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WHAT MAKES ALARM CALLS UNDISTINGUISHABLE BETWEEN AGES IN GROUND SQUIRRELS?

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In most mammals, adults produce low-frequency vocalizations compared to pups, as sizes of vibrating structures of their vocal apparatus are much larger (Morton 1977, *Amer. Natur.*, 111:855-869). This rule is not maintained however at least in four species of ground squirrels, whose pups call as low fundamental frequency as adults: speckled *Spermophilus suslicus*, yellow *S. fulvus*, Richardson's *S. richardsonii* and California *S. beecheyi* ground squirrels (Hanson, Coss 2001, *Ethology*, 107:259-275; Matrosova et al. 2007, *Behav. Ecol. Sociobiol.*, 62:181-191; Swan, Hare 2008, *J. Mammal.*, 89:889-894). These findings have been obtained however with separate sets of pups and adults and no data is available concerning ontogeny linked to these differences. We analyzed the acoustic structure of alarm calls of the same yellow and speckled ground squirrel individuals, recorded twice, first as pups and then as adults after hibernation. During the year-long maturation period passed between the two recordings, body mass increased significantly, from 283±120 to 819±430 g in yellow and from 98±33 to 205±59 g in speckled ground squirrels. However the maximum fundamental frequency decreased with age only in 4 of 8 yellow and in 2 of 7 speckled ground squirrels and increased with age in the rest 8 of 15 animals. That is, maturation does not result in the directional decrease of the alarm call frequencies and the values of adults did not differ significantly from those of pups. In yellow ground squirrels, differences in duration between ages were non-significant. But in speckled ground squirrels, the duration of alarm call notes was significantly shorter in juveniles than in adults. These age effects on temporal parameters in speckled but not in yellow ground squirrels could be due to the facts that small-sized speckled ground squirrels produce nevertheless longer calls than the larger-sized yellow ground squirrels. As can be seen from video recordings of calling animals, in both species each alarm call note represents a vocal emission during a single expiration. However, speckled ground squirrels use all their lung capacity to produce each alarm call note, whereas yellow ground squirrels do not use their lung capacity exhaustively. To sever the physical relationships between fundamental frequency values and body size, both species of ground squirrels probably tuned their vocal characteristics. From an anatomical viewpoint, juvenile larynges are more elastic and pups can more easily manipulate the length of their vocal folds. From functional viewpoint, pups mimicking adults could reduce the age-dependent risks because their adult-like alarms can deceive some mustelids, that are too small to predate adult, but are dangerous for pups (Matrosova et al. 2007). Also, juvenile ground squirrels may suffer from infanticide even more than from interspecific predators (Hanson, Coss 2001), while adult animals never suffer from infanticide. So infanticide may be another factor responsible for the vocal mimicry in ground squirrels. In Richardson's ground squirrels, lacking both the fundamental frequency-based and duration-based cues to age, adults do not recognize between alarms of adult and juvenile conspecifics (Swan, Hare 2008), what provides a strong support to the hypothesis of vocal mimicry. Besides the fundamental frequency, ground squirrels can use also other vocal cues to age (Hanson, Coss 2001), and our findings suggest that the alarm call duration may provide such a cue in the speckled ground squirrel. Juvenile sciurids are predated much more often compared to adults (Sibly et al. 1997, *J. Zool.* 243:1-12), so under heavy selection for vocal mimicry, even the elimination of a single cue to age may convey some selective advantage.

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