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Bees. The Tools of Their Trade

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BEES

and the

TOOLS

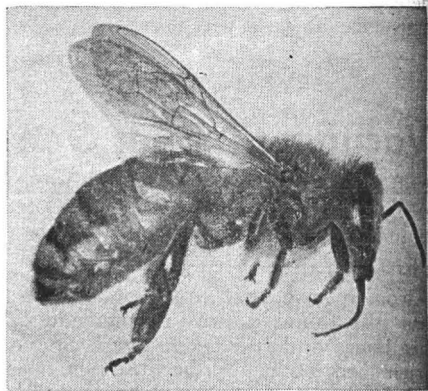
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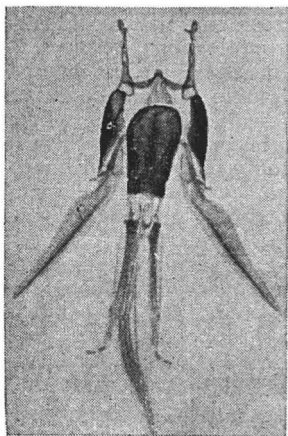
Trade

as reported by **GEORGE E. BOHART** and **WILLIAM P. NYE**, U.S.D.A., Agr. Res. Serv., Entomology Research Branch, in cooperation with Utah Agricultural Experiment Station.

AS WE HAVE said before, all of the 5,000 or more species of bees distributed in hundreds of genera and six or more families have branched hairs on some part of their body. This feature separates them from nearly all other Hymenoptera. Branched hairs trap pollen grains on the body surface, pollen later to be combed into specialized pollen carrying structures. Bees have another trademark—the broad first segment of the hind tarsus. It is used in conjunction with the hind tibia for carrying pollen, and sometimes



No. 1. Honeybee showing hairy glossa extending from tubular sheath.



No. 2. Mouth parts of honeybee showing development of maxillary blades and labial palpi.

(notably with honey bees) to transfer pollen from the body to the corbiculum. Parasitic bees, male bees, and bees that carry pollen on the abdomen have somewhat narrower tarsi without special structures for carrying or transferring pollen. Nevertheless, even they are more "paddle-footed" than the wasps.

Nectar Gathering

All bees are adapted for sipping nectar from flowers. For this purpose most of their mouth parts are interlocked to form a tubular sheath. Emerging from this sheath is an extensible tongue (glossa) with hairy sides and tip for sponging free liquid (Fig. 1). The most primitive bees (family Colletidae) have a short, broad proboscis with a two-lobed tongue that differs little from the apparatus of the sphecoid wasps from which they arose. However, the colletids have a well-developed honey stomach since, unlike the sphecoid wasps, they have to transport honey for later regurgitation into the brood cells.

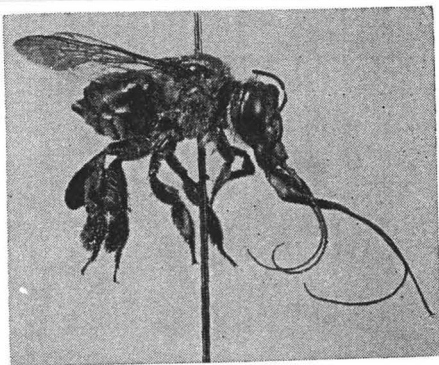
The more primitive members of the next family, Andrenidae, are a step higher in the scale. Their tongue has a simple, but well-tufted tip and a more extensible base than the tongue of the colletids. Both groups visit principally small flowers without corolla tubes or only short ones. A few of the andrenids have become adapted to deeper corollas and have a longer proboscis.

The sweat bees (family Halictidae) are remarkable for the long basal arms of their mouth parts, which give to their proboscis somewhat the proportions and action of a human arm. The important remaining families (Megachilidae, Anthophoridae, Xylocopidae, and Apidae) have a highly developed proboscis with a long, tightly interlocking sheath and a long, flexible, and extensible tongue.

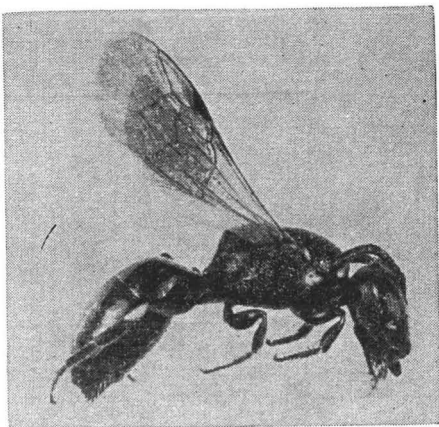
The honeybee has a proboscis about midway between those of the short-tongued and long-tongued bees (Fig. 2). This suits it admirably for its catholic tastes. Few flowers are so tiny or so deep that honey bees can't get at the nectar. Many members of the Anthophoridae and Apidae have a longer proboscis than the honeybee and prefer flowers with a long corolla tube or nectar spur. The large and beautiful tropical bees of the genus *Eulaema* (family Apidae) have a tongue so long that they can take nectar from flowers otherwise useful only to moths and humming birds (Fig. 3).

Pollen Gathering

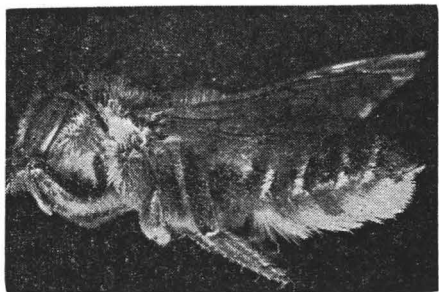
Structures for gathering and transporting pollen point up the importance of this habit among the bees. Here the



No. 3. *Eulaema* (Apidae), showing extreme development of proboscis for probing deep, narrow corolla tubes.



No. 4. *Hylaeus* (Colletidae), showing lack of external pollen-carrying apparatus.



No. 5. Female leaf-cutting bee (Megachilidae), showing pollen-collecting hair brush on under side of abdomen.

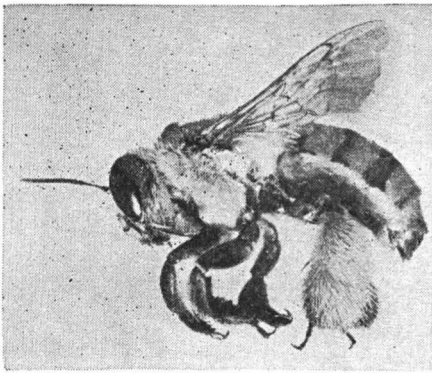


Fig. 6. *Centris* (Anthophoridae), showing well-developed pollen brush confined to hind tibia and first tarsal segment.

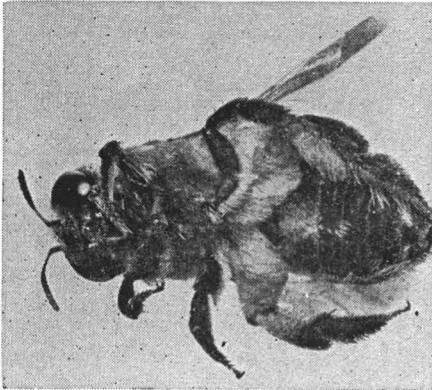


Fig. 7. Under side of *Oxaea* (Andrenidae), showing pollen carrying hairs on all major segments of hind leg and at base of abdomen.

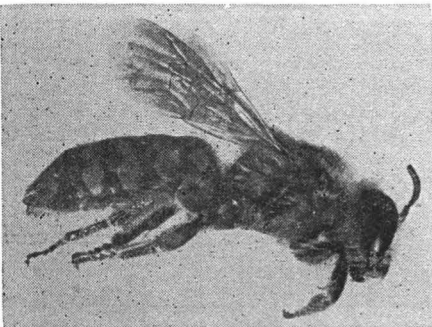


Fig. 8. *Nomadopsis* (Panurginae), showing sparse hairs on hind tibia for holding wet lump of pollen.

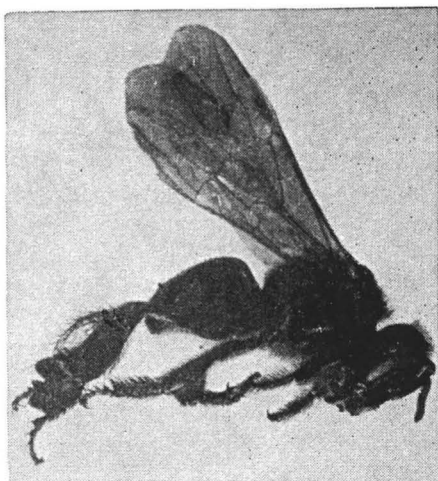
specialization is often quite narrow, since most bees visit a much smaller range of plants for pollen than for nectar. The most primitive condition is found in *Hylaeus* (family Colletidae), which carries its pollen in the honey stomach (Fig. 4). Early students of bees, noting its lack of pollen-carrying structures, thought *Hylaeus* was a cuckoo bee.

As might be expected, male bees have no well-developed arrangements for carrying pollen, though they sometimes show feeble developments in the direction of their sisters. The nonfunctional mammary structures in male mammals present a parallel situation. Parasitic bees, of which there are many genera scattered among several families, are like male bees in this respect.

The external pollen-carrying structures of bees are of three main types: (1) Dense brushes of hairs. These may be on the underside of the abdomen (Megachilidae) (Fig. 5), the hind tibia and first tarsal segment (Anthophoridae) (Fig. 6), or the hind leg and various other spots such as the base of the thorax and abdomen (Andrenidae and Halictidae) (Fig. 7). Pollen is combed into these brushes and carried to the nest in a dry condition. (2) A few long hairs on the hind tibia, which hold in place a honey-soaked mass of pollen (Andrenidae, subfamily Panurginae) (Fig. 8). (3) An expanded, fringed, and polished area on the hind tibia known as the corbiculum (honeybees and other members of the Apidae). The corbiculum holds a wet lump of pollen. Some of the tropical stingless bees and *Euglossa* have a pollen basket even more conspicuous than that of the honeybee (Fig. 9).

Most flowers make bees work hard for nectar and then load them with pollen while they are getting it. Consequently, bees have little need for special structures to take pollen from flowers. However, a number of unrelated bees that visit the tiny narrow corollas of *Cryptantha* have hooklets on the proboscis for pulling the pollen out of the corolla tube (Fig. 10). A small group of andrenid species that visit *Verbena* perform the same feat by pulling the pollen out of the corolla tube with curved bristles on the front tarsi.

Fig. 9. *Trigona* (Apidae), showing well-developed corbiculum of hind leg.



Nest Building

Nest building is a highly skilled occupation that calls for special tools. Indeed, the tools used by bees often seem too simple for the specific and precise tasks they perform. The turret-making bees of the family Anthophoridae shape intricate nest entrances with a simple triangular plate at the tip of abdomen (Fig. 11). The worker honeybee fashions the geometric wonder of its waxen cells with simple spatula-shaped mandibles. The Megachilidae specialize in the use of nesting materials that they have to tear with their mandibles from a solid substrate. *Anthidium*, for example, has saw-toothed jaws for carding the fibers from plant stems (Fig. 12). *Dianthidium* has simple cutting edges on its mandibles for scraping resin from plant stems and leaves (Fig. 12). *Megachile* has shearing areas between the teeth of its mandibles used for cutting circular and oval leaf pieces (Fig. 12). Many of these bees also use their mandibles for tunneling through wood or hard mud. Male bees gather no nesting materials; neither do they build nests, but they do have to escape from their brood chambers before taking wing. Consequently, they have well-developed mandibles suitable for simple scraping operations but not for the specialized functions of their sisters (Fig. 12). The male honeybee has weaker mouth parts than other bees because of its helpless dependence on the workers.

Adaptations of Cuckoo Bees

Parasitic bees enter the nests of other bees and lay their eggs in hidden places in or near the provisions of their hosts. For this assignment they are well provided with armor and a powerful sting (Fig. 13). Bandits with their guns and armored cars have nothing on these "cuckoo bees". *Triepeolus*, a parasitic anthophorid, lays its egg in a hole drilled in the soil beneath the provisions of its host. The unique and complicated



No. 10. *Proterias* showing hooklets on proboscis for taking pollen from flowers of *Cryptantha*.

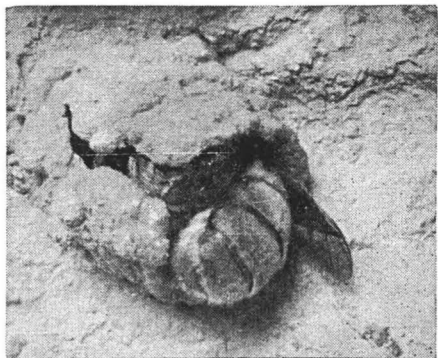
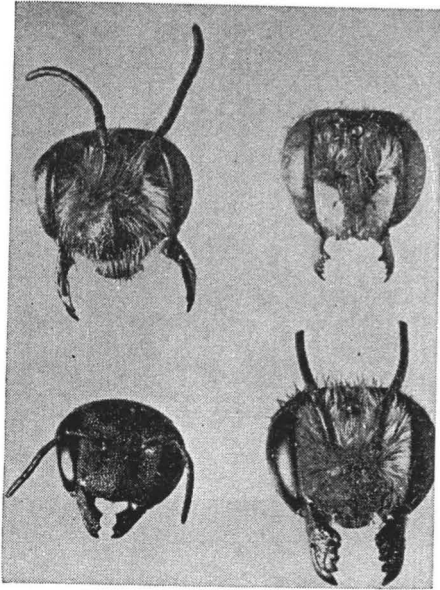


Fig. 11. *Anthophora occidentalis* troweling mortar with plate on the end of her abdomen.

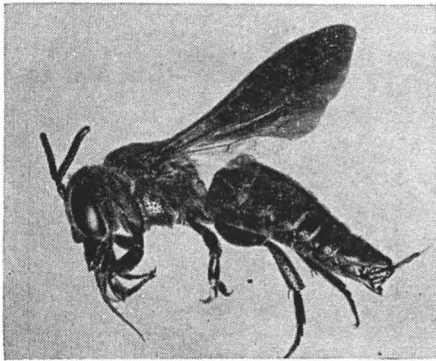


structures around its sting appear to be for drilling purposes although no one has ever seen them in action (Fig. 14).

Special Forms and Structures of Males

Especially intricate and specific are the primary and secondary sex structures of the males. The drone honey bee has the most remarkable genital apparatus of all bees. In other bees the penis is small in comparison with the surrounding genital armature and is used for repeated acts of copulation. In the honeybee the supportive structures are degenerate and the penis itself is enormously developed to hold the great quantity of sperm needed by the queen. In a single climactic and fatal act the whole structure is everted into the vagina of the queen and torn loose at its base. The male honeybee

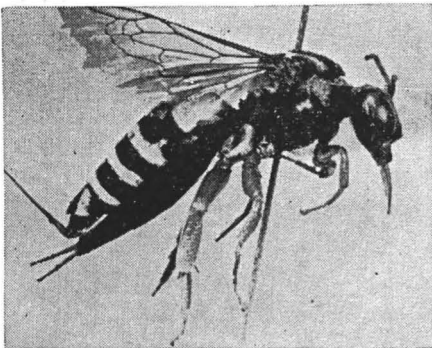
No. 12. Mandibles of (a) *Andrena* male (b) *Anthidium* (c) *Dianthidium*, (d) *Megachile*.



is highly specialized for pursuit. He seems clumsy around the hive, but his powerful thoracic muscles and huge eyes fit him well for high, free flight after the young queen. Some of the bumble bees show similar adaptations, but others are little different in body form from the females.

The flower-like front feet of many male leaf-cutting bees (family Megachilidae) are apparently ornaments for the attraction of the female (Fig. 15). Perhaps they attract her because she

No. 13. *Coelioxys* (Megachilidae), a parasite of leaf-cutting bees, showing heavy protective armor.



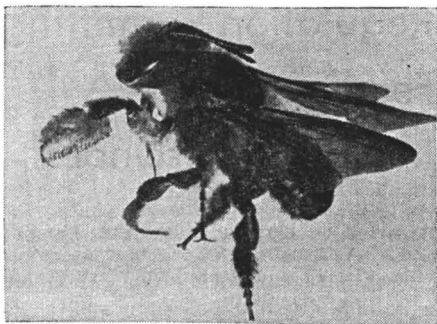
associates them with flowers. Many species of bees have males with swellings, spines, tufts of hair, and other odd structures on the legs and other parts of the body. The segments of the under side of the abdomen and the genitalia are often strangely modified. These characteristics whose actual uses are not completely known, are a boon to the systematists in their attempts to straighten out the chaotic condition of bee taxonomy.

When the layman says of a group of

No. 14. *Triepeolus* (Anthophoridae), a parasite of long-horned bees showing long sting and drilling apparatus.

No. 15. Male leaf-cutting bee (Megachilidae), showing flower-like front legs.

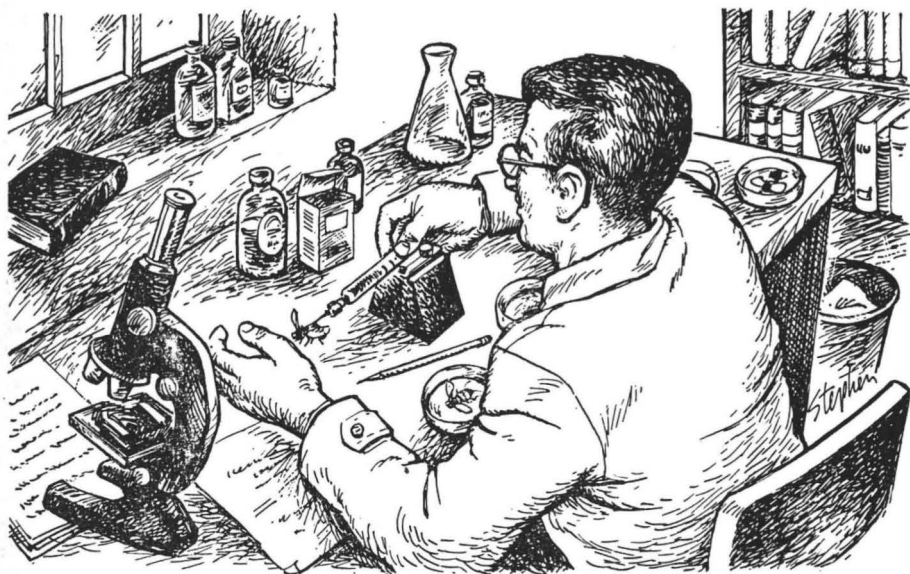
insects that "they all look alike," he merely means that he is unwilling to examine anything so small. A casual study of the forms and patterns represented in a collection of bees is a rewarding glimpse into the endless variety of nature. Observation of the living, working bees putting their specialized forms and tools to use is even more instructive and entertaining.



Bee Lore



Illustrated by
V. R. Stephen



STINGING A BEE. At the Bee Research Laboratory in Beltsville, Maryland, scientists have developed a way of stinging a bee. No child's play here . . . they have a real purpose in mind. Honeybees get shots of streptomycin for control of bee diseases. The bees are anesthetized, and after injection are allowed to recover.