of 20°C.

The geographical distribution of the native *A. mellifera* subspecies in Europe coincides remarkably well with summer temperatures, but not at all to those of winter, implying that the most important selection of honey bees by environmental factors operates in relation to summer temperatures (The northern limit corresponds roughly to those of hazel (*Corylus avellana*) and the hedgehog (*Erinaceus europaeus*).

A. m. mellifera foragers have abdominal over hairs some 40% longer than those of Italian bees (*A. m. ligustica*) and those hairs are also branched. Both features help heat retention, as well as enabling heavy pollen collection.

The wing vein patterns of honey bees are one of their most reliable indicators of race and that of *A. m. m.* is believed to be associated with wing muscle strength, ability to carry heavy loads and staying power.

Winter clustering and cool air clustering. Italian bees do not show the tight winter clusters of Northern bees and can die in colonies of moderate weight despite an abundance of food around them, when Northern bees in much smaller colonies survive with vigour, by virtue of the tightness of their clusters. There are in fact geographical clines in winter clustering efficiency among *A. m. m.* bees from South to North, from lowlands to hills and from coastal areas inland, that relate to survival rates in harsh conditions (Cooper, 1986).

I find that when native stocks are set up for overwintering with an empty shallow box beneath the brood to allow the cluster to hang naturally, stores are used from the outside frames first, leaving honey close to the central brood in readiness for the spring increase.

Another native brood nest feature of winter survival value is convex, white honey cappings enclosing a pocket of air. This is an attractive feature for sales of comb honey, but also it prevents capped honey from “weeping” and fermenting on the comb surface in the winter hive, which can lead to dysentery. This character is associated with “cool-air clustering” on combs when inspected in cool air, which is a great asset in comb production as it enables bees to maintain high body temperature for wax production.

Colony age profiles and “winter bees”. Most of the “cost” of producing the work force is expended during each bee’s early individual development. The Northern bee counters this by decreasing the number of its offspring, while increasing their longevity. This life extension is applied predominantly to the foraging stage, increasing the foraging force as a proportion of the colony as a whole.

Ability to withstand bad weather is a very important attribute during spring and summer when Northern natives accumulate enough pollen to last 2-3 weeks, whereas Italians and most other non-native types will store sufficient for only 3-6 days. *A. m. m.* also stores its pollen among and below the brood, where it is immediately available for tenders of the brood nest, while non-natives store it less accessibly to the sides and above the brood.

In early autumn young *A. m. m.* nurse bees consume large quantities of oily pollens, which they convert to body fat and store for over-winter survival. Since the brood nest is at that time contracting and they lack the necessity to secrete so much brood food, their development gets arrested at a juvenile stage. This allows them to produce brood food again when the brood nest expands in early spring. By contrast, Mediterranean bees need to raise new cohorts of young bees throughout the winter in order to ensure brood food secretors for the spring larvae. This is an expensive exercise in terms of depletion of stores and also makes the colony vulnerable to the cold conditions outside.

The internal fat stores of “winter bees” also mean that Northern natives need consume less food in winter and so can survive on minimal brood nest stores. They also produce enzymes that relieve gas build-up in the intestines of overwintering bees, which means they have less need to leave the hive to relieve themselves.

The characteristics of native bees will be further considered in the next issue of NBH. Editor.

BIBBA (Bee Improvement and Bee Breeders Association) - www.bibba.com and SICAMM (Society International for the Conservation of *Apis melliferae melliferae*) www.sicamm.org are the two most important organisations for the conservation of local bees, for more information log on to their websites.



Should We All Go Native? Part 2

Dorian Pritchard, Dip. Gen., PhD

Native bees in Brittany (Job Pichon).

Adaptation to forage

North European honey bees practise the thrifty habit of adjusting their breeding rate in pace with the income of food. This means that colony build-up and decline follow nectar availability; colony size expands to take advantage of plenty, but drops when there is a dearth. This is unlike other races which reproduce more independently of forage availability and consume their hard won stores or die of starvation during nectar dearths.

Native bees are also co-ordinated to components of their local forage in the regular timing of brood nest development, so that, for example, in heather areas brood nest build-up is delayed till mid-summer so that their foraging force is at maximum strength in August when ling heather (*Calluna vulgaris*) is in full bloom.

There is further adaptation to forage in the salivary enzymes bees use for digestion of nectar and pollen, which corresponds with the flowers they seek. Thus Northern bees overwinter well on the nectar and pollen of ling, which is abundant on the acid peat of northern hills, but these induce dysentery in some southern honey bees. When oil seed rape first came to Northumberland I placed a hive of uniformly dark, local bees alongside a hive of foreign, banded bees six feet away at the edge of a rape field. The banded bees produced honey that tasted and smelled of turnips and their brood frames were crammed with yellow rape pollen. By comparison, the local, dark bees produced honey with delicious taste and aroma and although rape pollen was still the predominant type, the brood nest contained other pollens of a variety of colours. A consequence of the difference in foraging habits of local and foreign bees is that we can expect local bees to play a

much more significant part than exotic bees in wildflower conservation.

Drone expulsion and apiary vicinity mating

Although the textbooks tell us that drones move from hive to hive, those of British native strains tend not to do so. The workers also show minimal drifting, both of which features cut down spread of disease. This also contributes to genetic isolation of native stocks, in relation to the drones being thrown out by Northern house bees in times of nectar shortage. Since migratory non-native drones are thrown out at the same time, this reduces foreign representation in drone assemblies in the longer term and helps protect the native genome from contamination.

In cold and wet weather when conditions are unsuitable for drone assemblies to form, northern bees will mate at hedge-top level near the apiary. This is called Apiary Vicinity Mating, or AVM. It is disadvantageous in promoting inbreeding with creation of diploid drones, which leads to reduction in the effective fertility of the colony. However, it at least keeps the breeding line alive when queens of non-native parentage become drone-layers or disappear and it can also be advantageous in conserving favourable recessive features like supersedure. Supersedure is relatively common in British native honey bees, providing a survival safeguard when conditions are too poor for swarm-related reproduction.

Temperament

I have heard beekeepers comment that “Black Bees” are particularly bad tempered. In my own experience their temper covers a range from exceptionally gentle

to unacceptably bad and for the beekeeper it is a matter of not raising daughter queens from badly behaved colonies while propagating both queens and drones from among the gentlest. When I did the latter, one of my neighbours was astonished at how gentle his own bees had suddenly become!

I suspect however, that in many cases the very aggressive dark stocks are not true *A. m. mellifera*, but inter-racial hybrids. Beowulf Cooper recognised “temperament groups” among honey bees (Cooper, 1986). Breeding within a group retains good temperament, but breeding between groups causes loss of good temper. The many variant ecotypes of *A. m. mellifera* all belong to the same temperament group, while the Mediterranean subspecies, *ligustica*, *carnica*, *caucasica*, etc. and the original Buckfast belong to another. It is however, commonly observed that first generation crosses between members of these two groups can be strong, vigorous and good tempered, benefiting in several ways from “hybrid vigour”. In subsequent generations, however, a disordered genetic shambles ensues and some colonies show horrendous temperament, such that they may have to be destroyed. Buckfast or *carnica* in combination with *mellifera* have the worst reputation in this respect.

Genetic introgression

F2 and subsequent generations from inter-racial crosses are of no use for breeding as they contain many disparate combinations of ancestral genes and the outcome of matings is quite unpredictable. Such a situation is common in Britain where foreign queens are or have been imported, especially in the neighbourhood of commercial honey farms.

Nevertheless, the native genome is

protected by natural barriers to introgression from foreign bees. There is the preferential culling of non-adapted bees by bad weather and I have already pointed to the habit of native house bees of ejecting foreign drones along with their own when nectar is scarce. Another relevant idea is that the drones and queens of different subspecies may fly at different altitudes within drone assemblies. Whatever the mechanisms may be, a recent survey of the DNA of British honey bees by Government scientists showed that despite 150 years of foreign importation, the native *A. m. mellifera* genome is still predominant overall in the UK, especially in some areas such as Northumberland, where I live.

Disease

Disease is spread largely by beekeepers moving bees, equipment, or hive products accidentally or knowingly from diseased areas to those that were formerly disease free. Deriving your stocks from local sources helps prevent this and long exposure to serious disease will have already culled out the most susceptible stocks.

So far as varroa is concerned, resistant stocks are reported in several apiaries and/or feral colonies at locations in Europe and the Americas (see Pritchard, 2016) and their resistance is said to involve, overall, a variety of behaviours or physiological factors. A degree of genetic variability within a colony is considered important for disease resistance as well as for homeostasis, thermoregulation and overall colony fitness (Meixner *et al* 2010; Tarpy, 2003; Jones *et al*, 2004; Mattila & Seeley, 2007; Oldroyd and Fewell, 2007). At the population level, genetic diversity is necessary for populations to evolve in response to increasingly challenging environments and these can include novel parasites, new diseases and new agricultural chemicals (Pinto *et al*, 2014). Due to many rounds of inbreeding and artificial selection, commercial stocks are genetically less variable so would be expected to be more susceptible to new diseases and this could be one of the factors explaining the superiority of native stocks in resisting varroa.

My personal experience suggests that auto- and/or allo-grooming is likely to be the most important and so far largely unappreciated basis of resistance to varroa among North European *A. m. mellifera* (Pritchard, 2016). Although genetic

predisposition to this behaviour must be necessary, experience of living with mites in the hive and the development by the bees of a culture of anti-varroa behaviour may also be necessary. That is, successful anti-varroa grooming behaviour seems to me to be an issue of both “nurture” and “nature”. Beekeepers who immediately on encountering mites try to destroy them are, I believe, also destroying the bees’ opportunity to solve the problem for themselves, so preventing them developing their hidden inherited strengths.

Adverse features of North European natives

Despite my glowing praise, native bees also have their difficulties. One of the biggest with *A. m. mellifera* is propagation, as by their nature they are non-prolific, although other, more prolific subspecies such as *ligustica* could be conscripted for propagation of queens from *mellifera* eggs.

The honey yields of native North Europeans are also generally considered small, although typically they will collect a harvest every year, irrespective of bad weather. When I routinely overwintered only 4 hives, I ran them during the summer with both a young and an old queen under each roof, combining them for the heather. Then I gathered on average just over 100lbs (45Kg) of honey per productive unit; in my best year it was 150 (68Kg). A better beekeeper would probably have increased this to 200. I am told commercial beekeepers aim at 250lbs (113Kg) per hive, but they are wedded to high input systems and I generally did not feed my bees, relying on their stocking up for winter at the heather. In Britain, Willie Robson and several others run successful enterprises with local bees, demonstrating that it is possible even in the British climate.

The future

So where do we go from here?

I think the recommended way ahead for the ordinary beekeeper is, as always, line breeding of local bees. The basic strategy is simply to cull the queens and drone brood from the poorest stocks at each generation. Groups of like-minded, sensible beekeepers could share stocks locally and discourage neighbours and especially beginners from importing exotic queens. It is bad policy to propagate many daughters from just one excellent queen; you should

maintain several lines and cull the weakest or poorest of each line. That is how nature does it – and she knows!

A priority, expressed perhaps surprisingly by Brother Adam in 1987, but echoed by Randi in 2008, Meixner *et al* in 2010 and latterly the COLOSS work group following their survey, is that there is a pressing need for conservation of native honey bee stocks (see Büchler *et al*, 2014; Pinto *et al*, 2014). Adam wrote: “*The greatest danger which today threatens almost every race of honeybee comes from the prevalent use of mongrel stock at an international level and at the same time from a widespread dissemination of certain very good strains of bees. This of course means that the good characteristics are being propagated, but at the same time it does entail a loss of the genetic riches which were once available*”. His motivation was to ensure continuation down the road on which he began with the Buckfast bee, to my mind a wrong road, as it involves uninformed dissemination of maladapted foreign stock and widespread destruction of native gene pools. Nevertheless he finished with a statement with which I am in full agreement. “*To preserve and promote these breeding possibilities it is essential to establish reservations to maintain these different races. The maintenance of the races with their original hereditary wealth and individuality is a pre-requisite for any progress in breeding the honeybee*”. Both BIBBA (*Bee Improvement and Bee Breeders’ Association*; www.bibba.com) and SICAMM (*Societas Internationalis pro Conservazione Apis Melliferae Mellifera*; www.sicamm.org) have been promoting these ideas for many years and the latter has recently expanded its scope to include the other native European subspecies.

Meixner *et al* (2010) pointed out a problem with European Union Trade Law, that “*trade of commercial animals, including bees, within the EU is regulated by Council Directive 91/174/EEC. According to this directive, free trade is the general rule, and the introduction of non-indigenous races should not be obstructed on the basis of zootechnical or genealogical rules that apply locally*”. However, they also noted that the EU Court modified its view in 2001, stating that the issue of conservation of local subspecies can now take precedence over that of free trade. Thus countries within the EU now *do* have the legal

right to set aside areas for conservation of their local subspecies and are allowed to ban use of imported stock, in line with the Rio Declaration on Environment and Development made at the Earth Summit of 1992. However, the experience of Danish conservationists with regard to the island of Laesø (see Jensen & Pedersen, 2005) shows that for any honey bee conservation effort to be successful, beekeepers in the proposed conservation areas must also agree to the plans and support them fully.

These days there are many ingenious genetic possibilities for the professional bee breeder, but he or she should always bear in mind that their bees will work within an open community and the drones of their stocks could mate with local queens and possibly cause problems for those bees and their owners. Honey farmers do not have a God-given right to despoil local gene pools by release of maladapted foreign drones and they should not be allowed to do so. Establishment of the native bee reserve on Colonsay, which forbids import of any honey bee subspecies other than *Apis mellifera mellifera* to the island, was facilitated by a special addendum to Scottish law designed to protect all wildlife native to Scotland, which unfortunately does not apply elsewhere.

Conclusions

While all beekeepers may not be convinced that “going native” is really for them, I hope there is widespread appreciation of the inestimable value of conserving native honey bee populations, with their unique combinations of hereditary strengths and virtues. They are one of the greatest natural treasures we have. As Büchler *et al* (2014) concluded: “*Conservation of genetic diversity is an essential precaution in order to preserve a high genetic adaptability of European honey bee populations. Furthermore, the results of our study show that it is not merely an ecological issue, but also a commercial one: the use of local honey bee populations provides a higher chance of colony survival and the use of maladapted bees attributes (sic) to high colony losses..... Thus local breeding activities should be promoted and encouraged throughout the native range of Apis mellifera*”. Pinto *et al* (2014) add: “*Honey bee diversity is the single most important legacy that we can leave to future generations of beekeepers.*”

If appropriate action is not taken in the near future to protect the genomes of native honey bee stocks, I would expect the demise of large scale honey production in Europe and the survivors of the craft will be the small-scale backyard beekeepers who do it for love, rather than profit. But, with the intervention of COLOSS (led appropriately by Romée Van der Zee, whose name tells us her ancestors came from the sea), the tide is turning and the fate of native bees could be about to undergo a sea-change, espe-

cially so if the big bee-handling organizations accept their advice and also decide to “go native”.

Acknowledgements

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