lacked intellectual cohesion and scientific precision. To use the phrase of another historian writing in another context, farmers in early-nineteenth-century America were engaged in the "chaos of experimentation."[13] Professional entomologists imposed order on this "chaos" in several ways, each of which helped root the national quest for insect control in a flexible set of localized tenets. In doing so, Harris and his dedicated followers placed pest control on a path toward strategies of insect management that would be responsive to the myriad agricultural systems that had evolved along the east coast in the seventeenth and eighteenth centuries. Between 1830 and 1890, economic entomologists would battle the insect empire with a range of scientific weapons that, while never perfect, helped systematize the process of insect control while remaining responsive to local concerns. It was due in part to their intimate connection to the experiences of farmers that their pioneering experiment had a fighting chance to make a difference.

His direct advice, in addition to his willingness to place his work in a public context, quickly solidified Thaddeus William Harris's reputation as the most influential economic entomologist in the United States. There was nothing generic about his accomplishment. After all, the professional model he built placed at the center of American entomology the prerequisites for an ethic of pest control that would deal with insects in a scientific and systematic manner. This foundation, in turn, provided a basis to guide a diverse farming community into an agricultural future marked by responsible, locally based, and effective insect management that preserved the spirit of cooperation that prevailed before the arrival of the economic entomologists.

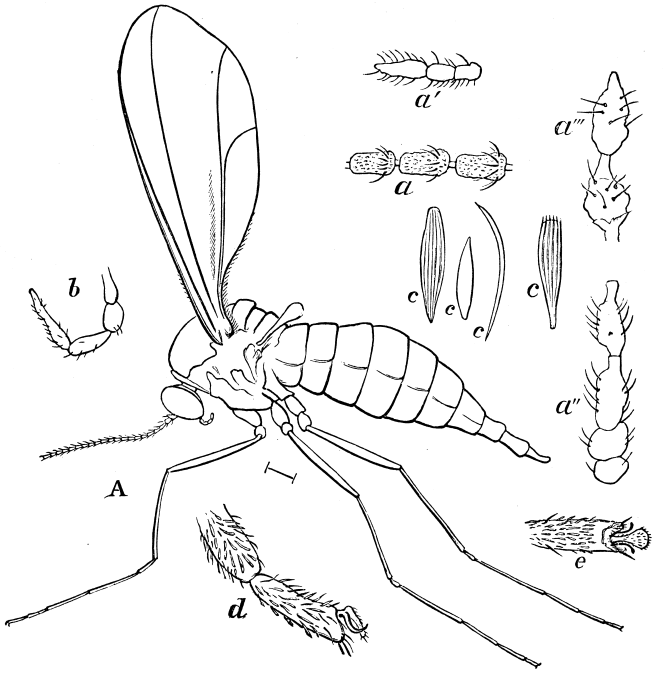
"the greatest quantities can be most readily destroyed by the simplest means"

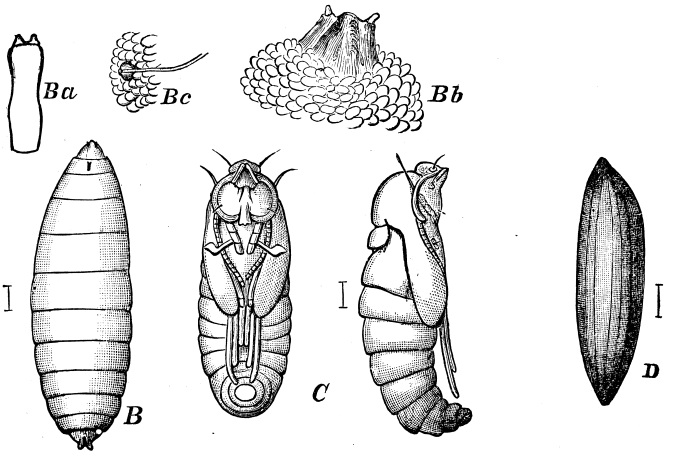
One primary way in which economic entomologists altered pest-control strategies was in their explicit emphasis on the life cycles of insects. Asa Fitch suggested in an annual report that a fresh perspective was needed: "[I]n this country, where so little accurate knowledge of our insects is diffused among the population . . . an indication of the external appearance and habits of the each species is a great desideratum." Fitch captured the na-

ture of the entomologists' mission when he promised to study only "those insects which are injurious" in a way that would allow "those who are suffering from these pests to devise the most suitable and effectual modes for combating them." The idea was fairly simple. As the editors of the *Prairie Farmer* put it, the nation's most destructive insects "might be easily remembered, and their history and habits become familiar to every young farmer of good observation." This change would prove to be a defining feature of what economic entomologists were attempting to accomplish. The cycles of insect life became critical to almost everything they wrote.[14]

Farmers and entomologists conversed comfortably over this matter. Farmers were obviously well aware that different insects appeared in their crops at different times of the year, but before the involvement of entomologists, they had only a vague understanding of the complete sequence of transformations that insects underwent before they damaged crops. Knowing where and how an organism bred and laid its eggs, under what conditions it changed into larval and pupal phases, when it became an adult and what it ate when, and the behavioral characteristics of each phase—all this information was critical to achieving greater precision with existing insect-control tactics. As the entomologist William LeBaron put it, "There is a period in the lives of most . . . noxious insects . . . when some one or other of the common remedies . . . is effective." The *Practical Entomologist* echoed this theme, editorializing that "the transformations of each species . . . will be faithfully recorded for [the farmers'] information by Entomologists whose time is devoted to this imperfectly understood subject." Only then, it concluded, would farmers "be enabled from the information thus obtained to determine at what period in the insect's life the greatest quantities can be most readily destroyed by the simplest means." Knowledge of insect life cycles thereby allowed farmers to pinpoint when and how the available methods were to be used.[15]

Economic entomologists studiously avoided the academic discussions that had so enthralled earlier generations of naturalists and, instead, worked to get their data on life cycles into the agricultural mainstream. Even for these nineteenth-century scientists, the medium was the message. Ambitious economic entomologists had begun to publish books for wider audiences by the 1850s. Their works reflected the spirit of Thaddeus William Harris's approach, an approach confirmed by his promise in *Report of the Insects of Massachusetts* that "this report is designed for the use of





LIFE CYCLE OF THE HESSIAN FLY

Early economic entomologists worked to educate farmers about insect life cycles in order to help them better time their control strategies. These diagrams of the stages in the life cycle of the Hessian fly are examples of such an effort.

persons who may not have elementary and other works on this branch of natural history at their command."

One of the most ambitious of these budding entomologists was Mary Treat, who (to support herself after her divorce) wrote popular manuals on insects and insect control that reflected the spirit of Harris's book, but was even more overt about appealing to a lay audience—frequently publishing her findings, for example, in *Harper's New Monthly Magazine*. In the preface to her *Injurious Insects of the Farm and Garden,* Treat's publisher complained that older entomological works "are written with reference to the identification of the species" rather than with information on how the species may be controlled. Treat's book, by contrast, provided "an account of the most destructive insects and the present knowledge of the methods of preventing their ravages." As the preface made clear, however, little of what followed was going to make much sense if the reader remained ignorant of the basics of insect biology. For several pages, Treat therefore provided an elementary overview of the primary metamorphoses in an insect's life. Her concern about the entomological knowledge of her farming audience was well founded. A correspondent to the *Practical Entomologist* had, just a few years earlier, explained that "it is lamentable to see how wide spread is the ignorance in regard to [the study of insects], even among those whose interest it is to possess a knowledge of insects and whose labors are affected by their operations." Treat fully appreciated how important it was to overcome such ignorance, and she left a trail of evidence that proves her dedication to the cause of educating her readers about basic entomological principles.[16]

Treat's work highlighted remedies that capitalized on the life cycles of insects. With respect to the asparagus beetle, she instructed the reader to follow "correct principles" and, just before the beetles laid their eggs in the early spring, to remove all the asparagus seedlings that had sprung up from the previous year's seed. "Thus," she ended, "the mother beetle is forced to lay her eggs upon the large shoots from the old stools; and as these are cut and sent to market every few days, there are no eggs left to hatch out into larvae for the second brood of beetles." The potential usefulness of this knowledge was undeniable for all committed entomologists and farmers. Fitch, for example, wrote passionately about the ravages caused by the striped flea beetle on New York's cabbage and radish crops. In 1867, however, he was thrilled to report that "the larva state

and transformations of this genus of insects has been discovered." Armed with the information that they "remain an egg ten days, a maggot six, and a pupa fourteen days," farmers now had "remedies against this insect . . . that we can scarcely desire anything further in the premises." Through the perpetuation of such "correct principles," Treat, Fitch, and their cohorts furthered Harris's legacy, which insisted that the entomologist empower the farmer with applicable ecological tools based on specialized knowledge about insect metamorphosis.[17]

The increasing emphasis on life cycles, as well as the need to elaborate their complexity, eventually encouraged entomologists to publish their own journals, proceedings, and state-funded reports. Critical to the success of this endeavor was that the scientists systematically solicit farmers' observations on insects life cycles before publishing their findings. This ongoing bottom–up approach to insect control was especially evident in such journals as the *Practical Entomologist* and, later, the *North American Entomologist.* Benjamin D. Walsh, editor of the *Practical Entomologist,* suggested the extent of this connection in the journal's first published article. "There is a new and very destructive enemy of the Potato," he wrote of the potato beetle, before going on to cite the firsthand observations and advice of five farmers who had direct experience with the pest. Stephen A. Forbes, as state entomologist of Illinois, frequently credited his "entomological assistants"—local farmers—for providing the evidence for his reports. These "local observers for the office" allowed Forbes to provide information on insects that he never would have had the chance to study himself. The Committee on Improvement of Lands in Plymouth, Massachusetts, expressed its expectation that "experts" should see their work from the New England farmers' perspective when it wrote, "We think many advantages would result if the committee on produce were required to view crops in the fields to examine themselves." Drawing on the insights of local farmers thus remained a standard approach for economic entomologists as they published their own journals. It was an approach that reflected Walsh's humble observation that "I am perpetually meeting with Farmers and Mechanics who know a great deal more about the Natural History of Insects than I do myself."[18]

This important symbiotic relationship only heightened the entomologists' ability to bring life-cycle data to farmers. An article in the *Michigan Farmer* on the curculio referred to four entomologists in the course of its analysis and, drawing on the finding that the beetles "oviposite in the

young fruit" in June, concluded that this discovery "may lead us to most important results." Reporting on the "wheat aphis" in 1864, the *New England Farmer* cited "Prof. [Townend] Glover" and "Dr. [Asa] Fitch" as the leading entomological authorities behind the theory that "unwinged females" deposit eggs "in the autumn on late sown wheat, where they remain all winter, and hatch the following spring." The *Southern Planter* printed a summary of Fitch's *Second Report on the Noxious, Beneficial, and Other Insects of the State of New York,* deeming itself "very much indebted" to the entomologist for his work and encouraging southern states to "undertake a similar enterprise." When a farmer had the nerve to assert his opinion that "our entomologists are woefully ignorant of the tactics of this band of guerrillas [curculios]," he found himself besieged with scornful rejoinders. The *Prairie Farmer,* for one, responded with a seething editorial against slandering entomological expertise: "This is a mistake. Entomologists know, and most fruit men know . . . that the curculio hibernates in the perfect or beetle state, and its natural history is as well known as that of a cow."[19] Through patience and prolific publication, American entomologists worked with farmers to ensure that they indeed knew as much about an insect's life cycle as they about any domesticated animal's life cycle. It was a critical transfer of knowledge.

"little friends that have come to the farmers' rescue"

A second way in which economic entomologists streamlined the task of insect control was through the rationalization of an amorphous method that farmers had been practicing haphazardly for centuries: biological control. "It is well known," wrote Asa Fitch in 1859, "that certain insects have been created apparently for the sole purpose of preying upon other insects." It all boiled down to the fact that, as Fitch concluded, "we have received the evil [from abroad] without the remedy." This signal point joined life-cycle analyses in becoming central to the work of early economic entomology.[20]

One motivation to intensify the entomological focus on biological control after 1850 was the increasing popularity of bogus elixirs marketed to farmers. "Nothing is more certain," wrote editor Benjamin D. Walsh, "than that there is no Royal Road to the destruction of bugs; and the only way we can fight them satisfactorily, is by carefully studying out the habits of each species." Walsh, who would become enemy number one of chemi-

cal pesticides, was hardly alone in his opinion. The editors of the *Practical Entomologist,* the leading journal for agricultural entomology, damned the rise of these "washes and decoctions" as "as useless in application as they are ridiculous in composition." They continued, "If the work of destroying insects is to be accomplished satisfactorily, we feel confident that it will have to be the result of no chemical preparations, but of simple means, directed by a knowledge of the history and habits of the depredators." As a result, "enquiring Agriculturalists who read this Bulletin must not expect to find any particular brew . . . as specific for any one or all of our insect enemies." Reiterating the power of traditional biological control over untested patented products, an entomologist advising the Essex Agricultural Society in Massachusetts explained, "It is gratifying to know that the same Hand that sends the bane sends the antidote. These insects not only have numberless enemies among the birds and other insects, but they all have their parasites by whose energies they are swept away." In the mid-nineteenth century, many entomologists were hoping to act in unison with farmers on the potential of such a concrete and observable reality.[21]

Entomologists therefore worked diligently to raise the status of biological control from a popular folk remedy to a legitimate aspect of insect management. They began their effort with birds. Every farmer had seen birds eat grubs, and most had capitalized to some extent on the implications of that observation. "I wish to add my testimony," Mary Treat wrote in the introduction to *Injurious Insects of the Farm and Garden,* "in favor of the various birds that visit our gardens and orchards in the capacity of helpers, as they feed upon some of the most noxious insects that we have to contend with." She noted that purple martins take "rose bugs from the grape vines," orioles "pull the bag worm from his case," and catbirds eat "the unsavory pear slug." The *Southern Planter* reported in 1857 that "the chickens seemed to be unceasing in their labours of destruction of the bugs," so much so that one Virginia farmer who introduced chickens into his fields "in one week's time could not find a bug." The conclusion he drew was as pithy as it was earnest: "farmers, try it." Fitch wrote in a widely distributed report that "by raising a brood of chickens annually in our gardens . . . we can readily prevent these striped beetles from becoming multiplied and injurious." Charles L. Flint, in his annual report as secretary of the Massachusetts Board of Agriculture, recounted that "last winter, I made a bird-house, and the tenements were taken right up. . . . I did not see a slug

on my asparagus all summer." As for the birds, "I am going to build them some more tenements, and rent them free."[22]

Economic ornithology—the field that studies bird–insect relationships—occupied the minds of all legitimate economic entomologists, many of whom worked directly with ornithologists to arrive at sound data. Formal efforts began in the 1860s. In 1861, Wilson Flagg declared it his intention "to make a vindication of the feathered race," as "almost every species is indispensable to our agricultural prosperity." Flagg urged recreational hunters to hold their fire because "the gunner who destroys ten birds in the spring, secures the preservation of so many millions of injurious insects to ravage our crops, and to destroy the trees of our forests and orchards." By the 1870s, studies had become more in-depth. In 1874, A.S. Packard, Jr., reported on the progress of a New York entomologist who had sliced open the stomachs of more than 3,000 birds in order to catalogue their consumption of insects. Throughout that decade, entomologists routinely took up like-minded experiments. Stephen A. Forbes investigated the relationship between insect and bird populations in an apple orchard in Illinois and concluded that "birds of the most varied character . . . were either attracted or detained here by the bountiful supply of insect food, and were freely feeding upon the species most abundant." An entomologist from New England wrote that "I have frequently seen where the woodpeckers have taken out the borers; and as they destroy no berries or other fruit, but are entirely carnivorous. . . . I think it well to protect them." Never before had so many scientists and farmers agreed that birds should be employed to the farmers' advantage.[23]

Predaceous insects also became best friends of the farmer as biological control gradually matured into a realistic option in the quest to manage injurious bugs. As early as 1864, Flint noted of plant lice that "were it not that their insect enemies tend to reduce their numbers materially, and keep in check this vast army of suckers, then we might reasonably apprehend the speedy destruction of all our crops." A farmer living near Columbus, South Carolina, wrote in 1857 to the *Southern Planter* about "the operations of the numerous qualities of ants . . . that were lying in wait for the grass-worm," doing little more than expressing the "natural desire for a fresh supply of food." Building on Fitch's work on predaceous insects, the editors of the *Southern Planter* noted, "We have heard from two distinct sources that the ants have been observed in large numbers feeding greed-

ily on the chinch bugs." In 1869, a Massachusetts report drew attention to "a species of Coccophagus" that "destroy[ed] a considerable number of bark lice." By 1871, Packard was declaring that "insects are a most powerful agency in nature." Of course, this declaration was nothing new. Again, though, the task for economic entomologists was now to formalize and standardize this knowledge with an eye toward making it a pragmatic option for insect control on farms. Entomologists began to achieve this goal by spreading the word through familiar channels—prominent scientific journals, agricultural newspapers, government reports, and textbooks.[24]

The knowledge that insects were their own worst enemies soon came to matter a great deal in the quest to control them. The aphids had been "rapidly blighting the grain," but even then, an editorial in the *Michigan Farmer* explained, "when the lice were countless in numbers, and when the winged forms were easily spreading to the oat-fields, the hand of deliverance was discerned in the comparatively few but wondrously prolific enemies of the lice, which had already sounded a halt in the march of destruction." Summarizing the destructive power of grasshoppers, one entomologist remarked that "fortunately there are a considerable number of species of animals"— the blister beetle and ground beetle—"that depend to a greater or less extent upon grasshoppers for substance. . . . All combine in keeping the pests in check." Walsh spoke favorably about the future of biological control, predicting that "our grandchildren will perhaps be the first to reap the benefit of a plan which we ourselves might, just as well as not, adopt at the present day." Charles V. Riley, the federal entomologist whose opinion mattered as much as anyone's, agreed: "[T]here are some instances which there can be no doubt whatever as to the good which would flow from the introduction of beneficial species." Packard added, "It is quite as essential for one to know what insects are beneficial to agriculture as what are injurious."[25]

Closely related to predacious insects in the quest for biological control were the parasitic ones, which lay their eggs inside the pest. The eggs proceed to hatch, and the larvae consume their host. As an article in *Science* described a parasite of the plant louse, "As soon as the parasite has devoured the viscera of the louse, it uses the skin or crust as a sort of cocoon." What emerges from the tiny cocoon is a "tiny black fly," which "is by far the most important of these little friends that have come to the farmers' rescue and saved the wheat, barley, and oat crops." Identifying

and writing extensively about the "most important group of parasitic insects" in the early twentieth century, Clarence M. Weed noted that "they are primary parasites of injurious insects" and that, when they deposit their eggs, "the host is doomed." The parasites, "like the fox in the fable, will gnaw away its vitals." Riley explained that parasitic insects are "fatal to their hosts" and, as a result, "quite beneficial to the agriculturalist." In 1869, the Connecticut Board of Agriculture noted that beetles can be injurious to vegetation, but should also be valued because "this great order includes many beneficial carnivorous insects."[26] While entomologists at the time did not know it, parasitic larvae start their attack by strategically feeding on their hosts' least vital organs in order to ensure that the hosts die as slowly as possible. Clearly, they had passed a lot of time perfecting their technique. First-generation entomologists and farmers simply wanted to capitalize on it.

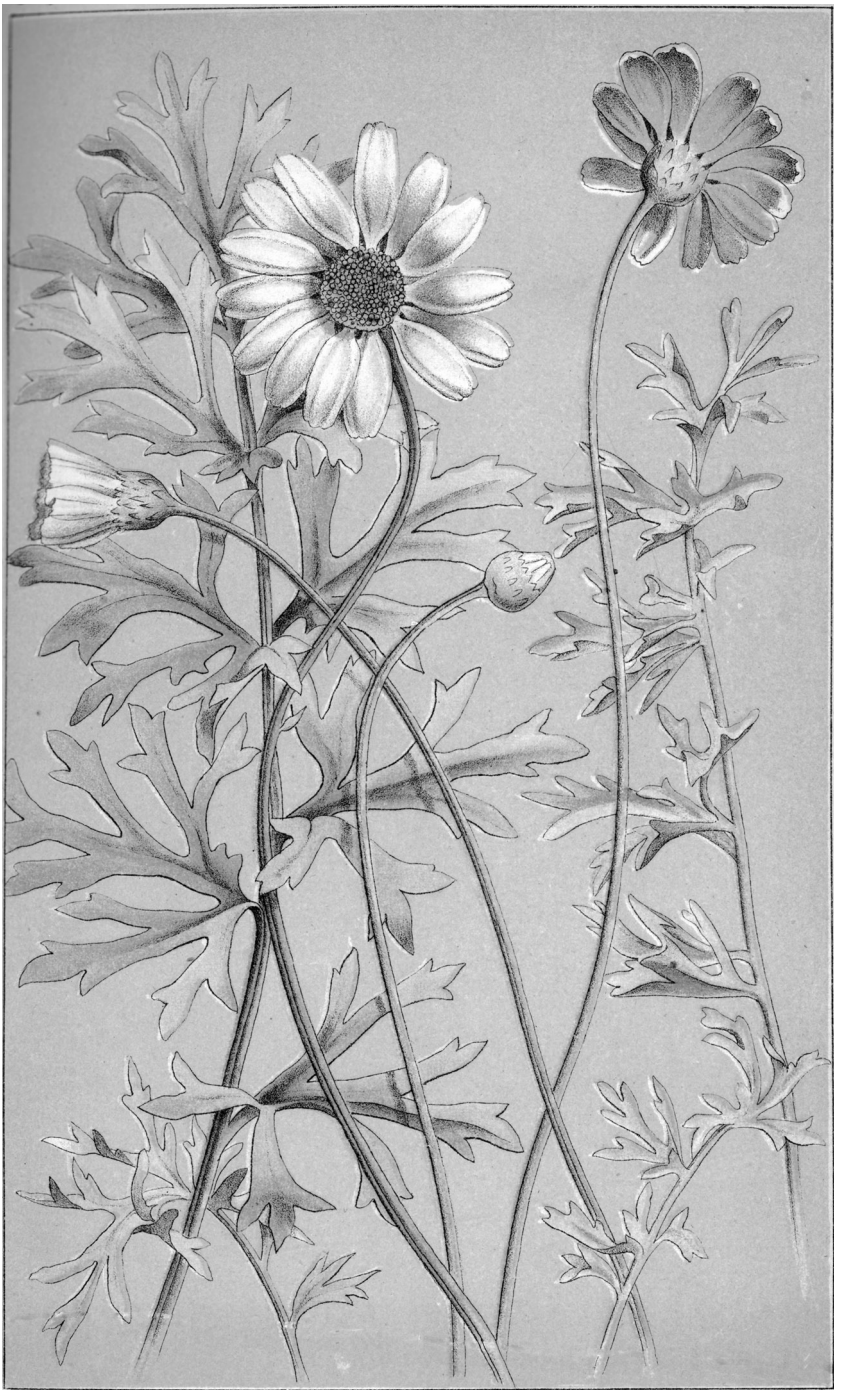
"I only throw it out as a suggestion"

The focused dedication among entomologists to life cycles and biological control should not imply that they were dampening the spirit of experimentation that had prevailed among farmers before their arrival. To the contrary, a third distinguishing feature of their work was an eager willingness to explore a wide spectrum of solutions to the ravages of insects, ranging from the ancient to the unknown, which they did in the spirit of the *Prairie Farmer*'s axiom that "trial is the only real test of measures." Because their profession was highly decentralized in organization, and thus deeply attuned to farmers' specific needs and methods of experimentation, entomologists proved eager to suggest that farmers explore any and all techniques that showed promise. They remained sensitive to the commonly articulated assumption that, as the *Southern Planter* put it, "many intelligent farmers look with distrust on all recommendations issuing from any other source other than that of practical experience."[27] The entomologists' openness to amateur fieldwork preserved the "chaos of experimentation" and the intensity of local emphasis while allowing them to evaluate proposed methods with relative objectivity and to preserve the option of pulling back. A full catalogue of these procedures would be virtually endless, but perhaps the best way to appreciate this inherent flexibility would be to look briefly at how journals and entomological reports presented ideas on

chemical experimentation, cultural control, and manual efforts—all tactics of pest management that farmers and entomologists tested as economic entomology matured into an established profession.

The use of natural insecticides had a long history in the annals of pest control. Since the late eighteenth century, American farmers had used pyrethrum, a repellant made from a vegetable powder (ground from petals of two kinds of chrysanthemum flowers and mixed with ashes or flour and water), to control pests. Hellebore, an extraction from a species of herbaceous flowering plant, was another popular vegetable poison that was, according to one set of instructions, "diluted with five to ten parts of flour and dusted on plants through a muslin bag." Tobacco had been refined into "nicotine dust" and used routinely in the eighteenth century for its natural insecticidal qualities. Common items—including soap, potash, and sulfur powder—also had served as acceptable insecticides well before the advent of economic entomology. This long-standing interest in chemical application only intensified after the publication of Harris's *Report of the Insects of Massachusetts,* making its way into state agricultural reports and entomologist-edited farm journals. Some of the solutions were familiar, as was the advice of "showering or syringing the bushes with liquor made by mixing with water the juice expressed from tobacco." Others were relatively novel, such as the Massachusetts Board of Agriculture's claim that "the universal search for an *insect elixir mortis,* of easy application and speedy effect, bids fair to be rewarded in the sea of petroleum or coal oil." Whether farmers read about age-old remedies, such as salting the ground to control for worms, or less familiar tactics, such as applying to their crops "whale oil soap or a weak solution of carbolic acid," they never for a moment believed that these proposed solutions were guaranteed to alleviate their insect problems. Still, the spirit of experimentation prevailed, a characteristic of economic entomology encapsulated in Jabez Fisher's qualification for his advocacy of an early arsenic-based compound: "I do not know that there is anything in it, I only throw it out as a suggestion."[28] Entomologists and farmers were generally willing to try it out.

But not always. Chemicals, despite their popularity, inspired deep skepticism among farmers, especially those in the South, when the remedies came from afar. An article in the *Southern Planter* illuminated this prevailing doubt in 1856 when it remarked that "another cause of the reaction is found in the fact that there exists a class of pseudo-scientific professors



PYRETHRUM CINERARIAEFOLIUM

This species of chrysanthemum was used by many farmers as a natural repellant. The flower petals were ground, cut with ashes or flour, and dusted over crops as a vegetable poison.

whose aim it is to take advantage of the willingness of farmers to believe that the revelations of science may be made directly available to them." Farmers were not fearful of the economic entomologists, but of "self-styled professors" all too eager "to write a prescription for the whole plantation." These doubts, which also directed attention to biological control, predisposed farmers to the myriad methods of cultural control. Since the dawn of agriculture, farmers had been inter-cropping, sowing hybrids, planting early or late, growing lure crops, and manipulating the soil to their benefit. With the establishment of experimental farms in several states, a direct result of the Morrill Land Grant Act (1862), scientists and farmers were able to test and systematize both old and new methods. Previous field testing may have been essential to the "chaos of experimentation" that farmers valued, but, as the Georgia State Agricultural Society declared in 1871, experimenters "compose a confused and unorganized mob." Agricultural experiment stations and agricultural colleges rationalized and funded experimentation while honoring a plea made by Joseph S. Howe, also in 1871: "Could we obtain a record of the experience and practice of [farmers] the result would be invaluable!"[29]

Cultural methods were far more familiar to most farmers than chemical controls and, because they required less knowledge of hard science than other tactics, were the one area where farmers had the upper hand over entomologists. It is therefore not surprising to find in the pages of the *Southern Planter* advice conveyed by "an old Negro" whose method of keeping lice off hogs was to smear tar on the rubbing posts of the pigpen. "I have kept it up," testified one farmer, "and have never had lice upon my hogs." Entomologists listened intently to farmers such as "Mr. Whitney, of Franklin Grove, Lee Co.," when he declared in reference to the bark louse, "I now propose heading down the tops of every tree in my orchard affected by them." Speaking of the Hessian fly, William R. Schuyler wrote to the *Michigan Farmer* to express his opinion that "on the sandy loams of Michigan, *when rightly tilled,* seeding may be safely be [*sic*] deferred until after the middle of September." The result would be that "a sufficiently vigorous growth in the fall will be insured, while the crop will be far less exposed to the spring and fall attacks." Acknowledging that "the farmer's life is a never ending conflict with weeds and insects," Howe nevertheless had faith that "by constant and timely cultivation," the problem could be managed.[30]

Perhaps the best indication of the entomologists' flexibility comes from their willingness to sanction the most basic and timeworn technique in the farmers' arsenal: manual removal. While entomologists certainly felt pressure to devise and refine methods of pest control that were more scientifically sophisticated, they also knew that nothing was more direct and tangible than picking insects off crops with the simplest tools in the kit: hands. In an article intended to confirm the virtues of progressive farming as it related to pest control, Howe explained that the farmer might make progress "by carefully watching every morning, and crushing every squash bug with a stone." Another scientist writing for the Massachusetts Board of Agriculture suggested that "it might be expedient, during the proper season, for our city authorities to employ persons to gather and kill every morning the caterpillars which may be found in those public walks where they abound." Whatever the particulars, these cases litter the entomological and agrarian literature after the rise of economic entomology as much as they did before. The critical point to appreciate is that entomologists were open-minded enough to realize that, for all their scientific progress on the biology of insect control, sometimes, as one of them put it, "the only remedy . . . is a hand-to-hand fight."[31] At the least, they were prepared to throw some punches.

"the good of creation requires that they should be destroyed"

The fourth and final way that economic entomologists and their work reshaped the quest to control insect pests was in the overall attitude they gradually disseminated about insects per se. The measured reverence that many Americans once held for insects, as well as the mystery that surrounded them, diminished substantially with the rise of economic entomology. It succumbed to a variety of forces, but three primary if disparate factors stand out: the secularization of nature, the quantification of insect destruction, and the rise of the home as a sacred space. Each reason deserves a closer look.

Knowledge demystified power. The breeding experiments and the determination of insect life cycles undermined the spiritual heft that insects once had. It was not so much that Darwinism was taking over during the latter half of the nineteenth century, as that farmers and entomologists were developing a genuine understanding of insect behavior and, to a cer-

tain extent, effectively acting on that knowledge in advantageous ways. As C. H. Fernald, writing in *Science,* put it: "I cannot rid myself of the conviction that in economic entomology God helps those most who help themselves."[32] Like the early Americans who took pride in their domesticated animals, Americans in the late nineteenth century took pride in their more detailed sense of insect habits. As a result, they felt themselves potentially more in control of them than they had ever been. Not a farmer on the face of the earth would have felt about insects the way he felt about his milk cows; he would never tame insects the way he tamed his horses. But he would not have been as awed by helplessness as he had been throughout the eighteenth century.

Entomologists therefore actively embraced a new, more muscular rhetoric. They did so in part because, while many animals were declining in number, insects were doing something quite contrary to the crush of economic expansion: they were proliferating. With industrialization transforming the American economy as thoroughly as it was, an ethic of wildlife conservation developed a substantial following. By the latter half of the nineteenth century, private organizations such as the Wildlife Refuge System joined federal programs such as the National Wildlife Preservation System to regulate practices that conservationists deemed a threat to the nation's natural heritage. This emerging preservationist mentality ultimately evolved from what many Americans viewed as the disheartening environmental consequences of economic growth. "However injurious wild animals may be to man," wrote Robert Kennicott in 1856, "he should not forget that he himself is very often the cause of their undue destructiveness."[33]

Although his comment applied perfectly well to insects, Kennicott was speaking of only mammalian quadrupeds. Insects, because so many actually *thrived* under the impact of human development, never made it onto the list of animals deserving of protection—a list that carried a certain amount of emotional weight with a portion of the American public. The ultimate cause behind the decline in wolves, deer, beavers, alligators, grizzly bears, mountain lions, and other increasingly exotic animals was primarily the loss of habitat as a result of land development and farm improvement. The proliferation of insects, however, ran against the grain of this scenario, and thus highlighted insects as the nail that had to be hammered down. By not falling under the umbrella of a conservation ethic, in short, insects stood out to be destroyed. Entomologists soon found

themselves to be the only zoologists who worked to kill the animals they studied.[34]

The explicitly economic devastation that insects were causing offered another reason for the demise of their once relatively positive reputation. It was rare for eighteenth- and early-nineteenth-century commentators to speak of infestations of insects in direct monetary terms. Farmers may have complained that their livelihoods were under attack, but they tended not to conceptualize the threat posed by insects in precise financial terms. For them, the problem was more personal than national, more immediate than long term. If they did speak in broader terms, it was along the generalized lines of John Hull's remark that "the canker worm hath for fower years devoured most of the apples of Boston." Economic entomologists, however, were not content with "most of the apples." Perhaps because their work hinged so directly on the economic consequences of insect infestations, they were quick to situate the problem in a larger, often more dramatic, and certainly more quantifiable framework. Scientists across the disciplinary spectrum were coming to embrace what A. Hunter Dupree has called "the measuring behavior of Americans." But entomologists, in conjunction with agricultural scientists, took special care to ensure that their knowledge was "duly classified and arranged." As one agricultural writer put in 1886, just as agricultural experiment stations were focusing on the study of insects, "Accurate observation of what one is doing is first necessary before progress can be made in amending it." It was in this measuring spirit that the insect problems plaguing farmers became quantified and reports such as this one routinely made the rounds in popular newspapers: "While investigating the probable amount of damage done to the wheat crop by insects, professor [Furnald], President of the Association of Economic Entomologists, estimates that 10 percent of the total production is lost. In dollars it amounts to over $38,000,000." American farmers had always aimed to kill insects. But with their devastation cast in such stark economic terms, they were quick to ratchet up the rhetoric of insect destruction. While nobody was yet embracing an ethic of extermination, the language clearly was moving in that direction.[35]

That language, of course, had always applied to the home. As long as humans have lived in shelters, they have had to endure invasions of insects. But in nineteenth-century America, the home became an especially sacred place—not so much integrated into the natural environment

as divorced from it. Evolving from a hovel to a haven, the household became a comforting refuge where many Americans embraced and displayed their middle-class status, a status that often hinged on modest urbanization and distance from the farm. The home, in other words, evolved from a place of work to a place of refinement, and there was nothing refined about invasive insects. It was under the influence of this larger cultural change that the prolific literature on pest control in the home reached a fevered pitch. Bedbugs, roaches, flies, moths, beetles, and ants became the victims of a torrent of not only harsh control strategies, but also rhetorical invective. The begrudging admiration that farmers and entomologists had once reserved for the creatures that caused them considerable pain dissolved in the shrill condemnations of those who viewed pests as feckless threats to the charms of domesticity.

Authors of domestic manuals made their points without equivocation. In *The Housekeeper's Receipt Book,* S. A. Oddy explained, "Civilization and the arts having made the desert to blossom as the rose, have also delivered us from the power of ravenous beasts; but we are still liable to be attacked by a more numerous though less powerful host of enemies, who commit their depredations on the animal and vegetable kingdom, and thereby destroy many of the comforts of human life." With the comforts of human life at stake, the most aggressive means were clearly in order. She continued, "It does not become us to be prodigal of life in any form, nor wantonly to seek its destruction; but where any species of animal becomes really noxious, the good of creation requires that they should be destroyed." When a house is filled with fleas, according to Clarissa Packard, author of *Recollections of a Housekeeper,* one may as well live "in a wigwam." The reference to primitive savagery, however prejudicial, reflected an underlying concern that bug-infested homes may very well compromise national stature. As William Cobbett wrote, "There never yet was, and never will be, a nation permanently great, consisting, for the greater part, of wretched and miserable families. In every view of the matter, therefore it is desirable that the families of which a nation consists should be happily off; and this depends, in great degree, upon the management of their concerns." Few concerns were as domestically pressing, he explained, than keeping the home rid of those "nasty things"—insects.[36]

By the late nineteenth and early twentieth centuries, these opinions about insects and the household had become pervasive enough for en-

tomologists to start writing about household pests in similarly disdainful terms in their own books and articles. A classic example is Clarence Weed's *Insects and Insecticides*. Despite the parasitism that prevailed in the natural world, nothing was redeemable about insects in the home. Cockroaches "destroy provisions of every kind," and were best compared to "immigrants from without." Insects were now known not for their discoverer, but for the object of their attacks—for example, clothes moths, bedbugs, and carpet beetles. A clothes moth in Weed's depiction was something like a thief, "working her way into dark corners and deep into the folds of garments." Ants, usually spoken of with special reverence as a result of their superior social organization, were now, in the context of the home, "the most annoying kinds of pests . . . getting into and running over everything." From their nests, they "sally forth and overrun the house, devouring or carrying off particles of food of all descriptions, getting into everything in sight, and often becoming an intolerable nuisance." There was no choice but to have "a successful fight with these [and other] insects."[37]

If fighting with insects was what farmers and housewives wanted to do, economic entomologists, who knew that eradication was impossible, were still eager to engage the battle. Having defined their profession around the pragmatic concerns of farmers, entomologists had, by 1870, a great deal to look back on and celebrate. Following the lead of Thaddeus William Harris, and working in the spirit of his book *A Report of the Insects of Massachusetts Injurious to Vegetation,* they had collectively transformed a hodgepodge of fragmented information scattered throughout dozens of agricultural journals into a coherent and loosely consolidated body of accessible and locally applicable knowledge. Professionalizing without pontificating, entomologists shored up their foundation by disseminating information about insect life cycles; promoting the potential of biological, chemical, cultural, and manual control; and—with the help of number crunchers and the cult of domesticity—lifting the veil of mystery and the attitude of admiration from the insect world.

Harris died from pleurisy in 1856 at the age of sixty. The developments he inspired appeared to him in only the vaguest of forms. In a letter sent to the geologist Ebenezer Emmons in 1845, he wondered if "my investigations pursued at intervals of leisure during some 25 years" had been "spent in vain."[38] But, as A. R. Grote recalled in 1889, Harris "ran the first furrow,

and his successors have but widened the field of practical and economic entomology." Those who did the widening of Harris's first well-placed furrow created a field of knowledge based on the early principles of integrated pest control. With this knowledge, they felt themselves prepared to tackle the insect problems that had plagued American farmers since the seventeenth century. Their plans were generally responsible, conservative, safe, linked to the past but not averse to change, and mired in the persistent power of observation. These qualities were in many ways the opposite of what would come to define the insect wars after 1900. But to fully understand how the quest to control insects ran in a direction that Harris could never have predicted, and most certainly would never have endorsed, we must turn to the frontier—the region that sustained America's ongoing insect paradox.