

Disappearing Disease of Honey Bees: A Survey of the United States¹

CONCLUSION

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RESULTS

The answers to the survey indicated that disappearing disease of honey bees has been observed by beekeepers and apiary inspectors in at least 27 (54%) states and in every geographical region of the United States (Fig. 1). Inspectors in four other states who reported no DD did, however, describe occasions when adult worker bees disappeared during periods of cool, damp weather or when an adult population failed to build up for no identifiable reason. In another two states, the inspectors reported no DD, but the direct responses of one large-scale queen breeder and several commercial beekeepers to the senior author indicated that they had experienced DD and that in some cases large numbers of colonies were affected. Inspectors in four states did not reply. Data sum-

mations in this text, however, do not always total 46 (no reply from 4 states) because most inspectors did not answer all questions or gave more than one answer to a single question.

The first question that the apiary inspectors were asked was: "Have any beekeepers contacted you concerning a problem with dwindling populations, disappearing adult bees or lack of population build-up, etc. that **could not be explained** readily by recent pesticide application or similar detrimental factors?" Twenty-seven answered "yes." Nineteen inspectors answered "no." Eleven of those 27 inspectors cited pesticides as the cause of loss despite the wording of the question. Nine cited DD.

Some inspectors mentioned more than one detrimental factor as being associated with the dwindling: nosema disease, starvation, unseasonably cool

and damp weather, poor quality or dead queens, dysentery, lack of pollen, genetic defects, chalkbrood, limited broodrearing, toxic emissions, small cluster, honeydew, and stress. Four of the 19 who replied "no" incriminated pesticides alone as the cause of dwindling and similar bee mortality.

Fifty-six percent (10 of 18) of the inspectors replying said that many beekeepers had transferred hive equipment and combs from colonies where the population had dwindled or disappeared on to healthy colonies without noticeable ill effects. One said that the bees died out from starvation, and one inspector said colony build-up was slow. Six respondents lacked information on this question.

Spring is the season when the DD problem is most frequently seen according to 13 of 24 inspectors. However, dwindling has been noticed during all seasons: autumn (two reports), winter (three reports), all seasons except summer (two reports), and summer (four reports). Of the four inspectors who reported dwindling in summer, three said it was caused by pesticides alone. Nine of 14 inspectors in states reporting DD claimed an unusually heavy loss of wintering colonies.

When asked if the problem of dwindling or disappearing bees had been noticed in the past, eight of 18 inspectors said it had been noticed frequently in the past five years. Five said DD has been a problem for more than five, but less than 10 years; four said DD has been seen and has gotten worse for the past 15 years. One person said the problem has been around for more than 15 years and attributed it to starvation and nosema. Sixty-six percent of those who had noted the problem in the past indicated that it is more serious some years than others. Sixteen of 18 inspectors said the importance of the problem to the beekeeping industry was remaining the same or is increasing.

To the question about whether DD-weakened colonies recover, 13 of 21

Figure 1. Location of disappearing disease in the U.S. from a survey of State Bee Inspectors - 1975.

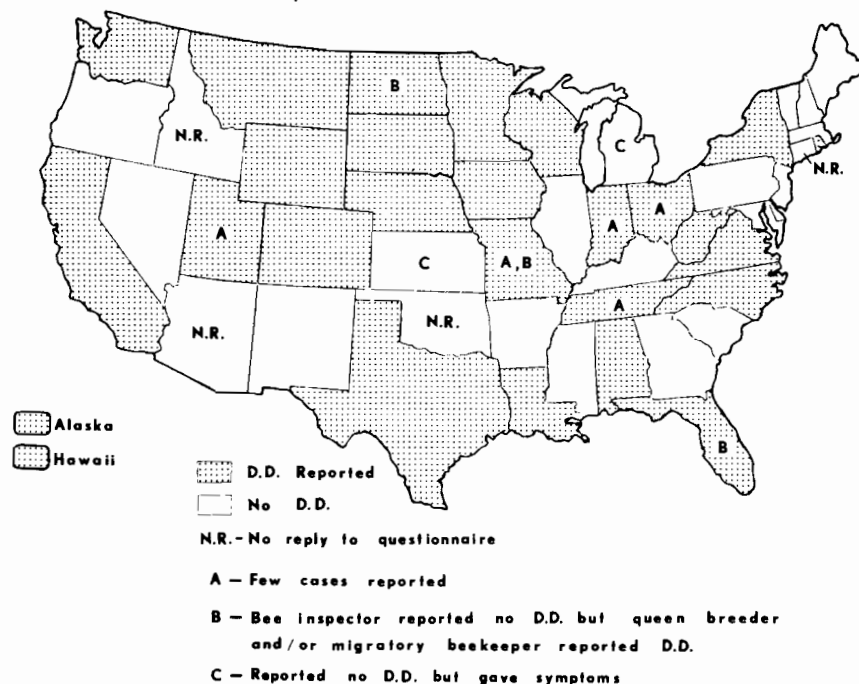


Fig. 1. — Location of disappearing disease in the U. S. from a 1975 survey of state bee inspectors.

inspectors said "yes": Some colonies were reported to recover on their own; others were united with other weakened colonies. Even when the weakened colonies managed to recover, there was no surplus honey according to 53 per cent (eight of 15) of the replies. Moreover, when a surplus was harvested, five of seven inspectors reported that the honey yield was reduced.

Fifty-eight per cent (14 of 24) of the inspectors acknowledging the existence of DD said northern beekeepers seemed to be having the most trouble with disappearing disease, especially the northern honey producers who purchased their packages and queens in the South. In fact, northern honey producers who divide colonies and rear queens in the north and migratory beekeeping outfits each accounted for 17 per cent of the reports of DD. Only 8 per cent of the inspectors reported that southern honey producers and queen and package breeders had the problem.

Most (71 per cent) inspectors indicated that the magnitude of the losses from DD ranged between 10 and 50 per cent. A few inspectors set the losses at less than 5 per cent. Although none specified whether the losses represented a percentage of the adult bees or a percentage of the colonies, it was determined by combining the data from five inspectors that more than 2,450 colonies died from DD in the worst year. Also, according to six respondents, more than 10,100 colonies in six states were greatly weakened by DD during the year when the problem was most severe. Four said that 27 to 50 per cent of the colonies were dead or weakened, another said *many*, and two lacked specific figures. (We assume that the percentages refer to those colonies belonging to beekeepers reporting a DD problem.) The estimated colony loss (dead and weakened) during the 5-year period 1970 to 1975 was given by nine inspectors as 43,000 colonies for their nine states. Nine other inspectors gave the 5-year percentages as 1 to 20 per cent of the colonies.

DISCUSSION

A revealing but not surprising difficulty with the survey was the general confusion caused by the similarity between the symptoms of pesticide poisoning and DD. Why are pesticides so often listed as the primary cause of dwindling / disappearing - bee problem? In the past, people have been inclined to "think" pesticides, often without thoroughly investigating all aspects of

the bee losses. In fact, if an inspector's repertoire of bee experience does not contain information on DD, the DD/dwindling or loss would be diagnosed as pesticide-related on the basis of general signs and symptoms.⁴ One inspector commented, "If you haven't heard of DD, what else fits the situation except pesticides?"

Certainly with both pesticide-related and DD-caused bee losses, the adult population of a colony may be reduced rapidly to a "handful" of bees or, in some cases, the entire population may be lost.

However, in the case of pesticide poisoning, there is usually evidence of pesticide application — a known airplane spray application to a specific crop or actual chemical residues found on plants. According to Atkins (1975), pesticide kill may be suspected when weather has been warm, dry, and pleasant for any length of time and the colonies are located in or near a field with a crop in bloom. The worker bees either die in the field or in or near the hive depending on the type of pesticide. When the field force is killed and they "disappear," many dead or dying bees may be seen on the ground in the field or on the ground between the treated field and the apiary with the nurse bees remaining in the hive. If the foraging bees bring poison into the hive, then the nurse bees either die in the hive or at the entrance so one can see many crawling and tumbling adults and large amounts of neglected brood. Exposure to pesticides over an extended period results in very weak colonies, and some die out.

In the case of DD, the situation is quite different. The colonies frequently have gone through a period of nectar and pollen collection with active brood rearing. Then the weather has turned unreasonably cool and damp and remained adverse for from about 3 to 14 days. Such a situation usually occurs in early spring. During the inclement weather, the bee populations dwindle because the worker bees disappear from the hive leaving a "handful" of bees and the queen. Often these small populations recover and increase in size during hot weather and a long nectar flow or, occasionally, the entire population absconds, possibly because adverse weather ends the nectar flow. In addition, stocks with DD problem are reported to winter poorly, partly because they remain too active during subfreezing temperatures and so have "loose" or separated clusters. These bees may also have an unusually high rate of honey consumption that termi-

nates in mid-winter with starvation because the 60 to 70 lb (about 30 kilograms) of stored honey customarily left for winter provisions is not adequate to winter these bees outdoors (Wilson, 1976).

Examinations of bees from hives with DD problems indicate that infectious pathogens are not the cause of dwindling or disappearance of adult bees. For example, several scientists (e.g. H. Shimanuki, G. M. Thomas, A. S. Michael, N. M. Kauffeld, and the senior author) checked samples of bees in the 1960's and 1970's and found little or no evidence of *Nosema apis*, although nosema disease can cause a type of population dwindling (Gochbauer *et al.*, 1975). Oertel (1965) and Foote (1966) were also able to eliminate nosema and viruses (to a reasonable degree) as the cause of DD. However, in some cases viruses are difficult to exclude, at least as a contributing factor. Neither evidence of dysentery nor dipteran larvae were found in the bees sent from Texas and examined at the Honey Bee Pesticides/Diseases Research Unit at Laramie.

Some beekeepers have associated chalkbrood (*Ascospaera apis*) with the occurrence of DD (Wilson, 1976). In fact, chalkbrood, a fungal disease, has appeared in colonies that have a history of DD. However, data (unpublished) obtained at this laboratory, show that *A. apis* is not the cause of DD though the spread of the two maladies across the United States in the 1960's has been similar (Menapace and Wilson, 1976; Fore, 1977; and Wilson unpublished data). Mraz (personal communication) reports a like situation in Mexico where chalkbrood and DD are often found in the same regions with stocks that seem highly susceptible to these two problems and to European foulbrood.

From the reports of U.S. beekeepers, weather definitely has a significant role in DD. The normal situation during a period of inclement weather with near freezing temperatures is a reduction or termination in the collection of nectar and pollen, but this does not seriously affect a colony's population. Colonies that develop DD have a relatively high loss of adults when weather is cool and accompanied by high humidity (rain) with some frost, but no snow. Therefore, the advent of DD in many colonies appears to depend on environmental conditions rather than calendar dates, i.e., the climatic conditions in January and February in southern states such as Florida may not be duplicated in the higher mountain valleys of Montana and Wyoming

until May or early June. Moreover, in a very interesting account from Mexico, Mraz (1977a) discounts cold weather as a stress factor influencing the occurrence of DD. He reports that in early February populations disappeared from colonies of honey bees in an area where there had been no cold weather (however, no day or night temperatures were given). As a result, the hives contained stored honey, but only a small cluster of young bees and practically no older field bees. We believe that it is unseasonably cool weather — not frigid cold weather (considerably below freezing) that triggers the disappearance of the bees.

Usually colonies that develop DD contain sizeable populations of adult bees and are expanding prior to the cool weather. Thus, losses are not likely associated with poor queens, low brood survival, or the lack of pollen. In addition as Oertel (1965) and Foote (1966) showed, inadequate nutrition is not the cause of DD. Since bees in colonies that are losing their populations have a tendency to fly out and disappear during inclement weather (or abscond if the nectar flow is interrupted), the failure of individual bees to return to the hive could be the result of chilling in flight, insufficient honey in the stomach to sustain the return flight, or improper orientation, all of which are physiological-behavioral functions. Mraz (1977a) says, "Apparently young field bees on their early flights, never return (to the hive)." In our opinion such problems, including absconding, could be caused by genetic deficiencies that are enhanced by stress (i.e. cool, damp weather). This concept is under investigation. For example, Dr. E. C. Martin, National Program Staff specialist for honey bees, USDA, Beltsville, Maryland (personal communication) states that in 1977 the Baton Rouge Bee Breeding Laboratory developed a cooperative research project with Dr. Walter Rothenbuhler of Ohio State University to study possible genetic causes of the problem, with concern also for microbiological, nutritional and management aspects. This is a project with a considerable degree of difficulty but it may provide us with a much better understanding of DD.

Economically, the bees losses and decreased honey yields caused by disappearing disease can be quite sizeable. Foote (1966) reported the loss of 10,000 colonies in one year in California. Nine inspectors reported 43,000 colonies lost over a period of 5 years

in nine states, which could represent a loss of more than \$2,000,000 at today's prices. We believe the figure of 43,000 colonies to be extremely conservative since beekeepers in more than nine states are involved and one migratory beekeeper alone had the problem of dwindling populations in 7,800 colonies.

Some inspectors and beekeepers, especially queen breeders, have questioned the existence of DD as a separate entity. In fact, Michael (1966) called the DD problem a "paper tiger" that did not exist. However, those beekeepers who have experienced the DD problem have no doubt regarding its existence and importance. Mraz (1977a and 1977b) says DD is a serious problem and some Mexican beekeepers appealed to him for help in solving this problem. A leader in apiculture said that DD would be much easier to comprehend if a "firm handle" could be placed on it, such as with American foulbrood where gross signs of the disease and microscopic identification of the pathogen are easily observed and consistent in appearance. The fact is that DD has a great diversity of signs and symptoms, not easily identified, and is often confused with other bee-mortality problems. However, this does not diminish the importance of DD to the beekeeping industry. It does indicate the need for more research and challenges our ability to solve the DD problem.

CONCLUSION BASED ON SURVEY RESULTS

1. DD is a distinct and identifiable malady of honey bees.
2. DD is found in all geographical regions of the United States and in at least 27 states.
3. DD results in reduced adult-worker-bee populations and loss of colonies and is a serious economic problem for some beekeepers.
4. The time of the heaviest bee loss due to DD is during the spring when the weather is cool and rainy. The loss is more severe some year than other years.
5. DD, and the customary dwindling populations, was noticed 15 years ago, but the greatest number of cases have occurred within the past 5 years.⁵
6. Dwindling during cool, wet weather and where the incidence of *N. apis* is low, is caused by either pesticide exposure or disappearing disease.⁶
7. Many colonies suffering from DD recover during the summer when the weather is hot, without rain and

the bees have access to a nectar flow, however the annual total honey yield per colony is reduced.

8. The beekeepers most frequently troubled by the DD problem are northern honey producers who purchase package bees, queens, or both from southern states.

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This paper is dedicated to the memory of an outstanding young man, Bobby Pfadt.

FOOTNOTES

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²Research Entomologist and Microbiologist, respectively.

³One beekeeper felt that the mortality was the result of air-borne pollutants; however, colonies had been in the general area for many years without similar loss of bees.

⁴This discussion is not intended to detract from the serious nature of pesticide-caused bee losses and the Federal Indemnity Program that compensates beekeepers for bee mortality due to poisoning.

⁵It should be noted that the figures were based on the survey, which was completed in 1975.

⁶Pesticide exposure is included because these conclusions are based on survey results; however, from published reports and in-depth reviews of bee losses sustained by individual beekeepers, the authors are convinced that pesticides are not the cause of cool-weather dwindling.

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