*Acta Bot. Neerl.* 30(1/2), February 1981, p. 151–153.

# BRIEF COMMUNICATION

## ENTOMOPHILY IN DIOECIOUS SPECIES OF EPHEDRA: A PRELIMINARY REPORT

R. J. BINO and A. D. J. MEEUSE

H. de Vries-Laboratorium, Plantage Middenlaan 2a, 1018 DD Amsterdam

Studies by PORSCH (1910, 1916) have shown that *Ephedra campylopoda* C. A. Mey. is frequently visited by insects, which collect and/or consume the sugary micropylar exudate of ovules of functionally female plants and of the sterile ovules of morphologically hermaphrodite but functionally male plants. The possible significance of such data in connection with the advent of entomophily during the early evolution of the angiosperms was pointed out by the senior author (MEEUSE 1978, 1979).

Although Porsch adduced some cogent evidence as regards the partial dependence of the *Ephedra* species on a form of biotic pollen transfer for its sexual reproduction, additional data are required. The junior author (R.J.B.) was going to investigate the anthecology of *E. campylopoda* in Israel between April and June, 1980, but did not find it in anthesis. However, the strictly dioecious species *E. alte* C. A. Mey., common in the coastal areas of Israel, produced large numbers of reproductive organs and plants of both sexes appeared to be regularly visited by a variety of insects (Diptera and Apids). As far as successful pollinations are concerned, the effectiveness of these visits in a dioecious species at first seemed negligible. However, the attractant appeared to be neither pollen nor a micropylar pollination droplet, but a different kind of liquid exudate produced by the reproductive regions of both male and female plants. In the female individuals the pollination droplet is minute or even absent, but the so-called 'chlamys' (the outer integument in our interpretation) produces a sweetly tasting nectar, which after a test with Fehling's reagent proved to contain an appreciable quantity of sugar. The male specimens produce smaller quantities of nectar on the outside of the socalled 'perianth' or 'involucre'. The location and anatomical structure of the secernent parts of these organs are under investigation.

The only other and almost completely forgotten record of such a condition is that by JACCARD (1984), who described a nectarial secretion of this kind in *Ephedra helvetica* C. A. Mey. This Swiss botanist failed to recognise its significance, however, and even categorically rejected the possible incidence of entomophily in this species. In the light of the recent discovery of nectar production in *E. alte* a re-examination of the anthecology of *E. helvetica* appears to be recommendable.

The insects found visiting *E. alte* belong to the following taxa: Diptera,

Syrphidae: *Metasyrphus corollae* (Fabr.), *M. latifasciatus* (Marquart), *Syritta pipiens* (L.), *Episyrphus balteatus* (De Geer), *Sphaerophoria scripta* (L.), *Scaeva albomaculata* (Marq.). *Eristolodes taeniops* (Wied.), *Paragus* spec., *Chrysotoxum* spec., and *Melanostoma* spec. Diptera, Calliphoridae: *Lucilia* spec., *Sarcophaga* spec. Diptera, Muscidae: *Musca* spec. Hymenoptera, Apoidae: *Apis*, *Halictus* spec.

Of these, the two *Metasyrphus* species, *Lucilia*, *Musca* and *Sarcophaga* were the most frequently recorded. All taxa concerned are known to be anthophilous.

The insects are apparently attracted to the plants by a specific scent. The female plants appear to the human eye to be green throughout. Cut branches placed in a vase near the laboratory at least 10 to 15 kilometres from the nearest growing site of *Ephedra alte* attracted at least some of the more frequent visitors encountered in the field. This is an aspect to be studied in greater detail at some later date.

As far as could be ascertained the visiting insects do not discriminate between the male and the female plants. There is some difference in their behaviour, however, because male reproductive organs of *E. alte* produce smaller quantities of nectar than female ones, and do so only just before and during the early stages of anthesis, so that the visitors move about much more in search of nectar than they do on female individuals and thus stand a considerable chance of getting contaminated by pollen. That appreciable quantities of the nectar are being consumed by insects is evident from the bloated abdomina of syrphid flies (also of male individuals!) after a feed. Insects caught on female plants often carried pollen (usually on their ventral side, on thorax and abdomen), which under a binocular microscope at magnifications of × 80 showed the characteristic shape and features of *Ephedra* pollen grains.

The 'stickiness' of the pollen was tested in a crude way by catching a quantity of pollen on a clean glass slide which was subsequently reversed and tapped over a second slide. The pollen caught on the second slide appeared to consist mainly of small aggregates of cohering pollen grains, which is indicative of the presence of an amount of *Pollenkitt* rendering the grains adhesive enough to stick to insect bodies even if the palynophilous pubescence is scanty.

*Ephedra alte* cannot possibly be altogether dependent on biotic pollination. When branches of male plants in anthesis are shaken, small clouds of pollen are liberated. Slides smeared with glycerol and hung up among a stand of *E. alte* appear to catch some airborne pollen, so that the species is most probably ambophilous. In view of the profusion of reproductive organs and the relatively low rate of visiting, one must conclude that there are simply not enough insects about to pollinate all ovuliferous organs. On the other hand, the insects become active so early in the morning that appreciable quantities of pollen may be taken up immediately after it has been released from the pollen sacs and before it has sufficiently dried to become air-borne. Further studies may throw some light on the ratio anemophily/entomophily and the respective contribution to effective pollen transfers. A second dioecious species of *Ephedra*, *viz*. *E. peduncularis* Boiss., encountered in the Negev area near Beer Sheba, (by R. J. B.), also has

nectarial secretion of the kind found in *E. alte*. At that time there was no opportunity to study the anthecology by establishing the incidence of insect visits, but it is to be expected that the pollination syndrome of this species resembles that of *E. alte* very closely.

The possible evolutionary significance of the condition in *E. alte* and, presumably, *E. helvetica* and *E. pedunculariis* is that an alternative evolutionary pathway to entomophily has been demonstrated to exist. Diclinous, and especially dioecious, taxa can only become entomophilous if individuals of the same insect species are induced to visit both the male and the female reproductive zones (or plants) at about the same rate of frequency, so that 'cross-visits' from a male to a female plant may occur (compare the analogous case in the secondarily entomophilous species of *Salix*: nectaries in both male and female florets provide the common attractant). The case of *E. campylopoda* is instructive in that it shows how a partial sex reversal, resulting in the production of pollination droplets on the sterile ovules of functionally male plants, entices insects to collect the exuded liquid on plants of both sexes, so that from potential pollen vectors they become effective pollinators. The condition in *E. alte* is interesting because it provides an example of an evolutionary pathway of escape from angioody (i.e., the inaccessibility of the micropyles at anthesis) in some early angiosperms by the advent of a common attractant in male and in female reproductive regions whilst a biotic pollen transfer persisted. The attractant can only have been a liquid source of food and not pollen, which is another argument pleading against the primacy of cantharophily, which idea is based, among other things, on the role of pollen as initial attractant of insect visitors in anthecological evolution.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Dr. A. Dafni (Inst. of Evolution, Univ. of Haifa, Israel) for his hospitality and for putting his laboratory facilities at the disposal of the junior author. The staff of the entomological department of the Inst. of Taxonomic Zoology, Univ. of Amsterdam (where the voucher specimens of the insects caught on *Ephedra alte* are being kept) kindly assisted with the naming of the Diptera, and we are also indebted to Drs. H. Wiering (Bot. Garden, Amsterdam) who identified our apids.

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