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Robert Ryshke

University of Wisconsin-Milwaukee

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COMMUNICATION IN GROUND SQUIRRELS

INTRODUCTION

Thirteen-lined ground squirrels (*Citellus tridecemlineatus*) are among the more abundant and conspicuous Midwestern mammals, yet surprisingly little is known of their behavior under natural conditions, except for the study of McCarley (1966) which concentrated on population dynamics. The object of my study was to describe the general behavior of the ground squirrel, with particular emphasis on postures and vocalizations used in communication.

Communication occurs whenever the behavioral activities of one animal affect the activities of another. Communication among members of a group is an essential part of social life, reducing aggression in animal groups as well as synchronizing reproductive activities.

MATERIAL AND METHODS

This study was conducted at The University of Wisconsin—Milwaukee Field Station from June 5, 1972 to August 1, 1972 in an area of approximately 200 by 120 feet of short, mowed grass surrounded by a field of higher vegetation. Observations using binoculars were conducted from blinds from about 8:00 A.M. to 4:00 P.M. All burrow entrances were marked with a number. Eight male and three female ground squirrels were trapped and marked individually by different colored collars. Feeding stations set up on boundaries between territories and in territories induced aggressive interactions, and I also observed natural interactions. Vocalizations were recorded using a Uher 4200 stereo tape recorder and two

Sennheiser microphones and then the vocalizations were analyzed on a Kay Sona-graph which produces a diagram showing frequency (pitch) over time. A Nikon 35mm camera with a 200mm telephoto lens was used to photograph postures, which were traced on paper.

SPATIAL DISTRIBUTION

Ground squirrels live in close proximity. Each conducts most of its activities within a particular area surrounding its burrows. Each squirrel defends an area of about 2800 square feet which includes the burrow and a small feeding area. Less time was spent in foreign areas than in their own area. Usually a male's area encompasses two female areas and the areas of those females are somewhat overlapping. Females defend their area against other females but rarely are aggressive towards males.

Territory is often defined as "a defended area". It usually does not involve an overlap of the areas, such as occurs in ground squirrels. If two animals have areas that overlap, but their homes are not in the overlap then the area around their home, excluding the overlap, is referred to as a core area. The core area may be defended. The core area concept is especially applicable to mammals such as the ground squirrels. I hesitate to call ground squirrels territorial because whether or not a ground squirrel behaves aggressively toward another is dependent as much on the distance between the two squirrels as on where they are in relation to the home burrow. Many of the chases resulted because two squirrels came too close to one another (violations of individual distance).

POSTURES

Postures associated with chasing- Chasing is not common. A chase may be initiated in several contexts: (1) if an individual comes into another's territory, (2) if two ground squirrels meet at territorial boundaries, (3) if two individuals approach each other too closely on a third ground squirrel's territory.

There are positions that ground squirrels assume prior to a chase which are different in the initiator of the chase than in the recipient and probably communicate information about the animal's mood. The initiator usually assumes a pre-attack position which is low to the ground with its head angled up (Fig. 1a). The initiator gives the growl vocalization and then lunges toward the other squirrel and a chase results. The pre-escape position also occurs in a ground squirrel that seems frightened by a human intruder; a closer approach results in the ground squirrel running into a burrow.

After the chase has ended ground squirrels have stereotyped positions. Chases terminate when the aggressor stops and assumes an upright position (Fig. 1d) and the individual who was chased assumes a low to the ground posture with its head turned away from the other and its tail hairs erected (Fig. 1e). The

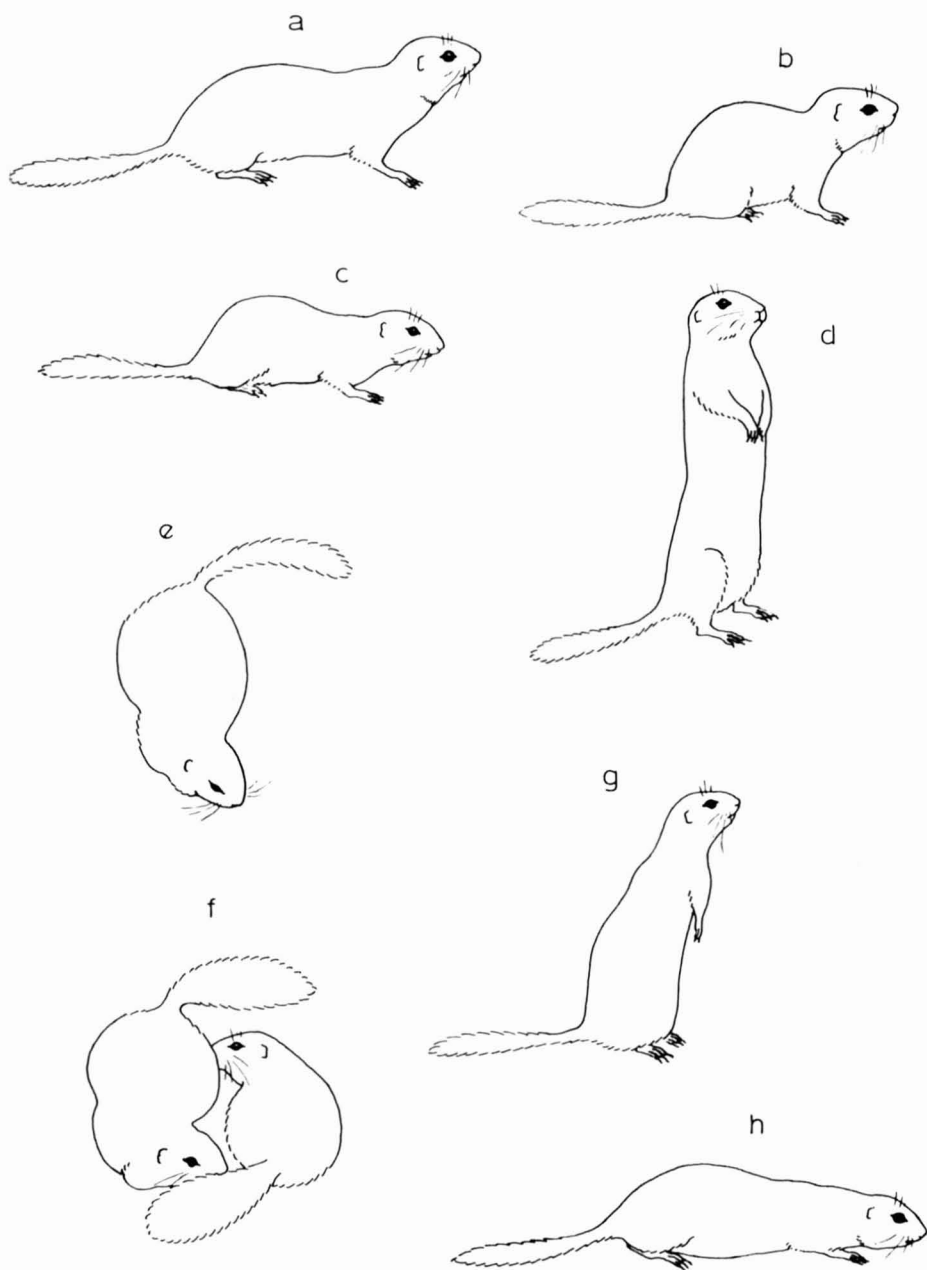


Fig. 1. Postures of ground squirrels. See text for explanation.

posture assumed by the recipient of the chase is apparently submissive, tending to inhibit attack. A female will assume this posture if a dominant male is close to her.

In some instances, chases ended as fights which lasted several seconds and ended with the individuals smelling anuses (Fig. 1f). This is an olfactory signal which may inhibit further conflict. Most chases ended in the squirrels feeding and going their separate ways.

Postures associated with alarm- When a dangerous situation arises, ground squirrels respond immediately. In response to a human intruder they behave in three ways. First, if the intruder is some distance away, about 40 feet, they get into a hunched upright position which I call a watching position (Fig. 1g). From that they gradually extend their bodies into a tall upright position which I call an alarm position (Fig. 1d). This posture is also assumed when an unseen danger arises, such as a loud noise. Secondly, if the intruder is close (about 20 feet) they assume a low to the ground hiding position (Fig. 1h), or they run to a burrow and assume a hunched position prior to entering it (Fig. 1c). Thirdly, they respond to immediate danger by taking refuge in a burrow. There is individual variation, some ground squirrels being more easily alarmed than others.

Postures of the young- I recorded three kinds of play: (1) wrestling, (2) pushing, and (3) a form of leap frog. Wrestling is similar to a mild form of adult fighting. Two young approach one another, grasp each other with their front paws and roll on the ground. Pushing is the most common form of play. Two or three young sit by each other, then stand on their hindlegs and with their front paws start pushing one another. When one is pushed down the bout is terminated. Pushing can sometimes result in wrestling. The third form of play is similar to leap frog, two young approaching one another and one jumping on the other's back and rolling around.

Another form of interaction is the nose kiss, a young approaching another and mouthing its nose. Nose kissing is usually followed by some form of play. It seems to serve as a recognition display that disappears by adulthood as a result of increasing intolerance of close contact. The last type of interaction, anal smelling, occurs after a wrestling interaction. The posture (Fig. 1f) is similar to the adults.

VOCALIZATIONS

Alarm- A whistle type call is given when a ground squirrel is alarmed, frequently when in a tall alarm position (Fig. 1d). An alarm call (McCarley, 1966) consists of 25-29 individual notes with a musical quality. The call lasts for about 2.3 seconds. The frequency range is from 4100-5123Hz (cycles per second). The amplitude decreases with time. The upper extent of the frequency is apparently dependent upon the degree of alarm, the more alarmed the higher the frequency. Also the time between notes changes according to degree of alarm. Playback of

the vocalization resulted in a number of reactions: (1) all the young went into their burrows; (2) two females ran to a burrow and assumed a tall alarm position; (3) a male got into an alarm position and ran into the field. This call probably serves as a warning to other ground squirrels in the area, alerting them to possible danger.

Threat- This vocalization was recorded when one ground squirrel approached another while at a feeding station. The recipient responded by running away. Apparently the call serves as a threat, increasing the distance between two individuals. Playback of the call resulted in the squirrel assuming a low to the ground hiding position (Fig. 1h). Both males and females were observed giving the call. The frequency range was 2500-5000Hz with harmonics up to 15,000Hz, and a duration of about 0.3 seconds.

Pre-attack- This call was given by a ground squirrel before it attacked its opponent and probably signals the aggressive mood of the vocalizing animal. Most of the time the attack resulted in a chase, but sometimes it ended in a fight. The structure of the call gives the appearance of noise. The frequency range is from 125-9000Hz. This call, consisting of only one note, lasts for about .35 seconds.

Growl- This vocalization always associated with posture 1a was recorded from both males and females. For example a male feeding at a feeding station was approached by a female. The female gave the call when she was within one foot of the male. A growl very seldom elicited an immediate reaction by the recipient. It could be a warning call that informs the other ground squirrel that it is violating territorial or individual distance limits. The growl is a low frequency call ranging from 85-2300Hz.

Fight calls- Aggression is usually in the form of chasing. Ground squirrels very seldom fight, but when they do it is extremely intense. A fight usually lasts about five seconds, but some last as long as seven seconds. Vocalizations given during fights are a series of different complex notes with the maximum frequency at 6,500Hz, the minimum at 1250Hz. Some notes had harmonics.

Teeth chatter- Teeth chattering was recorded only during a fight. Twice a fight occurred after I forced two squirrels (a male and a female) into the same burrow. The frequency range is 125-4500Hz. One had 32 notes extending over 1.9 seconds.

Submissive call- A female was approaching the feeding station where a male was eating. She situated herself off to one side and in back of the male and began vocalizing while in a low to the ground head up position (Fig. 1a). She called for about 4.5 seconds then a fight broke out for 2.3 seconds. After the fight the male continued to eat and the female was in a submissive posture (Fig. 1e) giving the call for 13.2 seconds. She finally approached the male after she finished vocalizing, and was able to feed in harmony with him. She was in a submissive posture all the while she fed. The call probably inhibited attacks by the male. The frequency of the call is from 3000-4250Hz, with a duration of .2 to .4 seconds.

Male bark- The stimuli eliciting this call were not clear. However, the male gave the call while: (1) sitting by a burrow and feeding, (2) approaching the feeding station when no other ground squirrels were there. The call consists of two notes of equal amplitude with a frequency range from 125-8000Hz. Each note lasts .04 seconds.

Female warning to young- This call was given by females to their young. If other ground squirrels came into the mother's territory while her young were out, she chased the young into a burrow and emitted this vocalization. The call was first recorded when the young were 44 days old and was last recorded when they were 52 days old. The frequency range is from 125-8000Hz with the main part at 3300-5700Hz. The duration of the call is .15 seconds. The call has similarities to the alarm call of the female and probably serves to alert the young to danger.

Alarm call of young- This call was given by the young when they were 45 days old when a human intruder came within fifty feet. At 54 days old they gave the call in response to the mother. The call originally consisted of three notes and as the young matured the number of notes increased. The frequency range is 4727-5909Hz. The call lasts .12 seconds and each note is separated by .04 seconds. The note structure is similar to the adult alarm call.

Chirp call- Young emitted the call on two occasions, both times in response to approach by an adult male. The call was recorded nine days following their first emergence from the burrow. The frequency range is 2000-8500Hz. The call lasted .15 seconds.

DISCUSSION

Ethologists have emphasized the stereotypy of species-typical behavior patterns of a variety of animals, particularly birds and fish. Mammals, although in general having somewhat more flexible behavior than other animals, also have a variety of stereotyped behavior patterns functioning in communication (Balph and Stokes, 1963). Alarm postures of the Uinta ground squirrel (*Citellus armatus*) (Balph and Stokes, 1963) are quite similar to those of *Citellus tridecemlineatus*. The alarm call is similar, but with a lower frequency (pitch) and longer duration. These closely related species tend to have similar communicatory signals, but certain of these signals are specific for each species.

Since this study did not deal with sexual behavior, the 17 signals of the adult ground squirrels represent behavior associated with aggression, submission and alarm. In addition to visual and vocal displays ground squirrels undoubtedly use olfactory stimuli, for example anal sniffing, in communication. It is interesting to compare the ground squirrel's communicatory repertoire with those of some other mammals. Wilson (1972) notes that most mammals have between 16 and 37 signals. Among rodents the prairie dog (*Cynomys ludovicianus*) has 18

(however, the vocalizations were not studied intensively), and the deer mouse (*Peromyscus maniculatus*) has 16.

The ground squirrel's life consists of a brief (about four to six months) during which occur the establishment of core areas, reproduction, and growth and dispersal of the young. The remaining months are spent in hibernation (McCarley, 1966). Communication makes the achievement and synchronizations of these events possible. Exchange of signals enable the male and female to break down their individual distances to briefly achieve sexual contact. Communication is also important in warning other individuals of impending danger. Communication serves as a spacing device so overcrowding does not occur enabling ground squirrels to obtain adequate nutrition in their partially exclusive areas, which is imperative for such a long hibernation period. Communication is the key to the survival of a species.

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Robert Ryshke
Department of Zoology
The University of Wisconsin—Milwaukee