An introduction to understanding honeybees, their origins, evolution and diversity

by Ashleigh Milner

What are honeybees, anyway?

Bees of all kinds belong to the order of insects known as Hymenoptera, literally "membrane wings". This order, comprising some 100,000 species, also includes wasps, ants, ichneumons and sawflies. Of the 25,000 or more described species of bees (more are recognised every year) the majority are solitary bees most of which lay their eggs in tunnels, which they excavate themselves. In some species small numbers of females may share a single tunnel system, and in other cases there may be a semi/social organisation involving a hierarchical order among the females, These bees provide a supply of food (honey and pollen) for the larvae, but there is no progressive feeding of the larvae by the adult bees.

Honeybees belong to the family of social bees which includes bumble bees and the tropical stingless bees of the genus Meliponinae. The social bees nest in colonies headed by a single fertile female, the queen, which is generally the only egg layer in the colony. Foraging for nectar and other tasks such as feeding the queen and the larvae, cleaning brood cells and removing debris, are carried out by a caste of females, the Workers. Honey and pollen is stored, and larvae are reared in cells made from wax secreted by the worker bees.

Typical colonies may amount to no more than a few dozen insects, and may be annual as in the case of bumble bee colonies, or they may number several tens of thousands and persist for a number of years, as in the case of honeybees and species of Meliponinae.

The sub-family Apinae or honeybees, comprises a single genus, Apis, which is characterised by the building of vertical combs of hexagonal cells constructed bilaterally from a midrib, using only the wax secreted by the worker bees. The cells are multifunctional, being used repeatedly for rearing the larvae and for the storage of honey and pollen. Progressive feeding of the larvae is carried out by young bees with food produced by glands in the head of the bee from honey and pollen.

Two attributes of honeybees which have been essential to their evolution and biology are their clustering behaviour and, particularly in the case of the cavity-nesting species, their ability to cool the nest by evaporation of water collected outside. These attributes enable

the colonies to achieve a marked degree of temperature regulation within the nest irrespective of the external temperature. The genus Apis was thus enabled to colonise a wide variety of environments, ranging from tropical to cool temperate. The Meliponinae which lack this capability are confined to tropical regions.

Another behavioural character of honeybees is the communication of information about food sources and the recruitment of foragers by "dance language". The accurate dissemination of information concerning direction and distance of forage areas leads to efficient exploitation of food sources.

Whereas representatives of most types of bee were indigenous to all the continents, bees belonging to the genus Apis were originally to be found only in the Old World, namely Asia, Africa and Europe. This suggests that the genus appeared much later than the other types. The genus comprises four species: Apis florea, the Little Honeybee; Apis dorsata, the Giant Honeybee; Apis cerana, the Eastern Honeybee; and Apis mellifera, the Western Honeybee. (Some authors include Apis laboriosa and Apis andreniformis as separate species, but it is likely that these are geographical subspecies of Apis dorsata and Apis florea respectively which show greater physical variations than the other subspecies and are possibly in a more advanced stage of speciation.

Apis florea and Apis dorsata build single comb nests in the open, Florea in low bushes and Dorsata in trees. Like other tropical honeybees they are prone to migrations, at times over considerable distances. These migrations may be seasonal or in some cases may be a defence against predators and parasites. Although unsuitable for apicultural use, both these species make a major contribution to the supply of honey and wax in the countries in their territorial range. Human predation usually involves destruction of the nest including the brood, but in some areas collection of honey is practised without destruction of the nest, and some honey gatherers even provide nest sites to which they transfer the whole colony.

The lifestyle of Apis cerana is similar to that of the Western Honeybees, and like Apis mellifera it is used in apiculture with modern moveable comb hives. The numerical strength of Cerana colonies is usually much less, and honey yields are smaller. It is therefore being rapidly supplanted by imported Mellifera races, chiefly A.m.ligustica.

Bees of the genus Apis are not the only bees which contribute to the World's supply of honey and wax. Some species of Meliponinae form very large colonies and store sufficient honey to make their exploitation worthwhile. Modern apicultural methods are inapplicable, but tribes of Central and South American Indians have kept such bees in "hives" for hundreds of years. (It should not be inferred however, that Stingless bees are necessarily gentle and easy to handle; they may carry out mass attacks on large intruders such as man, inflicting painful bites with their powerful mandibles. some species inject a caustic venom which causes severe burns to the areas of skin affected.)

The origins of honeybees

It is thought that bees originally evolved from hunting wasps which acquired a taste for nectar and decided to become vegetarians. Fossil evidence is sparse but bees probably appeared on the planet about the same time as flowering plants in the Cretaceous period, 146 to 74 million years ago. The oldest known fossil bee, a stingless bee named Trigona prisca, was found in the Upper Cretaceous of New Jersey, U.S.A., and dates from 96 to 74 million years ago. It is indistinguishable from modern Trigona. The precursor of the

honeybees may have been living about this time, but fossils of the true Apis type were first discovered in the Lower Miocene (22 to 25 million years ago) of Western Germany. A bee resembling Apis dorsata but much smaller (about the size of a present day mellifera) was present in the Upper Miocene (about 12 million years ago). It is thought that Apis florea and Apis dorsata may have existed as separate species as early as the Oligocene period. It has not been possible to estimate when bees of' the Mellifera/Cerana type first appeared on Earth. Mellifera and Cerana must have acquired separate identities during the latter part of the Tertiary era. The two species were apparently physically separated at the time of the last glaciation, and there was no subsequent contact between them until that brought about by human intervention in recent times. In the post glacial period Mellifera and Cerana (and to a less extent Dorsata and Florea) have shown similar evolution into geographical subspecies, or races.

The development of subspecies

Although it has long been known that there are many kinds of honeybee, and these have been the subject of scientific study for more than two centuries, only in recent years has a comprehensive classification been attempted which takes into account not only differences in physical characters between subspecies and their present geographical distribution, but also the geological evidence pointing to their origins, and to the course of their subsequent evolution and distribution.

Like the stingless bees, honeybees first evolved in tropical conditions. The fossil record shows that at the time the area of land that is now Europe had a tropical climate. As the climate became cooler the open nesting types would not have been able to survive except by migrating to the tropical region of Southern Asia. For the greater part of the Tertiary era Africa was isolated from Europe by sea, and no Tertiary types of honeybee reached Africa even after a land bridge was established. It is likely that the development of advanced thermal homeostasis in honeybees which permitted the occupation of cool temperate zones therefore occurred in Southern Asia, possibly in the Himalayan region. Once established, the cavity nesting Cerana-Mellifera type would spread East and West, eventually occupying both tropic and cool temperate zones.

A physical separation into two groups probably took place as a result of the glaciations which occurred during the Pleistocene period (1 million to 25,000 years ago) and desert and semi-desert then kept the two groups separate during intervening warm periods. Thus Mellifera and Cerana, although originating from a common stock, evolved into distinct species. The ultimate Western boundary of the Cerana territory was in Afghanistan some 600 km to the East of the nearest Mellifera colonies in Iran. The Cerana territory comprised the Indian Subcontinent South of the great mountain ranges, Ceylon, Malaysia and Indo-china, and the East Indies including the Celebes, Timor and the Philippines. In Eastern Asia it reached latitude 46, and occupied Japan except for the island of Hokkaido.

Mellifera spread westwards through Asia Minor to colonise the Balkans and the Mediterranean region, and southwards through the Arabian peninsula to occupy Central and Southern Africa. Similarities between neighbouring subspecies suggest that the Iberian peninsula and Southern France were colonised from North Africa

How far Mellifera bees may have penetrated into Northern and Western Europe during the warm intervals between the glaciations of the Pleistocene period can only be a matter of conjecture; what is certain is that no honeybees could have existed North of the Mediterranean region, the Iberian peninsula and South Western France at the time of the

most recent Ice Age. Although at its maximum extent in Western Europe some 18,000 years ago, the ice sheet only reached as far as Northern Britain, the area for hundreds of miles to the South was inhospitable tundra.

In the warm period which followed the Ice Age (starting about 14,000 years ago) the ice sheet gradually retreated and the tundra was replaced by forests of birch, pine, hazel, elm and broad-leaved oak. The Western honeybee was once more able to extend its domain in Europe. In the East advance beyond the Caucasian region proved impossible, owing to the lack of suitable nesting sites in the steppes of Southern Russia The bees of the Balkan area spread northwards to occupy the Eastern Alpine valleys, Central Europe as far as the 50th parallel of latitude, and the Western shores of the Black Sea. In the West the bees which had found refuge in Southern France during the Ice Age spread across Europe North of the Alps eventually occupying an area from the Atlantic seaboard to the Ural Mountains. The northernmost limit of the territory may have been in Southern Norway; honeybee remains dating from Ca. 1,200 have been found in an archaeological dig in Oslo although honeybees had not been reported in Norway prior to the l9th Century. The mountain ranges of the Alps and the Pyrenees obstructed the northward movement of the bees in the Italian and Iberian peninsulas. however.

In colonising this vast territory, stretching from the Urals to the Cape of Good Hope, Apis mellifera had to adapt itself to a large variety of habitats and climates ranging from the Continental climate of Eastern Europe with its harsh Winters, late Springs and hot, dry Summers, through Alpine, cool temperate, maritime, Mediterranean, semi-desert and tropical environments. This adaptation was achieved by natural selection, producing some two dozen subspecies or races. All the subspecies of the Mellifera group can interbreed given the right conditions, but the crosses show hybridity characters.

Although Cerana bees must have shared a common ancestor with Mellifera, they have evolved into separate species. It is not possible to cross Cerana with Mellifera even using instrumental insemination, because the two species are now genetically incompatible, and viable eggs do not result from the cross fertilisation Other differences include their differing reactions to diseases, infestations and predators. Cerana can tolerate varroa and has developed an effective defence strategy against the Giant Hornet, against which Mellifera bees have no defence. Cerana is however, highly susceptible to the acarine mite, which arrived with the introduction of Mellifera bees into Cerana territory. It is also highly susceptible to sac brood and foul brood, but not markedly so to nosema.

The different races of A.mellifera can generally be differentiated in physiological terms. Bees from warmer climates tend to be smaller in size and lighter in colour than those adapted to the colder regions, although this rule is not invariable. The effect of altitude seems to be similar to that of increasing latitude. Accurate differentiation between races of similar appearance requires precise morphometric examination of representative samples of bees. There are also differences between races in natural history and biology. Some subspecies are more prone to swarming than others, some produce large numbers of young queens when swarming, others only a few. Tropical honeybees frequently "abscond" or migrate, sometimes due to lack forage through drought or other causes, perhaps as a defence against predators. Heavy predation is also a likely cause of the vigorous defence reaction of some races, for example, the bees of tropical Africa.

The bees of the warmer regions do not need to cluster as tightly as those confined to the nest through long, cold winters. Brood rearing is adapted to take maximum advantage of the local flora. Where bees of the same race have occupied different kinds of habitat, they

have formed local strains which have accommodated themselves to the different conditions. Similarly, honeybees of different races which have occupied similar habitats have evolved similar behavioural characters. Even the "dance language" by which honeybees communicate information about the location of food sources may differ in detail between races as different races may be conditioned to foraging over different distances from the nest. (Professor Goats described these differing dance patterns as "honeybee dialects".)

The behavioural characters of the different races and strains, brood rearing pattern, foraging behaviour, clustering, etc., are fixed genetically, so that a colony cannot readily adapt itself when transferred to a different kind of environment.

The Dark European Honeybee, Apis mellifera mellifera, is fairly uniform over its whole range, having had but a comparatively short time in which regional varieties could evolve, but even in this race differences can be observed between strains. In France, where the bee has been domiciled longest, there are distinct differences in brood rearing pattern between the Mellifera bees of the Landes district in the Southwest, the bees of the Paris area, and those of Corsica. The Landes bees are typical "heather bees", conditioned to a principal nectar flow in late Summer and early Autumn. In the Paris area there is no Summer nectar flow and the bees show early Spring brood activity. Exchange of colonies between the Landes and Paris resulted in poor performance in both cases. In Corsica the Mellifera bees follow a Mediterranean pattern with little or no brood production in Summer and a second peak in Autumn.

The effect of transferring bees to environments to which they are not adapted is graphically illustrated by experience in the tropic zone of South America. European honeybees have been kept in Brazil for centuries, yet failed to establish a feral population in the country. When a few queens of a tropical race from Africa were introduced into the country, in a matter of a few years feral colonies of hybrids, "africanised bees" had crossed the Amazon rain forest and moved North and South completely eliminating the European bees.

The behavioural patterns which have evolved in the different races have ensured the survival of the various subspecies in their native habitats, and some of these patterns may be repeated in different races. There is one race which, although of small economic importance, possesses an apparently unique biological character which renders it of great importance in the study of the genetics of honeybees. In all other races, when a colony is rendered queenless, laying workers may appear which are capable of laying drone eggs only. In A.m.capensis, the Cape Bee, when a colony is deprived of its queen, a laying worker appears within a few days which, for a period, is able to lay predominantly diploid worker eggs. From these eggs true queens capable of being mated can be raised, re-establishing queenrightness in the colony.

The present situation

Apiculture has been practised in Europe and Asia throughout recorded history. For most of the time the honeybees kept in any country would be indigenous to the locality. In the New World countries, where the true honeybees, Apinae, were originally absent, the early settlers imported the bees with which they were familiar. Thus, Iberian bees were taken to Brazil and North European bees to North America, Australia and New Zealand. Whereas the Iberian bees were unsuited to the tropical climate of South America and failed to establish a feral population, the North European bees adapted well to the harsher

conditions and feral colonies quickly established themselves over a wide area. Indeed, colonisation by honeybees far outstripped that by the settlers. In New Zealand and Tasmania feral and managed colonies of A.m.mellifera have existed in a pure state in spite of massive importation's of Italian bees.

In most parts of the World, especially where beekeeping is practised on a commercial scale, the Italian bee has proved the most popular, owing to its docility, its rapid build-up, and its ability to rear brood continuously until late in the season as long as food is available. It is therefore pre-eminently suitable for those countries where long, continuous nectar flows occur from late Spring onwards. Where the nectar flows are intermittent or are interrupted by bad weather, feeding may be necessary during the barren periods, and also in Spring and Autumn. A.m.ligustica cannot survive the harsh Winters of the Northern and Midwestern states of America. Migratory beekeeping has therefore been adopted; new colonies are raised each Spring in the Southern states and transported to the forage grounds of the North, where they remain until the Fall. With adequate brood space and young queens, swarming is not a problem. At the end of the season the colonies are destroyed. Unfortunately, one of the desirable characters of the race, namely docility, may be quickly lost by interbreeding with feral colonies of A.m.mellifera or its hybrids.

Italian bees were first imported into Britain in the middle of the last century, more as curiosities than for any known apicultural advantage. Importation in bulk with Government encouragement took place from 1920 onwards, following the so-called "Isle of Wight disease" epidemic. This disease has been equated with acarine, and undoubtedly acarine played a part, but it seems likely that wartime neglect, and the loss of beekeeping experience resulting from World War I contributed to the loss of colonies. The losses were greatest in the South of England, where the greater proportion of beekeepers, and particularly the large bee farms, were to be found. Even so, in spite of massive imports of Italian bees, A.m.mellifera still exerts a dominant influence over large areas of Great Britain and Ireland although pure examples are comparatively rare. The Italian bee has performed well in warm summers, particularly in the South of England, but heavy losses usually occur during the so-called hard winters.

The other race which has been exported world-wide is the Carniolan, A.m.carnica. In Germany the native dark bee had been completely mongrelised by the large scale introduction of foreign bees, chiefly Ligustica and Carnica, and the honeybee population was generally unproductive and aggressive. A decision was made by the Deutscher Imkerbund (the German beekeepers association), supported by the Provincial and Federal Governments and the majority of German beekeepers, to convert completely to Carniolan bees, using selected strains, and to control bee breeding by licensing breeders, so as to ensure maintenance of the purity of the breed and improve the productivity and other desirable attributes. This programme has now been virtually completed, although importation of foreign bees is still permissible under the law.

In other North European countries there has been a tendency to move over to Carniolan bees, although in recent years an increasing interest has been shown in re-establishing the North European Dark Bee, A.m.mellifera, in most countries in which it is autochthonous (the original sub-species). The move to Carniolans or Italians is unlikely to progress as far as Eastern Russia or Central Siberia, where the harsh Winters and late Springs may demand a hardy bee with a late build-up. Beekeeping in these regions is said to be possible where the rivers are frozen for less than six months in the year, in spite of the severe Winters. Although the post-glacial migration of A.m.mellifera did not progress beyond the Ural Mountains, beekeeping using the North European bee has been practised

in Siberia since the early part of last century. Only in the easternmost province is a different race of honeybee kept; the Ukrainian bee, A.m.macedonica, was introduced into Ussuria towards the end of the l9th century.

Which bee?

Twenty five thousand different kinds of bee have been described, divided into eleven Families, numerous subfamilies, tribes and genera, and still more numerous species and subspecies. Honeybees belong to the family Apidae, which includes other social bees such as bumble bees (Bombinae), and stingless bees (Meliponinae). The subfamily Apinae, consists of one tribe Apini, comprising one genus, Apis. There are four species within the genus: florea, dorsata, cerana and mellifera, but only the last two are suitable for apiculture in modern, moveable comb hives. Two dozen geographic races of the Western Honeybee, Apis mellifera, have been recognised, adapted to a range of environments from the cold Continental climate of Eastern Europe, through the moist temperate climate of the Atlantic seaboard, the warmth of the Mediterranean, and the heat of the tropics and semi-deserts. Only Four of these races need be considered for apiculture in a cool temperate climate such as that of Britain. namely A.m.ligustica, A.m.carnica, A.m.caucasica and the native bee of the British Isles, A m.mellifera.

It was formerly believed not only by ordinary beekeepers but by some notable scientists, that improvements in the desirable attributes of honeybees, productivity, docility, resistance to disease, for example, could be achieved by crossbreeding different races. It is well known in other fields of bioculture that a first or second cross of two different breeds or strains will often produce progeny which are superior to either progenitor in some desirable character. It is also known that such hybrids are generally unsuitable for further breeding as the results are frequently unpredictable and generally inferior particularly if continued through several generations. So it is with honeybees; first or second crosses sometimes produce colonies which give exceptional performance, "hybrid vigour", but succeeding generations seldom repeat this performance. Moreover, crossing of any of the four races mentioned is likely to result in hybrids with very undesirable characters, namely excessive stinginess and a predilection to " following".

It is now widely accepted that the best way to get improvement in bee stocks is by selective breeding within a single subspecies.

It is worthwhile considering the reputed behavioural characters of the races most likely to be chosen for apicultural purposes in Britain. The Italian or Ligurian honeybee, A.m.ligustica, is the foreign bee which has been imported in greatest numbers, and has largely supplanted the native bee in the South of England, although surprisingly, pure or nearly pure colonies of the latter have survived into recent years, even when surrounded by predominantly Ligurian apiaries. Many beekeepers have found that their "Italian" bees turned dark within the space of a few generations. Some of the most vicious hybrids retain the bright colouring of the Italian race, however. Further North the performance of the Italian bee has been less impressive, and many experienced beekeepers prefer the native bee. Carniolans and Caucasians have also been imported into Britain but not in numbers comparable to those of the Italian imports and generalisations about their performance under British conditions could be misleading.

Apis *mellifera ligustica*

The Italian honeybee is the most widely distributed of all honeybees, and has proved adaptable to most climates from subtropical to cool temperate, but it is less satisfactory in humid tropical regions. It is very prolific but brood rearing starts late and lasts long into late Summer or Autumn, irrespective of nectar flow. It is therefore at its greatest advantage in those regions where favourable weather prevails throughout the Summer, and there is a long, uninterrupted supply of nectar. It is less satisfactory where the main nectar flow occurs in Spring, or where the weather is uncertain, as in the cool maritime regions. In poorer districts a honey crop may only be obtainable at the expense of heavy Autumn feeding.

A.m.ligustica has been described as having a low swarming tendency with few queen cells, but this is contrary to the experience of many beekeepers in Great Britain. This may possibly be due to the use of brood chambers which are too small for such prolific breeders. In the migratory beekeeping practised in America it is usual to operate without a queen excluder, so that the breeding area is unrestricted. It is said that the queen seldom goes above the second lift of the hive.

Italian bees, having been conditioned to the warmer climate of the central Mediterranean, are less able to cope with the "hard" winters and cool, wet springs of more northern latitudes. Their bodies are smaller and their overhairs shorter than those of the darker races, and they do not form such tight Winter clusters. More food has to be consumed to compensate for the greater heat loss from the cluster. The tendency to raise brood late in Autumn also increases food consumption. They are unable to retain faeces in the gut for long periods and require more frequent cleaning flights than the dark bees; they are more likely to be lured out of the hive by bright winter sunshine.

There is no clear evidence that Ligustica is any more resistant to acarine than Mellifera; no epidemic corresponding to Isle of Wight disease was ever reported from Northern Europe. Moreover, acarine is undoubtedly a problem among the Italian bees of the United States of America. Ligustica also appears to be less tolerant of Nosema than Mellifera.

Ligustica tends to forage over shorter distances than either Carnica or Mellifera, and may therefore be less effective in poorer nectar flows. It apparently lacks the ability to ripen heather honey before sealing.

Italian bees are much more prone to drifting and robbing than the other principal races of Europe. It has a reputation for gentleness, but hybrids with the darker races can be especially vicious.

Apis *mellifera carnica*

The Carniolan bee of Slovenia and Austria is the nearest relative of the Italian, but it is larger and darker, the characteristic yellow rings of Ligustica being replaced by dark bands. The Carnica territory covers a large area of south-eastern Europe, and there are numerous regional variations. The characteristic brood rhythm is a rapid build-up in Spring, followed by a slow decline and an early cessation of brood rearing in the Autumn. It is particularly suited to an early Spring honey flow. Like A.m.mellifera it can survive hard Winters with a small winter cluster.

Carniolan bees are said to be more prone to swarming than Italian bees , but that this tendency can be reduced by selective breeding. In recent years selective breeding has

also been used with great effect in both Austria and Germany to improve the productivity of the bees.

A.m.carnica are reputed to have better homing ability than any of the other major races, and are much less prone to drifting (and presumably to robbing). They are sparing in the use of propolis.

Carniolan bees have a well deserved reputation for gentleness and quietness on the comb, but their hybrids with both Mellifera and Ligustica are said to be particularly vicious.

Apis *mellifera caucasica*

The Caucasian bee closely resembles A.m.carnica in general appearance, and may not be easily distinguished from the latter except by morphometric examination (longer proboscis, cubital index about 2 on average). Indeed, it has been alleged that many bees sold as "Caucasians" were in fact Caucasica-Carnica hybrids.

A.m.caucasica is autochthonous (the original sub-species) to the mountain range and southern valleys of the Caucasus, and to the eastern end of the Black Sea coast in Anatolia. The climate varies from humid subtropical on the coast to cool temperate in the mountains, and local strains reflect the different climates, the bees from the mountains being larger and darker, with longer overhair, than those from the lowland region.

The Caucasian bee is noteworthy for the length of its proboscis, being the longest of all the mellifera races. One might expect that this would give it an advantage over shorter-tongued races from a foraging point of view, but this does not seem to be borne out in practice.

Brood rearing generally starts late and the Spring build-up is slow, leading to a medium population size in Summer and Autumn. Swarming tendency is said to be low, and the number of swarm cells moderate. Caucasian bees are said to be at their best in protracted slight nectar flows; they seem to be unable to cope with short heavy flows, most of which is stored in the brood chamber rather than the supers. Honey cells are "wet" capped, i.e. there is no air space between the honey and the capping, and this may lead to "weeping" of the comb.

Caucasian bees are notorious for their heavy use of propolis, especially at the hive entrance. In Winter the entrance may be almost completely closed by a curtain of resin, leaving only a few small holes for ventilation and flight activity. Caucasian bees have poor resistance to Nosema disease and this may lead to heavy winter losses.

A.m.caucasica is described as having a "high level of gentleness", and certainly it had this reputation in the 1930's, although there was little experience of this bee in Britain at that time. It is said to combine well with other races, particularly Carnica and Ligustica. There has been a report of very aggressive behaviour by "Caucasian" bees in this country, but the bees in question may have hybridised with local bees. They apparently showed poor wintering qualities.

The native bee: Apis mellifera mellifera

The "A. mellifera" (1758) or "A. mellifica" (1761) of Linnaeus is but one small section of the Dark European Honeybee whose natural territory included the island of Corsica and

ranged from the Pyrenees over Europe north of the Alps to the Ural Mountains in the East, and included Great Britain and Ireland and southern Sweden. Although there is no historical record of honeybees in Norway before 1775, it is known from archaeological evidence that A.m.mellifera was present in southern Norway round about 1200 A.D.

It is well adapted to survive in a harsh climate. It is thrifty in its use of stores; brood rearing is reduced when the nectar flow is interrupted. It forages over longer distances than the Italian bee and can make better use of meagre food resources. It will be observed foraging both earlier and later than A.m.ligustica, and will fly in dull and drizzly weather which would keep Italian bees indoors. It may also be that mating can take place at lower temperatures than in the case of the southern races. Although less prolific than Italians, the workers live longer and there is a higher ratio of foraging bees to hive bees. The wintering capabilities of the Dark bee are excellent; although colony size is at all times moderate, and the winter cluster is small, heat is conserved by the tightness of the cluster and the large bodies and long overhair of the bees. The "winter" bees of the northern race have the ability to retain faeces in the gut for long periods, due apparently to a greater production of catalase by the rectal gland in Autumn. They are thus less dependent on cleaning flights. They are also less likely to be lured out of the hive by bright winter sunshine than Italian bees.

A.m.mellifera forms a compact brood nest with pollen stored as close to the brood as possible, sometimes below as well as above the brood. Honey is stored outside the pollen circle.

It has often been heard said among beekeepers that heather honey should be disposed of quickly because it "does not keep". Another widely held belief is that heather honey is unsuitable for winter stores. Apparently A.m.mellifera had not heard these maxims, or if they had they chose to ignore them. How otherwise would "heather bees" have chosen to live for centuries in areas where there was only the heather honey crop to support them from one year's end to the next (and perhaps for two or more years if the weather was bad at the time of subsequent harvests)?

The native bee of the British Isles is renowned for the whiteness of the sealed honeycomb. The cappings are convex and a small air space is left between the honey and the capping. This prevents "weeping" and reduces the risk of fermentation which might give rise to dysentery.

The swarming behaviour of A.m.mellifera is variable, depending on the region. In heather districts the local populations tended to be very swarmy, but some strains from the North of Britain have shown a low inclination to swarm, with the construction of only small numbers of swarm cells. Where the swarming tendency is low, queen replacement takes place by supersedure.

A.m.mellifera makes abundant use of propolis to seal up small fissures and small gaps, and may even construct curtains at the hive entrance in the manner of Caucasian bees, although in general it is not as free in its use of the resin as the latter.

The Dark European Honeybee generally had a reputation for aggressive behaviour, but this was not the reputation of the British bee as reported by earlier writers. Pure strains of A.m.mellifera from different parts of Britain have been found to be docile and easily handled. Hybrids with other races are often highly productive, but they frequently show a fierce temperament and proneness to "following", highly objectionable characters in densely populated countries.

One character of the Dark bee on which all authors seem to agree is its nervous behaviour when the hive is disturbed. It usually manifests itself by the bees running to the bottom of the comb where they hang in a cluster when a frame is removed from the brood chamber. This behaviour may be extreme with some strains; colonies of pure Mellifera bees bred from feral bees from Skeldale in Yorkshire showed a marked tendency to run out of the hive when smoke was used at the start of a manipulation, although they were quiet and easily handled without the use of smoke. On the other hand , native bees from other parts of Britain have not shown this extreme reaction to smoke.

The gentle behaviour of the major races of honeybee may be due, of course, to selection for this quality over many generations; even the "skep" beekeepers of former days would, no doubt, tend to destroy the worst tempered bees and retain the gentler colonies.

What of the future?

The most urgent problem in apiculture, not only in Britain and Ireland but throughout the world, is that of protecting the Western honeybee against extermination by the varroa mite. The only proven method at the present time is by using acaricides such as Bayvarol and Apistan, but these become less effective as immune strains of the mite evolve, and there must be constant research to develop new products. Research on the biology of the mite is proceeding, and alternative methods of treatment are being sought. The ultimate hope is that varroa-resistant strains of bees may evolve, but at best this likely to be a very long term solution to the problem. If, as is supposed, the separation of the Cerana and Mellifera species occurred in (relatively) recent times, the gene which enabled Cerana to develop a defence against varroa may still be lurking somewhere among the genes of the Mellifera races. There is a danger that the development of resistance among apiary stocks might be concealed by the normal anti-varroa treatments and that a resistant strain might be lost through the death of the queens. A case might be made out for encouraging feral colonies in suitable areas. In due course most if not all feral colonies will be wiped out by varroa, and the argument that they would act as centres of infection for apiary colonies need scarcely be considered as they would never exist in sufficient numbers to threaten apiary stocks - unless of course a resistant strain evolved in the wild, in which case they might transmit through the drones resistance to the apiary colonies,

There have been many changes in the flora on which British bees have depended during the past 10,000 years. Woodland has given way to downland and moorland, pasture and arable. Agricultural methods have changed, first during the "Agricultural Revolution" of the 18th century, and even more drastically in the more recent "Second Agricultural Revolution". White clover, once the principal honey crop throughout Britain, has been largely eliminated through the introduction of "improved pasture" based on nitrogenous fertiliser and selective weed killer. Thousands of miles of hawthorn hedges have been ripped out to make way for bigger and still bigger machines, and the remaining hedges are trimmed as closely as an ornamental hedge in a Stately Home. (Hawthorn honey is arguably the most delicious of our native honeys.) Even roadside verges are mown and treated with selective herbicide. Where heather moorland has been over-grazed or otherwise neglected, the heather has been replaced by bracken; let us hope there will never be a shortage of wealthy sportsmen to pay for the maintenance of the grouse moors. The latest threat to the variety of British honey is the grubbing up of orchards to make way for imported "supermarket" apples. Our main honey crop is now the inferior and rather troublesome product of the ubiquitous oilseed rape.

There have been pronounced changes in the climate of these islands during the past 10,000 years. Following the Ice Age there was a warm period when the land was colonised, or perhaps re-colonised, by honeybees, and when for a time the climate may have been almost Mediterranean in character. From about 1335 A.D. the climate grew colder; this was the start of the "Little Ice Age" which continued well into the l9th century. This was typified by long cold winters with much snow and severe frost, and frequent cold, wet summers.

The native bee survived these vicissitudes in the wild and in apiaries, and adapted itself (if adaptation were needed, for it is clearly a most versatile honeybee) to all the changing conditions. Further changes in agricultural practice can be expected but not predicted. As beekeepers we can only hope that agriculture will become more "natural" and will encourage the cultivation of home-grown produce of all kinds.

In the last few years there have been extremes of weather which in the short term can be regarded as exceptional. It has been suggested that this is part of the "greenhouse effect" of manmade pollution causing global warming. It is too early to separate the climatic changes due to pollution from the short term fluctuations and long term trends in the Earth's climate. However, careful measurements over many years have shown changes from which inferences may be drawn. For example, the carbon dioxide content of the atmosphere increased from 290 parts per million in 1850 to 315 parts per million 1958, and since then has increased further to 350 parts in 1990. The increase up to 1950 was attributed partly to deforestation and partly to combustion of fuels, mainly coal. The increase since 1950 is thought to be due almost entirely to the combustion of fuels. Methane, another "greenhouse gas" has also shown a significant increase, although the concentration of this gas is much lower. Another and clearer indicator of global warming is the retreat of glaciers throughout the world, and of the arctic and Antarctic icefields which has been taking place for many years.

There is little doubt that global warming is already taking place. What the effect on the British climate will ultimately be if this trend continues cannot yet be predicted. It may become warmer and drier, or warmer and more humid, but if global warming should redirect the ocean currents on which our climate largely depends, then it could even become much colder.

One further matter to which beekeepers should be giving urgent attention is the need to improve the social acceptability of honeybees. Too many of our colonies become bad tempered and aggressive when disturbed, some even attack people without this provocation. Such bees are a menace to the public and a nuisance to the beekeeper. A swarm of bees can be a terrifying sight to anyone unaccustomed to them, and sensational films and newspaper articles about "killer" bees can only affect adversely the public's perception of beekeeping. It has been pointed out that the principal European races of honeybee in the pure form have the reputation for gentleness, and this character can be preserved and enhanced by selective breeding. It is widely recognised that innate bad temper in European bees almost invariably arises from the crossing of incompatible subspecies. The need for the adoption in Britain of single race beekeeping in order to improve the social acceptability of the craft therefore becomes apparent. The adoption of such a policy would have the added advantage that selective breeding could then be practised to pursue other desirable aims such as greater productivity, lower swarming tendency and better disease resistance.

So why the native bee?

In Great Britain the economic importance of the honeybee as a pollinator far exceeded that of the hive products and was recognised by government at both national and local level. Beekeeping research was financed by central government, beekeeping instructors were employed by many county councils, and agricultural colleges maintained beekeeping units. During World War II a sugar ration was made available to beekeepers ostensibly for colony feed, to ensure that beekeeping activity was maintained in the national interest. Since the War as agricultural productivity increased, so the public recognition of the importance of beekeeping declined, and government encouragement for beekeeping in recent years has been less than lukewarm. Indeed, in some quarters there has been a tendency to regard honeybees as pests rather than as beneficial insects. Only the threatened extinction of the western honeybee by varroasis has brought about a positive if somewhat muted response from government.

It is important not only that varroasis be brought under control, but that positive steps be taken to improve the standard of beekeeping generally, and the quality of the bees kept in this country with regard to temper and other attributes. The second of these objectives is only likely to be achieved by selective breeding on a broad front of bees of a single race.

The Native Bee, Apis mellifera mellifera, still exerts a dominant influence over most of the British Isles in spite of the continuing importation of foreign races, owing to its better adaptation to the British climate. It has proved itself able to cope with great changes in climate and other environmental factors, a capability which may be of critical significance in time to come. It has a genetic inheritance different from those of other races; indeed it may possess genes unique to these islands, that is, not even possessed by Continental strains of A.m.mellifera. On this consideration alone it should be worth preserving as a gene bank.

Italian bees have from time to time given spectacular results in honey production particularly in the South of England and during the warm summers which typified the early part of the present century. There is no evidence that the Native Bee is on average inferior to the imported bee in honey yield, and it is likely to prove superior at times and in places where forage is less plentiful. Many beekeepers have found that honey production has increased when they have changed over to A.m.mellifera. It is certainly better equipped for surviving "hard" winters. cold springs and wet summers.

The only other European bee which might adapt successfully to our climate is the Carniolan, but the total replacement of the whole of our honeybee popula.tion by Carniolan bees cannot easily be envisaged. The piecemeal importation of Carniolan bees could only perpetuate and make even worse the present unsatisfactory situation. Far better to stop importing all foreign bees, and concentrate on a general improvement of our honeybee stocks by large scale selective breeding from the best of our native colonies.

Acknowledgements

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