

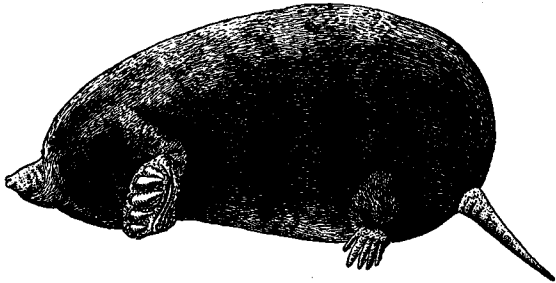
Moles, Shrews and Bats

By E. LAURENCE PALMER

This is the sixty-sixth in NATURE MAGAZINE's series of educational inserts.



COMMON EASTERN MOLE



WESTERN MOLE



HAIRY-TAILED MOLE



STAR-NOSED MOLE



PYGMY SHREW



WATER SHREW

HERE is a group of mammals that should bring great satisfaction to those naturalists who revel in the matter of adaptation.

Bats are adapted to flight, the moles to digging, and the shrews to getting about on the ground, in trash and in trees. I, personally, get a thrill when I see how these creatures, so different in structure and habit, fit into Nature's scheme of things.

There are few natural environments where some member of this group cannot be found. They have been seen hundreds of miles at sea. They burrow in earth, swim readily in water, enter little holes in trash, and fly through the air over waterways, in forests, in our larger cities, and over fields. Of course, no one specie of the group does all of these things. Bats do not burrow any more than moles fly. And there is no doubt but that the animals in these groups are more abundant than most persons realize. Some species may range widely over the continent, while others have a decidedly limited range.

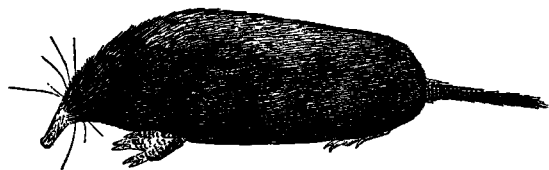
Probably the most conspicuous differences in these groups are associated with their different types of locomotion. Our moles have powerful forelegs backed by strong shoulders, and pointed noses. These all simplify the work of burrowing through loose earth. The hair of moles may be rubbed either way without affecting the sleekness of the pelt. This simplifies going forward or backward in a burrow. The star-nosed moles, with their finger-like nose parts, are particularly suited to burrowing in soft, wet earth.

Locomotion for bats is remarkable when it is realized that they can fly without harm in the night through the twig-filled forest where their insect food may be in flight. How they do this was a secret only relatively recently conclusively solved. The answer was suspected as early as 1790 by Spallanzani. This will be developed later in this article.

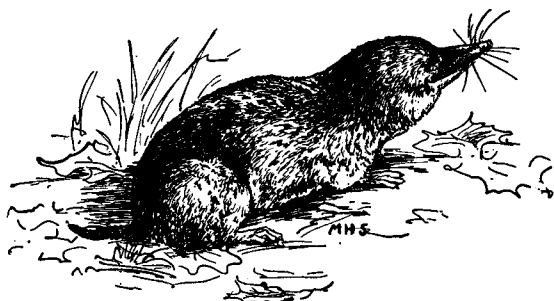
Shrews usually confine their activities to the loose trash that lies on the ground in their hunting area. The water shrews find their living in the water. For this they have virtually webbed toes. Hairs between the toes increase the paddle effectiveness of these structures. Animals like shrews, whose digestion may be so rapid that food eaten at noon may have passed through the alimentary canal by 1:30, must keep busy to avoid starvation. The shrews seem blessed with boundless energy and are able to stand the pace. As a rule a life span of two or three years would be long for these dynamic livers.

Anyone going through brush and forests at night is likely to tear his clothing. We frequently hear the expression "blind as a bat," and yet bats can go with ease through remarkable mazes of twigs and branches. Most of us who know bats marvel at their ability to get about safely in their world.

The eyes of moles are minute and probably of little use in the world of darkness in which they live. While night-flying owls have large



SHREW MOLE



SHORT-TAILED SHREW



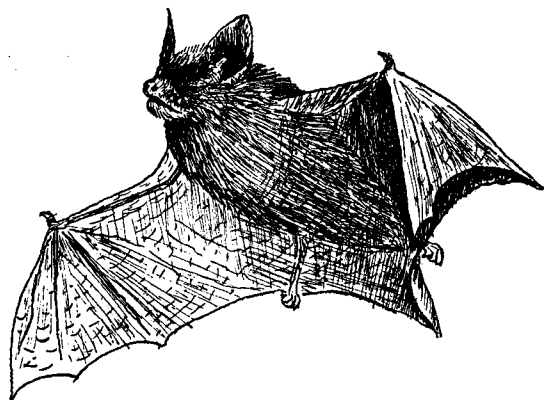
LESSER SHORT-TAILED SHREW



SMOKY SHREW



MASKED SHREW



PIPISTRELLE BAT

eyes, the eyes of bats are not abnormally large. Even the shrews, which seem to be on the run most of the time, probably do not depend greatly for their safety on sight.

There is no doubt but that some of our bats, moles and shrews depend heavily on the sense of touch. Probably the master in this is the star-nosed mole, on whose nose some twenty pink, fleshy "fingers" probe their way into their surroundings in search of food. No doubt other moles can feel vibrations in the soils through which they make their way and find them useful for survival.

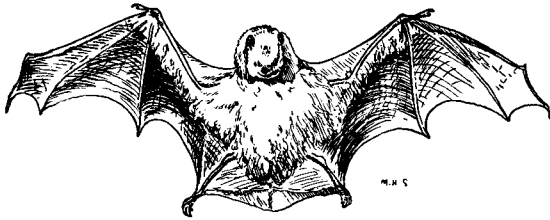
Of course we may interpret feeling variously. Bats can probably feel echoes and sound waves before they have come in contact with the source. We consider this ability as associated with hearing rather than with feeling.

Man is insensitive to many of the reactions to feeling that are possessed by other animals. I once stood beside a stream and watched earthworms make their way hastily from underground. I could detect no reason for this activity except that nearby grass tops were waving, although there was no wind to cause their movement. A quick scoop with my hands brought a star-nosed mole out into the light. It seems doubtful if it was scent that moved the earthworm to seek escape, but that it was motivated by reactions to vibrations sent through the soil by the activities of the mole.

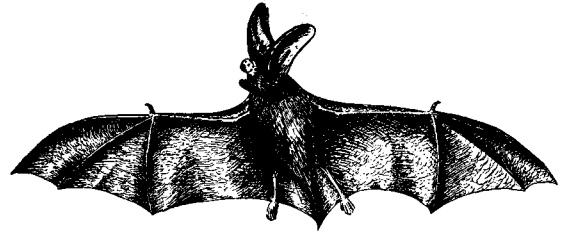
So far, we have not considered the matter of hearing. In the table dealing with the little brown bat we give many of the details regarding the "radar" system used by bats in finding their way about. It can be demonstrated that bats make sounds, many of which we cannot hear. When they are deprived of their ability to hear, they lose their ability to dodge obstacles in darkness. When bats are deprived of the opportunity to make sounds they also crash into obstacles. It would seem plain from this that they send and receive sound impulses that help them meet problems peculiar to their way of living.

As indicated in the tabular matter discussion on the little brown bat, a flying bat gives off protective sound signals with varying frequency. When flying in the open the calls may be given at a 25 per second rhythm, while this is doubled when the bat makes its way through a maze of tree twigs in total darkness. D. R. Griffin, specialist in bat lore, believes that bats locate flying food by their radar system, that they hear echoes from their food rather than sounds produced by their food, that they can detect inert, marble-sized objects at least six feet away and can avoid objects only a foot away while in full flight. When we think of these gifts possessed by "lesser" organisms it makes us definitely humble, as it should.

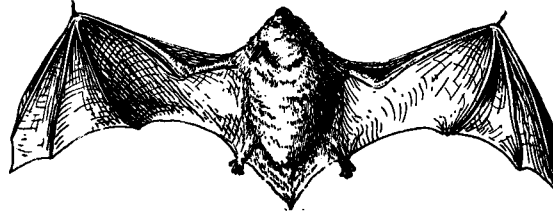
We recognize superior sensory skill as being characteristic of one or the other of the groups of animals we here consider. The bats excel in the use of their ears. The moles excel in their ability to feel things, although they also obviously have acute hearing ability. Probably the shrews excel in their ability to locate parts of their environment in some other ways. Obviously they have a good sense of hearing. While some shrews definitely have a poor sense of smelling, others may have this ability. Frequently, in the animal kingdom the possession of an ability to create a stimulus is accompanied by a corresponding ability to receive it. Bats produce supersonic sounds and are able to receive them. They are without exceptional scent although they can scent food. Obviously the eyes of shrews and moles are not of major importance to them in their daily activities. There is no doubt but that shrews have an exceptional ability to give off scents at times. This might argue that, in turn, they have an ability to use scent in exploring their habitat. It is possible that they, too, are more dependent on a sense of hearing than we



SILVER-HAIRED BAT



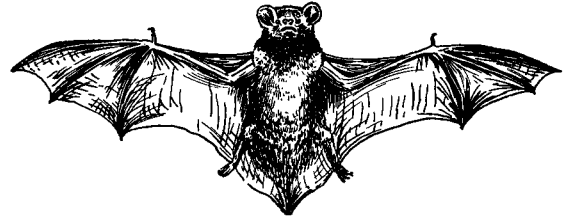
LUMP-NOSED BAT



LITTLE BROWN BAT



HOARY BAT



RED BAT



BIG BROWN BAT

might at first suspect from observation of the animals.

Anyone who has watched a shrew in action, which means anyone who has ever watched a shrew, realizes that they are sensitive to what goes on about them. Who can say just what sensations mean the most to them?

Just as there seems to be a nice relationship between the structure of these animals and the type of territory they inhabit, so there is an equally exact limitation as to the time when they are active. Some suspend activities at certain times in the twenty-four hours of a day. The time of the year also has its effect on their activities. A creature suited to capturing insects in the air as a livelihood must be active at the time and place, when and where its food is available.

In bats there seems to be a definite order of appearance as the daylight fades into the west. Among the first to appear may be the red bats, which sometimes may be active in broad daylight. Sometimes the little brown bat may be active even earlier in the evening than some red bats. Following these two, the silver-haired bat will probably appear, followed by the big brown bat. Still later in the evening comes the hoary bat, which is seen by relatively few persons. The major activities of each of these species of bats is limited to about an hour in the evening and another hour at dawn. Considerable overlapping of periods of feeding exists between the species. Of course the order of appearance of the species

in the morning is the reverse of that suggested for the evening. The first to be active in the morning would be the hoary bat, followed roughly at half hour intervals by the big-brown bat, the silver-haired bat, the red bat and the little brown bat.

Since the shrews and moles apparently depend little on light it is not surprising that they do not restrict their activities so closely to light stimulus as do the bats.

Shrews and moles live largely in an environment where there may be some insect and small animal activity through the year. These animals, then, may be expected to be active at any time. With the bats there are definite seasonal restrictions. Some of the bats migrate north and south with the seasons. The hoary bat is possibly the most conspicuous of these. Other bats may hibernate or may migrate, with no hard and fast rule being followed by all members of the species.

Possibly the most interesting seasonal activity is that found with some of the bats. In the fall most of these animals mate. Seton, in his masterful *Life Histories of Northern Animals*, writes of the hoary bat, basing his conclusions on statements of Merriam that the gestation period is for $9\frac{1}{2}$ to 10 months. He assumes that, as with other bats, the time of true gestation is the period between mating and the birth of the offspring. According to the dictionary the gestation period is the time between conception, or fertilization of the egg, and birth. If we accept this definition the gesta- (Continued on page 256)

NAME SCIENTIFIC NAME	COMMON EASTERN MOLE <i>Scalopus aquaticus</i>	WESTERN MOLE <i>Scapanus townsendi</i>	BREWER'S MOLE HAIRY-TAILED MOLE <i>Parascalops breweri</i>	STAR-NOSED MOLE <i>Condylura cristata</i>
DESCRIPTION	Length male 7-1/5 inches, with 1-1/5 inch tail. Female, 6 1/2 inches with 9/10-inch tail. Pelt of close, gray, velvety soft fur may be brushed either direction. Tail naked or nearly so. Forefeet modified into powerful digging structures. Nose pointed. Eyes small and difficult to locate.	Length to 9 inches with tail to 1-4/5 inch and 1-inch hindfoot. Tail of male about 1-3/5 inch; of female, 1-4/5 inch. Males larger than females, which rarely exceed 8-1/5 inch overall length. Dark blackish-brown with purple highlights above. Paler beneath with brown tinge. Paler in winter.	Length to 6 inches with 1-1/5-inch tail, with males and females equal in size and similarly colored. Like common mole in general colors but with furry tail that is smallest at base and with coarser snout that is shorter. Fur also coarser than in common mole.	Length, male to 8 inches with 3-1/5-inch tail. Sexes colored alike. Tail much enlarged in winter. Blackish-brown to black above, with paler brown underparts with underside of tail often much lighter. Weight to 77 grams. Nose ending in 22 fleshy rose-colored "fingers." Legs weak.
RANGE AND RELATIONSHIP	Ranges from Massachusetts to Nebraska and south to the Gulf, taking the place of the western mole. <i>Scapanus</i> , discussed elsewhere. Found usually in loose soft ground where plants and their enemies are present. Teeth: I, 3/2; C, 1/0; P, 3/3; M, 3/3. Total: 36.	Ranges through northwestern United States from Washington and Oregon south into California, between the Cascades and Coast ranges. There are at least 4 species closely related. Work most commonly in sod-covered earth where the food needed is available.	Found from southern New Brunswick to North Carolina and west to Ohio and through southern Ontario. Varies greatly in abundance and may be more common than may be expected. One species. Teeth: I, 3/3; C, 1/1; P, 4/4; M, 3/3. Total, 44. Found to elevations of 3000 feet.	Found in damp meadows and lowlands from southern Labrador to southeastern Manitoba and south to Georgia and Illinois. One species. May be found in same area and even in same tunnels with other moles of similar distribution. Teeth: I, 3/3; C, 1/1; P, 4/4; M, 3/3. Total; 44.
REPRODUCTION	Usually solitary, but in breeding season 2 or more may be found to a tunnel. Breeds in March and 4-6 young born 6 weeks later. Young independent at 4 weeks and mature in 10 months. Nest a 5- to 8-inch grass-lined den. Probably are not long-lived and in winter may remain active.	During rutting season adults may leave burrows and move about on earth surface. Young numbering usually about 4 are born in April or May, and there usually is but a single litter a year. Young remain in nest apparently until reasonably well developed. Few young are found in burrows.	Little known of its life habits. Mates in March or April, with 4 or 5 young born a month later. Young blind and helpless at birth, but grow rapidly so that in a month they may be weaned. Become sexually mature at one year. One annual litter. Can never become an abundant animal.	May mate in fall, wintering in pairs. Male at height of breeding in January. Young, 3 to 6, born from mid-April to mid-June, became independent at 3 weeks and mature at 10 months. One annual litter. Nest an 8-inch ball lined with soft shredded plant materials.
ECOLOGY	Food choices include, in order, white grubs, earthworms, insect larvae, adult insects and plant materials. Plants may constitute 13% of total volume of food. No food storage, and daily consumption totals about 1/3 the weight of the animals. May eat corn, wheat and oats but not beans or peas.	Food largely insect larvae and earthworms caught by prowling about underground with assistance of nose, powerful shoulders and digging legs. They disfigure lawns in search of grubs that destroy lawns, and injure vegetables in search of insects that destroy vegetables.	Food largely earthworms and insects. May eat more than its weight in earthworms in a day, but major food may be beetle larvae caught underground during burrowing activities. May also eat ants and other small invertebrates. Burrows may be used by mice that may destroy vegetable crops.	Active night or day through the year and sometimes in groups. Food includes basically about 50% earthworms and 1/3 insects with the rest miscellaneous. Detects food by nose parts, probably by contact since sense of smell is poor. Hearing is excellent. Forefeet capable of digging well through earth.
ECONOMY	May injure lawns and vegetable gardens but since 50% of food is insects it is probable that the animals are basically useful. Earthworms may comprise 31% of food. Enemies include large predators and a louse, a beetle, a flea, and threadworms that act as parasites.	Probably fundamentally useful but do some damage in being useful. Formerly used as fur to limited extent. Teeth: I, 3/3; C, 1/1; P, 4/4; M, 3/3. Total: 44. May be caught in traps or dug from ground when detected at work building tunnels. Related smaller <i>Neurotrichus</i> has teeth: I, 3/3; C, 1/1; P, 2/2; M, 3/3. Total; 36.	Of little economic importance although it may injure lawns and golf links. Greatest economic value lies in destruction of burrowing insects that are destructive of grass and other plants.	Of neutral value. More interesting to naturalists than to others and since it occupies soil normally too wet for agriculture it does not raise the ire of farmers and lawn keepers as do its relatives that live in drier grounds.

SHREW MOLE <i>Neurotrichus gibbsii</i>	SMOKY SHREW <i>Sorex fumeus</i>	WATER SHREW <i>Sorex palustris</i>	PYGMY SHREW <i>Microsorex hoyi</i>	LESSER SHORT-TAILED SHREW <i>Cryptotis parva</i>
Length to 4½ inches with female slightly larger, tail to 1½ inches. Smallest American mole. Fur, iridescent, fine, close, dark gray above, to purplish with underparts slightly lighter. Toes not webbed. Snout long, with naked tip. Usually found in dry soft soil.	Length to 5 inches nearly 2/3 being tail that in adults is smooth and round-tipped in young with pencil of hairs on tip. Weight to 11 grams. Dark gray in winter and lighter beneath. In summer browner, paler and to silvery beneath. In breeding season tails may be swollen to twice normal size.	Length to 6-2/5 inches for either sex, with tail nearly 1½ inches long. Hind feet unusually large and broad for shrew with 3rd and 4th toes hair-fringed and somewhat webbed. Dark brownish-black above in winter and paler and browner in summer, with tail differing in color above and below at tip.	Length to 3½ inches with tail over 1 inch. Weight about 4 grams. Reddish-brown above, smoky gray beneath. In winter darker olive-brown above. Tail obscurely two-colored above and below but darker at tip. Ears inconspicuous. Eyes small but distinct.	Length about 3½ inches, with tail to over 3/5 inch. Much like a small short-tailed shrew. Eyes hidden in fur and almost invisible. Brown-gray to slate, silvery beneath in winter. Tail conspicuously lighter beneath. Weight, under 5 grams.
Ranges from southern British Columbia south into Washington, Oregon and California with 2 subspecies recognized. May be found in much the same territory as that the supports the western mole. Teeth: I, 2/1; C, 1/1; P, 3/4; M, 3/3. Total: 36.	Closely related to common shrew but about 1 inch longer, with more prominent ears. Over 30 species of <i>Sorex</i> in North America. Smoky shrews range from Carolinas to Tennessee and north into Canada. Teeth: I, 4/2; C, 1/0; P, 2/1; M, 3/3. Total: 32. Favors deep leaf mold and stumps for range.	Ranging through colder parts of North America from coast to coast and represented by 5 subspecies, Nova Scotia, Great Lakes, Rocky Mountain, Richardson, (Rocky Mountains to Minnesota) and white-chinned (Pennsylvania to Labrador).	Found from the Carolinas to Wisconsin, discontinuously, and north to the border roughly. One species in the genus with a half dozen forms recognized that extend range nearly to Pacific Coast and on up to Alaska. Teeth: I, 4/2; I, 1/0; P, 2/1; M, 3/3. Total: 32.	Ranges from New York to Florida and through mid-West with 17 related species, all but two being tropical three being within the borders of the United States. Teeth: I, 3/2; C, 1/0; P, 2/1; M, 3/3. Total: 30. Compare with total for the similar <i>Blarina</i> . Usually a rare species.
Little is known of life history but it is probably much like that of other moles. Usually known as Gibbs Mole.	Young, 4 to 7 born blind and naked in April, with 1 or 2 other litters during summer and adults probably die in second year after breeding season. Abundance varies greatly in places and at times but animal is active throughout its life, day or night, summer or winter.	Little known of reproduction but may have 2 or 3 litters a year, with possibly to 7 in a litter but the details are apparently not well known. They are probably short-lived like their close relatives. Teeth: I, 4/2; C, 1/0; P, 2/1; M, 3/3. Total: 32.	Habits of this rare animal are not well known, but the mother bears several litters of young a season, with probably 5 or 6 to a litter. Probably the major reproductive habits are not unlike those of the better known <i>Sorex</i> . There is need for much more information on this genus.	Nest a ball of shredded vegetation often occupied by to 5 adults. Nest to 5 inches in diameter. Several litters a year beginning in March with to 6 young in a litter. Young are weaned at about 3 weeks. Probably is not long-lived, but remains active through the year like other shrews.
The shrew mole probably spends more time on the ground surface than its relatives and its burrows are, of course, smaller than those of other moles. Food largely insects.	Food, any animals it may overcome but chiefly insects, salamanders, earthworms, sowbugs, centipedes and some plant material. Enemies may include other shrews, possibly moles, cats and other preying creatures, such as weasels, foxes and hawks and owls.	Food undoubtedly small animals of waterways, egg and young of fishes and many kinds of water insects that may be useful to fish. They swim readily and well using all 4 feet to keep submerged and rising to surface when desired. Pelt is highly water-repellent. Can run on water-film.	Food unquestionably small animals like insects and earthworms. Fourth upper incisor small and almost hidden as contrasted with that of the genus <i>Sorex</i> . Hawks, weasels and other predators are the chief enemies.	Food largely insects and earthworms, but will eat vegetation in captivity and probably when free. Hard parts of insects may go through alimentary canal in 1½ hours. Enemies include cats, owls, foxes, snakes, weasels but it may kill snakes as large as 9 inches in length.
Of little economic importance because of its limited range. Of great interest to biologists largely because of its close relationship to <i>Urotrichus</i> or other small moles of Eastern Asia. Well worthy of close study as to habits and behavior.	Probably serves a useful function as destroyer of small animals that are enemies of plants that are useful to us. They do not get along well with each other, apparently, and live more or less solitary lives, desperately seeking the food they must have.	May be useful in controlling some water insects that may be enemies of fishes but may also be injurious to fishes. Of doubtful economic importance in either direction. Eskimos are highly superstitious about shrews and may refuse to cross their trails knowingly. The Crees of the Norway House region call it the Beaver mouse, since it may winter in beaver lodges.	Probably useful as a destroyer of insects although may destroy useful animals as well. This little animal has a strong odor from its side glands much in excess of that given off by some of its larger relatives. Possibly because of this cats bring these and other shrews in uneaten.	Probably of little economic importance but of some definite value and of great scientific interest. Does not yield easily to confinement and requires constant attention to survive under such conditions.

NAME SCIENTIFIC NAME	BLARINA SHORT-TAILED SHREW <i>Blarina brevicauda</i>	COMMON SHREW <i>Sorex cinereus</i>	LITTLE BROWN BAT <i>Myotis lucifugus</i>	SILVER-HAIRED BAT <i>Lasionycteris noctivagans</i>
DESCRIPTION	Length to 5 inches with tail of 1 inch. Weight around 20 grams varying from 12 to 27. Sexes superficially alike. Stout. Eyes small. Fur soft. Nose pointed and active. Dark slate-gray above and lighter beneath. Paler in summer. Tail black. Sheds hair in March and October.	Length to 4 inches including tail to 1-3/5 inch. Weight to 3-3/5 grams. Sexes apparently alike. Brown sprinkled with lighter hairs above and grayish buff beneath. Ears almost hidden in fur and eyes also inconspicuous but minute. Tail yellowish brown and slender. Teeth colored.	Length to 3-3/5 inches with 1 1/2-inch tail and 1 1/2-inch forearm. Face furry. Has appearance of being a slender bat. Ears laid forward reach to nostrils. Sexes colored alike with little seasonal or age change. Dull brown above and lighter beneath. Weight 4 to 5 grams or equal to a nickel.	Length to 4 inches with 1-2/3-inch tail and 1-2/5-inch forearm. Ear 2/3 inch from crown, relatively large. Sexes colored alike without seasonal or great age variation. Dark chestnut-brown above, tipped with silver white. Under parts like upper but not so abundantly silver-tipped.
RANGE AND RELATIONSHIP	Found in fields and roadsides, in farm buildings and wooded areas usually where there is a loose trash cover in which food may be found. More than half a dozen species or subspecies which range through eastern North America. Teeth: I, 4/2; C, 1/0; P, 2/1; M, 3/3. Total; 32.	Closely related to smoky-shrew and water shrew. Ranges through most of North America, being found in open fields, on forest floor and elsewhere. Probably most common, and widely distributed of America's ninety odd shrew species. May go up trees but more common on ground. Teeth: I, 4/2; C, 1/0; P, 2/1; M, 3/3. Total; 32.	Ranges widely over water, fields or wooded lands or in towns and in buildings. Found throughout most of North America from Labrador to Alaska and south. Some 30 recognized subspecies. There are over 2000 kinds of bats in the world. Teeth: I, 2/3; C, 1/1; P, 3/3; M, 3/3. Total, 38. Has good homing instinct.	Common about waterways flying early in evening or just after sunrise. Ranges through most of northern America north of Mexico, but not breeding in southern part of range. Males may range much farther north than females in summer months. Teeth: I, 2/3; C, 1/1; P, 2/3; M, 3/3. Total 36. One species.
REPRODUCTION	Young born 3 weeks after breeding, 4 to 8 in a litter, several litters a year. At birth like pink, wrinkled honeybees. At 1 day, 30 mm.; at 1 week, 60 mm.; at 2 weeks 73 mm.; at 3 weeks, 90 mm., weaned. Half-grown in 1 month. Mature in 6 months. Aged at 16 months. Mates for season.	Females may live with males but drive them out when bearing young. 5 to 9 young born blind and helpless about 3 weeks after breeding, with to 3 litters a year. 1 day old young is hairless, about 1/35 weight of mother, 4/5 inch long, with 1/8 inch tail.	Mates promiscuously in fall, but actual fertilization usually delayed until spring. Young weighs about 1 1/2 grams at birth which takes about 1/2 hour with gestation about 56 days. Nurses for 3 weeks and young reaches mature size in 4 weeks. Males breed at 14 months; females at 10 months. Fly at 3 weeks.	Definite segregation of sexes during period in which young are developing. Young number 1 or 2, born in late June or early July, black when born but grow rapidly as do other bats and in 3 weeks may be flying, be weaned and have begun independent existence, although at first flight is weak.
ECOLOGY	Food largely insects being nearly half by bulk in 244 specimens examined. Food included also mollusks, earthworms, occasionally salamanders, and sometimes to 12% plants. Nest kept clean, under ground, lined with fine vegetable material. May store some food. Has poor sight. Many enemies include cats, owls, foxes, and other predators.	Food mainly small animals captured by incessant hunting day and night through the year. Eats 3 1/2 times its weight in a day. Has good sense of hearing but poor sense of smell and sight. Can jump 4 to 5 inches standing and to 6 inches when running.	Home range may be 100 miles with winter rest in caves. Food insects caught on wing. Gives off sounds (50,000 to 98,000 c.p.s.) while flying and is guided by echoes or radar effects. Calls at 25 per second in open, 50 per second in trees. May fly 30 miles in search of food and roost with other bats.	Food probably exclusively insects. May hibernate or migrate and has been seen far out at sea. It is a common species, sometimes being the commonest, but abundance may be erratic at a given time or place. This may be due in part to the sex segregation.
ECONOMY	Useful insect destroyer, one record showing 60% of a year's crop of destructive larch sawflies were killed by blarinas. Reputed to have poisonous bite comparable to that of cobra. Makes a difficult pet. Active the year round day or night. Gives off offensive odor. Worthy of protection.	Highly useful as insect destroyer. May carry mite parasite possibly associated with distribution of spotted fever. Bite may be poisonous but not seriously so to man. Reputed to be vicious but this may be questioned. Relatively short-lived.	Useful as insect destroyer. Body parasites including fleas do not favor man as host. May live to 10 years of age. Manure or guano collected from bat caves is of considerable fertilizer value, one colony producing in one year fertilizer worth \$200 and weighing over 2 tons.	Undoubtedly a useful species whose habits are not greatly different from those of the associated species. Evening flight later than red bat or little brown bat and earlier than big brown bat or hoary bat. Usually begins the evening's activity, as with many other bats, with a drink from a waterway.

PIPISTRELLE. PYGMY BAT <i>Pipistrellus subflavus</i>	BIG BROWN BAT HOUSE BAT <i>Eptesicus fuscus</i>	RED BAT <i>Lasiurus borealis</i>	HOARY BAT GREAT NORTHERN BAT <i>Lasiurus cinereus</i>	LUMP-NOSED BAT RAFINESQUE BAT <i>Corynorhinus rafinesquii</i>
Length to 3½ inches with tail to just over 1½ inches. Forearm 1-1⅓ inches. Weight to 6 grams. Wingspread to nearly 10 inches but one of the smallest of the bats. Sexes colored alike, without seasonal change. Light yellow-brown above but paler beneath. Hair slaty-black at base.	Length to 4½ inches with tail to 1½ inches. Forearm to 1-4/5 inches. Wingspread to 1 foot. Membrane between hindlegs not furred above. Weight to 6 grams. Uniform yellow-brown above. Thumb is large. Ears longer than broad and taper to narrow rounded tip. Membranes of wings black, not furred.	Length to 4 1/5 inches; tail to inches; forearm to 1-3/5 inches. Male orange-red with under parts paler and with less red. Females duller and with touches of chestnut. May be some individual differences in color. Ears low, broad, rounded. Has appearance of medium sized red bat.	Length to 5½ inches, with tail to nearly 2 inches. Forearm to 2 inches and wingspread to 16 inches. Weight to 35 grams the females being the heavier. Yellow-brown to dark mahogany-brown with grayish-white over whole body. Ears short, rounded, with naked black borders. Web between legs well furred.	Length about 4 inches with tail nearly 2 inches. Sexes equal in size. Wingspread to over 1 foot. Membranes of wings and tail furless. Ears bent backward reach to mid body. Brown above and more slaty beneath with fur softer than in the brown bats. Little fur on inner ear margins.
Ranges throughout eastern United States but is poor flier. Remains active until late in October being most abundant about waterways or in woodlands near waterways. Two species each with 2 subspecies recognized. Teeth: I, 2/3; C, 1/1; P, 3/2; M, 3/3. Total 34.	Ranges through most of North America with 2 species recognized. A wide-ranging species being found south into Central America. Favors settlement and towns, flying lower than the hoary bat. Individual range apparently is not well known. Teeth: I, 2/3; C, 1/1; P, 1/2; M, 3/3. Total; 32.	Found about villages near buildings or in openings in wooded lands. Common through North America south of Canada, migrating to the south for the winter months or sometimes approximating a hibernation. Moves south to Panama and north along Pacific Coast to Sitka.	From Gulf of St. Lawrence to Great Slave Lake and south to southern Mexico, summering usually north of Pennsylvania and wintering usually south of it. Essentially a woodland species flying high and late, swiftly and erratically. Teeth: I, 1/3; C, 1/1; P, 2/2; M, 3/3. Total; 32.	Ranges from the southeastern states to Vancouver Island and south into Mexico to the west. It is a cave bat by preference so far as roosting habits are concerned. Four subspecies are recognized. Teeth: I, 2/3; C, 1/1; P, 2/3; M, 3/3. Total; 36.
Sexes become segregated and females produce two young usually. Mother carries them with her on flights for the first few days but leaves them as they grow and in 3 weeks the young are large enough to take flight and take care of selves. Probably mate in fall.	Young born in mid June or earlier in South, usually numbering 2. Probably true fertilization does not take place until the spring, although mating may take place in fall. Young weigh to 3 grams at birth but grow rapidly and are weaned at 3 weeks and full sized at 2 months.	Mates probably in August flight. Females congregate in spring and true fertilization takes place with increase in temperature. Young, 2 to 4, born in June, the young being carried by mother for a few days. Young independent and flying at 3 weeks of age. Teeth: I, 1/3; C, 1/1; P, 2/2; M, 3/3. Total; 32.	Young usually 2, born by mid-June, although mating is suggested as taking place nearly a year earlier. One annual litter. Females congregate during nursing period, and carry young after birth relatively long. Young develop to independent size within a month. Hoary by 3 weeks of age.	Probably mate in fall, judging from conditions of males at that time. Single young born in late June and carried by mother as long as possible. Species does not migrate but hibernates in some suitable cave, often until late April.
Food almost exclusively insects, being largely flies, beetles and wasp relatives. Probably are not active through the night, except possibly during the breeding season, but have flights at dusk and at dawn. May begin activity early in March if season is warm.	Food almost exclusively insects caught on wing with beetles approximating 1/3 the volume with relatively few moths in the usual list. Few enemies include owls and snakes, the latter raiding roosts at times. Usually spends winter in a bat cave more or less in torpid condition.	Food exclusively insects, taken usually ½ to 1½ hours after sunset or before sunrise. Fall colony forms in October; summer colony, May to September in different places. May migrate at heights of to 400 feet, and has been found 240 miles at sea. Has good homing instinct. Usually gentle if handled carefully. Gives squeaks.	Food almost exclusively insects. Because of size may feed on larger insects than do other bats. Most active during second hour after sunset and next to last hour before sunrise. Southern migration in fall begins with the frosts. Roosts commonly in trees.	Food apparently largely moths, but probably includes other insects. The large ears are curled up in spirals like horns on rams when at rest. May find rest in hollow trees, in houses or under the loose bark of trees but favors caves as already suggested.
Usefully destroyers of insects and probably may be considered as almost wholly useful. May be confused with large moths because of their relatively small size and slow flight as compared with some other bats.	Useful destroyers of harmful insects and worthy of protection they do not get. Reputation as carrier of vermin overdone, if not wholly unjustified. Use sounds beyond our range of hearing to guide them in flight, being guided by echoes as are other bats described elsewhere.	Useful insect destroyer. In captivity may be fed mixture of bread, American cheese, chopped hard-boiled egg, banana, cottage cheese, unsalted vegetables and clabbered milk with broken beetles and grasshoppers to help prevent diarrhoea. Probably uses sound to guide relatively slow flight.	Unquestionably a useful species worthy of all protection. Found about settled areas most commonly in October and November. Too beautiful an animal to be shot as a sporting proposition.	Economic importance probably similar to that of other bats and primarily associated with control of insects. Evening flight beginning with late dusk and before real darkness of the night.

(Continued from page 251)

tion period in bats is surprisingly short. While the period between mating and birth may be long, it is believed that in most bats conception does not take place until some time after the mating period. Some details for the different species may be found in the accompanying tabular material. It is quite probable that Seton was not informed on this point.

Following the late summer or fall mating period, many bats may seek refuge in a winter hiding place. Commonly this is a cave where the temperature may be constantly above freezing. The bats in such a resting place may crowd each other thickly. Usually there is a high percentage of one sex in such groups. In the spring with the first activity true conception probably takes place, and in a relatively short time the young are born.

When the weather gets suitable the bats may leave their winter hiding place and take up a new resting place. Such groups of hiding bats are almost predominantly one sex or the other, disregarding the young. Certainly there are many groups of nursing mother bats with no adult males in the group at all. With the rearing of the young finished and the approach of fall, the women's "sewing circles" break up and from then on the story is different. We need not here repeat what is to be found in the tabular material on the development of the bat young.

The social natures of shrews vary greatly through the year and with the different species. Pertinent data on this may be found in the detailed matter in the tables. Suffice it to say that while some shrews are highly unsocial for most of their lives, a few species not only may live together as family groups but some groups may be composed of males and females with more than one of either sex being present. Even the antisocial species relax their habits and, during the breeding season, live with some harmony with each other. It is only natural that since the shrews are usually short-lived there may be sometimes more than one litter a year, and since this is the case it is also only natural that their lives cannot be wholly antisocial at all times.

Zoologists place moles, shrews and bats in a group known significantly as the Insectivora. This, of course, means that they are the insect-eaters. There are, of course, a few exceptions. The forefeet of the animals in these groups are for distinctly different purposes. The bats, of course, have their forefeet serving as wings; the moles use theirs for digging, while the shrews have feet apparently not specialized for digging, and certainly not for flying. The teeth of the animals are of importance in classification, and arguments that may arise as to identification generally can be settled by reference to the tooth formulae given in the chart section. The formula, of course, gives the number of teeth of the different types on a given side — I, 1/1 meaning that the animal has one incisor on the upper and one on the lower jaw on one side. C refers to canines, P to premolars and M to molars, of course. Sometimes the color of the teeth is helpful in making identification of remains found in the stomachs of enemies.

There is no doubt but that the insectivora have great economic importance. Probably none in the temperate zones are seriously harmful to man's interests. They all destroy enormous numbers of insects that may be harmful to agriculture, and only a few of the shrews ever eat any appreciable amount of plant material. This is more than earned by the great abundance of insects eliminated. The dung of bats has a high fertilizer value, and a colony of bats in a cave has been known to yield in a year some \$200 worth of this fertilizer. This probably equals in value any other average agricultural crop harvested from an equal area of the earth's surface.

In the Tropics, of course, we have bats, such as the vampire bats, that are serious pests, and also have fruit-eating bats. We cannot adequately consider them here. There are, of course, superstitions that bats seek to get into the hair of humans. Such beliefs may usually cease if information is given that the food of temperate zone bats is 100 percent insects. While bats may harbor fleas and other body parasites, these little pests have specific tastes and do not voluntarily shift their activities to human bodies.

It is unfortunate that such useful animals as moles, shrews and bats should have fared so badly in popular public opinion. In the story of Cock Robin the mole dug a grave, but there are few places where the words shrews or bats incite a favorable reaction. Katharina in *The Taming of the Shrew* lacked some of the graces that we think desirable in a woman, and bats are associated either with evil spirits, with Hallowe'en witches, or with screws that are loose in our mental machines. I know of few references to shrews, bats and moles in *The Bible*. In Isaiah 2, 20 we find that man may escape the judgment of the Lord by casting his silver and gold idols "to the moles and to the bats." It is difficult for a naturalist to appreciate the use that might be made of silver and gold by insect-eaters, but the implication is that moles and bats are about the lowest form of life possible. I understand from a friend that there is in the New Testament a kindly reference to bats but to date have been unable to find it. Can you help me?

Of the shrews, again, we find the name applied to an unpleasant woman when we read the proverb: "Every man can tame a shrew but he that hath her." Things are a little more gracious in the proverb that says it is better to be "a shrew than a sheep." Moles fare a little better in folklore. Pope suggests that man "learn from the mole to plow." In an essay on Holy Living by Jeremy Taylor we read that Harcatius, the king of Parthia, was a mole catcher, thus classifying him with other famous persons who filed needles, fiddled and made lanterns. It happens in our modern days that there are not a few college professors who spend some time catching moles and the mole-catcher's role in a golf-links staff is not always wholly unimportant. No doubt the term vamp refers to vampire and vampire bats, and ordinarily we do not recognize vamping as one of the more desirable qualities of the fair sex. On the whole it would seem that bats, moles and shrews have fared poorly in man's opinion.