HOW CELLS RELEASE STORED ENERGY

The Killers Are Coming! The Killers Are Coming!

In 1990, thanks to selective breeding experiments gone wrong, descendants of "killer" bees that flew out of South America a few decades earlier buzzed across the border between Mexico and Texas. By 1995, they had invaded 13,287 square kilometers of southern California and were busily setting up colonies. By 1998, when nectar-rich desert flowers bloomed profusely after heavy El Niño storms, the invasion extended even farther west and north than scientists had predicted.

When provoked, the bees behave in a terrifying way. For example, thousands flew into action simply because a construction worker started up a tractor a few hundred yards away from their hive. Agitated bees entered a nearby subway station and started stinging passengers on the platform and in trains. They killed one person and injured a hundred others.

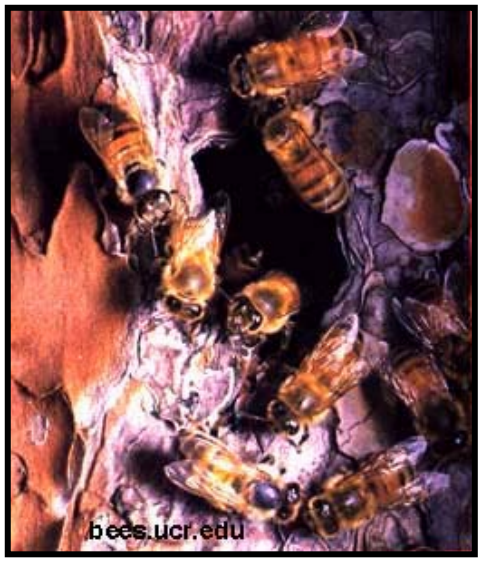
Where did these bees come from? Some queen bees were shipped from Africa to Brazil for breeding experiments in the 1950s. Why? As it happens, honeybees are big business. Besides being a source of nutritious honey, bees are rented to commercial orchards, where their collective pollinating activities may significantly enhance fruit production. For example, enclose a blossoming orchard tree in a pollinator-excluding cage, and less than 1 percent of the tree's flowers will set fruit. But put a hive of honeybees inside the cage with the tree and 40 percent of the flowers will set fruit. Compared to their relatives in Africa, bees in Brazil are rather sluggish pollinators and honey producers. By cross-breeding the two, researchers thought they might come up with a strain of mild-mannered but zippier bees. So they put local bees and imported ones together in netted enclosures, complete with artificial hives. Then they let nature take its course.

Figure 8.1 One of the mild-mannered honeybees buzzing in for a landing on a flower, wings beating with energy provided by ATP. If this were one of its Africanized relatives protecting a hive, possibly you would not stay around to watch the landing. Both kinds of bees look alike. How can we tell them apart? From our own biased perspective, Africanized bees are the ones with an attitude problem.

Twenty-six African queen bees escaped. That was bad enough. Then beekeepers got wind of preliminary experimental results. After learning that the first few generations of offspring were more energetic but not overly aggressive, they imported hundreds of African queens and encouraged them to mate with the locals. And they set off a genetic time bomb.

Before long, African bees became established in commercial hives—and in wild bee populations. Their traits became dominant. The "Africanized" bees do everything other bees do, but they do more of it faster. Their eggs develop into adults more quickly. Adults fly more rapidly, outcompete other bees for nectar, and even die sooner.

When something disturbs their hives or swarms, Africanized bees become extremely agitated. They can remain that way for as long as eight hours. Whereas a mild-mannered honeybee might chase an intruding animal fifty yards or so, a squadron of Africanized bees will chase it a quarter of a mile. If they catch up to it, they collectively can sting it to death.



Doing things faster means having a continuous supply of energy and efficient ways of using it. An Africanized bee's stomach can hold thirty milligrams of sugar-rich nectar—which is enough fuel to fly sixty kilometers. That's more than thirty-five miles! Besides this, compared to other kinds of bees, an Africanized bee's flight muscle cells have larger mitochondria. These organelles specialize in releasing a great deal of energy from sugars and other organic compounds, then converting it to the energy of ATP.

Whenever they tap into the stored energy of organic compounds, Africanized bees reveal their biochemical connection with other organisms. Study a primrose or puppy, a mold growing on stale bread, an amoeba in pondwater, or a bacterium living on your skin, and you will discover that their energy-releasing pathways differ in some details. But all of the pathways require characteristic starting materials. They yield predictable products and by-products. And they yield the universal energy currency of life—ATP.

In fact, throughout the biosphere, organisms put energy and raw materials to use in amazingly similar ways. *At the biochemical level, we find undeniable unity among all forms of life.* We will return to this idea in the concluding section of the chapter.