BJHS **48**(4): 639–660, December 2015. © British Society for the History of Science 2015
doi:10.1017/S000708741500062X First published online 27 October 2015

The ichneumon fly and the equilibration of British natural economies in the eighteenth century

SHEILA WILLE*

Abstract. The parasitic ichneumon fly, discovered by European natural philosophers in the seventeenth century, remained largely unstudied until it captured the attention of Enlightenment-era natural historians. Although this sudden surge of interest has been explained as an effort to understand the natural 'evil' of parasitism, the heyday of ichneumon studies was actually inspired by the political and agricultural context of late eighteenth-century Britain. British naturalists were captivated by this insect for reasons both philosophical and practical. In the providentially self-equilibrating qualities of 'natural' ichneumon economies, they saw solutions to political problems of famine, dearth, national wealth, governance and excess population, in addition to finding reassurance that Enlightened confidence in nature's inherent stability and fruitfulness was not unfounded.

> … each species shall multiply in such abundance or scarcity, as are best adapted to preserve, by a just equilibrium, the harmony of the universe: When I say, we behold this, the mind can scarcely forbear crying out, under a rapturous sense of conviction, 'every thing is good.'
>
> Dru Drury (1725–1804), *Illustrations of Natural History* (1770).[1]

The ichneumon fly was not newly discovered in the eighteenth century, nor was it known to be particularly beautiful, or even medicinally useful. Neither was it social, such that it was easily coopted as a model for good society. Indeed, the ichneumon was a killer, a 'parasitoid' insect that injected its eggs into other insects' bodies, ensuring the eventual destruction of the host. Why, then, was there such a surge of affectionate and scholarly interest in the fly among enlightened intellectuals at the end of the eighteenth century? What quality of this insect so compelled them and, further, what occasioned the tamping of their blaze of regard in the nineteenth century? In this essay, I will argue that this sudden surge and withdrawal of esteem for the ichneumon had its origins in the politics of a particular historical moment.[2]

* Kaplan Institute for the Humanities, Northwestern University, 1800 Sherman Ave, Suite 1-200, Evanston, IL, 60208, USA. Email: wille@northwestern.edu.

I am grateful to Fredrik Albritton Jonsson, the generous anonymous reviewers, Charlotte Sleigh and Rick DeJonghe for support and incisive criticism. Special thanks to the incredible and inspiring entomology department at the Oxford Museum of Natural History and head of Life Collections Darren Mann, who introduced me to the modern science of entomology and shared his valuable time and expertise.

1 Dru Drury and John O. Westwood, *Illustrations of Exotic Entomology, Containing Upwards of Six Hundred and Fifty Figures and Descriptions of Foreign Insects*, 3 vols., London: H.G. Bohn, 1837, vol. 1, p. 93. The original work was Drury's own, published in three volumes in 1770, 1773 and 1782.

2 For the importance of metaphor in guiding the ecological sciences see Donald Worster, *Nature's Economy: A History of Ecological Ideas*, 2nd edn, New York: Cambridge University Press, 1985, pp. xiv–xv.

The mid-eighteenth century was a critical juncture for the ichneumon, marking the inception of its heyday as an object of study vested with philosophical and practical significance. Prior to this juncture, investigations of the insect were resultant from its appearance in captive host caterpillars that were being observed for other reasons, and while investigators in these earlier years also tended to tout the philosophical significance of parasitism, they were largely interested in attacking atheism and proving the benevolence of Creation. After mid-century, however, naturalists saw something much grander in the vision of newly hatched ichneumon larvae eating a caterpillar from the inside out. They divined a system of natural governance and economy in the insect's life cycle which resonated with myriad late eighteenth-century concerns about the agricultural wealth of nations, the stability of nature, the new police state and population politics. Enthusiasm for the insect centred, as entomologist Dru Drury noted (above), on its ability to maintain the 'just equilibrium' of natural systems by targeting the worst of the crop pests.[3] The equilibrium of the ichneumon economy supported human agriculture directly and resonated with the contemporary political scene. However, the philosophical and practical significance of the ichneumon in its heyday dwindled by the mid-nineteenth century. The insect was forced to vacate its starring role in the 'economy of nature' as the political and social concerns that had buoyed it up faded and breeding projects failed to produce fruit.

One author, writing on the same group of insects, has argued in exactly the opposite way regarding the short-lived fascination with the ichneumon economy. Stephen Jay Gould contends that interest in the ichneumon arose because it was a source of significant theological anxiety for naturalists. In his version, an ichneumon bursting forth from a caterpillar's body was a challenge to dearly held notions of natural morality. How could the disgusting violence of the ichneumon's behaviour exist in a world governed by a benevolent and loving God? In Gould's story, this 'inappropriate' early modern binding of the moral to the natural was indicative of a 'traditional' knowledge of nature which compelled naturalists to waste their resources wrangling with theodicy.[4] They ostensibly had time for little else until Charles Darwin (1809–1882) liberated them from their obligation to consider the connection between the moral and the natural, setting the stage for modern science.[5] Although Gould could be correct in positing that such tension existed in late nineteenth-century biology, his preoccupation with modern science and the lasting influence of Victorian-era anti-cruelty movements causes him to project tension from that historical moment back into earlier periods, where it simply did not exist.

While natural evil did concern eighteenth-century entomologists, it was not the evil of cruelty that caught their attention; they fretted instead about the forces that pushed nature out of balance and the social and political implications of such disequilibrium. Witness, for example, the sheer volume of pages that entomologists William Kirby

3 Despite the difficulty of using the word 'entomologist' to describe natural historians of the eighteenth century, the author occasionally employs the term to denote those naturalists who focused their entire effort on insects, as Drury did.

4 Stephen Jay Gould, *Hen's Teeth and Horse's Toes*, New York: Norton, 1983, p. 43.

5 Gould, op. cit. (4), pp. 32–45.

(1759–1850) and William Spence (1782–1860) dedicated to describing the decimation of human agriculture by insect pests in their most famous and influential work, the *Introduction to Entomology*, and their dedication to explaining the place of such insects in an otherwise perfect Creation.[6] Kirby and Spence's prolix treatment of insect evil was founded on Enlightenment-era concerns with invasive wheat pests and other insect depredations.[7] The ichneumon's terrible efficiency was renowned as a check to natural evil, not condemned as the embodiment of it.[8]

The rise of the ichneumon as an object of study after the mid-eighteenth century had instead to do with the new practical and philosophical significance of natural stability to British understandings of governance, population politics and agricultural wealth. Choosing among the thousands of insect groups known to them, taxonomists began to focus on the ichneumon because of the insects' philosophical significance as supporters of natural balance and stability. Concern with balance in the ichneumon natural economy acquired a specifically political valence when they were depicted as a 'police' of nature in a time when European states were increasingly expected to act as policing agents in the individual lives of subjects and citizens. Agriculturally speaking, pest problems increased across Britain during the eighteenth century as a result of the agricultural revolution and the new political fashion for agricultural improvement among domestic and colonial elites that C.A. Bayly has called 'patriotic agrarianism'.[9] The ichneumon's ability to balance populations of insect pests linked discussions of its natural history both to population politics of a Malthusian variety and to fears of famine and dearth. These three themes – police, population and agricultural wealth – were woven together in the story of the much-lauded self-equilibrating ichneumon economy of nature after 1750.

Some of the most influential ideas to emerge from this period also evoked balance, so the philosophical and practical significance of the ichneumon is not a simple case study in how politics influence science but instead indicates a world where ideas about nature and the natural police passed easily between the realms of the political, social, cultural and scientific. Indeed, one need only look to the gloomy considerations of the painful, yet necessary, natural checks and balances against expanding populations devised by Thomas Malthus or the 'invisible hand' of Adam Smith for examples of how models of the natural balance influenced political economy.[10] In short, the ichneumon transformed

6 William Kirby and William Spence, *An Introduction to Entomology, or, Elements of the Natural History of Insects*, 2nd edn, 4 vols., London: Longman, Hurst, Rees, Orme, and Brown, 1816, vol. 1. The second edition is cited here as it is more readily available than the first. There are no significant differences between these editions.

7 Philip J. Pauly, 'Fighting the Hessian fly: American and British responses to insect invasion, 1776–1789', *Environmental History* (2002) 7, pp. 485–507.

8 Gould, op. cit. (4), p. 40.

9 C.A. Bayly, *Imperial Meridian: The British Empire and the World 1780–1830*, New York: Longman, 1989; Richard Drayton, *Nature's Government: Science, Imperial Britain and the 'Improvement' of the World*, New Haven: Yale University Press, 2000.

10 Margaret Schabas, 'Adam Smith's debts to nature', in Margaret Schabas and Neil DiMarchi (eds.), *Oeconomies in the Age of Newton*, Durham, NC: Duke University Press, 2003, pp. 262–281; Schabas, *The Natural Origins of Economics*, Chicago: The University of Chicago Press, 2005.

from a benign and solitary creature, of interest to a handful of naturalists, into an insect group that had philosophical and possibly practical roles to play in maintaining natural and national economies. The ichneumon's unique life cycle harmonized with and contributed to a rising refrain on natural balance that had implications for Britain's place in the world; it became exciting to naturalists as a result.

The study of the ichneumon before the mid-eighteenth century

Between its discovery in the seventeenth century and its heyday after the mid-eighteenth century, investigators of the ichneumon fly contributed to a small and eclectic field of study in which any symbolic meaning attached to the insect was rather subdued. The appearance of the fly itself was often accidental, occurring when artists and entomologists attempted to observe the emergence of a butterfly and found themselves watching the birth of an ichneumon instead. Intentional investigation of the ichneumon gained ground, but it was mostly oriented towards the project of dissolving the notion of spontaneous generation in insects. In all, early investigations of the ichneumon sought to establish its life cycle and, although representations of the insect did display a metaphorical valence, they were not as intense or politically relevant as that which came after.

To understand the 'accidental' nature of early studies of the ichneumon, it is crucial to grasp the biology of the insect as we know it today. The term 'ichneumon' is quite vague in its historical usage, but pertained in general to the modern grouping of the parasitoid Hymenoptera, or wasps, as opposed to parasitoid beetles or flies.[11] The parasitoid wasps are easily recognizable by non-entomologists because of their memorable behaviour and morphology. Adult parasitoid wasps have a long, hollow tail or ovipositor which they use to pierce the skin of a host insect and deposit eggs.[12] When the eggs hatch, the larvae eat the host insect from the inside out, often dining with remarkable discretion. Some choose, for example, to preserve organs that keep the host alive while destroying those responsible for motion. There are two types of parasitoid wasp. Ectoparasitoids form elongated egg sacs on the back or side of the host insect which are easily identifiable by even the most amateur of entomologists. By contrast, endoparasitoids inject their eggs into the bodies of the host, producing less obvious changes.[13]

The covert endoparasitoid wasp is the more historically interesting of the two types. Observing strange, slender wasps emerge from the bodies of insects that were decidedly not wasps themselves, early naturalists often felt surprise, which generated research.[14] In

11 Dipteran parasitoids or parasitoid flies appear occasionally in eighteenth-century works alongside their Hymenopteran counterparts. Maria Sybilla Merian's paintings contain many easily identified tachinid flies. Maria Sybilla Merian, *De Europische Insecten, Naauwkeurig Onderzogt, Na't Leven Geschildert, En in Print Gebragt Door*, Amsterdam: J.F. Bernard, 1773, Plates 33, 73, 93, 124 and 143.

12 Nick Mills, 'Parasitoids', in Vincent H. Resh and Ring Cardé (eds.), *The Encyclopedia of Insects*, San Diego: Academic Press, 2003, pp. 845–846.

13 Merian depicted ectoparasitoid egg sacks on at least one occasion. Merian, op. cit. (11), Plate 93, bottom.

14 Moses Harris, *The Aurelian: Or, Natural History of English Insects*, London: For the Author, 1766, p. 80; James Rennie, *Insect Transformations*, London: Longman, Rees, Orme, Brown, and Green, 1830, p. 60. On the intellectual history of surprise or wonder see Lorraine Daston and Katherine Park, *Wonders and the Order of Nature*, New York: Zone Books, 1998, Chapter 8.

addition to emerging from other insects, the ichneumon had also been noticed breaking free from 'vegetable excrescences' or galls, which are plant tissue tumours triggered by insect infestation.[15] In fact, gall-making insects continued to be classified loosely with their ichneumons well into the eighteenth century, likely based on this element of surprise.[16] Ichneumons became even more visible when artists, naturalists and physicians began to bring pupae and caterpillars into their homes for the purposes of study and could not avoid observing the inevitable surprising infestations. Maria Merian (1647–1717) and Eleazar Albin (1690–1742), the great painter–naturalists, watched ichneumons hatch from their subjects and eventually included them in their paintings.[17]

For some seventeenth-century naturalists, the surprising ichneumon was a problem to be solved because its mysterious emergence seemed to provide evidence in support of the potentially atheistic doctrine of spontaneous generation. The British physician Martin Lister (1639–1712) presented his research on the ichneumon in the *Philosophical Transactions* in the 1670s, hoping to spark an upsurge in ichneumon studies by including a list of queries for further work.[18] He declared the ichneumon to be one of the 'greatest puzzels [*sic*] in nature', which, if solved, might lay low the doctrine of spontaneous generation once and for all.[19] He was answering the call of John Ray (1627–1705), the great natural theologian, who had recently invited 'ingenious naturalists' to investigate the matter of the ichneumon's generation precisely because of its theological implications. Ray used the details of the parasitization of a caterpillar to inspire his readers, showing that 'all creatures are generated univocally by Parents of their own Kind'.[20] While Lister busied himself with galls in the pages of the Royal Society's

15 Oak galls were associated in Britain with the Restoration in the form of 'Oak Apple Day'. J.C. Loudon, *Arboretum Et Fruticetum Brittannicum; or, the Trees and Shrubs of Britain*, 8 vols., London: Longman, Orme, Brown, Green, and Longmans, 1838, vol. 3, pp. 1823–1824.

16 William Derham was likely the last naturalist to class galls with ichneumons, even though he understood the life cycle of the parasitoid and was even able to differentiate between dipterous ('musca') and hymenopteran ('vespa') parasitoids. William Derham, *Physico Theology: Or, a Demonstration of the Being and Attributes of God from His Works of Creation*, 13th edn, London: Robinson and Roberts, 1768, p. 241. For parasitoid life cycle, p. 379; for 'musca' and 'vespa' ichneumons, p. 228.

17 Merian, op. cit. (11), Plate 93. Eleazar Albin, *A Natural History of English Insects Illustrated with a Hundred Copper Plates, Curiously Engraven from the Life*, London: Printed by William and John Innys, 1724. Dozens of ichneumons occur in the *English Insects* and are mentioned in the text accompanying each painting, usually at the end of the page.

18 Martin Lister, 'Some Additions of Mr. Lyster to His Former Communications about Vegetable Excrescencies and Ichneumon Wasps: Together with an Inquiry Concerning Tarantulas', *Philosophical Transactions of the Royal Society* (1671) 6, pp. 3004–3005.

19 Martin Lister, 'A Letter of Mr. Martin Lister, Written at York August 25 1671, Confirming the Observation in No. 74 About Musk Sented Insects; Adding Some Notes Upon D. Swammerdam's Book of Insects, and on That of M. Steno Concerning Petrify'd Shell', *Philosophical Transactions of the Royal Society* (1671) 6, pp. 2281–2284, 2281. John Ray's correspondence with Lister is warm and entomological; see *The Correspondence of John Ray: Consisting of Selections from the Philosophical Letters Published by Dr. Derham and Original Letters of John Ray in the Collection of the British Museum* (ed. Edwin Lankester), London: Printed for the Ray Society,1848. Lister to Ray, 8 February 1670.

20 John Ray, *The Wisdom of God Manifested in the Works of the Creation, in Two Parts*, 6th edn, London: Printed for William Innys, 1714, p. 322.

Transactions, other Dutch, Italian and English naturalists across Europe watched their captive caterpillars for parasitoid attacks in order to elucidate the insect's life cycle.[21] Jan Swammerdam (1637–1680) is credited with putting the pieces together to understand the complete life cycle of the insect in 1669.[22]

By contrast, eighteenth-century entomologists had closed the book on debates about life cycle and spontaneous generation and were drawn to study these insects for reasons that had more to do with the ichneumon's apparent allegiance with humanity. The idea that the ichneumon was humanity's ally already had a long pedigree. In the ancient world, the name 'ichneumon' indicated a weasel, but the weasel's characteristics put one very much in mind of its eighteenth-century insect namesake. This weasel was well known for stealing crocodile eggs and killing asps, two creatures supposed to have plagued ancient Egyptians. Pliny described an ichneumon weasel that was utterly fearless on humanity's behalf as it dived into the mouth of a crocodile to destroy it in a distinctly parasitoid-like manner:

> the [ichneumon] spieth his vantage, and seeing him lie thus broad gaping, whippeth into his mouth, and shooteth himself downe his throat as quicke as an arrow, and then gnaweth his bowel, eateth a hole through his bellie, and so killeth him.[23]

Catholic bishop and theologian Albertus Magnus (1193/1206–1280) reiterated this version of the ichneumon story in the twelfth century and it was certainly not forgotten in the eighteenth, since the gullet-diving version of the ichneumon weasel appeared with regularity in British periodicals.[24] In 1792, it even made the front page in agriculturalist and political economist James Anderson's popular weekly magazine *The Bee*, which catered to a wide range of intellectuals but often took up the topics of politics and farming.[25]

The insect version of the ichneumon was variously defined in the sixteenth and seventeenth centuries, but the vision of it narrowed and consolidated over time, and its classifications often emphasized its loyalty to human well-being. Some early naturalists, such as Thomas Moffett (1553–1604), followed Aristotle in their cataloguing of the

21 J.C. van Lenteren and H.C.J. Godfray, 'European science in the Enlightenment and the discovery of the insect parasitoid life cycle in the Netherlands and Great Britain', *Biological Control* (2005) 32, pp. 12–24; Frank N. Egerton, 'Leeuwenhoek as a founder of animal demography', *Journal of the History of Biology* (1968) 1, pp. 1–22. See Egerton for a summary of Leewenhoek's voluminous correspondence with the Royal Society.

22 E. Tremblay and L. Masutti, 'History of insect parasitism in Italy', *Biological Control* (2005) 32, pp. 34–39; Lenteren and Godfray, op. cit. (21), p. 17. Italian naturalist Ulisse Aldrovandi (1522–1605) recorded a parasitoid hatching in a woodcut print in 1602, calling it an 'alternate form of the usual butterfly'. R.G. Van Driesche and M.S. Hoddle, 'Biological control of insect pests', in Vincent H. Resh and Ring Cardé (eds.), *Encyclopedia of Insects*, New York: Academic Press, 2003, pp. 103–115.

23 Pliny, *The Natural History of Pliny*, 6 vols., London: G. Bell & Sons, 1890, vol. 2, pp. 286–287, Book 8:35–36.

24 Pauline Aiken, 'The animal history of Albertus Magnus and Thomas of Cantimpré', *Speculum* (1947) 22, pp. 205–225, 211. William Wood, *Zoography: Or, the Beauties of Nature Displayed in Select Description from the Animal, and Vegetable*, 3 vols., London: Cadell and Davies, In the Strand, 1807, vol. 1, pp. 256–259; 'The Ichneumon', *Saturday Magazine* (1841) 559, pp. 109–110; Foucher d'Obsonville, *Philosophic Essays on the Manners of Various Foreign Animals, with Observations on the Law and Customs of Several Eastern Nations* (tr. Thomas Holcroft), London: John Johnson, 1784, pp. 75–79.

25 'An Account of the Ichneumon', *The Bee: Or Literary Weekly Intelligencer* (1792) 12(102), pp. 81–84.

ichneumon insect as a predatory wasp which only killed venomous spiders, establishing that it was a friend to humans in the tradition of the ichneumon weasel.[26] But by the late eighteenth century, the ichneumon took on a grander role in an optimistic vision of Britain's historical trajectory. It was strictly considered to be a parasitoid (and not a predatory) wasp or fly that was apparently designed to support British aspirations to dominance through the preservation of a waning domestic food supply in an age of burgeoning human population.

Ichneumon heyday: the philosophical and practical significance of the ichneumon after the mid-eighteenth century

In its heyday as an object of study, the ichneumon attained a high level of philosophical and practical significance to intellectuals, agriculturalists and naturalists. It was increasingly found in print after the mid-eighteenth century, particularly in works of taxonomy, where its classification was consolidated over time. Enlightenment taxonomists complained about the 'location of portions of the *Ichneumonites* in separate classes', an ostensibly common practice among earlier taxonomists, like Ray and Swammerdam.[27] Enlightenment taxonomists worked to gather these ichneumons from their diffuse taxonomic locations into a more exclusive and singular group, which was eventually designated the 'parasitic Hymenoptera' in the 1830s.[28] Ichneumons had also begun to appear in ornate and artistic volumes on insect nature, marking a departure from earlier works in which pictures of ichneumons were only secondary characters in illustrations of the butterflies they parasitized.[29]

Among the seemingly endless known groups of arthropods available for taxonomic work in the eighteenth century, taxonomists found the ichneumon to be a particularly gratifying insect to classify, working on it to the exclusion of other orders and genera because of its philosophical and practical significance. Eighteenth-century taxonomy

26 Moffett used the word 'Phalangia' to describe these spiders, a general term that meant only 'any venomous spider' in the seventeenth century and did not indicate the harmless spiders that inhabit the *Phalangium* genus today. Edward Topsell *et al.*, *The History of Four-Footed Beasts and Serpents*, 2 vols., London: G. Sawbridge, 1658, vol. 2, pp. 1061–1062. For the harmlessness of modern *Phalangium*, Oxford English Dictionary Online, '*Phalangium*', at www.oed.com.proxy.uchicago.edu/view/Entry/142130?redirectedFrom=phalangia#eid, accessed 5 November 2012. For Aristotle's ichneumon see Aristotle, *History of Animals in Ten Books* (tr. Richard Cresswell), London: George Bell and Sons, 1883, p. 127, Book 5:15.

27 Edward Newman, 'Further Observations on the Septenary System', *Entomological Magazine* (1837) 4, pp. 234–251, 247.

28 A.H. Haliday, 'An Essay on the Classification of the Parasitic Hymenoptera, Which Correspond with the Ichneumones Minuti of Linnaeus', *Entomological Magazine* (1833) 1(3), pp. 259–276; William Kirby, *Monographia Apum Angliæ*, Ipswich: Printed for the Author by J. Raw, 1802; A.H. Haliday, 'Essay on Parasitic Hymenoptera', *Entomological Magazine* (1834) 4(2), pp. 92–106; Haliday, 'Essay on the Classification of Parasitic Hymenoptera', *Entomological Magazine* (1834) 2(3), pp. 225–259.

29 Edward Donovan, *The Natural History of British Insects*, 10 vols., London: Bye and Law, St John's Square, 1802, vol. 2, pp. 12–14; vol. 3, pp. 56–57; vol. 10, p. 13. The third volume of Donovan's work also finds room for the *Sphex sabulosa*, which had only recently been removed from the ichneumon category. Another insect that he is careful to parse from the ichneumon is the *Sirex spectrum*, which resembles it; ibid., vol. 7, p. 25. For the ichneumon's host insects see ibid., vol. 4, p. 40.

was already a philosophically significant endeavour; Kirby stopped just short of declaring that Judgment Day itself lay at the end of it, calling that moment instead the 'day of true and genuine science' when 'we shall then behold each natural object in its proper place; we shall learn its history, economy, and uses, its moral and spiritual signification, and find God's work and God's word'.[30] But ichneumon taxonomy was even more significant. That Kirby's own taxonomic work focused heavily on ichneumons and predatory insects was no accident. He not only wrote several influential articles on the ichneumons of wheat pests, but also worked on two groups of insects with such potential value in biocontrol that they have captured the attention of modern scientists working in agriculture today.[31] One of these groups was the order Strepsiptera, which contains parasitoid insects that may have applications in palm oil production. The other was the family Staphylinidae or 'rove beetles', which are aggressive predators that can be purchased today in bulk for biocontrol purposes.[32] Kirby, it seems, had some inkling of the potential boon these insects could provide to human agriculturalists long before they caught the eye of modern biologists. Their apparent support of British agriculture drew Kirby to them as a taxonomic subject.

Although it may have been acceptable to be inspired to taxonomize by the philosophical significance of an insect, that significance was thought by some to be distracting taxonomists from physical morphology, which historians of taxonomy have identified as the centre of taxonomical debates in the mid-eighteenth century (alongside whether such schemes ought to be 'natural' or 'artificial').[33] However, the example of ichneumon taxonomy and the influence of its behaviour on naturalists' work may complicate this picture. For example, Kirby loudly criticized the famous Swedish taxonomist Carolus Linnaeus (1707–1778) for allowing parasitism to eclipse dramatic morphological differences as the heart of his taxonomy of the minute ichneumons. Keeping the minute ichneumons lumped together with other ichneumons strictly on the basis of shared behaviour was causing science to regress: 'we never think of putting together into one

30 Kirby, op. cit. (28), pp. 3–4.

31 Jeyaraney Kathirithamby *et al.*, 'Strepsiptera parasites: novel biocontrol tools for oil palm integrated pest management in Papua New Guinea', *International Journal of Pest Management* (1998) 44(3), pp. 127–133; R.E. Orth *et al.*, 'A rove beetle, *Ocypus Olens*, with potential for biological control of the brown garden snail', *Canadian Entomologist* (1975) 107(10), pp. 1111–1116; Alois Honěk *et al.*, 'Rove beetles (Coleoptera: Staphylinidae) in an apple orchard', *Plant Protection Science* (2012) 48(3), pp. 116–221.

32 William Kirby, 'Addendum to Strepsiptera', *Transactions of the Linnean Society of London* (1818) 11, pp. 233–234; Kirby, 'Strepsiptera, a New Order of Insects Proposed; and the Characters of the Order, with Those of Its Genera, Laid Down', *Transactions of the Linnean Society of London* (1816) 11, pp. 86–122; Kirby, 'Three Notebooks on Staphylinidae', in William Kirby's Papers, Natural History Museum, London; Kirby, 'A Continuation of the History of Tipula Tritici, in a Letter to Thomas Marsham', *Transactions of the Linnean Society of London* (1800) 5, pp. 96–110; Kirby, 'History of the Tipula Tritici and Ichneumon Tipulæ, with Some Observations Upon Other Insects That Attend the Wheat, in a Letter to Thomas Marsham', *Transactions of the Linnean Society* (1798) 4, pp. 230–239.

33 Indeed, historians of taxonomy seem to be focused on questions of artificial versus natural systems based on body parts and definitions of 'essentialism' and 'species fixity', as well as other topics that dwell in locations even more distant from our question of behaviour. See John S. Wilkins, *Species: A History of the Idea*, London: University of California Press, 2009; Charissa S. Varma, 'Threads that guide or ties that bind: William Kirby and the essentialism story', *Journal of the History of Biology* (2009) 42, pp. 119–149; Mary P. Winsor, 'The development of Linnaean insect classification', *Taxon* (1976) 25(1), pp. 57–67.

genus those insects that prey on dead animals, or live in dung, or upon the same plant. This is going back to the old entomologists who made Habitat a generic character'.[34] In this case, Kirby was referring to taxonomic work done two generations earlier in John Ray's *Historia Insectorum*. Other entomologists, like René de Réaumur (1683–1757), also mentioned their anxiety about the influence of the behavioural characteristics, when perhaps the truth of classificatory relationships was more subtle.[35] If taxonomy was such a divine and vital pursuit, it is remarkable that naturalists found the ichneumon's behaviour so compelling as to distract them from their morphologically based classificatory work. Its behaviour held the promise of an even higher purpose than was to be found in the pursuit of a perfect taxonomy.

The ichneumon's capabilities in service of humanity were promising indeed. As an arbiter of excess, the ichneumon potentially had a place in any Enlightened consideration of the 'economy of nature', which was a foundational concept for natural historians, natural theologians, political economists and moral philosophers. The self-equilibrating quality of natural systems was the fundamental premise in Malthusian population management, Huttonian geology, Smithian economics, Linnaean natural history, Paley's and Ray's natural theology and Mill's utilitarian moral economy. In the case of writings about the ichneumon in our period, the just equilibrium appears most clearly as being connected to two themes: the governance of populations, both insect and human, and its assistance with agricultural improvement.

Carolus Linnaeus was one of the naturalists who wrote most prolifically on the just equilibrium of the economy of nature, and he remarked on the ichneumon's place within it. In the 'Police of Nature', he meticulously described as many of the natural mechanisms of the just equilibrium as he could imagine in order to develop a model of natural stability. In that model, a number of interrelated elements were dynamically balanced: populations, food, waste, manure, detritus, carcasses, weeds and other plants. He noted especially the insects that kept detritus and excess populations of other insects and animals from running rampant, and included the ichneumon in his list.[36] Each type of thing in the economy of nature had another to keep it in check, lest it take over the surface of the Earth.[37] The Swede's vision of the just equilibrium resonated in Britain with naturalists and with scholars in political economy who similarly emphasized such self-governing qualities in nature.

The idea of police did not arrive on the European scene with Linnaeus; it was introduced into Continental lives in the wake of the Reformation. Historian Marc Raeff

34 Kirby, op. cit. (28), p. 44.

35 Winsor, op. cit. (33), 59.

36 Carolus Linnaeus and Henricus Christianus Daniel Wilcke, 'On the Police of Nature', in Benjamin Stillingfleet (ed.), *Select Dissertations from the Amoenitates Academicae: A Supplement to Mr. Stillingfleet's Tracts Relating to Natural History*, London: G. Robinson and J. Robson, 1781, pp. 129–166, 143. Linnaeus was likely the author of most of the dissertations in the Stillingfleet tracts.

37 For overpopulation parables in natural history see Fredrik Albritton Jonsson, *Enlightenment's Frontier: The Scottish Highlands and the Origins of Environmentalism*, New Haven: Yale University Press, 2013, pp. 188–212. For Linnaeus on the economy of nature see Frank N. Egerton, 'A history of the ecological sciences part 23: Linnaeus and the economy of nature', *Bulletin of the Ecological Society of America* (2007) 88, pp. 72–88.

argues that the police state rose to prominence as ecclesiastical authorities withdrew. Instead of remaining in their old role as dispensers of justice, European states became fixated on public utility, happiness and prosperity by encouraging wealth-making and industrious morality. 'Police' in this new context did not simply mean men in uniforms. Rather, it entailed the establishment of a bureaucracy of offices for the even-handed enforcement of policies. From these offices were born efforts in public health, welfare, infrastructural development and education that served the state by serving the populace first. These developments reached a critical mass in Europe by the middle of the eighteenth century.[38]

The police in early modern Europe were a structural and administrative force which mirrored quite precisely the police of nature appearing in entomological texts at the same time.[39] Lawmakers believed they were creating a natural system of laws that would ultimately reduce criminal excess through its internal structure, rather than through the endless interventions of the leader or creator. Thus the creation of policy in the new police state was meant to reflect the creation of laws of nature by God. Raeff has described the ruler's new mission in these terms:

> As the Divine maker has put into motion the well-regulated mechanism of nature and has kept it in operation by means of rational laws, so should the ruler enact the laws and regulations that shape society and keep it on the right path.[40]

In this moment, law became 'natural' and nature became lawful, and society and nature were both policed by an intentionally created and providential structure. That a minority of creatures might suffer in such an economy was expected, both in states and in nature. For example, the ichneumon is often shown to be torturing the victimized caterpillar, but these accounts of violence should not be interpreted as a critique of the parasitoid's violence against its own class, if not its own species. Instead, the graphic nature of these descriptions was part of the naturalization of the new police state.

Even though the ichneumon's violence could be folded into its police work, few writers ever showed any need to justify the horror of its parasitism. Enlightenment intellectuals, who were often deeply embroiled in questions of human pain and pleasure, were convinced that animals also felt pain but had no interest in condemning the causes of such suffering. For example, it was never suggested that researchers should stop the collection of biological specimens on the grounds of animal suffering.[41] Kirby and Spence mentioned in passing the torture of a beetle on a pin,[42] but only one author in the wider literature ever felt the need to defend the murder of insects for entomological collections

38 Marc Raeff, 'The well-ordered police state and the development of modernity in seventeenth- and eighteenth-century Europe: an attempt at a comparative approach', *American Historical Review* (1975) 80, pp. 1221–1234. Jonsson, op. cit. (37), distinguishes the British 'police' state as one which located such policing within civil society.

39 Winsor, op. cit. (33), p. 59.

40 Raeff, op. cit. (38), p. 1226.

41 Bernard E. Rollin, 'Animal mind: science, philosophy, and ethics', *Journal of Ethics* (2007) 11, pp. 253–274, 254–255.

42 Kirby and Spence, op. cit. (6), vol. 2, p. 225.

(in *The Kaleidoscope* in 1823).[43] Before the 1850s, cruelty to or among animals was no more problematic than it had been for perhaps two hundred years.[44] Similarly, concern with the caterpillars' pain would have been no more intense in the eighteenth century than it had been when the insect's behaviour was first discovered in the seventeenth century.[45] Therefore the sudden interest in recounting its story must have had a more proximate cause in the late eighteenth and early nineteenth centuries than a simple unease about violence. In general, the ichneumon parable did not condemn cruelty in the animal world, in part because such violence was justified, but also because the discomfort of animals provoked little anxiety as a rule.

The ichneumon's policing, welcome or justified as it was, was indeed violent. Writers continually remarked on the courage and efficacy of their insect ally. Not only was the ichneumon a police of nature, it was stunningly good at its job. The ichneumon was fearless, much like its weasel counterpart. The description of the weasel in *The Bee* in 1792 focused heavily on its fearlessness: 'Neither the strength of the dog, nor the malice of the cat, can terrify it; neither the claws of the vulture, nor the poison of the viper, can intimidate it'.[46] Author and poet Oliver Goldsmith (1730–1774), who had little praise for insects of any kind (much less for any form of undomesticated 'incorrigible nature'), simultaneously admired characteristics that we might find at odds, praising both the 'courage and rapacity' of the fly in a single breath.[47] The ichneumon was ruthlessly efficient, using its long ovipositor to reach the most carefully concealed grubs and subvert the dedicated parenting of other adult insect species in an operation that was 'ordained by nature'.[48] Entomologist Edward Donovan (1768–1837) described the ichneumon as 'voracious … robust and powerful, and armed with a formidable sting; they are the dread, and destroyer of other tribes … exist[ing] by rapine and plunder'.[49] In short, the ichneumon was a merciless killer, but admirably proficient. It was a good creature to have on your side.

Other descriptions dealt variably with the caterpillar's pain. James Rennie (1787–1867), another early popularizer of entomology, having described an episode of the parasitoid stabbing the caterpillar and injecting her eggs, portrayed the host's passivity in the face of molestation:

> It is not a little remarkable, that the poor caterpillar, whose body is thus pierced with so many wounds, seems to bear it very patiently, and does not turn upon the fly, as he would be certain to do upon another caterpillar should it venture to pinch him; a circumstance by no means

43 O.R.U., 'Entomology Defended from the Charge of Cruelty', *The Kaleidoscope: or, Literary and Scientific Mirror* (1823) 4(165), pp. 57–58.

44 Anita Guerrini, 'The ethics of animal experimentation in seventeenth-century England', *Journal of the History of Ideas* (1989) 50, pp. 391–407.

45 Anne Larsen Hollerbach, 'Of sangfroid and sphinx moths: cruelty, public relations, and the growth of entomology in England, 1800–1840', *Osiris* (1996) 11, pp. 201–220, 203.

46 'An Account of the Ichneumon', op. cit. (25), pp. 81–82.

47 Oliver Goldsmith, *An History of the Earth and Animated Nature, in Eight Volumes*, Dublin: James Williams, 1777, vol. 1, for incorrigible nature p. 221, for courage p. 130.

48 'Entomology', in Thomas Curtis (ed.), *The London Encyclopaedia: Or, Universal Dictionary of Science, Art, Literature, and Practical Mechanics*, London: For Thomas Tegg, 1829, pp. 477–478.

49 Donovan, op. cit. (29), vol. 2, p. 14.

> unusual. Sometimes, indeed, he gives a slight jerk, but the fly does not appear to be at all incommoded by the intimation that her presence is disagreeable.[50]

The 'poor' caterpillar was pitiable but, since it did not resist, Rennie imagined it to be barely inconvenienced by the wasp's sting. In other depictions, the caterpillar was less docile and 'shews evidence of great torture, while its intrails are devoured'. Such torture was further extended because the caterpillar was not permitted to die until all possible nourishment in its body had been siphoned up by the parasitoid larvae.[51] Donovan's caterpillar is 'scarified' by oviposition, sometimes dying prematurely from the trauma, though sometimes it 'survive[d] in misery'.[52] Dru Drury's caterpillar executed suicidal contortions or threw itself from great heights when lit on by the ichneumon, putting all its strength into disengaging its attacker.[53] Drury's caterpillar won its life, but most of the rhetorical caterpillars succumbed to their natural role as prey.

Naturalists found it imperative that the caterpillar should in general succumb, since the consequences of the failure of the police of nature to do their work would render the globe uninhabitable.[54] Goldsmith's description of the battle admitted that the ichneumon police was indeed 'very terrible' to other insects. However, if left unchecked for a 'single summer', pest insects would multiply at such a rate as to reduce the surface of the planet to a pile of writhing insect bodies: 'the fruits of the earth would only rise to furnish a banquet for the insect race, to the exclusion of all the noble ranks of animated nature'.[55] This refrain persisted well into the nineteenth century; various encyclopedias quoted Kirby, who explained that the ichneumon was 'sent in mercy, by Heaven', with a purpose of 'keeping within their proper limits the infinite host of lepidopterous larvae'.[56] Drury's version of the vegetable apocalypse came to pass in two summers, but an extension of the epigraph from the beginning of this essay further reveals his conviction that providential intervention against such disaster was assured:

> If we examine the glorious works of creation, and reflect on the paternal care and wisdom of the Almighty, displayed in the preservation and increase of all ranks and kinds of animals; that even the most direful and noxious, have such a proportion in the scale of life, as is most agreeable to

50 Rennie, op. cit. (14), p. 61.

51 'Explanation of the Phenomenon Respecting the Caterpillar', *The Bee: or Literary Weekly Intelligencer* (1792) 11, p. 287.

52 Donovan, op. cit. (29), vol. 2, p. 14.

53 Drury and Westwood, op. cit. (1), pp. 93–94.

54 On Earth as a 'habitable' planet see Clarence Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century*, Berkeley: University of California Press, 1967, pp. 375–429.

55 Oliver Goldsmith, *The History of the Earth and Animated Nature*, 8 vols., London: Printed for J. Nourse, in the Strand, 1774, vol. 8, p. 114.

56 'Entomology', op. cit. (48), p. 477. The entry for 1829 is the same as the one published in 1839. Later, more specialized encyclopedias would continue to quote Kirby's declaration on the insect. 'Ichneumon', in Charles Knight (ed.), *Natural History, Or, The Second Division of 'The English Cyclopaedia'*, London: Bradbury, Evans, and Co., 1867, pp. 197–198. Interestingly, these encyclopedia entries omit the section about 'God's mercy', but still imply a final cause or purpose to the activity of the ichneumon through the use of the phrase 'proper limits'.

> the ends of His divine providence; that the limits he hath prescribed to each, extend so far and no farther; and that each species shall multiply in such abundance or scarcity, as are best adapted to preserve, by *a just equilibrium*, the harmony of the universe, When, I say, we behold this, the mind can scarcely forbear crying out, under a rapturous sense of conviction, 'every thing is good.' It is to this end we see the strong are permitted to prey on the weak, that the number of the latter increase in a proportion to the sufficient supply to the wants of the former.[57]

Drury sustained his latter comment on the eaters and eaten by reminding his readers of the significance of the prey animals that provided sustenance for the 'nobler' creatures in the economy of nature. Their sacrifice was not a tragedy, but a cause for celebration. Pest insects were created to be destroyed and in their deaths lay the survival of other participants in the system, including (especially) humans.

A later and popular work, Edward Newman's (1801–1876) *Grammar of Entomology* (1835), evinced a similar fascination with the ichneumon's divine calling to assist in the preservation of a habitable Earth. Each chapter of the *Grammar* takes as its subject a single insect group and its relation to humans – apple moth, mosquito, silkworm and bee – but only the ichneumon chapter endowed the insect–human relationship with a divine purpose. Newman's ichneumon is a divinely created check on the devastation wrought by other, highly fecund insects, which 'increase so rapidly, that, without a check, their caterpillars would, in two or three years at the utmost, devour every green leaf on the face of the earth, and render it incapable of supporting its present inhabitants'.[58] Newman's ichneumon group was a standard police of nature with a novel twist – it contained specific subtypes of insect especially tailored to attack certain pest species.

The most influential entomologist to present the ichneumon's just equilibrium was certainly Kirby, whose work drew a much wider audience than any of these others had commandeered. Kirby, together with political economist William Spence, wrote the lengthy and much-lauded *Introduction to Entomology*, which moved through six editions in Kirby's life alone. Almost immediately, it became one of the most influential books on entomology for a general readership and was often cited in books and magazines.[59]

The ichneumon of the *Introduction* appears almost entirely in the first of the four volumes, which focuses on insect–human relations and contains the best examples of the just equilibrium. It comprises sections on injurious and beneficial insects, food procurement, habitation and metamorphosis, all of which pay varying degrees of attention to the mechanisms of the just equilibrium: the checks and balances on insect populations, the machine-like efficiency of natural systems, and the sacrifice of parts of those systems

57 Drury and Westwood, op. cit. (1), pp. 93–94.

58 Edward Newman, *The Grammar of Entomology*, London: Frederick Westley and A.H. Davis, 1835, pp. 40–41.

59 J.F.M. Clark, 'History from the ground up: bugs, political economy, and God in Kirby and Spence's *Introduction to Entomology* (1815–1856)', *Isis* (2006) 97, pp. 28–55, 29. Clark's excellent article describes the relationship between the political economist and theologian and the way their respective societal roles were reflected in the *Introduction*.

for the greater good.[60] The exposition of the ichneumon is one of many carefully crafted examples in the *Introduction* designed to make entomology compelling to the novitiate.

The ichneumon materializes with a rhetorical flourish about halfway through the volume, attended by its comrades-in-arms, the predator insects, which kill insects outright instead of infesting them. The reader feels relief when this tiny army of the just equilibrium finally takes the stage, since prior sections comprise a laundry list of the damage insects do to human bodies, health, wealth, food, beer-making, clothing, housing and leisure. The *Introduction* tells us that that our cabbages are doomed, that each species of tree has a pest specially designed to destroy it, and that there is even an insect which is ordained to eat only the paste holding our beloved books together. The depredations seem infinite, until at last the authors commiserate with us:

> And here I think, I can see you throw aside my papers, and hear you exclaim – 'Will this enumeration of scourges, plagues, and torments ever be finished? Was the whole insect race created merely with punitive views … Are they all … the powerful agents and instruments of the great enemy of mankind?'

Of course not, they write, and offer readers their redemption. Insects are only 'evil' when their populations 'exceed their natural limits', which happens occasionally in order to teach lessons to humanity. When the lesson is learned, populations quickly fall back into their proper proportion through the activities of the ichneumon, predator insects, and, to some predetermined degree, humans.[61] The *Introduction* assures us that even when nature seems unstable, it is not. Providence is always at work and insects' 'numbers, forces and powers … may neither exceed His purpose nor fall short of it'.[62] These evils were, of course, only evils for humans. The writers of the *Introduction* do not suggest that insects' violence against one another is at all a cause for concern.

This rhetorical device of describing the evils of certain parts of insect nature before introducing its powerful redemptive side was also employed by Erasmus Darwin (1731–1802) in Canto IV of his poem *The Temple of Nature*. In this work, the ichneumon actually appears on the other side of the war, in a similar list-like onslaught of nature's terrors. A spare stanza offers a variation on the theme of the story of the caterpillar:

> The wing'd Ichneumon for her embryon young
> gores, with sharp horn, the caterpillar throng
> the cruel larva mines its silky course
> an' tears the vitals of its fostering nurse.[63]

60 Kirby and Spence, op. cit. (6), vol. 1.

61 Kirby and Spence, op. cit. (6), vol. 1, p. 248. Kirby, unlike his seventeenth-century predecessors, believed there was little restriction on human efforts to reduce insect populations, although the outcome of such effort was determined entirely by God.

62 Kirby and Spence, op. cit. (6), pp. 240–241.

63 Erasmus Darwin, *The Temple of Nature, or, the Origin of Society, a Poem*, Baltimore: John Butler and Bonsal and Niles, 1804, p. 156, lines 34–38.

The insinuating ichneumon is accompanied by volcanos, murderous dragonflies, horse parasites and 'rapacious' sharks, evoking in the reader a great fear of the excesses of nature. Although the ichneumon of Darwin's poem is not a specific example of natural equilibration, the moral of his enumeration of excesses is one of balance. Canto IV changes its tone in line 137 when the bludgeoning we have received from the fear-inducing 'Muse' is interrupted by a new character, the Nymph, who appears to chastise her:

'Hear O Ye, Sons of Time!' the Nymph replies
Quick indignation darting from her eyes;
'When in soft tones the Muse lamenting sings,
And weighs with tremulous hand the sum of things;
She loads the scale in melancholy mood,
Presents the evil, but forgets the good.
But if the beam some firmer hand suspends,
And good and evil load the adverse ends;
With strong libration, where the Good abides,
Quick nods the beam, the ponderous gold subsides'.[64]

Darwin, like Kirby, offers a lengthy exposition on unstable and dangerous nature before presenting the metaphor of the 'firmer hand' of natural balance. Any visions of excess natural violence tended to 'forget the good' and, by widening their view to include the owner of the 'firmer hand', observers of nature could access a true account of nature, in which goodness abides. Given Darwin's echo of Drury's assessment that 'every thing is good', it is perhaps no wonder that there are several citations of 'Dr Darwin' in the first volume of the *Introduction*.[65]

For Darwin, the 'firmer hand' of nature could also solve the problem of famine through the elimination of excess populations. Humans, insect-like, multiplied into 'prolific hordes', touching off a Malthusian 'positive check' in his poem:

But war, and pestilence, disease, and dearth,
Sweep the superfluous myriads from the earth.
Thus while new forms reviving tribes acquire
Each passing moment, as the old expire;
Like insects swarming in the noontide bower,
Rise into being, and exist an hour;
The births and deaths contend with equal strife,
And every pore of Nature teems with Life.[66]

Human populations were subject to exactly the same natural processes as insects, including the positive checks of death through famine. What is most dire about his depiction is

64 Darwin, op. cit. (63), p. 167, lines 135–44.
65 Kirby and Spence, op. cit. (6), vol. 1, pp. 31, 38, 265, 302, 306, 425.
66 Darwin, op. cit. (63), p. 188, lines 369–380.

that it naturalized famine and suggested that both human and insect populations contained 'superfluous myriads' – short-lived and faceless creatures which were expendable for the greater good. Humans could not stop this violent process any more than the caterpillar, however valiant, could stop the ichneumon.

Kirby and Spence's picture of famine did not dally in metaphor. They argued instead that Britain avoided famine because of its special providential status, suggesting that the 'superfluous myriads' of people who existed in those 'less favoured nations of the globe' existed specifically to absorb the damage of the locusts, which never touched down on British soil.[67] Within the confines of the island, the just equilibrium was kept and famine avoided, both by Britain's status as a superior nation and by the careful ministrations of the providential ichneumon which saved (British) 'mankind from the horrors of famine'.[68] The idea that natural mechanisms governed famine through the ichneumon was regularly found in print for a more general readership, often quoting Kirby on the 'horrors of famine'.[69]

These naturalists were not evincing a disembodied argument about famine and dearth. Concern with the food supply is the final piece to the puzzle of the ichneumon heyday. The population of Britain doubled in size between 1750 and 1850 and agricultural outputs increased apace, causing an explosion of pest populations in what one historian has called the 'insect paradox' – more intensive farming meant more devastating insect visitations.[70] Despite these huge increases in output, dearth came to Britain by the 1790s. Yields dropped for key crops, such as barley, wheat and oats.[71] Crop failures, war restrictions, military commitments and subsequently high grain prices contributed to the increasingly urgent food problem. As a result, Kirby and others felt compelled to lend their expertise to the study of wheat pests and their ichneumons.[72] His account of one grain ichneumon was particularly impassioned:

67 Kirby and Spence, op. cit. (6), p. 120.

68 Kirby and Spence, op. cit. (6), pp. 260–279 for the *Introduction*'s lengthiest treatment of policing tactics of the predator bugs and ichneumon, p. 269 for the 'horrors of famine'.

69 'Ichneumon', *The Supplement to the Penny Cyclopædia of the Society for the Diffusion of Useful Knowledge*, London: Charles Knight, 1846, p. 70; Edwin Sidney, *The Blights of Wheat and Their Remedies*, London: Religious Tract Society, 1846, p. 130. By 1867, the moral weight of the 'horrors of famine' was sometimes actively repudiated in entries on the ichneumon, as in a posthumously published essay, Edward Newman, 'Collected Observations on the British Sawflies by the Late Edward Newman', *The Entomologist* (1878) 11(182), pp. 147–154, p. 150.

70 M.E. Turner, J.V. Beckett and B. Afton, *Farm Production in England, 1700–1914*, New York: Oxford University Press, 2001, p. 210; V.G. Dethier, *Man's Plague? Insects and Agriculture*, Princeton: Darwin Press, 1976, p. 54. For the insect paradox see James E. McWilliams, *American Pests: The Losing War on Insects from Colonial Times to DDT*, New York: Columbia University Press, 2008, p. 24–25. For the axiomatic nature of the idea that pest increase accompanies agriculture see May R. Berenbaum, *Bugs in the System: Insects and Their Impact on Human Affairs*, New York: Helix Books, 1995, pp. 106–107. For the other factors in pest increase, such as weaker plants generated by excessive weeding and breeding, see Dethier, op. cit., p. 54. Dethier's best example of cross-pollination with wild grain comes from South America, with maize and teosinte, but similar episodes were occurring in Europe with wheat, oats and rye.

71 Turner, Beckett and Afton, op. cit. (70), pp. 212–213.

72 Kirby, 'Tipula Tritici', op. cit. (32); Kirby, 'Strepsiptera' op. cit. (32); Kirby, 'Addendum', op. cit. (32); Kirby, 'Three Notebooks', op. cit. (32); Thomas Marsham, 'Further Observations on the Wheat Insect in a Letter to the Reverend Samuel Goodenough', *Transactions of the Linnean Society* (1798) 4, pp. 224–229.

> The superstition of the Ancients, had they been acquainted with the advantages which appear to be derived to man through the instrumentality of this important though minute link in the chain of creation, would have erected altars to it, as to a beneficent deity: Can we, who enjoy the clear light of revelation, do less than adore and extol that goodness, which thus preserves a due balance in his works, and says to the destroyer, 'Thus far shalt thou come, and no further?'[73]

Kirby's evocation of the 'due balance' in the case of the wheat pest counselled faith in the providentially equilibrating economy in the face of scarcity.

Entomologists' shared enthusiasm for the policing powers of the ichneumon (as well as for the taxonomical genius of William Kirby) was finally enshrined in the seal for the Entomological Society of London (ESL), founded in 1833.[74] The ESL's predecessor groups were the several 'Aurelian Societies' that rose and fell in the eighteenth century and had a bee for their emblem. However, the newly formed ESL decided to jettison the bee from its symbolic position and replace it with a parasitoid of the bee. The *Stylops kirbii*, a parasitic insect first described by Kirby, soon appeared as the ESL's new seal. As entomologist and artist of the new emblem John O. Westwood (1805–1893) put it in 1835, 'We may very entomologically infer that the Bee of the old Society had been Stylopized, and had at length given birth to the *Stylops kirbii*'.[75] The old societies had died, but in their death was the birth of a new intellectual life for entomologists, who were ready to serve the public good through the pursuit of a more economically oriented entomology. The ichneumon had become the most personal of metaphors for a wide swath of these experts and their first modern scientific society took the insect as its symbolic face.

Ichneumon heyday: improving the ichneumon after the mid-eighteenth century

Interest in and study of the ichneumon surged, but an urgent question still remained at the turn of the nineteenth century: was it a practical possibility that the good works of these animals might be managed by humans for profit? Or, as Kirby suggested, must we be restricted only to erecting philosophical altars to that 'minute link in the chain of creation', the ichneumon? Increasingly, sanguine naturalists partnered with agriculturalists to act as the police of insect nature themselves.[76] As a result, far more ink was spilled on expert intervention in pest control than ever before. Some naturalists were still optimistically counselling inaction with regard to insect invasion, on the

In these works, Kirby appears to be involved with at least three different kinds of ichneumon, including the Strepsiptera.

73 Kirby, 'Tipula Tritici', op. cit. (32), p. 235. Kirby was citing Job 13:11 here, as well as Linnaeus's *Systema Natura*: 'Finis creationis telluris est gloria Dei ex opere naturae per hominem solum', meaning, 'There is no clearer expression of his admiration than his placing man above the rest of creation'.

74 The ESL later transformed into the modern Royal Entomological Society.

75 Westwood spoke at an anniversary meeting of the ESL on 26 January 1835, in an 'Address on the Recent Progress and Present State of Entomology'. Audrey Z. Smith, *A History of the Hope Entomological Collections in the University Museum Oxford, with Lists of the Archives and Collections*, Oxford: Clarendon Press, 1986, p. 38.

76 Pauly, op. cit. (7).

grounds that such excesses of population would self-equilibrate, but such advice was increasingly rare in the nineteenth century.[77] The cause of pest control was taken up by the Board of Agriculture (established in 1793), by the ESL (1833) and by many periodicals, such as the densely written *Gardener's Chronicle* (1841).

Pest control depended on expert knowledge of the insect, but while Enlightenment-era naturalists had learned a great deal about the ichneumon since the days of Swammerdam and Ray, the potential application of that knowledge was still notional. Some confusion even persisted about the identity of the insect. In 1768, the *Gardener's Dictionary* was still declaring some species of ichneumon to be gall-makers on roses, an idea that appeared at least once more in print in 1813.[78] Some authors presented the ichneumon as a pest insect, a seed-eater, and a destroyer of vetches (a kind of wild legume under scrutiny in the late eighteenth century as a possible crop to replace the fallow in field rotations).[79] The notion of ichneumon as vetch-eater was not widespread and one article expressed serious doubts about the argument for its pestiferousness, as it was well known to be 'a cannibal'.[80] One French travel writer even tried to convince readers of the *Edinburgh Review* that the real value of the ichneumon lay in the excellent 'animal cotton' it produced to be harvested for use by humans.[81] However, many agriculturalists were inspired by Kirby's work and began publishing increasingly clear accounts of the ichneumon's police work, even though the new-found descriptive clarity did not lead to relief of pest problems.

Some agriculturalists joined the conversation about the ichneumon's efficacy with a view from the fields that threatened faith in natural equilibration. Thomas Ruggles (1747–1813), an Essex landowner and honorary member and correspondent of the Board of Agriculture, had read Kirby's essays. However, he was confronted with a daily reality which did not match up with the hopeful notions of the just equilibrium presented in those papers.[82] Ruggles wrote twice to the secretary of the board in the winter

77 For the equilibration argument in 1782 see William Curtis, *A Short History of the Brown-Tail Moth and the Caterpillars of Which Are at Present Uncommonly Numerous and Destructive in the Vicinity of the Metropolis*, London: B. White, J. Sewell, J. Johnson, J. Strahan, R. Faulder, 1782.

78 'Rosa Muscosa', in Philip Miller (ed.), *The Gardeners Dictionary; Containing the Best and Newest Methods of Cultivating and Improving the Kitchen, Fruit, Flower Garden, and Nursery*, London: For the Author, 1768, n.p; 'Bedegua', in John Mason Good, Olinthus Gregory and Newton Bosworth (eds.), *Pantologia: A New Cyclopaedia, Comprehending a Complete Series of Essays, Treatises and Systems*, London: T. Davison, 1813, n.p.

79 Thomas Potts, 'Bush Vetch', in Potts (ed.), *The British Farmers Cyclopedia: Or, Complete Agricultural Dictionary of Improved Modern Husbandry*, London: B. Crosby, 1808, n.p; James Adams, *Practical Essays on Agriculture, Containing an Account of Soils and the Manner of Correcting Them*, 2 vols., London: T. Cadell, 1789, vol. 1, p. 459. Adams echoes Swayne and pairs the ichneumon with an aggressive pest, the weevil.

80 George Swayne, 'On the Culture of the Bush Vetch, a Letter to the Secretary of the Society for the Encouragement of Agriculture, Arts, Manufactures and Commerce at Bath. Oct. 13 1785', in *Letters and Papers on Agriculture, Planting &C, Addressed to the Society Instituted at Bath for the Encouragement of Agriculture, Arts, Manufactures and Commerce*, London: R. Crutwell, 1786, pp. 71–78.

81 Louis Narcisse Baudry des Lozières, *Voyage a La Louisiane: Et Sur Le Continent De L'amérique Septentrionale, Fait Dans Les Années 1794 À 1798*, Paris: Dentu, 1802; 'Second Voyage a La Louisiane', *Edinburgh Review; A Critical Journal* (1803) 3(5), pp. 81–90, 89.

82 'Thomas Ruggles, 1745–1818', in Harry Inglis (ed.), *Dictionary of Political Economy*, Chicago: McMillan, 1913, p. 332.

of 1800 about the pest in his wheat fields, which Kirby visited in 1795. Ruggles could not explain why the visit had apparently failed to produce specimens of the pest, but insisted that it had recently returned: 'just before harvest I have walked into fields of wheat, where the colour showed the disease, and my stockings and cloaths have been almost covered with those insects these gentlemen found it so difficult a matter to possess themselves of in 1795'.[83] Of the presence and providence of Kirby's ichneumon there, Ruggles had no doubt, but if it did destroy the pest at all, he reckoned it was probably only an occasional gift and that 'it is not generally the case, or at least it was not so this year'. Despairingly, he recounted the near total losses on neighbours' farms, in which he saw his own lean future. In the dark days of December, the desperate Ruggles wrote another short letter, asking for the board's position on the ichneumon and the wheat pest, hoping for some expert advice for the coming year.[84]

The ichneumon appeared for the consideration of the Board of Agriculture in another context in the early nineteenth century, in conjunction with another of the most pressing pest problems in Britain – the wireworm.[85] Entomologist Thomas Marsham (1747/1748–1819) took the lead in informing the board of the trouble this subterranean larval pest caused for farmers. He cited one contemporary author who claimed that it destroyed several varieties of grain, as well as a number of other useful plants ranging from kitchen vegetables to juniper berries.[86] Marsham cited the groundbreaking work already accomplished in Sweden by the naturalist Clas Bierkander. Bierkander wrote in 1779 that there existed an ichneumon of this 'army of vermin', but also found that turning it to human benefit in their war against pests was a surprisingly difficult task. After unsuccessful breeding attempts in the 1770s, Bierkander was resigned to suggesting the only wireworm remedy he knew, which was to have children walk behind the plough and pull the larvae from the earth for imprisonment in glass bottles. 'Posterity', he lamented, 'must discover some more fortunate methods to exterminate or diminish them'.[87] Marsham thought it was high time for gentlemanly improvers to take up Bierkander's call to arms about extermination, but with his recounting of the Swede's failure to breed the ichneumon, he too fell silent on the issue of wireworm biocontrol.[88]

The benevolent but unmanageable ichneumon appeared again in the correspondence of the Board of Agriculture in 1814. In a somewhat lengthier consideration of farm pests, the improver and politician Sir John Sinclair (1754–1835) wrote on the ichneumon of wheat pests, paraphrasing Kirby on the vegetable apocalypse:

83 Thomas Ruggles, 'Wheat Insect, Nov 16, 1800', in Arthur Young (ed.), *Annals of Agriculture and Other Useful Arts, Collected and Published by Authur Young, Secretary to the Board of Agriculture*, Bury St Edmund's: Rackham, 1801, pp. 133–142, 140.

84 Thomas Ruggles, 'Wheat Insect, Dec 9, 1800', in Young, op. cit. (83), pp. 215–217.

85 The wireworm, apple aphis, turnip fly, hops fly and wheat midge (and possibly the cane fly and cassava/indigo worm) were the main pest problems in Britain and the empire in this period.

86 Thomas Marsham, 'On the Wire Worm', in *Communications to the Board of Agriculture on Subjects Relative to the Husbandry and Internal Improvement of the Country*, London: W. Bulmee, 1805, pp. 412–415, Clas Bierkander's entire article on the 'Root Worm' is included in Marsham's letter, pp. 413–415.

87 Marsham, op. cit. (86), p. 415.

88 Marsham, op. cit. (86), p. 412.

> The destruction effected by these insects would be immense and incalculable were it not that they are fortunately liable to the attacks of a number of enemies … [which] set bounds to the ravages of an insect which however insignificant it may seem at first sight might if permitted to exceed its due limits deprive us of the staff of life and might almost occasion the destruction of our species.[89]

The wheat insect was destructive, but Sinclair leaned on Kirby's position to argue that the ichneumon balanced the scales just enough to save humans from complete starvation.[90] But, like Bierkander, Sinclair also found the ichneumon unmanageable and urged agriculturalists towards more mechanical pest-control methods, such as the use of metal and stone rollers, lime spreading and burning.[91] For Sinclair, the ichneumon's providential work was worth mentioning, but it ought not to get in the way of more practical intervention.

Despite Sinclair's ambivalence, others continued to speculate about whether the ichneumon's assistance might be amplified by the thoughtful improver. Carolus Linnaeus is often seen to be the first proponent of such measures of biocontrol because of an oft-cited statement he made in 1752, that 'predatory insects should be caught and used for disinfesting crop-plants'.[92] However, it was the naturalist Erasmus Darwin who articulated a precise mechanism for such parasitoid management, when in 1800 he began to devise schemes to protect fruit trees in his *Phytologia*.[93] The aphis of the peach tree, he suggested, might be battled by preserving the eggs of an aphidivorous fly through the winter and placing them on the trees in spring, when one insect could then devour the other, 'as the serpent of Moses devoured those of the magicians'.[94] Like many of the writers mentioned so far, Darwin also reckoned that British vegetable nature was on the verge of 'total destruction' by the aphis at any given moment, a circumstance which was only avoided by a human-directed combination attack by predaceous flies and the ichneumon.[95] If humans could just discover a way to help nature along, they would be much gratified.

Others also had trouble with ichneumon management. Publications in the *Journal of the Agricultural Society of England* show us that losses to wheat pests in particular remained high in the nineteenth century, and that the ichneumon also continued to

89 John Sinclair, *An Account of the Systems of Husbandry Adopted in the More Improved Districts of Scotland; with Some Observations on the Improvements of Which they are Susceptible*, 2nd edn, 2 vols., Edinburgh, 1813, vol. 2, Appendix 35, p. 134.

90 John Sinclair, *General Report of the Agricultural State and Political Circumstances of Scotland, Drawn up for the Consideration of the Board of Agriculture and Internal Improvement under the Directions of the Right Honorable John Sinclair (President)*, 3 vols., Edinburgh: Abernethy and Walker, 1814, vol. 3, p. 405.

91 Sinclair, op. cit. (90), 401.

92 Sven Hörstadius, 'Linnaeus, animals, and man', *Biological Journal of the Linnaean Society* (1974) 6(4), pp. 269–275, 272. Hörstadius, a renowned experimental embryologist writing from Sweden in 1974, seems to be the original source for this quote, which he does not cite. C.O. Jacobson, 'Sven Otto Hörstadius. 18 February 1898–16 June 1996', *Biographical Memoirs of Fellows of the Royal Society* (2000) 46, pp. 245–256.

93 Erasmus Darwin, *Phytologia: Or, the Philosophy of Agriculture and Gardening*, London: J. Johnson, 1800, p. 360.

94 Darwin, op. cit. (93), p. 356.

95 Darwin, op. cit. (63), pp. 48, 54.

resist being bred in captivity as a solution to the problem.[96] Botanist Reverend John S. Henslow (1796–1861), as well as the famous nineteenth-century economic entomologist John Curtis (1791–1862), both tried and failed to get the ichneumon to reproduce in a controlled setting.[97] Curtis did manage to discover that some parasitoids had parasitoids of their own, making it doubly difficult to breed them or even depend upon them as the ultimate police. For a concise description of this hyperparasitism, Curtis turned to Jonathan Swift, whom he paraphrased when he noted 'that fleas have little fleas to bite 'em, and so go on ad infinitum'.[98] In the end, however, Darwin's call to arms went largely unanswered until almost a century later, when Charles V. Riley (1843–1895), the London-born Missouri state entomologist, succeeded with parasitoid biocontrol and became rather celebrated for it.[99]

Early nineteenth-century entomologists conceded defeat in the realm of ichneumon breeding and began to argue, if not for the propagation of the ichneumon, then at least for its active conservation. After waxing providential about the ichneumon's virtues in 1842, Curtis admitted that he only hoped to acquaint farmers with the species in order to prevent blanket eradication of all farm insects, whether friend or foe.[100] He was still warning farmers about mistaking the new ichneumon for its 'parent', the wheat midge, and dispatching it under the assumption that it was just another pest, in 1860.[101] The just equilibrium, it seemed, was well and good, but the move towards economic entomology required the development of methods that remained within the realm of human influence. Most improvers considered that realm to be quite extensive.

It may seem unusual that, after such a profound surge of interest in the metaphorical significance of the ichneumon, the subject of study should simply fade away in the face of the intractable practical problem of breeding. Ants, after all, were of little use to economic entomologists, but managed to stay in the public and professional eye for centuries precisely because of their symbolic lure. However, ant societies served as a long-standing analogy for industrious human society, while the significance of the ichneumon was tied up in a highly specific late eighteenth-century historical context. The insect supported the wealth of nations through its provision for both subsistence and cash-crop agriculture,

96 J.S. Henslow, 'Report on Diseases of the Wheat', *Journal of the Royal Agricultural Society of England* (1840) 2, pp. 1–25, 24–25.

97 J.S. Henslow, 'Observations on the Wheat-Midge', *Journal of the Royal Agricultural Society of England* (1841) 2, pp. 36–40, 36.

98 John Curtis, *Farm Insects: Being the Natural History and Economy of the Insects Injurious to the Field Crops of Great Britain and Ireland, and Also Those Which Infest Barns and Granaries*, Edinburgh: Blackie and Son, 1860, p. 98.

99 P. DeBach and D. Rosen, *Biological Control by Natural Enemies*, Cambridge: Cambridge University Press, 1991. Chapters 4 and 5 outline historical biocontrol measures by insects. See also Charles V. Riley, *Parasitic and Predaceous Insects in Applied Entomology*, Washington, DC: Government Printing Office, 1893, pp. 133–134.

100 John Curtis, 'Observations on the Natural History and Economy of Various Insects Affecting the Turnip Crops, Including the White Cabbage Butterflies, the Turnip Seed Weevil, &C', *Journal of the Royal Agricultural Society of England* (1842) 3, pp. 306–323, 310.

101 Curtis, op. cit. (98), p. 279. Curtis was still citing Kirby in 1860, not to praise the just equilibrium, but to revisit the long-standing confusion of the ichneumon and *Tipula* by laymen.

which in turn subverted famine and bolstered prosperity in a period when food shortages, population panic and patriotic improvement of agriculture were on the minds of British subjects. As a police of nature, the insect resonated both with recent changes in European governance and with arguments made by Enlightenment intellectuals, who depended on the stability of nature as a foundation for their reasoning. Paradoxically, the ichneumon also lost some of its metaphorical clout when, in an age of increased human responsibility over created nature and human society, it failed to allow its divine powers to be harnessed immediately. Rather than producing any kind of tension with divine order in the minds of British agriculturalists and entomologists, the ichneumon went on operating quietly in the background as an assistant to British endeavours, while humans focused their attention on their own increasingly large role in policing the economy of nature.