

A NEW SPECIES OF *MELANOPLUS* (ORTHOPTERA:
ACRIDIDAE) FROM AN ISOLATED UPLAND IN PENINSULAR
FLORIDA

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ABSTRACT

A new species of flightless acridid grasshopper, *Melanoplus withlacoocheensis* n. sp., is described from an isolated upland, the Southern Brooksville Ridge, in west central peninsular Florida. It occurs in open sandhill habitat. It appears to be closely related to *Melanoplus rotundipennis* Scudder, which is widespread in sandhill and Florida scrub habitats in central and northern peninsular Florida; the species are distinguished by details of the male cerci and genitalia. The new species is one of several species of flightless *Melanoplus* in Florida whose geographic ranges are small and biogeographically revealing. The new species is the first clear biological indicator of the long-term isolation of the Southern Brooksville Ridge from other uplands, including the Northern Brooksville Ridge.

Key Words: flightless grasshoppers, biological islands, speciation

RESUMEN

Una nueva especie de saltamonte que no vuela de la familia Acrididae es descrita en esta publicación. Este saltamonte no volador (*Melanoplus withlacoocheensis* n. sp.) fue encontrado en una zona aislada de tierras relativamente altas llamada "Southern Brooksville Ridge" en el interior centro occidental de la península de Florida. Esta especie se encuentra en un hábitat de dunas arenosas. *Melanoplus withlacoocheensis* está cercanamente relacionada a la especie *Melanoplus rotundipennis* Scudder, la cual está ampliamente distribuida en los hábitats de dunas arenosas y de arbustos del centro y norte de Florida. Estas dos especies se pueden distinguir por estructuras de los genitales y los cercos de los machos. *Melanoplus withlacoocheensis* es una de varias especies que no vuelan de este género, las cuales se encuentran distribuidas en rangos geográficos pequeños en Florida, biogeográficamente significativos. Esta nueva especie constituye el primer obvio indicador de un largo aislamiento del área "Southern Brooksville Ridge" de otras tierras altas de Florida, que incluyen el área llamada "Northern Brooksville Ridge".

With the increased interest in the taxonomy and distribution of the insects of North America, biogeographers have identified peninsular Florida as an area of endemism (Allen 1990). Florida is believed to have emerged out of the sea 25 million years ago in the Miocene period (Ashton and Ashton 1985). Since then the sea level has risen and fallen, changing the size and shape of Florida. Locations such as the Welaka area were submerged as much as 90 feet below the water (Friauf 1953). During the largest of these floods, or high water levels, Florida was covered by water, leaving only

a crescent-shaped part of the peninsula in the northwest. The rest of the state was represented by islands of the higher ridges (Hubbel 1984).

The Brooksville Ridge was one of the elevated ridges during this time. The Brooksville Ridge is an area of raised and scattered habitat that spans Hernando and Citrus counties. The Brooksville Ridge is around 25 km wide and 80 km long. Sandhill (high pine) habitat constitutes the largest plant community of the ridge. Sandhill habitat occurs on rolling land with rapid water movement through the soil. It is easily identified by the presence of longleaf pine, *Pinus palustris*, and turkey oak, *Quercus laevis*. The first sandhill habitats in Florida appeared around 20 million years ago (Myers 1990).

Shaping of the land by alternate flooding and draining affected Florida's flora and fauna. The physical and biotic barriers associated with habitat islands affected the establishment of plants, animals, and insects through isolation (Myers 1990). The isolation of these ridges is still in effect today even after the water has subsided. Ridges are easily considered islands to small flightless grasshoppers if they are bordered by even a small amount of water, unfavorable plant habitat, or civilization. The Southern Brooksville ridge presently is isolated by physiographic features unsuitable for grasshopper survival. It is possible to see that over time these grasshoppers could diverge from their closest relatives.

Melanoplus withlacoocheensis Squitier & Deyrup, **NEW SPECIES**

HOLOTYPE MALE: Body length from front of head to tip of abdomen 15.5 mm. Head width from outer edge of the eyes 3.2 mm. Antennae 5.6 mm long. Minimum distance between eyes on vertex nearly 2 times the maximum width of second antennal segment (scape). Frontal costa diverges gradually with surface shallowly depressed above and below median ocellus. Costa fades out before clypeal suture. Pronotum measures 3.4 mm in length, with three sulci present on pronotum. First two sulci vary in length but not crossing median carina; all three sulci cut lateral carinae. Third sulcus traverses the median carina. Oval tegmina 1.2 times as long as wide. Tegmina extending to first ¼ of the third tergite of abdomen. Prosternal spine rounded. Hind femora 3.5 times as long as wide. Cerci (Fig. 1a) nearly rectangular when viewed from side, with mild constriction near middle, and distal portion rounded. Ventral portion of distal end tapers into a point; upper end expanding into swollen spherical bulb. Cercus length 1.2 mm. Cercus width, viewed from the side, 0.4 mm at depression and 0.5 mm at distal end. Thickness of bulbous portion of cerci 0.5 mm. Furcula reduced to two small rounded lobes. Supranal plate triangular, nearly as long as it is wide at proximal end, extending to rounded point, and with distal edges slightly upcurved. Median groove on supranal plate distinct but short. Pallium erect and measuring 1.2 mm in length. Basal part of penis (Fig. 1b) split from the rear, forming two flaps running ½ the length of the penis; once the flaps join, remainder of penis rounded in cross section. Length of penis 2.5 mm. Orientation of penis from base is 90-degree turn towards front of body followed by 45-degree gradual curve up and away from body. Distal end of penis hollow with a spade culminating in spade-shaped point. Overall body color mottled grayish brown; abdomen and ventral surfaces cream colored. First four tergites of abdomen with black spot on each side and forming line when abdomen is constricted. Black stripe on sides of pronotum extending into pleurites; light cream beneath. Narrow white stripe located on pleurites of thorax beneath wings. Outer surface of femur dark, becoming lighter in color toward lower edge. Inside of femora completely cream colored. Two faint bands on dorsal edges of each femur. Tibiae purple with two columns of black spines.

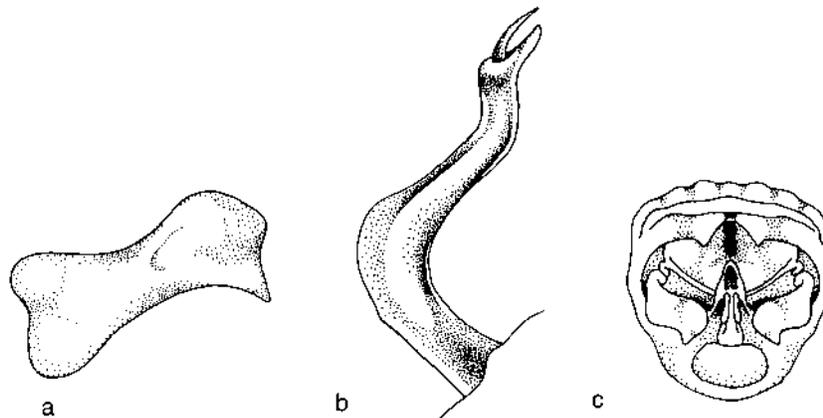


Fig. 1. *Melanoplus withlacoocheensis* n. sp.; a: male left cercus, lateral external view; b: male internal genitalia, lateral view; c: tip of male abdomen, dorsal view.

TYPE LOCALITY: Florida: Hernando Co., State road 50, 5 miles west of Brooksville, collected 15-XI-97. J. M. Squitier.

ALLOTYPE FEMALE: The length of the body from front of head to tip of abdomen is 20.5 mm. The width of the head from the outer edge of the eyes is 3.6 mm. The antennae are 6.8 mm long. The minimum distance between the eyes on the vertex is 2.25 times the maximum width of the second antennal segment (scape). The frontal costa diverges gradually with the medial ocellus evaginated. The costa is as in the male. The sulci are as in the male. The tegmina are 1.8 times as long as wide. The tegmina extends to the first $\frac{1}{4}$ of the third tergite of the abdomen. The prosternal spine is rounded. The hind femora are 3.9 times as long as wide. The cerci are reduced to small broad triangular shaped processes. There are two indentations on the first abdominal tergite under the wings. Color is the same as the male.

LOCALITY: same as holotype male.

ETYMOLOGY: The specific epithet is derived from the Withlacoochee State Forest, which contains a large population of the species. Suggested common name: Withlacoochee Grasshopper.

DIAGNOSIS: With the unaided eye, males of this species can be separated from all other southeastern *Melanoplus* except for *M. rotundipennis* (Fig. 2) by the greatly enlarged, conical, hood-like pallium. With only moderate scrutiny (a 10 \times hand lens is adequate) it is easy to see the bulbous apex and ventral tooth of the male cerci in *M. withlacoocheensis*.

The cerci of *M. rotundipennis* (Fig. 2a) are expanded, but not inflated at the tip, and may have an apical ventral angle, but not a ventral tooth-like projection. The cerci also are only about one-half as thick. The penis of *M. rotundipennis* is somewhat variable through its range (Fig. 3), but is never strongly sinuate; the penis of *M. withlacoocheensis* is also larger, generally about 1.5 times as long, as that of *M. rotundipennis* (Table 1). The penis of *M. withlacoocheensis* has a distinct S-shaped curve and is round in cross section, whereas in *M. rotundipennis* there is one gradual curve along the entire structure and it is oval in cross section. We have not found reliable characters for separating females of *M. withlacoocheensis* and *M. rotundipennis*. A discussion of the relationship between these two species appears below.

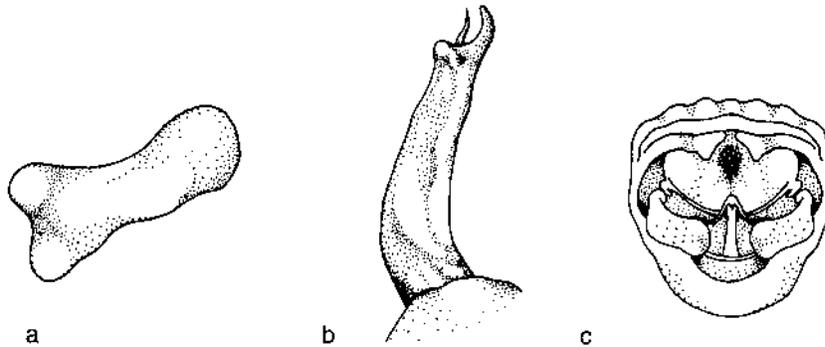


Fig. 2. *Melanoplus rotundipennis*; a: male left cercus, lateral external view; b: male internal genitalia, lateral view; c: tip of male abdomen, dorsal view.

PARATYPES: Two males, 1 female, same locality, date, collector as holotype; 3 males, 1 female, Florida, Hernando Co., 11.2 km south of junction U.S. Route 19 and State Road 50, along road, 15-IX-1997, J. M. Squitier; 4 males, 4 females, Florida, Citrus Co., Withlacoochee State Forest, 1 km south on forest road that begins 7.2 km west of jct. State Road 44 and County Road 581, open sandhill habitat, sparse ground cover of *Aristida stricta*, scattered mature *Pinus palustris*, *Quercus laevis*, 3-XI-1991, M. and N. Deyrup; 1 male, 2 females, same forest road and habitat as previous record, 3.2 km south on forest road, 14-XI-91, M. Deyrup; 4 males: same forest road and collection data as previous record, 14.4 km south on forest road; 1 male same data as previous record, but 4.8 km south on forest road; 1 male, same data as previous record, but 12.8 km south on forest road; 1 male, 1 female: 9.6 km west of Brooksville, on State Road 50, open sandhill habitat on south side of road, 26-VIII-92, M. Deyrup and Z. Prusak.

DEPOSITION OF TYPE MATERIAL: Holotype male, allotype female, 4 males: Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, Florida; 3 males, 2 females: U.S. National Museum of Natural History, Washington, D.C.; 3 males, 2 females: Academy of Natural Sciences, Philadelphia, Pennsylvania; 3 males, 2 females: University of Michigan Museum of Zoology, Ann Arbor, Michigan; 3 males, 1 female: Archbold Biological Station arthropod collection, Lake Placid, Florida; 2 males, 1 female: collection of Department of Entomology and Nematology, University of Florida, Gainesville, Florida.

HABITAT: All specimens were collected in sandhill (high pine) habitat; for a detailed description of this habitat and its dependence on frequent fires, see Myers (1990). The specimens were found in open areas with a sparse to moderately sparse ground cover of wiregrass, *Aristida stricta* Michx., mixed with other herbaceous plants, such as *Pityopsis graminifolia* (Michx.) Nutt. (the most common species), *Polygonella robusta* (Small) Horton, *Paronychia* sp., *Balduina angustifolia* (Pursh) Robins, and *Chrysopsis scabrella* Torr. and Gray. There were scattered mature trees of *Pinus palustris* Mill., *Quercus laevis* Walt., and *Q. incana* Bartr., and in some collecting sites there were *Quercus geminata* Small, *Quercus chapmanii* Sarg., and *Quercus stellata* Wang. Insects found regularly at the collecting sites and represented by voucher specimens include the Acrididae *Melanoplus puer* (Scudder) and *Eritettix obscurus* (Thomas) and *Achurum carinatum* (F. Walker), the Tettigoniidae *Odontophipidium apterum* Morse, the Formicidae *Odontomachus clarus* Roger, *Pogono-*

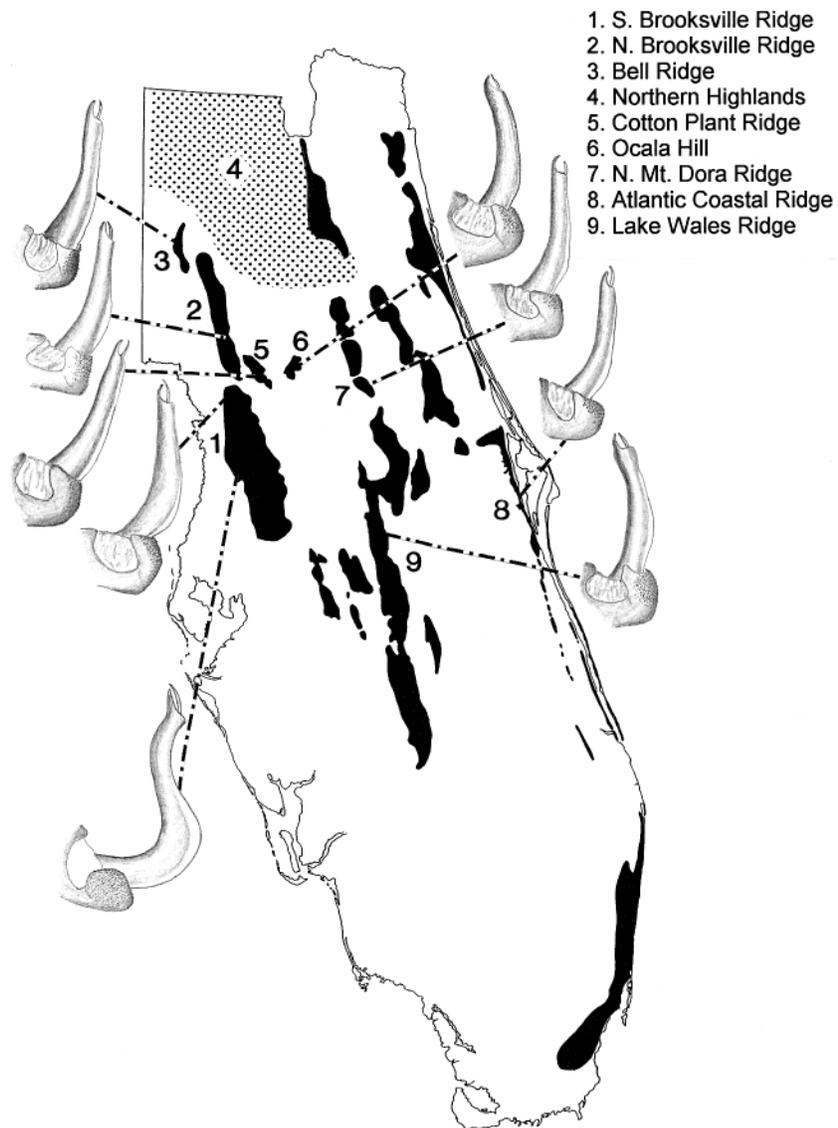


Fig. 3. Sand ridges of peninsular Florida (redrawn from White 1970), showing internal male genitalia of *M. withlacoocheensis* (drawing in lower left) and eight populations of *M. rotundipennis*.

myrmex badius (Latreille), *Pheidole morrisi* Forel, *Monomorium viride* Brown, *Leptothorax texanus* Wheeler, *Trachymyrmex septentrionalis* (McCook), *Dorymyrmex* cf. *elegans* (Trager), *Camponotus socius* Roger, *Paratrechina arenivaga* (Wheeler), and *Formica pallidefulva* Emery. All these associated plants and insects are typical of san-

TABLE 1. SIZE VARIATION (MM) IN SOME SPECIMENS (N = 10) OF *M. WITHLACOOCHEENSIS* AND *M. ROTUNDIPENNIS*.

	MALE		FEMALE	
	<i>M. withlacocheensis</i>	<i>M. rotundipennis</i>	<i>M. withlacocheensis</i>	<i>M. rotundipennis</i>
Body length	15.4-16.5	13.0-16.0	20.0-20.5	16.7-21.3
Antenna length	6.3-6.5	5.8-7.0	6.6-7.0	6.2-8.0
Tegmen length	3.1-3.5	3.0-3.7	3.7-4.1	3.6-4.6
Tegmen width	1.6-1.9	1.6-1.9	2.1-2.2	1.7-2.5
Femora length	9.0-9.7	9.4-11.0	11.2-11.8	11.4-13.2
Femora width	2.4-2.6	2.4-2.8	2.9-3.1	3.0-3.3
Cercus length	1.1-1.3	1.1-1.4	0.5-0.6	0.5-0.6
Cercus thickness	0.4-0.5	0.1-0.2	0.2-0.3	0.1-0.2
Cercus min width	0.4-0.5	0.3-0.4	NA ¹	NA ¹
Cercus distal width	0.4-0.6	0.3-0.6	NA ¹	NA ¹
Cercus basal width	0.6-0.7	0.6-0.8	0.4-0.5	0.4-0.5
Adeagus length	1.9-2.7	1.3-1.6	NA ²	NA ²

¹Shape of cercus in female is triangular.²Present in males only.

dhill habitat through peninsular Florida, except for *Odontomachus clarus* and *Dorymyrmex elegans*, which are confined to the Lake Wales and Orlando Ridges in the interior of the state.

DISCUSSION

Relationships of *M. withlacoocheensis*

Flightless *Melanoplus* species are similar to one another in appearance. The best features one has for identification are the cerci and aedeagus of the male. The cerci are easily viewed by eye or with a hand lens while the aedeagus (penis) must be physically exposed, usually under a dissecting microscope. *Melanoplus withlacoocheensis* is closely related to *M. rotundipennis*. Although the differences between the two species in male cerci and internal genitalia (see Figs. 1 and 2) may seem dramatic by the standards of interspecific divergence seen in many other groups of insects, these are small differences compared with those separating most other flightless *Melanoplus* species. Therefore, it is possible that this population might represent a clinal extreme of *M. rotundipennis*, a species that was already known to show some geographic variation in male cerci and internal genitalia (Hubbell 1932). We therefore collected samples from populations throughout its range in Florida, with special emphasis on populations inhabiting central Florida's upland ridges that might have been isolated by adjacent lowlands, especially those ridges that have produced distinctive, often allopatric, species of flightless *Melanoplus* (Deyrup 1996). The internal genitalia of representatives of these populations of *M. rotundipennis* are shown in Fig. 3. This not only shows that there is no trend toward the highly sinuate penis of *M. withlacoocheensis*, but also that *M. rotundipennis* shows no tendency to give rise to notably divergent populations elsewhere in peninsular Florida. More recently, we have found specimens of typical *M. rotundipennis* at the northern end (Pine-Oak Estates) of the Southern Brooksville Ridge, and the two species occurring sympatrically on the east-central edge of the Southern Brooksville Ridge (1.5 km west of Nobleton) (vouchers in Archbold Biological Station arthropod collection).

Between this pair of species and any other *Melanoplus* there is a great gap in terms of male genitalic morphology. This is not unusual among the flightless *Melanoplus*, a group in which there appears to be rapid divergence of male genitalic morphology, probably driven by sexual selection (Deyrup 1996), combined with a tendency for populations to become isolated on "islands" of habitat (Hubbell 1961). In his "rotundipennis group," Hubbell (1932) included one other species, *M. pygmaeus* Davis, chiefly on the basis of the expanded and spatulate tips of the cerci. This reflects the earlier judgement of Davis (1915) that *M. rotundipennis* and *M. pygmaeus* are related, and sensibly removes these two species from the *puer* group. In addition to the distal expansion of the cerci, *M. pygmaeus* and *M. rotundipennis* resemble each other in general size and markings. They are both relatively common inhabitants of sandhill habitat, and always associated with wire grass (*Aristida stricta* and its relatives) and scattered upland oaks. The two species are separated by about 120 km, including the Ochlockonee and Apalachicola River systems. With the addition of *M. withlacoocheensis*, the *rotundipennis* group now includes three recognized species, but with more analysis additional species might be found that fit into this group among southeastern *Melanoplus* associated with high pine habitats.

The description of *M. withlacoocheensis* raises the number of Florida flightless *Melanoplus* species to about 18. In the keys provided by Blatchley (1920) and Hubbell (1932), this species keys to *M. rotundipennis*. It will soon be possible to identify Flor-

ida *Melanoplus* using a new manual of Florida grasshoppers (Capinera et al. 1998), and Daniel Otte is engaged in the major task of revising the North American species of *Melanoplus*. This latter effort, in particular, should reveal the high level of speciation among the short-winged *Melanoplus* spp.

Biogeography of *M. withlacocheensis*

The Withlacochee grasshopper appears to be a classical peripheral isolate (as discussed in Mayr 1963) of the *rotundipennis* lineage. We believe that *withlacocheensis* is an isolate, rather than a relic of a lineage ancestral to *rotundipennis* because the male cerci and internal genitalia are more elaborate in *withlacocheensis*, in accordance with the normal course of sexual selection. If we hypothesized that *withlacocheensis* was the less derived species, we would be forced to invoke other phenomena, for which we have no evidence, to explain the more widespread distribution of *rotundipennis* with its less elaborate structures.

The Withlacochee grasshopper is known only from the Southern Brooksville Ridge, isolated to the north by the Withlacochee River, which bisects the Brooksville Ridge, to the east by the Tsala Apopka lowlands, to the west by the coastal lowlands, and to the south by the Zephyr Hills Gap (the names of these features are from White 1970). The large sand ridges of the Florida peninsula are likely to maintain islands of xeric habitat in long-term isolation because some of the rain that falls on these ridges percolates out to the sides in the surficial water table to support extensive seeps and strips of swamp forest. Even during dry periods, such as those that prevailed during various times in the Pleistocene (Webb 1990), enough water might be slowly moving out from the edges of the larger ridges to support a mesic habitat that would serve as a barrier to the movement of flightless grasshoppers adapted to xeric habitats. This was recognized and discussed by Hubbell (1932), who made a special effort to visit some of the ridges. He may even have seen *M. withlacochee*, as he mentions (1984) an undescribed *Melanoplus* from western peninsular Florida (the first definite reference to the species is in Deyrup 1996).

The massive sand deposits that form the Brooksville Ridge and other inland ridges and uplands in Florida were washed down from the north at the end of the Miocene and during the Pliocene, and the higher parts of the Brooksville Ridge are among the oldest and most continuously exposed sites in Florida (Scott 1997). Theoretically, therefore, the Brooksville Ridge has been available for colonization for several million years, and would not have been completely inundated even during the high stand of the sea (32-35 m above present) that left the Wicomico shoreline in the early Pleistocene (Webb 1990). The dry longleaf pine savannahs that are the present habitat of *M. rotundipennis* and *M. withlacocheensis* also appeared in Florida in the early Pleistocene, so this stock could theoretically have occurred in Florida for roughly 1.5 million years (Webb 1990). This was the peak of the migration of dry savannah species from southwestern North America (Webb 1990), so the *rotundipennis* group may have a western origin, although it is more conservative to consider it an endemic southeastern lineage until there has been more analysis of *Melanoplus* phylogeny. The isolation of the southern Brooksville Ridge by the Withlacochee River might have been a crucial development for the isolation of the ancestors of the Withlacochee grasshopper, and the narrowness of its cut through the unconsolidated sands of the Brooksville Ridge suggests that this is not a particularly old river valley. To summarize, *M. withlacocheensis* is probably a relatively recently derived species (as species go), probably a million years old or less, and the present distribution suggests that it evolved on the Southern Brooksville Ridge, which has become accessible to typical *M. rotundipennis* only recently, perhaps during a dry period of the late Pleistocene glaciations, or per-

haps since humans began to drain the area, and establish open grassy road shoulders leading from one isolated upland to another. This species and other flightless *Melanoplus* would be ideal subjects for combining geological evidence with biochemical techniques to show patterns of speciation.

The Withlacoochee grasshopper is an important indicator species in the effort to preserve the diversity of Florida's upland habitats because it is the first example of a species endemic to the xeric habitats of the Southern Brooksville Ridge. It is unlikely that this is the only species isolated on this ridge, and surveys for other new endemic species are in order. Some plants to examine carefully are members of the genera *Lechea*, *Paronychia*, *Chrysopsis*, *Galactia*, *Tephrosia*, and *Bulbostylus*. Some insects to check are crickets of the genera *Gryllus*, *Pictonemobius*, and *Cycloptilum*; beetles of the genera *Selenophorus*, *Selonodon*, *Psammodius*, *Phyllophaga*, *Serica*, *Anomala*, *Mecynotarsus*, *Pleotomodes*, and *Blapstinus*; flies of the genera *Nemomydas*, *Townsendia*, *Phthiria*, *Glabellula*, and *Asyndetus*; Hymenoptera of the genera *Photomorphus*, *Tachytes* and *Perdita*. The time of expeditions of discovery in Florida is far from over.

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REFERENCES CITED

- ALLEN, R. T. 1990. Insect endemism in the interior highlands on North America. Fla. Entomol. 73: 539-569.
- ASHTON, R. E., AND P. A. ASHTON. 1985. Handbook of Reptiles and Amphibians of Florida. Windward Press, Miami. 191 pp.
- BLATCHLEY, W. S. 1920. Orthoptera of Northeastern America, with special reference to the faunas of Indiana and Florida. Nature Publ. Co., Indianapolis. 748 pp.
- CAPINERA, J. L., C. W. SCHERER, AND J. M. SQUITIER. 1998. Grasshoppers of Florida. Scientific Publishers, Gainesville. (In press).
- DAVIS, W. T. 1915. List of the Orthoptera collected in northern Florida for the American Museum of Natural History with descriptions of new species. J. N.Y. Entomol. Soc. 23: 91-101.
- DEYRUP, M. 1996. Two new grasshoppers from relict uplands of Florida (Orthoptera: Acrididae). Trans. Amer. Entomol. Soc. 122: 199-211.
- FRIAUF, J. J. 1953. An ecological study of the Dermaptera and Orthoptera of the Welaka area in northern Florida. Ecol. Mono. 23: 79-126.
- HUBBELL, T. H. 1932. A revision of the *puer* group of the North American genus *Melanoplus* with remarks on the taxonomic value of the concealed male genitalia in the Cyrtacanthacridinae (Orthoptera: Acrididae). Univ. Mich. Mus. Zool. Misc. Publ. 23: 1-64.
- HUBBELL, T. H. 1961. Endemism and speciation in relation to Pleistocene changes in Florida and the southeastern coastal plain. Eleventh Internat. Congr. Entomol. Wein. 1960. Vol. 1: 466-469.

- HUBBELL, T. H. 1984. Unfinished business and beckoning problems. *Fla. Entomol.* 68: 1-10.
- MAYER, E. 1963. *Animal species and evolution*. Harvard University Press, Cambridge. 797 pp.
- MYERS, R. L. 1990. Scrub and high pine. Pp. 150-193 *in* Myers, R. L. and T. T. Ewel, eds. *Ecosystems of Florida*. University of Central Florida Press, Orlando. 765 pp.
- SCOTT, T. M. 1997. Miocene to Holocene history of Florida. Pp. 57-67 *in* Randazzo, A. F. and D. S. Jones, eds. *The geology of Florida*. University Press of Florida, Gainesville. 327 pp.
- WEBB, S. D. 1990. Historical biogeography. Pp. 70-100 *in* Myers, R. L. and T. T. Ewel, eds. *Ecosystems of Florida*. University of Central Florida Press, Orlando. 765 pp.
- WHITE, W. A. 1970. The geomorphology of the Florida Peninsula. *Fla. Dept. Nat. Resources Geol. Bull.* 51: 164 pp.