How Honeybees Find a Home

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How Honeybees Find a Home

In most of the Temperate Zone a new colony of honeybees must locate a snug shelter in order to survive the winter. The search is carried out by the older "scout" bees with remarkable rigor

by Thomas D. Seeley

The honeybees arose in the Tropics, and two of the four living species (*Apis florea* and *A. dorsata*) still live only there. *A. cerana* and *A. mellifera,* however, have gradually extended their ranges far north and south of the Equator and therefore have confronted the problem of surviving through the winter, when there is no nectar or pollen to be gathered and when for days or weeks on end the temperature is below the level at which honeybees are able to fly (10 degrees Celsius, or about 50 degrees Fahrenheit). The remarkable method honeybee colonies have evolved for getting through the winter depends critically on the type of enclosure a colony occupies; in a suitable enclosure the colony may be able to carry on for several years, whereas in a poor one the bees may perish in the first winter. The adequacy of the enclosure in turn depends critically on the activity of the small group of older workers that chose it: the scout bees.

In the Tropics *A. florea* and *A. dorsata* nest in the open, hanging their nest from the underside of a tree branch, whereas *A. cerana* and *A. mellifera* nest in a cavity. It is this habit that has enabled the latter two species to extend their range. In the temperate zones the bees in a colony of *A. cerana* or *A. mellifera* spend the nonwinter months storing up 10 kilograms or more of honey that will serve as food during the winter and thus indirectly as a heating fuel. When winter comes, the colony contracts into a tight cluster. The bees in it generate heat by small vibrations of their powerful flight muscles, maintaining the surface temperature of the cluster at about 10 degrees C. In a snug shelter that has an adequate store of honey the bees usually get through the winter quite well.

Clearly, then, an important first step by a new colony is the selection of a snug shelter. In the wild the shelter is usually a cavity in a tree. Over the past five years I have been studying the house-hunting behavior of *A. mellifera* honeybees living in central New York State. These studies have revealed that the process of nest-site selection is remarkably thorough and have yielded findings that are of practical value to beekeepers.

House hunting is a part of swarming, which is the honeybees' method of establishing a new colony. Colonies swarm in the late spring; for bees in New York State the time is from late May to the end of June. Swarming follows a period of intense rearing of brood, which considerably enlarges the population of the colony and creates congestion in the nest cavity. Studies by James Simpson of the Rothamsted Experimental Station in England indicate that overcrowding stimulates the colony's workers to begin rearing a batch of daughter queens. The strongest queen (determined by stinging duels among the young queens) inherits the established nest. Once the rearing of new queens is well under way, and even before the first daughter queen emerges, the mother queen moves out with about half of the colony's 30,000 or so workers to start a new colony in another location.

The old queen and her retinue of workers depart in a mad whirl, pouring out of the nest and beginning a short flight. The swarm travels only a few tens of meters and then settles in a beardlike cluster on some object, usually a branch of a tree or bush. Soon after the swarm has settled the scout bees fly off in all directions to begin their reconnaissance.

Their search extends out to 10 kilometers or more from the old nest. The scouts are the oldest bees in the swarm, the ones that have already foraged for the colony and so are familiar with the territory around the old nest. They number a few hundred, or about 5 percent of the swarm's population.

Once the scouts have selected the future home site they make zigzag runs (punctuated by bursts of wing buzzing) through the swarm, thereby signaling the other bees to break up the cluster. Bernd Heinrich of the University of Vermont has shown that before lift-off a swarm warms itself throughout to about 36 degrees C., the temperature at which flight muscle functions best. In the final minutes before lift-off a swarm teems with scouts scrambling over the cluster, vibrating their wings and boring through the interlocked nets of hanging bees. A loud humming noise emanates from the cluster, a mixture of deep wing buzzes and shrill piping sounds. The sound reaches a climax as the once solid surface of the swarm appears to melt because the chains of hanging bees begin to disintegrate. Within another minute the entire swarm is airborne, filling the air with the penetrating buzz of thousands of bees circling tightly overhead.

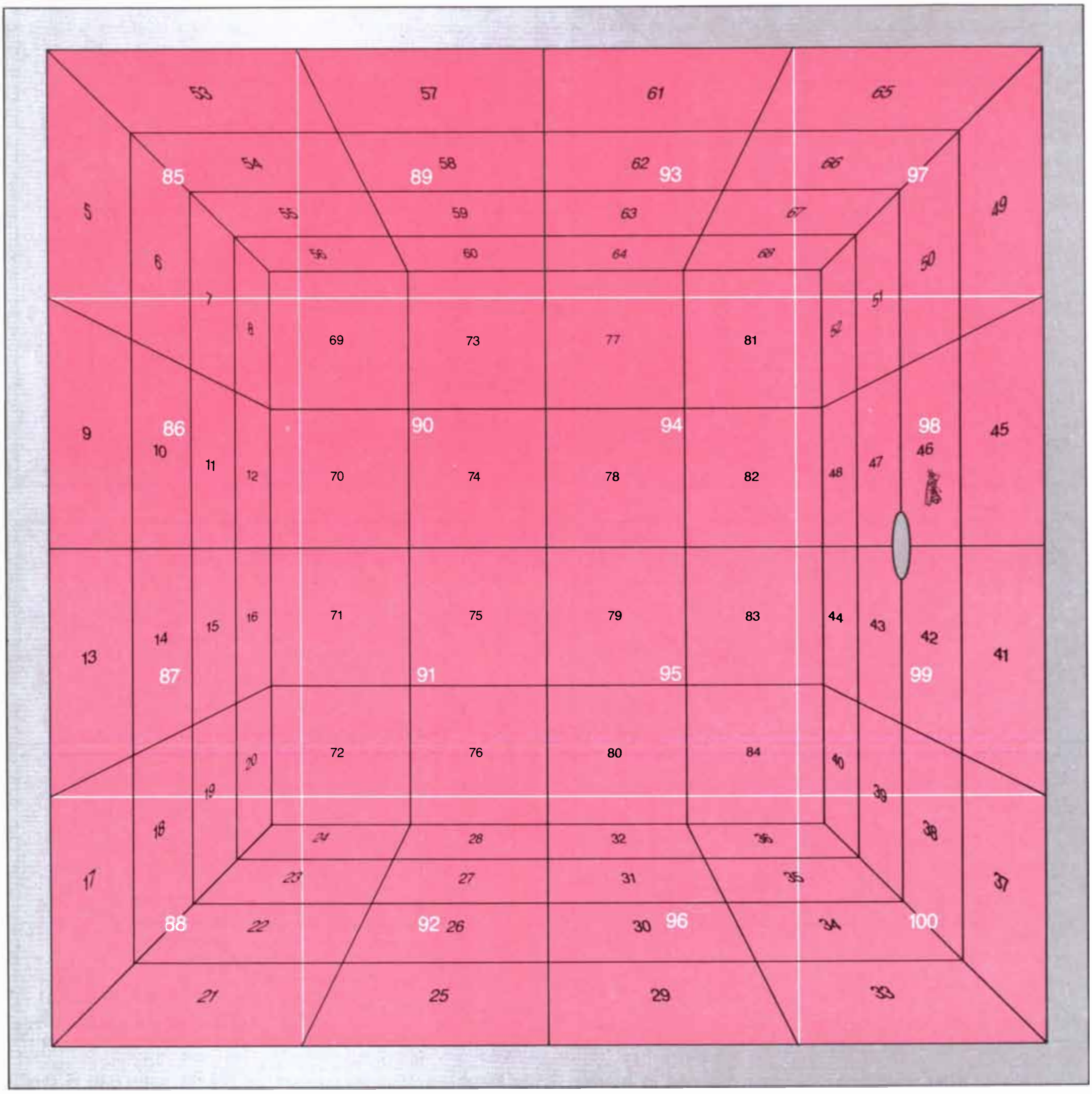
The airborne swarm forms a cloud about 10 meters in diameter. To pilot their sisters to the new home site the scouts streak through the swarm in the direction of the site. The swarm moves slowly at first, traversing the first 30 meters at a speed of less than one kilometer per hour, but within 200 meters it accelerates to 10 kilometers per hour or more, flying a few meters above the vegetation.

When the swarm reaches the nest site, the scouts somehow signal it to stop. Then they drop down from the cloud formed by the swarm, alight at the entrance to the nest (a knothole, a gap among the roots of a tree or a narrow crack in a limb) and release assembly pheromone from the Nassanoff gland in the tip of the abdomen. The pheromone, a chemical signal that the bees sense as an odor, pinpoints the entrance to the nest. Soon the other bees are streaming into the nest cavity in a formation that resembles a whirlpool. Within 30 minutes of lift-off nearly all the bees are safely inside their new home. Within a few hours they are cleaning out debris, constructing combs and flying off to forage for nectar and pollen. A new colony has been established.

Martin Lindauer of the University of Würzburg studied honeybee swarms in Munich just after World War II while he was working at the Munich Zoological Institute. He analyzed the process whereby scout bees decide which of the various sites discovered will be the swarm's future home. His first observation was that soon after a swarm assembles in a cluster near the old nest bees appear on the surface of the cluster doing "dances" of the type that Karl von Frisch, who was then also at the Munich Zoological Institute, had found to be the means by which foragers direct their nestmates to new sources of food.

Lindauer also observed that the dancers on a swarm never brought back nectar or pollen; therefore they were apparently not foragers. To make sure he marked the dancers with spots of paint and read from their dances the locations of the targets indicated. Further investigation called for a compass to measure the orientation of the dance with respect to the position of the sun and a stopwatch to time the cycles of the dance. The orientation indicates the direction to the site and the tempo of the dance indicates the distance: the faster the dance, the closer the target. Lindauer marked the indicated spots on a topographical map and set out to find precisely where the bees were going. In a few instances he found the bees he had marked. They were not foraging but were busily inspecting holes in the ground, hollows in trees or cracks in old walls. These bees were house hunters. Their dance announced prospective dwelling places, not patches of flowers.

By following the dances of the scouts continuously from the time a swarm settles until it lifts off Lindauer was able to determine how the scouts reach accord on a site. At first they search independently, and each one that finds a prospective site announces it independently by dancing on the swarm. Some sites are



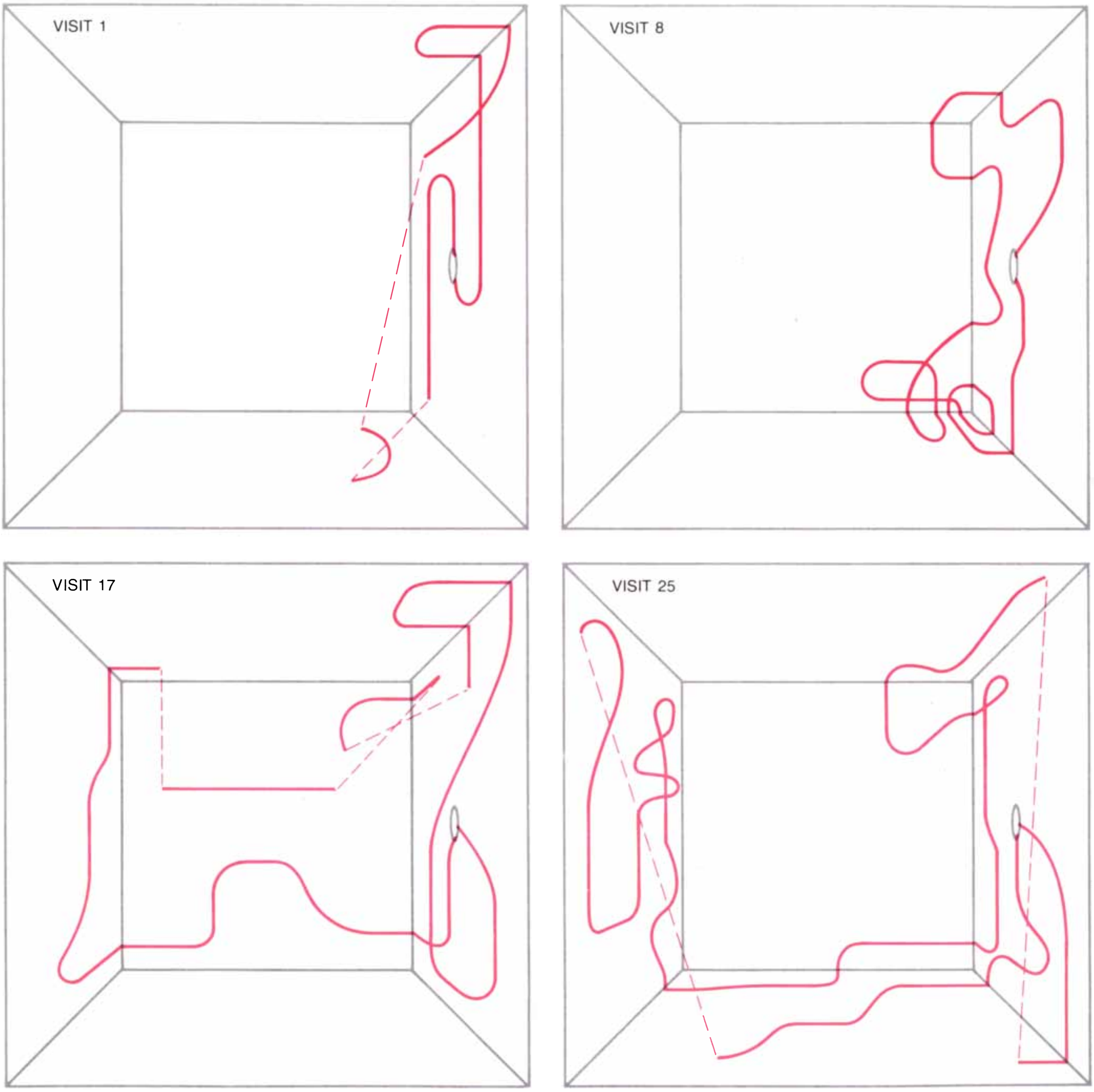
EXPERIMENTAL NEST BOX devised by the author enabled him to observe a scout bee as she explored a potential nest site. The box was mounted outside a red window on the side of a hut. Because bees do not see red light the experimenter could look through the window without disturbing the scout and could record her movements by means of numbered squares. Squares 85 through 100 are on window.

represented by a lively dance that is repeated for a long time, others by a dance a human observer can only characterize as unenthusiastic. The liveliness of a scout's dance reflects the quality of the site she has found. A dance for an inferior dwelling place is sluggish.

When a scout engaged in a sluggish dance encounters one that is dancing vigorously, she senses the lively dance and flies off to inspect the site. If her inspection reveals that it is indeed superior, she begins advertising it in her dance at the swarm. In this way the scouts gradually reach a consensus about the best dwelling place. Often it takes them several days to come to an accord. It is when they are all advertising the same goal in unison that they give the signal that causes the swarm to break up the cluster and fly to the new nest.

Lindauer's work revealed what happens at the clustered swarm while the scouts are house hunting but gave few clues about what happens at the prospective sites. What do the scout bees seek as an ideal site? How do they inspect a potential site and ascertain its properties? After repeating Lindauer's observations on the way the scouts reach and convey a consensus at the swarm I decided to explore these questions as the research on which I would base my doctoral thesis at Harvard University.

A logical starting point for studying what honeybees look for in a site for a



SCOUT'S METHOD of exploring a cavity is indicated by tracings of what a single scout bee did on four out of 25 visits during her initial inspection of a potental nest site. Where the line is solid the bee was walking; where it is broken she was flying. At first she stayed near the entrance, but eventually she explored the entire cavity. After the initial inspection she returned sporadically, apparently to check the site as external conditions changed. When she was away, she was either advertising the site to other members of the colony by means of a stereotyped "dance" on the surface of the swarm (the beardlike cluster the bees had formed) or visiting sites found by other scouts.

home is to study the nests of honeybee colonies living in nature. Each colony occupies a site its scouts have selected, and so it seemed reasonable to expect that patterns in the properties of such sites would yield clues about what the bees prefer. Working with Roger A. Morse of Cornell University, I found 21 honeybee colonies living in hollow trees in the forests around Ithaca, N.Y.

In order to fully describe the architecture of these natural nests we cut down each tree, transported the section with the nest to the laboratory and split open the log to expose the nest. We measured all the properties we could think of as likely to be significant to the bees: the height and size of the entrance and the shape and volume of the cavity (measured by removing the combs and filling the cavity with sand). Numerous consistencies emerged. A typical nest occupies a vertically elongate tree hollow with a volume of about 45 liters.

Once I knew what the natural homes of honeybees are like I sought to test whether the patterns we had found reflect the preferences of scout bees as they pursue their search. The idea for the experimental design of the test came from what I had read about beekeeping in East Africa. There the beekeepers acquire bees by hanging hives (hollowed logs with the ends stoppered except for an entrance hole) in trees and waiting for swarms to occupy them.

I tried the same thing around Ithaca except that I put up nest boxes in sets of two or three. In each set the boxes were identical except for one property, such as cavity volume or the height of the entrance above the ground. I hoped that scouts from wild swarms would discover my nest boxes and reveal their nest-site preferences by choosing among the boxes in a set.

The plan worked quite well. Over four summers approximately half of the nest-box sets attracted a swarm each summer. Moreover, the patterns of occupation were sufficiently consistent to show the nest-site preferences of the bees. Of course, in order to get statistically meaningful data I needed several occupations of the nest-box set for each variable in nest-site properties. To test for preferences in 11 variables I built 276 nest boxes, using up enough plywood (more than 70 sheets) for a small house.

The bees indicated preferences in the following nest-site variables: the volume of the cavity, the size of the entrance, the height of the entrance above the ground, the height of the entrance above the floor of the cavity, the direction the entrance faced and the presence of combs in the cavity. Honeybees avoid cavities with less than 10 liters of volume and more than 100. A small cavity cannot hold the store of honey the colo-

HONEYBEE SWARM hangs from a branch of a tree. A swarm consists of the queen from an established colony and about half of the colony's 30,000 or so workers. Soon after leaving the old nest the group settles in this manner and the scouts (a few hundred of the older workers) fly off to begin looking for a new site. They may go as far as 10 kilometers from the old nest.

SWARM IN FLIGHT is on its way to a new nest, on which the scouts have reached a consensus after a few hours or days. The swarm is moving from left to right. Most of the bees, which appear as dots or short streaks, are flying slowly. The scouts fly through the swarm rapidly, showing the direction of the new site. The scouts appear in the picture as relatively long streaks.

ny needs in order to survive the winter, and a large one may be difficult to heat in the winter.

Bees prefer an entrance that is less than 50 square centimeters in size, is at least two meters above the ground, faces south and opens into the bottom of the nest cavity. A small entrance is easily defended and helps to isolate the nest from the outside environment. High entrances are inaccessible to predators that cannot fly or climb trees and are harder to find than entrances near the ground. An entrance that faces south provides a warm, sunny perch from which foragers can take off and on which they can land. (Beekeepers face their manmade hives to the south to help their bees fly out in cool weather; the orientation is particularly important in the winter months, when bees fly out on sunny days to eliminate accumulated body wastes.) An entrance at the bottom of the nest cavity rather than at the top may help to minimize the loss of heat from the nest by convection currents. The preference for a site already filled with combs (built by a preceding colony that did not get through the winter) doubtless reflects the tremendous saving of energy that would otherwise have to go into the building of combs.

NATURAL HONEYBEE NEST was a cavity in a tree. Here the section containing the nest has been split open, revealing the combs containing brood and honey. The entrance hole is on the left side, about two-thirds of the way up the cavity. The author and Roger A. Morse of Cornell University examined a number of natural nests to determine what scout bees look for.

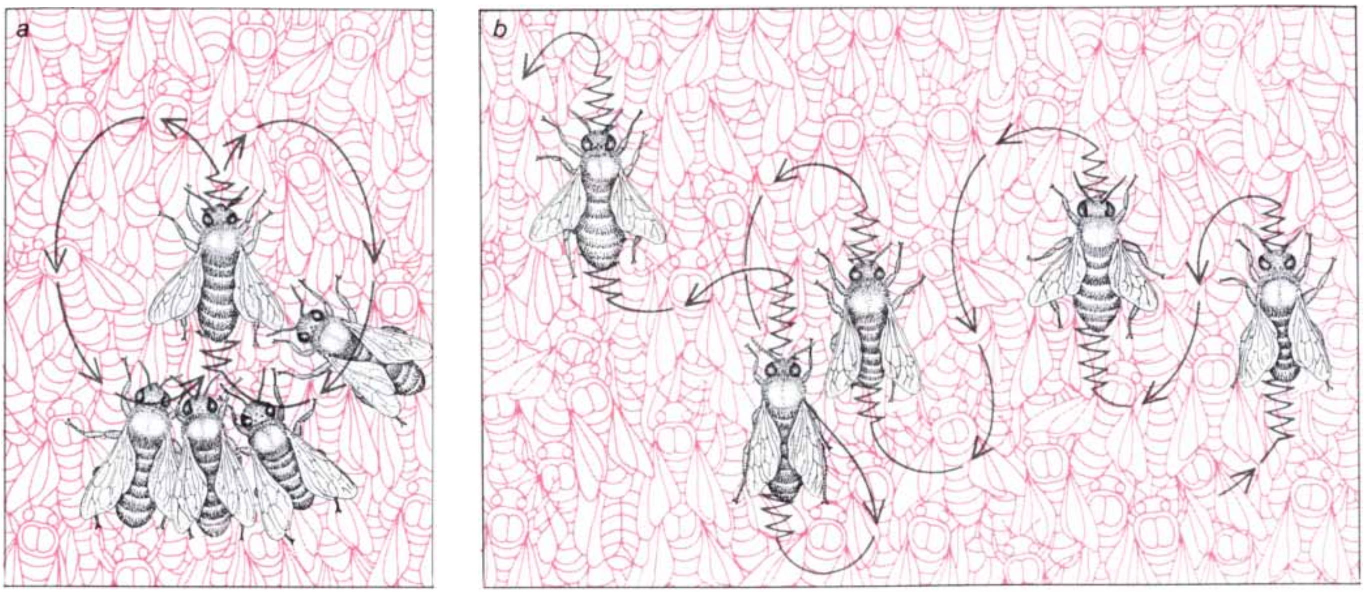
The nest-site properties for which I detected no preference were the shape of the entrance, the cavity's shape, its draftiness, its dryness and the distance of the site from the old nest. Honeybees probably prefer draft-free and dry nests, but because the colony can plug with tree resins any cracks that let in drafts and water the scouts apparently do not give much weight to these properties. In contrast, bees cannot modify the volume of a cavity or the height of the entrance and the direction in which it faces, and so they must make a choice in these matters before they move in.

The ability of bees to remedy a drafty or damp site was demonstrated by colonies that occupied our experimental nest boxes. I had made some of the boxes drafty by drilling into the sides a grid of six-millimeter holes spaced 10 centimeters apart; the bees plugged up all the holes with tree resins within a few days after moving in. They also quickly dried out damp nest boxes by dumping outside the soggy sawdust I had put on the floors and sealing the leaky wall and ceiling joints with resin.

Although I did these studies only to satisfy my curiosity about how honeybees choose a home when they are left to their own devices, the research yielded information of practical value to beekeepers. Applying the knowledge of what honeybees seek in a nest site, Morse and I designed what we call a bait hive, that is, a hive designed to catch wild swarms of honeybees. Physically the hive is basically just a box nailed to a tree, but its size, the characteristics of the entrance and the height above the ground meet the preferences of the bees and so make it an ideal nest site. (We do not fill bait hives with combs for fear of transmitting certain honeybee diseases to the incoming swarms.)

Between 1975 and 1980 we collected 251 bait-hive-years of data on our design; in the process we captured 124 swarms for an occupation rate of 49 percent per year. In the past beekeepers wanting to collect wild swarms had to rely on being notified when a swarm had settled somewhere; then they had to hurry to collect it in a hive before the bees could finish choosing a nest site and moving into it. With bait hives beekeepers can collect swarms automatically.

Up to this point in my studies I had treated the evaluation process of the nest site like a black box. I knew what scout bees seek in a prospective nest but I had little information on how they inspect one. To look into their inspection behavior I had to leave the countryside around Ithaca and shift my investigation to Appledore Island in Maine. This 39-hectare island lies 10 kilometers offshore and is the site of the

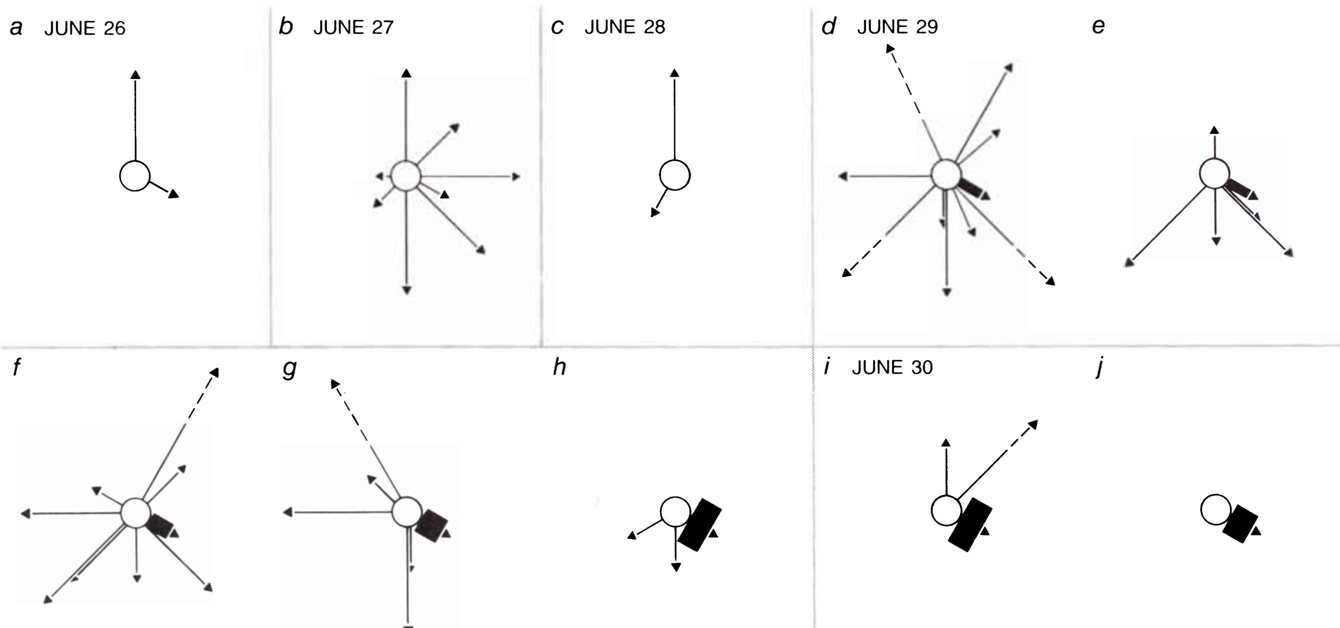


SCOUT'S DANCE advertising a nest site she has found is made on the surface of the swarm. Often the dancer moves in a pattern resembling a figure eight (*a*), waggling her abdomen during the central part. The direction of the waggling run conveys the direction of the site in relation to the sun; here the run is upward and means the site is toward the sun. The rhythm of the dance indicates the distance to the site; the farther the site, the longer the waggling middle part of the dance. Four other scouts are shown observing the dance. Sometimes a scout will dance in one place and then will walk a short distance along the surface of the swarm and perform the dance again (*b*).

Shoals Marine Laboratory of Cornell and the University of New Hampshire. Its particular importance for my work is that it has no large, hollow trees. Hence when I took honeybee swarms out to the island, I forced them to concentrate their house hunting on the experimental nest sites I provided. In this way I could easily observe and analyze the process of nest-site evaluation.

My first goal on Appledore Island was to record the behavior of scout bees inspecting nest sites. I hoped the observations would suggest how scouts evaluate the critical nest-site properties. It was particularly important to be able to watch scouts inside a prospective nest in order to understand how they judge such things as the volume of the cavity and the height of the entrance.

To this end I built a hut with a cube-shaped nest box mounted on one of its walls. The box was positioned outside a red window (bees cannot see red light) so that I could look in without disturbing the scouts. The inner surfaces of the box bore a grid-coordinate system that enabled me to record where a scout went while she was in the cavity. After setting up the hut on one



SUMMARY OF SCOUTING is given from the time a new colony left the old nest (at 1:35 P.M. on June 26) until it moved into the new nest site (at 9:40 A.M. on June 30). The observations were made by Martin Lindauer of the University of Würzburg. In each case the circle represents the location of the swarm, the arrows indicate the direction in which scouts found potential nest sites and the thickening of the arrows shows that increasing numbers of scouts were visiting a particular site. The longer an arrow is, the farther away the site was; distances beyond 1,000 meters are represented by broken lines. The most distant site (*f*) was 4,500 meters away. The scouts discovered 21 sites, but gradually they reached a consensus on the one that was 350 meters to the southeast, a site found by one of the first two scouts to advertise a find (*a*). On June 28 scouts were inactive because of rain. Multiple entries for June 29 and 30 are several periods of observation.

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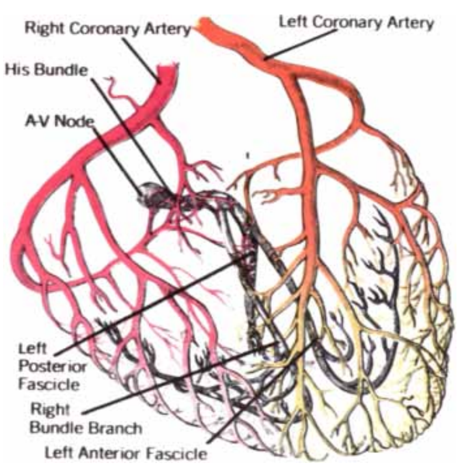

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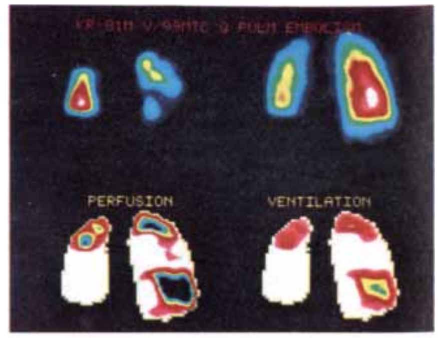

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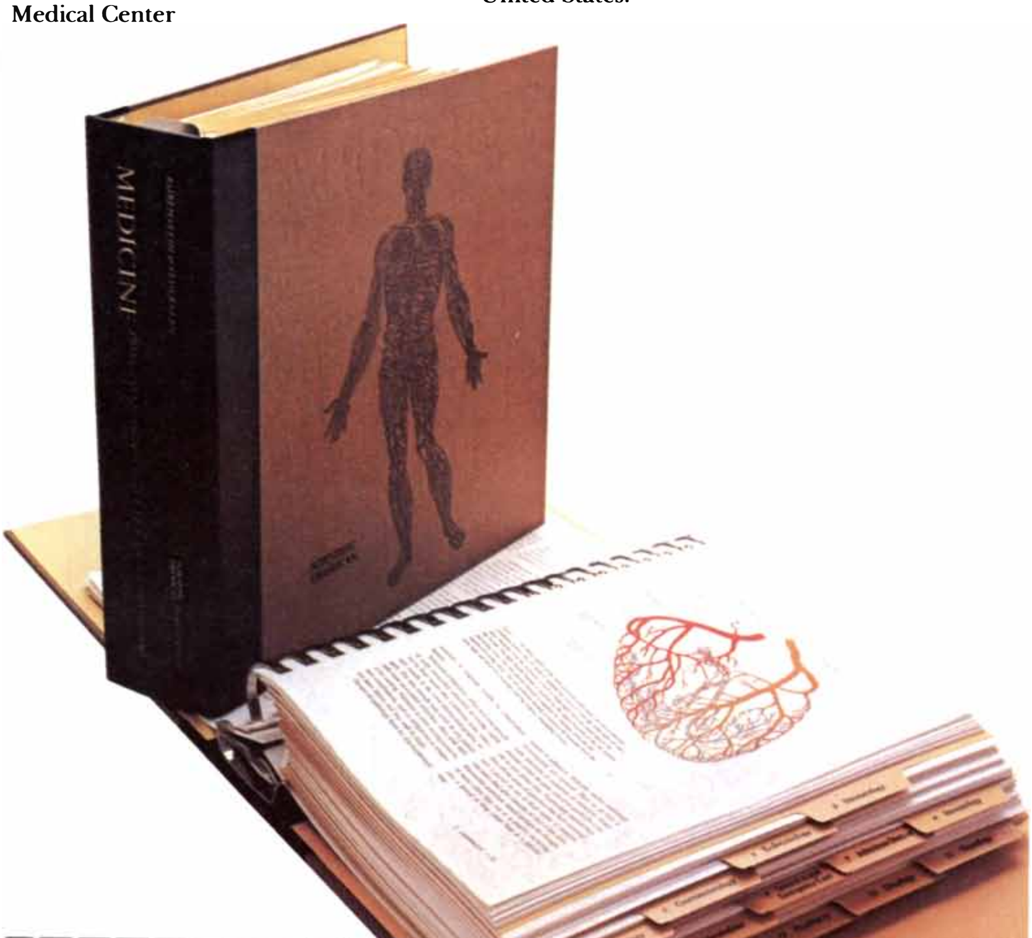

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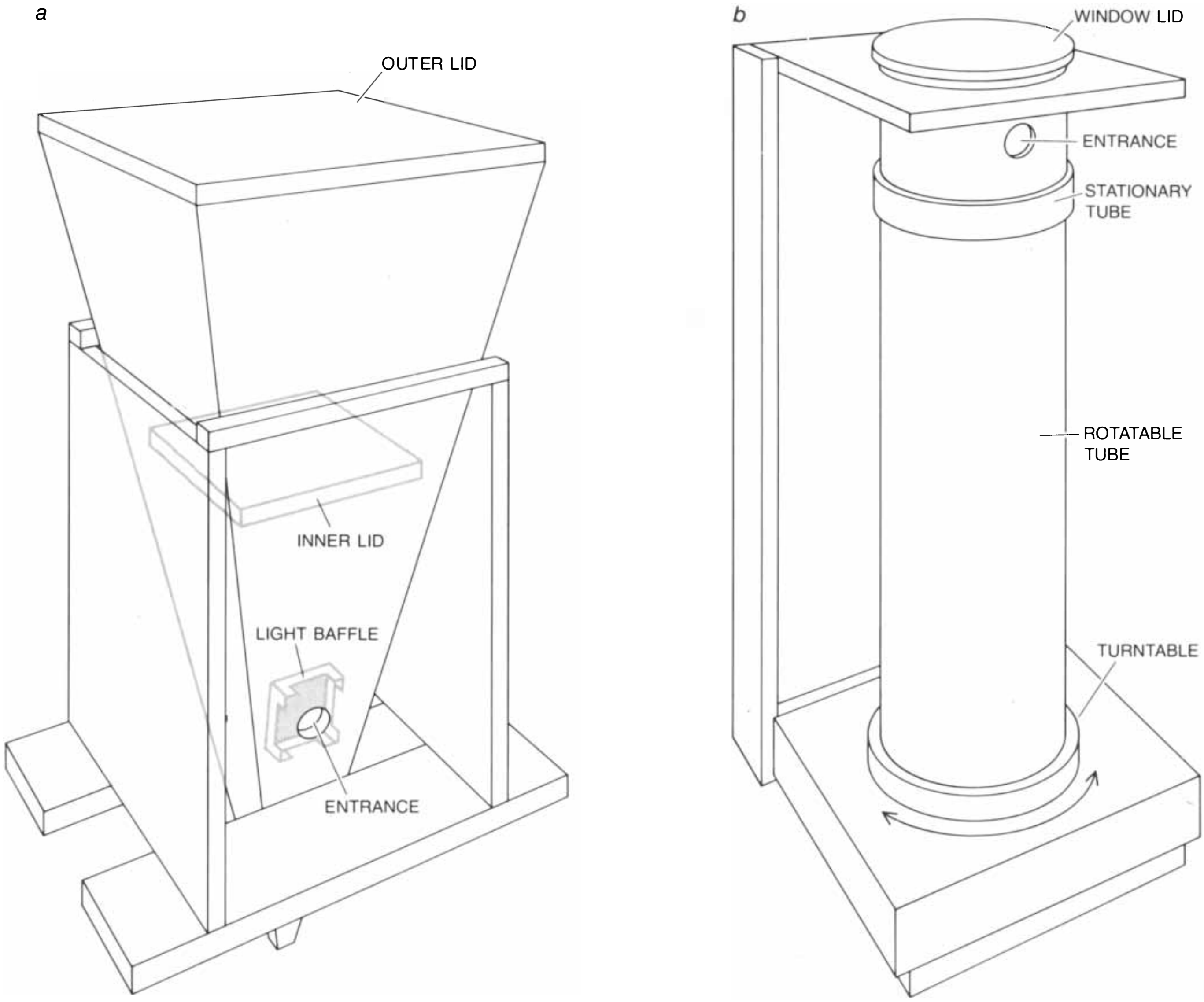
side of the island I would position a small swarm (about 2,000 bees) on the opposite shore, putting a dot of paint on each bee according to a color code that made them individually identifiable. Then I would retire to the hut to wait for the scout bees.

A scout bee needs about 40 minutes for inspecting a nest site. The complete inspection is a summation of numerous excursions inside the cavity, each one lasting for less than a minute and alternating with equally brief periods outside. I call this initial phase, in which a scout is primarily at the nest site, popping in and out of the cavity, the discovery phase.

Following the discovery phase a scout continues to visit a good site, but the visits become sporadic, each visit perhaps an hour after the preceding one and lasting for less than a minute. Evidently a scout conducts a detailed inspection of a prospective site during the discovery phase and thereafter spends most of her time elsewhere, either back at the swarm advertising the site or off inspecting other sites. The sporadic returns probably enable scouts to quickly check a site under different conditions, such as later in the day when the angle of the sun has changed or after a rainstorm that may have flooded the cavity.

When a scout is inside a cavity, she devotes most of her time (about 75 percent) to rapid walking about on the inner surfaces. This quick pacing is interspersed with brief flights, each usually less than a second in duration, in which she moves from one point to another. A geometric pattern in these inspections is that early in the discovery phase a scout walks about primarily near the entrance, whereas later she penetrates to the deepest recesses of the cavity. Three-dimensional reconstructions of the walking paths of individual scouts reveal that when the inspection is finished, a scout has walked 50 meters or more around the inside of the cavity and has covered all its inner surfaces.

The volume of a cavity is the nest-site property that is perhaps most critical to a colony's long-term survival. Since the colony needs at least 10 kilograms of honey to get through the win-



EXPERIMENTAL APPARATUS was devised by the author to test how a scout bee measures the volume of a cavity. The colony requires a site with a minimum volume of about 15 liters in order to store up the 10 kilograms of honey needed to get through the winter; anything larger than 100 liters is usually avoided, probably because the colony would have difficulty keeping warm inside it in the winter. With one apparatus (*a*) the experimenter could vary the volume between five liters (with the inner lid down) and 25 (inner lid up). By means of the light baffle he could change the amount of light coming in through the entrance hole to see whether scout bees estimating the size of the cavity relied mainly on walking or on vision. The chief sensory input turned out to be walking. In the other apparatus (*b*), which had a volume of 14 liters, the experimenter could rotate the wall in order to increase or decrease the amount of walking a scout bee had to do in order to measure the volume. The number of other scouts she recruited to the box was the measure of how she perceived its size.

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BETTER TOOLS FOR MICROCOMPUTERS

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PROPERTY	PREFERENCE	FUNCTION
HEIGHT OF ENTRANCE	MORE THAN THREE METERS	DEFENSE OF COLONY
AREA OF ENTRANCE	LESS THAN 60 SQUARE CENTIMETERS	CONTROL OF MICROCLIMATE IN NEST AND DEFENSE OF COLONY
POSITION OF ENTRANCE	BOTTOM OF CAVITY	CONTROL OF MICROCLIMATE IN NEST
DIRECTION OF ENTRANCE	FACING SOUTHWARD	CONTROL OF MICROCLIMATE IN NEST
VOLUME OF CAVITY	BETWEEN 10 AND 100 LITERS	STORAGE SPACE FOR HONEY AND CONTROL OF MICROCLIMATE IN NEST
COMBS	COMBS IN CAVITY	ECONOMY IN CONSTRUCTION OF NEST

NEST-SITE PROPERTIES that honeybees apparently prefer are listed on the basis of nest-box selections made by bee swarms. A site with all the properties presumably would be ideal.

ter and that amount of honey requires about 15 liters of storage space, the volume must be at least 15 liters if the colony is to survive the winter.

How do scout bees measure the volume of a cavity? Their active walking in the course of an inspection may provide the basis for an estimate, but another hypothesis is that they simply go inside and look around. By means of experiments with nest boxes in which the traversable surface area and the interior illumination could be varied I found that in order to measure a volume scout bees need either inner surfaces that can be traversed or interior illumination of more than .5 lux (about the illumination provided by a full moon).

What are the conditions inside a cavity in a tree? Certainly the inner surface of bare wood is easily traversed by a scout bee. To measure the level of illumination in a similar cavity I built a model based on the measurements I had made of natural nests. It had a series of openings into which I inserted a light meter. I found the illumination to be less than .5 lux except near the entrance. Evidently in nature scout bees rely primarily on walking about in a prospective nest site to measure its volume.

To test this hypothesis more directly I tried modifying a scout's perception of volume by manipulating the amount of walking required to move from point to point inside a cavity. The device for this experiment was a cylindrical nest box mounted vertically on a turntable, enabling me to smoothly rotate the box while a scout bee was inside. By means of a window at the top I could look inside and see which way the bee was walking; then I could turn the walls according to whether I wanted to increase or decrease the amount of walking required for her to complete a horizontal circuit.

The volume of this experimental box was 14 liters, on the boundary between an unacceptably small cavity and a suitably large one. If walking contributes to the perception of volume, the first scout to discover the box should find it either more or less attractive than its true volume would suggest according to whether she had been made to walk more or less than she would in a normal 14-liter cavity. The test was the number of other scouts the first scout recruited to visit the box; she should recruit more scouts if she found the box suitably large than she would if the box had seemed unacceptably small. That is what I observed in four trials of this delicate experiment. It seems clear a scout's estimate of the volume of a cavity is proportional to the amount of walking she must do to circumnavigate it.

The founding of a honeybee colony is fraught with danger. To survive the first winter the colony must surmount the many hurdles of finding a good site, building a nest of energy-expensive beeswax combs, rearing offspring that can outlive the winter and gathering the necessary provisions for winter. Most colonies do not succeed. Long-term observations of the forest-dwelling colonies around Ithaca have revealed that only 24 percent of the newly founded colonies survive their first winter, whereas the survival rate for established colonies is 78 percent.

These observations have also revealed that if a colony does survive the critical first winter, it will endure on the average for another five years. In short, a colony has the potential to survive for a long time but faces great risks in moving from an old nest to a new one. Therefore a swarm cannot rely on trial-and-error methods in finding a suitable site. Each colony must make a single, careful decision with which it can live for many years.

THE CARE AND FEEDING OF A LIGHTWEIGHT.

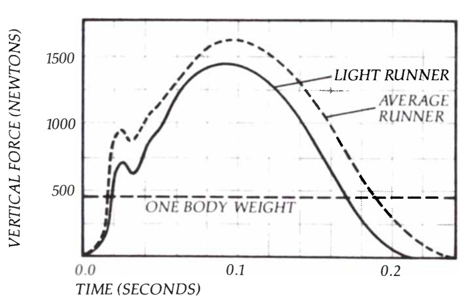
Believe it or not, one of the most envied group of runners—the lightweights—has a very unenviable problem.

While the rest of us are out there causing street lamps to sway, these folks are hitting the ground with considerably less force. The typical 6 footer who is 20 pounds underweight, is receiving a jolt about 14 percent less than normal.

This is a problem? You bet. Especially when you start cranking out the weekly miles in shoes designed for the average weight runner.

What lightweights should fear most is too much cushioning. An overdose here and the shoe can become dangerously inflexible.

If you're one of nature's more slimmed down versions, you won't be applying enough weight to penetrate the forefoot area as much. And what you lack in pounds, you'll have to make up for in effort. It takes more energy to flex a thicker sole, so you'll run less efficiently.



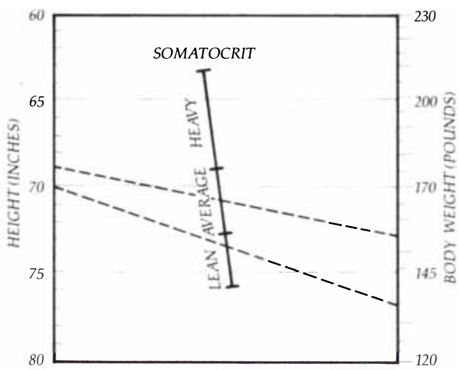
Vertical ground reaction forces for a 150 lb. runner and a 100 lb. runner at a 6:00 mile pace. Forces under the heel and forefoot are both proportionally smaller for the lighter runner.

You may also be flirting with shin splints and Achilles tendinitis, the most common results of too little flexibility.

Unfortunately, things really get sticky if your shoe size is less than a size 9. Because most midsoles aren't scaled the way the human body is.

Until we started investigating, the general assumption was that the forces under the foot were directly proportional to shoe size.

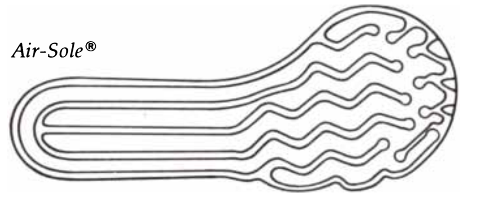
In other words, if a size 7 shoe is 9 percent smaller than a size 10, then a typical runner in a size 7 will experience 9 percent less vertical force.



Are you a lightweight? Draw a line between your height and weight and see where it intersects the somatocrit scale.

As it turns out, nature doesn't work that way. In actuality, that size 7 runner will hit the ground with 18 percent less force.

All of which means the smaller sizes of most running shoes have an over-generous amount of cushion. For even the average weight runner.



The Air-Sole® (top) in the Columbia, Aurora and Tailwind has different air pressure in the various sizes to give more appropriate cushioning. The Terra T/C (below) has a Phylon™ midsole also scaled for cushion as well as the same degree of heel lift in all sizes.

It was a startling discovery. And we did something about it.

First with our air shoes—the Columbia, Aurora, and the Tailwind. Not only are these shoes slip lasted for the flexibility lightweight runners need, but we also adjusted the air pressure in the various sizes for more appropriate cushioning.

Lightweights will also appreciate the Terra T/C and the Lady Terra T/C. They are slip lasted in the front to make them flexible and board lasted in the rear to make them stable. In addition, the midsole has been molded to give the proper cushion and heel lift for each size.

So if you're on the thin side, put your feet on a diet. When it comes to cushioning, don't ask for second helpings.

Or you'll wind up a glutton for punishment.

NIKE

Beaverton, Oregon