



## A new species of Meadow Katydid (Orthoptera: Tettigoniidae: Conocephalini) from the Apalachicola River Basin of Florida, USA

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### Abstract

*Odontoxiphidium apalachicola*, **sp. nov.**, is described from seasonally flooded savannah habitats of the Central Panhandle of Florida. The new species differs from the only other member of the genus, *O. apterum* Morse, in morphology, coloration, calling song, and habitat. Color variation in *O. apterum* is also discussed. The new species appears to be a member of a unique insect fauna that is endemic to the Apalachicola River Basin, a well-known refugium and center for speciation in vascular plants. Continued exploration of this area is needed to fully document arthropod diversity in the region.

**Key words:** North American Coastal Plain, biodiversity, *Odontoxiphidium*

### Introduction

The North American Coastal Plain (NACP) was recognized as a global biodiversity hotspot by Noss *et al.* (2015), using a standard definition of over 1500 endemic plant species coupled with greater than 70% habitat loss in the region. Within the NACP, there are local concentrations of endemics which reflect such factors as glaciation cycles, large rivers as biogeographic barriers to gene flow, and the inherent patchiness of certain habitats. The Eastern Gulf Coastal Plain region of the southeastern USA, extending from southwest Georgia through northwest Florida and into southeast Louisiana, has been characterized as an important phytogeographic area for speciation and endemism. Sorrie and Weakley (2001) reported that 122 vascular plant species approximate this distribution. The presence of several large rivers in this region, along with the ecological effects of Pleistocene glaciation cycles, have resulted in a fascinating mix of endemics, as well as populations of traditionally northern and southern species. A unique subset of this region, the Central Panhandle of Florida, is confined to the six counties flanking the Apalachicola River. This area served as a major refugium during the Pleistocene, and the vascular plant fauna is filled with relict populations of species that occur primarily to the north and west, as well as a host of narrowly endemic species (Sorrie and Weakley 2001). The terrestrial arthropod fauna of the Apalachicola River basin has generally been poorly characterized, but those groups that have been studied show biogeographic patterns concordant with the documented plant diversity. Several species of spur-throated grasshoppers (Orthoptera: Acrididae: Melanoplinae) have clearly speciated in this region, with endemic members of the genera *Aptenopedes*, *Eotettix*, *Melanoplus*, and *Gymnoscirtetes* present in a number of different habitats ranging from dry, upland sandhills to seasonally flooded savannahs and pitcher plant bogs (Hill 2018, 2022; Otte 2014)

The katydid genus *Odontoxiphidium* Morse (Orthoptera: Tettigoniidae: Conocephalinae) was erected by Morse (1901) for a single species, *O. apterum* Morse, 1901. This species is unique among the North American Conocephalinae in its possession of two teeth on each cercus in the male, as well as the reduction of the wings, which are absent in the female and present in the male as shortened tegmina only. *O. apterum* has been reported across much of the southeastern USA, but primarily in Florida, where it is found in a wide variety of terrestrial habitats. Despite its flightless nature, populations across its range are quite homogenous in morphology, coloration, and calling song, indicating an ability for dispersal unmatched by many of the flightless, narrowly endemic grasshoppers of the region. This could be due to its usage of many habitat types, including roadsides, which allow populations to intermingle freely. In the course of fieldwork in Florida over summer 2022, I discovered a population of katydids that clearly belonged to *Odontoxiphidium*, but differed in several important respects from typical populations of *O. apterum*.

## Methods

*Sampling.* Specimens of the new species, as well as of *O. apterum*, were collected in Florida, USA, during the summers of 2021, 2022, and 2023. All specimens were collected either by tracking the songs of singing males, or by sweeping vegetation in the immediate vicinity of singers. At some locations, individuals of *O. apterum* were photographed but not collected; these records are described below in order to fill in the distribution map for that species.

*Determination.* Specimens were identified using Morse (1901) as members of the genus *Odontoxiphidium* based on the form of the male cerci.

*Measurements and terminology.* Measurements of the body (head to end of abdomen), pronotum, male tegmen, hind femur, and ovipositor were made to the nearest 0.5 mm using digital calipers (Mitutoyo Corp., Japan). Terminology follows Morse (1901).

*Photographs and maps.* Live adult katydids were photographed in a whitebox studio setup using a Canon EOS Rebel T3 with an attached Canon 100 mm macro lens, and an external flash (Sunpak Auto 383 Super connected with a CowboyStudio 4 Channel Wireless Hot Shoe Flash Trigger & Receiver). Images of the habitat were taken with an iPhone SE. Images of preserved specimens were made using a Visionary Digital LK Imaging System in combination with a Canon EOS 7D camera with attached 100mm macro lens (MP-E 65mm lens used for genitalia images). Images were stacked using Zerene Stacker v.1.04 (Zerene Systems LLC, Richland, WA). Adobe Photoshop CS5 Extended was then used to add a scale bar, adjust light levels, and increase sharpness. Images were also processed using Adobe Lightroom CC 2015.8 to crop, adjust white balance, and remove sensor dust. Composite figures were created using Adobe Photoshop CC, v.14.2.1. Maps were created with SimpleMappr (Shorthouse 2010). GPS data were acquired using Google Maps.

*Sound recordings and mating trials.* Live adult katydids (one male and one female of *O. apterum*, and seven males and one female of the new species), all from the type locality of the latter, were maintained alive in a shaded room at 28 °C; each individual was housed singly inside plastic containers (6.5 x 6.5 x 9.5 cm). The clear plastic allowed for close observation and the size of the cages facilitated interactions between pairings of insects. Fresh carrot, lettuce, and fish flakes were provided *ad libitum*, and cages were cleaned every other day. Recordings were made using an Amazon Kindle Fire with a connected Echo Meter Touch 2 (Wildlife Acoustics, Maynard, MA), and were analyzed using Audacity 3.5.1. During recording sessions (September 6th and 7th, and July 4th, 2023), the solid plastic container lids were replaced with a wire mesh lid to facilitate better recordings. To make preliminary observations of potential prezygotic barriers, different pairings of males and females of *O. apterum* and the new species (all from the same locality) were made. Specifically, I looked at the time taken for conspecific pairings to progress to attempted mating, whether heterospecific pairings resulted in attempted mating or not, and whether heterospecific pairings caused males to sing either a courtship or aggression call. Observations were made starting at 4:15pm on August 20, 2023. All individuals were fed fresh carrot, lettuce, and fish flakes two hours prior to the observations. Due to the small number of available individuals, only qualitative observations were made.

*Depository.* All specimens, including types, are deposited in the Texas A&M University Insect Collection (TAMUIC), College Station, Texas, USA.

## Results

### Taxonomy

#### Genus *Odontoxiphidium* Morse 1901

Type species: *Odontoxiphidium apterum* Morse, by original monotypy Morse. 1901. *Canadian Entomologist* 33(5):129.

Etymology: From *odonto* = relating to a tooth or teeth, and *Xiphidium*, an old name for members of *Conocephalus* Thunberg 1815.

Diagnosis (from Morse 1901): “Allied to *Xiphidium* [sic], from which it is probably derived. Distinguished from that genus by the form of the anal cerci of the male, which are elongate, straight, with the lateral tooth reduced in size, and an additional tooth upon the dorsal side near the base; and, in the type, by the form of the pronotum,

which is sub-sellate and prolonged backward, covering the base of the abdomen both above and on the sides, in correlation with the absence of flight-organs”.

Updated diagnosis of the genus: Similar to members of *Conocephalus*, differing primarily in the morphology of the male cerci and tegmina. Prosternum armed with two short spines. Pronotum without lateral carinae, posteriorly covering abdominal base. Two narrow longitudinal stripes present on dorsal pronotum, ranging from white to turquoise in life. Exposed portion of male tegmina  $\frac{2}{3}$  as long as pronotum; male hind wings absent; tegmina and wings absent in female. Hind femora thickened at base, with dark maculation, hind knees black. Male cerci straight and evenly tapering, bearing two lateral, inwardly directed teeth; basalmost tooth extremely short, about  $\frac{1}{5}$  length of distal tooth. Male subgenital plate not extending past basalmost cercal tooth, bearing two short styli. Titillator sclerite elongated, gently curving; apices slightly expanded and bearing small dark teeth. Female cerci conical, tapered at apex. Ovipositor shorter than hind femur, mostly straight throughout basal and middle sections, gently upcurved or downcurved at apex. Female subgenital plate broadly rounded, bilobed, with lobes forming a rounded notch at apex.

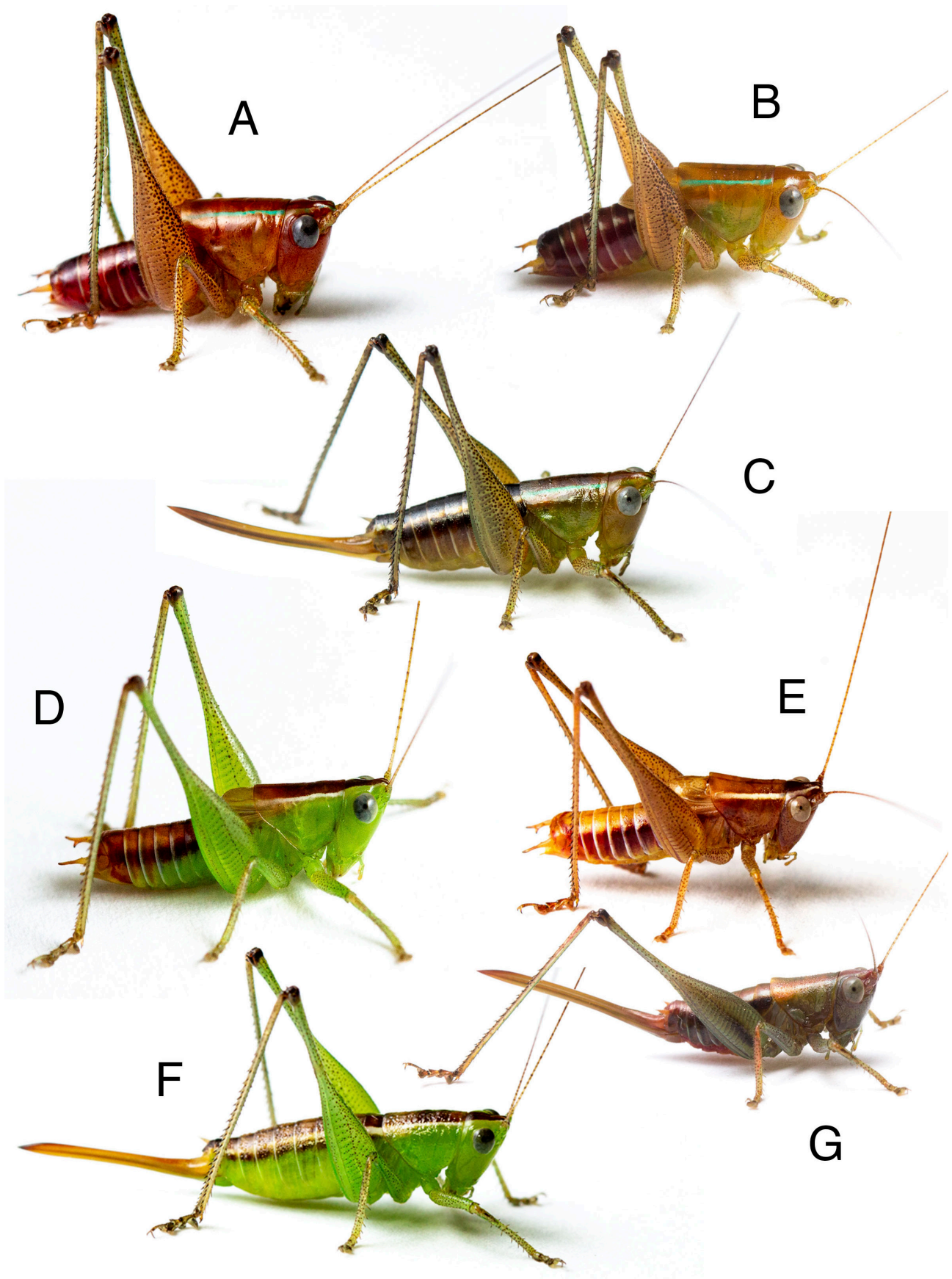
### *Odontoxiphidium apterum* Morse 1901. Figs. 1(D–G), 3, 5, and 6 (D–F)

*Type information.* The type series described by Morse (1901) consisted of 12 males, 15 females, and two nymphs from “Hastings, Florida” [St. Johns County] collected by Brown between August 15th and September 5th (year unspecified), and one female from “Sandford, Florida” [Sanford, Seminole County, Florida] collected by G.B. Frazer, with no collection date given. The deposition of these specimens is not given, but the majority of Morse’s collection is curated at the Museum of Comparative Zoology (MCZ) of Harvard University (Dow 1937), and the MCZ online type database shows at least one *O. apterum* specimen with type number 15749.

*Etymology.* From Latin *apterus*, wingless.

*Distribution.* Southeastern USA: Florida, Mississippi, Alabama, Georgia, South Carolina, and the southernmost counties of Tennessee and North Carolina.

*Material examined.* USA, Florida • 1 ♂; Clay County: Mike Roess Gold Head Branch SP: 29.843, -81.947; 15 July 2022; B. Woo and L. Chen leg.; open sandhill with scrub close by; specimen in ethanol • 1 ♂; Collier County: Rookery Bay NERR-Shell Island Rd. uplands: 26.02293, -81.711023; 27 June 2023; B. Woo leg.; scrub habitat; specimen in ethanol • 2 ♂; Columbia County: Osceola NF: 30.276447, -82.483788; 22 June 2023; B. Woo leg.; specimens in ethanol • 1 ♂; Escambia County: Big Lagoon SP: 30.311195, -87.406587; 19 June 2023; B. Woo leg.; coastal dune scrub; specimen in ethanol • 1 ♀; Highlands County: Archbold Biol. Station; 27.177, -81.353; 02 Jul. 2023; J.B. Linde leg.; dry pinned specimen • 2 ♂; Highlands County: Sebring, Highlands Hammock State Park, Kosovo Pavilion; 27.468317, -81.526733; 26 May 2011; Song, Raszick, Gotham, Coello, Alava, Shaibu, Maragh leg.; open pine flat; dry pinned specimens • 1 ♂; Highlands County: Sebring, Highlands Hammock State Park: 27.482117, -81.532333; 27 May 2011; Song, Raszick, Gotham, Coello, Alava, Shaibu, Maragh leg.; dry pinned specimens • 5 ♀, 4 ♂; Leon County, Tallahassee, Apalachicola National Forest; 30.35315, -84.2612133333; 09 August 2021; H. Song and B. Woo leg.; dry pinned specimens • 1 ♂; Liberty County: Hosford: 30.404353, -84.820855; 11 July 2023; B. Woo leg.; specimen in ethanol • 1 ♂; Liberty County: Apalachicola NF, County Road 379, 1 mi N Sumatra: 30.033228, -84.994613; 11 July 2023; B. Woo leg.; dry pinned specimen • 2 ♀, 3 ♂; Marion County: Fort McCoy, Hopkins Prairie, nr lake wetland; 29.269917, -81.697533; 03 August 2021; H. Song and B. Woo leg.; specimen in ethanol • 1 ♂; Marion County: Cross-Florida Greenway Triangle: 29.067, -82.181; 01 July 2022; B. Woo leg.; overgrown scrub; specimen in ethanol • 1 ♂; Orange County, UCF Arboretum; 28.599117, -81.188353; 17 May 2011; Song, Raszick, Alava, Shaibu, Maragh leg.; dry pinned specimen • 1 ♀, 1 ♂; Orange County: Apopka, Wekiva Springs State Park, near Sand Lake: 28.722767, -81.473017; 31 May 2011; Song, Alava, Shaibu leg.; open scrub; dry pinned specimens • 2 ♀, 1 ♂; Osceola County, Kissimmee, The Disney Wilderness Preserve; 28.083800, -81.393950; 03 June. 2011; Song, Raszick, Gotham, Bitzel-Jaffe, Coello, Maragh, Alava, Shaibu leg.; dry pinned specimens • 1 ♂; Polk County: Allen David Broussard Catfish Creek Preserve SP: 27.983, -81.495; 21 June 2022; B. Woo leg.; yellow sand scrub; specimen in ethanol • 1 ♂; Polk County: Lake Marion Creek: 28.113966, -81.550799; 26 June 2023; B. Woo leg.; yellow sand scrub; specimen in ethanol • 1 ♀; Sarasota County: Oscar Scherer SP: 27.176, -82.460; 25 June 2022; B. Woo leg.; specimen in ethanol • 2 ♂, 1 ♀, 1 nymph ♂; Washington County: Chipley--Whitewater Lakes: 30.483358, -85.552095; 17 June 2023; B. Woo leg.; white sand rim of karst lake; specimens in ethanol.



**FIGURE 1.** Habitus images of live adult individuals of *Odontoxiphidium* spp. A-C, *O. apalachicola*. A) and B), color variations of male; C) female. D-G, *O. apterum*. D and E, color variations of male; F and G, color variations of female.

*Photo records.* USA, Georgia • 1 ♂; Emanuel County: Ohoopce Dunes SNA, Halls Bridge Rd. tract: 32.534195, -82.4589216667; 19 July 2022; B. Woo leg.; photograph; USA, Alabama • 1 ♂; Baldwin County: vacant lot near Gulf SP: 30.2618783333, -87.6242216667; 16 June 2023; B. Woo leg.; photograph; USA, Florida • 1 ♂; Alachua County: Palm Point Park: 29.6366916667, -82.2390366667; 08 July 2022; B. Woo leg.; photograph • 1 ♂; Bay County: St. Andrews SP: 30.1322945, -85.7400966667; 25 July 2022; B. Woo leg.; photograph • 1 ♀; Brevard County: Merrit Island, Scrub Jay trail: 28.6939583333, -80.715775; 05 June 2022; B. Woo leg.; photograph • 1 ♂, Brevard County: Cruickshank Sanctuary: 28.2981716667, -80.7105116667; 06 June 2022; B. Woo leg.; photograph • 1 ♀, Clay County: Camp Blanding: 29.84098, -81.9766466667; 10 July 2022; B. Woo leg.; photograph • 1 ♂, Escambia County: Perdido Key SP: 30.2939716667, -87.4670866667; 16 June 2023; B. Woo leg.; photograph • 1 ♂ nymph, Franklin County: Bald Point SP: 29.91455, -84.3378916667; 21 July 2022; B. Woo leg.; photograph • 1 ♂, Franklin County: Tate's Hell SF: 29.792045, -84.7680666667; 21 July 2022; B. Woo leg.; photograph • 1 ♂ nymph, Glades County: Fisheating Creek: 26.9421216667, -81.320275; 20 June 2022; B. Woo leg.; photograph • 1 ♂, Hernando County: Suncoast Trail: 28.6798164844, -82.5089471132; 26 June 2022; B. Woo leg.; photograph • 1 nymph, Hernando County: Weeki Wachee Springs SP: 28.5275976052, -82.589004016; 01 July 2022; B. Woo leg.; photograph • 1 ♂, Hernando County: Hill 'N Dale, Withlacoochee SF: 28.538625, -82.2730633333; 01 July 2022; B. Woo leg.; photograph • 1 ♂, Hillsborough County: Little Manatee River SP: 27.6585366667, -82.3737416667; 19 June 2022; B. Woo leg.; photograph • 1 ♂ nymph, Lafayette County: 13 km N Steinhathee: 29.8244883333, -83.31517; 12 July 2022; B. Woo leg.; photograph • 1 ♂, Lee County: Estero Bay Buffer Preserve: 26.4415966667, -81.8407833333; 16 June 2022; B. Woo leg.; photograph • 1 ♂, Levy County: Goethe SF: 29.3573166667, -82.6026; 06 July 2022; B. Woo leg.; photograph • 1 ♀, Liberty County: Torreya SP: 30.561675, -84.9479; 22 July 2022; B. Woo leg.; photograph • 1 ♀, Manatee County: Lake Manatee SP: 27.481175, -82.3425916667; 19 June 2022; B. Woo leg.; photograph • 1 ♀ nymph, Martin County: Jonathan Dickinson SP: 27.0132722167, -80.12265; 11 June 2022; B. Woo leg.; photograph • 1 ♂, Okaloosa County: Okaloosa county rest stop on I-10: 30.7262947043, -86.5038842976; 02 August 2021; B. Woo leg.; photograph • 1 ♂, Okaloosa County: Henderson Beach SP: 30.38468, -86.4481416667; 25 July 2022; B. Woo leg.; photograph • 1 ♀, Palm Beach County: Jupiter Ridge Natural Area: 26.9176013395, -80.0744614384; 11 June 2022; B. Woo leg.; photograph • 1 nymph, Polk County: Lake Blue scrub: 28.0460166667, -81.7832866667; 24 June 2023; B. Woo leg.; photograph • 1 ♀ nymph, Polk County: Horseshoe scrub tract: 28.1561305, -81.5606083333; 26 June 2023; B. Woo leg.; photograph • 1 ♀, Putnam County: Etoniah Creek SF: 29.7807366667, -81.8728866667; 09 July 2022; B. Woo leg.; photograph • 1 ♀, Seminole County: Little Big Econ SF: 28.6729866667, -81.1145638333; 14 July 2022; B. Woo leg.; photograph • 1 ♂, Seminole County: Chuluota Wilderness area: 28.6223283333, -81.0631721667; 14 July 2022; B. Woo leg.; photograph • 1 ♂, St. Johns County: Moses Creek West trailhead: 29.760605, -81.2959883333; 05 June 2022; B. Woo leg.; photograph • 1 ♂, Walton County: Topsail Hill Preserve SP: 30.3613033333, -86.285745; 25 July 2022; B. Woo leg.; photograph

*Variation.* This species varies considerably in size (Rehn & Hebard 1907), and specimens from the Florida Keys and extreme south Florida average larger than material from Georgia and northern Florida (Rehn & Hebard 1914). A description of color variation comes from Rehn and Hebard (1907), who describe the only notable color variations as occurring in the intensity of the median dorsal dark band and in the brown suffusion of the limbs. The author has documented a somewhat wider spectrum of color variation, with the extreme being insects with a brownish suffusion over the entire body (Fig. 1D–G), with any dull green coloration restricted to the tibiae. Most specimens, regardless of their color in life, fade to a dull yellow or brown after death, whether pinned or in ethanol. Brown individuals, although possessing proportionately larger eyes in relation to their heads than green individuals, otherwise agree morphologically with typical *O. apterum*, and their songs appear identical. Brown *O. apterum* have so far only been found in areas of xeric scrub habitat. Specimens with intermediate color patterns can be found at the ecotones of scrub and adjacent habitats such as sandhills or flatwoods, indicating gene flow between these populations.

*Song.* The song of *O. apterum* (Fig. 6D–F) is quite variable (even among males from the same locality) and consists of a series of high-pitched buzzes of varying length. The number of pulses in each song varies immensely. Typical songs last between 4–16 seconds, with 3–4 seconds between songs. For two recorded males, carrier frequencies were 19488 and 22638 Hz, with additional harmonics at 54440, 62445, 68675, 74484 Hz in the second male. Males seem to sing both day and night.

*Habitat.* Rehn and Hebard (1907) note that the species is versatile in habitat preference in northern Florida, ranging from ‘dry palmetto scrub and undergrowth in pine woods to grassland, to tall fresh marsh grass and salt marsh’. Rehn and Hebard (1916) report the species as ‘one of the most ubiquitous species of the pine woods

undergrowth and palmetto flats in the Carolinas, Georgia, and Florida'. They note that it is often abundant around 'oak shoots' in these habitats. During the present fieldwork, this species was collected in many different habitats, including scrub, sandhill, flatwoods, old fields, and roadsides. It never seemed to be associated with any particular plant taxa.

*Odontoxiphidium apalachicola*, n. sp. Figs. 1 (A–C), 2, 3, 4, 6 (A–C)

*Etymology.* Named for the Apalachicola National Forest, the major stronghold of this species.

*Proposed Common Name.* Apalachicola Meadow Katydid

*Material examined.* Holotype: USA • ♂; Florida: Liberty County: Apalachicola NF, County Road 379, 1 mi N Sumatra: 30.033228, -84.994613; 11 July 2023; B. Woo leg.; dry pinned specimen. Allotype: USA • ♀; Florida: Liberty County, same information as holotype; dry pinned specimen. Paratypes: USA • 3 ♂, Florida: Liberty County: same location as holotype; 23 July 2022; B. Woo and L. Chen leg.; specimens in ethanol • 8 ♂, Florida: Liberty County: same information as holotype; 2 specimens in ethanol and 6 dry pinned specimens • 2 ♂, Florida: Franklin County: Tate's Hell SF, FR-165: 30.010506, -84.935287; 11 July 2023; B. Woo leg.; wet savannah; dry pinned specimens.

*Diagnosis.* The form of the male cerci, with two subapical teeth, and the shorter length of the male tegmina relative to the pronotum, distinguishes this species from all but *O. apterum*. It can be easily separated from that species by the distinctive coloration in life, the male calling song, and the overall more robust morphology, as well as the shape of the female ovipositor.

*Measurements (mm).* Body (head to end of abdomen): ♂, 11–15.4; ♀, 15.9; pronotum: ♂, 3.5–5; ♀, 4.5 mm; tegmen: ♂, 3.1–4.1; hind femur: ♂, 10.7–12.1; ♀, 11.8 mm; ovipositor: ♀, 10.6 mm.

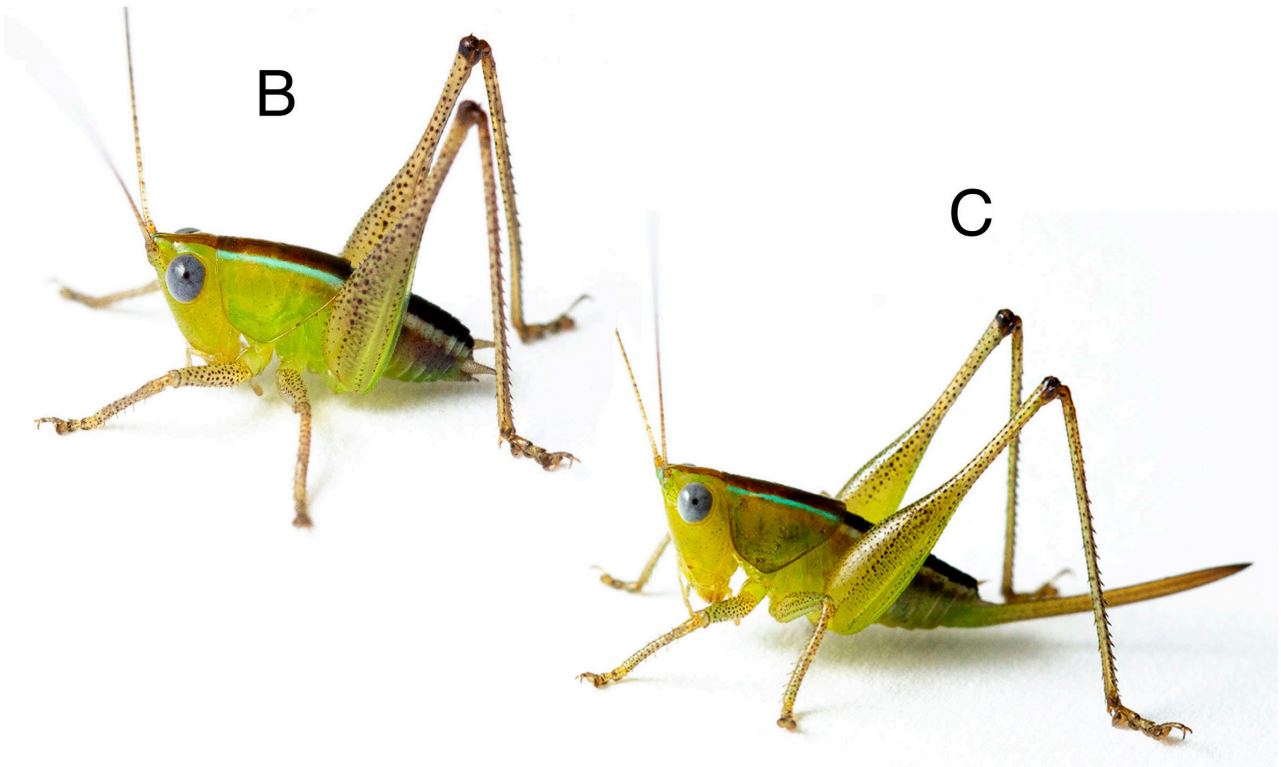
*Description.* Male. Overall morphology similar to *O. apterum*. Eyes and head proportionately larger than in *O. apterum*: interocular space  $\frac{3}{4}$  length of fastigium. Pronotum lacking lateral carinae; posterior margin of lateral lobe very slightly convex, lacking sinuosity as seen in *O. apterum*. Exposed portion of tegmina  $\frac{2}{3}$  as long as pronotum. Hind femora stout, almost bulbous at base. Cerci straight and evenly tapering, slightly shorter in length than the last two segments on the dorsum; lateral, inwardly directed tooth  $\frac{2}{3}$  as long as apex of cercus and borne at base of distal third; stem of cercus bearing an additional small tooth about midway between the lateral tooth and the base. Supra-anal plate bilobed, not quadrate. Subgenital plate longer than its width, emarginate at apex, bearing two short styli. Titillator sclerite elongated, gently curving; apices slightly expanded and bearing small dark teeth.

Female. Similar to male in overall structure. Tegmina and wings absent. Cerci simple conical, strongly tapered at tip (more so than in *O. apterum*). Ovipositor gently curving upward (gently downcurved in *O. apterum*). Subgenital plate broadly rounded, bilobed, with lobes forming a rounded notch at apex.

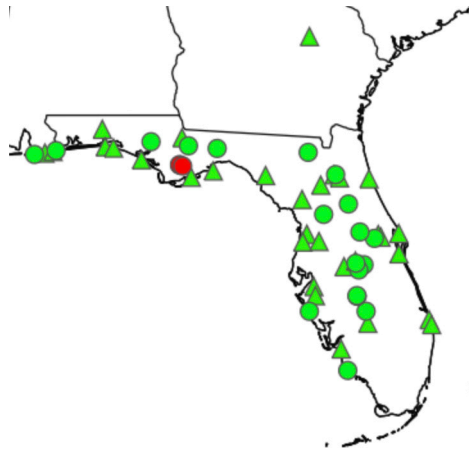
*Coloration in life* (Fig. 1). Male. Head light yellow-orange overall with dark speckling on the face. Eyes dull bluish grey. Burnt rusty orange stripe on fastigium bordered on each side by two greenish yellow stripes. Pronotum dorsally burnt rusty orange, with two narrow longitudinal stripes of a brilliant turquoise; lateral lobes orange but grading into yellow-green, with minute black speckling. All limbs with dense dark maculation (much more so than in *O. apterum*); femora pale orange; tibiae and tarsi greenish; hind knees black. Tegmina pale orange and shiny. Abdomen burgundy with cream edges to tergites, which form spots laterally before disappearing dorsally; last two abdominal segments dark maroon. Cerci yellow-orange with dark apices.

Female. Pattern similar to male, but darker brown overall. Head greenish brown; antennal bases dull green. Eyes bluish grey. Rusty brown stripe on fastigium bordered on each side by two yellowish green stripes. Pronotum dorsally very dark rusty, with two narrow longitudinal stripes of a bright malachite color; lateral lobes dull green, edged with brown. All limbs with dense dark maculation; femora light brown with greenish tinge; tibiae and tarsi light brown; hind knees black. Abdomen dark brown dorsally, light brown laterally, two creamy dorsal stripes extend from pronotum to cerci. Cerci yellow-brown; ovipositor reddish brown, paler yellow in middle portion.

*Song.* The male calling song (Fig. 6A–C) consists of a series of one to four short, high-pitched buzzes with three seconds between each set of buzzes. The song is quite consistent and easily distinguished from that of other katydids, including *O. apterum*, in the field. Among seven singing males that were recorded, carrier frequencies ranged between 18318 to 23723 Hz, but the song has several additional harmonics; for one male, these were at 54031 and 68786 Hz. In the field, males sang during the day in full sunlight; in the lab, most singing was again conducted during the day, with only intermittent singing at night.



**FIGURE 2.** Habitat and live nymph photos of *Odontoxiphidium apalachicola*. A) Seasonally flooded savannah habitat at the type locality (Liberty County, FL). B) Nymph male. C) Nymph female.



**FIGURE 3.** Distribution map of *Odontoxiphidium* specimens studied during this work. Red circles=specimen records of *O. apalachicola*. Green circles=specimen records of *O. apterum*. Green triangles=photo records of *O. apterum*.

*Habitat.* All known specimens have been taken in seasonally flooded savannahs with pitcher plants (Fig. 2A). Surrounding habitat is primarily longleaf pine woods or dense cypress swamps, where the songs of these katydids were not heard. Typical flora at the type locality included pondcypress (*Taxodium ascendens*), ten-angled pipewort (*Eriocaulon decangulare*), coastal plain St. John's Wort (*Hypericum brachyphyllum*), Carolina redroot (*Lachnanthes caroliana*) sandswamp whitetop sedge (*Rhynchospora latifolia*), cross-leaved milkwort (*Polygala cruciata*), grassleaf Barbara's-Buttons (*Marshallia graminifolia*), and pink sundew (*Drosera capillaris*). Other orthopterans present at the type locality and represented by voucher specimens in the TAMUIC include: *Dichromorpha viridis* (Scudder 1862), *Dichromorpha elegans* (Morse 1896), *Chortophaga australior* Rehn & Hebard 1911, *Aptenopedes appalachee* Hebard 1936, *Eotettix pusillus* Morse 1904, *Gymnoscirtetes rex* Hill 2022, and *Paroxya atlantica* Scudder 1877. The Franklin county locality is a powerline cut, with similar floral composition to the type locality.

Interestingly, both *O. apterum* and the new species were present at the type locality, but clearly segregated by habitat. *O. apterum* occurred along the grassy road margins, while *O. apalachicola* dominated in the wet savannah just a few feet away. Neither species was seen or heard in the domain of the other.

*Additional photo records.* Photographs of katydids from the counties bordering the Apalachicola River and posted to iNaturalist and BugGuide were examined in search of any additional records of the new species. Three images were found that seem to represent nymphs of this species based on overall morphology and coloration (matching that of nymphs collected at the type locality and reared to adulthood), as well as presumed habitat. The data for these records is as follows:

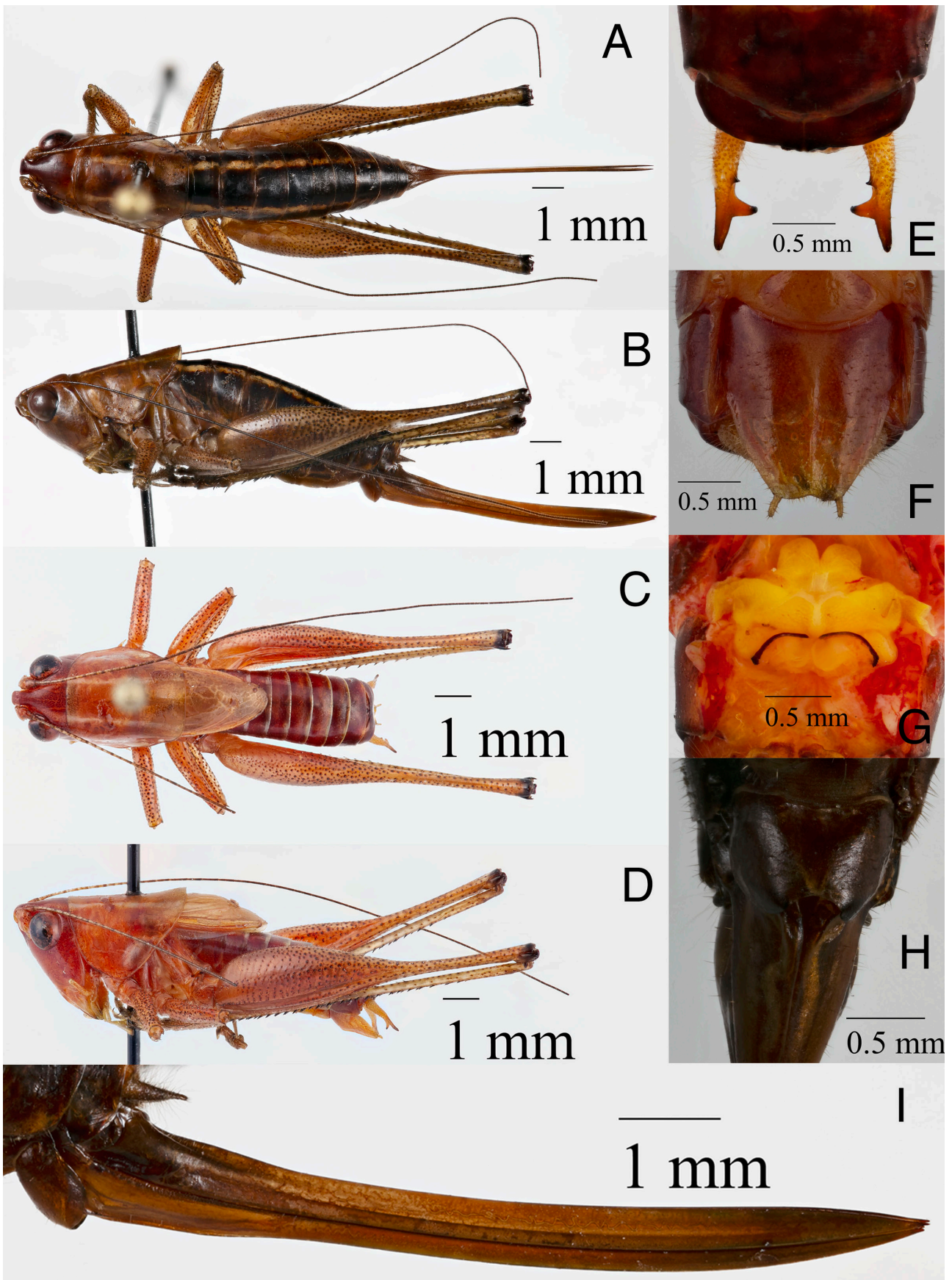
USA • 1 ♂ nymph, Florida: Liberty County: 3 km E intersection of Co. Rd. 379 and NF Rd 115: 30.0831027778, -85.0032583333; 04 September 2020; L. Gaudette; <https://www.inaturalist.org/observations/61146233>; 1 nymph, 500 m E intersection of Co. Rd. 379 and NF Rd 123: 30.0584, -85.0156111167; 21 April 2024; K. Guin; <https://www.inaturalist.org/observations/208984007>; 1 nymph, Apalachicola National Forest (general locality pin); 21 April 2024; P. and K. Connolly; <https://www.inaturalist.org/observations/210346580>

*Mating trials.* Following are descriptions of the behavior of adult male and females of *O. apterum* and *O. apalachicola* when placed together.

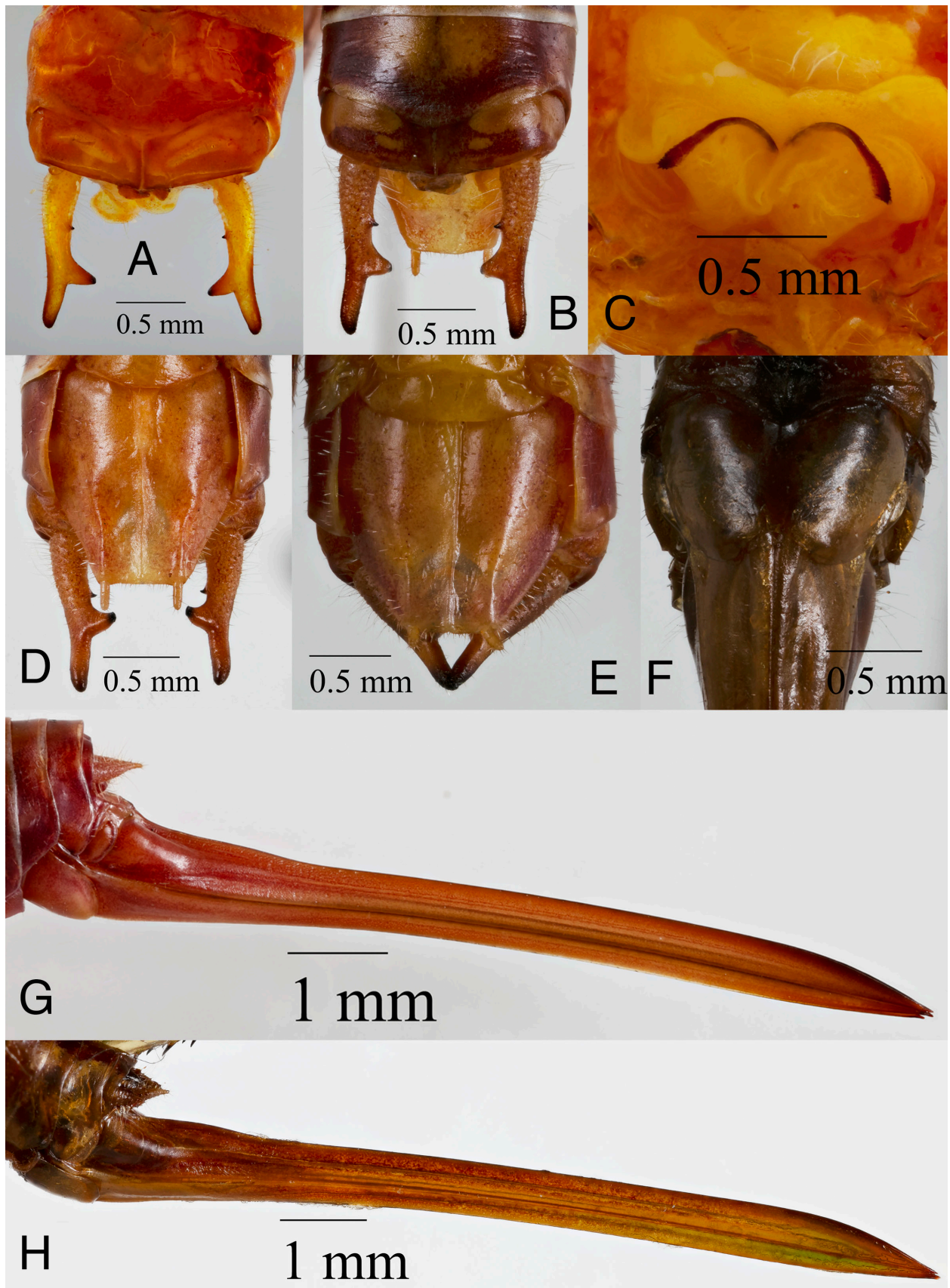
*O. apterum* male with *O. apterum* female: The pair immediately began antennating and tremulating, and the male began to sing a broken version of the normal song (presumably a courtship song). Within five minutes, they attempted pairing and were separated.

*O. apalachicola* male with *O. apalachicola* female: The male and female stayed on opposite sides of the cage after first being introduced, apparently not noticing each other. The female approached the male after 30 minutes, who upon contact immediately began tremulating and singing a courtship song. Although the female seemed to become receptive more slowly than in the case of the conspecific pairing of *O. apterum*, they did attempt pairing and were then separated.

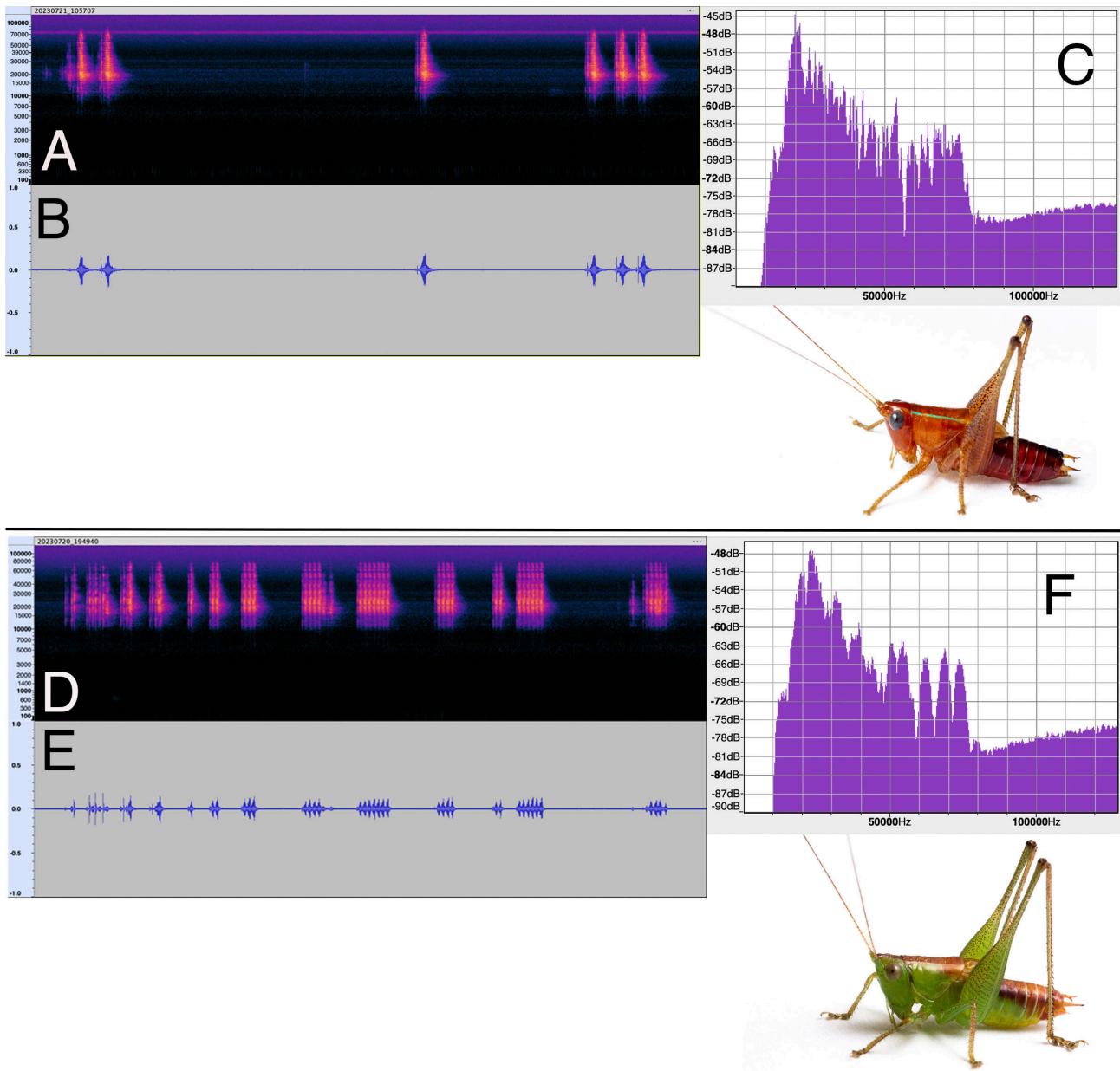




**FIGURE 4.** *Odontoxiphidium apalachicola*, holotype male and allotype female. A-D, dorsal and lateral habitus views of female (A-B) and male (C-D); E) Male cerci. F) Male subgenital plate. G) Titillator. H) Female subgenital plate. I) Ovipositor.



**FIGURE 5.** *Odontoxiphidium apterum*. A) Male cerci (Apalachicola NF, Liberty Co.). B) Male cerci (Whitewater Lakes, Washington Co.). C) Titillator (Apalachicola NF, Liberty Co.). D) Male subgenital plate (Whitewater Lakes, Washington Co.). E) Male subgenital plate (Osceola NF, Columbia Co.). F) Female subgenital plate (Disney Wilderness Preserve, Osceola Co.). G) Ovipositor (Oscar Scherer SP, Sarasota Co.). H) Ovipositor (Disney Wilderness Preserve, Osceola Co.).



**FIGURE 6.** Calling songs of *Odontoxiphidium*. A-C, *O. apalachicola*. A) Spectrogram of an echeme sequence. B) Waveform of same. C) Power spectrum. D-F, *O. apterum*. D) Spectrogram of an echeme sequence. E) Waveform of same. F) Power spectrum.

*O. apterum* male with *O. apalachicola* female: Upon contact, the pair antennated briefly and then moved to opposite sides of the cage. After 20 minutes, the male *O. apterum* began singing a typical calling song. After another 30 minutes had passed with no interactions, the pair were separated.

*O. apalachicola* male with *O. apterum* female: Upon contact, the pair began antennating and tremulating. The male did not sing at all throughout. After two minutes, the male *O. apalachicola* began attempting to approach the female and occasionally curved his abdomen as if to mate, but the female *O. apterum* seemed generally unresponsive and continuously moved away from him. Fifteen minutes later, the male managed to nearly attempt a pairing before being separated.

*O. apalachicola* male with *O. apterum* male: For two minutes, both males sat unmoving on opposite sides of the cage. The *O. apalachicola* male eventually approached the *O. apterum* male and seemed to actively pursue him in an aggressive manner. After five minutes of this behavior, the *O. apterum* male dropped to the bottom of the cage and began to feed on carrot, while the *O. apalachicola* male climbed to the top of the cage and began to

sing a short, harsh series of buzzes (presumably an aggression call, as it was quite different from the typical calling song as well as the presumed courtship song heard in a prior trial). Ten minutes later, the *O. apterum* male began to climb upwards and re-encountered the *O. apalachicola* male, who immediately commenced pursuit again. The *O. apalachicola* male continuously oriented towards and walked quickly in the direction of the *O. apterum* male, all while tremulating vigorously and uttering the aggression call. The pair was separated after 30 minutes.

## Discussion

The discovery of this new species adds yet another endemic to the already rich flora and fauna of the Apalachicola River basin and shows that even large, reasonably conspicuous arthropods still lack proper surveys in this region. Despite the wide-ranging nature of *O. apterum* and the overall lack of morphological variation across its range, it is clear that there is potential for speciation if populations are isolated. Color variation across Florida populations is more extensive than previously thought; however, no individuals I have seen approach the coloration or distinct morphology of the new species. The presence of brown form *O. apterum* in xeric scrub habitats warrants further investigation as to whether the species has any population structure across Florida's upland ecosystems. A population genetic study of *Odontoxiphidium*, with samples from across its range and within varying habitat types, would surely yield interesting results as to the biogeography of this unique taxon. A phylogeny of the North American Conocephalini would help to place those results in a broader context of the radiation of meadow katydids in the New World.

Populations of *O. apterum* and *O. apalachicola* seem to maintain their integrity even though the introduction of roads has surely allowed *O. apterum* to invade the limited range of *O. apalachicola*. The two species do not overlap in habitat, and even if they were to meet along ecotones, some behavioral prezygotic barriers appear to be present. Although the mating trials described herein were necessarily preliminary, and subject to bias due to individual personality traits of the katydids, some tentative conclusions can be drawn. Conspecific pairings progressed quickly to attempted mating, whereas heterospecific pairings resulted in little to no interaction between the two species. It certainly seems possible that a heterospecific pairing could occur and result in a successful population, but whether viable hybrid offspring would be produced is unknown. *O. apalachicola* males appeared to be overall more aggressive, whether in mating attempts or in territorial interactions. Perhaps their dominance over *O. apterum* males helps maintain spatial isolation between their populations.

The complete distribution of *O. apalachicola* is not yet known, but current records suggest that it is limited to the Central Panhandle of Florida, in seasonally flooded savannahs. The only other orthopteran with this distribution is *Gymnoscirtetes rex*, a recently (2022) described species that co-occurs with *O. apalachicola*. This species is known only from Bay, Calhoun, Franklin, Gulf, and Liberty counties, and occurs in sandhills, savannahs, and pitcher plant bogs. Similar habitats in these counties might be searched for the presence of *O. apalachicola*.

Much of the vascular plant flora of the Apalachicola River basin is considered of conservation concern due to restricted geographic ranges and high levels of habitat destruction. The known range of *O. apalachicola* lies entirely within the bounds of the Apalachicola National Forest and Tate's Hell State Forest, where it seems to be abundant in proper habitat. Its future appears relatively secure so long as pitcher plant savannahs and bogs are maintained in their current state. Even so, it might be prudent to examine factors that could lead to the degradation of these habitats and potentially impact *O. apalachicola* as well as the many other interesting species that occur there.

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