ACTA ENTOMOLOGICA MUSEI NATIONALIS PRAGAE

1961, XXXIV, 571

THE ROLE OF THE HONEY BEE (HYM.: APIS MELLIFERA L.) IN RELATION TO LUCERNE IN HUNGARY

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The increased breeding of the honey bee and its transporting to different localities may concern its important role in the pollination of lucerne. Even in countries with a poor wild bee stock it was believed that the honey bee represented, by its large individual numbers, the natural pollinator of lucerne. The observations, however, carried out in this respect, do not justify this assumption; they were contradictory, or even of a negative character.

According to Helmbolt (1929), the pollen-collecting honey bee opens the flowers of the lucerne with its mandibles. Tysdal (1940) observed that there are, in this respect, certain differences between individual bees, and stated their flower opening work as 1—2%. According to Rudnev (1941), the bees open the flowers well during pollen-collecting, but when sucking nectar, they do so only occasionally. Stapel (1943) established of 5578 flower visits of 925 individuals a flower opening of 1,3 % only. He found 6830 and 4950 individuals on one hectare in 1941 and 1942, respectively. The same author remarked that the number of honey bee individuals was seldom lower on the lucerne. According to Gubin (1947), a honey bee visited 801 flowers within 1 hour on an average. Linsley (1946) found a very poor pollen collector in the honey bee. Akerberg and Lesins (1946) recorded on the pollen-collecting and flower opening work of the honey bee. The same authors (1949) state that the honey bee visited 17,4 flowers in one minute but opened only 0,83 %. According to Shchibirya (1947) and Kopershinskiy & Shchibirya (1950), the role of the honey bee is unimportant in the pollination of lucerne. Bőjtös (1951) found only 1—2 % positive activity regarding observations on the flower visitings of the honey bee.

According to Popov (1951), the honey bee, owing to being strongly struck by the stigma and to getting its mouth parts jammed in the flowers of lucerne, avoids it and prefers other plants. Contrary to the oligotrophy of wild bees, the honey bee is polytrophous and will therefore easily switch to another plant species for the purpose of collecting pollen. While collecting nectar, it forces its mouth parts into the fissure of the wings and the keel of the flowers, and therefore it does not open (Fig. 1).

Other authors again regard the role of the honey bee as being successful. Hare and Vansell (1946), also Vansell and Todd (1946) record the honey bee as being the main pollinator of lucerne in Utah. According to these authors, the pollen-collecting depends on the proximity and abundance of competitive plants. The honey bee worked for as long as 11 hours a day, and pollen-collecting individuals opened 7 flowers in a minute. Vansell (1951) recorded that in Utah the flower opening work of the honey bee reached 59 % on lucerne grown on dry soil, whilst, in its vicinity, it was only 13 per cent on irrigated lucerne. Vansell and Grigg (1952) attained a considerable yield with honey bees in California; they found no wild bees there. I was unable to obtain Reinhardt's paper (1952). In the outdoor cage experiments of Pharis and Unrau (1953), 2,5 % of the flowers were opened by the honey bee. Khalifman (1953) published some successful data on the pollen collecting of honey bees. According to the observations of Petersen (1954), the number of flowers opened by the honey bee varied between 2,3—3,9 per cent. Vansell (1955) demonstrated that even the nectar-collecting individuals of the honey bee open a few flowers.

As concerns the honey bee, we had the following experiences in flowering lucerne fields in Hungary (Móczár 1956, 1957, 1959).

Results of collections of Apis mellifera L.

In 1954, we collected 58 specimens only.

In 1955, we captured 663 specimens; the majority were taken in Com. Fejér (246), Bács-Kiskun (237) and Szolnok (160); the honey bee attaining a percentage of 46,50, 42,63 and 29,20, respectively, of the total collected specimens.

In 1956, we caught 303 specimens. The only large number of individuals (273) was collected in the Nagykunság; the bees representing 43,64 percent of the fauna.

We collected 1024 specimens in 1954—1956. They represented 11,14% of all Apoid insects (9192) collected. The quantity of the collected honey bees, in a decreasing order, was as follows: Nagykunság 434 specimens, 37,15% of the local fauna; Com. Fejér 256 (22,39%); Kiskunság 243 (18,53%); Somogy 37 (3,20%); Baranya 35 (8,53%); Békés 12 (0,58%); Hanság 4 (1,02%); Com. Csongrád 3 (2,08%), respectively. (We record the above data only for the sake of completeness. The real quantity relations are demonstrated by the zonal surveys.)

Results of the zonal surveys.

In 1954, we noted at least 1304 honey bee specimens on a plot of 7000 m^2, which means a density of 2,0 specimens per 10 m^2, as well as 2000 individuals on one hectare. We use the term "at least" owing to the factor

of conversion applied in the zonal surveys made in the Hajduság; the exact calculation is, in this instance, of no importance and may be negligible.

We observed a great amount of lucerne visiting by the honey bee in Szarvas (Area Békés). According to the local observations, we found, in our zonal surveys made on 8000 m², 933 honey bee specimens in 8 days. This number corresponds to 11,6 individuals per 10 m², and 11,600 individuals per hectare. Within a distance of 150 m from this irrigated lucerne field, there was a small one without irrigation and with hardly any honey bees visible. But although the yield in seeds was very favourable in this field, it was very low on the irrigated one. According to the data taken in Turkestan (Őrösi 1951), the nectar production is 24-times higher in irrigated lucerne, and it is may be for this reason that the irrigated lucerne was so assiduously visited by the honey bees. Although honey bees are generally searching for a high concentration nectar, and as an increased soil humidity results in a decrease of the sugar-concentration, it is still more probable that the honey bee chose the plentiful though less valuable nectar since there was nowhere else in the vicinity a similar wide and rich nectar source. And the reasen for the absence of the wild bees may be the mass visiting of the lucerne by the honey bee, lessening the attractiveness of the nectar on the irrigated field, as pointed out also by Tysdall (1940). Meanwhile, the wild bees might have found, on the small lucerne field, a nectar amount suitable for their numbers. Any exact findings could have been drawn only by a contemporaneously detailed investigation of the small field in question.

In 1955, we noted a total of 6095 honey bees on 8000 m² on the investigated plots mentioned above. This corresponds to 7,8 individuals per 10 m², or 7600 per hectare. We obtained the following results on the different (lots: Békés (Szarvas) 15,240/hectare; Hanság 11,890/hectare; Somogy 10,020/hectare; Com. Fejér 8,610/hectare; Nagykunság 5,080/hectare; Kiskunság 4,130/hectare; Békés (Bánkut) 2,950/hectare; Baranya 1,700/hectare.

In 1956, we noted a total of 12,200 honey bees on 11,900 m². This amount corresponds to 9,7 specimens per 10 m², or 9,700 per hectare. We counted the following numbers of bee individuals for one hectare on each plot: Nagykunság 24,410; Hanság 14,160; Baranya 13,650, Békés (Bánkut) 11,800; Békés (Szarvas) 15,240; Somogy 10,980; Com. Fejér 6,460; Com. Csongrád 6,390; Hajduság 4,640; Kiskunság 3,710; Békés (Székkutas) 2,550.

The presence of honey bees in the lucerne fields was neither constant nor uniform. It was established more than once that their numbers decreased considerably from one day to another, and for some days they were completely absent. In these days, however, there was an unusually abundant flight of wild bees. Vansell and Todd (1946) had already referred to the fact that the quick flower opening of the wild bees appearing in large numbers decrease the formation of nectar and, as a consequence, the honey bees are not attracted. It is probable that similar motives are often responsible for the absence of the wild bees in Hungarian lucerne fields.

A total of 19,619 honey bees was noted in the years 1954—1956 on 26,990 m²; this corresponds to an average of 7,3 individuals per 10 m², or 7,300 per hectare. There was found the following numbers of honey bee individuals per hectare in the different lucerne fields:

Nagykunság	14,700/hectare
Békés: Szarvas	14,000
Hanság	13,000
Com. Fejér	12,500
Somogy	10,500
Baranya	7,600
Békés: Bánkut	7,300
Kiskunság	3,800
Com. Csongrád	3,100
Hajduság	2,300
Békés: Székkutas	1,200

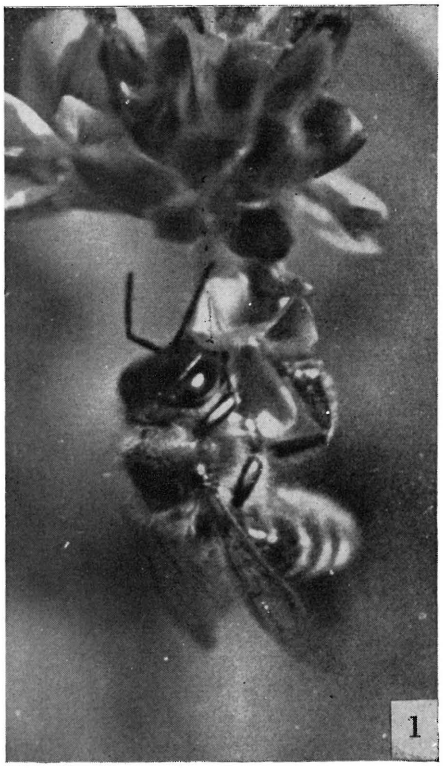
Results of the flower visiting.

According to observations in Somogy in 1954, there were opened 13 blossoms, i. e. 8 percent in a minute (Fig. 2) of 250 flowers visited within a space of 20 minutes. In the course of the visitings, we met with but one instance in which this value was higher (11/9); this honey bee individual was probably collecting pollen and not nectar. Our observations agree with the literature which records that the honey bee sucks the nectar from the sides (Fig. 1) never opening th petals, and, as a result, it does not pollinate the lucerne.

In 1955, they visited 700 flowers in 54 minutes, 13 per minute, but opened 3,1 percent of the flowers only. Among the flower visitings, high values were observed in two instances only, viz 4/4 in Somogy and 9/6 in Nagykunság. Generally, they hardly opened one single flower among the visited ones.

In 1956, the honey bee visited 309 flowers in 20 minutes, that is, 1,5 flowers per minute, but with only 16,18 percent opened among them. An opening work of higher values (12/7, 20/19, 13/13 and 7/3) was observed, in four instances, in Nagykunság only.

If we summarise the observations on flower visiting made in the three years 1954—1956, we can draw the following conclusions. The honey bee visited 1259 flowers in 95 minutes, 13 flowers in a minute, but it opened but 7,3 percent of them. The rapidity of the visiting agrees with the data of Gubin (1947); the percentage of the flower visiting, however, is nearer to the more satisfactory data presented in the literature. The number of flowers really opened within a minute was less than 1, not more than 0,9 (Móczár 1959).



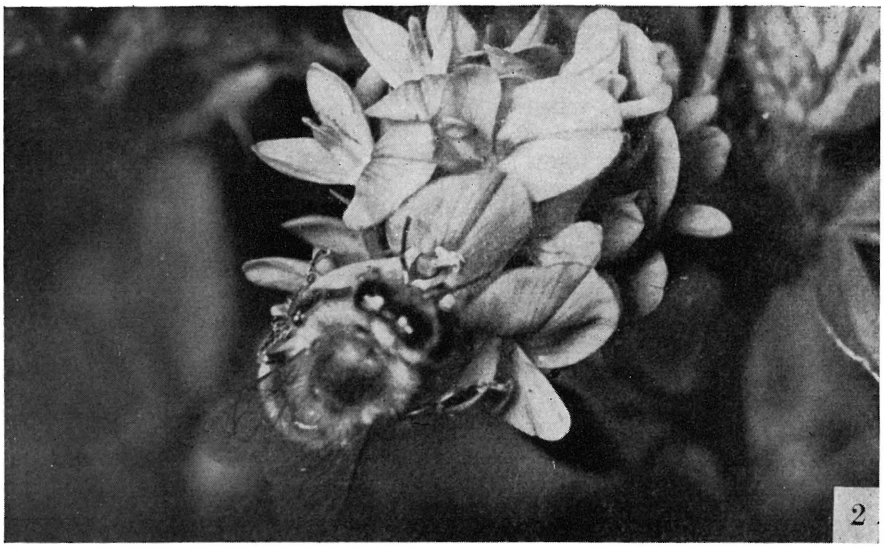


Fig. 1—2. Honey bees collecting nectar and pollen on lucerne. — Fig. 3. *Eucera cinerea* Lep. (above) and *Melitta leporina* Pz. (below) before and after the opening of the flower (Orig.).

The work of the honey bee.

If we multiply the average number of the honey bee specimens found on one hectare (7,300) with the number of the opened flowers, the result shows that the honey bees opened 6570 flowers per hectare in a minute. This number varies, of course, according to the average number of honey bee individuals in the different localities. It is highest in the area of the Nagykunság and in the Békés, lowest in the Com. Csongrád (cf. density data of the zonal surveys).

Comparing the number of flowers (6570) opened by the honey bee on 1 hectare in a minute with those opened by the wild bees on a silimar area in the same time, we were inclined to regard the activity of the honey bee as not only a positive one, but to place it, as one of the best openers, just behind *Eucera clypeata* and *Melitta leporina.* The comparison of the results obtained from different localities is far less advantageous for the honey bee. But we shall not overlook a special circumstance in our evaluation. The honey bees attained this relatively high percentage in the opening work by their extraordinarily large individual numbers. 7,300 individuals opened 6570 flowers in a minute on 1 hectare; whilst but 780 *Melitta leporina* individuals opened as many as 7332 flowers in the same time as 1 hectare! Yet the emphasis is not on the exceedingly great numerical difference. The density of the honey bee can be raised anywhere to an extraordinarily high level by transporting the hives, while the transport of the wild bees is still at the very beginning.

Whilst the wild bees open the visited flowers at a very high rate as was pointed out above, and as any failures may be attributed to special circumstances and not to their own fault, further, as in the majority of cases the wild bees open the flowers for their nectar (Fig. 3.), the situation concerning the honey bee is quite different.

In the great majority of the 95 minutes observations in Hungary, the honey bee sucked the nectar from the sides of the flowers without opening them (Fig. 1.). For this reason, one needs a high density of honey bee individuals to execute the real flower opening on 1 hectare. Likewise they suck the nectar out of the flowers they visit, rendering them thereby less attractive, at least until the formation of fresh nectar. Therefore, 7,300 honey bee individuals have to visit at least 89,800 flowers to open 6570 of them! So, of about 90,000 flowers deprived completely or to a great extent of their nectar content, the honey bees open but 6570 flowers. Accordingly, it is more correct to regard the honey bee, despite its apparent high flower opening percentage, not as a useful insect from the point of view of the pollination of lucerne, but even as a harmful one during its nectar collecting activity.

It is quite another matter when the honey bee collects pollen from the lucerne (Fig. 2). In accordance with the observations abroad, we too have established a very high flower opening percentage for the honey bee individuals when they are after the pollen and not the nectar (cf. the 80,70 percent flower opening in 1956 in the Nagykunság). Vansell and Todd (1946) listed the pollen collecting honey bee *Nomia melanderi* and

some *Megachile* spp. as among the most useful bee species for seed production in Utah. In California, the number of honey bee individuals per area unit were gradually raised by proper distribution, and after having shifted the hives several times, they were able to raise by 12—40 percent the pollen-collecting work of the honey bee. It was found by experience that it is best to shift the hives every third day, since they work far afield on the fourth day.

This pollinating service requires a good many hives and the seed growers have to compensate the apiarists to at least such an extent as if the bees were put to plants rich in nectar (Vansell 1951).

In Saratov, Khalifman (1953) removed the pollen stock from the hives, after failing to exert a successful influence on the honey bees by using lucerne syrup extract. The bees, flying out from the empty hives in the vicinity of the lucerne field, collected copious amounts of lucerne pollen after having had their attention turned by lucerne syrup. To augment results, Khalifman placed a special screen in front of the entry hole, which brushed off the collected pollen from the body of the returning bee, so that the bees, finding repeatedly empty cells flow away again, urged on by their reflexes, to collect pollen anew. Though this method is successful, it can only be applied by a frequent exchange of the hives, otherwise the mechanical stress exserted by this "undressing" procedure will destroy a considerable percentage of the pollen collectors with the result that the hive becomes excessively weakened. When applying this structure, the hives should be provided with plenty of honey.

It was learned by experience that selected lucerne clones were up to 86 percent more successfully visited by the honey bee (Khalifman 1953). It is therefore necessary to approach the question, concerning the side opening of the flowers. According to the observations of Lesins, Akerberg, Bőjtös (1954), in a selected stock of Medicago falcata, where the angle was very acute between the banner, wing and keel petals, the flower opened even after the visit of the honey bee. Indeed, there was observed a difference of 10—11 percent in the flower openings of the honey bee on different sorts of lucerne sown alternately (Vansell 1951). It should be the task therefore of lucerne improvement projects to evolve lucerne types with flowers easily accessible to the honey bee. And if a lucerne type of this kind were visited by honey bees deprived of their pollen stock and conditioned to lucerne by the use of lucerne syrup, and if the hives were shifted every three days and "undressed" but for a few hours, at most in the main collecting period, they would not suffer on account of this procedure. Commission and tenancy, as well as other expenses, would be manifoldly repaid by the surplus in the seed production caused by the pollinating activity of the honey bee.

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