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New records of biting midges of the genus *Culicoides* Latreille from the southeastern United States (Diptera: Ceratopogonidae)

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Abstract. We provide new state and county records of biting midges in the genus *Culicoides* Latreille (Diptera: Ceratopogonidae) from the southeastern United States collected with CDC miniature light traps during 2007–2012 in Florida, Georgia, Alabama, Mississippi, Louisiana, Arkansas, and Texas. The primary goals of the surveys were to identify the presence of exotic *Culicoides*, and determine the ranges of known and possible vectors of bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV). Included are the first records of: *Culicoides* (*Amossovia*) *beckae* Wirth and Blanton from Louisiana and Mississippi, *C. (A.) oklahomensis* Khalaf from Alabama and Arkansas, *C. (Avaritia)alachua* Jamnback and Wirth from Alabama, *C. (Culicoides) neopulicaris* Wirth from Alabama, *C. (Drymodesmyia) butleri* Wirth and Hubert from Texas, *C. (Hoffmania) insignis* Lutz from Mississippi, *C. (Oecacta) barbosai* Wirth and Blanton from Georgia, *C. (Silvaticulicoides) loisae* Jamnback from Alabama, and *C. kirbyi* Glick and Mullen from Mississippi. We also provide new Florida county records for *C.alachua*, *C. barbosai*, *C. (Beltranmyia) hollensis* (Melander and Brues), *C. insignis*, and *C. (Monoculicoides) sonorensis* Wirth and Jones; a new Georgia county record for *C.alachua*; and new Alabama county records for *C. insignis*, and *C. sonorensis*.

Key words. Ceratopogoninae, Culicoidini, Nearctic, distribution

Introduction

The biting midge genus *Culicoides* Latreille (Diptera: Ceratopogonidae) includes nearly 1,350 species worldwide (Borkent 2014), with 151 species in the United States and Canada (Borkent and Grogan 2009). Due to their haematophagous nature, these insects are of particular interest as major pests of humans and other vertebrates, as well as vectors of viruses and some parasites. However, all species are not equal in their ability to irritate humans and other vertebrates, and transmit pathogens. Many species prefer certain hosts and do not readily bite humans (Kettle 1977), and only a few are known vectors of pathogens in North America (Borkent 2004). Additionally, while the ranges of some species include much of the continent, others are restricted by larval habitat requirements, climate, geography, or other factors. Differentiating midge species (pest vs. non-pest; vector vs. non-vector) and knowing their past and current ranges is vital to assessing pathogen transmission risk and employing effective management strategies, especially in the face of a changing climate (Mellor et al. 2004).

Culicoides are small (1–3mm) nematoceros flies, the majority of which are crepuscular, although some are diurnal or nocturnal. In North America, they occupy a wide variety of habitats and climates, but are usually associated with aquatic or semiaquatic habitats. Varied and often species-specific, larval habitats include mud, wet sand, tree holes, hollow and decaying cacti, decaying vegetation, and manure. Adults tend to stay close to breeding sites, though those associated with ephemeral habitats often disperse greater distances (Greiner et al. 1978; Borkent 2004). Adult females of most species require a blood meal to produce a clutch of eggs, although a few species are autogenous for the first gonotrophic cycle, and some have reduced, vestigial mouthparts and never take a blood meal (Downes and Wirth 1981; Koch and Axtell 1978). In North America, mammals and birds are the primary hosts for most species of *Culicoides* (Blackwell 2004), however some species target more specific hosts, such as *C. testudinalis* Wirth and Hubert, which feeds only on turtles (Blanton and Wirth 1979; Grogan et al. 2009). Other specific climate and microhabitat requirements for feeding dictate where and when *Culicoides* actively seek a bloodmeal (temperature, relative humidity, time of day, wind speed, location of host, etc.) (Carpenter et al., 2008; Kettle 1977). In addition, adult males and females use flower nectar as an energy source, and can be significant pollinators in some parts of the world (Magnarelli 1981; Borkent et al. 2009).

Many species of *Culicoides* have been implicated in the transmission of viruses, protozoa, and filarial parasites worldwide (Borkent 2004). In North America, they are perhaps best known as vectors of two Orbiviruses of domestic and wild ruminants, bluetongue virus (BTV) and epizootic hemorrhagic disease virus (EHDV) (Sanders et al. 2010; Mellor et al. 2000). The distributions of these and other vector-borne pathogens are expected to shift with global climate change due to the environmental changes influencing the distribution of their vectors (Guis et al. 2012). In addition to being vectors, *Culicoides* often inflict painful bites which leave irritating welts that can lead to infection and dermatitis from induced scratching (Greiner et al. 1990; Correa et al. 2007). In some regions of the world, they are so pestiferous and difficult to control that development has been limited; in other places they can have a serious impact on recreation and tourism (Linley and Davies 1971). Any environmental or climate changes that affect the distribution of *Culicoides* have the potential to also have significant economic impact through increased pathogen transmission and/or direct impact on outdoor activities.

This report documents new state records from a seven-state, six-year survey of *Culicoides* in the southeastern United States, as well as new county records for certain species in Florida, Georgia, and Alabama. For some species, these new state records likely indicate a rare species that has always been present but never previously captured at a particular location. In other instances, these new records may represent actual range expansions for particular species, for example, *C. insignis* Lutz, in Mississippi and additional new county records in Florida.

Materials and Methods

The Southeastern Cooperative Wildlife Disease Study (SCWDS) has been conducting a survey for *Culicoides* in the southeastern United States since late 2007. Our primary focus was to survey the Atlantic and Gulf coastal regions of Louisiana, Mississippi, Alabama, Georgia, and Florida during the active midge season of late summer to early fall, when infection rates of BTV and EHDV are highest. Since the project's inception, SCWDS personnel set out over 5,400 individual traps at 249 different sites in the above five primary states and two other states, Texas and Arkansas. We also conducted year-round surveys in central and south Florida. Most surveys were conducted on public lands such as state/county parks, state forests, and wildlife management areas. Several private sites, however, have been surveyed due to their proximity to BTV/EHDV outbreaks or presence of a BTV/EHDV serotype of exotic origin, including livestock operations and deer ranches. Surveys were conducted with CDC miniature light traps, and early in the project, all traps were equipped with white, incandescent lights. During 2008 some traps were reconfigured to operate with UV lights because of their ability to collect greater numbers of some species (Bishop et al. 2006; Nelder et al. 2010). By 2009, all traps were operating with UV lights. Site surveillance by SCWDS Field Technicians involved placing eight to twelve light traps at various locations within each property. Potential *Culicoides* emergence sites were targeted, such as areas surrounding wetlands, lakes, streams, ditches, sloughs and/or forest cover. For ranches

and farms, locations adjacent to livestock were targeted. Traps were usually hung 1.5–2.0 m from the ground and placed out just before dusk. Collections were retrieved the next morning within 1–2 hours of sunrise, and the collected insects were stored in 70% ethanol for laboratory processing.

Trap contents were examined and sorted in the lab, and all *Culicoides* were counted and grouped by subgenus or species group for further identification. Easily determined species were identified with a dissecting stereomicroscope, stored in 70% ethanol, and several voucher specimens were subsequently dissected and slide-mounted. Species not readily identifiable or those considered notable, were cleared in a solution of phenol crystals dissolved in 100% ethanol, then dissected and slide-mounted in a mixture of phenol-ethanol solution and Canada balsam (early in the project) by the methods of Wirth and Marston (1968). For all later collections, specimens were dissected and slide-mounted in a solution of HistoClear-balsam. All slide-mounted specimens were examined in detail with compound microscopes and compared with slide-mounted, previously identified species from the synoptic collections of WLG and the Florida State Collection of Arthropods, Gainesville, Florida (FSCA). We also compared specimens with photos in the Nearctic Wing Atlas (Wirth et al. 1985) and with descriptions and illustrations in the *Culicoides* of Florida (Blanton and Wirth 1979). Assignment of species to subgenera and species groups follows the arrangement in the recent Nearctic Catalog by Borkent and Grogan (2009). Voucher specimens of all species we report on are deposited in the FSCA.

Results

Diptera: Ceratopogonidae Subfamily Ceratopogoninae Tribe Culicoidini

Culicoides (*Amossovia*) *beckae* Wirth and Blanton

Culicoides beckae Wirth and Blanton, 1967: 213 (Florida); Gazeau and Messersmith 1970: 35 (Maryland record); Wirth et al. 1985: 20 (in Nearctic Wing Atlas).

Culicoides (*Drymodesmyia*) *beckae*: Battle and Turner 1971: 26 (Virginia records)

Culicoides (*Oecacta*) *beckae*: Blanton and Wirth 1979: 63 (Florida records; distribution); Wilkening et al. 1985: 522 (Florida records).

Culicoides (*Amossovia*) *beckae*: Borkent and Grogan 2009: 12 (in Nearctic catalog; distribution).

Discussion. *Culicoides beckae* is an uncommon species that closely resembles females of *C. villosipennis* Root and Hoffman and *C. ousairani* Khalaf, and males of *C. arboricola* Root and Hoffman. *Culicoides beckae* can be differentiated from these species by the female dark halteres and pale-banded hind femora, and more slender male parameres (Wirth and Blanton 1967). This species utilizes tree-holes for larval development like most other species in the subgenus *Amossovia* Glukhova (Lamberson et al. 1992), and like other species in this subgenus, it is ornithophilic (Garvin and Greiner 2003). This species inhabits the Coastal Plain from New York south to northern Florida and Alabama (Blanton and Wirth 1979; Borkent and Grogan 2009). We provide the first records of *C. beckae* from Mississippi and Louisiana.

New State Records. LOUISIANA, Tensas Parish, Winnsboro, Big Lake Wildlife Management Area, 14 September 2012, 2 females. Caldwell Parish, Columbia, Boeuf Wildlife Management Area, 15 September 2012, 2 females. MISSISSIPPI, Adams Co., Garden City, Sandy Creek Wildlife Management Area, 25 September 2008, 1 female; same data except 12 July 2010, 1 female. Franklin Co., Meadville, Caston Creek Wildlife Management Area, 10 August 2012, 1 female.

Culicoides (*Amossovia*) *oklahomensis* Khalaf

Culicoides villosipennis oklahomensis Khalaf, 1952: 355 (Oklahoma; as new subspecies of *C. villosipennis* Root and Hoffman).

Culicoides (Oecacta) oklahomensis: Wirth 1965: 129 (in Nearctic catalog).

Culicoides oklahomensis: Wirth et al. 1985: 20 (in Nearctic Wing Atlas).

Culicoides (Amossovia) oklahomensis: Borkent and Grogan 2009: 12 (in Nearctic catalog; distribution).

Discussion. *Culicoides oklahomensis* has a wing pattern that is very similar to *C. arboricola* (Jones and Wirth 1958; Wirth et al. 1985), which is a common, wide-ranging species with which it has often been confused. Both species key to couplet 3 in the key to species in the *C. guttipennis* group by Wirth and Blanton (1967), but females of *C. oklahomensis* have a dark brown hind femur and 11–16 mandibular teeth, whereas females of *C. arboricola* have a pale subapical band on their hind femur and 14–18 mandibular teeth. The male genitalia of *C. oklahomensis* more closely resembles those of *C. villosipennis*, however, it can be differentiated from that species by the single pair of subapical hyaline filaments below the sharply pointed tip of the aedeagus (Khalaf 1952; Wirth and Blanton 1967).

As is the case with most other species in the subgenus *Amossovia*, *C. oklahomensis* breeds in tree holes (Pappas et al. 1991). The feeding habits of *C. oklahomensis* are unknown, however, at least two other species in the subgenus *Amossovia* are ornithophilic, *C. arboricola* (Blanton and Wirth 1979) and *C. beckae* (Garvin and Greiner 2003). Another closely related species, *C. guttipennis* (Coquillett), has been known to feed on humans and other mammals, but has also been found in high numbers in poultry houses (Wirth and Blanton 1967; Messersmith 1965). In addition, the number of antennal flagella with sensilla coeloconica (sensory pits) is an indicator of species host preferences. Species with a large number of flagella with sensilla coeloconica tend to be primarily ornithophilic, whereas those with few flagella containing these sensilla tend to be primarily mammalophilic (Jamnback 1965). Because female *C. oklahomensis* typically possess sensilla coeloconica on flagellomeres 1, 3, 5, 7 and 9–13, it is also likely to be primarily ornithophilic.

Both *C. arboricola* and *C. villosipennis* have been found throughout all of central and eastern North America, whereas *C. oklahomensis* has only been recorded from California to Mississippi, and south to Guatemala (Borkent and Grogan 2009). However, the ranges of all three species overlap throughout the south-central portion of the United States. We provide the first records of *C. oklahomensis* from Alabama and Arkansas in the extreme southeastern region of that state.

New State Records. ALABAMA, Clarke Co., Jackson, Fred T. Stimpson Wildlife Management Area, 14 August 2012, 1 male, 1 female; same data except 12 September 2012, 1 male. ARKANSAS, Chicot Co., Eudora, 14 October 2009, 1 female.

Culicoides (Avaritia)alachua Jamnback and Wirth

Culicoides obsoletus (Meigen), 1818: 76; Beck 1952: 102 (Florida); Beck 1956: 133 (Florida); Beck 1957: 8 (Florida).

Culicoidesalachua Jamnback and Wirth, 1963: 187 (Florida; in review of the *C. obsoletus* group in eastern USA); Brickle et al. 2008: 54 (Georgia record).

Culicoides (Avaritia)alachua: Wirth 1965: 128 (in Nearctic catalog); Blanton and Wirth 1979: 54 (Florida records; distribution); Wirth et al. 1985: 12 (in Nearctic Wing Atlas); Wilkening et al. 1985: 519 (Florida records); Borkent and Grogan 2009: 12 (in Nearctic catalog; distribution).

Discussion. *Culicoidesalachua* is in the subgenus *Avaritia*, which contains several vector species: *C. imicola* Kieffer, a vector of BTV in Africa and Southern Europe, *C. brevitarsis* Kieffer, a vector of BTV and EHDV in Australia, *C. pusillus* Lutz, a BTV vector in the Neotropics, and *C. obsoletus*, a possible BTV vector in Europe (Borkent 2004; Mellor et al. 2004). Apparently, *C.alachua* is primarily a mammalophilic species that is known to feed on livestock (Kramer et al. 1985a; Greiner et al. 1990). It was originally described by Jamnback and Wirth (1963) from specimens that were considered to be *C. obsoletus* (Beck 1952, 1956, 1957) collected from the interior counties of Alachua, Highlands, Lake and Marion in north-central Florida. Blanton and Wirth (1979) also reported this species from the eastern portion of the Florida panhandle in Jefferson and Liberty counties and in South Carolina. Hagan and Wirth (1985) surveyed coastal Georgia for *Culicoides*, but did not collect any specimens of *C.alachua*,

however, they suggested that it was "...reasonably expected to occur in Georgia". Subsequently, Brickle et al. (2008) reported on the first record of this species from Georgia, a female collected in a hardwood forest in Bulloch County on the southeastern Coastal Plain. We provide the first records of *C.alachua* from Alabama. We also include a new Florida county record for St. Lucie County, on the southeastern coast of that state as well as the second record from Georgia in Ware County from a site adjacent to the Okefenokee National Wildlife Refuge.

New State Records. ALABAMA, Lowndes Co., White Hall, Lowndes County Wildlife Management Area, 8 July 2008, 2 females; same data except 16 August 2008, 1 male; same data except 14 September 2011, 1 female.

New Florida and Georgia County Records. FLORIDA, St. Lucie Co., Fort Pierce, Teague Hammock Preserve, 4 April 2011, 1 male. GEORGIA, Ware Co., Waycross, Dixon Memorial Wildlife Management Area, 14 July 2010, 2 females.

Culicoides (Beltranmyia) hollensis (Melander and Brues)

Ceratopogon hollensis Melander and Brues, 1903: 13 (Massachusetts).

Culicoides hollensis: Kieffer 1906: 50 (combination); Foote and Pratt 1954: 24 (in review of eastern USA *Culicoides*; notes on types).

Culicoides (Beltranmyia) hollensis: Jamnback 1965: 73 (in review of *Culicoides* of New York); Wirth 1965: 131 (in Nearctic catalog; distribution); Blanton and Wirth 1979: 101 (Florida records; distribution); Wirth et al. 1985: 30 (in Nearctic Wing Atlas); Wilkening et al. 1985: 520 (Florida records); Borkent and Grogan 2009: 13 (in Nearctic catalog; distribution).

Culicoides canithorax Hoffman, 1925: 284 (Georgia).

Discussion. *Culicoides hollensis* can be abundant in salt marsh habitats along the Atlantic coast of North America, particularly in areas with tall-growth *Spartina alterniflora*, saltmarsh cordgrass (Kline and Axtell 1977). Greiner et al. (1978) documented *C. hollensis* biting humans in Nova Scotia and New Brunswick, Canada. Blanton and Wirth (1979) noted that "This is the most important man-biting *Culicoides* in the salt-marshes along the eastern seaboard of the United States." This pestiferous species inhabits New Brunswick, Prince Edward Island, and Nova Scotia, Canada and the entire Atlantic U.S. coast to central Florida (Borkent and Grogan 2009).

Culicoides hollensis exhibits geographical variation in its wing pattern, with more northern individuals having almost no pattern, and more southern individuals with a more conspicuous pattern that resembles *C. mississippiensis* Hoffman. In general, *C. hollensis* differs from *C. mississippiensis* by its less conspicuous wing pattern and the lack of a pale spot over the distal portion of the 2nd radial cell. *Culicoides mississippiensis* is thought to replace *C. hollensis* in similar saltmarsh habitat on most of the U.S. Gulf Coast (Blanton and Wirth 1979). Blanton and Wirth (1979) noted in Florida that "*C. mississippiensis* is found along the entire Gulf Coast from Escambia to Monroe counties, and continues up the Keys to Dade Co., but is most abundant and pestiferous in the panhandle." More recently however, Cilek et al. (2003) recorded *C. hollensis* on the Gulf Coast in the panhandle of Florida and in Mississippi. In at least two of our *C. hollensis* specimens, there is a slight pale area over the 2nd radial cell, a characteristic of most specimens of *C. mississippiensis*. However, the overall wing pattern is inconspicuous, as is typical for *C. hollensis*. Blanton and Wirth (1979) suggested that there has been gene flow between these two very similar species in the past, as may be the case here. With the confirmation of *C. hollensis* in southwest Florida, an area within the known range of *C. mississippiensis*, the possibility of gene flow between these species exists. Conversely, only a single species may inhabit the Atlantic and Gulf coasts of North America, and this possibility could be confirmed with future genetic studies. We provide new records of *C. hollensis* from two counties on the southwestern Gulf coast of Florida.

New Florida County Records. FLORIDA, Collier Co., Naples, Collier Seminole State Park, 28 October 2009, 1 female. Lee Co., St. James City, Galt Preserve, 14 December 2009, 3 females; Ft. Myers Beach, Lovers Key State Park, 12 April 2010, 3 females.

***Culicoides (Culicoides) neopulicaris* Wirth**

Culicoides neopulicaris Wirth, 1955: 355 (Texas; Mexico).

Culicoides (Culicoides) neopulicaris: Vargas 1960: 39 (in review of New World subgenera of *Culicoides*); Wirth 1965: 128 (in Nearctic catalog; distribution); Wirth and Blanton 1969: 229 (in review of North American species in *C. pulicaris* group; figs.; Costa Rica, El Salvador); Wirth et al. 1985: 12 (in Nearctic Wing Atlas; Louisiana); Borkent and Grogan 2009: 13 (in Nearctic catalog; distribution).

Discussion. *Culicoides neopulicaris* is a moderately sized species, and like other North American species in the subgenus *Culicoides*, it has a very distinctive, contrasting wing pattern (Wirth et al. 1985). The feeding habits of *C. neopulicaris* are unknown, however, several other species in the subgenus *Culicoides* are primarily mammalophilic. These species include *C. freeborni* Wirth and Blanton, reported to feed on deer and jackrabbits; *C. neofagineus* Wirth and Blanton, known to feed on deer and quail; *C. cockerellii* (Coquillett), *C. frohnei* Wirth and Blanton, *C. tristriatulus* Hoffman, and *C. yukonensis* Hoffman, reported to feed on humans (Wirth and Blanton 1969). Wirth (1955) described *C. neopulicaris* from Texas and Mexico, Wirth and Blanton (1969) recorded it from Costa Rica and El Salvador, and Wirth et al. (1985) recorded it from Louisiana. We provide the first records from Alabama in the southwestern portion of that state.

New State Records. ALABAMA, Clarke Co., Fred T. Stimpson Wildlife Management Area, 21 September 2011, 1 female. Marengo Co., Demopolis, David K. Nelson Wildlife Management Area, 19 September 2011, 1 female.

***Culicoides (Drymodesmyia) butleri* Wirth and Hubert**

Culicoides (Oecacta) butleri Wirth and Hubert, 1960: 650 (Arizona; in review of Ceratopogonidae reared from cacti); Wirth 1965: 130 (in Nearctic catalog; distribution).

Culicoides (Drymodesmyia) butleri: Wirth et al. 1985: 14 (in Nearctic Wing Atlas); Borkent and Grogan 2009: 14 (in Nearctic catalog; distribution).

Discussion. *Culicoides butleri* is a cactus-breeding species that has a similar wing pattern to several other closely related species in the subgenus *Drymodesmyia*, including *C. jamaicensis* Edwards, *C. si-tiens* Wirth and Hubert, and *C. jonesi* Wirth and Hubert. However, it can be differentiated from those species by its distinctive, elongate, sac-like spermathecae. The related *C. (Drymodesmyia) loughnani* Edwards that was originally described from Jamaica, but is also known from Bahamas and Cuba, Texas and Mexico, as well as Florida and Georgia (Wirth and Blanton 1974; Borkent and Grogan 2009), also has elongate, sac-like spermathecae, but its wing pattern is greatly reduced and much paler. In addition, *C. butleri* has a more restricted range than *C. loughnani*, and has only been previously recorded from Arizona and extreme northeastern Mexico in Nuevo Leon (Borkent and Grogan 2009). The host preferences of *C. butleri* are unknown, but, because all 13 flagellomeres possess sensilla coeloconica, this suggests that it feeds on birds. We provide the first record of *C. butleri* from Texas.

New State Record. TEXAS, Uvalde Co., Uvalde, 4 May 2010, 1 female.

***Culicoides (Hoffmania) insignis* Lutz**

Culicoides insignis Lutz, 1913: 51 (Brazil).

Culicoides (Hoffmania) insignis: Fox, 1948: 25 (as type species of new subgenus *Hoffmania*); Wirth and Blanton 1956a: 319 (designated male syntype as lectotype; Florida records); Blanton and Wirth 1979: 106 (in review of *Culicoides* of Florida; Florida records); Wirth et al. 1985: 12 (in Nearctic Wing Atlas; Alabama, Georgia); Wilkening et al. 1985: 520 (Florida records); Borkent and Grogan 2009: 14 (in Nearctic catalog; distribution).

Culicoides inamollae Fox and Hoffman, 1944: 110 (Puerto Rico).

Culicoides painteri Fox, 1946: 257 (Honduras).

Discussion. *Culicoides insignis* is a common, primarily Neotropical species that inhabits most of South America, Central America and the Caribbean region (Wirth and Blanton 1974; Borkent and Spinelli 2007). It also occurs in the southeastern United States, in particular, Florida where it can be locally abundant (Kramer et al. 1985b; Veggiani et al. 2010). This species is often associated with livestock operations and cattle pastures (Kramer et al. 1985a), but can also be found in many other habitat types such as mangrove swamps, tidal mud flats, drainage ditches, sugarcane fields, pond and stream banks, and many intermediate habitats (Blanton and Wirth 1979).

Throughout its range, *Culicoides insignis* is a serious pest to livestock with bites often causing generalized skin reactions and inflammation (Greiner et al. 1990; Correa et al. 2007). In addition, *C. insignis* is one of the few known vectors of BTV in the Neotropics, and a likely vector in the southeastern United States (Greiner et al. 1985; Sáenz and Greiner 1994; Tanya et al. 1992). This species probably plays a large role in BTV transmission in areas where *C. sonorensis* is not present (Kramer et al. 1985b; Mellor et al. 2000). Blanton and Wirth (1979) recorded *C. insignis* from most Florida peninsular counties, coastal and interior, but not from the panhandle. Wilkening et al. (1985) listed *C. insignis* from several additional Florida counties, including some in the panhandle region. In their Nearctic wing atlas, Wirth et al. (1985) listed *C. insignis* from Alabama, and Hagan and Wirth (1985) found this species during their surveys of coastal Georgia, as did Smith et al. (1996) during their surveys of southwestern Georgia. During the current surveys by SCWDS, we collected *C. insignis* in Florida, Georgia, Alabama, and Mississippi. We provide the first records of *C. insignis* from Mississippi in three counties in the southeastern region and from one county in the north-central region of this state. We also provide new county records of *C. insignis* from Florida, Georgia, and Alabama. The recent discoveries of *C. insignis* in Alabama, Georgia, and Mississippi suggest that it is undergoing a continued northward expansion of its range.

New State Records. MISSISSIPPI, Harrison Co., Saucier, Little Biloxi Wildlife Management Area, 20 September 2012, 2 females. Jackson Co., Lucedale, Pascagoula River Wildlife Management Area, 25 September 2010, 1 female, same data except 21 September 2012, 3 females; Vancleave, Ward Bayou Wildlife Management Area, 27 September 2008, 5 females, 1 male, same data except 26 September 2010, 3 females, 1 male. Stone Co., Saucier, Little Biloxi Wildlife Management Area, 24 September 2010, 2 females; same data except 20 September 2012, 2 females, 1 male. Yalobusha Co., Water Valley, 11 August 2009, 1 female.

New County Records in Alabama, Florida and Georgia. ALABAMA, Elmore Co., Tallassee, Yates Lake West Wildlife Management Area, 13 September 2011, 1 female. Geneva Co., Kinston, Geneva State Forest Wildlife Management Area, 18 September 2010, 1 female. FLORIDA, Broward Co., Tamarac, Hillsboro Pineland Natural Area, 3 December 2008, 1 female. Clay Co., Green Cove Springs, Bayard Conservation Area, 20 July 2009, 7 females. Columbia Co., High Springs, O'Leno State Park, 1 October 2008, 6 females, 2 males. De Soto Co., Arcadia-1, 22 May 2008, 10 females, 1 male, same data except 15 February 2010, 4 females 1 male; Arcadia-2, 21 April 2008, 5 females, same data except 23 April 2008, 4 females, same data except 24 January 2011, 5 females; Arcadia-3, 1 March 2008, 1 female, same data except 20 October 2009, 7 females, same data except 21 October 2009, 2 females, 1 male; Arcadia, Morgan Park, 9 May 2011, 2 females, same data except 11 May 2011, 2 females; Arcadia, RV Griffin Reserve, 3 March 2008, 14 females, 21 males, same data except 4 March 2008, 7 females, 8 males, same data except 5 March 2008, 2 females, 10 males, same data except 14 June 2010, 5 females, same data except 16 June 2010, 3 females; Nocatee, 25 August 2009, 3 females, same data except 27 August 2009, 1 female. Martin Co., Stuart, Atlantic Ridge State Park, 18 October 2010, 1 female, same data except

19 October 2010, 2 females. Okeechobee Co., Okeechobee, Kissimmee Prairie Preserve State Park, 25 September 2008, 1 female. Pasco Co., Groveland, Green Swamp Wildlife Management Area, 3 July 2008, 2 females, 1 male; Land O' Lakes, Cypress Creek Preserve, 3 May 2010, 2 females, 1 male, same data except 4 May 2010, 1 female. Volusia Co., De Leon Springs, Lake George State Forest, 28 September 2009, 8 females. GEORGIA, Dooly Co., Vienna, Flint River Wildlife Management Area, 6 August 2012, 2 males. Long Co., Jesup, Griffin Ridge Wildlife Management Area, 22 September 2008, 1 female.

Culicoides (Monoculicoides) sonorensis Wirth and Jones

Culicoides variipennis sonorensis Wirth and Jones, 1957: 18 (Arizona).

Culicoides sonorensis: Holbrook et al. 2000: 70 (species status; genetic analysis of *C. variipennis* complex; distribution).

Culicoides (Monoculicoides) sonorensis: Borkent and Grogan 2009: 15 (in Nearctic catalog; distribution); Grogan et al. 2010: 27 (Florida records from Escambia, Jackson, and Jefferson counties).

Culicoides variipennis australis Wirth and Jones, 1957: 15 (Louisiana); Atchley 1967: 975 (as synonym of *C. v. sonorensis*); Holbrook et al. 2000: 70 (as synonym of *C. sonorensis*).

Culicoides variipennis albertensis Wirth and Jones, 1957: 17 (Alberta); Holbrook et al. 2000: 70 (as synonym of *C. sonorensis*).

Culicoides (Monoculicoides) variipennis: Blanton and Wirth 1979: 161 (Florida records, in part); Wilkening et al. 1985: 521 (Florida records, in part).

Culicoides occidentalis albertensis: Downes 1978: 63.

Culicoides occidentalis sonorensis: Downes 1978: 63.

Discussion. Wirth and Jones (1957) originally described *Culicoides sonorensis* as a subspecies of *C. variipennis* (Coquillett), and it was only recently recognized as a distinct species by Holbrook et al. (2000). Based on detailed electrophoretic and morphological analyses, Holbrook et al. concluded that the *C. variipennis* complex included three distinct species: *C. variipennis*, *C. occidentalis* Wirth and Jones, and *C. sonorensis* Wirth and Jones. In North America, *C. sonorensis* is the primary vector of BTV, but it also can vector EHDV (Mellor et al. 2004; Ruder et al. 2012), whereas *C. variipennis* is the primary vector of EHDV (Borkent 2004). However, *C. occidentalis* apparently does not vector either of these viruses (Holbrook et al. 2000). Females of *C. sonorensis* are readily distinguished from females of *C. variipennis* by their greatly swollen palpal segment 3 with a large, rounded sensory pit that is often partially subdivided, and males are the only species in this complex with a spiculate aedeagus (Holbrook et al. 2000).

Both *C. sonorensis* and *C. variipennis* are typically associated with livestock operations, and they can be extremely abundant at such sites (Kramer et al. 1985a; Schmidtman et al. 2000; WLJ, personal observations). *Culicoides sonorensis* is a wide-ranging species that inhabits western North America in British Columbia, Alberta, Washington, Montana, and South Dakota, south to California, Kansas, Texas, and Puebla, Mexico (Huerta et al. 2012). East of the Mississippi River, it occurs in scattered populations throughout the midwestern, southeastern, and middle Atlantic United States (Holbrook et al. 2000; Borkent and Grogan 2009). Because many publications that dealt with *C. sonorensis* were published before it was formally recognized as a morphologically and genetically distinct species, specific records for this vector are often difficult to find. However, Kramer et al. (1985b) conducted a study of cattle feedlots throughout Florida and were only able to collect species in the *C. variipennis* complex at sites in northern Florida and along the eastern coast, but few in the southernmost sites.

More recently, Grogan et al. (2010) re-examined slides of the *C. variipennis* complex from Florida primarily in the U. S. National Museum of Natural History, Washington, D. C. (USNM), and listed records of *C. sonorensis* from the panhandle region of that state. We provide the first records of *C. sonorensis* from Manatee and Sarasota counties, Florida, from livestock operations on the central Gulf coast of that state. We also provide several new records of *C. sonorensis* from Clarke County, Alabama that are unusual because they are from locations without livestock. Also included are new county records from Escambia, County, Alabama and Alachua County, Florida based on slide-mounted specimens in the synoptic collection of WLJ.

New County Records in Alabama and Florida. ALABAMA, Clarke Co., Jackson, Fred T. Stimpson Wildlife Management Area, 24 August 2011, 6 females; same data except 21 September 2011, 2 females; same data except 14 August 2012, 2 females. Escambia Co., Atmore, June 1962, F. S. Blanton, 1 male (WLG). FLORIDA, Alachua Co., Gainesville, Chantilly Acres, March 1967, F. S. Blanton, light trap, 1 female (WLG). Manatee Co., Bradenton, 26 May 2008, 1 female. Sarasota Co., Arcadia, 5 June 2008, 1 female.

***Culicoides (Oecacta) barbosai* Wirth and Blanton**

Culicoides barbosai Wirth and Blanton, 1956b: 161 (Panama; Bahamas, Ecuador, Florida).

Culicoides (Oecacta) barbosai: Vargas 1960: 44 (in review of New World subgenera of *Culicoides*); Blanton and Wirth 1979: 58 (Florida records; distribution); Wirth et al. 1985: 28 (in Nearctic Wing Atlas; distribution); Wilkening et al. 1985: 521 (Florida records); Borkent and Grogan 2009: 15 (in Nearctic catalog; distribution).

Discussion. *Culicoides barbosai* is a coastal, primarily Neotropical species that has been recorded throughout the Caribbean, Central America, and northern South America (Borkent and Spinelli 2007). It is very similar to the related *C. (O.) furens* (Poey), and was confused with that species until it was described by Wirth and Blanton (1956b). The wing of *C. barbosai* lacks the small circular pale spot found on *C. furens*, located distad of the large pale spot beyond the apex of the costal vein. It is a serious pest in some coastal communities of Florida and the Caribbean, as females readily and frequently bite humans (Linley and Davies 1971). It is typically associated with mangrove swamps, coral, coquina, and sandy beaches, and brackish tidal marsh habitats in Florida (Blanton and Wirth 1979). In North America, it has only been reported from Florida (Wilkening et al. 1985; Borkent and Grogan 2009), but present as far north as Duval County on the extreme northeastern Atlantic coast and Bay County on the Gulf coast (Blanton and Wirth 1979; Cilek and Kline 2002). We provide the first record of *C. barbosai* from Georgia in Dooly County, located in the southwestern interior portion of that state. This specimen was trapped at a site along the Flint River, a major tributary of the Apalachicola River which has a broad delta on the Gulf of Mexico in northwestern Florida. We also include several new county records of *C. barbosai* from Florida.

New State Record. GEORGIA, Dooly Co., Vienna, Flint River WMA, 6 August 2012, 2 females.

New Florida County Records. FLORIDA, Charlotte Co., Punta Gorda, Charlotte Harbor Preserve State Park, 8 June 2009, 3 females; same data except 9 June 2009, 1 female; Port Charlotte, Tippecanoe Environmental Park, 6 June 2011, 1 female. De Soto Co., Arcadia, 22 April 2008, 3 females. Hendry Co., Clewiston, 18 June 2008, 1 male. Pasco Co., New Port Richey, Starkey Wilderness Preserve, 12 June 2011, 1 female.

***Culicoides (Silvaticulicoides) loisae* Jamnback**

Culicoides (Oecacta) loisae Jamnback, 1965: 77 (New York; Maryland, Virginia, West Virginia); Blanton and Wirth 1979: 112 (Florida records; distribution); Wilkening et al. 1985: 521 (Florida records).

Culicoides loisae: Battle and Turner 1970: 426 (records from North Carolina); Wirth et al. 1985: 34 (in Nearctic Wing Atlas; in *C. biguttatus* group; distribution).

Culicoides (Beltranmyia) loisae: Battle and Turner 1971: 54 (Virginia records).

Culicoides (Silvaticulicoides) loisae: Borkent and Grogan 2009: 15 (in Nearctic catalog; Quebec, Canada; distribution).

Discussion. *Culicoides loisae* is a drab, dark brown midge with a grayish wing with little, if any, discernible pattern, and a very short proboscis (proboscis/head ratio about 0.50). In addition, as noted by Blanton and Wirth (1979), females lack mandibular teeth and have reduced tormae, and accordingly,

it is not haematophagous. Jamnback (1965) described this species from specimens collected in New York, Maryland, Virginia, and West Virginia. Soon after, Battle and Turner (1970) recorded it from North Carolina. By 1979, *C. loisae* had been found in all other southeastern coastal states as well as the western portion of the Florida panhandle (Blanton and Wirth 1979). More recently, Borkent and Grogan (2009) also listed it from Quebec, Canada. We provide the first record of *C. loisae* from Alabama, a female collected in Geneva County near the southeastern border of that state, adjacent to Holmes County, Florida.

New State Record. ALABAMA, Geneva Co., Kinston, Geneva State Forest Wildlife Management Area, 18 September 2010, 1 female.

Unplaced to Subgenus

Piliferus Species Group

Culicoides kirbyi Glick and Mullen

Culicoides kirbyi Glick and Mullen, 1983: 380 (Maryland; Alabama); Wirth et al. 1985: 24 (in Nearctic Wing Atlas; distribution); Borkent and Grogan 2009: 17 (in Nearctic catalog; distribution).

Discussion. *Culicoides kirbyi* is a relatively recently described and poorly known species, which seems to have a very specific emergence and peak population period. It was described by Glick and Mullen (1983) from specimens collected at two sites, in Lee Co. Alabama and Patuxent Wildlife Refuge, Prince Georges Co., Maryland (type locality). In Alabama, it has only been captured in mid-spring, during the last week of April and first week of May, and from mid- to late May in Maryland. This very narrow emergence period may explain why *C. kirbyi* is so rarely captured. Glick and Mullen (1983) noted that although its feeding habits were unknown, the fact that it possessed antennal sensilla coeloconica on eight flagellomeres suggested that it is ornithophilic. Glick and Mullen also indicated that *C. kirbyi* was most similar to the slightly darker *C. testudinalis* Wirth and Hubert, which has a similar wing with faint pale spots, but, is larger (female wing length 0.89–1.26 mm vs. 0.83–0.94 mm in *C. kirbyi*), with a longer proboscis (proboscis/head ratio 0.79 vs. 0.60–0.65 in *C. kirbyi*), and a more slender palpal segment 3 (palpal ratio 2.00–2.60 vs. 1.83–1.95 in *C. kirbyi*). We provide the first record of *C. kirbyi* from Mississippi, a female collected during the last week of April in the south-central region of that state.

New State Record. MISSISSIPPI, Marion Co., Columbia, Marion County Wildlife Management Area, 27 April 2009, 1 female.

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