

## Dynamics of re-migration of sexuparae to their primary hosts in the gall-forming Fordinae (Homoptera: Aphidoidea: Pemphigidae)

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### Aphids, Fordinae, galls, sexuparae, migration, host selection

**Abstract.** Migratory flight of sexuparae of gall forming Fordinae to 3 species of *Pistacia* hosts was monitored using sticky traps. Sexuparae arrived from late March to July. Species arrival time distributions overlapped but modes did not coincide. Although the Fordinae are strictly host-specific, sexuparae landed and reproduced not infrequently on the wrong *Pistacia* host, a reproductive dead end. These results show that their host-selection ability is imperfect.

### INTRODUCTION

Fifteen species of aphids (Homoptera: Aphidoidea: Pemphigidae: Fordinae) induce host-specific galls on three species of *Pistacia* (Anacardiaceae) in Israel (Koach & Wool, 1977; Wool, 1984 and references there). Past research focussed on the ecology of the gall stage, from colonization of the tree by fundatrices to the fall migration from the galls to secondary hosts, and on clone size dynamics within galls of some species (Wool & Manheim, 1986, 1988; Wool, 1990; Wool & Burstein, 1991; Burstein & Wool, 1993). The present paper reports the first detailed investigation of the re-migration of sexuparae from the secondary to the primary hosts.

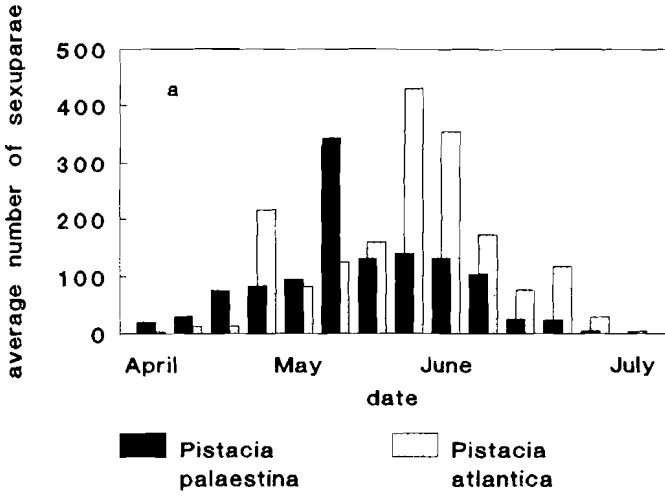
### METHODS

We monitored the arrival of sexuparae at 28 trees at two sites from March to July, 1992. Three branches of the main trunk were "ringed" with strips of masking tape smeared on the outside with tangle-foot. Sexuparae land on the canopy and then walk down to the main branches and the trunk, where they deposit their sexual offspring (Wertheim, 1954; Moran & Whitham, 1990). Traps were replaced weekly and all sexuparae were counted. Samples from each trap were mounted on microscope slides in Euparal for species identification.

### RESULTS

1) Sexuparae arrival distribution (all species pooled): The first sexuparae were observed on March 26 but migratory flight probably commenced a few days earlier. At this date the trees were bare of leaves and the buds were just breaking. The mean numbers of sexuparae caught per tree (Fig. 1a,b) continued to rise to a peak in mid-May, then declined, but large numbers of migrants were caught until mid-June. The same pattern occurred at both sites. The peak arrival on *Pistacia palaestina* occurred about two weeks earlier than on *P. atlantica* (Fig. 1a).

### Canada Park



### Tel Aviv

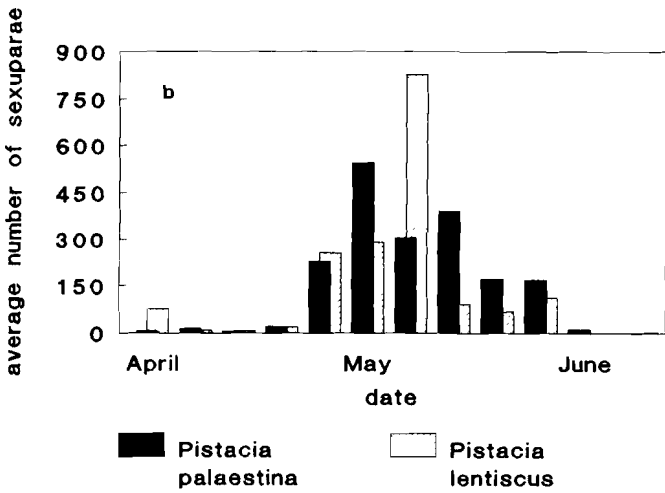


Fig. 1. Mean weekly catches of sexuparae per tree in 1992. (a) Canada Park, (b) Tel Aviv University.

2) Dynamics of migration of different aphid species: Frequencies of the common species in the identified samples from traps on each host tree at the Canada Park site are illustrated in Fig. 2. The first species to arrive at the trees was *Forda formicaria* von Heyden. This species dominated the samples on *P. palaestina* until mid-April (Fig. 2b). The other 3 common species on this host were first caught in mid-April. *Baizongia pistaciae* (L.) and *Paraclotus cimiciformis* von Heyden were quite abundant at this site until early June (Fig. 2b). Interestingly, *Geoica* spp. increased to a small peak in early May, and after a short decline, increased in frequency again to completely dominate the later samples. On the other host, *P. atlantica*, at the same site, the dominant species in April and May was *Smynthuroides betae* Westwood (Fig. 2a). (For the ecology of this species see Wool & Burstein, 1991). From early May, *Geoica* spp. progressively became the dominant species in the samples. A third species, identified by Koach & Wool (1977) as *Forda* sp. B, occurred in the samples in late April-early May (Fig. 2a).

3) Host selection by the migrating sexuparae: No sexuparae were caught in traps on non-*Pistacia* trees (pine, carob, and almond) adjacent to the true hosts. However, many were captured on the wrong species of *Pistacia* (Table 1). The species with the least host-selection capability seems to be *Aploneura lentisci* Passerini: although its true host, *P. lentiscus*, abounds in the Canada Park (traps were not set on this host at this site) its sexuparae were caught in large numbers on the former two hosts, as well as on *P. palaestina* at TAU. No galls of *A. lentisci* are formed on these hosts.

TABLE 1. Numbers of sexuparae trapped and identified on wrong host trees. (1) *Pistacia palaestina*, (2) *P. atlantica*, (3) *P. lentiscus*. CP = Canada Park, TAU = Tel Aviv University.

species	site	numbers caught on:		percent errors *
		true host	wrong hosts	
<i>B. pistaciae</i>	CP	487 (1)	45 (2)	8.5%
	TAU	898 (1)	33 (3)	3.5%
<i>F. formicaria</i>	CP	810 (1)	2 (2)	1.1%
<i>P. cimiciformis</i>	CP	492 (1)	0 (2)	0%
	TAU	39 (1)	0 (3)	0%
<i>S. betae</i>	CP	994 (2)	12 (1)	1.2%
	TAU	37 (2)	23 (1 + 3)	38.3%
<i>Forda</i> sp. B	CP	103 (2)	50 (1)	32.7%
<i>A. lentisci</i>	CP	? (3)	435 (1)	?
	CP	? (3)	365 (2)	?
	TAU	449 (3)	123 (1)	21.5%

\* Note: These estimates of percentage erroneous landings are probably biased by nonrandom sampling.

## DISCUSSION

The sexuparae have a critical role in the complex life cycle of the Fordinae: they must select the primary host tree on which to deposit their sexual offspring. Landing on the wrong host results in zero fitness because the fundatrices, which emerge a year later from overwintering eggs, will not be able to induce a gall and reproduce on the wrong host.

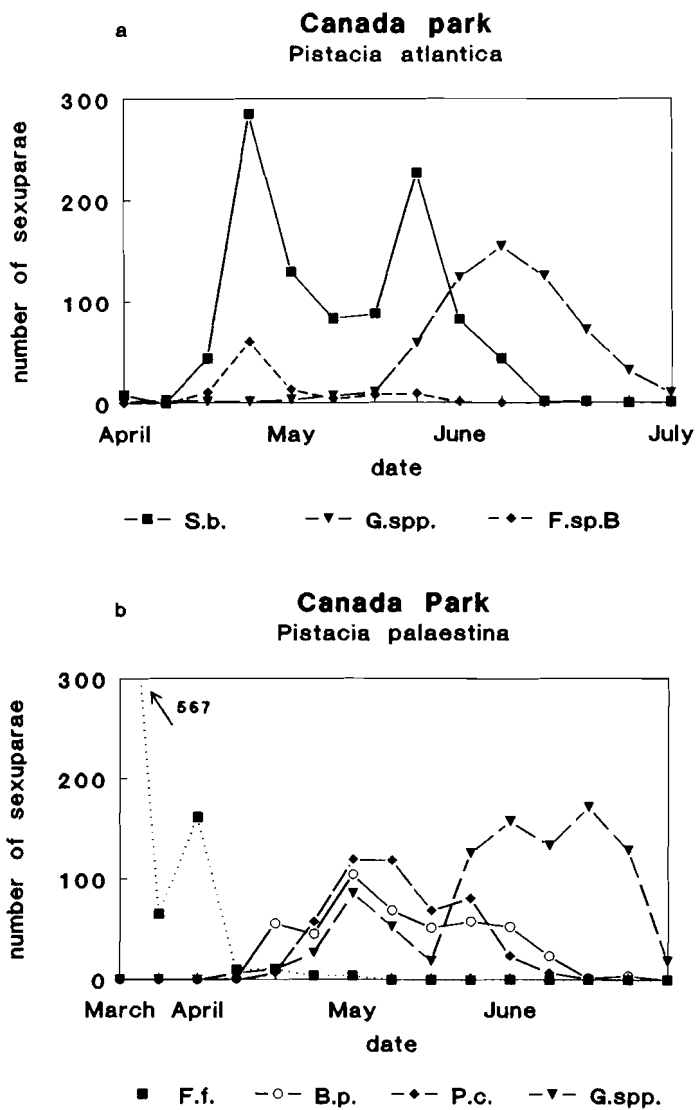


Fig. 2. Numbers of sexuparae of the common species in the identified samples. (a) traps on *Pistacia atlantica*, (b) traps on *P. palaestina*. F.f. - *Forda formicaria*; B.p. - *Baizongia pistaciae*; P.c. - *Paraclestus cimiciformis*; G. spp. - *Geocsa* spp.; S.b. - *Smynthuodes betae*; F. sp. B - *Forda* species B. Note that the distribution modes of different species do not coincide.

The only similar study on sexuparae of gall-forming aphids is by Moran & Whitham (1990) with *Pemphigus betae* on *Populus*. From the consistent differences in sexuparae catches on marked trees in successive years, they concluded that the sexuparae were able to select the "better" trees, although their ability to do so was not perfect. Taking into account that sexuparae of *P. betae*, arriving in the fall, find the tree in a completely different morphological and physiological condition than the fundatrices which have to induce galls on it, even an imperfect ability to select the "best" trees half a year in advance is quite impressive. In our system, involving several aphid and host species, the migrants are not always able to detect differences among tree species (although they arrive in the spring and find the trees in much the same growth conditions as the fundatrices will one year later). We doubt therefore that they can select among individuals of the same species (see also Burstein & Wool, 1993).

We have not identified in our samples the sexuparae of all 15 species of Fordinae which are known to induce galls on *Pistacia* in Israel. First, galls of some species are not known from the two studied sites. Second, rare species could have escaped our notice since only samples of the catch were identified (and see footnote to Table 1). On the other hand, the list of species from Israel is probably incomplete – and in particular, *Geoica urticularia* is believed to include more than one species. Three species were identified from our samples (Manheim, unpublished) although two of them are not known to induce galls on the *Pistacia* species that we studied. If we consider these as erroneous landings, the proportion of landing errors would have been greater. Our data with all its limitations, seem to give an adequate description of the more common galling Fordinae. It remains to be seen how consistent are the trends described here in subsequent years.

Finally, it may not be accidental that, of all species, *Aploneura lentisci* seems to make the most landing errors. Both the fall migrants and the sexuparae of this species lack secondary rhinaria on the alate antennae. We do not know that these sensory organs are involved in host location, but the only other species in Israel which lacks them is *Slavum wertheimae* Hille Ris Lambers, and that species is monoecious on *Pistacia atlantica* and does not alternate between hosts.

#### REFERENCES

- BURSTEIN M. & WOOL D. 1993: Gall aphids do not select optimal galling sites (*Smythurodes betae*; Pemphigidae). *Ecol. Entomol.* **18**: 155–164.
- KOACH J. & WOOL D. 1977: Geographic distribution and host specificity of gall-forming aphids (Homoptera: Fordinae) on *Pistacia* trees in Israel. *Marcellia* **40**: 207–216.
- MORAN N.A. & WHITHAM T.G. 1990: Differential colonization of resistant and susceptible host plants: *Pemphigus* and *Populus*. *Ecology* **71**: 1059–1067.
- WERTHEIM G. 1954: Studies on the biology and ecology of the gall producing aphids of the tribe Fordini (Homoptera: Aphidoidea) in Israel. *Trans. R. Entomol. Soc. Lond.* **105**: 79–97.
- WOOL D. 1984: Gall-forming aphids. In Ananthakrishnan T.N. (ed.): *Biology of Gall Insects*. Oxford & IBH, New Delhi, pp. 11–58.
- WOOL D. 1990: Regular alternation of high and low population size of gall-forming aphids: analysis of ten years of data. *Oikos* **57**: 73–79.
- WOOL D. & BURSTEIN M. 1991: A galling aphid with extra life-cycle complexity: population ecology and evolutionary considerations. *Res. Popul. Ecol.* **33**: 307–322.
- WOOL D. & MANHEIM O. 1986: Population ecology of the gall-forming aphid, *Aploneura lentisci* in Israel. *Res. Popul. Ecol.* **28**: 151–162.

WOOL D. & MANHEIM O. 1988: The effect of host-plant properties on gall density, gall weight and clone size in the aphid *Aploneura lentisci* (Pass.) (Aphididae: Fordinae) in Israel. *Res. Popul. Ecol.* **30**: 227–234.