NOTES AND DISCUSSIONS

POLLINATION ECOLOGY OF THE DATE PALM AND FIG TREE: HERODOTUS 1. 193. 4–5

The following passage appears in Herodotus' description of Babylonian agriculture. It describes the culture of date palms and compares it with the culture of fig trees in Greece:

> εἰσὶ δέ σφι φοίνικες πεφυκότες ἀνὰ πᾶν τὸ πεδίον, οἱ πλεῦνες αὐτῶν καρποφόροι, ἐκ τῶν καὶ σιτία καὶ οἶνον καὶ μέλι ποιεῦνται· τοὺς συκέων τρόπον θεραπεύουσι τά τε ἄλλα καὶ φοινίκων τοὺς ἔρσενας Ἕλληνες καλέουσι, τούτων τὸν καρπὸν περιδέουσι τῇσι βαλανηφόροισι τῶν φοινίκων, ἵνα πεπαίνῃ τέ σφι ὁ ψὴν τὴν βάλανον ἐσδύνων καὶ μὴ ἀπορρέῃ ὁ καρπὸς τοῦ φοίνικος· ψῆνας γὰρ δὴ φέρουσι ἐν τῷ καρπῷ οἱ ἔρσενες κατά περ δὴ οἱ ὄλονθοι.[1]

The biological systems described in this apparently straightforward passage are complicated, and Herodotus has added confusion of his own. Furthermore, in attempting to set Herodotus straight, commentators have frequently introduced additional misinformation. The passage stands in need of a thorough explanation.

The process involved here is pollination, that is, sexual intercourse as it occurs in flowering plants. Like all but the simplest living things, flowering plants produce two different types of reproductive cells. Each reproductive cell contains half the genetic material required for the development of a new individual of the parent species. To make up the full complement of genetic material, one type of reproductive cell must fuse with a cell of the opposite type. The smaller of the two types is contained in pollen, the male aspect of flowers. The analogous female cells are contained in the part of the flower that develops into seeds. Pollination occurs when pollen comes into contact with this female organ. Fertilization—the fusion of male and female reproductive cells—follows. Without pollination and fertilization, seeds and fruit rarely develop.

Different species of flowering plants produce different flower structures. In some species, male and female structures occur in the same flower. Pollen need move only a short distance to reach the female structures—jarring the plant may suffice to effect transferral. Other plant species bear male and female structures in separate flowers, which are then called male or female flowers according to the structures they bear. Yet other species bear male and female flowers on separate,

1. 1. 193. 4–5: "Palm trees grow on the whole plain, most of them a fruit-bearing kind, from which they make bread and wine and syrup. They are cultivated like the fig in many respects, particularly the following: they tie the fruit of those palms which the Greeks call male to the fruit-bearing palms, so that the gall wasp, entering the fruit, may ripen it and the fruit of the palm might not fall off; for the males, like caprifigs, bear gall wasps in their fruit." I translate μέλι as "syrup" rather than "honey" because it is unlikely that a wind-pollinated flower like the date would produce nectar, from which bees make honey. The syrup may be made from the dates themselves or from sap from the trunk of the palm (R. C. Haldane, *Subtropical Cultivations and Climates* [London, 1886], p. 67).

male and female plants. In other species, while male and female structures occur in the same flower, they mature at different times. Increasing the separation between male and female flower structures spatially by bearing them in separate flowers or on separate plants or temporally decreases the ease of transfer of pollen from one to the other. In most cases, however, the added risk of failure is more than offset by the decreased likelihood that female flowers will be fertilized by pollen from the same plant that bears them. When male and female flowers are borne on separate plants, this so-called self-fertilization is of course impossible; and chemical barriers may prevent self-fertilization even in flowers in which male and female structures are neither spatially nor temporally separated. In these cases, if pollination is to take place at all, the pollen must come from another plant, one with male flowers. This is known as cross-pollination. The advantage of cross-pollination is this: the new plant that develops from the resulting seed contains genetic material from two parents. Such a plant usually has a better chance of success. The superiority of a cross-bred offspring over both parents is sufficiently common to justify the existence of a term to describe it: hybrid vigor.

There exist various strategies for transferring pollen from male to female flowers. Some plants rely on wind; such plants produce large quantities of pollen to increase the probability that at least some of the pollen will reach female flowers of the same species. Many other plant species rely on insects (e.g., bees) to transport pollen and lure their pollinators by producing nectar or by yet more intricate means.

In nature, date palms are pollinated by wind. As Herodotus states, male and female flowers are borne on separate trees. The chance that random, wind-pollination will result in a heavy crop of dates is small, but transferring quantities of pollen artificially to the female flowers (more or less as described by Theophrastus[2]) results in crops worth the additional labor, though it is considerable. A date palm in its prime consists of a straight, branchless, forty-foot bole. The gardener must climb a male tree to gather stalks of pollen-bearing flowers; then he must climb each female tree at least twice: first to deposit pollen on the female flowers, and again to gather fruit.[3] Contrary to Herodotus' description, no wasp is involved in the process.

The wasp takes part only in fig-tree pollination. Like date palms, figs bear pollen-producing male flowers and seed-producing female flowers on separate trees. Depending on the climate, the trees may produce as many as three crops a year. They bear figs in some stage of development all year; when temperatures fall below 53° F, development of the current crop is suspended until warmer temperatures return.[4] Strictly speaking, the figs themselves are not fruit but syconia, hollow balls lined with flowers. The edible fig contains only seed-producing flowers. The syconia containing male flowers are inedible and are called caprifigs. Since both male and female flowers are contained entirely inside syconia, transfer

2. *HP* 2. 8. 4. The word Theophrastus uses to describe the process, ὀλυνθάζειν, is derived from ὄλονθος, which Herodotus used for the fruit of the male tree instead of the more common ἐρινόν. Ἐρινάζειν, the verb for the pollination of figs, is derived from the latter.

3. V. H. W. Dowson, "Dates and Date Cultivation of the Iraq: Part 1," *Memoir of the Agricultural Directorate, Ministry of the Interior, Mesopotamia* 3 (1921): 27.

4. Haldane, *Subtropical Cultivations*, p. 70.

of pollen from one to the other presents special problems. Pollen cannot be accidentally transferred by wind or ordinary flower-feeding insects. Over evolutionary time, the fig tree has become highly modified and specialized; it requires a pollinator that is equally specialized: the gall wasp, *Blastophaga psenes*.

The caprifig produces pollen and thus functions as the male. In addition, it is modified to accommodate the pollinator wasp by the presence within its syconia of reproductively nonfunctional flowers of female structure; these are called gall flowers. The young wasps develop in gall flowers, feeding on tissue that in female flowers would give rise to seed.[5] The wasps in a caprifig syconium mature at about the same time as its male flowers. The wingless, nearly blind male wasps emerge from their flower galls into the syconium cavity first. There they seek out galls containing female wasps, chew holes into the galls, and mate. They then proceed to the orifice, or eye, of the syconium and start chewing a way out for the females—the male wasps themselves never leave the syconium. The winged, sighted females emerge from their galls and leave the syconium through the opening made by the male wasps. As they leave, they are coated with sticky pollen from the male flowers, which surround the opening. They seek out the next crop of syconia, in which gall or female flowers are now mature. A female wasp enters a syconium through its eye. Her body is designed for squeezing through this narrow passage: her antennae fold back into grooves in her head, and her middle pair of legs is reduced in size. The first and last pairs are well developed to pull and push her into the syconium. If she succeeds in entering the syconium, however, she does so at the expense of her wings and most of her antennae. If she has entered a caprifig syconium, she lays her eggs in the short gall flowers. She then dies, and her offspring continue the cycle. It is a different matter if she enters an edible-fig syconium. The tall female flowers contained in such a syconium are unsuitable for egg-laying and development of the wasp; their function is strictly seed production. Inside such a syconium the wasp presumably pollinates the flowers in attempting to lay eggs before she dies.[6]

The fig depends on the wasp for pollination. The wasp depends equally on the fig for the completion of its own life cycle. The wasp spends most of its life in the caprifig syconium. Only the adult female can be found outside it, and since she does not feed, she does not live long.[7] The gall flower is the only place in which young gall wasps can develop. Unless there are syconia in the proper stage of development on the trees when the female wasps emerge, the wasps will die out and pollination will cease. Mutual dependence necessitates synchronization of the activities of host fig and pollinator wasp.

Harvesting caprifigs and hanging them in female trees as Herodotus describes increases the probability that wasps will enter female syconia and pollinate the flowers. The process, called caprification, is still practiced. In the nineteenth century it was argued that caprification had no effect on the development of

5. As Theophrastus noted (*HP* 2. 8. 2), caprifigs rarely contain seeds. Even the rare exceptions are not the result of self-pollination, since the male flowers in a caprifig syconium mature much later than its female flowers. These, too, must be pollinated by the wasp.

6. D. S. Hill, "Figs and Fig-Wasps," *Journal of Natural History* 1 (1967): 420–23.

7. Ibid., p. 422.

syconia and was unnecessary.[8] Until the turn of the century, most evidence supported this view.

In the late nineteenth century, fig growers in California attempted to introduce a particularly desirable fig variety known as the Smyrna. They initially met with failure: the Smyrna syconia invariably dropped prematurely. Other varieties of figs had been grown successfully in California, and at first growers concluded that there was something wrong with the stock they had purchased. The fig is not native to North America, and no caprifigs or fig wasps had been introduced. After this deficiency was remedied, the imported Smyrnas produced perfect fruit[9] and provided incontrovertible evidence of the validity and benefits of caprification.[10]

Thus caprification as described by Herodotus is an accepted horticultural practice in the production of certain varieties of figs. The parallels between this procedure and that associated with date cultivation are close, although less close than Herodotus believed—date pollination is independent of insect activity. Nevertheless, artificial pollination is an unusual phenomenon, and Herodotus deserves at least as much praise for drawing attention to the similarity as condemnation for overlooking the difference.

The major commentaries on this passage are inadequate or even inaccurate. A. H. Sayce recognized that the wasp is not involved in date palm pollination, but his statement, "The fruit of the date tree only needs the pollen of the male palm," is misleading.[11] It implies that caprification is fundamentally different from pollination. Superficially, caprification appears to entail hanging male "fruit" in female trees. But in spite of its appearance and use, the caprifig is not a fruit. The so-called fruit is a hollow ball containing flowers. The fruit of the female fig tree, like that of the date palm, requires only the pollen of the male tree. The structure of the fig inflorescence (flower stalk) makes it more practical to leave the actual pollen transfer to the wasps. Date palm pollination and fig tree caprification are essentially identical processes. P. E. Legrande appears to share Sayce's position.[12] W. W. How and J. Wells correctly describe caprification as pollination, but accept the incorrect conclusions of the nineteenth century: "H. wrongly thinks the purpose of the process was to prevent the fig falling off."[13] In some cases, the Smyrna variety, for example, this is exactly what the process accomplishes. There is no reason to say Herodotus is wrong merely because this is not always the case. H. Stein's commentary is the most accurate, but it is out of date. He treats caprification as a thing of the past.[14]

8. Theophrastus (*HP* 2. 8. 1) knew of trees that produced ripe syconia without caprification in Italy and parts of Greece, but attributed the phenomenon to environmental factors.

9. G. Eisen, "The Fig," *United States Department of Agriculture, Division of Pomology, Bulletin* 9 (1901): 100. Eisen found that caprifig pollen alone, when injected into Smyrna syconia at the proper stage in their development, also resulted in the production of perfect fruit.

10. One other variety grown in the United States, the White San Pedro, produces its first crop of the season without caprification but requires caprification to perfect its second crop; I. J. Condit, *The Fig* (Waltham, Mass., 1947), p. 40.

11. *Herodotos 1–3* (London, 1883), p. 112.

12. *Hérodote Livre 1* (Paris, 1932), p. 188.

13. *A Commentary on Herodotus*, vol. 1 (Oxford, 1912), p. 149.

14. *Herodotos erster Band* (Berlin, 1877), pp. 216–17.

Herodotus was correct in saying that male and female are separate in both date palms and fig trees. His description of caprification is reasonably accurate: caprifig syconia inhabited by wasps are hung in fig trees; the wasps enter new syconia with the result that the syconia remain on the tree until they ripen. His sole mistake was in assigning to the date the mechanical details of pollen transfer in figs. There is no wasp involved in the pollination of dates.

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THE MEANING OF ΘΡΑΣΟΣ IN ARISTOTLE'S *ETHICS*

Aristotle says that courage is a mean concerning fear and confidence (*EN* 1115a6–7 μεσότης . . . περὶ φόβους καὶ θάρρη; also at 1107a34); moreover, he defines fear and specifies its objects: fear is a painful passion whose object is danger or risk, the possibility of future evils. Unfortunately, nowhere does he define confidence or even indicate its relation to fear. Recent commentators have with good reason inferred that confidence is a pleasant emotion directed toward the same objects as fear. But, having defined confidence, a commentator must then relate both it and fear to courage; and here W. D. Ross, W. F. R. Hardie, and D. J. Allan have all created unnecessary complications. Thus Hardie follows Allan and sees fear and confidence as separate passions, each a continuum ranging from too much to not enough and each needing control.[1] Ross goes farther still and maintains that, not only are fear and confidence in this sense distinct emotions, but that courage actually contains two separate virtues, one concerned with fear and the other with confidence. Their reason for relating fear and confidence to courage in this way, making courage a mean concerning each, comes from a single paragraph (1115b24–34) where Aristotle talks about three vices between which courage is a mean—the cowardly feeling of too much fear, the nameless vice of feeling too little fear, and rashness, or feeling too confident.[2] Since it is hard to see how something can be a mean between three extremes, his commentators have concluded that there must be a fourth, unmentioned extreme to complete the possibilities; if there are four extremes, then courage must in fact be two virtues, one hitting the mean with respect to confidence,[3] or, at least, courage

1. *Aristotle's Ethical Theory* (Oxford, 1968), p. 140: "In Aristotle's account of courage two types of feelings are involved, fear and 'cheer' or love of danger. Both must be controlled. So, Ross suggests, we must substitute for Aristotle's trinity 'not one duality but two.' Courage is control of fear and cowardice the lack of control. Discretion is the control of cheer and rashness the lack of control. Again the distinction between virtue and continence disappears in this corrected version of Aristotle."

2. Aristotle says that the third vice is a nameless one, not only at 1115b24–34 but also at 1107b2, where he points out that many virtues and vices are nameless. The anonymous referee for this journal has noted that Aristotle does in fact refer to this vice by name, using ἀδεής at 1115a33 and ἄφοβος at 1117a19; he offers a persuasive reason why these terms cannot designate the vice of fearlessness: "Presumably in Greek usage these terms are so regularly commendatory that they are not available for use in a pejorative sense." The comments of the referee were most helpful throughout the paper.

3. W. D. Ross, *Aristotle* (London, 1949), p. 206.