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An Interesting Method of Pollen Collecting by Bees from Flowers with Tubular Anthers

by

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Moderate sized and large female bees of various systematic groups can be heard in several tropical parts of the world producing intermittent brief loud buzzing sounds as they collect pollen from certain flowers, notably those of the genus *Cassia* (Leguminosae) and at least one species of *Solanum* (Solanaceae). I have frequently used these sounds, often audible at distances of several meters, as an aid in collecting specimens but am entirely indebted to Mr. John H. Barrett of the Highlands Agricultural Experiment Station, Aiyura, New Guinea, for providing the basic idea which led to the observations on which this note is based. At a meeting of the Queensland Entomological Society in Brisbane, Australia, in 1959 he described his observations, now fully verified by me, on the function of this sound.

Many plants have anthers that open only at their apices, so that pollen escapes through apical openings or pores. In various species of *Cassia* (arborescent species with conspicuous yellow flowers) and in *Solanum wendlandii* Hook. (identified by Dr. Rafael Lucas Rodriguez of the Universidad de Costa Rica), the pollen does not seem to escape easily from the anthers, and it is in such flowers that the buzzing sounds described above are produced.

The flower of *Solanum wendlandii* is blue, with the basal parts of the large anthers yellow. Figure 1 shows the cluster of stamens and the two apical pores in each anther through which pollen escapes. The anthers are often directed more

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or less upward, sometimes horizontally, and rarely downward. (The pistil is extremely short and hidden among the bases of the stamens). The *Cassia* flowers have equally large anthers, their apices not so close together as in *Solanum wendlandii* but grouped in a curious way, as described by KIRCHNER (1, pp. 98-101), and opening, as in the *Solanum,* by apical pores. No nectar is produced by either *Cassia* or *Solanum wendlandii;* Kirchner considers certain parts of some of the anthers of *Cassia* as trophic tissue.

The behavior of bees in flowers of both genera is essentially the same. The following notes were prepared when observing bees visiting the *Solanum* but apply equally to those on *Cassia:*

Only female bees were observed in the flowers; there is nothing to attract nectar feeding males. All the bees land on or move to the group of stamens, curl their bodies over the ends of the anthers, and then buzz their wings in one to several short bursts of sound much louder than the usual sound of flight (except perhaps for *Xylocopa).* The wings are closed over the back, not extended, but can be seen to vibrate. At the same time some of the bees bite at the anthers (but do not cut into them or cause any visible damage). Presumably the biting only serves to loosen pollen which may sometimes clog the anthers. Females of *Thygater* approach each flower with the proboscis extended but withdraw it when they settle on the flower, and cling to the flower with the fore and middle legs only.

Regardless of the position of the flower, even if the anthers are directed upward, the vibration of the wings results in a burst of loose pollen which shoots out of the ends of the anthers. Since the bee is curled over the anthers, much of the pollen lodges on the ventral surface of the bee. Some of it, however, floats away in the air, as can be observed particularly in bright sunlight with large, sluggish specimens of *Bombus.* (The pollen shooting out of the ends of the anthers was observed in *Cassia* flowers in New Guinea by Barrett). After receiving pollen on its venter in this way, the bee combs it off with its legs and transfers it to the scopa. The abundance of the bees and the large amounts of pollen which they carry on their scopal hairs are evidence of a rich pollen supply.

To verify the effectiveness of vibrations in causing pollen to fly out of the apices of the anthers, the cone of anthers of various flowers of *Solanum wendlandii* was touched to a vibrating knife blade. The vibrations caused pollen to shoot out, especially from rather old flowers, even when the anthers were directed upward. The rate of vibration is evidently not important within broad limits since different kinds of bees vibrate at different rates to judge by the sound.

Bees buzzing in flowers of *Cassia* have been observed by me in various places in the state of Oaxaca, Mexico; three miles south of Yautepec in the state of Morelos, Mexico; in Curitiba in the state of Paraná, Brazil; near Cairns in the state of Queensland, Australia; and near Lae in northeastern New Guinea. In Costa Rica I have noted such activity on the *Solanum* in San José. The following is a list of the genera of bees concerned, with indications of the localities:

Family Halictidae

Subfamily Nomiinae

Pseudaugochlora [*nigromarginata* (Spinola)] Paraná
Pseudaugochlora [near *nigromarginata* (Spinola)] Oaxaca, Costa Rica
Agapostemon [near *texanus* Cresson] Oaxaca

Subfamily Nomünae

?Nomia Queensland, New Guinea

Family Andrenidae

Subfamily Oxaeinae

?Protoxaea [near *gloriosa* (Fox)] Morelos

Family Apidae s.l.

Subfamily Anthophorinae

Amegilla [group of *zonata* (Linnaeus)] Queensland, New Guinea
Anthophora Oaxaca
Centris Oaxaca, Morelos, Costa Rica
Epicharis [elegans Smith] Oaxaca
Thygater [*analis* (Lepeletier) and relatives] Paraná, Costa Rica

Subfamily Exomalopsinae

Exomalopsis (subgenus *Exomalopsis*) Oaxaca, Morelos, Costa Rica

Subfamily Xylocopinae

Xylocopa [*frontalis* (Olivier)] Morelos, Oaxaca
Xylocopa [*brasilianorum* group] Oaxaca, Costa Rica

Subfamily Apinae

?Euplusia Morelos
?Eulaema Morelos

Bombus [*mexicanus* Cresson] Costa Rica

Question marks in the above list indicate that there exists some doubt as to whether or not the bees concerned were buzzing.

The smallest bees concerned are in the genus *Exomalopsis* but in spite of their size (as little as 8 mm long but robust) they can make remarkably loud sounds. In Costa Rica minute bees of the genera *Chilicola* and *Lasioglossum* (subgenus *Dialictus)* were seen gathering pollen from the flowers, but only by picking up the minute quantities left, probably by the large bees, on the apices of the anthers around the openings.

The list is noteworthy for the forms that are lacking. For example, *Apis mellifera* Linnaeus which exists almost everywhere was never seen using these flowers, nor were species of *Megachile.* In Costa Rica the *Solanum* flowers were intermingled with those of a species of Bignoniaceae visited by *Apis, Trigona,* and males of *Thygater,* yet none of these was ever seen on the *Solanum,* even though females of *Thygater* were the most abundant bees buzzing in the *Solanum* flowers.

The list is further noteworthy for containing representatives of a wide variety of systematic groups, in all of which the rather complicated behavior pattern necessary to collect pollen in the way described above seems to be a part of the potential behavioral repertoire of at least some species. All the bees concerned are polylectic, i.e., they collect pollen from many different flowers. For most of these flowers, entirely different methods of obtaining pollen are used, presumably aided by characteristics of form and color pattern of the flower. The methods, of course, must be different for different kinds of flowers and are presumably learned, as a result of experience, by each bee as it encounters different flowers during its life. It is not obvious what characteristics the flowers of *Cassia* and *Solanum wendlandii* might have that may assist in the acquisition of buzzing behavior by bees of different systematic groups and in different parts of the world. It does seem safe to say that only a small percentage of the individuals of these species of bees evr com in contact with flowers requiring this behavior for successful pollen collecting, and it is therefore evident that the buzzing behavior must be inherited merely as a potential activity, first stimulated, possibly, for each individual by the difficulty of obtaining pollen from the flowers concerned or by some other stimulus.

SUMMARY

Varous plants have anthers which open by apical pores; in some *(Cassia* in the Leguminosae and *Solanum wendlandii* in the Solanaceae) the pollen does not readily come out of these pores, yet is abundant and is collected and used by females of certain large and moderate sized bees. A bee obtains pollen by curling its body over the ends of the anthers and then vibrating its wings (wings held in folded position). The vibrations, which produce a loud sound, cause the pollen grains to shoot out of the pores in the anthers; many of them lodge on the body of the bee from which they are transferred to the pollen-carrying scopal hairs. A vibrating knife blade touched to the anthers also causes pollen to be discharged through the pores.

The bees concerned are all polylectic, i.e., they obtain pollen from many different plants. Most individuals of most of the species never have an opportunity to use the collecting method described above. The potentiality to learn this method must be inherent in a number of groups of bees, but so far as known is absent in others such as *Apis*.

RESUMEN

En varias plantas de anteras con poro apical (*Cassia*, en las Leguminosas y *Solanum Wendlandii* en las Solanáceas), el polen no sale fácilmente. Sin embargo, es abundante y las hembras de algunas especies de abejas de tamaño grande o moderado lo recogen. La abeja obtiene el polen encorvando el cuerpo sobre las puntas de las anteras y haciendo vibrar las alas, que quedan cerradas. Las vibraciones que producen un sonido fuerte, hacen que los granos de polen salgan con fuerza por los poros apicales de las anteras. Muchos granos se quedan en el cuerpo de la abeja, que los pasa a los pelos de la escopa, portadores de polen. Una hoja de cuchilla vibrante en contacto con las anteras también hace salir el polen por los poros.

Las abejas en cuestión son todas polilécticas, es decir, recogen polen de muchas plantas diversas. La mayor parte de los individuos de casi todas estas especies no llegan nunca a usar este método de recolección de polen. La capacidad de aprender este método debe ser inherente en un número de grupos de abejas, pero hasta donde se sabe, falta en otros como el género *Apis*.

REFERENCE

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Fig. 1. Stamens of *Solanum wendlandii* Hook, showing apical pores in anthers, and a female *Thygater* (dotted) in the position in which buzzing occurs.

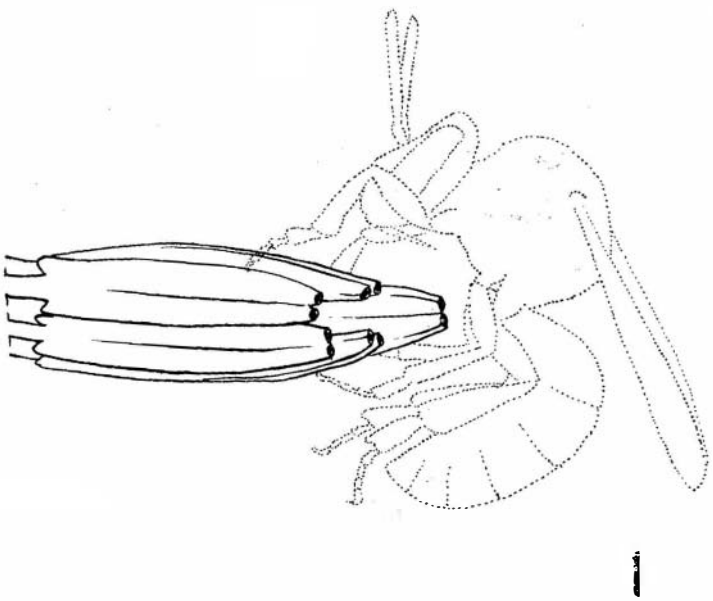
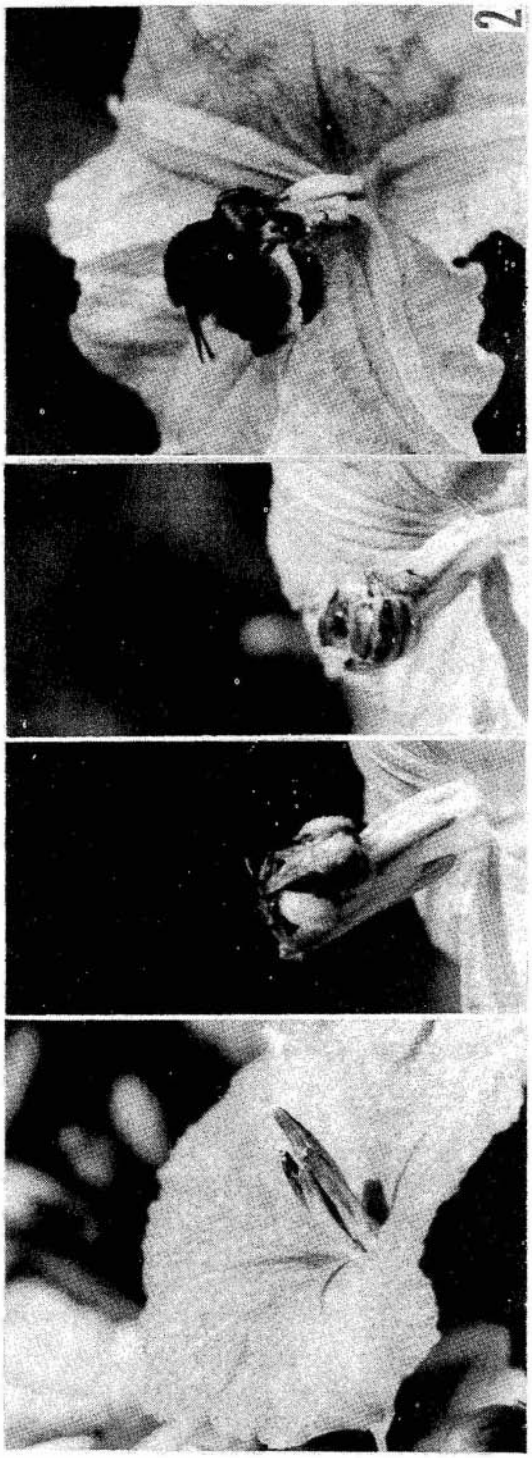


Fig. 1. Stamens of *Solanum wendlandii* Hook, showing apical pores in anthers, and a female *Thygater* (dotted) in the position in which buzzing occurs.

Fig. 2. Flowers of *Solanum wendlandii* Hook. Left, showing stamens; next, showing an *Exomalopsis* about to take up the position on the apex of the group of stamens; next, a *Thygater* and at right, a worker of *Bombus mexicanus*, in the buzzing position on the summit of the group of stamens.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