Bee Research Digest

by EDWARD E. SOUTHWICK
Department of Biological Sciences
State University of New York
College at Brockport, New York 14420

INTERNET: eSouthwi@ACSpr1.ACS.Brockport.edu
FAX: 716-395-2416

Importance of Bees

There are at least four large groups of people interested in bees; hobby beekeepers, commercial beekeepers, agriculturalists, and scientists. If we think of keeping honey bees as "only" a hobby, we may miss the substantial role they play in nature. They are much more than just a backyard honey producer with interesting behavior. Even those persons who raise bees as a primary business necessarily think in terms of profit and loss associated with the products bees produce or with their crop pollination services. Agriculturalists are interested in pollination services provided by bees on specific monoculture crops. Scientists who study bee biology have discovered that bees provide a window into deep biological concepts through an endless supply of unanswered questions. How do they fly? How do they resist disease? How do they communicate? What determines the nectar or pollen they collect? How do they cope with cold weather? How do they operate as individuals in the field and in the colony? How does the colony function in such organized ways? What role does social behavior play in the success of bees over the millenia?

Numbers and Biomass in Natural Ecosystems

Bees certainly do have interesting behaviors. They are important pollinators of agricultural crops. They are worthy of biological investigation. But all these still miss some of the major considerations in the importance of these little insects. The social insects including bees, wasps, ants and termites comprise an amazingly large portion of the animal world in many environments of the planet, from northern climates to arid deserts and tropical rain forests. Recent conclusions reached after decades of study are that the social insects in a tropical rain forest make up as much as one-third of the animal biomass. The sheer numbers of these little insects staggers the imagination. Although honey bee colonies seem to average about 30 thousand individuals (with summer peak populations as high as 90 thousand), ant colonies may number in the millions of individuals in a single nest. There are tens of billions of these insects sharing the earth with us today. Their sum total mass is greater than that of the entire human population.

Energy and Material Turnover

Numbers or biomass alone do not equate to importance. The success of colonies of bees and ants is highly dependent on securing adequate home sites and obtaining sufficient long-term sources of food and water. In the process of maintaining the home nest, the individuals move out into the local habitat scouring the landscape for food. Edward O. Wilson of Harvard University, who has spent his life studying the social ants, has likened the colonial feeding to the stretching of tentacles, made up of large numbers of walking and running foragers, out over the landscape, to bring in the food. Bees, too, show this sort of food gathering with the tentacles made up of flying foragers. While the bees are vegetarians eating only pollen and flower nectar, many ant species are omnivorous or carnivorous, and most wasps are carnivorous. The consumption of materials and elimination of waste products contributes substantially to the turnover of materials in any terrestrial ecosystem. In fact, it is likely one of the most important activities of colonies of social insects, making them one of the most significant biological structures in nature.

Ant species occupy home sites that they alter considerably by moving soil and forming cavity enlargements and reshaping. Social bees, on the other hand, are not good at changing the dimensions of cavities to their liking. Instead they look for and occupy cavities that already have shapes and locations that are satisfactory to them. Site characteristics include cavity volume (honey bees prefer cavities of about 40 liters but accept larger or smaller volumes as well), height above the ground (honey bees prefer to be 2 meters or higher with a small entrance), wetness of the cav-

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ity (if it is too wet, honey bees may abscond), and even the compass direction the entrance faces (south preferred).

The nest size has to be adequate to house not only the individuals but also the food stores. Honey bees require about 25 liters of storage space for their typical honey and pollen stores in wild nests. Of course, when man intervenes to make the storage space larger, the bees accommodate by storing even three or four times as much food as they would normally need to survive. If there is insufficient forage within a reasonable range, the homesite may become unattractive. So both homesites and floral resources are important in the maintenance of honey bee colonies.

The energy flow through colonies of bees and the turnover of materials by colonies are an important contribution to the dynamics of community structure in ecosystems. The only determination of these factors was made by David Roubik of the Smithsonian Tropical Research Institute (1989) in a tropical rainforest. The biomass and rates of return of nectar, pollen and resins by foragers from 37 species of stingless colonies (189 nests) were averaged and used to determine the amount of material collected. The movement of materials and cycling of energy through the colonies were determined using measured sugar compositions of the honeys and derived energy and pollen protein values. Bees occupying a hectare of tropical lowland harvest about six million kilojoules (kJ) of carbohydrate each year (a kilojoule is a unit of energy equal to 239 calories). There is an annual collection of nearly nine kilograms of pollen which contains about five liters of nitrogen. The energy in the pollen is an additional quarter million kilojoules . Energetic costs of wax production and foraging activity itself were not considered so the energy estimate is likely to be a conservative underestimate. The total energy for primary producers (trees and other plants) for tropical forests is about fifty-four million kilojoules for each hectare. Therefore, the bees alone account for some eleven percent of the energy flow in this habitat!

In the natural scheme of things, every day the colonies distribute dead bees, frass (feces), wax and other litter over the surrounding forest floor. Using about 100 dead workers being disposed of from the nest each day, along with those hundreds that die in the field while foraging, a complete turnover of worker populations of tropical honey bees takes place each 40-50 days. This amounts to a few hundred kilograms of dead bees scattered over a square kilometer in a year with the energy equivalent of nearly ten million kilojoules. The colony litter ejected from nests (by cleaners carrying the debris 20 to 30 meters away from the nest before dropping it) contributes about 1.8 metric tons each year per square kilometer. The feces are also scattered about (2 to 10 meters from the nest) during cleansing flights. After nest confinement because of a dearth in food supply or inclement weather, bees may do this as groups collectively voiding liquid frass in the air over the nearby ground area (yellow rain). If 30,000 bees in a colony each voided 30 mg in this fashion, the total of almost 10 kg would be released.

Summing all the above gives us the total annual contribution in bee cycling of materials over one square kilometer of ecosystem to be about three metric tons of material containing fifteen million kilojoules of energy.

Pollination

Finally, we need to consider the impact of bees on the pollination of plants. This aspect is not considered in the treatment above. According to the National Geographic Atlas (6th edition, 1990), about seventy percent of the earth is covered by water, and if all the land masses were leveled, there would not be a dry spot of ground, but the entire earth would be under two and one half kilometers of water. Nevertheless, the existing land masses show a physical richness visible from satellite mosaic images as well as close up on hands and knees. About 34% of the land area is desert, tundra, rock and marshes, 29% is forested (6% is tropical rain forests that are being reduced by nearly one percent annually), 25% is meadows and pastures, 10% is croplands, and the remaining 2% is cities and towns, highways, parking lots, parks, and protected wilderness and wildlife refuges. This land supports about two hundred and fifty thousand species of flowering plants. Many thousands of species require cross pollination which is mostly achieved by social bees. The pollination benefit through bees including honey bees in natural ecosystems is likely to be substantial. Although no good economic estimates have been made, consider that these benefits include, through primary production, the absorption of carbon dioxide from, and injection of oxygen into the atmosphere. It also provides fruit and seed set for food and plant cover for wildlife, plant cover that reduces erosion, plants that ameliorate airborne pollutants by acting as pollutant sinks filtering out and detoxifying poisonous substances, plants that recycle nutrients, decompose wastes, serve as a storehouse of genetic material, and regulate fresh water cycling. These bee-pollinated flowering plants also provide secondary pollination resources in the vicinity of agricultural crops (an increasingly threatened habitat especially important as nesting sites for wild bees and as a continuing food resource for bees when crop flowers are unavailable).

Habitat destruction and pesticide reduction of natural pollination fauna have been partly counteracted by the introduction of honey bee colonies. In locations throughout the world where loss of natural habitat of wild bee species has been great, honey bees are imported for effective pollination of agricultural fields.

Recent examination of bee pollination of agricultural crops in the world shows that hundreds of species in more than 40 plant families are dependent at least partly on bees and other insects. Many agricultural crop plants must have out-crossing to produce viable fruit. Some crops show hybrid vigor with the production of bigger and better fruits. The yields of many fruit, vegetable, seed, and nut crops would decrease substantially without the pollination services of bees. The demand for pollination services is increasing with the demand for hybrid seed production. Without honey bees, many popular agricultural products would be missing from the marketplace.

Our estimate of the economic value of honey bees alone to agriculture in the United States is more than $1.6 billion annually (Southwick and Southwick 1992). When other wild bees that pollinate crops are included, the total value reaches $5.2 billion. If we assume that agriculture in the United States is about one-sixth of the total world, then worldwide value of bees in agriculture is around $31 billion. It wouldn't surprise me if the total economic impact of honey bees, wild bees and other social insects in the world as a whole is on the order of ten to fifty times this value.

Indeed, social bees and other social insects are more than just another pretty face; they are essential in the balance of natural environments and they are of direct importance to humankind!

References:

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