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Behavioral adaptations of bees for pollen collecting from Cassia flowers

by

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Very recently MICHENER (1) described an interesting method for collecting pollen by bees from flowers with tubular anthers. Since in these flowers the anthers open only at their apices and the pollen does not escape easily from them, bees are not able to get the pollen in the usual manner. Apparently, however, certain bees have evolved a quite different technique of pollen collecting. This method consists of forcing out the pollen from the anthers by means of vibrations. In order to accomplish this the bees curl their bodies over the ends of the anthers and produce peculiar intermittent buzzing sounds, sometimes audible at distances of several meters. These sounds are due to vibrating movements of the wings, which are kept closed over the back. These vibrations are transmitted to the anthers making the pollen shoot out of the apical openings. In this way the bees are able to collect pollen from such flowers, which usually are rich in pollen supply.

While examining a *Cassia* plant for insects, the author noted that some bees were using the buzzing technique to obtain pollen from its tubular anthers, while other bees apparently succeeded in doing so using wholly different methods. Further investigation led to the preparation of the present paper.

The plant in question is *Cassia biflora* Linnaeus, which is one of the common weedy shrubs through much of Central America, especially along the Pacific slope, and is probably the most common flower during the dry season in the Province of Guanacaste, Costa Rica. Apparently it is the main source of pollen for a great number of bees in Guanacaste, where the plant is called "abejón", meaning large bee, in reference, no doubt, to the attraction of large bees like *Xylocopa* and *Centris*. The plant can grow easily and fast in the grassland areas and people

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have to cut the bushes constantly to avoid invasion of these plants into the fields. They start to bloom about November and continue until about the end of the dry season. When the plants are allowed to grow to their full development they reach as much as three and a half meters in height.

The flowers are yellow, with seven fertile stamens, the other three rudimentary. The anthers, which are slightly curved, are distributed in two groups. One group is composed of four anthers 4 to 5 mm long, which are apically truncated by the strong reflexion and fusion of the two-pored rostrum. The other group is composed of three anthers 8 to 10 mm long, each of which terminates in a long cylindric rostrum (about 3 mm in length) opened apically as a pair of subconfluent pores.

Twenty-three species of bees were seen collecting pollen from the flowers of *C. biflora*. These bees can be grouped in three categories according to the method they use to obtain the pollen grains. For convenience, these three categories may be called 1) *the buzzing bees*, 2) *the biting bees*, and 3) *the gleaning bees*.

1) *The buzzing bees:* In this category belong the bees that obtain the pollen with the aid of vibrations, a method which has already been described by MICHENER (1). The greatest number of species collecting pollen on *C. biflora* falls in this category. The following species were recorded:

FAMILY COLLETIDAE

1. *Ptiloglossa* sp.

FAMILY HALICTIDAE

2. *Augochloropsis ignita* (Smith)
3. *Augochloropsis* sp.
4. *Augochloropsis* sp.
5. *Pseudoaugochloropsis* near *graminea* (Fabricius).

FAMILY APIDAE

SUBFAMILY EXOMALOPSINAE

6. *Exomalopsis* (near *similis* Cresson)

SUBFAMILY ANTHOPHORINAE

7. *Centris fuscata* Lepeletier
8. *Centris trigonoides* Lepeletier

SUBFAMILY XYLOCOPINAE

9. *Xylocopa (Schonherria) subvirescens* Cresson
10. *Xylocopa (Schonherria) muscaria* (Fabricius)
11. *Xylocopa (Schonherria) barbatula* Cockerell

12. *Xylocopa (Megaxylocopa) fimbriata* Fabricius
13. *Xylocopa (Neoxylocopa) gualanensis* Cockerell

SUBFAMILY APINAE

14. *Eulaema tropica* (Linnaeus)
15. *Bombus mexicanus* Cresson
16. *Melipona beecheii beecheii* Bennett

2) *The biting bees:* In this category are included those bees which make small holes with their mandibles on the tubular anthers and then collect the pollen through these holes with the aid of the proboscis. The first species of bee that was observed to use this type of pollen collecting technique was *Trigona fulviventris,* the most common stingless bee found on flowers of *C. biflora.* In order to collect pollen from these flowers the bee lands on or moves to the anthers; then standing usually head down it bites the anther several times, either at or close to its base, until it makes a small hole. The bee quickly introduces its extended proboscis in the hole and brushes off the pollen grains, which are then temporarily attached to the tongue. When the proboscis is taken out of the anther it is loaded with pollen. This pollen is taken up immediately by the fore legs and placed on the thoracic sternum, between the second coxae. This procedure of introducing the proboscis in the anther and brushing off the pollen grains, which are then placed on the sternum by the fore legs, is repeated several times. When the thoracic sternum is well loaded with pollen, the bee flies away, and, without getting too far from the flower, it hovers for a while, as if it were suspended at one point in the air. This is the precise moment when the bee transfers the pollen to its corbiculae; to do this the bee uses its legs: the fore legs brush the pollen off the thoracic sternum onto the middle legs, which in turn transfer the pollen to the corbiculae on the hind legs. The hind legs are moved slightly forward, apparently to facilitate the transfer of the pollen. The process takes place very fast while the bee is flying, although practically without moving away from the same spot in the air. The whole procedure is repeated several times, until the bee has enough pollen, then it goes away.

Three species of bees were observed to use this method of pollen collecting from flowers of *Cassia biflora.* All of them were stingless bees of the genus and sugbenus *Trigona.* They are *Trigona fulviventris fulviventris* Guérin- Méneville *Trigona fuscipennis* Friese [=*amalthea* (Olivier)], and *Trigona silvestriana* Vachal (=*trinidadensis silvestriana).* It is possible that other species of stingless bees of the subgenus *Trigona* also use the biting technique for collecting the pollen from flowers of *C. biflora.* It should be pointed out that *T. silvestriana* makes rather large holes on the anthers, sometimes even cutting completely through them. This is not surprising since *T. silvestriana* is a large bee with very powerful mandibles.

3) *The gleaning bees:* In this third category are included those bees that pick up the pollen grains left on the corolla and anthers by the buzzing and biting bees, and which themselves never buzz over or bite a hole in the anthers. It is

interesting to note that MICHENER (1) also observed bees using this method of pollen collecting on flowers of *Solanum wendlandii* Hook, but he saw only minute bees of the genera *Chilicola* and *Lasioglossum,* possibly because only small quantities of pollen were left on the corolla of those flowers. In the case of *C. biflora,* however, it seems that larger quantities of pollen are left on the corolla, since larger bees use, apparently very successfully, the gleaning method of pollen collecting on these flowers. Thus, among these bees is found the honey bee, *Apis mellifera* Linnaeus, which in a rather short time is able to collect a large load of pollen, aided probably by its ability to pick up very rapidly the pollen grains left on the corolla while stopping on each flower only a few seconds. The other bees observed using the gleaning method on flowers of *C. biflora* are the following stingless bees: *Trigona (Tetragona) jaty* Smith, *T. (Tetragona) nigra* Cresson, and *T. (Nannotrigona) testaceicornis perilampoides* Cresson. The latter species, besides picking up grains of pollen left on the corolla, uses very frequently the holes already made on the anthers by the bitting bees in order to draw the pollen grains directly from the anthers with the aid of the proboscis. *T. jaty* was also observed using the holes but less frequently than *T. testaceicornis.*

DISCUSSION

As has been pointed out already by MICHENER (1), the buzzing bees use the normal method of pollen collecting when visiting different types of flowers without tubular anthers. This seems to indicate that the buzzing bees must, as a result of experience, recognize the flowers with tubular anthers in order to adopt the buzzing behavior.

It is interesting to speculate as to the reason why certain bees are able to produce vibrations with the peculiar buzzing sounds and other bees are apparently incapable of doing so. Although there are many species of buzzing bees beloging to a wide variety of systematic groups, there is a still larger number of species in the same area where flowers with tubular anthers are found, that never visit these flowers, seemingly because they are not able to collect the pollen. Since most tropical bees are polylectic, and since flowers with tubular anthers are usually not dominant in any particular area, the non-vibrating bees can ignore the presence of these flowers without much detriment to their pollen supply. One exception to this is perhaps the case of *Cassia biflora,* which es apparently dominant at certain periods during the year in the Guanacaste area, consequently becoming a main source of pollen supply for many bees. It seems significant that it is in this case where several non-vibrating species of bees use very successfully other methods in the way described above to collect pollen from these flowers. It is also significant that the species of buzzing bees found by MICHENER on *Solanum wendlandii* in the central valley (over 1000 m high) of Costa Rica are similar to those found by me as buzzing bees on *Cassia biflora* in Guanacaste (lowland), like *Pseudoaugochloropsis, Centris, Exomalopsis, Xylocopa,* and *Bombus mexicanus.* Other bees observed by MICHENER close to the flowers of *S. wendlandii,* like

Apis and *Trigona,* ignored the flowers with tubular anthers.[1] Likewise, species of bees which exist almost everywhere, like those of the genus *Megachile,* were not found by MICHENER on the flowers of *S. wendlandii.* A similar situation was observed by me in Guanacaste, where *Apis, Trigona* and *Megachile* were also apparently incapable of using the vibrating technique in order to collect pollen, although *Apis* and *Trigona* were successful in collecting pollen from the tubular anters of *Cassia biflora* by using a different method.

At the present state of our knowledge we can not come to definate conclusions as to why certain bees are capable of producing vibrations and others are not. However, it is possible that the bees which are able to vibrate with their wings do so because of certain anatomical conditions which the others lack.

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SUMMARY

Among the plants which have tubular anthers with apical pores is *Cassia biflora,* a very common weedy shrub in the Guanacaste region, Costa Rica. In order to collect pollen from these flowers bees have adopted quite different techniques of pollen collecting. One is by means of vibrations which produce peculiar intermittent buzzing sounds and cause the pollen to shoot out of the anther. Another technique is making small holes with the mandibles on the tubular anthers and then collecting the pollen through these holes with the aid of the proboscis. The pollen is then lodged on the thoracic sternum from which it is transferred to the corbicula (bees observed using this method were stingless bees of the subgenus *Trigona).* The transfer of pollen from the sternum to the hind legs is accomplished while the bee hovers, as if suspended

1 In June, 1963, C. D. MICHENER revisited the locality in San José where he observed bees buzzing on flowers of *Solanum wendlandii.* He found *Centris fuscata* there, in addition to other bees, increasing the number of species in common between the San José and Guanacaste lists. He also verified the absence of any "biting bees" at that location, where an abundance of other flowers is available, in spite of the presence of *Trigona fuscipennis* and *T. fulviventris* on nearby flowers.

at one point in the air. A third technique observed, used by the honey bee and certain species of stingless bees, consists merely in picking up the pollen grains left on the corolla and anthers by the other bees, sometimes utilizing the holes already made on the anthers by biting bees.

RESUMEN

Entre las plantas que tienen anteras tubulares con poros apicales se encuentra *Cassia biflora*, arbusto muy común en la región de Guanacaste, Costa Rica. En vista de que el polen de estas flores no sale fácilmente por los poros apicales, las abejas que las visitan han adoptado diferentes métodos de recolección. Una forma es por medio de vibraciones que van acompañadas de zumbidos intermitentes muy carecterísticos, y provocan la salida del polen. Otra forma es haciendo pequeños agujeros en las anteras, con las mandíbulas, lo que permite sacar el polen directamente de aquéllas con ayuda de la proboscis. Este polen sustraído de las anteras es depositado temporalmente sobre el esterno toráxico, para ser luego transferido a las patas posteriores. La transferencia del polen del esterno a las patas posteriores se lleva a cabo mientras la abeja vuela suspendida en el aire, sin apartarse mucho del mismo punto. Las abejas que se observan usando esta forma de recolectar son ciertas especies de jicotes del subgénero *Trigona*. Un tercer método, usado por la abeja doméstica y ciertas especies de *Trigona*, consiste simplemente en recolectar los granos de polen que las otras abejas han dejado perdidos sobre la corola y las anteras, algunas veces también utilizan los agujeros hechos en las anteras por las abejas que usan el segundo método para tomar granos de polen directamente con la ayuda de las proboscis.

LITERATURE CITED

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