

## Ticks and Fleas of Shrews in Appalachian Georgia and North Carolina

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**ABSTRACT:** Ticks (Acari: Ixodidae) and fleas (Insecta: Siphonaptera) were recovered from 8 smoky shrews, *Sorex fumeus* Miller, and 9 northern short-tailed shrews, *Blarina brevicauda* (Say), trapped at elevations of 720–1,310 m in Macon and Jackson counties in western North Carolina and Union County in northern Georgia from April 1994 to August 1995. The ticks *Ixodes angustus* Neumann and *Ixodes woodi* Bishopp, and the flea *Corrodopsylla curvata* (Rothschild), were recovered from smoky shrews. The same 2 tick species, in addition to the fleas, *Ctenophthalmus pseudagyrtis* Baker and *Doratomyia blarinae* Fox, were recovered from northern short-tailed shrews. New state records for *I. angustus* from Georgia and *I. woodi* from North Carolina are established.

Faunas associated with higher elevations of the Appalachian mountain chain in eastern North America are often unique, more diverse, or more complex than adjacent lowland faunas (Linzey and Linzey, 1971; Benton, 1980a). Also, the southern reaches of the Appalachian mountains, which are mainly in Georgia, North Carolina, and Tennessee, are austral refuges for several species that inhabit lower elevations at more northerly latitudes (Brooks, 1971). For example, several rodent and shrew species occur in these 3 states only in high elevation Appalachian habitats (Linzey and Linzey, 1971). Other rodent and shrew species occur in these habitats and also in the adjacent lowlands.

A similar phenomenon has been noted for certain species of ticks and fleas that parasitize these small mammals (Benton, 1980a; Robbins and Keirans, 1992). However, records of such ectoparasites are fragmentary and there are significant gaps in our knowledge, particularly with respect to the precise zoogeographical limits for these arthropods. To determine the presence and host associations of some of these ectoparasites in the southern Appalachians, we completed a study of the ticks and fleas associated with 2 species of shrews in selected upland areas of Georgia and North Carolina.

Shrews were trapped at elevations of 720–1,310 m in adjoining Jackson and Macon counties in western North Carolina, and in Union County in northern Georgia from April 1994 to August 1995. Shrews from Macon County, North Carolina and Union County, Georgia were collected using pitfall traps partially filled with 10% formalin as part of other studies of small mammal ecology. These specimens were transferred to 70% ethanol (fluid preserved) and examined prior to accession into the collections of the Museum of Natural History at the University of Georgia. Shrews from Jackson County, North Carolina, were captured using live traps, anesthetized with ethyl ether, and examined alive.

Shrews were examined with the aid of a low-power binocular microscope, and ticks and fleas found were retained in 70% ethanol. Fleas were prepared for microscopical examination and identification as described in Durden (1995). Voucher shrew specimens are deposited in the Museum of Natural History at the University of Georgia (accession numbers 10307, 10370, 10725, 11207, 11229, 12539, 13306, 13756, 14275, 14408, 15087, 15088), whereas voucher ectoparasites are deposited in the U.S. National Tick Collection at Georgia Southern University, Statesboro (accession numbers RML 122089–122091, RML 121933–121935).

Ticks, or fleas, or both were removed from 8 smoky shrews, *Sorex fumeus* Miller, and 4 northern short-tailed shrews, *Blarina brevicauda* (Say), that were fluid preserved and from 5 of the northern short-tailed shrews that were examined alive. Nine ticks, comprising 8 female *Ixodes angustus* Neumann and 1 female *Ixodes woodi* Bishopp, were collected from the 8 smoky shrews. One flea, a male *Corrodopsylla curvata* (Rothschild), was also recovered from 1 of the smoky shrews. Fourteen ticks, consisting of 12 *I. angustus* (5 females, 7 nymphs) and 2 female *I. woodi*, were collected from the 4 fluid-preserved northern short-tailed shrews. One larval *I. angustus* tick and 23 fleas, including 2 *Ctenophthalmus pseudagyrtis* Baker (1 male, 1 female) and 21 *Doratopsylla blarinae* Fox (15 males, 6 females), were recovered from the 5 shrews of this species that were examined alive.

Geographically, *I. angustus* was collected from both Jackson and Macon counties in North Carolina and from Union County, Georgia, whereas *I. woodi* was recorded only from Macon County, North Carolina. The fleas *C. pseudagyrtis* and *D. blarinae* were both recovered only in Jackson County, North Carolina, whereas *C. curvata* was collected in Macon County, North Carolina.

Both of the tick species we collected, *I. angustus* and *I. woodi*, typically parasitize small mammals in damp, cool habitats, especially at high elevations (Robbins and Keirans, 1992). Both ticks are widely distributed in these habitats in North America, with most records from western states and provinces. Although there are relatively few collections of *I. angustus* from the southeastern United States, Whitaker et al. (1975) collected it from smoky and northern short-tailed shrews in Clay County, North Carolina. The specimens we report here for Georgia represent new state records.

Similarly, there are very few records of *I. woodi* in eastern North America with specimens from Alabama and Indiana representing the only previous records east of the Mississippi river (Wilson, 1958; Cooney and Hays, 1972; Robbins and Keirans, 1992). Our North Carolina records for this tick therefore represent new state records and the easternmost records to date. More diligent collecting in the southern Appalachians will likely produce more specimens of these ticks.

Two of the 3 flea species we collected are common shrew parasites at both low and relatively high elevations in eastern North America. Both *C. pseudagyrtis*, which parasitizes several species of insectivores and rodents (Lewis, 1974; Benton, 1980b), and *D. blarinae*, which parasitizes *Blarina* spp. (Benton, 1980b; Durden, 1990; Whitaker et al., 1994), have been collected at various altitudes. Indeed, both *C. pseudagyrtis* and *D. blarinae* have been taken in Clay County, North Carolina at elevations comparable to those at our study areas (Whitaker et al., 1975).

The remaining flea, *C. curvata*, mainly parasitizes *Blarina* and *Sorex* spp. (Lewis, 1974). *Corrodopsylla curvata* is a boreal species (Benton, 1980b; Holland, 1985), and high elevation specimens from western North Carolina (Whitaker et al., 1975; the present study) represent the southernmost records known.

We expected to collect a greater number of fleas from live shrews than from fluid-preserved specimens. Fleas typically leave rapidly or fall from dead hosts and specimens preserved in fluid. However, because their mouthparts are embedded in host tissue, ticks cannot rapidly leave their hosts and, in many cases, remain attached to hosts preserved in fluid (Westrom and Yescott, 1975). Therefore, it is likely that the ectoparasites we collected in this study reflect true infestation parameters of shrews by ticks in nature but provide a low estimate of flea infestations for shrews preserved in fluid.

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