Successive swarms are sent off as long as the increase of population permits; and the number thus produced in a season depends on a variety of circumstances, such as the abundance of flowers, the warmth of the climite, and capacity of the hive. Bosc, while he was French consul in Carolina, found a stock of bees in the woods which had been robbed of its wax and honey by the negroes; he contrived to convey the bees in his hat to a hive in his garden. He obtained from this hive eleven swarms before the end of autumn; and these, again, gave him the same number of secondary swarms, so that by the end of the year he had twenty-two hives stocked from the one he had thus saved from destruction. In Britain a hive commonly sends off only two and sometimes three swarms in the course of the summer; and prudent apiarians will be satisfied with one swarm only, returning all subsequent ones to the parent hive, which would otherwise become very weak. When bar-frame hives are used, the issue of after-swarms is easily and surely prevented by destroying all queen-cells but one after the issue of the first swarm.

Massacre of the drones.

Very few drones accompany the new colonies, so that almost all those produced in the spring remain in the hive. But when the queens are impregnated, and no new swarms are about to take place, the workers, who had till then suffered them to live unmolested in the hive, are on a sudden seized with a deadly fury towards them, and a scene of carnage ensues. This usually happens in June, July, or August. They chase their unhappy victims in every quarter, till they seek a refuge at the bottom of the hive, where they collect in crowds, and are indiscriminately, and without a single exception, massacred by the working bees, who, with implacable fury, bite, maim, and throw them out of the hive. So great is their antipathy to all the race of drones, that they destroy, at the same time, the male eggs and larvæ, and tear open the cocoons of their pupæ, in order to devote them to one common destruction. This sacrifice of the males is not, however, the effect of a blind and indiscriminating instinct; for if a hive be deprived of its queen, the massacre does not take place, while the hottest persecution rages in all the surrounding hives. In this case the males are allowed to survive the winter.

Provision for the winter.

Having thus got rid of the useless mouths which consumed, without any advantage to the public, a large portion of their provisions, the bees spend the remainder of the summer in collecting stores of honey and of pollen for the ensuing winter. Their gleanings are now less abundant than in the spring, and require more labour in the search and collection. But at this season the leaves of many kinds of trees, which are covered in the morning with a saccharine fluid that exudes from them, furnish them with a species of nourishment, which, though of very inferior quality to the nectarial fluid, still contributes to their support. Fruit is also attacked by bees, after the cuticular covering has been broken through by birds or snails. They also find nutriment in the *honey-dew*, which is an excrementitious fluid deposited on the leaves of plants by certain species of aphides. Often, however, these resources fail, and the hive is threatened with famine. On these occasions the distressed bees frequently betake themselves to plunder; and if a weak or queenless hive can be discovered they begin a furious onset, which costs great numbers their lives. If the invaders should fail in their attempt to force the entrance they retreat, and are not pursued by those whom they have assailed; but if they succeed in making good the assault, the war continues to rage in the interior of the hive until one side finds itself beaten, in which case, should the conquerors be the invaders, the invaded will generally join their forces, and help their late enemies to carry of their plunder, and at once become members of the lately hostile hive.

The life of a queen-bee will sometimes extend to three or four years, but her fertility decreases after her second breeding season. When absent from the hive on her matrimonial excursions she very often becomes a prey to a bird, and not seldom on her return mistakes her hive, when she is probably killed by the stranger bees, or by the queen on whose territory she has intruded. Drones seldom die a natural death; there is no evidence of the duration of the lives of individuals, but normally they are hatched about May and slaughtered by the workers in June, July, or August; should the hive be queenless, however, the workers do not harm the drones, and some will then live far into the winter or even to the following spring. The life of a worker is greatly dependent on the season of the year and the amount of labour performed. The modern method of introducing a fertile Ligurian queen (*Apis ligustica*) into a queenless stock of the common black bee (*Apis mellifica*), in order to obtain pure stocks of the former variety, has plainly demonstrated the short life of the worker bee. If the Ligurian queen be introduced in May, when bees are busy and work abundant, in from six to eight weeks thereafter scarcely a black bee will be found in the hive, although at the time of the introduction multitudes of young larvæ were present, which probably would not all be fully developed for nearly three weeks; therefore, in the season of hardest work, the inhabitants of the hive would seldom attain the age of six weeks. But if the experiment of the queen's introduction be deferred until October, then not until the following May will the black bees have become extinct. And it is a curious fact that if a hive be deprived of its queen in October (and none other supplied), then the workers, having no labour to perform either in replenishing stores or attending on the larvæ, will possibly in May be found still living, although somewhat reduced in numbers. Such a colony, however, generally becomes a victim to robbers when the activity of spring arrives, for a queenless stock rarely makes much defence of its stores. In fine winter days, when the sun shines brightly, numbers of bees are tempted abroad, which easily become benumbed by cold, fall to the ground, and die. Insectivorous birds also make victims of great numbers at such times, other insect food being scarce; so that, probably, in winter and early spring, more workers die from accident than by natural decay. The fecundity of the queen-bee is, however, adequate not only to repair these losses, but to multiply the population in a very high progression. *Apis ligustica* has the reputation of being more prolific than *A. mellifica*; and a young and vigorous queen will, in the fine weather of a warm May and June, deposit as many as 2000 eggs per day for several weeks in succession, and this fertility is of much longer continuance in America and other warm climates than in England. In England, eggs are deposited and young reared ten or eleven months in the year, when the colony is strong in numbers and well supplied with stores; but the increase in the cold months seldom equals the decrease by deaths.

The loss of the queen is an event which has the most marked influence on the conduct of the workers. Although the queen is constantly an object of attention and of affection to the whole community, they are not immediately sensible of her absence when she is removed from the hive. The ordinary labours are continued without interruption, and it is not till a whole hour has elapsed that symptoms of uneasiness are manifested, and it is even then only partially displayed. The inquietude begins in one part of the hive, the workers become restless, abandon the young which they were feeding, run to and fro; and, by striking each other with their antennæ, communicate the alarming intelligence very quickly to their companions. The ferment soon extends to the whole community; the bees rush

precipitately out of the hive, and seek for their lost queen in every direction This state of confusion continues for a day or two, after which tranquillity is again established; they return to their labours; and, selecting an egg, or one of the larvæ that is not more than three days old, they break down two of the contiguous cells, sacrificing the larvæ contained in them, and proceed to build up one royal cell from their ruins. They then supply the worm with the food necessary to promote its quick growth, and leaving untouched the rhomboidal bottom they raise around it a cylindrical enclosure In three days the larva has grown to such a size as to require an extension of its lodging, and must inhabit a cell nearly of a pyramidal figure, and hanging perpendicularly. A new pyramidal tube is therefore constructed with the wax of the surrounding cells, which is soldered at right angles to the first, and the bees, working downwards, gradually contract its diameter from the base, which is very wide, to the point. In proportion as the worm grows, the bees labour in extending the cell, and bring food, which they place before its mouth and round its body, forming a kind of coiled zone around it. The worm, which can move only in a spiral direction, turns incessantly to take its food before its head; it insensibly descends, and at length arrives at the orifice of the cell. It then transforms itself into a pupa, is enclosed with a covering of wax, as before described, and, in the space of ten to sixteen days the original loss is thus repaired by the birth of a new queen. Schirach found that, if a number of bees be confined with even a single larva, which in the natural course would have become a worker bee, they immediately set about giving it the royal education above described, and thus raise it to the dignity of queen.

The discovery that queens may be reared at will has been confirmed by recent experiment, and is now largely taken advantage of by apiarians both in Europe and America, to facilitate the making of artificial swarms and otherwise increase the production of bees. By the aid of small frame hives called nucleus boxes, which only materially differ from the larger or mother hive by containing frames less in number and in size (generally three), a stock of fertile queens is kept on hand ready to supply any colony requiring a sovereign, or to exchange an old queen for a young one, or a Ligurian queen for an ordinary English one. An example of the method of rearing these queens is as follows:—A full comb containing young worker larvæ and eggs is taken, with all its attendant bees, and placed in the centre of the nucleus box, flanked on both sides by other combs containing honey. Sufficient young bees, which have not flown, are now added to cover well the brood comb, in order that proper heat may be kept up to mature the brood. As soon as the members of this small community find themselves without a queen, a dreadful uproar ensues; and, probably, should there be bees among them who know their way home, they will desert, but enough will usually remain to carry on the desired work; if not, more young bees must be added. These may be known by their fresher and greyer appearance. After a few hours the commotion will subside, and the bees will proceed to the construction of royal cells, and take proper care for the feeding and hatching of the larvæ selected for royal honours. Generally on the second day, the foundations of royal cells are perceptible, the number of these vary from one or two to as many as sixteen. In from ten to sixteen days, according to the age of selected eggs or larvæ, the young queens will arrive at maturity; and as the first at liberty will destroy the others if allowed, the apiarian in good time cuts out the sealed royal cells, which are distributed by grafting on other combs into newly-formed nuclei, or into such hives as require a queen. The young queens, on their emergence from the pupa state, are now each at the head of a colony, where they remain until they become fertile in the natural way, and are then ready for such purposes as they are required for.

In Switzerland, Italy, and Germany a large business is done in Ligurian queen-raising for export. Great numbers of those queens come to England and America in little wooden boxes, accompanied by sufficient workers to develop enough heat. The price in Italy varies, according to the season, from five francs in October to twelve francs in March: but few are raised until May, owing to the difficulty of their obtaining impregnation. To overcome this difficulty in the autumn some colonies are purposely kept queenless, whose drones remain in existence. The advantage of having fertile queens at the bee-master's disposal is very great. When a swarm issues the young queen is not usually mature, and has to become impregnated. Should unfavourable weather ensue, a still further delay occurs; and the virgin queen, on her excursion, is liable to be lost or killed. Should no such accident occur, it may still be two or three weeks before ovipositing again commences, and this in the very height of the breeding season; while if the skilful bee-master, first taking the precaution to destroy any existing queen cells, can immediately, on the issue of the swarm, introduce the queen and her retinue from a nucleus hive, no time is lost, and probably 20,000 to 40,000 eggs will be deposited in the time that would otherwise have been lost. By this system of nucleus queen-rearing, it may be fairly calculated that the increase of population may be doubled. While the hive remains without a queen swarming can never take place, be the hive ever so crowded.

Queen combats

Huber has made the singular observation that two queens, however inveterate may be their mutual hostility, never actually destroy each other, and that when in the course of their contest they are placed in such a relative position that each has it in her power to strike a mortal blow on the other with its sting, they suddenly separate, and part with every appearance of being panic-struck. The final cause of the instinct that prompts this conduct is sufficiently obvious, as, without it, the hive would be altogether deprived of a queen.

Alien queens.

Bees recognise the person of their own queen. If a stranger enter the hive, they seize and surround her until a ball of bees is formed one or two inches in diameter; in which imprisonment the unfortunate monarch is kept until death puts an end to her misery, for it is very remarkable the bees seldom sting a queen. A hive that has lost its queen may, however, by certain precautions be induced to accept a substitute. The most common way of attaining success in this operation is to imprison the stranger queen in a small cage of wire gauze or perforated zinc; this being suspended between two central combs or fixed upon one, the bees become accustomed to the odour and appearance of their new sovereign, and after the lapse of one or two days will readily accept her. If a supernumerary queen be introduced into the hive, she is laid hold of by the bees and presented to the reigning queen, while a ring is formed by the bees, who continue to be spectators, and even promoters of the combat, in which one or other of the queens is destined to perish. Schirach and Reims had imagined that, in these circumstances, the stranger met her death from the hands of the working bees, but this mistake has been corrected by Huber, who gives the account above stated.

We have next to relate the results of experiments of a more cruel kind, which illustrate several points in the physiology of these insects. The amputation of the four wings of the queen did not interfere with her laying eggs, and the workers did not show her the less attention on account of her being thus mutilated. Of course, if the

operation be performed before she is impregnated, she remains barren, since it is necessary for the normal congress that she should fly out of the hive. The amputation of a single antenna appeared to be productive of no bad consequence of any kind; but the removal of both the antennæ was followed by singular effects. The queen which had suffered this operation ran about in apparent confusion, dropping her eggs at random, and was incapable of directing her tongue with precision to the food that was offered her. At times she appeared desirous of escaping from the hive; and when this was prevented, she returned in a state of delirium, was indifferent to the caresses of the workers, and received another similarly mutilated queen that was presented to her without the least symptom of dislike. The workers, on the other hand, received the stranger queen with great respect, although the first still remained in the hive. A third queen, not mutilated, was next introduced; she was very ill received and immediately detained and kept a close prisoner, being evidently regarded as an intruder. When the queen deprived of her antennæ was allowed to quit the hive, she was followed by none of the workers, and was abandoned to her fate.

Enemies of bees.

The wasp and the hornet have long been known as the determined enemies of the bee, committing great ravages among these weaker insects; they attack them individually, but oftener commit their aggressions in large armies, on which occasions numbers perish on both sides. In some parts of America wasps have multiplied to so great a degree as to render it impossible to rear bees. Among quadrupeds the ant-eater occasionally devours them. The bear and the badger overturn the hives, and plunder their contents. Rats and mice are very formidable enemies, as they attack the bees at all seasons, and especially during the torpid state of the insects, when they are incapable of revenging the aggression. The woodpecker may succeed in breaking through the hive, and then speedily destroys all its inhabitants; the swallow, the sparrow, the titmouse, the cuckoo, the *Merops apiaster*, or bee-eater, and poultry of every kind, prey upon them separately. According to Bosc, they are also food for the shrikes and for the *Falco apivorus*. Lizards watch for them, and seize them as they alight near the hive. Toads occasionally devour them. They are in some danger from the larger kinds of spiders, and of *Libellulæ*, as also from the *Philanthus apivorus* of Fabricius. But the most insidious and destructive enemies of these insects are moths, two species of which, *Galleria mellonella* and *Achroia grisella*, insinuate themselves into the hive, and deposit their eggs on the combs in such numbers, that the hive is soon overrun with the larvæ, the combs destroyed, and the bees eventually forced to vacate the hive. In America and in Italy these moths are much more troublesome than in England. On the Continent of Europe bees are also troubled with a parasite called the bee-louse (*Braula cæca*), sometimes as many as 50 or 100 being found on a single bee, and as they live by suction they are great pests. This insect is not frequently found in England except accompanying imported Ligurian bees.

Bees are subject to few diseases, but these few are sometimes very fatal. Dysentery occasionally commits great havoc in a hive, and is usually caused by the neglect of sanitary measures, by close confinement, want of ventilation, and damp. Dysentery is indicated by the appearance of the excrement within the hive, which the bees in a healthy state are particularly careful to exclude. It is often induced by the bees being forced into undue excitement in cold, ungenial weather. The disease known generally by the name of "foul brood" is the most fatal of all; it is highly contagious,—the infection from its presence remaining in the hives, combs, and honey long after the bees are exterminated. Dysentery is a disease of the perfect insects only. Foul brood is confined to the larvæ, which, having grown to near maturity, die and putrefy after being sealed over by the bees. The workers seem totally unable to remove the foul mass which thus remains to spread infection all around. The seed of the disease is believed to lie in the presence of the spores of a microscopical fungus (*Micrococcus*), and long scientific discussions and experiments have been made on the Continent to demonstrate this, particularly by Drs Preusz and Schönfeld. The devastation caused in apiaries by this disease is sometimes fearful. Dzierzon relates that, in 1848, he had nearly the whole of his colonies destroyed by it, more than 500 being destroyed, and only 10 escaping. Quinby also, in America, has lost as many as 100 stocks in a single year by this pestilence. And when once fully developed a total destruction of all hives and combs infected appears to be the only way of eradicating it. Honey from a foul brood hive will carry the germs of the disease to any bees which may consume it. The presence of this disease may be detected by the foul smell emanating from the hive, and from the circumstance of many cells remaining covered longer than naturally occurs when there are living pupæ within them.

Pasturage

In the management of bees a great deal must, of course, depend on supplying them with an abundant pasture. A rich corn country is well known to be to them as a barren desert during a great portion of the year. Hence the judicious practice of shifting them from place to place according to the circumstances of the season. It was the advice of Celsus that, after the vernal pastures were consumed, bees should be transported to places abounding with autumnal flowers; and in accordance with that advice they were in ancient times annually carried from Achaia to Attica, and from Eubœa and the islands of the Cyclades to Scyrus. In Sicily, also, they were brought to Hybla from other parts of the island. So also in Scotland, so soon as the "bright consummate flowers" of summer are on the wane, the people of the Lowlands despatch their hives in cart-loads to the blooming heather of the mountain pastures, where a never-ending paradise of sweets is spread before them. It is, indeed, to be regretted that our moorlands are not more utilized for this object than they are. The very air of the Highland hills is often redolent with rich perfume, giving earnest of a bountiful harvest; only a solitary bee is seen here and there, labouring with wearied wing among the inexhaustible stores of nature, and scarcely able to regain with its burden its lonely shieling in the distant vale. Considering the poverty of the peasantry, and their frequent want of occupation, it is to be lamented that so easy and pleasant a source of emolument should be so much neglected by them. In consequence of this neglect a large sum is paid every year to foreign nations for articles that could be raised at home, in every respect superior, with very little outlay either of labour or of capital.

We learn from Pliny that the practice of removing bees from place to place was frequent in the Roman territories. "As soon," he says, "as the spring food for bees has failed in the valleys near our towns, the hives of bees are put into boats, and carried up against the stream of the river in the night, in search of better pasture. The bees go out in the morning in quest of provisions, and return regularly to their hives in the boats, with the stores they have collected. This method is continued till the sinking of the boats to a certain depth in the water shows that the hives are sufficiently full; and they are then carried back to their former homes, where their honey is taken out of them." And this is still the practice of the Italians who live near the banks of the Po, the river which Pliny instanced particularly in the passage above quoted.

M. Maillet relates, in his description of Egypt, that, "in spite of the ignorance and rusticity which have got possession of the country, there yet remain in it several footprints of the industry and skill of the ancient Egyptians. One of their most admirable contrivances is sending their bees annually into distant countries, in order to procure sustenance, at a time when they could not find any at home, and afterwards bringing them back,—like shepherds who should travel with their flock, and make them feed as they go. It was observed by the ancient inhabitants of Lower Egypt, that all plants blossomed, and the fruits of the earth ripened, above six weeks earlier in Upper Egypt than with them. They found that the same law applied to their bees; and the means they then made use of to enable these usefully industrious insects to reap advantage from the more forward state of nature there, were exactly the same as are now practised for the like purpose in that country. About the end of October, all such inhabitants of Lower Egypt as have hives of bees, embark them on the Nile, and convey them up that river into Upper Egypt, observing to time the journey so that they arrive there just when the inundation is withdrawn, the lands have been sown, and the flowers begin to bud. The hives thus sent are marked and numbered by their respective owners, and placed pyramidally in boats prepared for the purpose. After they have remained some days at their furthest station, and are supposed to have gathered all the wax and honey they could find in the fields within two or three leagues around, their conductors convey them in the same boats two or three leagues lower down, and there leave the laborious insects as long time as is necessary for them to collect all the riches of this spot. Thus the nearer they come to the place of their more permanent abode, they find the productions of the earth, and the plants which afford them food, forward in proportion. In fine, about the beginning of February, after having travelled through the whole length of Egypt, gathering all the rich produce of the delightful banks of the Nile, they arrive at the mouth of that river, towards the ocean, from whence they originally set out. They are now returned to their several homes, great care being taken to keep an exact register of every district from which the hives were sent in the beginning of the season, their numbers, the names of the persons who sent them, and likewise of the mark or number of the boat in which they were placed."

In many parts of France floating bee-houses are also common; there are on board one barge three to five score of bee-hives, well defended from the inclemency of an accidental storm. The owners allow their barges to float gently down the river, the bees continually choosing their flowery pasture along the banks of the stream, and thus a single floating bee-house yields the proprietor a considerable income. They have also a method of transporting their bees by land which is well worth imitation. Those hives being selected whose combs are firm and not likely to be broken by jolting, thirty to forty of them are carefully packed in tiers in a cart, which proceeds slowly on its travels. If the season be sultry, they journey only at night, the hives being covered up with a cloth. On arriving in a suitable locality the hives are taken out of the cart, set upon the ground, and the bees go forth in search of food. In the evening, as soon as they are all returned, the hives are shut up, and being placed again in the cart they proceed on their journey. When the caravan has arrived at its destination, the colonies are distributed in the gardens or fields adjacent to the houses of the different peasants, who, for a very small remuneration, undertake to look after them.

Bee keeping in different

On the continents of Europe and America bee-keeping is carried on in a much larger and more scientific manner than in the United Kingdom, where the cottagers still, in the greater majority of instances, use only the ancient straw skep or hive, and know no other method of depriving the colonies of their stores than the barbarous and wasteful practice of smothering them with brimstone. In Russia the province of Pultowa boasts of 500,000, and Ekaterinoslaw has 400,000 hives. In Western Russia the industry chiefly flourishes in the province of Kowno, where the Tchmude tribe are almost wholly engaged in bee-keeping; and in Eastern Russia the Finnic tribe are enthusiastic apiarians. In Siberia bee-keeping is mostly carried on about the Altai mountains, and in Caucasia by the Meretinzes and Grusinians. In Southern Russia artificial hives are used, while in North Russia the bees are kept in a natural manner in the forests. The principal reasons why bee-culture is so industriously carried on in Russia are, first, because the peasants use honey instead of sugar, and, secondly, because wax tapers, to the value of 1,200,000 roubles are required for the churches. Mr Buschen states that the quantity of honey annually produced in European Russia is 600,000 to 700,000 lb. In Hungary and Germany apiaries of 2000 to 5000 colonies are said to be not infrequent; and great numbers are in the autumn often found congregated together on the heaths. In 1873 the aggregate number of stocks in Germany, including Hanover and Hesse Cassel, was found to be 1,453,764 stocks; Bavaria alone had 338,897. The German Government encourages bee culture in every possible manner; teachers, paid by the state, travel through the rural districts teaching the best methods of cultivation; and all schoolmasters, before receiving their diplomas, have to pass an examination in this subject. Bee-clubs in the villages are common, money for prizes and expenses being in part supplied by the Government. The result of this fostering care is that Germany produces many skilful apiarians, who contribute greatly to our knowledge of the science. In the United States bee-farming is largely carried on as a distinct trade, every scientific appliance being eagerly brought into use. The country also seems to be particularly productive of honey-secreting flowers, and consequently large harvests are gathered. In 1874 one bee-farm alone, that of Mr Harbison, situated in San Diego county, California, produced 150,000 lb of honey, of a market value of $30,000, from 2000 stocks of bees. The honey-bee of both varieties (*Apis mellifica* and *A. ligustica*) has also been introduced into South Africa and New Zealand, where it flourishes amazingly.

Apiaries and Hives.

Apiaries and hives.

Having thus given at considerable length the natural history of the hive-bee, we proceed to describe the most approved hives, &c., in use in a well-managed apiary. Greater attention to this useful appendage to the cottage would not only be productive of commercial advantage, but would tend to improve the condition of the peasantry. It is not generally known, indeed, what profitable results may be obtained, at a trifling expense of time and labour, from bee-keeping. Even supposing the first cost of a swarm to be one guinea, which is a high price, the cottager, with proper care and management, will clear, in five years, a net profit of nearly £60, and have besides, at the end of that period, ten good stocks of bees in his garden.

The principal objects to be considered in the construction and management of an apiary, are, first, to secure the prosperity and multiplication of the colonies, and then to increase the amount of their productive labour, and to obtain their products with facility and with the least possible detriment to the stock. The apiary should afford to the bees shelter against moisture and the extremes of heat and of cold, and especially against sudden vicissitudes of temperature. The hives should render every facility for constructing the combs and rearing the young; they should allow of every part of the combs being occasionally inspected, and of their being removed when necessary; and, while due attention is paid to economy, they should be made of materials that will insure durability. Much ingenuity has been displayed by different apiarians in the construction of hives to unite in the greatest possible degree all these advantages; but there is still great room for improvement on the hives that are in common use.

While some cultivators of bees have been chiefly anxious to promote their multiplication, and prevent the escape of the swarms in the natural way by procuring what are termed "artificial swarms," which is effected by various means, others have taken into consideration only the