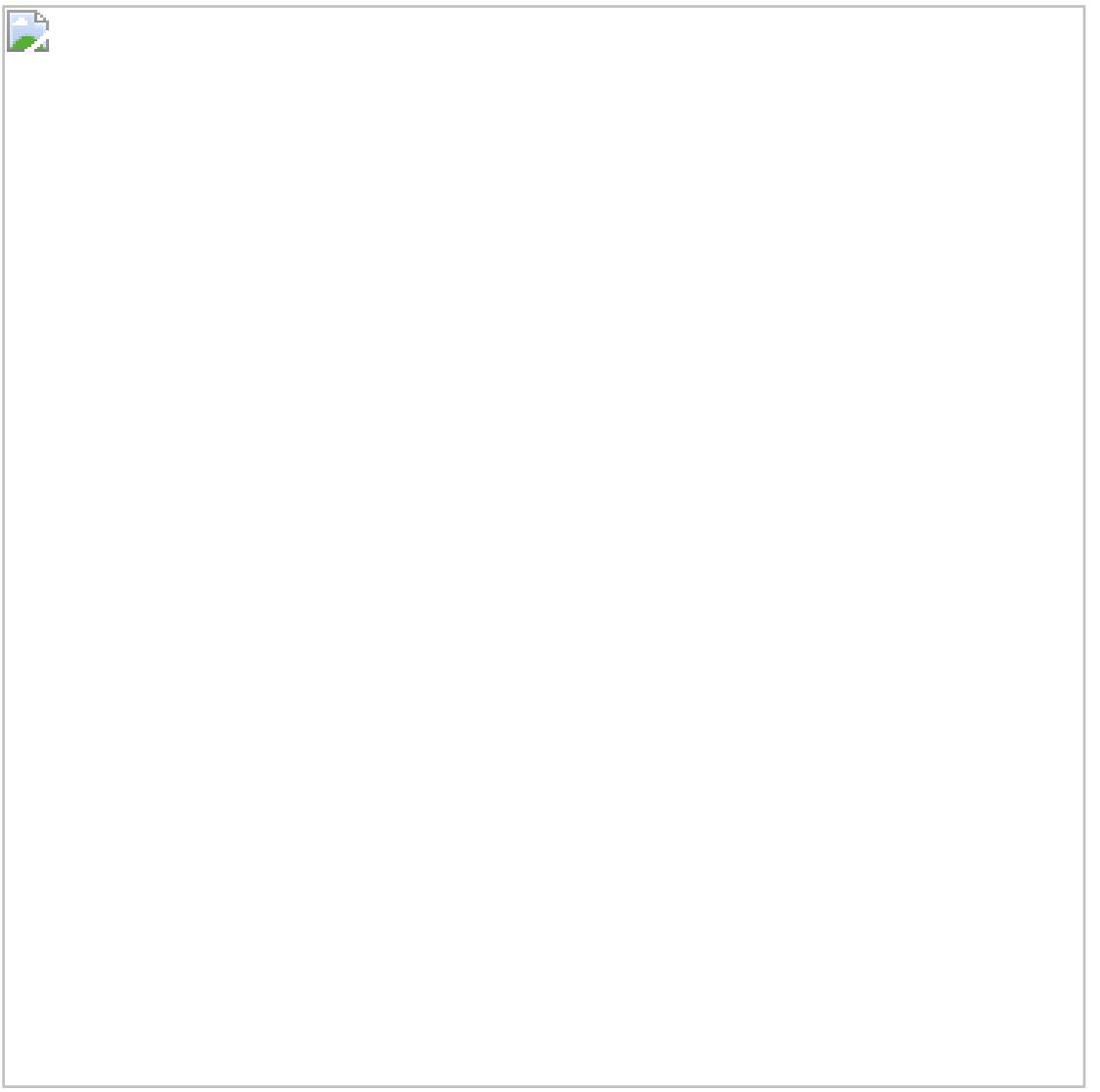

Pollen Load in an Active Pollinator, The Yucca Moth Tegeticula yuccasella (Prodoxidae)

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POLLEN LOAD IN AN ACTIVE POLLINATOR, THE YUCCA MOTH *TEGETICULA YUCCASELLA* (PRODOXIDAE)

Additional key words: active pollination, evolutionary novelty, resourse allocation

Insect pollination of flowers is a dominant trait among flowering plants, with estimates of 75% of all angiosperms relying on animal-mediated pollen dispersal (Committee on the Status of Pollinators in North America 2007). In almost all cases, this is a passive process in that a flower-visiting insect accidentally picks up pollen while visiting a flower for foraging purposes, and that pollen will be accidentally deposited on flowers subsequently visited. Conspecific pollen grains deposited onto stigmas may then complete ovule fertilization.

The probability that a pollen grain will reach the stigma of a conspecific flower is very low, and as a consequence pollen-to-ovule ratios in flowers in outcrossing species tend to be very high (Cruden 1977), commonly several thousand pollen grains per ovule. In some circumstances, there may be a selfish interest in the pollinator to cause pollination, such as when its larvae rely on developing seeds for completing their development. In Lepidoptera, there are at three known cases of this kind, including yucca moths (*Tegeticula* and *Parategeticula*; Prodoxidae; 20+ spp.; Riley 1872; Davis 1967; Pellmyr 2003), *Upiga virescens* (Pyralidae) on the columnar senita cactus *Lophocereus schottii* (Holland & Fleming 1999; Fleming & Holland 1998), and *Epicephala* (Gracillariidae) on trees of Phyllanthaceae (500+ spp.; Kato et al. 2003; Kawakita & Kato 2004, 2009, 2010; Kawakita 2010). In the associations involving yucca moths, the female moth uses sex-specific unique tentacular mouthparts (Fig. 1.) to actively gather pollen of the larval host plant, and then uses some of that pollen to actively pollinate each flower in which she has oviposited. In *Epicephala*, the proboscis is used for the same purpose, and in the case of the senita cactus, the moth uses an abdominal scale brush for pollen collection and deposition. In so doing, the female assures that lack of pollination will not prevent development of seed-bearing fruit for her larval progeny.

While the pollen load carried by the female yucca moth was described in Riley's original papers (Riley 1872, 1873, 1892), the actual quantity of pollen that a female collects and transports has never been determined. Here I report on pollen loads carried by *Tegeticula yuccasella*, the most wide-ranging pollinator species (Davis 1967; Pellmyr 2003).

Forty-nine female *T. yuccasella* were collected in flowers of *Yucca filamentosa* in and around Spring Grove Cemetery in central Cincinnati, Ohio, USA (39.165°N 84.5229°W) during 24–29 June 1993 and 23-26 June 1994, at which time moths were abundant in the area. Moths were weighed individually within an hour of harvest on a Mettler AC100 balance (Mettler Toledo GmbH, Greifensee, Switzerland) to the nearest 0.00001g. The pollen load and the tentacles were then removed from each female with surgical forceps and scissors, respectively, and weighed separately to the same precision. Each pollen load was placed in clear mounting medium on a glass slide and the pollen grains were manually counted for each sample.

Investment in specific structures for pollen movement the in the form of the unique tentacles of the female constitute a minor allocation as the tentacles constituted 0.16–1.24% of total body mass (median = 0.39%). This variation in part derives from variation in

FIG. 1. Head of female *Tegeticula yuccasella* carrying a pollen load under her head. Light arced structure in front of pollen is proboscis, darker brown structure placed against pollen load is left tentacle, used for pollen manipulation.

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overall body mass attributable to different proportions of egg loads retained by females at the time of collection. Pollen loads varied within a considerable range, between 0–9670 grains, and an average of 3676 ± 2235 (SD). Three individuals carried no pollen when sampled, either because their supply had been depleted or they had yet to gather pollen. In circumstances where flower density is moderate and moth density is relatively high, as was the case at our study site, it was indeed common later during the activity period to find females searching at length to replenish their pollen supplies. Individual *Yucca filamentosa* flowers at the study site typically contained 150–200 ovules so there is very substantial demand on females to provide sufficient pollen; in addition, resource competition among simultaneously developing fruits result in early fruit abscission and consequent death of all moth larvae within it (Pellmyr & Huth 1994). There is indeed strong selection on females to gather and deposit ample pollen on flowers where she has oviposited, as the effects of pollination on probability of retention of the developing fruit with the feeding larvae is a key factor in determining the reproductive success.

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