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FIRST STATE RECORDS FOR *MEROPE TUBER* (MECOPTERA: MEROPEIDAE) IN FLORIDA AND BIOGEOGRAPHICAL IMPLICATIONS

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The earwigfly, *Merope tuber* Newman, is 1 of only 2 extant members of the family Meropeidae worldwide (Kaltenbach 1978; Byers 2005). This family was once considered a hypothetical primitive taxon in the order Mecoptera (Tillyard 1926, 1935; Remington 1968); however, recent phylogenetic work disputes this placement (Willmann 1987, 1989; Whiting 2002). The immature stages have not been described to date, and much of its general biology remains unknown. Adults are nocturnally active and for many years were considered rare, but recent collection methods (especially flight traps) have led to the finding that *M. tuber* is more common than once thought (Byers 2005). Byers (1973, 1993) recorded the range of *M. tuber* from southeastern Canada to northern Georgia, west to Kansas, Minnesota, and eastern Iowa, largely restricted to environmental conditions similar to those known along the Appalachian range and eastern mesic forests. Recent collection records indicate that *M. tuber* is found further west and south, suggesting that it may have found refuge in disjunct areas during glacial advances (Byers 1969, 1993; Schiefer & Dunford 2005). We present the first records of *M. tuber* in Florida, the southernmost localities for this insect, and provide new phenological data associated with adult activity. *Merope tuber* presently has a NatureServe Global Conservation Status Rank of G3G5 (=vulnerable to secure globally, but there is not enough information to give it a definite rank), and the Florida Natural Areas Inventory (FNAI) has State-listed it as S1S2 (=critically imperiled due to extreme rarity based on current information, but may be less rare than is known at present) based on the data provided herein.

Yearlong, general insect surveys were conducted at The Nature Conservancy (TNC) Apalachicola Bluffs and Ravines Preserve (ABRP), and Tall Timbers Research Station and Land Conservancy (TTRS) by P. W. Kovarik in

1996. Passive insect traps including baited and unbaited pitfall traps, Lindgren funnel traps, and flight intercept traps were established within mesic hardwood forests at each locale and checked biweekly. Adult *M. tuber* were taken at 3 sites in Leon and Liberty Counties in the Florida panhandle (Table 1). A total of 16 males and 24 females were collected from 20 Apr-30 Nov in the flight intercept traps set in primarily beech-magnolia dominated forests. Seasonal records previously reported for *M. tuber* collected north of Florida included dates encompassing early May through late Oct (Webb et al. 1975; Byers 1993; Griffiths 1995). Johnson (1995) reported having a Malaise trap set from May 1992 through Nov 1993 in Ohio, and provided a range of collection dates from 9 Jul-24 Sep. Unpublished collection records of *M. tuber* adults housed in the National Museum of Natural History (NMNH) include one female taken in Essex County, Virginia, between 24 Oct and 20 Nov 1995 (D. Smith, pers. comm.). Early season Florida samples span late Apr through early May; thus, we cannot definitively report the end of Apr as an early seasonal record. However, one of our samples included only the latter part of Nov (16-30); thus, we confidently report this range of dates as latest seasonal records. Although 39 of the 40 Florida specimens conformed to the overall dull, colorless appearance that typifies this species (Fig. 1—male collected Jun-Jul) (Newman 1834; Byers 1973), a single female from Woodyard Hammock, TTRS, Leon Co., collected between 17-28 Jun has an unusual degree of melanism, including stigate apical wing margins and black terminalia (Fig. 1).

Our collection localities were in proximity to the Apalachicola and Ochlockonee Rivers (Fig. 2), and likely represent disjunct, southern Appalachian refugia. Upland longleaf pine savannahs interspersed with mixed hardwood forests in steepheads characterize the Apalachicola Bluffs

TABLE 1. DATA FOR *MEROPE TUBER* COLLECTED IN FLORIDA IN 1996. INDIVIDUALS WERE TAKEN FROM LIBERTY CO., APALACHICOLA BLUFFS PRESERVE, TRAVELERS TRACT, 30°32' 13" N, 84°58' 00" W* (LOCALITY 1), AND LEON CO., TALL TIMBERS RESEARCH STATION, WOODYARD HAMMOCK, 30°39'21"N, 84°14'35"W* (LOCALITY 2) AND GAYS ISLAND, 30°38'39"N, 84°13'55"W* (LOCALITY 3).

Locality	Dates	Number of males/females	Collectors
1	20 Apr-4 May 1996	2/0	P. E. Skelley & P. W. Kovarik
1	2-13 Jun 1996	0/1	P. W. Kovarik
1	10-24 Aug 1996	0/1	P. W. Kovarik
1	7-21 Sep 1996	0/1	P. W. Kovarik
1	16-30 Nov 1996	1/0	P. W. Kovarik
2	4-17 May 1996	1/4	P. W. Kovarik
2	17-28 Jun 1996	2/5	P. W. Kovarik & Zhang X.-c.
2	27 Jul-11 Aug 1996	3/6	P. W. Kovarik & Zhang X.-c.
2	22 Sep-5 Oct 1996	1/0	P. W. Kovarik & Zhang X.-c.
2	20 Oct-3 Nov 1996	2/3	P. W. Kovarik & Zhang X.-c.
2	3-17 Nov 1996	0/1	P. W. Kovarik & Zhang X.-c.
3	Jun-Jul 1996	4/2	P. W. Kovarik & Zhang X.-c.

*Approximate latitude and longitude coordinates for sampling sites (coordinates were not taken at the time of sampling).

and Ravines Preserve. Here specimens of *M. tuber* were captured in a mature beech-magnolia forest along the slope of a steephead ravine, close to an intermittent stream. The ravine forests are biologically unique in Florida, and species that commonly occur in the Appalachian Mountains are present here (Rogers 1933; Hubbell et al. 1956; Neill 1957; James 1961; Means 1985).

The vegetational communities of TTRS include loblolly pine-dominated uplands and a beech-magnolia forest located on a sandy floodplain. The Woodyard Hammock site is a mature beech-magnolia forest in a relatively flat area near an intermittent stream. The Gays Island site (=north end of Hall Island) is a relatively open mixed pine-hardwood forest. Both the Woodyard Hammock and Gays Island sites are located along the margin of Lake Iamonia (Fig. 2). This portion of Florida, also known as the Tallahassee Red Hills region, extends to southwestern Georgia and harbors biota disjunct from more northern locales (Rogers 1933; Hubbell et al. 1956; Neill 1957; James 1961).

Extant Mecoptera are not especially speciose and are absent in many regions of the world (Remington 1968; Kaltenbach 1978). The disjunct distributions of the two extant members of Meropeidae in eastern North America and western Australia (Kaltenbach 1978; Byers 2005), and the extinct meropeid *Boreomerope antiqua* Novokshonov from Middle Jurassic of Siberia (Novokshonov 1995, 1998), suggests that as far back as the Jurassic ancestral Meropeidae may have been widespread, and that *Merope* and its Australian confamiliar *Austromerope poultoni* Killington are relict survivors on opposite ends of the former familial range (Killington 1933; Byers 1988). Pleistocene geology in North America indicates that the northern part of the earwigfly's Appalachian and eastern range, as well as much of its midwestern range, was covered in glacial ice at various times during this epoch (Delcourt & Delcourt 1984, 1987). Byers (1969, 1973) could not confidently determine where *M. tuber* may have found refuge during glacial advances based on

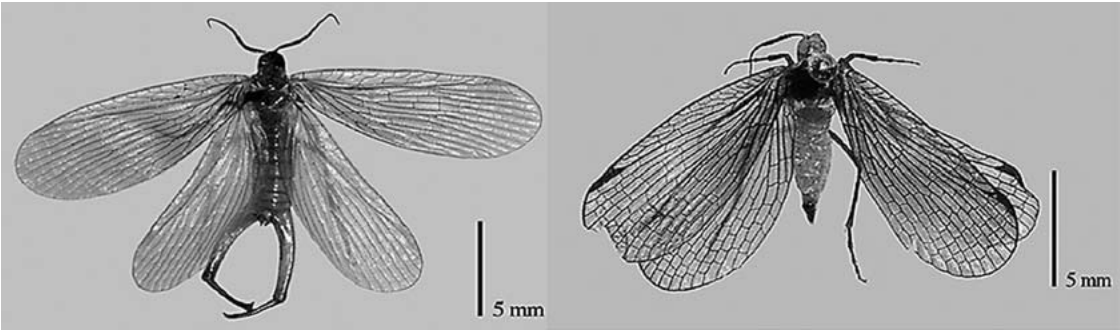


Fig. 1. Left: Male *Merope tuber*. Leon Co. Tall Timbers Research Station, Gays Island; Right: Female *Merope tuber*. Leon Co. Tall Timbers Research Station, Woodyard Hammock.

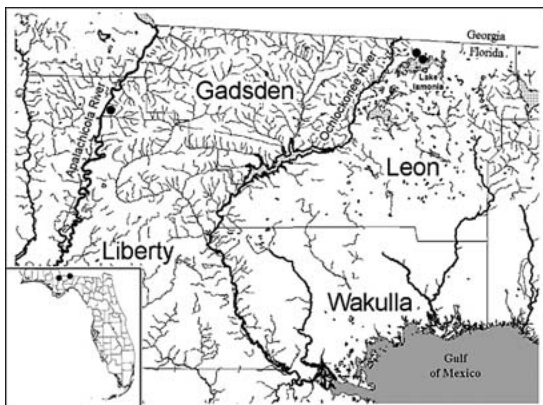


Fig. 2. Localities (dots) for *Merope tuber* adults collected in Florida.

available distributional records. Our Florida records, and those recently reported from other southern localities (Schiefer & Dunford 2005), indicate that suitable refugia for *M. tuber* were apparently available in the southeast during the glacial maximum. Pleistocene marine flooding of Floridian landmasses (MacNeil 1950; Neill 1957) would have reduced this meropeid's southeastern populations to discrete, limited refugia. Both of the areas where this species was taken coincide with one of the limited areas postulated by Delcourt & Delcourt (1984) as a refugium for temperate deciduous hardwood forest communities during the height of the last continental glaciation. These forest communities require rich soils, moisture, and nonsevere winters to survive. Temperate forests during the last glacial maximum would have been in fire protected mesic habitats such as river bluffs, ravines, and sink holes (Delcourt & Delcourt 1984, 1987).

Fossil evidence indicates that these habitats, suitable to *M. tuber*, were present during peak Pleistocene glaciation and still exist in parts of northern Florida (Delcourt & Delcourt 1984), especially in steephead ravines. These deep, shady ravines are dominated on the middle of their slopes by beech, southern magnolia, oaks, other hardwoods, and endemic Florida yew (Kwit et al. 1998). The temperatures of the streams within these ravines vary only slightly from 20°C; thermally buffering the environment (Means 1985). Because the headwater streams of the Apalachicola River drain the south face of the Blue Ridge in northern Georgia, stream valleys along the Chattahoochee River, a northern tributary of the Apalachicola, likely provided suitable habitats for Appalachian biota to disperse southward during glaciation and northward during interglacial periods. Coastal Plain river systems and steephead valleys contain a number of rare or otherwise

unique species (Rogers 1933; James 1961; Means 1981, 1985; Skelley 2003; Enge 2005). Somewhat similar climatic conditions, including ravines and sinkholes, and parallel biotic elements exist in the Tallahassee Red Hills region (Rogers 1933; Hubbell et al. 1956; Neill 1957; James 1961). The antiquity and relictual distribution of *M. tuber*, and hypothesized geological and biogeographical associations of the Appalachians with steephead systems and the Tallahassee Red Hills in northern Florida, indicate the earwigfly is yet another inhabitant of these biologically rich and unique ecosystems which will provide important insights into the geologic and climatic events of past ages.

P. W. Kovarik obtained permits to conduct general insect surveys in our study areas. We are indebted to Lenny Brennan (formerly of TTRS) and Rick Studenmund (formerly of Florida TNC) for granting permission to conduct insect surveys in these protected areas. We thank David T. Almquist (FNAI, Tallahassee, Florida) for helping develop locality maps, providing habitat data associated with collection records, critically reviewing our manuscript, and including *M. tuber* on the FNAI Element Tracking List. We are grateful to Paul E. Skelley (Florida Department of Agriculture & Consumer Services, Division of Plant Industry, Entomology Section-Florida State Collection of Arthropods [FSCA]) for critical comments on Florida biogeography, manuscript review, and for helping procure Florida specimens, and David R. Smith (NMNH, Systematic Entomology Laboratory) for providing data associated with specimens housed at the NMNH. *Merope tuber* collected in Florida are deposited in the FSCA, Gainesville, Florida. Finally, we are much indebted to George W. Byers for critically reviewing our manuscript. This is Entomology Contribution No. 1074, Bureau of Entomology, Nematology, and Plant Pathology, Florida Department of Agriculture and Consumer Services, which provided support through funding and the use of their facilities at FSCA.

SUMMARY

We report *Merope tuber* Newman from Florida for the first time. Locality and phenological data associated with specimens represent the southern-most distributional records and extend previously recorded seasonal records. Additionally, we discuss the relevance of Florida biogeography, geological history, and Appalachian refugia to the distribution of *M. tuber*.

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