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BOT FLY (DIPTERA: CUTEREBRIDAE) INFESTATION OF NEST-BOUND INFANT EASTERN GRAY SQUIRRELS

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Cuterebra bot fly larvae are obligate, subcutaneous parasites of rodents (mice, rats, tree squirrels, chipmunks, etc.) and lagomorphs (rabbits and hares) in the Americas (Sabrosky 1986). Infestation is revealed by lumps (referred to as warbles) on an animal caused by the presence of second and third instar larvae under its skin (Cogley 1991, Slansky & Kenyon 2000, 2001). Evidence from a limited number of studies indicates that *Cuterebra* flies do not oviposit directly on their hosts but rather on foliage, twigs or other substrates, often in the vicinity of an animal's nest (Catts 1967, Baird 1974, 1997). A potential host thus risks exposure to newly hatched *Cuterebra* larvae when leaving its nest and moving about in its habitat (Catts 1982).

Once the tiny, infective-stage larvae transfer to a potential host, they enter an orifice or wound and begin their approximately week-long journey through the animal's body, eventually settling under its skin (Gingrich 1981). They then use their pointed mouth hooks to cut through the host's hide to create a warble pore through which they respire and excrete fluid. A larva typically remains in its warble, which increases in size as the larva grows, until completing development in about 3 to 10 weeks, depending on the species of *Cuterebra* and host (Baird 1975, Jacobson et al. 1978). The mature larva exits through the warble pore and falls to the ground, where it burrows into the soil to pupate (Catts 1982).

Over the past several years, we have been studying the relationship between *Cuterebra emasculator* Fitch and its tree squirrel hosts. This bot fly parasitizes eastern gray (*Sciurus carolinensis* Gmelin) and fox (*S. niger* L.) squirrels, as well as eastern chipmunks (*Tamias striatus* L.), throughout the eastern and midwestern regions of North America, from southern Canada to Florida (Sabrosky 1986); American red (*Tamiasciurus hudsonicus* (Erxleben)) and flying (*Glaucomys* spp.) squirrels seem to be rarely infested (Dorney 1965, Slansky & Kenyon 2000). *Cuterebra emasculator* is apparently univoltine throughout its range, spending some ten months underground in the pupal stage (Bennett 1972a). Infested animals are observed from mid-late July to the end of October (Bennett 1955, Jacobson et al. 1981, Slansky & Kenyon 2000). While there are many published records of *C. emasculator* infesting tree squirrels and chipmunks active outside the nest, to our knowledge this note is the first documenta-

tion of infestation of nest-bound infants by larvae of this bot fly.

As part of a wildlife rehabilitation program in northcentral (Alachua Co.) Florida, over the last 18 years we have encountered 10-15 cases of infant *S. carolinensis* infested by bot fly larvae (out of several hundred infants brought in for rehabilitation), including a record high of five in the summer, 2000 squirrel breeding season (no cases were reported in 2001). This rarity contrasts with the situation in adult squirrels, where the incidence of *Cuterebra* parasitization often exceeds 50% (unpubl. obs.). Infestations of the infants typically consisted of one or two, and rarely three, larvae per individual (Fig. 1). All of these animals would have been nest-bound at the time of parasitization; most were young enough to have not yet opened their eyes (i.e., they were less than five weeks of age) and even those with opened eyes were too young to have begun exploring outside the nest. Juvenile *S. carolinensis* typically do not begin extra-nest activity before about eight weeks of age (unpubl. obs.).

In that exposure to *Cuterebra* larvae is believed to occur when an animal moves about outside of its nest, infestation of nest-bound infants seems highly unusual. We are aware of only a few anecdotal reports of *Cuterebra*-infested infant animals (e.g., a 6-day-old rabbit and a litter of nursing wood rats; Dalmat 1943). Kittens and puppies, both of which are incidental hosts, can also be parasitized (Hall 1925, Rosenthal 1975, McKenzie et al. 1978). How infestation of nest-bound animals occurs has not been determined. Assuming that female *Cuterebra* did not deposit eggs directly on these infants, it is possible that a mother animal that had acquired infective-stage larvae while out foraging inadvertently brought these back to her nest and some transferred to her nursing offspring. Another possibility is that larvae from eggs laid on nest material entered the nest and parasitized the animals within. It is not known where *C. emasculator* females oviposit.

Parasitism by *Cuterebra* typically has been studied in juvenile, subadult and adult animals (Bennett 1955, 1972b, 1973, Jacobson et al. 1981, Manrique-Saide et al. 2000). Individuals in these age classes typically exit their nests on a daily basis to forage in the habitat and thus risk exposure to infective-stage larvae; it is also these individuals that are sampled through the commonly used techniques of trapping, hunting and collection of roadkills. However, as documented here, seden-

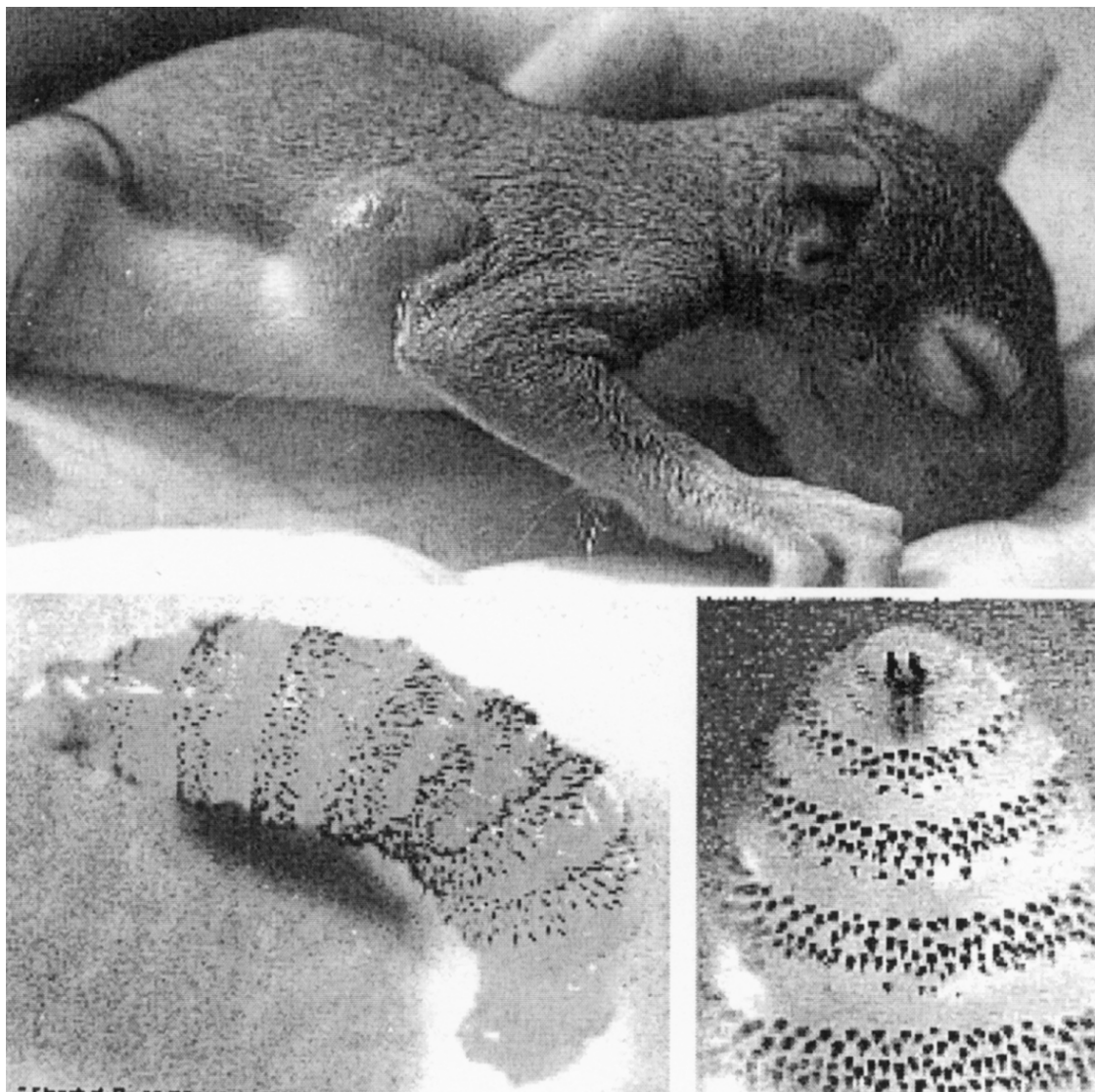


Fig. 1. Upper panel: Nest-bound infant gray squirrel (4-5 weeks old, eyes not yet opened) with a moderate-sized bot fly warble on its side behind its right front leg; the warble contained a second instar larva. Lower left panel: Second instar *C. emasculator* larva removed from its warble; bands of dark spines are visible ('head' end at left; length = 10.0 mm; original photomicrograph, 25 \times). Lower right panel: Ventral view of anterior portion of second instar bot fly larva showing paired mouth hooks (toward top of image) and bands of dark, posterior-pointing spines (the internal cephaloskeleton to which the mouth hooks are attached is faintly visible through the translucent cuticle; original photomicrograph, 60 \times).

tary, nest-bound infants may also become infested. Therefore, when evaluating the effects of parasites on their host populations (Grenfell & Gulland 1995, Milton 1996), it would seem to be important to study not just animals moving about in their habitat, but nest-bound individuals as well, even though locating nests to sample the infants will typically be more difficult in a field setting than trapping mobile animals. Associated

with their small size and the high energy and nutrient demands of their rapid growth, it is likely that infants will be deleteriously affected by parasites to a greater extent than adults with a comparable intensity of infestation. Thus, when only older, mobile animals are studied, the impact of parasites on the host population could be significantly underestimated, especially if the incidence of infant infestation is substantial.

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SUMMARY

Although infestation of tree squirrels and chipmunks active outside the nest (i.e., juveniles, subadults and adults) by larvae of the bot fly *Cuterebra emasculator* has been well documented, this is apparently the first report of nest-bound infant eastern gray squirrels (*Sciurus carolinensis*) parasitized by this species.

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