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Letter to the Editor

DE GEER'S PIONEERING PHYTOCHEMICAL OBSERVATION

Chemical ecology is thriving on many fronts, making history. Yet there is little in contemporary writing to remind us of the unfolding of the discipline, of early events and discoveries that might have been real "firsts" in the field, but have faded into obscurity. Sometimes cited is the paper by Wray (1690), on formic acid production in ants, doubtless one of the first publications on the chemical defenses of arthropods, but there must be other early citations awaiting rediscovery. I recently chanced upon some writings of the Swedish pioneer entomologist Karl De Geer (1720–1788), in which some chemical-ecological questions are raised that are remarkably modern in flavor.

In his seven-volume treatise on insects, De Geer (1776) provides mostly descriptions and commentary, as was typical for the time, but he also gives accounts of genuine experiments. These are often "spur of the moment" in design, but they are presented lucidly, conceived rationally, and controlled. In Volume 1, Section 3, beginning on page 58, he provides a delightful account of a small moth, already noted by two famous contemporaries (Frisch, 1720–1738; Rösel, 1746), which, as a larva, lives on pine, within a "gall" made up of resin from the host. The moth is almost certainly *Petrova* (formerly *Evetria*) *resinella* (L.), a tortricid, nowadays mentioned routinely in treatises (for example, Lampert, 1907).

De Geer describes in some detail how the larva feeds by carving out a groove along the length of a small branch of its host, and how the surrounding gall, which takes the form of an igloolike enclosure, is formed by the resin that oozes from the plant wound (Figures 1 and 2). He notes that the larva lives protectively confined within the gall and that it encrusts the enclosure from within with some of its feces. Not surprisingly, given that the difference between the vascular and resin systems of plants had not been clarified at the time, he errs in his interpretation of the nature of resin, which he takes to be part of the plant's nutrient juices ("Nahrungssafte des Baums")[1]. However, he does betray

[1] De Geer's treatise originally appeared in French. I am here quoting from the German edition (De Geer, 1776), where the phraseology and spelling are sometimes archaic.

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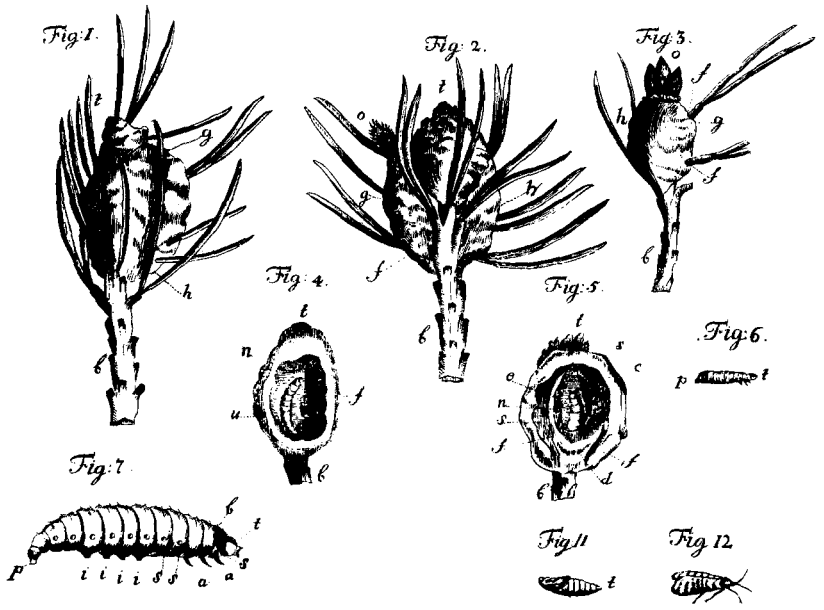

FIG. 1. Some of the illustrations provided by De Geer with his account of *Petrova resinella*. Intact resin galls are shown (1–3), as well as opened galls with the larva inside (4, 5), and drawings of the larva (6, 7), pupa (11), and adult (12). From De Geer (1776, volume 1, plate 33).

awareness of the special chemical peculiarities of resin, and it is this awareness that prompts him to wonder about the insect's seeming ability to tolerate the substance. Conifer resin, he states, like the odorous turpentine oil derived from it, is well known to be ill-tolerated by insects ("bekanntermassen . . . schlechterdings nicht ertragen . . ."). [2] How, then, can *Petrova* withstand living so closely exposed to resin ("mitten in einer harzigen Materie")?

As a start, he sought reassurance that the gall was constituted of resin. He found that it was soluble in alcohol ("Weingeist"), smelled of turpentine oil, and emitted upon ignition the odor of burned mastic ("Mastix"), a well-known resin product, commonly used as a varnish ingredient.

Then he experimented. He took a *Petrova* larva and placed it on a piece of paper soaked in turpentine oil. The larva crawled about and became visibly wetted with oil, but remained alive. A control arctiid caterpillar ("Bärraupe"), similarly placed, promptly became restless ("unruhig") and had to be herded

[2] Turpentine oil must have been in general use at the time. It was, for instance, recommended for entomological purposes by Hoppe (1752), who suggests brushing pinned beetles with the fluid to aid in their preservation.

FIG. 2. Typical resin gall of *Petrova resinella*. The gall on right is opened to show the larva within. Photos taken by author in summer near Saarwiesen, Germany.

by hand to be kept on the paper. It quickly weakened and within 4 min "gave up the ghost" ("gab . . . den Geist auf").

A further three *Petrova* larvae, placed in a closed jar with pieces of turpentine-soaked paper, fared well initially, but drowned overnight in excess oil. Proper precautions to prevent drowning showed yet another larva to emerge alive from two days of such confinement. Prolonged tolerance also was shown by a larva that was placed in a jar while still within the hollow of its partly opened gall, and therefore exposed to the vapors of the oil only. Two "smooth green caterpillars" confined as controls died in 2 minutes; a fly lasted only half an hour.

De Geer concludes succinctly that neither turpentine vapors nor turpentine oil ("weder Terpentinölgeruch, noch das öl") are fatal to *Petrova*. The larvae, he reasons, must be structured differently from other insects ("anders . . . eingerichtet"), in some fashion that he presumes to involve the respiratory system. He expresses regret that the larva's respiratory orifices and tubes ("Luftlöcher und Lungenröhren") are too small for him to examine in detail. He does not elaborate beyond this point, nor does he look for parallels with other insects. However, he obviously does raise the notion of food specialization and of adap-

tive tolerance by a herbivore of the noxious chemistry of its host. I know of no other comparably dated writings that address these issues. De Geer is remembered mostly as a prolific describer of insects. He was evidently otherwise insightful as well.

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