A History of the Ecological Sciences, Part 12: Invertebrate Zoology and Parasitology during the 1500s

The terms invertebrate zoology and parasitology were coined later, but since our concern here is the history of ecology, not classification, these terms are convenient indicators of subjects discussed. A number of physicians advanced the knowledge of these subjects; the most prominent are discussed here.

Girolamo Fracastoro (1478–1553) was from a patrician family of Verona, and he studied medicine at the University of Padua, which had one of the best medical schools in Europe. He was a true Renaissance humanist who had broad interests and many friends in high places (Thorndike 1941:488–493, Zanobio 1972). His most famous work, a 1346-line poem in three books, *Syphilis sive morbus Gallicus* (1530), was more famous for its literary than its scientific merits; it is the most famous Renaissance poem in Latin (Eatough 1984:1). Perhaps he chose a verse format because his own ideas were uncertain, and he wanted to convey them ambiguously. Our name for this disease comes from the title of his poem.

Fig. 1. Girolamo Fracastoro [Wright 1930]

He tells us that this disease came to Italy with the invasion of Charles VIII's French army, hence the name morbus Gallicus (Fracastoro 1984, I:5), but that earlier it had come to Europe with Columbus' sailors (Fracastoro 1984, I: 69–70). He thought it was contagious (Fracastoro 1984, I: 130), but did not mention sexual transmission. What was its source? Perhaps the air, corrupted by the planets and modified by climate (Fracastoro 1984, I:182–185). He was more explicit in describing its symptoms (Fracastoro 1984, I:320–367). Book I was devoted to such speculations, and Books II and III were devoted to its cure. He warned that south winds and the filth and sweat of unclean marshes are dangerous (Fracastoro 1984, II:81–86), and he thought that fish was a dangerous food (Fracastoro 1984, II:118–120). A concoction of thyme, hops, fennel, parsley, and other herbs could help (Fracastoro 1984, II:174–180), but if not effective, then try a mixture of styrax, mercuric sulphide, lead, antimony, and grains of incense (Fracastoro 1984, II:260–263). However, another cure comes from the land where the disease originated: lignum-sanctum, or guaiacum (Fracastoro 1984, III). None of his advice seems original (Munger 1949, Eatough 1984:20). Neither remedy was effective, and of course mercury and lead are dangerous. Mercury might cause some sores to shrink, but at the expense of poisoning the body.

After 16 years of further medical practice, reading, and pubishing, Fracastoro's ideas on contagious disease were more definite, and he published the prose treatise that is the basis of his place in the history of medicine and his relevance for the history of ecology. This book contained two distinct works: the first, on sympathy and antipathy, was quite traditional and vacuous in its speculations (Wright 1930: xxxiv–xxxv, Thorndike 1941:493–496); the second part, on contagion, contagious diseases, and cures, broke new theoretical ground. One historian of medicine calls it "a truly marvellous triumph of close observation and clear reasoning," and the most important statement of contagion theory before Pasteur (Winslow 1943:143). A later evaluation of Fracastoro's concepts emphasizes their speculative nature (Howard-Jones 1977). Both evaluations seem valid; he studied the problem for many years, but could only reason about it before development of the experimental method.

He identified three means of contagion: direct contact with a sick person, contact with objects contaminated by a sick person, and contagion at a distance (Fracastoro 1930: 7). Although reasoning by analogy often led astray early naturalists, including Fracastoro, his reasoning about contagion through contact was perceptive; he compared it to spoiled grapes or apples spoiling others adjacent to them. Like Lucretius in ancient Rome, he believed invisible germs could travel through air, though neither of them argued that such germs were alive. Fracastoro's concept of germs was chemical (Winslow 1943:133).

Although unable to penetrate the fundamental mystery of contagious diseases, it was a valuable step to survey the different kinds. He realized that some diseases mainly attack children, and that some of them cause fevers and pustules on the skin (Fracastoro 1930:73). He interpreted these "variolae" as diseases of blood, and the pustules as putrefactions escaping the body. Once that happens, the person seldom suffers the same disease again. Rabies was a disease primarily of dogs, and it was known since antiquity that they transmit it by their bites. Then it incubates for 20 or 30 days, but sometimes for 4–6 months (Fracastoro 1930: 125). The symptoms he describes were well known, but his further speculations on hydrophobia beyond that were fruitless. His ideas on syphilis were now more definite than when he wrote his poem on it. He again tells us it came to Naples from France with King Charles' army in the 1490s, and that it had come from the New World with Spanish seamen. But now he also tells us that it is transmitted mainly by sexual intercourse, though infants could get it from an infected mother or wet nurse by suckling their milk (Fracastoro 1930: 135–137). Syphilis can cause pustules, and he wanted to separate it from other maladies such as elephantiasis, leprosy, and scabies, but that was too difficult a challenge, since one might evolve into another: "Psora, which is nowadays called scabies, is a still milder affection than leprosy, but in a severer form it may pass into leprosy, just as leprosy in a severe form may pass into elephantia" (Fracastoro 1930: 171). To go further would require the laboratory techniques of the 1800s.

Girolamo Gabuccini was an Italian physician who published the first separate treatise on parasitic worms (Gabuccini 1547), which attracted enough attention to appear in a second, possibly pirated edition at Venice in 1547, and a third edition at Lyon in 1549. Parts of his account of tapeworms (which were known since antiquity) are quoted in Latin by Hoppeli (1959:104, 152, note 9); Gabuccini believed that the lesser heat in the intestine leads to tapeworm formation (Hoppeli 1959:134). He also described the liver fluke of sheep and goats (quoted in Latin by Reinhard 1957: 209), first identified by a French sheep farmer, Jean de Brie, who, at the encouragement of Charles V, wrote a treatise on managing sheep in 1379. De Brie believed that sheep got flukes (*Fasciola hepatica*) by eating a herb, la dauve, in marshy places. He was close to the truth, since larval stages encyst on vegetation in marshy places to await sheep, but de Brie thought the herb's leaves actually turned into flukes. Anthony (or his brother John) Fitzherbert went further in his *Boke of Husbandrye* (1523), describing two dangerous plants in marshy places, but also describing the fluke itself (de Brie's and Fitzherbert's accounts are quoted by Kean, Mott, and Russell [1978:561–562], [Fitzherbert 1882: 50–51]). Gabuccini came no closer to solving the mystery of the liver fluke's life cycle than his two predecessors, and it would be three centuries before breakthrough discoveries were made (Reinhard 1957:216–220). His book is digested in a long chapter by Thomas Mouffet entitled "Of the Signs and Cure of Worms out of Gabucinus" (1967:1111–1122). It is so heavily documented with references to ancient and medieval authors that it is difficult to detect any innovations beyond the synthesis itself.

Not only did physicians in the 1500s write medical books, but some also wrote extensively on plants and animals (Egerton 2003*a*, *b*). Edward Wotton (1492–1555) received his undergraduate education at Oxford and his medical doctorate at Padua, then returned to practice in London, where he served a term as president of the Royal College of Physicians (Wheeler 1976). His *De differentiis animalium libri decem* (Paris, 1552) was a survey of the animal kingdom, compiled largely from classical sources. His original contributions were inserted in Book 9 on insects, where he struggled to reconcile his observations of sexual reproduction with traditional belief in spontaneous generation. The weight of tradition was too strong for him, and he concluded that both methods of reproduction occur (Raven 1947:42).

During the second half of the 1500s there was a race to publish the first book entirely on insects, although the participants probably did not know of each other's work. The Italian Ulisse Aldrovandi became known in Europe first for his three volumes on birds (1599–1603); the Englishman Thomas Penny had devoted much of his research to plants. Aldrovandi and his assistants easily won the race with publication of *De animalibus insectis Libri VII* (Bologna, 1602; later editions in 1618, 1623, 1638), because Penny died before he had progressed beyond collecting his information.

Aldrovandi, as he explained in a letter to Cardinal Maffeo Barberini (later Pope Urban VIII, who condemned Galileo), collected his insects on little expeditions (translated in Ley 1968:158):

> *I was in the habit of going into the country for months during the summer and autumn, not for relaxation, like others; for at these times I employed all my influence, as well as money, to induce the country-people to bring me such insects, whether winged or creeping, as they could procure, in the fields or under ground, and in the rivers and ponds. When any were brought to me, I made inquiries about its name, habit, locality, &c. I often, too, wandered over the marshes and mountains, accompanied by my draughtsman and amanuenses, he carrying his pencil, and they their notebooks. The former took a drawing if expedient, the latter noted down to my dictation what occurred to me, and in this way we collected a vast variety of specimens.*

Since Gessner had not published on insects, Aldrovandi was much more on his own for *De Animalibus insectis* than in other volumes that depended heavily on Gessner's work. Some of the original pages of illustrations made by his draughtsman survive, and two of them are published, along with extensive translations of the Latin text into German, and modern identifications by Bodenheimer (1928–1929, I:250–276, II:336–345), including the first dichotomic key ever written, to determine the higher groups. Aldrovandi's three volumes on birds contained 1009 pages of text; he devoted 300 pages to insects. Section I, of 95 pages, describes bees, wasps, and hornets; Section II, "De papilionibus," includes 81 species of Lepidoptera and also dragonflies; Section III describes two-winged insects, including flies and mosquitoes; Section IV, those with more than two wings: grasshoppers, crickets, beetles, praying mantis; Section V, insects without wings: true insects—bugs and ants—but also spiders, scorpions, centipedes, and millipedes; Section VI, "De vermibus," includes earthworms and shell-less snails; Section VII is on water insects, but also includes marine worms and starfish (Ley 1968:158–159, Beier 1973:85–86).

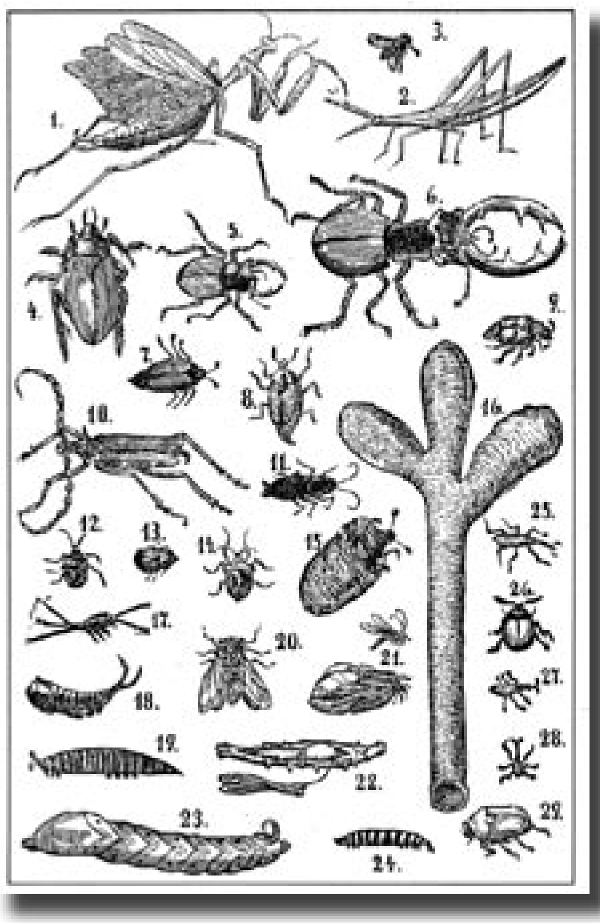

Fig. 2. Aldrovandi 1602. Reproduced from and identifications by Bodenheimer 1928–1929, I:268.

Thomas Penny (c.1530–1588/1589) followed in the footsteps of William Turner, and was a friend of Turner's son, Peter (Raven 1947: 153). Like Turner, he studied theology and medicine at Cambridge, and in 1565 he traveled to Zurich to study medicine with Conrad Gessner. That lasted only a few months before Gessner died suddenly of plague. Before going there, Penny had already begun studying both plants and insects, and after arriving he and Gessner shared their knowledge of these subjects with each other. Gessner had planned a volume on insects (Théodoridès 1966), but his only "insect" account ever published was on scorpions (Topsell 1967:750–757). After Gessner's death, Penny assisted in preparing some of the manuscripts for publication, and he acquired some of the manuscripts on insects (Raven 1947:157). Penny then traveled and studied in Europe, 1566–1569, before returning with his M.D. degree to England, where he practiced medicine in London. When he returned, his botanical interest was dominant, but he spent the last 15 years of his life preparing to write a book on insects, using Wooton's, Gessner's, and his own materials. However, he never wrote the book, and gave his materials to his young friend and colleague, Thomas Mouffet (1553–1604).

Mouffet had also studied at Cambridge, and had then received his M.D. at Basel before practicing in London (Simpkins 1974). He reported that Penny's materials were ill-arranged and ill-written (Raven 1947:172, Mouffet 1967, Preface). As he organized them he added his own comments, which were less useful than Penny's (Raven 1947:180, 189). Mouffet was distracted by his busy medical practice and never published his Latin manuscript. His widow sold it to Theodore Mayerne, who finally did publish it at London in 1634. It has about 500 wood engravings of varying quality, some of which are quite good (Beier 1973:86). An English translation was published in 1658 as Volume 3 to Edward Topsell's *History of Four-Footed Beasts and Serpents* (Mouffet 1967). There was a strong emphasis on insect pests and ways to combat them (Ordish 1976:54–64). Although Raven, an Englishman, found much to criticize in Mouffet's book, he nevertheless concluded that it was superior to Aldrovandi's (1947:191). It seems doubtful, however, that Italian scholars would agree; Aldrovandi was quite interested in naming the different kinds of insect, but Mouffet, when faced with a variety of different but similar kinds (such as butterflies), was content merely to number them, though he did provide illustrations and descriptions of each, which are often adequate for modern identifications (Bodenheimer 1928–1929, II:345–352). Although not denying the possibility of spontaneous generation, he expressed skepticism about it because no one claimed to have seen it happen (Mouffet 1967: 984). On the other hand, he was not always skeptical of folklore, such as the report of India having locusts three feet long, whose hind legs were used as saws (Mouffet 1967:985).

In at least one instance Mouffet's (or Penny's?) medical and entomological interests converged to produce original observations—on the itch mite, *Sarcoptes scabiei* (1967: 1094–1096), which had been known since medieval times. We have a summary of his discoveries (Friedman 1934: 627).

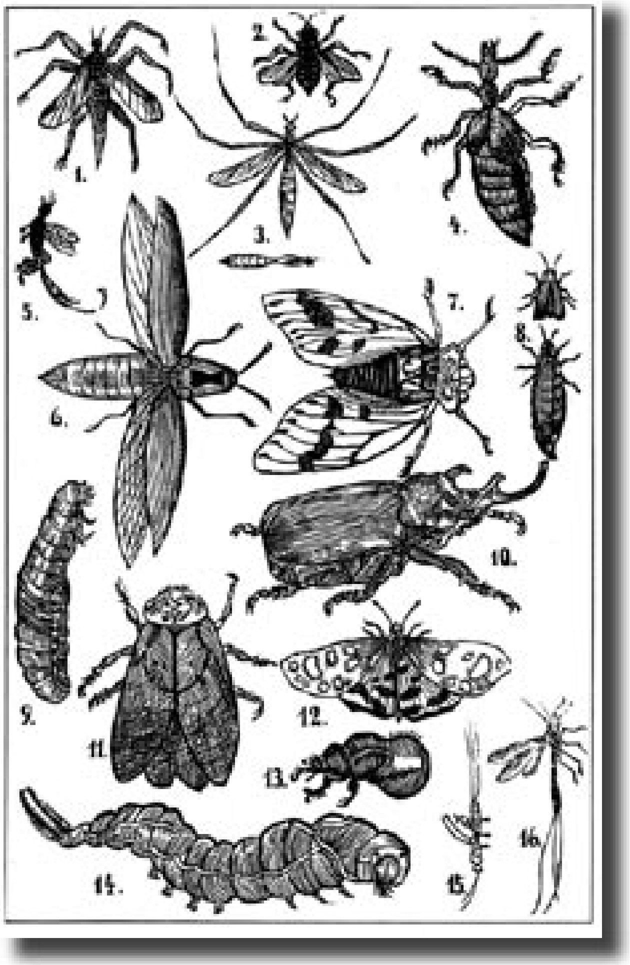

Fig. 3. Mouffet 1934. Reproduced from and identifications by Bodenheimer 1928–1929, I:280

> *(1) Moffet's description of the acarus, as well as its itch-provoking and burrow-forming activities, was not only the first account of the itch-mite published by an English author but was also the best and most accurate that had anywhere been given up to his time. Moffet, of course, was also familiar with the method of removing the parasite by means of a needle. (2) He was the first to differentiate the acarus from the pediculi. (3) His observation that the acarus was to be found in the "mines" or "furrowes" hard by the vesicle of scabies and not in the vesicle, antedated Renucci's epochal statement to the same effect by exactly two hundred years.*

This last comment on anticipating Renucci points to the disadvantage of the vast encyclopedic works of the 1500s: pearls of wisdom were easily lost in compendiums of ancient and medieval learning.

The honey bee had been domesticated in antiquity and was common in Europe and elsewhere (Chauvin 1968). Mouffet's longest discussion is on bees (1967:889–921), but their social structure was not understood. Among other things, the queen was considered a king. Although Mouffet made the connection between caterpillars and butterflies and moths, he nevertheless discussed them in different chapters for the good reason that he seldom could connect particular adults with particular caterpillars (1967: 957–974, 1029–1041). The same was true about the connection between grubs in the ground and beetles, which he also discussed in different chapters (1967:1005–1016, 1042–1044), though he knew that the whurlworm "The next year after they are bred, they are alwaies transformed into May Beetles" (1967:1043).

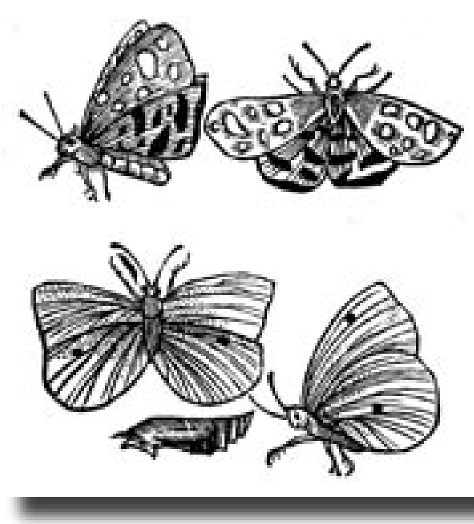

Fig. 4. Mouffet 1967:971: "The middle sort of Day-Butterflies" 1 and 2.

Invertebrate animals and diseases were more difficult subjects to study during the 1500s than either vertebrate animals or vascular plants, because there were so many invertebrates, and they, and the causal organisms of parasitic diseases, were smaller beings. Although eyeglasses were invented about 1285 (James and Thorpe 1994), stronger magnifying lenses and microscopes were not developed until the 1600s, stimulated by development of the telescope in 1608 (Bud and Warner 1998:387). Despite the difficulties, physicians and naturalists made important progress in describing invertebrates and diseases, as well as interactions with other organisms.

Literature Cited

Beier, Max. 1973. The early naturalists and anatomists during the Renaissance and seventeenth century. Pages 81–94 in R. F. Smith, T. E. Mittler, and C. N. Smith, editors. History of entomology. Annual Reviews, Palo Alto, California, USA.

Bodenheimer, F. S. 1928–1929. Materialien zur Geschichte der Entomologie bis Linné.

Two volumes. W. Junk, Berlin, Germany.

Bud, R., and D. J. Warner, editors. 1998. Instruments of science: an historical encyclopedia. Garland, New York, New York, USA.

Chauvin, R., editor. 1968. Traité de biologie de l'abeille. Volume 5: Histoire, ethnographie et folklore. Masson, Paris, France.

Eatough, G. 1984. Introduction. Pages 1–35 *in* Fracastoro's Syphilis. Translated by G. Eatough. Francis Cairns, Liverpool, UK.

Egerton, F. N. 2003*a*. A history of the ecological sciences, Part 10: Botany during the Italian Renaissance and beginnings of the scientific revolution. ESA Bulletin **84**: 130–137.

Egerton, F. N. 2003*b*. A history of the ecological sciences, Part 11: Emergence of vertebrate zoology during the 1500s. ESA Bulletin **84**:206–212.

Fitzherbert, A. [or J.] 1882. The book of husbandry. Edited by W. W. Skeat. Trübner, London, UK.

Fracastoro, G. (1530, fide Wright 1930). Syphilis sive morbus gallicus. Niccolini da Sabbio, Verona, Italy.

Fracastoro, G. (1546, fide Wright 1930). De sympathia et antipathia rerum liber I. De contagione et contagiosis morbis et Curatione libri III. L. Iuntae, Venice, Italy.

Fracastoro, G. 1930. De contagione et contagiosis morbis et eorum curatione, libri III. Latin with English translation by W. C. Wright. G. P. Putnam's Sons, New York, New York, USA.

Fracastoro, G. 1984. Fracastoro's Syphilis. Latin with English translation by G. Eatough. Fransic Cairns, Liverpool, UK.

Friedman, R. 1934. Thomas Moffet. The tercentenary of his contribution to scabies. Medical Life **41**:620–621.

Gambuccini, G. [Latin: Gabucinus, H.] 1547. De lumbricis alvum occupantibus, ac de ratione curande eos, qui ab illis infestantur, commentarius. Joan Gryphium and H. Scotus, separate editions, Venice, Italy.

Howard-Jones, N. 1977. Fracastoro and Henle: a reappraisal of their contribution to the concept of communicable disease. Medical History **21**:61–68.

James, P., and N. Thorpe. 1994. Ancient inventions. Ballantine Books, New York, New York, USA.

Kean, B. H., K. E. Mott, and A. J. Russell, editors. 1978. Tropical medicine and parasitology: classic investigations. Two volumes. Cornell University Press, Ithaca, New York, USA.

Ley, W. 1968. Dawn of zoology. Prentice-Hall, Englewood Cliffs, New Jersey, USA.

Mouffet, T. 1634. Insectorum sive minimorum animalium theatrum: olim ab Edoardo Wotton, Conrado Gesnero, Thomaque Pennio inchoatum. T.Cotes, London, UK.

Mouffet, T. 1967. The theater of insects. [Volume 3 of E. Topsell, The history of four-footed beasts and serpents and insects. Facsimile of 1658 edition.] Da Capo Press, New York, New York, USA.

Munger, R. S. 1949. Guaiacum, the holy wood from the New World. Journal of the History of Medicine and Allied Sciences **4**:196–229.

Ordish, G. 1976. The constant pest: a short history of pests and their control. Charles Scribner's Sons, New York, New York, USA.

Raven, C. E. 1947. English naturalists from Neckam to Ray: a study of the making of the modern world. Cambridge University Press, Cambridge, UK.

Reinhard, E. G. 1956. Landmarks of parasitology I. The discovery of the life cycle of the liver fluke. Experimental Parasitology **6**:208–232.

Simpkins, D. M. 1974. Thomas Moffett (Moufet, Muffet). Dictionary of Scientific Biography **9**:440–441.

Théodoridès, J. 1966. Conrad Gesner et la zoologie: les invertébrés. Gesnerus **23**:231–237.

Thorndike, L. 1941. A history of magic and experimental science. Volume 5. Columbia University Press, New York, New York, USA.

Topsell, E. 1967. The history of four-footed beasts and serpents and insects. Volume 2: The history of serpents taken principally from the Historiae Animalium of Conrad Gesner. Da Capo Press, New York, New York, USA.

Wheeler, A. 1976. Edward Wotton. Dictionary of Scientific Biography **14**:507–508.

Winslow, C. E. A. 1943. The conquest of epidemic disease: a chapter in the history of ideas. Princeton University Press, Princeton, New Jersey, USA.

Wright, W.C. 1930. Introduction. Pages v–liv in G. Fracastoro. De contagione et contagiosis morbis et Eorum curatione, libri III. G.P. Putnam's Sons, New York, New York, USA.

Zanobio, B. 1972. Girolamo Fracastoro. Dictionary of Scientific Biography **5**:104–107.

Acknowledgments

I thank Anne-Marie Drouin-Hans, Université de Bourgogne, Jean-Marc Drouin, Musée National d'Histoire Naturelle, Paris, Benedicte Bilodeau, Centre Alexandre Koyré, Paris, and Sidney A. Ewing, College of Veterinary Medicine, Oklahoma State University, Stillwater, Oklahoma, for their assistance.

Frank N. Egerton
Department of History
University of Wisconsin-Parkside
Kenosha WI 53141
E-mail: frank.egerton@uwp.edu