

= Colony collapse disorder =

Colony collapse disorder (CCD) is the phenomenon that occurs when the majority of worker bees in a colony disappear and leave behind a queen , plenty of food and a few nurse bees to care for the remaining immature bees and the queen . While such disappearances have occurred throughout the history of apiculture , and were known by various names (disappearing disease , spring dwindle , May disease , autumn collapse , and fall dwindle disease) , the syndrome was renamed colony collapse disorder in late 2006 in conjunction with a drastic rise in the number of disappearances of western honey bee (*Apis mellifera*) colonies in North America . European beekeepers observed similar phenomena in Belgium , France , the Netherlands , Greece , Italy , Portugal , and Spain , Switzerland and Germany , albeit to a lesser degree , and the Northern Ireland Assembly received reports of a decline greater than 50 % .

Colony collapse disorder causes significant economic losses because many agricultural crops (although no staple foods) worldwide are pollinated by western honey bees . According to the Agriculture and Consumer Protection Department of the Food and Agriculture Organization of the United Nations , the worth of global crops with honey bee 's pollination was estimated to be close to \$ 200 billion in 2005 . Shortages of bees in the US have increased the cost to farmers renting them for pollination services by up to 20 % .

In the six years leading up to 2013 , more than 10 million beehives were lost , often to CCD , nearly twice the normal rate of loss .

Several possible causes for CCD have been proposed , but no single proposal has gained widespread acceptance among the scientific community . Suggested causes include : infections with Varroa and Acarapis mites ; malnutrition ; various pathogens ; genetic factors ; immunodeficiencies ; loss of habitat ; changing beekeeping practices ; or a combination of factors . A large amount of speculation has surrounded a family of pesticides called neonicotinoids as having caused CCD .

= = History = =

Limited occurrences resembling CCD have been documented as early as 1869 and this set of symptoms has , in the past several decades , been given many different names (disappearing disease , spring dwindle , May disease , autumn collapse , and fall dwindle disease) . Most recently , a similar phenomenon in the winter of 2004 / 2005 occurred , and was attributed to varroa mites (the " vampire mite " scare) , though this was never ultimately confirmed . The cause of the appearance of this syndrome has never been determined . Upon recognition that the syndrome does not seem to be seasonally restricted , and that it may not be a " disease " in the standard sense ? that there may not be a specific causative agent ? the syndrome was renamed .

A well @-@ documented outbreak of colony losses spread from the Isle of Wight to the rest of the UK in 1906 . These losses later were attributed to a combination of factors , including adverse weather , intensive apiculture leading to inadequate forage , and a new infection , the chronic bee paralysis virus , but at the time , the cause of this agricultural beekeeping problem was similarly mysterious and unknown .

Reports show this behavior in hives in the US in 1918 and 1919 . Coined " mystery disease " by some , it eventually became more widely known as " disappearing disease " . Oertel , in 1965 , reported that hives afflicted with disappearing disease in Louisiana had plenty of honey in the combs , although few or no bees were present , discrediting reports that attributed the disappearances to lack of food .

From 1972 to 2006 , dramatic reductions continued in the number of feral honey bees in the U.S. and a significant though somewhat gradual decline in the number of colonies maintained by beekeepers . This decline includes the cumulative losses from all factors , such as urbanization , pesticide use , tracheal and Varroa mites , and commercial beekeepers ' retiring and going out of business . However , in late 2006 and early 2007 , the rate of attrition was alleged to have reached new proportions , and the term " colony collapse disorder " began to be used to describe this sudden rash of disappearances (sometimes referred to as " spontaneous hive collapse " or the " Mary

Celeste syndrome " in the United Kingdom) .

Losses had remained stable since the 1990s at 17 % ? 20 % per year attributable to a variety of factors , such as mites , diseases , and management stress . The first report of CCD was in mid @-@ November 2006 by a Pennsylvania beekeeper overwintering in Florida . By February 2007 , large commercial migratory beekeepers in several states had reported heavy losses associated with CCD . Their reports of losses varied widely , ranging from 30 % to 90 % of their bee colonies ; in some cases , beekeepers reported losses of nearly all of their colonies with surviving colonies so weakened that they might no longer be able to pollinate or produce honey .

Losses were reported in migratory operations wintering in California , Florida , Oklahoma , and Texas . In late February , some larger nonmigratory beekeepers in the mid @-@ Atlantic and Pacific Northwest regions also reported significant losses of more than 50 % . Colony losses also were reported in five Canadian provinces , several European countries , and countries in South and Central America and Asia . In 2010 , the USDA reported that data on overall honey bee losses for 2010 indicated an estimated 34 % loss , which is statistically similar to losses reported in 2007 , 2008 , and 2009 . Fewer colony losses occurred in the U.S. over the winter of 2013 @-@ 2014 than in recent years . Total losses of managed honey bee colonies from all causes were 23 @.@ 2 % nationwide , a marked improvement over the 30 @.@ 5 % loss reported for the winter of 2012 @-@ 2013 and the eight @-@ year average loss of 29 @.@ 6 % .

After bee populations dropped 23 % in the winter of 2013 , the Environmental Protection Agency and Department of Agriculture formed a task force to address the issue . In the six years leading up to 2013 , more than 10 million beehives were lost , often to CCD , nearly twice the normal rate of loss . However , according to Syngenta , the total number of beehives worldwide continues to grow . An insecticide produced by Syngenta was banned by the European Commission in 2013 for use in crops pollinated by bees . Syngenta together with Bayer is challenging this ban in court .

= = Signs and symptoms = =

In collapsed colonies , CCD is suspected when a complete absence of adult bees is found in colonies , with little or no buildup of dead bees in the hive or in front of the hive . A colony which has collapsed from CCD is generally characterized by all of these conditions occurring simultaneously :

Presence of capped brood in abandoned colonies : Bees normally will not abandon a hive until the capped brood have all hatched .

Presence of food stores , both honey and bee pollen :
which are not immediately robbed by other bees

which when attacked by hive pests such as wax moth and small hive beetle , the attack is noticeably delayed

Presence of the queen bee : If the queen is not present , the hive died because it was queenless , which is not considered CCD .

Precursor symptoms that may arise before the final colony collapse are :

Insufficient workforce to maintain the brood that is present

Workforce seems to be made up of young adult bees

The colony members are reluctant to consume provided feed , such as sugar syrup and protein supplement .

= = Scope and distribution = =

= = North America = =

The National Agriculture Statistics Service reported 2 @.@ 44 million honey @-@ producing hives were in the United States in February 2008 , down from 4 @.@ 5 million in 1980 , and 5 @.@ 9 million in 1947 , though these numbers underestimate the total number of managed hives , as they exclude several thousand hives managed for pollination contracts only , and also do not include

hives managed by beekeepers owning fewer than five hives . This under @-@ representation may be offset by the practice of counting some hives more than once ; hives that are moved to different states to produce honey are counted in each state 's total and summed in total counts .

Non @-@ CCD winter losses as high as 50 % have occurred in some years and regions (e.g. , 2000 ? 2001 in Pennsylvania) . Normal winter losses are typically considered to be in the range of 15 ? 25 % . In many cases , beekeepers reporting significant losses of bees did not experience true CCD , but losses due to other causes .

In 2007 in the US , at least 24 different states had reported at least one case of CCD . In a 2007 survey of 384 responding beekeepers from 13 states , 23 @.@ 8 % met the specified criterion for CCD (that 50 % or more of their dead colonies were found without bees and / or with very few dead bees in the hive or apiary) .

In the US in 2006 ? 2007 , CCD @-@ suffering operations had a total loss of 45 % compared to the total loss of 25 % of all colonies experienced by non @-@ CCD suffering beekeepers .

A 2007 ? 2008 survey of over 19 % of all colonies revealed a total loss of 35 @.@ 8 % . Operations that pollinated almonds lost , on average , the same number of colonies as those that did not . The 37 @.@ 9 % of operations that reported having at least some of their colonies die with a complete lack of bees had a total loss of 40 @.@ 8 % of colonies compared to the 17 @.@ 1 % loss reported by beekeepers without this symptom . Large operations were more likely to have this symptom , suggesting a contagious condition may be a causal factor . About 60 % of all colonies that were reported dead in this survey died without the presence of dead bees in the hive , thus possibly suffered from CCD .

In 2010 , the USDA reported that data on overall honey bee losses for the year indicate an estimated 34 % loss , which is statistically similar to losses reported in 2007 , 2008 , and 2009 . In 2011 , the loss was 30 % . In 2012 ? 2013 , CCD was blamed for the loss of about half of the US honey bee hives , far more than the 33 % losses observed on average over previous years .

During the spring of 2015 , President Barack Obama unveiled the very first national strategy for improving the health of bees and other key pollinators . The plan calls for restoring 7 million acres of bee habitat with a variety of different plants for bees to eat . The administration is also proposing spending \$ 82 @.@ 5 million for honey bee research .

= = = Europe = = =

According to the European Food Safety Authority (EFSA) , in 2007 , the United Kingdom had 274 @,@ 000 hives , Italy had 1 @,@ 091 @,@ 630 , and France 1 @,@ 283 @,@ 810 . In 2008 , the British Beekeepers Association reported the bee population in the United Kingdom dropped by around 30 % between 2007 and 2008 , and an EFSA study revealed that in Italy the mortality rate was 40 ? 50 % . However , EFSA officials point out the figures are not very reliable because before the bees started dying , no harmonisation was used in the way different countries collected statistics on their bee populations . At that time (2008) , the reports blamed the high death rate on the varroa mite , two seasons of unusually wet European summers , and some pesticides .

In 2009 , Tim Lovett , president of the British Beekeepers ' Association , said : " Anecdotally , it is hugely variable . There are reports of some beekeepers losing almost a third of their hives and others losing none . " John Chapple , chairman of the London Beekeepers ' Association , put losses among his 150 members at between a fifth and a quarter . " There are still a lot of mysterious disappearances ; we are no nearer to knowing what is causing them . " The government 's National Bee Unit continued to deny the existence of CCD in Britain ; it attributes the heavy losses to the varroa mite and rainy summers that stop bees foraging for food .

In 2010 , David Aston of the British Beekeepers ? Association stated , " We still do not believe CCD (which is now better defined) is a cause of colony losses in the UK , however we are continuing to experience colony losses , many if not most of which can be explained " . He feels recent studies suggest " further evidence to the evolving picture that there are complex interactions taking place between a number of factors , pathogens , environmental , beekeeping practices and other stressors , which are causing honey bee losses described as CCD in the US " .

Beekeepers in Scotland also reported losses for the past three years . Andrew Scarlett , a Perthshire @-@ based bee farmer and honey packer , lost 80 % of his 1 @,@ 200 hives during the 2009 winter . He attributed the losses to a virulent bacterial infection that quickly spread because of a lack of bee inspectors , coupled with sustained poor weather that prevented honey bees from building up sufficient pollen and nectar stores .

In Germany , where some of the first reports of CCD in Europe appeared , and where , according to the German national association of beekeepers , 40 % of the honey bee colonies died , there was no scientific confirmation ; in early May 2007 , the German media reported no confirmed CCD cases seemed to have occurred in Germany .

At the end of May 2012 , the Swiss government reported about half of the bee population had not survived the winter . The main cause of the decline was thought to be the parasite *Varroa destructor* .

= = Possible causes = =

The mechanisms of CCD are still unknown , but many causes are currently being considered , such as pesticides , mites , fungi , beekeeping practices (such as the use of antibiotics or long @-@ distance transportation of beehives) , malnutrition , poor quality queens , starvation , other pathogens , and immunodeficiencies . The current scientific consensus is that no single factor is causing CCD , but that some of these factors in combination may lead to CCD either additively or synergistically .

In 2006 , the Colony Collapse Disorder Working Group , based primarily at Pennsylvania State University , was established . Their preliminary report pointed out some patterns , but drew no strong conclusions . A survey of beekeepers early in 2007 indicated most hobbyist beekeepers believed that starvation was the leading cause of death in their colonies , while commercial beekeepers overwhelmingly believed invertebrate pests (*Varroa* mites , honey bee tracheal mites , and / or small hive beetles) were the leading cause of colony mortality . A scholarly review in June 2007 similarly addressed numerous theories and possible contributing factor , but left the issue unresolved .

In July 2007 , the United States Department of Agriculture (USDA) released its " CCD Action Plan " , which outlined a strategy for addressing CCD consisting of four main components : survey and data collection ; analysis of samples ; hypothesis @-@ driven research ; mitigation and preventive action . The first annual report of the U.S. Colony Collapse Disorder Steering Committee was published in 2009 . It suggested CCD may be caused by the interaction of many agents in combination . The same year , the CCD Working Group published a comprehensive descriptive study that concluded : " Of the 61 variables quantified (including adult bee physiology , pathogen loads , and pesticide levels) , no single factor was found with enough consistency to suggest one causal agent . Bees in CCD colonies had higher pathogen loads and were co @-@ infected with more pathogens than control populations , suggesting either greater pathogen exposure or reduced defenses in CCD bees . "

The second annual Steering Committee report was released in November 2010 . The group reported , although many associations , including pesticides , parasites , and pathogens have been identified throughout the course of research , " it is becoming increasingly clear that no single factor alone is responsible for [CCD] " . Their findings indicated an absence of damaging levels of the parasite *Nosema* or parasitic *Varroa* mites at the time of collapse . They did find an association of sublethal effects of some pesticides with CCD , including two common miticides in particular , coumaphos and fluvalinate , which are pesticides registered for use by beekeepers to control varroa mites . Studies also identified sublethal effects of neonicotinoids and fungicides , pesticides that may impair the bees ' immune systems and may leave them more susceptible to bee viruses .

A 2015 review examined 170 studies on colony collapse disorder and stressors for bees , including pathogens , agrochemicals , declining biodiversity , climate change and more . The review concluded that " a strong argument can be made that it is the interaction among parasites , pesticides , and diet that lies at the heart of current bee health problems . " Furthermore :

" Bees of all species are likely to encounter multiple stressors during their lives , and each is likely to reduce the ability of bees to cope with the others . A bee or bee colony that appears to have succumbed to a pathogen may not have died if it had not also been exposed to a sublethal dose of a pesticide and / or been subject to food stress (which might in turn be due to drought or heavy rain induced by climate change , or competition from a high density of honey bee hives placed nearby) . Unfortunately , conducting well @-@ replicated studies of the effects of multiple interacting stressors on bee colonies is exceedingly difficult . The number of stressor combinations rapidly becomes large , and exposure to stressors is hard or impossible to control with free @-@ flying bees . Nonetheless , a strong argument can be made that it is the interaction among parasites , pesticides , and diet that lies at the heart of current bee health problems . "

= = = Pesticides = = =

According to the USDA , pesticides may be contributing to CCD . A 2013 peer @-@ reviewed literature review concluded neonicotinoids in the amounts typically used harm bees and safer alternatives are urgently needed . At the same time , other sources suggest the evidence is not conclusive , and that clarity regarding the facts is hampered by the role played by various issue advocates and lobby groups .

Scientists have long been concerned that pesticides , including possibly some fungicides , may have sublethal effects on bees , not killing them outright , but instead impairing their development and behavior . Of special interest is the class of insecticides called neonicotinoids , which contain the active ingredient imidacloprid , and other similar chemicals , such as clothianidin and thiamethoxam . Honey bees may be affected by such chemicals when they are used as a seed treatment because they are known to work their way through the plant up into the flowers and leave residues in the nectar . The doses taken up by bees are not lethal , but possible chronic problems could be caused by long @-@ term exposure . Most corn grown in the US is treated with neonicotinoids , and a 2012 study found high levels of clothianidin in pneumatic planter exhaust . In the study , the insecticide was present in the soil of unplanted fields near those planted with corn and on dandelions growing near those fields . Another 2012 study also found clothianidin and imidacloprid in the exhaust of pneumatic seeding equipment .

A 2010 survey reported 98 pesticides and metabolites detected in aggregate concentrations up to 214 ppm in bee pollen ; this figure represents over half of the individual pesticide incidences ever reported for apiaries . It was suggested that " while exposure to many of these neurotoxicants elicits acute and sublethal reductions in honey bee fitness , the effects of these materials in combinations and their direct association with CCD or declining bee health remains to be determined . "

Evaluating pesticide contributions to CCD is particularly difficult for several reasons . First , the variety of pesticides in use in the different areas reporting CCD makes it difficult to test for all possible pesticides simultaneously . Second , many commercial beekeeping operations are mobile , transporting hives over large geographic distances over the course of a season , potentially exposing the colonies to different pesticides at each location . Third , the bees themselves place pollen and honey into long @-@ term storage , effectively meaning a delay may occur from days to months before contaminated provisions are fed to the colony , negating any attempts to associate the appearance of symptoms with the actual time at which exposure to pesticides occurred .

Pesticides used on bee forage are far more likely to enter the colony by the pollen stores rather than nectar (because pollen is carried externally on the bees , while nectar is carried internally , and may kill the bee if too toxic) , though not all potentially lethal chemicals , either natural or man @-@ made , affect the adult bees ; many primarily affect the brood , but brood die @-@ off does not appear to be happening in CCD . Most significantly , brood are not fed honey , and adult bees consume relatively little pollen ; accordingly , the pattern in CCD suggests , if contaminants or toxins from the environment ' are ' responsible , it is most likely to be via the honey , as the adults are dying (or leaving) , not the brood (though possibly effects of contaminated pollen consumed by juveniles may only show after they have developed into adults) .

To date , most of the evaluation of possible roles of pesticides in CCD have relied on the use of

surveys submitted by beekeepers , but direct testing of samples from affected colonies seems likely to be needed , especially given the possible role of systemic insecticides such as the neonicotinoid imidacloprid (which are applied to the soil and taken up into the plant 's tissues , including pollen and nectar) , which may be applied to a crop when the beekeeper is not present . The known effects of imidacloprid on insects , including honey bees , are consistent with the symptoms of CCD ; for example , the effects of imidacloprid on termites include apparent failure of the immune system , and disorientation .

In Europe , the interaction of the phenomenon of " dying bees " with imidacloprid has been discussed for quite some time . A study from the " Comité Scientifique et Technique (CST) " was at the center of discussion , and led to a partial ban of imidacloprid in France . The imidacloprid pesticide Gaucho was banned in 1999 by the French Minister of Agriculture Jean Glavany , primarily due to concern over potential effects on honey bees . Subsequently , when fipronil , a phenylpyrazole insecticide and in Europe mainly labeled " Regent " , was used as a replacement , it was also found to be toxic to bees , and banned partially in France in 2004 .

In February 2007 , about 40 French deputies , led by Jacques Remiller of the UMP , requested the creation of a parliamentary investigation commission on overmortality of bees , underlining that honey production had decreased by 1 @, @ 000 tons a year for a decade . By August 2007 , no investigation had opened . Five other insecticides based on fipronil were also accused of killing bees . However , the scientific committees of the European Union are still of the opinion " that the available monitoring studies were mainly performed in France and EU @-@ member @-@ states should consider the relevance of these studies for the circumstances in their country . "

Around the same time French beekeepers succeeded in banning neonicotinoids , the Clinton administration permitted pesticides which were previously banned , including imidacloprid . In 2004 , the Bush administration reduced regulations further and pesticide applications increased .

In 2005 , a team of scientists led by the National Institute of Beekeeping in Bologna , Italy , found pollen obtained from seeds dressed with imidacloprid contain significant levels of the insecticide , and suggested the polluted pollen might cause honey bee colony death . Analysis of maize and sunflower crops originating from seeds dressed with imidacloprid suggest large amounts of the insecticide will be carried back to honey bee colonies . Sublethal doses of imidacloprid in sucrose solution have also been documented to affect homing and foraging activity of honey bees . Imidacloprid in sucrose solution fed to bees in the laboratory impaired their communication for a few hours . Sublethal doses of imidacloprid in laboratory and field experiment decreased flight activity and olfactory discrimination , and olfactory learning performance was impaired .

Research , in 2008 , by scientists from Pennsylvania State University found high levels of the pesticides fluvalinate and coumaphos in samples of wax from hives , as well as lower levels of 70 other pesticides . These chemicals have been used to try to eradicate varroa mites , a bee pest that itself has been thought to be a cause of CCD . Researchers from Washington State University , under entomology professor Steve Sheppard in 2009 , confirmed high levels of pesticide residue in hive wax and found an association between it and significantly reduced bee longevity .

The WSU work also focused on the impact of the microsporidian pathogen *Nosema ceranae* , the build @-@ up of which was high in the majority of the bees tested , even after large doses of the antibiotic fumagillin . Penn State 's Dr. Maryann Frazier said , " Pesticides alone have not shown they are the cause of CCD . We believe that it is a combination of a variety of factors , possibly including mites , viruses and pesticides . "

In 2010 , fipronil was blamed for the spread of CCD among bees , in a study by the Minutes @-@ Association for Technical Coordination Fund in France , which found that even at very low nonlethal doses , this pesticide still impairs the ability to locate the hive , resulting in large numbers of foragers lost with every pollen @-@ finding expedition , though no mention was made regarding any of the other symptoms of CCD ; other studies , however , have shown no acute effect of fipronil on honey bees . Fipronil is designed to eliminate insects similar to bees , such as yellowjackets (*Vespula germanica*) and many other colonial pests by a process of ' toxic baiting ' , whereby one insect returning to the hive spreads the pesticide among the brood .

A large 2010 survey of healthy and CCD @-@ affected colonies also revealed elevated levels of

pesticides in wax and pollen , but the amounts of pesticides were similar in both failing and healthy hives . They also confirmed suspected links between CCD and poor colony health , inadequate diet , and long @-@ distance transportation . Studies continue to show very high levels of pathogens in CCD @-@ affected samples and lower pathogen levels in unaffected samples , consistent with the empirical observation that healthy honey bee colonies normally fend off pathogens . These observations have led to the hypothesis that bee declines are resulting from immune suppression .

In 2010 , a sequencing of the honey bee genome provided a possible explanation for the sensitivity of bees to pesticides . Its genome is deficient in the number of genes encoding detoxification enzymes , including cytochrome P450 monooxygenases (P450s) , glutathione @-@ S @-@ transferases , and carboxylesterases .

In 2012 , researchers announced findings that sublethal exposure to imidacloprid rendered honey bees significantly more susceptible to infection by the fungus *Nosema* , thereby suggesting a potential link to CCD , given that *Nosema* is increasingly considered to contribute to CCD .

Neonicotinoids may interfere with bees ' natural homing abilities , causing them to become disoriented and preventing them from finding their way back to the hive .

Also , in 2012 , researchers in Italy published findings that the pneumatic drilling machines that plant corn seeds coated with clothianidin and imidacloprid release large amounts of the pesticide into the air , causing significant mortality in foraging honey bees . According to the study , " Experimental results show that the environmental release of particles containing neonicotinoids can produce high exposure levels for bees , with lethal effects compatible with colony losses phenomena observed by beekeepers . " Commonly used pesticides , such as the imidacloprid , reduce colony growth and new queen production in experimental exposure matched to field levels . Lu et al . (2012) reported they were able to replicate CCD with imidacloprid . Another neonicotinoid , thiamethoxam , causes navigational homing failure of foraging bees , with high mortality .

A 2012 in situ study provided strong evidence that exposure to sublethal levels of imidacloprid in high fructose corn syrup (HFCS) used to feed honey bees when forage is not available causes bees to exhibit symptoms consistent to CCD 23 weeks after imidacloprid dosing . The researchers suggested , " the observed delayed mortality in honey bees caused by imidacloprid in HFCS is a novel and plausible mechanism for CCD , and should be validated in future studies . "

In March 2013 , two studies were published showing that neonicotinoids affect bee long @-@ term and short @-@ term memory , suggesting a cause of action resulting in failure to return to the hive . In another study done in 2013 , scientists reported that experiments suggested that exposure to the neonicotinoid pesticides clothianidin and imidacloprid results in increased levels of a particular protein in bees that inhibits a key molecule involved in the immune response , making the insects more susceptible to attack by harmful viruses . Growth in the use of neonicotinoid pesticides has roughly tracked rising bee deaths . In 2015 , an 11 @-@ year British study showed a definitive relationship between increasing agricultural use of neonicotinoid and escalating honey bee colony losses at a landscape level . This is the first field study to establish a link between neonicotinoids and CCD .

In July 2013 , scientists from the University of Maryland and the US Department of Agriculture found that a combination of pesticides has been contaminating the pollen bees use to feed their hives . When researchers collected pollen from hives on the east coast , they discovered that it was contaminated (on average) with 9 different fungicides and pesticides , although scientists found a blend of 21 different agricultural chemicals in one sample of pollen . Eight ag chemicals were identified to be associated with increased risk of infection by *Nosema ceranae* .

A meta @-@ analysis study published in February 2016 strongly suggests a pattern linking imidacloprid to sublethal effects on honey bees , stating : " trace dietary imidacloprid at field @-@ realistic levels in nectar will have no lethal effects , but will reduce expected performance in honey bees by between 6 and 20 % . Statistical power analysis showed that published field trials that have reported no effects on honey bees from neonicotinoids were incapable of detecting these predicted sublethal effects with conventionally accepted levels of certainty . "

=== European Food Safety Authority statement ===

In 2012 , several peer @-@ reviewed independent studies were published showing that neonicotinoids had previously undetected routes of exposure affecting bees including through dust , pollen , and nectar and that subnanogram toxicity resulted in failure to return to the hive without immediate lethality , one primary symptom of CCD . Research also showed environmental persistence in agricultural irrigation channels and soil . These reports prompted a formal peer review by the European Food Safety Authority , which stated in January 2013 that some neonicotinoids pose an unacceptably high risk to bees , and identified several data gaps not previously considered . Their review concluded , " A high acute risk to honey bees was identified from exposure via dust drift for the seed treatment uses in maize , oilseed rape and cereals . A high acute risk was also identified from exposure via residues in nectar and / or pollen . " Dave Goulson , an author of one of the studies which prompted the EFSA review , has suggested that industry science pertaining to neonicotinoids may have been deliberately deceptive , and the UK Parliament has asked manufacturer Bayer Cropscience to explain discrepancies in evidence they have submitted to an investigation .

= = = = Neonicotinoids banned by European Union = = = =

Early in 2013 , the European Food Safety Authority issued a declaration that three specific neonicotinoid pesticides pose an acute risk to honey bees , and the European Commission (EC) proposed a two @-@ year ban on them . David Goulson , who led one of the key 2012 studies at the University of Stirling , said the decision " begs the question of what was going on when these chemicals were first approved . " The chemical manufacturer Bayer said it was " ready to work with " the EC and member states . In April 2013 , the European Union voted for a two @-@ year restriction on neonicotinoid insecticides . The ban will restrict the use of imidacloprid , clothianidin , and thiamethoxam for use on crops that are attractive to bees . Eight nations voted against the motion , including the British government , which argued that the science was incomplete . The ban can be seen as an application of the " precautionary principle " , established at the 1992 Rio Conference on the Environment and Development , which advocates that " lack of full scientific certainty shall not be used as a reason for postponing cost @-@ effective measures to prevent environmental degradation . "

= = = = Initiatives to ban neonicotinoids in the United States = = = =

In March 2013 , professional beekeepers and environmentalists jointly filed a lawsuit against the United States Environmental Protection Agency (EPA) for continuing to allow the use of neonicotinoids in the United States . The suit specifically asks for suspension of clothianidin and thiamethoxam . The lawsuit follows a dramatic die off of bees in the United States , with some beekeepers losing 50 % of their hives . The EPA responded to the suit by issuing a report blaming the Varroa mite for the decline in bees and claiming the role of neonicotinoids in bee extinction has been overstated .

Also in 2013 , the Save America 's Pollinators Act of 2013 (H.R. 2692) was introduced in Congress . The proposed act asks that neonicotinoids be suspended until a full review of their impacts has occurred . The bill was reintroduced on 4 March 2015 as the Saving America 's Pollinators Act (H.R. 1284) , where it is currently being debated by the House Subcommittee on Biotechnology , Horticulture , and Research .

= = = Pathogens and immunodeficiency theories = = =

Early researchers commented that the pathway of propagation functions in the manner of a contagious disease ; however , some sentiment existed that the disorder may involve an immunosuppressive mechanism , potentially linked to " stress " leading to a weakened immune system . Specifically , according to research done in 2007 at the Pennsylvania State University : "

The magnitude of detected infectious agents in the adult bees suggests some type of immunosuppression " . These researchers initially suggested a connection between Varroa destructor mite infestation and CCD , suggesting that a combination of these bee mites , deformed wing virus (which the mites transmit) and bacteria work together to suppress immunity and may be one cause of CCD . Parasites , such as varroa mites (Varroa destructor) , honey bee tracheal mites (Acarapis woodi) , fungal , bacterial and viral diseases , and kleptoparasites such as small hive beetles (Aethina tumida) , are all problems that have been introduced within the last 20 years in the continental U.S. , and are faced by beekeepers .

When a colony is dying , for whatever cause , and other healthy colonies are nearby (as is typical in a bee yard) , those healthy colonies often enter the dying colony and rob its provisions for their own use . If the dying colony 's provisions were contaminated (by natural or man @-@ made toxins) , the resulting pattern (of healthy colonies becoming sick when in proximity to a dying colony) might suggest to an observer that a contagious disease is involved . However , it is typical in CCD cases that provisions of dying colonies are not being robbed , suggesting that at least this particular mechanism (toxins being spread via robbing , thereby mimicking a disease) is not involved in CCD . Additional evidence that CCD is an infectious disease came from the following observations : the hives of colonies that had died from CCD could be reused with a healthy colony only if they were first treated with DNA @-@ destroying radiation , and the CCD Working Group report in 2010 indicated that CCD @-@ exhibiting hives tended to occur in proximity to one another within apiaries .

Coumaphos , an organophosphate , is lipophilic , and so accumulates in wax . Increased levels of compound in wax have been shown to decrease survivorship of developing queens .

===== Varroa mites =====

According to a 2007 article , the mite Varroa destructor remains the world 's most destructive honey bee killer , due in part to the viruses it carries , including deformed wing virus and acute bee paralysis virus , which have both been implicated in CCD . Affliction with Varroa mites also tends to weaken the immune system of the bees . Dr. Ernesto Guzman , an entomological researcher at the University of Guelph in Canada , studied 413 Ontario bee colonies in 2007 ? 08 . About 27 % of hives did not survive the winter , and the Varroa mite was identified as the cause in 85 % of the cases . Varroa mites also affect the queen 's ability to reproduce which is detrimental to the survival of the hive . As such , Varroa mites have been considered as a possible cause of CCD , though not all dying colonies contain these mites .

===== Israeli acute paralysis virus =====

In 2004 , Israeli acute paralysis virus (IAPV) , was discovered in Israel and at one time it was considered the cause of CCD . It was named after the place it was first identified ; its place of origin is unknown . In September 2007 , results of a large @-@ scale statistical RNA sequencing study of afflicted and unafflicted colonies were reported . RNA from all organisms in a colony was sequenced and compared with sequence databases to detect the presence of pathogens . All colonies were found to be infected with numerous pathogens , but only the IAPV virus showed a significant association with CCD : the virus was found in 25 of the 30 tested CCD colonies , and only in one of the 21 tested non @-@ CCD colonies .

Research in 2009 has found that an indicator for an impaired protein production is common among all bees affected by CCD , a pattern consistent with IAPV infection . It is conjectured that Dicistroviridae , like the IAPV , cause degradation of the ribosomes , which are responsible for protein production of cells , and that this reduced ribosomal function weakens the bees , making them more vulnerable to factors that might not otherwise be lethal .

===== Nosema =====

Some have suggested the syndrome may be an inability by beekeepers to correctly identify known diseases such as European foulbrood or the microsporidian fungus *Nosema apis*. The testing and diagnosis of samples from affected colonies (already performed) makes this highly unlikely , as the symptoms are fairly well known and differ from what is classified as CCD . A high rate of *Nosema* infection was reported in samples of bees from Pennsylvania , but this pattern was not reported from samples elsewhere .

When healthy bees are fed pollen filled with fungicides , insecticides and other agriculture chemicals , they are more likely to be infected by *Nosema ceranae* , a parasitic microsporidian fungus associated with widespread death of honey bees . Hives of western honey bees infected with *Nosema ceranae* are wiped out within eight days indicating that CCD may be caused by *N. ceranae* . A research team claim to have ruled out many other potential causes , however , a 2009 survey of US CCD @-@ affected bee populations found only about half of the colonies sampled , both in CCD and control populations , were infected with *N. ceranae* .

The primary antifungal agent used against *Nosema* is fumagillin , which has been used in a German research project to reduce the microsporidian 's impact , and is mentioned as a possible remedy by the CCDWG . Higes also claims to have successfully cured colonies with fumagillin . A review of these results described these results as promising , but cautioned " *N. ceranae* may not be to blame for all cases of colony collapse " . Various areas in Europe have reported this fungus , but no direct link to CCD has yet been established .

In 2007 , *N. ceranae* was reported in a few hives in California . The researcher did not , however , believe this was conclusive evidence of a link to CCD ; " We don 't want to give anybody the impression that this thing has been solved " . A USDA bee scientist has similarly stated , " while the parasite *Nosema ceranae* may be a factor , it cannot be the sole cause . The fungus has been seen before , sometimes in colonies that were healthy " .

N. ceranae has been detected in honey bees from several states using PCR of the 16S gene . In New York , *N. ceranae* was detected in 49 counties , and of the 1 @,@ 200 honey bee samples collected , 528 (44 %) were positive for *Nosema* , from which , PCR analysis of 371 spore positive samples revealed 96 % were *N. ceranae* , 3 % had both *N. ceranae* and *N. apis* , and 1 % had *N. apis* only .

== = Viral and fungal combination == =

A University of Montana and Montana State University team of scientists headed by Jerry Bromenshenk and working with the US Army 's Edgewood Chemical Biological Center published a paper in October 2010 saying that a new DNA virus , invertebrate iridescent virus or IIV6 , and the fungus *Nosema ceranae* were found in every killed colony the group studied . In their study , they found neither agent alone seemed deadly , but a combination of the virus and *N. ceranae* was always 100 % fatal . Information about the study was released to the public in a front page article in The New York Times . A few days later , an article was published in Fortune Magazine with the title , " What a scientist didn 't tell the New York Times about his study on bee deaths " . Professor of entomology at Penn State University James Frazier , who is currently researching the sublethal impact of pesticides on bees , said that while Bromenshenk 's study generated some useful data , Bromenshenk has a conflict of interest as CEO of a company developing scanners to diagnose bee diseases . A few months later , the methods used to interpret the mass spectrometry data in the Bromenshenk study were called into question , raising doubts as to whether IIV6 was ever correctly identified in any of the samples examined .

== = Fungicides == =

In 2013 , researchers collected pollen from hives and fed it to healthy bees . The pollen had an average of nine different pesticides and fungicides . Further , the researchers discovered that bees that ate pollen with fungicides were three times more likely to be infected by parasites . Their study shows that fungicides , thought harmless to bees , may actually play a significant role in CCD . Their

research also showed that spraying practices may need to be reviewed because the bees sampled by the authors foraged not from crops , but almost exclusively from weeds and wildflowers , suggesting that bees are more widely exposed to pesticides than thought .

Dennis vanEngelsdorp , an entomologist at the University of Maryland , has been quoted as saying " Fungicides , which we didn 't expect to harm insects , seem to have a sub @-@ lethal effect on bee health " . He went on further to state this is important because fungicides are not heavily regulated .

= = = Antibiotics and miticides = = =

Most beekeepers affected by CCD report that they use antibiotics and miticides in their colonies , though the lack of uniformity as to which particular chemicals are used makes it seem unlikely that any single such chemical is involved . However , it is possible that not all such chemicals in use have been tested for possible effects on honey bees , and could therefore potentially be contributing to the CCD phenomenon .

= = = Fluvalinate / coumaphos = = =

In 2008 high levels of the pesticides fluvalinate and coumaphos were found in samples of wax from hives , as well as lower levels of 70 other pesticides . These chemicals have been used to try to eradicate varroa mites , a bee pest that itself has been thought to be a cause of CCD . A 2009 study confirmed high levels of pesticide residue in hive wax and found an association between the pesticide and reduced bee longevity . *Nosema ceranae* , was found in high concentrations in the majority of the bees tested , even after administering large doses of the antibiotic fumagillin . Maryann Frazier commented , " Pesticides alone have not shown they are the cause of CCD . We believe that it is a combination of a variety of factors , possibly including mites , viruses and pesticides . "

= = = Climate Change = = =

Studies in Europe and North America have shown dramatic declines in bee colonies . The U.S. has lost 59 % of its bee colonies since 1947 , and Europe has lost over 25 % since 1985 . Determining the causes of bee colony collapse is crucial to the global economy , as bee pollination assists with 9 @. @ 5 % of the global agricultural production worth billions of dollars .

Through ecological modeling and retrospective studies , research has shown a link between bee colony collapse and climate change . Although the shifting weather conditions themselves negatively affect bees , the link between colony collapse and climate change is also closely tied to the interaction between bees ? climatic niches and food @-@ plant reductions . Climate change affects the floral environment by stunting flower development and nectar production , which in turn directly impacts colonies ? abilities to collect pollen and sustain themselves .

As weather conditions shift due to climate change , bees change their behaviors . When it rains , bees do not go out and during extremely hot weather they try to gather water to keep the colony cool . Climatologists have predicted that the occurrence of extreme weather events (such as intense rainy seasons and prolonged drought) will increase as the climate continues to change . Additionally , in regions that experience increasingly more rain , pollen will be washed away more easily making it more difficult for bees to provide for their colonies . Meanwhile , in environments experiencing prolonged drought , flower environments may dwindle with dry weather . These patterns lead to less suitable and viable environments in which bees can thrive . A British journal published projections of plant diversity loss against spatial sensitivity ; the researchers found major species loss in the southern part of the UK forcing bee colonies further north .

Since it can take decades of studying climate change and tracking bee colonies to find correlations between them , many researchers have turned to ecological modeling . In a Brazilian study , researchers investigated the impact that climate change will have on ten endemic bee species in

various future climatic scenarios . It is known that moderate temperatures and high relative humidity impacts flight activity and foraging behavior in bee species such as *Melipona* and *Centris* . As a result , the scientists predict that in scenarios where temperatures continue to increase and humidity continues to decrease the only suitable climates for bees in Brazil will be in the more mountainous environments . The most optimistic scenario estimated climate change would still lead to a five percent reduction in these species ? populations . While this may not seem like a large change , bees are very sensitive to the effects of small population size ; small populations can lead to reduced genetic variability and decreased fitness . As a result of this sensitivity , fragmented habitat are less likely to support a viable population and may lead to additional colony collapse .

From these models , researchers also predict that bee populations will start declining most significantly in the southern latitudes with lagging range expansion in the north . Kerr and his colleagues found that as the climate has shifted and bumblebees have been forced to operate outside of their thermal ranges , causing range losses along the species ? southern limits . However , the study also found that while other flora and fauna have expanded their northerly ranges to account for the climate shifts , bumblebees have not expanded farther north . The most important findings in this study came from statistical models built to study whether or not these range shifts were due to confounding factors such as pesticide use or changes in land cover . The researchers found that climate change had the most meaningful impact on range shifts and bee distributions . To support these findings , the scientists note that failure for the bumblebee to respond to thermal changes and expand their northern range underscores the idea that bumblebees are susceptible to climate change .

One of the most significant studies on climate change and bees examined the species , *B. Distinguendus* and *B. sylvarum* between 2000 and 2006 in the UK . The study showed that as the climate of western Europe warmed , these two bee species experienced range declines and narrower climatic niches pushing them to the fringes of their environments . Geographically and climatically we expect this , as climate change continues bees will move and abandon areas of drought and migrate towards the fringes , as this has already been seen within desert oases . Europe has done significant work in tracking bee colony changes within the regions . Additional longitudinal surveillance needs to be conducted in other regions of the globe among a wider array bee species in order to build the body of research surrounding the impact of climate change on bees .

= = = Bee rentals and migratory beekeeping = = =

Since U.S. beekeeper Nephi Miller first began moving his hives to different areas of the country for the winter of 1908 , migratory beekeeping has become widespread in America . Bee rental for pollination is a crucial element of U.S. agriculture , which could not produce anywhere near its current levels with native pollinators alone . U.S. beekeepers collectively earn much more from renting their bees out for pollination than they do from honey production .

Researchers are concerned that trucking colonies around the country to pollinate crops , where they intermingle with other bees from all over , helps spread viruses and mites among colonies . Additionally , such continuous movement and re @-@ settlement is considered by some a strain and disruption for the entire hive , possibly rendering it less resistant to all sorts of systemic disorder .

= = = Selective commercial breeding and lost genetic diversity in industrial apiculture = = =

Most of the focus on CCD has been toward environmental factors . CCD is a condition recognised for greatest impact in regions of ' industrial ' or agricultural use of commercially bred bee colonies . Natural breeding and colony reproduction of wild bees is a complex and highly selective process , leading to a diverse genetic makeup in large populations of bees , both within and between colonies . Genetic diversity through sexual reproduction is a significant evolutionary factor in resistance to parasites and infectious diseases . Many artificially bred species , especially domestic and

agricultural species , suffer from lack of genetic variation. resulting in increased risk of hereditary diseases , loss of vitality or vigour , and heightened uniform susceptibility to infectious diseases . There may be an analogy in artificially introduced invasive ants , which displace native species by their ecological release and supercolonies (a manifestation of genetic homogeneity) , only to suffer collapse of colonies attributed to lack of genetic diversity . Displaced indigenous species rebounded from residual populations .

Industrial apiculture has adopted simple breeding programs for uniform desired traits , and seasonal transportation of colonies over vast distances causes increased infectious exposures from mixing of these domestic and residual displaced wild populations . Brood incubation conditions may be stressful with respect to deficient nutrition , temperature and other basics . This combination of ecological factors , especially the host factor of loss of genetic variation and hybrid vigor , may account for the apparent multifactorial environmental ' causes ' of CCD including concurrent infections .

= = = Malnutrition = = =

In 2007 , one of the patterns reported by the CCD Study Group at Pennsylvania State was that all producers in a preliminary survey noted a period of " extraordinary stress " affecting the colonies in question prior to their die @-@ off , most commonly involving poor nutrition and / or drought . This was the only factor that all of the cases of CCD had in common in the report ; accordingly , there appeared to be at least some significant possibility that the phenomenon was correlated to nutritional stress that may not manifest in healthy , well @-@ nourished colonies . This was similar to the findings of another independent survey done in 2007 in which small @-@ scale beekeeping operations (up to 500 colonies) in several states reported their belief that malnutrition and / or weak colonies was the factor responsible for their bees dying in over 50 % of the cases , whether the losses were believed to be due to CCD or not .

Some researchers have attributed the syndrome to the practice of feeding high @-@ fructose corn syrup (HFCS) to supplement winter stores . The variability of HFCS may be relevant to the apparent inconsistencies of results . One European writer has suggested a possible connection with HFCS produced from genetically modified corn .

Other researchers state that colony collapse disorder is mainly a problem of feeding the bees a monoculture diet when they should receive food from a variety of sources / plants . In winter , these bees are given a single food source such as corn syrup (high @-@ fructose or other) , sugar and pollen substitute . In summer , they may only pollinate a single crop (e.g. , almonds , cherries , or apples) . The monoculture diet is attributed to bee rentals and migratory bee keeping . Honey bees are only being introduced to select commercial crops such as corn . These single pollen diets are greatly inferior to mixed pollen diets . However , there are a few pollens that are acceptable for honey bees to be introduced to exclusively , including sweet clover and mustard .

A study published in 2010 found that bees that were fed pollen from a variety of different plant species showed signs of having a healthier immune system than those eating pollen from a single species . Bees fed pollen from five species had higher levels of glucose oxidase than bees fed pollen from one species , even if the pollen had a higher protein content . The authors hypothesised that CCD may be linked to a loss of plant diversity . Researches found a proper diet that does lead to a healthy honey bee population . " The authors recommended a diet containing 1000 ppm potassium , 500 ppm calcium , 300 ppm magnesium and 50 ppm each of sodium , zinc , manganese , iron and copper . "

The lack of variance in plant pollen does not appear to affect a healthy colony of honey bees however . Once a fungus or parasite invades a colony , research has proven that honey bees introduced to a wider variety of pollen are much more likely to survive longer due to receiving key nutrients and alkaloids like zinc .

A 2013 study found that p @-@ Coumaric acid , which is normally present in honey , assists bees in detoxifying certain pesticides . Its absence in artificial nutrients fed to bees may therefore contribute to CCD .

== Electromagnetic radiation ==

A study on the non-thermal effects of radio frequency (RF) on honey bees (*Apis mellifera carnica*) reported there were no changes in behavior due to RF exposure from DECT cordless phone base stations operating at 1.880 ? 1.900 MHz however , a later study established that close range electromagnetic field (EMF) may reduce the ability of bees to return to their hive . In the course of their study , one half of their colonies broke down , including some of their controls which did not have DECT base stations embedded in them . In April 2007 , news of this study appeared in various media outlets , beginning with an article in The Independent , which stated that the subject of the study included mobile phones and had related them to CCD . Though cellular phones were implicated by other media reports at the time , they were not covered in the study . Researchers involved have since stated that their research did not include findings on cell phones , or their relationship to CCD , and indicated that the Independent article had misinterpreted their results and created " a horror story " .

A review of 919 peer reviewed scientific studies investigating the effects of EMF on wildlife , humans and plants included seven studies involving honey bees ; six of these reported negative effects from exposure to EMF radiation , but none specifically demonstrated any link to CCD . The review noted that according to one study , when active mobile phones were kept inside beehives , worker bees stopped coming to the hives after 10 days . The same study also found drastic decrease in the egg production of queen bees in these colonies and stated " electromagnetic radiation exposure provides a better explanation for Colony Collapse Disorder (CCD) than other theories " . The review authors concluded : " existing literature shows that the EMRs are interfering with the biological systems in more ways than one " and recommended recognising EMF as a pollutant . However , they also noted that " these studies are not representative of the real life situations or natural levels of EMF exposure . More studies need to be taken up to scientifically establish the link , if any , between the observed abnormalities and disorders in bee hives such as Colony Collapse Disorder (CCD) " .

== Parasitic phorid fly ==

In 2012 , a parasitic fly (*Apocephalus borealis*) larva , known to prey on bumble bees and wasps , was found in a test tube containing a dead honey bee believed to have been affected by CCD , possibly indicating the phorid fly may be one cause of CCD . The mature fly lays eggs in the bee 's abdomen , which feed on the bee after hatching . Infected bees behave abnormally , foraging at night and gathering around lights like moths . Eventually the bee leaves the colony to die . The phorid fly larvae then emerge from the neck of the bee .

== Genetically modified crops ==

In 2008 a meta analysis of 25 independent studies assessing effects of Bt Cry proteins on honeybee survival (mortality) showed that Bt proteins used in commercialized GE crops to control lepidopteran and coleopteran pests do not negatively impact the survival of honeybee larvae or adults . Additionally , larvae consume only a small percent of their protein from pollen , and there is also a lack of geographic correlation between GM crop locations and regions where CCD occurs .

== Management ==

As of 1 March 2007 , the Mid Atlantic Apiculture Research and Extension Consortium (MAAREC) offered the following tentative recommendations for beekeepers noticing the symptoms of CCD :

Do not combine collapsing colonies with strong colonies .

When a collapsed colony is found , store the equipment where you can use preventive measures to

ensure that bees will not have access to it .

If you feed your bees sugar syrup , use Fumagillin .

If you are experiencing colony collapse and see a secondary infection , such as European Foulbrood , treat the colonies with oxytetracycline , not tylosin .

Another proposed remedy for farmers of pollinated crops is simply to switch from using beekeepers to the use of native bees , such as bumble bees and mason bees . Native bees can be helped to establish themselves by providing suitable nesting locations and some additional crops the bees could use to feed from (e.g. when the pollination season of the commercial crops on the farm has ended) .

A British beekeeper successfully developed a strain of bees that are resistant to varroa mites . Russian honey bees also resist infestations of varroa mites but are still susceptible to other factors associated with colony collapse disorder , and have detrimental traits that limit their relevance in commercial apiculture .

In the United Kingdom , a national bee database was set up in March 2009 to monitor colony collapse as a result of a 15 % reduction in the bee population that had taken place over the previous two years . In particular , the register , funded by the Department for Environment , Food and Rural Affairs and administered by the National Bee Unit , will be used to monitor health trends and help establish whether the honey industry is under threat from supposed colony collapse disorder . Britain 's 20 @, @ 000 beekeepers have been invited to participate . In October 2010 , David Aston of the British Beekeepers ? Association stated , " We still do not believe CCD is a cause of colony losses in the UK , however we are continuing to experience colony losses , many if not most of which can be explained . The approach being taken in UK beekeeping is to raise the profile of integrated bee health management , in other words identifying and trying to eliminate factors which reduce the health status of a colony . This incorporates increasing the skill level of beekeepers through training and education , raising the profile of habitat destruction and its effect of forage (nectar and pollen) availability , and of course research on the incidence and distribution of diseases and conditions in the UK together with more applied research and development on providing solutions . "

= = Economic and ecological impact = =

Honey bees are not native to the Americas , therefore their necessity as pollinators in the U.S. and other regions in the Western Hemisphere is limited to strictly agricultural / ornamental uses , as no native plants require honey bee pollination , except where concentrated in monoculture situations ? where the pollination need is so great at bloom time that pollinators must be concentrated beyond the capacity of native bees (with current technology) .

The phenomenon is particularly important for crops such as almond growing in California , where honey bees are the predominant pollinator and the crop value in 2011 was \$ 3 @. @ 6 billion . In 2000 , the total U.S. crop value that was wholly dependent on honey bee pollination was estimated to exceed \$ 15 billion . Because of such high demand in pollinators , the cost of renting honey bees has increased significantly , and California 's almond industry rents approximately 1 @. @ 6 million honey bee colonies during the spring to pollinate their crop . Worldwide , honeybees yield roughly \$ 200 billion in pollination services .

They are responsible for pollination of approximately one third of the United States ' crop species , including such species as almonds , peaches , apples , pears , cherries , raspberries , blackberries , cranberries , watermelons , cantaloupes , cucumbers , and strawberries . Many , but not all , of these plants can be (and often are) pollinated by other insects in the U.S. , including other kinds of bees (e.g. , squash bees on cucurbits) , but typically not on a commercial scale . While some farmers of a few kinds of native crops do bring in honey bees to help pollinate , none specifically need them , and when honey bees are absent from a region , there is a presumption that native pollinators may reclaim the niche , typically being better adapted to serve those plants (assuming that the plants normally occur in that specific area) .

However , even though on a per @- @ individual basis , many other species are actually more

efficient at pollinating , on the 30 % of crop types where honey bees are used , most native pollinators cannot be mass @-@ utilized as easily or as effectively as honey bees ? in many instances they will not visit the plants at all . Beehives can be moved from crop to crop as needed , and the bees will visit many plants in large numbers , compensating via saturation pollination for what they lack in efficiency . The commercial viability of these crops is therefore strongly tied to the beekeeping industry . In China , hand pollination of apple orchards is labor @-@ intensive , time consuming , and costly .

In regions of the Old World where they are indigenous , honeybees (*Apis mellifera*) are among the most important pollinators , vital to sustain natural habitats there in addition to their value for human societies (to sustain food resources) . Where honeybee populations decline , there is also a decline in plant populations . In agriculture , some plants are completely dependent on honeybees to pollinate them to produce fruit , while other plants are only dependent on honeybees to enhance their capacity to produce better and healthier fruits . Honeybees also help plants to reduce time between flowering and fruit set , which reduces risk from harmful factors such as pests , diseases , chemicals , weather , etc . Specialist plants that require honeybees will be at more risk if honeybees decline , whereas generalist plants that use other animals as pollinators (or wind pollinating or self @-@ pollinating) will suffer less because they have other sources of pollination .

With that said , honeybees perform some level of pollination of nearly 75 % of all plant species directly used for human food worldwide . Catastrophic loss of honeybees could have significant impact , therefore ; it is estimated that seven out of the 60 major agricultural crops in North American economy would be lost , and this is only for one region of the world . Farms that have intensive systems (high density of crops) will be impacted the most compared to non @-@ intensive systems (small local gardens that depend on wild bees) because of dependence on honeybees . These types of farms have a high demand for honeybee pollination services , which in the U.S. alone costs \$ 1 @. @ 25 billion annually . This cost is offset , however , as honeybees as pollinators generate 22 @. @ 8 to 57 billion Euros globally .

= = Media = =

Silence of the Bees (October 2007) is a part of the Nature television series and covers several recent investigative discoveries .

The 2009 documentary Vanishing of the Bees pointed to neonicotinoid pesticides as being the most likely culprit , though the experts interviewed concede that no firm data yet exists .

The 2010 feature @-@ length documentary Queen of the Sun : What are the bees telling us ? features interviews with beekeepers , scientists , farmers , and philosophers .

The 2012 documentary , Nicotine Bees , argues that neonicotinoid pesticides are principally responsible for Colony Collapse Disorder .

More than Honey , a 2012 documentary , examines the relationship between humans and bees and explores the possible causes of CCD .