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Vespid Wasps Eat Pollen (Hymenoptera: Vespidae)

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ABSTRACT: Counts of pollen grains from the digestive tracts of 23 species of wasps and bees reveal that both solitary and social taxa in the Vespidae in some cases ingest pollen at levels equal to those of some bees. This finding shows, for the first time, that these adult wasps can derive some protein nourishment from pollen.

Pollens of different plant taxa are known to contain from 5% to 40% protein (Todd and Bretherick, 1942; Grogan and Hunt, 1979) and can be a source of protein nourishment for insects. Pollen also has enzymatic activity adequate and appropriate for its own protein digestion in vivo (Grogan and Hunt, 1979). Most bees provision their larvae with pollen, and adult bees nourish themselves on pollen and nectar mixtures. This source of proteinaceous nourishment for adult bees has been hypothesized to be fundamental to the many evolutions of social behavior in Apoidea (Hunt, 1982). Observations of wasps foraging at flowers raised the question in our minds as to whether wasps might not also, in some cases, ingest pollen in quantities adequate for adult proteinaceous nourishment.

Materials and Methods

Pinned, dried specimens of 23 species of wasps and bees were selected from the collection of the Museum of Natural History at the University of Missouri–St. Louis. To remove any externally adhering pollen, the specimens were relaxed, removed from their pins, and immersed individually in detergent solution in an ultrasonic cleaner. (Though the specimens used in this study were not themselves visually examined for externally adhering pollen that may have remained after this cleaning, examinations of specimens of the same taxa treated in the same way revealed effectiveness of the cleaning technique.) After drying in a low temperature oven, the gasters of three specimens of each taxon were then individually removed (except *Metapolybia aztecoides,* for which pairs of specimens were used to compensate for its small size). Each gaster (except two together for *M. aztecoides*) was crushed in a test tube, to which was added 2.5 ml of an 8:1 mixture of acetic anhydride and concentrated H_2SO_4 before placing in a boiling water bath for 5 min. The test tubes were removed from the boiling water and cooled. The contents were then strained into a centrifuge tube through brass screen to remove remaining cuticle fragments, centrifuged, and the solution was pipetted off. An ethanol wash, followed by centrifugation, was followed by two water washes and centrifugation. After the final centrifugation, two samples were taken from each centrifuge tube using small cubes of glycerine jelly. The sample was placed on a microscope slide on a warmer to melt the jelly, which was then covered with a cover glass and sealed. The number of pollen grains on each slide was counted using a hand counter and compound microscope. Further description of the pollen

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Table 1. Total counts of the numbers of pollen grains in samples from acetolyzed gasters of wasps and bees. The data comprise two samples from each of three specimens for each taxon except *Metapolybia aztecoides* (see text).

Taxon	Specimen 1		Specimen 2		Specimen 3	
Scolioidea: Myzininae						
Myzinum 5-cinctum males	0	0	3	1	0	0
Myzinum 5-cinctum females	0	6	2	0	0	0
Pompilidae						
Pompilus scelestus	34	0	0	0	1	0
Nyssonidae						
Microbembix monodonta	0	2	1	0	0	0
Sphecidae						
Chalybion californicum	0	0	0	0	0	0
Sceliphron caementarium	0	1	0	1	1	0
Sphex ichneumoneus	1	3	2	1	9	3
Vespidae: Eumeninae						
Eumenes fraternus	1	5	1	1	0	2
Monobia quadridens	17	2	16	86	4	3
Vespidae: Masarinae						
Pseudomasaris vespoides	8900	9840	4470	11,030	762	11,440
Pseudomasaris edwardei	9120	18,080	19,300	9300	1641	27,400
Vespidae: Polistinae						
Polistes fuscatus	3	0	42	47	19	16
Polistes instabilis	6	2	4	1	2	10
Polistes metricus males	15	15	3	15	6	24
Brachygastra mellifica	2	6	19	4	2	1
Metapolybia aztecoides	1	0	0	0	2	2
Parachartergus fraternus	0	2	8	1	0	1
Vespidae: Vespinae						
Dolichovespula maculata workers	54	15	8	6	1	0
Vespula maculifrons workers	0	0	6	1	0	6
Vespula maculifrons males	0	1	1	5	1	0
Apoidea: Halictidae						
Agapostemon virescens	150	59	2	2	1273	1413
Apoidea: Colletidae						
Colletes inaequalis	649	924	2810	4630	640	587
Apoidea: Megachilidae						
Megachile brevis	110	93	494	293	16	51
Apoidea: Apidae						
Apis mellifera workers	11	21	14	33	284	235
Bombus pennsylvanicus workers	23	63	111	141	73	1090

acetolysis technique and a recipe for the glycerine jelly are given in Lewis et al., 1983.

Results and Discussion

Counts of the pollen grains on each slide are reported in Table 1. The number of pollen grains on the slides is less than the total that would have been present in each gaster, but the relative differences revealed by the consistent application of the standard sampling technique should accurately reflect real differences.

Several patterns are apparent. Highest counts, by far, are from the two species of masarines. These wasps are known to transport pollen in their crops as provisions for their larvae, and both flower preferenda and external adaptive modifications for pollen gathering are well documented (Richards, 1962). The high counts from the Masarinae were thus expected. Moderate to high counts are found in all bee taxa. Among these, highest counts occur in the short-tongued bees (*Agapostemon, Colletes*), which suggests an inverse correlation with the known relative lower concentration of amino acids in the nectar of flowers visited by short-tongued bees (Baker and Baker, 1975), though the small sample size calls for caution in this conclusion. Differences between individuals, most conspicuous in *Agapostemon virescens,* reflect expected vagaries in both foraging and specimen collection. Among the non-masarine wasps, most taxa have counts so low as to confirm the conventional wisdom that wasps do not ingest pollen. However, some individuals in several species of Vespidae (*Monobia quadridens, Polistes fuscatus, P. metricus* males, *Brachygastra mellifica, Dolichovespula maculata*) have pollen counts that reach the lower range of counts found in some of the bees. This finding indicates that some individuals in the Vespidae, other than the obvious Masarinae, ingest pollen in at least low to moderate quantities. The ingestion of pollen would provide proteinaceous nourishment to those wasps, though the present data cannot indicate the percent of their total nourishment.

The occurrence of pollen in the digestive tracts of species in the Eumeninae, Polistinae, and Vespinae as well as the Masarinae, together with the absence of significant pollen counts in all but one of the non-vespid wasps sampled, suggests that ingesting pollen (probably in suspension in nectar) may be a basic behavioral trait of the Vespidae. If so, it is not possible at this time to distinguish two alternative possible explanations: that the vespids in our sample are more likely than the other wasps to have actively ingested pollen, or that the vespids in our sample visited flowers with pollen more likely to have been passively ingested. In either event, it is interesting to speculate that pollen ingestion, at low to moderate levels, may have characterized Vespidae at an early period of their evolution, before the divergence of Masarinae from the other subfamilies.

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