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Electric charge in the food chain

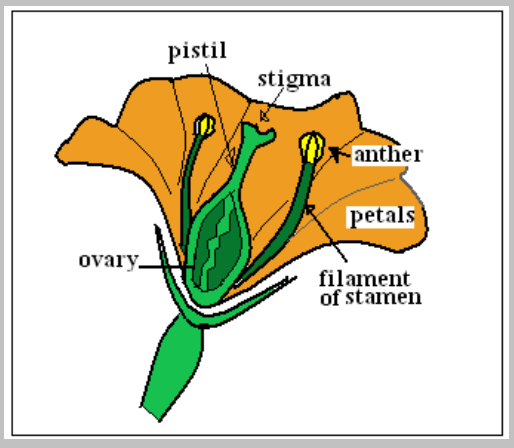
The honey bees' foraging advantage has its downside, says S.Ananthanarayanan.

Flowers and pollinators have co-evolved. Flowers form carefully matched colours and scents to advertise their store of nectar, to draw honey bees, the principal pollinator. The bees come to feed and help carry pollen from the stamen of one flower to the pistil of another, to set off the reproductive process of the plants.

Pollen is also nutritious food for the bee and she has evolved specialized pollen gathering and pollen carrying structures, which helps her efficiently perform the function for which flowers keep these good things for her. To do a great job, in fact, the honey bee uses electric charges on her body to pick up the pollen from the flower, like a magnet can pick up iron filings. But biologists at the University of California at Berkley have found that the wily spider has evolved its web to make use of the electric charge to trap the bee!

Pollen

Pollen is a fine, sometimes rough powder, of particles which are the precursor of ***sperm cells*** of the plant. They are produced in the flower in the ***stamen***, which consists of a stalk and a head, called the ***anther***. Pollen that is released from the anther forms lumps which can attach to birds or insects, or pollen grains can be spread by the wind or water. When the pollen lands on the ***pistil*** of a flower, it germinates and transfers sperm cells to the ***ovule***, the source of egg cells.



Bees are the main agents of transfer of pollen from plant to plant and they are clearly adapted for this role. Apart from pollination that takes place while gathering nectar, bees also gather pollen, to use as food for themselves and for their young. The pollen gathering activity is the more efficient in pollination. For pollen gathering, bees are fuzzy and have dense, long, often branched hair covering their hind legs and on the lower abdomen, with a cavity, fringed with hairs, in the hind legs. But the most remarkable adaptation is that bees generate electrostatic charge, which helps attract and retain pollen grains.

Electric charge

Electrostatic charge, like electricity, consists of electrons that detach from atoms of materials. Unlike electricity, which flows in conductors, static charge collects on insulators, after being transfered from other material during contact. We may have experienced the effect with plastic wrapping material that sticks to out hands. Rubbing silk in the dark can cause flashes of light when the silk gets charged and discharges. This is also the effect that makes a plastic comb pick up bits of paper after the comb has been run through our hair. In practice, the effect is used in the photocopier – the image to be printed is transferred to the paper as electric charge to make the ink stick to the paper
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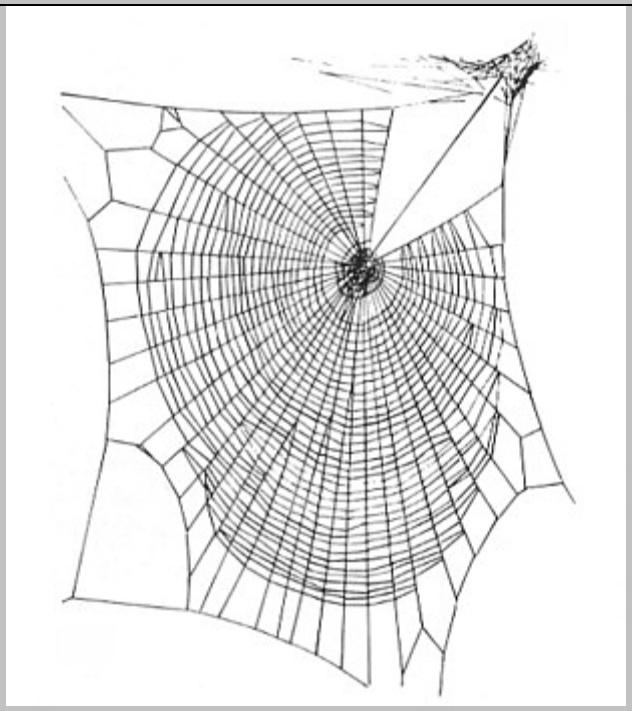
The honey bee, by rapid movement of its wings, generates a sizeable electric charge, a positive charge, on its body and scopa. The comb that attracts bits of paper is able to do this because the charge on the comb affects the charges on the paper, it pushes like charges away and attracts unlike charges. The like charges then crowd in the part nearer the comb and there is a net attraction. In the same way, the charge on the honey bee attracts the unattached pollen grains on the anthers and on the petals, even before it actually comes in contact. And then, the pollen sticks to the scopa, and is not easily shaken off.

In fact, flowers have also adapted to make best use of electrostatic charges - they have a slight negative charge. The charge on the flowers also seems to lead the bees to them. In an experiment, half a collection of uncharged, artificial flowers was sweetened with sugar water, while the other half had quinine, which bees find distasteful. When the flowers were uncharged, the bees landed randomly on the flowers, the ones that found sugar staying to sip, while the others beat a hasty retreat. But when the sweetened flowers were lightly charged, the bees went to them in preference. This shows that the bees can sense the charge that flowers carry.

Spiders' web

The spiders' web is a marvel of biotechnology, engineering and material science. Spider silk is spun from protein-rich material in complex silk spinning organs, called ***spinnerets***, located on the abdomen of the animals. The spinnerets create the orientation of molecules to give the material it phenomenal strength. There could be just one spinneret or two, four or eight, working independently or in concert, to create patterns that combine strength and economy. The result is the cobweb (so called from the word, ***coppe***, which means spider), which has been around for over 100 million years.

There are different kinds of webs, spiral, tangle, funnel or tubular and the sticky strands help trap prey without the need to run them down. But spinning the protein-rich web is energetically expensive and the material loses its texture. Spiders hence eat part of their web every day, to recycle the protein. The construction of the strand is so efficient that weight for weight, spider web is many times stronger than steel,



But the icing on the cake is the discovery that ***Ortega-Jimenez***, post-doctoral fellow at the University of Carilfornia at Berkley and ***Robert Dudley***, professor of integrative biology, report their findings in ***Scientific Reports***, and on line facility of the publishers of the journal, ***Nature***. The team reports thinner strands of spider web are electrically attracted by the positive charge on the bodies of insect that fly past. In an experiment, dead insects that were charged with the charge they usually carry were dropped on to cobwebs, to see, with high speed cameras, if the charge affected the strands. It was seen that the falling insects deformed the webs, which reached out to touch the insects before they reached the web

"You would expect that if the web is charged negatively, the attraction would increase," says Ortega-Jimenez. The research is to be continued, to see how much this effect helped spiders in the wild, and whether charged webs attracted dirt and pollen, to need daily renewal. It would also be interesting to see if electric charge affected the adhesion of the sticky web material, which is known to have its own surface structure.