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Insecticides, Honey Bee Losses and Beekeeper Advocacy in Nineteenth-Century Ontario

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See table of contents

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Article abstract

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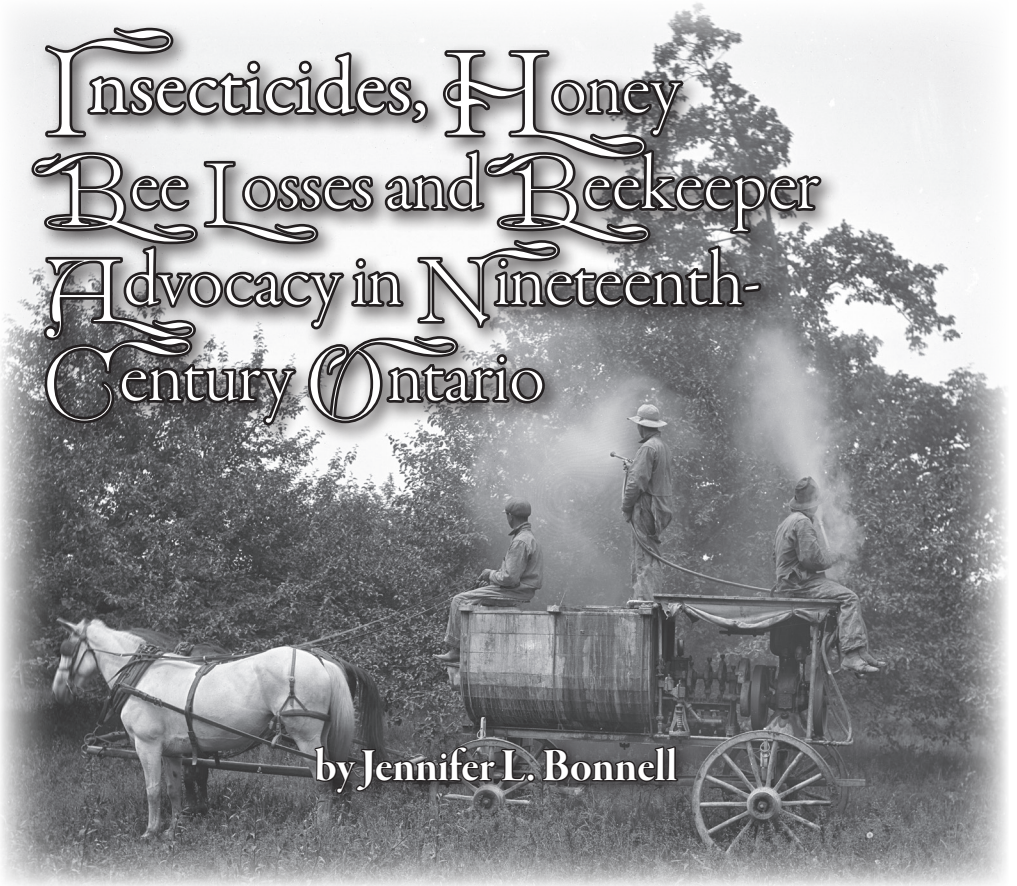

Insecticides, Honey Bee Losses and Beekeeper Advocacy in Nineteenth-Century Ontario

by Jennifer L. Bonnell

In 2007, thirty billion honey bees—one quarter of the population in the northern hemisphere—disappeared from hives in North America and Europe. The losses signalled what has come to be called "colony collapse disorder" or CCD, a condition that scientists have attributed not to one single cause, but rather to the interaction of diverse threats to honey bee health. Access to adequate sources of nutrition is one concern: as monoculture cropping has come to dominate modern agricultural landscapes, the ability of honey bees to obtain pollen and nectar from a range of plant sources has been circumscribed. Pests and pathogens, and their combined effects in reducing honey bee resilience, have also been implicated as a potential cause of CCD. By far the most damning evidence, however, comes from a recent series of studies that have shown that neo-nicotinoid insecticides, used widely on corn and other crops in the US and Canada, are harmful to honey bees and other pollinators.[1] These concerns about

[1] Francisco Sanchez-Bayo and Koichi Goka, "Pesticide Residues and Bees—A Risk Assessment."

Abstract

This article examines the debates that surrounded honey bee poisoning in the southern Ontario in the 1890s and early 1900s. It follows the efforts of beekeepers and supportive entomologists to press for toxicity studies, negotiate with neighbouring farmers, and advocate for legislative and educational remedies. Debates over such poisonings reveal the strained relationship between beekeepers and fruit growers in this period, and highlight the inconsistency of grower knowledge about the value of honey bees to their crops. Efforts to understand the poisoning problem and to protect honey bees from harm resulted in scientific studies that not only established the toxicity of early insecticides to honey bees, but also resulted in greater understanding of the role of honey bees in pollination. Finally, these debates illuminate the role of beekeepers as early advocates for environmental protection.

Résumé: *Dans cet article, nous examinerons les débats portant sur l'empoisonnement des abeilles mellifères dans le sud de l'Ontario dans les années 1890 et au début des années 1900. Nous suivrons les efforts des apiculteurs et des entomologistes à faire des études de toxicité, négocier avec les agriculteurs voisins, et plaider pour des remèdes législatifs et éducatifs. Les débats à propos de ces mesures révèlent la relation tendue entre apiculteurs et producteurs de fruits à cette période, et mettent en évidence l'incohérence des connaissances des producteurs sur la valeur des abeilles pour leurs cultures fruitières. Les efforts visant à comprendre le problème de l'empoisonnement et à protéger les abeilles ont abouti à des études scientifiques qui ont non seulement établi la toxicité des premiers insecticides pour les abeilles mellifères, mais ont également contribué à une meilleure compréhension de leur rôle dans la pollinisation. Enfin, ces débats mettent en lumière le rôle des apiculteurs en tant que premiers champions de la protection de l'environnement.*

exposure to toxins and disease pathogens have long preoccupied beekeepers. Indeed, contemporary debates about insecticides and their risks to honey bee health have a surprisingly long history.

This paper examines the debates that surrounded incidents of honey bee poisoning in the southern Ontario in the 1890s and early 1900s. It follows the efforts of beekeepers and supportive entomologists to press for toxicity studies, negotiate with neighbouring farmers, and advocate for legislative and educational remedies. Debates over honey bee poisonings reveal the strained relationship between beekeepers and fruit growers in particular in this period, and highlight the inconsistency of grower knowledge about the value of honey bees to their crops. Efforts to understand the poisoning problem and to protect honey bees from harm resulted in scientific studies that not only established the toxicity of early insecticides to honey bees, but also

PLOS ONE 9:4 (9 April 2014): e94482; Andrea Tapparo et al., "Assessment of the Environmental Exposure of Honeybees to Particulate Matter Containing Neonicotinoid Insecticides Coming from Corn Coated Seeds." *Environmental Science & Technology* (17 February 2012), 2592-99. While honey bees do not always die immediately upon exposure to neo-nicitinoid insecticides (NNIs), scientists are in general agreement that NNI exposure reduces honey bee resilience and survival over the longer term.

resulted in greater understanding of the role of honey bees in pollination. Finally, these debates illuminate the role of beekeepers as early advocates for environmental protection. Deeply familiar with the seasonal weather and floral cycles of the locations in which they worked, and with the amenities and threats of surrounding land uses for their honey crop, nineteenth-century-Ontario beekeepers pressed for prudent insecticide use and "bee-friendly" horticultural practice more than half a century before the more familiar insecticide controversies of the post-war period.

By the 1880s, southern Ontario constituted what can be considered the heartland of early Canadian beekeeping. Favorable climate, expanding transportation networks, and established agricultural landscapes in turn provided excellent conditions for honey production and distribution. Along the shores of Lake Ontario and Lake Erie especially, the buffering effect of Great Lakes water temperatures on surrounding air masses extended growing seasons and supported the development of specialized "fruit belts" that in turn provided excellent sources of pollen and nectar for honey bees. If the western provinces came to dominate the industry after the 1920s, it was southern Ontario that kept the majority of honey bees and produced the bulk of Canadian honey until that time.[2]

Specialization in honey bee science followed success in apiculture, with the establishment of instruction and research in apiculture at the Ontario Agricultural College (OAC) in the 1870s. The Ontario Beekeepers' Association (OBA), one of the oldest agricultural associations in the province, formed in 1880 to represent the interests of the province's regional beekeeping associations.[3] But the development of apiculture in Ontario was never confined to provincial or national borders. Prominent Ontario beekeeper D.A. Jones (of Clarksville, renamed Beeton in his honour in 1875) made a name for himself importing pure breeding stock from Europe and the Middle East and distributed them throughout North America.[4] Furthermore, OBA executives and entomologists based at the OAC and the Central Experimental Farm in Ottawa communicated regularly with their counterparts south of the border.

[2] Townsend, Gordon F., and Henry Theo T. Hiemstra, *History of Beekeeping in Ontario* (Milton, ON: Ontario Beekeepers' Association [hereafter OBA], 2006), 85. The 1891 Canadian Agricultural Census listed 146,341 hives of bees in Ontario, constituting 73% of the bees kept in Canada (Census of Agriculture—Historical, 1871-1911, Queen's University Library, Kingston, ON, https://library.queensu.ca/data/hist-agri-census/). See also M.B. Holmes, "Progress of Beekeeping in Canada," *American Bee Journal* [hereafter *ABJ*] 37:51 (23 December 1897), 802.

[3] In 1891, the OBA comprised eight affiliated societies with a total membership of 180 (OBA, *Annual Report*, 1891).

[4] Jones' efforts to import new breeding stock and his work to establish breeding colonies in southern Ontario in the early 1880s were especially significant given the fact that honey bees are not native to North America. Until Jones and others made breeding stock more available, many beekeepers had replenished their stocks by capturing feral honey bees ("Jones, David Allanson," Dictionary of Canadian Biography, Vol. XIII (1901-1910), <http://www.biographi.ca/en/bio/jones_david_allanson_13E.html>).

F.A. Gemmell Apiary, Stratford, Ontario, c.1893. Note the hives in the background are named, rather than numbered, after prominent beekeepers in the United States and Canada. Source: Gleanings in Bee Culture *vol.21, no.6 (1893): p.217.*

They published columns and convention reports in international apiculture periodicals and hosted continental events, such as the North American Bee-keepers' Convention, held in Toronto in 1895. Beekeepers across southern Ontario also participated in these international forums, subscribing to American beekeeping periodicals and attending regional and international beekeeper association meetings. Ontario beekeepers were well represented at the World's Columbia Exposition in Chicago in 1893, taking away seventeen apiculture awards, "more than twice as many as that taken by any State in the Union, or any other foreign country."[5]

In navigating the novel concerns surrounding insecticide poisoning in the 1890s, Ontario beekeepers drew upon these regional and cross-border networks of knowledge and communication. Incidents of honey bee poisoning generated significant correspondence, as beekeepers, entomologists, and horticultural experts based at agricultural colleges and government experimental stations on both sides of the border contributed to the evolving understanding of the relationship between honey bees, fruit production, and insecticide use.

Poisoning incidents also exposed the interdependent but often troubled relationship between fruit growers and

[5] M.B. Holmes, "Progress of Beekeeping in Canada," *ABJ* 37:51 (23 December 1897), 802.

beekeepers. While we take for granted the symbiotic nature of these industries today, in the late nineteenth century fruit growers did not always understand the role of honey bees in fruit pollination, and they sometimes characterized honey bees as enemies, rather than aids, to fruit production. Because of this, growers were often cavalier about the impact of spraying on honey bees. In more extreme cases, animosity toward bees and beekeepers led to complaints of nuisance and even trespass by a neighbour's bees, complaints that occasionally resulted in lawsuits. This paper draws upon the detailed records of the OBA and from widely-read bee-keeping periodicals such as the weekly *American Bee Journal* (the *ABJ*, distributed in the United States and in Canada) and the monthly *Gleanings in Bee Culture* to document the efforts of beekeepers to defend their livelihoods and protect their interests during a period of rapid agricultural expansion and corresponding environmental change.

Early Poisonings

Beekeepers began publicizing reports of honey bee die-offs as a result of insecticide poisoning in the late 1880s. One of the earliest reported incidents was related by beekeeper John G. Smith of New Canton, Illinois in the May 25, 1889 issue of the *American Bee Journal* (*ABJ*). The apple bloom that year, he reported, proved a "'death-warrant' to millions of bees in [his] immediate neighbourhood" when the owner of a neighbouring orchard sprayed his trees with a solution of Paris green when the trees were in full bloom.[6] Smith conducted a tour of neighbouring apiaries and found that "all the bees within the radius of 3 miles [of the sprayed orchard]... were affected, though the ones nearest suffered the worst."[7] Smith, whose own apiary lay 1.5 miles south-west of the one-hundred-acre orchard, lost sixty of his own honey bee colonies, and by his estimate "ten or twelve bee-keepers... [were] totally ruined, as far as getting a spring crop of honey [was] concerned."[8]

No mention is made of insecticide die-offs in Ontario until 1891, when OBA apiary inspector William McEvoy reported that "on [his] rounds through the province inspecting bee yards, [he] heard many complaints that bees were being killed wholesale on account of trees being sprayed while in bloom." The

[6] John Smith, "Ruined by Paris Green," 15 May 1889. *ABJ* vol 25:21 (25 May 1889), 331. <http://bees.library.cornell.edu/b/bees/browse/title/6366245.html>, accessed 18 June 2018. Losses were especially pronounced in Michigan and Illinois, where "the value and safety of spraying were first demonstrated, and hence where spraying has been most general" (A.J. Cook, "Spraying Fruit-Trees While in Bloom," printed in OBA *Annual Report*, 1891, and later published in *Gleanings in Bee Culture*, 1 May 1892).

[7] John G. Smith, "Poisoned Bees—Here is the Proof," *ABJ* vol. 29:7 (11 February 1892), 223-24.

[8] At the peak of the season, each colony would comprise 20,000 to 80,000 bees. In the 1890s, each colony yielded an average of fifty pounds of marketable honey annually (valued at 10 cents per pound, about five Canadian dollars in 1890s currency). Allen Pringle, "Bee Culture in Ontario," OBA President's Address to the Central Farmers' Institute 1891 annual meeting, Toronto (reprinted in the OBA *Annual Report, 1891* [Toronto: Warwick & Sons, 1892]); *ABJ* vol 25:21 (25 May 1889), 331; *ABJ* vol. 27:16 (16 April 1891), 505.

practice, he continued, had the result of "wiping out bee yards alongside... orchards."[9] As Ontario beekeepers began to discuss their concerns, they looked to the experience of fellow producers in the United States. The Smith account was relayed at the January 1892 annual meeting of the OBA and reprinted in subsequent editions of the *ABJ* in 1891 and 1892, as incidents of honey bee poisoning began to accumulate across the region.

The compound used most frequently in Canada and the US at this time was Paris Green (cupric aceto-arsenite), a highly toxic copper-arsenite used as both an insecticide and a rodenticide (most famously in the sewers of Paris). Growers used the poison to reduce damage caused to fruit by insects such as codling moths, plum curculio, canker worms and caterpillars. By 1889, when the *ABJ* first recorded the problem of insecticide poisoning, American orchardists had been experimenting with arsenical poisons for about twenty years.[10] Insecticide use, however, was not yet widespread, especially among Ontario growers. "If we could only get our farmers to spray more," Dominion entomologist and botanist James Fletcher told OBA members at their 1891 annual meeting, "we would have better fruit crops. Spraying has really only been introduced here for two or three years, but more of it is done this year than before."[11] As George Cook argues, the outlay of time and labour and the inefficiency of horse- and hand-powered spray pumps, in addition to a general wariness of poisons, inhibited the early adoption of insecticides among Ontario growers.[12]

For those growers who did experiment with arsenate insecticides, the positive effects of spraying upon their crop yields were indisputable. P.C. Dempsey of Trenton, Ontario, told a provincial hearing on the spraying problem in 1891:

> I have been spraying ever since I knew anything about it. We have sprayed for different objects for the last 30 years, but with Paris green only for the last 5 or 6 years. Before that we could scarcely keep a perfect specimen of an apple.... Since I have sprayed we would not find in 50 barrels of apples one barrel of bad ones, whereas before spraying was introduced it would've been difficult to get that number of really good ones out of the same number

[9] "Spraying of Fruit Trees," OBA, *Annual Report, 1891*.

[10] James Whorton, *Before Silent Spring: Pesticides and Public Health in Pre-DDT America* (Princeton, N.J.: Princeton University Press, 1974), 20.

[11] OBA, *Annual Report, 1891*, p. 36. Lawson Caesar identifies Ontario's first use of Paris Green for orchard insects in 1878 in his "History of Orchard Spraying in Ontario," Ontario Department of Agriculture Bulletin 462 (Toronto: Statistics and Publications Branch, 1948).

[12] George Cook, "Spray, Spray, Spray! Insecticides and the Making of Applied Entomology in Canada, 1871-1914," *Scientia Canadensis* 22:51 (January 1998), 25. The experience of San José scale infestations of orchard crops in 1897, and the introduction of gasoline-powered pumps in 1904, Cook argues, contributed to the rapid rise of insecticide use among Ontario growers in the first decade of the twentieth century. Cook cites former provincial entomologist Lawson Caesar's estimate that no more than one quarter of Ontario orchardists sprayed their crops before 1904 (Lawson Caesar, "History of Orchard Spraying in Ontario," Bulletin 462, Ontario Department of Agriculture, 1948, p. 10).

Spraying fruit trees with horse-powered spray jig near Ayr in southwestern Ontario, c.1910. Source: Robinson Studio Photographs Fonds F4592-7, H-1015, Archives of Ontario.

> of barrels. I attribute the change altogether to spraying in the proper season.[13]

Agricultural periodicals such as the *Canadian Horticulturalist* and the *Farmer's Advocate* helped to disseminate these successes, advocating the spraying of berry vines and fruit trees, and running ads for spraying equipment.

While rising insecticide use in this period reflected growing market pressures to produce unblemished fruit, farmers also faced a very real and growing insect problem. As former *Canadian Bee Journal* editor R.F. Holtermann wrote in 1900, "while rapid transit and the interchange of products between different countries has its advantage, there is no doubt that insect pests, disease, etc., have also thru [sic] it been spread." James Whorton confirmed these observations in his description of the 1880s as an "insect emergency" for farmers in neighbouring states. Land disturbance, monoculture cropping, and an ever-expanding transportation system created highly favorable conditions for insect outbreaks to the extent that "farmers throughout the second half of the nineteenth century

[13] OBA, *Annual Report, 1891*, p. 31.

found themselves besieged" by a range of specialized insect adversaries.[14] For orchardists in particular, high investments in tender fruit crops produced correspondingly high incentive to spray.

By far the most vocal and persuasive advocates for insecticide spraying, however, was a nascent group of professional entomologists employed by the Ontario Agricultural College (OAC) in Guelph and the Central Experimental Farm (CEF) in Ottawa. Dominion entomologist and botanist James Fletcher, stationed at the CEF from 1887 until his death in 1908, worked with CEF horticulturalist John Craig to demonstrate the value and method of spraying to sometimes skeptical farmers. In his extension work with fruit growers in the early years of the poisoning debates, Fletcher advocated unbridled spraying and downplayed the threat to honey bees. His entreaties to growers to spray more relied heavily upon the scientific and technical knowledge of colleagues in the United States.[15] Fletcher's addresses to the OBA and the Ontario Fruit-Growers' Association in this period, for example, cited endorsements by New York State Entomologist J.A. Lintner, who stressed the necessity of spraying and pointed to the absence of "conclusive proof... that spraying kills bees," and by Michigan Agricultural College entomologist A.J. Cook, who urged greater use of arsenical insecticides to reduce damage and waste in fruit production and to generate larger quantities of high quality fruit crops for market.[16] Beekeepers saw the effects of these endorsements in the growing adoption of spraying by southern Ontario farmers through the 1890s and early 1900s. As Fletcher enthused in an address to the Royal Society of Canada in 1895, "[D]uring the present spring there [has been] an enormous increase in the number of fruit-growers and farmers who are adopting this useful method of protecting their crops from injury."[17]

Toxicity and Timing

As honey bee losses to poison sprays increased in the early 1890s, Ontario beekeepers grew increasingly alarmed. At the January 1892 Annual Meeting of the OBA, outgoing president Allen Pringle chaired a discussion of the spraying problem. "I think there is no doubt that bees are poisoned by the spraying of trees in bloom," he began, referencing agreement on the question by Professor J. Hoyes Panton of the Ontario Agricultural College (OAC) and Professor

[14] R.F. Holtermann, "Spraying Fruit-Trees—The Ontario Law." *ABJ* 40:18 (3 May 1900), 277; Whorton, *Before Silent Spring*, 5-6.

[15] George Cook, "Spray, Spray, Spray!," 10, 17.

[16] Cited in *ABJ* 27:19 (7 May 1891), 615; "Spraying of Fruit Trees," *ABJ* 29:2 (8 January 1892), 39. On early conflicts between beekeepers and members of the emerging field of economic entomology, see OBA member William McEvoy's column in the *ABJ* (vol. 34, no.8 [23 August 1894], 240-41). See also Paolo Palladino, *Entomology, Ecology and Agriculture: The Making of Scientific Careers in North America, 1885-1985* (London and New York: Routledge, 1996).

[17] Fletcher, "Presidential Address: Practical Entomology," *Transactions of the Royal Society of Canada*, 1895, Section IV, pp. 3-4, 8-9, cited in George Cook, "Spray, Spray, Spray!," 24.

A.J. Cook of the Agricultural College in Michigan. Cook, an entomologist credited with developing the spraying system for fruit trees, and an authority on beekeeping,[18] penned an influential essay on honey bee protection in spraying operations in 1892. In it he stressed the unlikelihood of otherwise strong colonies of honey bees dying in large numbers at the time of the spring bloom: "every well-informed experienced beekeeper... knows that such mortality at such time was previously unknown. In every case, large orchards in the immediate vicinity had been sprayed with the arsenites while the trees were in bloom."[19] Panton and Cook agreed that the problem lay within the timing of the spray. Honey bees visited fruit-tree orchards to forage for nectar and pollen only when the trees were in bloom. Their exposure to risk was limited to a brief, two-week window when the blossoms still clung to the branches, before the fruit began to form. Cook proposed a simple solution: refrain from spraying while the trees were in bloom.

Even Dominion entomologist James Fletcher, a tireless advocate for insecticide use among Ontario farmers, came to urge caution in the timing of spray applications. Mid-bloom spraying was not only harmful to bees, he argued in an 1894 address to the OBA, but also next to useless in targeting insect pests, most of which attacked the forming fruit after the blossoms had fallen. Furthermore, it posed a risk to the trees themselves, corroding blossom pistils and "destroying [their] fertilizing power."[20]

In the wake of these findings about the significance of the timing of the spray, Ontario became the first jurisdiction in North America to pass protective spraying legislation.[21] In early 1892, Fletcher facilitated meetings between a delegation from the OBA and senior staff at the Ontario Ministry of Agriculture. Their efforts resulted in the passage of *An Act for the Further Protection of Bees in April of that year*. The Act stipulated that fruit trees could be sprayed only *after* the bloom had fallen, thereby protecting bees from harm.[22] The

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[18] *ABJ* 27:19 (7 May 1891), 615. Cook developed best practices for spraying arsenical pesticides on fruit trees in a series of reports for the US Department of Agriculture in the 1880s. Cook published the first edition of his *Manual of the Apiary* in 1876 and reprinted it annually to meet high demand until 1883, when he expanded and reprinted the work as *The Bee-Keepers' Guide; or Manual of the Apiary* (9th ed., revised and enlarged, Lansing, 1883).

[19] A.J. Cook, "Spraying Fruit-Trees While in Bloom," *Gleanings in Bee Culture* (1 May 1892), 322

[20] OBA, *Annual Report*, *1894*, p. 13.

[21] Gordon F. Townsend and Henry T.T. Hiemstra, *History of Beekeeping in Ontario* (Milton, ON: Ontario Beekeepers' Association, 2006), p. 118.

[22] Legislative Assembly of Ontario, *An Act for the Further Protection of Bees*, April 8, 1892. The *Act* came into force in January 1893, with the following provisions: "1. No person in spraying or sprinkling fruit trees during the period within which such trees are in full bloom shall use or cause to be used any mixture containing Paris green or any other poisonous substance *injurious to bees*. 2. Any person contravening the provisions of this act: fine of not less than $1 or more than $5, or max term of 30 days in common gaol if fines not paid" (OBA, *Annual Report, 1891*, p. 29; Townsend and Hiemstra, *History of Beekeeping in Ontario*, p. 118).

Ontario legislation spurred similar attempts south of the border. In 1893, the North American Bee-Keepers' Association pushed for state spraying legislation among its member states.[23] In the end, several US states passed legislation similar to Ontario's, including Michigan and Vermont (1896), Colorado (1897), New York and Washington State (1898). Others, including Ohio, Illinois, and California, had spraying bills rejected in response to counter-lobbying by fruit-growing interests.[24]

The discussions that took place around the securing of legislation in Ontario are especially interesting for the light they shed on the relationship between growers and beekeepers in this period. Evidence taken before the Special Committee of the House which reported upon the Bill included testimony from both beekeepers and fruit growers on the scope of the problem, the effectiveness of the proposed legislative remedy, and, for growers, the potential burdens that the Act would place upon them. Most growers who testified assented to the provisions of the Act, noting that they only ever sprayed before and after the bloom. The few growers who argued against the legislation pointed to the infringements the Act would place their ability to cultivate their crops based on their own judgment and experience. Legislation, some growers argued, would inhibit their ability to generate economies of scale: "Suppose my orchard is composed of various kinds of apples, some of which blossomed very late," a grower from Beamsville argued. "I would have to wait until every individual tree was ready before I could spray. That would be very inconvenient and expensive...."[25] Grower resistance to spray legislation presents an early example of what became more widespread skepticism among rural producers towards the prescriptions of expert authorities in this period.[26]

As doubts persisted among orchardists reluctant to circumscribe their activities and scientists enamoured with the results of insecticide use, the OBA executive, OAC and Dominion entomologists sought to establish with certainty the toxicity of Paris Green and other arsenical insecticides to honey bees. Incidents of poisoning also raised ancillary questions for beekeepers: Was it only the adult worker bees who were poisoned? How long did it take the bees to die? Could the poison be transmitted to the bee brood? Could it contaminate honey supplies? Answers to these questions would rely upon communication with honey bee experts at experimental stations south of the border. Fletcher at the Central Experimental Farm in Ottawa and A.J. Cook at the Agricultural

[23] *ABJ* 31:4 (26 Jan 1893), 113-14; *ABJ* 31:8 (23 Feb 1893), 241.

[24] *ABJ* 27:25 (18 June 1891), 791; *ABJ* 38:21 (May 1898), 326; *ABJ* 40:22 (31 May 1900), 347.

[25] Mr. Kew, Beamsville, Ontario. OBA, *Annual Report*, *1891*, p. 34.

[26] On the subject of grower resistance to expert authorities, see for example Steven Stoll, *The Fruits of Natural Advantage: Making the Industrial Countryside in California* (Berkeley: University of California Press, 1998), pp. 146-47.

College in Michigan had each conducted informal studies which confirmed that Paris Green, the most widely used of the arsenate insecticides, was toxic to honey bees. Honey bees died approximately twenty-four hours after poisoning, Cook found in an 1892 study, long enough "to carry the poisonous liquid to the hives and store it there," thereby poisoning the brood (young bees) as well.[27] More exacting studies were required, however, to convince the influential American Association of Economic Entomologists (AAEE). In 1894, F.M. Webster of the Ohio Agricultural Experiment Station provided conclusive proof. While Cook and Fletcher's earlier studies demonstrated honey bee mortality by netting bees within tree canopies sprayed with Paris Green, Webster examined the bodies of dead bees submitted for analysis and found "unmistakable traces of the poison" in their abdomens.[28] Fletcher presented Webster's results to a vindicated group of beekeepers at the OBA annual meeting in Stratford in January 1895, putting an end to doubts about honey bee sensitivity to Paris Green.[29]

Toxicity concerns also extended to humans. As OBA member William McEvoy wagered darkly in 1891, honey bee poisoning is a serious matter, "but it is more serious when the honey made from... [contaminated bee] yards is placed on the table, and a job possibly given to the undertaker."[30] In January 1892 OBA President F.A. Gemmell referenced an 1888 study by A.J. Cook that had found no trace of copper arsenite in honey from exposed colonies. "Bees... [produce] so little honey from the fruit-bloom," Cook later explained, "that it is rarely stored for sale, and only used by the bees." There is likely not enough poison in blossom nectar, he added, "to do us any perceptible harm; yet I think all of us would prefer our honey with the Paris green left out."[31] Quantity mattered, but so did timing: fruit trees in southern Ontario are typically sprayed in May, when bees are feeding most of the honey they produce to their brood, rather than storing it for future use (or consumption by people). This explained why honey bee brood routinely died when adult bees were exposed to arsenites, but honey drawn later in the season for human use showed no trace of poison. Fletcher added to these doubts about honey contamination, reasoning that "the bees will almost always die before depositing their load [at the hive]."[32] By 1900, concerns that had emerged

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[27] Cook, "Spraying Fruit-Trees While in Bloom," *ABJ* 35:6 (7 Feb 1895), 89; OBA, *Annual Report, 1895*, p. 18.

[28] F. Greiner. "Bees, and Spraying Fruit-Bloom with Arsenites," *Gleanings in Bee Culture, reprinted in ABJ* 40:27 (5 July 1900), 418-19; Whorton, *Before Silent Spring*, 28.

[29] OBA *Annual Report*, 1894, p. 13; *ABJ* 36:25 (8 June 1896), 389.

[30] OBA, Annual Report, 1891, 30.

[31] Professor A.J. Cook, "Spraying Fruit Trees--Expert Opinion," *ABJ* 39: 36 (September 7, 1899), 565.

[31] OBA *Annual Report*, 1891.

[32] For a description of concerns surrounding arsenical residues on American apple exports, see Whorton, *Before Silent Spring*, 34.

about arsenic contamination of honey (and fruit)[33] had been largely dismissed in North America, leaving beekeepers among the only dissenting voices.

Educating Growers

The Ontario legislation and the debates it prompted exposed the inconsistency and variability of grower knowledge about the role of honey bee in pollinating their crops. As James Whorton notes in his work on pre-World War II insecticide use, the role of bees in fruit pollination was not widely appreciated until the last quarter of the nineteenth century, and before that time, bees were often viewed more as an enemy than an aid.[34] A small but vocal group of growers across the province held to these older assumptions. Some feared that their buckwheat yield would be reduced after bees had "sucked the flowers." OBA President Allen Pringle addressed these concerns in a presentation to the Central Farmers' Institute in 1891, explaining that honey bee pollination would produce for the farmer "more grain, not less."[35] Others argued that bees damaged their fruit by piercing its skin and drinking the juice. Theodore Woodruff, a grower from Niagara Falls, Ontario, testified at the 1891 provincial hearing on spraying legislation that the bees "rob my orchard every year. I know it by experience.... They sting [the fruit] and eat them. I have known them to eat a peach nearly up." Fletcher, who was present at the hearing, disputed Woodruff's claims, citing an 1885 study published by the US Department of Agriculture which proved that bees "did not puncture sound fruit" but only "drank [the] juice of injured fruit."[36] Woodruff's complaints were, like many borne by beekeepers, a case of mistaken identity: it was the malicious wasp, and not the industrious bee, that was to blame for damages to ripening fruit.

However bizarre these debates might seem to us now, in the late nineteenth century tensions between fruit growers and beekeepers sometimes had to be settled by the courts. Nuisance cases against neighbouring beekeepers were most common. In *Queen v. Sparling*, an Ontario court ruled in favour of the beekeeper when a neighbouring grower claimed that his bees were creating a public nuisance by stinging fruit pickers and bothering horses. The case was one of several brought against beekeepers in southern Ontario in this period. It was won on a legal technicality, however, and not on the merits of the beekeeper's case.[37] Firm-

[34] Whorton, *Before Silent Spring: Pesticides and Public Health in Pre-DDT America*, 27.

[35] Allen Pringle, "Bee Culture in Ontario," Address to the Central Farmers' Institute Annual Meeting, Toronto, ON, printed in OBA, *Annual Report, 1891*.

[36] Honey bee mandibles, the study found, are not capable of biting through the skin of a sound and solid grape; this is instead the work of wasps, birds, and over-ripeness (OBA, *Annual Report*, 1891; Henry K. Staley, "Forestry and Apiculture," *ABJ* 28:25 (17 December 1891), 780-2; Fletcher, "The Value of Bees in Fruit Orchards," OBA *Annual Report*, 1900, pp. 56-63).

[37] *Queen v. Sparling*, United Counties of Northumberland and Durham, Ontario, 1900, RG 22-392-0-4474, MS 8489, Criminal Assize Clerk criminal indictment files, Archives of Ontario; OBA, *Annual*

er support for beekeeper interests came from a case in New York state the previous year, reported upon by OBA delegates to the North American Bee Keepers' Association meetings. In *Utter vs. Utter,* the plaintiff, a fruit grower, alleged that his neighbouring brother's bees had punctured his peaches and drained their juices, destroying the fruit and causing the branches of his trees to wither and die due to the acidity in the dripping juice. USDA entomologist Prof. Frank Benton was one of the expert witnesses for the defense. Bees, he argued, "in no case are the first cause of fruit being injured, as it is not possible for a bee to puncture the skin of even so tender a thing as a ripe peach." He blamed the withering of fruit and trees instead on a bacterial disease of peach trees known as "the yellows."[38] The jury ruled in favour of the defendant, giving beekeepers authoritative backing to their claims that honey bees were necessary assistants, rather than pests, of the orchard.

Within this context of widespread uncertainty and occasional animosity towards honey bees and their keepers, the OBA and their American counterparts sought scientific evidence to demonstrate the value of honey bees to the orchard and their role in enhancing crops and profits for fruit-growers. A series of pollination studies conducted by supportive entomologists in the 1890s proved especially effective in convincing growers. These studies proved, first, that pollinated trees bear more fruit. A.J. Cook conducted the first of these experiments at Michigan Agricultural College in 1891, covering a number of blossoming fruit trees with cheesecloth to prevent honey bee pollination and comparing their fruit yield with uncovered trees. Cook's experiments were refined and repeated by other experiment stations with similar results: trees in full bud exposed to honey bee pollination produced exponentially more fruit than unexposed trees.[39] Second, they showed that for most orchard fruits, "the common honey-bee is the most regular, important and abundant visitor, and probably does more good than any other species."[40] Fletcher elaborated on the significance of these findings in an address to the OBA in 1900:

> owing to its size, weight and habits, no insect is so well calculated to ensure the fertiliza-

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Report, 1900, pp. 6-8, 56-7. The judge ruled that the plaintiff failed to establish the bees as a "common" nuisance to the community at large. Private nuisances were a matter for damage claims in the civil court, and not the criminal assize court (OBA, *Annual Report*, 1900, p. 8).

[38] "May Outlaw the Bees." *The New York Times*, September 3, 1900; "Bees vs. Fruit." *Butler County Democrat*. January 17, 1901; A. I. Root and E. R. Root, *The ABC and Xyz of Bee Culture*, 40th edition (Medina, OH: A. I. Root Co., 1990 [first edition published 1877]), <https://archive.org/stream/Encyclopedia_Of_Bee_Culture/Encyclopedia_Of_Bee_Culture_djvu.txt>, p. 79.

[39] See, for example, Prof. V.H. Lowe's studies at the Geneva Experiment Station in 1899 (referenced in Root, E.R., *The Bee-Keeper and the Fruit-Grower*, 1920 edition, p. 7).

[40] Merton B. Waite, "Pollination of Pear Flowers," Bulletin No.5, USDA, 1894, cited in Prof. A.J. Cook, "Bees and Pollination of Blossoms", delivered to S. CA Pomological Society at Pasadena. *ABJ* 33:22 (31 May 1894), pp. 694-96.

> tion of fruit blossoms as the honey-bee, which flies rapidly from plant to plant, and, by running over the flowers in search of pollen or nectar, brushes off the pollen and carries this vitalizing element on the hairs of its body to the next flower visited. The habit of bees... of confining the visits... to the same kind of plant, is... advantageous to the plants... [as] the pollen... carried by the bee... [is] kind necessary for the fertilization of its flowers.[41]

The work of Fletcher, Cook, and other US entomologists underlined the necessity of honey bee pollination for robust fruit harvests. While native pollinator species played a role, the size and number of orchards in the fruit-belt zones of places like southern Ontario demanded additional support from "more numerous and efficient honey-bees."[42] "Were it not for... the honey bee," Fletcher proclaimed, the grower's "crops of fruit would be far less than they are every year, and even in some cases.. he would get no crops at all."[43]

Another way to demonstrate the value of the honey bee, especially in the context of trespass and nuisance suits, was to present it as a form of livestock that added rather than detracted value from a farmer's harvest. OBA President Allen Pringle made this point in an 1891 address to Ontario farmers, arguing that "unlike grain crops and meat which, when harvested and sold, carry away with them a certain amount... of our agrarian capital, ...the honey harvest involves no corresponding impoverishment of the soil. The "sweet nectar of the flowers," he continued, "would be mostly wasted in the air were it not in-gathered by the bees."[44] One of the benefits of beekeeping, President R.F. Holtermann noted five years later, was "that it took nothing from the soil and that it displaces no other crop from the farm."[45] The value of bees not only to orchard crops but also to grain production such as buckwheat was something beekeepers laboured to demonstrate in agricultural periodicals, producers' association meetings, and promotional pamphlets.

In the end, dialogue with neighbouring growers proved more effective in reducing honey bee losses than legislative remedies. Ontario's ground-breaking 1892 *Act for the Further Protection of Bees*, which required growers to spray only before or after the bloom, proved difficult to enforce. The OBA reported at its 1916 annual meeting that the law against spraying trees in bloom is "routinely broken" and the associated fine "is not enough... to actually discourage [the grower] from early spraying since the loss to his crop from not spraying would be more." However ineffective the legisla-

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[41] James Fletcher, "The Value of Bees in Fruit Orchards," Address to the OBA, OBA *Annual Report*, 1900, p. 60.

[42] Waite, "Pollination of Pear Flowers," cited in Cook, "Bees and Pollination of Blossoms," p. 696.

[43] Fletcher, "The Value of Bees," p. 59.

[44] OBA, *Annual Report*, 1891 (January 1892).

[45] OBA, *Annual Report,* 1895 (January 1896), p. 2.

tion proved to be, it was nevertheless useful as an educational device. Ontario beekeepers "welcome any copy they can secure of the 'Act for the Protection of Bees,'" former *Canadian Bee Journal* editor R.F. Holtermann wrote in 1900, employing it as circular to educate neighbouring growers.[46]

By the mid-1890s, consensus existed among entomologists in Ontario and neighbouring states on the value of honey bees to pollination and the dangers of mid-bloom spraying.[47] The dissemination of expert opinion in periodicals such as *Canadian Horticulturalist* and in government and agricultural college bulletins helped to raise awareness about the role of honey bees in pollination. In 1895, the Ontario Ministry of Agriculture published a free Spray Calendar that was widely taken up by growers. In the same year, Ohio's A.I. Root Co. published a pamphlet on "bees and fruit" citing expert opinion from Ontario and the US and intended for "handy distribution of bee-keepers among their fruit-growing neighbors."[48] Together with ongoing advocacy efforts by the OBA, these initiatives reduced the frequency and severity of poisoning incidents. Ignorant or malicious activities continued, but as the exception rather than the norm. Beekeepers noted in particular the damaging work of itinerant spraying-machine operators. "The bulk of the mischief," R.F. Holtermann wrote in an 1897 article in the *Toronto Globe*, "was done by men who were about the country with spraying outfits, charging so much for each tree. It was to their interest to begin as early and spray as late as they could induce the farmer to give the contract."[49]

Increased understanding about the role of honey bees in pollination and resulting economic gains through greater crop yields not only led to greater care in spraying operations, but also greater cooperation between growers and beekeepers. The advent of pollination contracts in the 1920s is a good example of this. Declines in apple yields in the 1910s and 20s prompted beekeepers and agricultural extension agents to suggest imports of honey bees for pollination services, and resulting increases in yields led to mutually beneficial relationships between growers and apiarists.[50] Within this context, pollination contracts provided beekeepers with an important mechanism for protection from losses. As legal agreements, they allowed beekeepers to require that their bees be re-

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[46] R.F. Holtermann, "Spraying Fruit-Trees—The Ontario Law," *ABJ* 40:18 (3 May 1900), 277.

[47] Cook, "Spraying Fruit Trees—Expert Opinion," p. 565.

[48] J.H. Panton, "Spraying Calendar," Toronto: Ontario Department of Agriculture, 1895, <https://babel.hathitrust.org/cgi/pt?id=aeu.ark:/13960/t2q53mj7q&view=1up&seq=5>; A. I. Root Company, *Bees and Fruit* (Medina, OH: A. I. Root Co., 1893).

[49] "Canadian Bee-Keeping Interests," *ABJ* 37:47 (25 November 1897), 744.

[50] George Cook, "Spray, Spray, Spray!," 37. For reference to similar developments in the Hudson River Valley, New York State, see George H. Rea's reflections on the 1910s and 20s in "Beekeeping and Fruit Growing in the Hudson Valley," *ABJ* 80:4 (April 1940), 157.

turned in good health, and that growers protect rented bees from exposure to insecticides.[51] These developments led to greater communication between growers and beekeepers. By the early twentieth century, Ontario beekeepers could feel more confident that their colonies could forage in nearby orchards without risk of poisoning.

Conclusion

Over the longer term, efforts to protect honey bees from harm brought greater frustration than success. The twentieth century saw Ontario orchardists take up a growing array of new insecticide compounds, beginning with the shift from Paris Green to lead arsenate, prized for its effectiveness and greater adhesion to foliage, in the early 1900s.[52] After World War II, the availability of an ever-expanding number of commercially-available synthetic insecticides resulted in heavy losses for beekeepers. The lethal effects of new broad-spectrum insecticides like DDT were exacerbated by the growing complexity and reach of spraying practice. In the wake of new insect outbreaks such as the San José scale infestations of southern Ontario orchards in 1897, government entomologists like Fletcher and his successors extended the regulatory reach of government inspection and treatment programs. With the passage of the provincial Fruit Pests Act in 1910, orchard inspectors could require growers to spray their crops in cases of insect infestation. Spraying, in other words, became compulsory in Ontario orchards.[53] The advent of aerial spraying in the 1940s created new problems of drift onto non-target crops and wildflowers, extending the size and unpredictability of sprayed environments for beekeepers. As orchards expanded and fruit production intensified in the early twentieth century, the frequency and quantity of insecticide applications also increased. New cycles of losses for beekeepers in this context led them to pull back their colonies from orchard locations and to rent out their bees for pollination services with greater trepidation.

Today, beekeepers find themselves with more challenging problems still. The release in the 1990s of a new class of systemic neo-nicitinoid insecticides (NNIs)—insecticides that are taken up by the plant through coated seeds, and later secreted in its pollen and nectar—have produced new complications for beekeepers. Foraging honey bees are exposed to NNIs when they collect pollen and nectar from, or drink water that collects upon, targeted plants. The effects of this exposure, beekeepers and scientists have found, are more often chronic than acute: hives exposed to NNIs show reduced resilience over the longer term, in lower life spans of honey bee queens, for example,

[51] Tammy Horn, *Bees in America: How the Honey Bee Shaped a Nation* (Lexington, KY: University Press of Kentucky, 2006), pp. 148-49.

[52] By the early 1900s, lead arsenate had replaced Paris green as the most widely used insecticide by Ontario orchardists (Cook, "Spray, Spray, Spray!," p. 34).

[53] George Cook, "Spray, Spray, Spray!," 37.

or lower sperm counts in drones (male bees). These declines in honey bee resilience raise the cost of doing business for beekeepers. Studies point, furthermore, to the interaction of a range of stressors, including parasites, disease, low nutrition, and chronic pesticide exposure, in reducing honey bee health. Because systemic insecticides can move through the water table to be taken up by non-target plants, the problem of honey bee exposure cannot be solved simply by regulating the timing or location of the spray.[54]

And today, as in the nineteenth century, the burden of proof in poisoning claims rests with beekeepers. Unlike Paris Green or DDT spraying, however, where consequences were immediately apparent in the stench of piles of dead and dying bees, bees suffering from acute NNI poisoning often simply vanish. Vanishing bees mean no bodies of evidence—quite literally—for beekeepers. Even when poisoned bee bodies can be produced, few avenues for redress exist. As current OBA president André Flys commented in a recent telephone conversation,

> We can have all of our lab analysis data, our dead bees coated in pesticide, but it doesn't amount to anything.... If we had a bear wreck our hives, we could send a snapshot of the damage to the provincial apiarist and receive compensation. But for pesticide losses there is nothing.[55]

In 2014, the Ontario government responded to that year's especially heavy losses with a one-time compensation payment to beekeepers.[56] But no ongoing mechanism for compensation for pesticide losses exists. Changes to provincial pesticide regulations in 2015 created a new class of regulations for NNI-coated seeds (which until that time had been unregulated as seeds, and not insecticides). But chemical availability moves faster than pesticide regulation, and farmers have generally moved on to adopt other, unregulated substances.[57]

As the recent experience of beekeepers shows, we continue to forget, and relearn, the lessons of the 1890s. Beekeepers still bear the brunt of losses from widespread insecticide use, and the heavy burden of evidence required by the courts continues to stymy beekeeper claims for redress. But unlike the 1890s, when misconceptions about honey bees led a small subset of vocal fruit growers to distinguish their interests from those of neighbouring beekeepers, twenty-first-century growers are deeply aware of their reliance upon honey bee pollination. This awareness has reached further into public consciousness than ever before through the powerful knowledge dissemination tools of social media. Public concern for pollinators has led to swelling memberships for organizations like the OBA, to rooftop hives at

[54] André Flys, President, Ontario Beekeepers' Association, personal communication, 20 February 2020.
[55] *Ibid*.
[56] Susan Mann, "Province Issues Compensation for Ontario Beekeepers," *AgMedia Inc,* 30 April 2014, <https://www.betterfarming.com/online-news/province-issues-compensation-ontario%E2%80%99s-beekeepers-55790>, accessed 28 February 2020.
[57] *Ibid*.

luxury venues such as the Toronto's Royal York hotel, and to the transformation and rebranding of undeveloped lands as pollinator parks in Guelph and other locations. Like their nineteenth-century predecessors, Ontario beekeepers have led the way in pushing for pollinator protections. This time, however, their bees have served not only as objects of protection in their own right, but also as indicators of the plight of pollinators more generally. Heavily managed, enumerated, and regularly monitored by their keepers, honey bees have much to tell us about the fortunes of wild pollinator species we don't track as carefully.