HABITAT ASSOCIATIONS OF GRASSHOPPERS AT THE MACARTHUR AGRO-ECOLOGY RESEARCH CENTER, LAKE PLACID, FLORIDA

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ABSTRACT

Grasshopper populations of the MacArthur Agro-Ecology Research Center at Lake Placid, in south-central Florida were monitored during the period 1993-1995. Samples were taken monthly during the spring, summer, and autumn months from 3 discrete habitats: citrus groves, improved pastures, and weedy margins of irrigation ditches. The grasshopper species assemblage at the Research Center consisted of 16 species in the family Acrididae, 7 species in the family Tettigoniidae, and 3 species in the family Tetrigidae. Family and species dominance varied among habitats. Grasshopper abundance was highest in citrus groves and ditch margins, and these habitats had proportionally more acridids. Pastures were inhabited by fewer grasshoppers, and were dominated by tettigoniids. The nymphal tettigoniid population was relatively high, and adult population relatively low, in pastures. Tetrigids were infrequent in all habitats. The most abundant grasshoppers were *Dichromorpha viridis* (Scudder) and *Conocephalus fasciatus* (DeGeer), grass-feeding species that were abundant in all habitats sampled. Collection of *Melanoplus bispinosus* Scudder is a new state

record. Potential effects of grasshoppers and land management on avifauna are discussed.

RESUMEN

Las poblaciones de saltamontes del MacArthur Agro-Ecology Research Center en Lake Placid, Florida, fueron muestreadas durante los años 1993-95. Fueron tomadas muestras mensualmente durante la primavera, verano y otoño en tres habitats discretos: campos de cítricos, pastos mejorados, y márgenes enyerbadas de embalses de riego. El conjunto de especies de saltamontes consistió de 16 especies de la familia Acrididae, 7 especies de la familia Tettigoniidae y 3 especies de la familia Tetrigidae. La dominancia de familias y especies varió entre los habitats. La abundancia de saltamontes fue más alta en los campos de cítricos que en las márgenes de los embalses y estos habitats tuvieron proporcionalmente más acrídidos. Los pastos fueron habitados por pocos saltamontes, y fueron dominados por los tetigónidos. La población ninfal de tetigónidos fue relativamente alta y la población de adultos relativamente baja en los pastos. Los tetrígidos fueron infrecuentes en todos los habitats. Los saltamontes más abundantes fueron *Dichromorpha viridis* (Scudder) y *Conocephalus fasciatus* (DeGeer), las especies que se alimentan de hierba fueron abundantes en todos los habitats muestreados. La colecta de *Melanoplus bispinosus* Scudder es un nuevo record para el estado. Son discutidos los efectos potenciales en la avifauna de los saltamontes y el manejo de la tierra.

Grasshoppers are usually the dominant aboveground invertebrates in pastures and natural grasslands, at least when judged by biomass (Scott et al. 1979, Risser et al. 1981). By any measure, they usually are central to the conversion of plant matter into animal matter and in nutrient cycling. They also are critical elements in the food supply of many birds and mammals. Most birds, even those normally considered to be granivorous, rely on insects for part of their diet, and for rearing their young (McEwen 1987). Thus, resource management that impinges on grasshopper population dynamics potentially affects several trophic levels.

Much of south Florida is experiencing major change in land use, but not without considerable controversy. One of the most frequent forms of land conversion is replacement of grazing land with citrus groves. Debate continues as to the most appropriate use for land. The debate would be clarified considerably if data were available on actual impacts of land conversion. The MacArthur Agro-Ecology Research Center (MAERC) was established in 1988 to foster study of the ecological relationships among cattle ranching, citrus production, and the native environment. Herewith we report results of a study designed to obtain baseline data on the effects of land management practices on grasshoppers at MAERC.

MATERIALS AND METHODS

Research Site

MacArthur Agro-Ecology Research Center is adjacent to, and administered by, Archbold Biological Station, near Lake Placid, in Highlands County, Florida. MAERC is a 4,170 ha working cattle and citrus ranch, consisting principally of cabbage palm savannas, and wet and dry prairies. Most of the property is used to support cattle grazing, although there is a citrus grove on the property. The area is dissected by ditches to drain excess water from the pastures and grove.

The vegetation varies, but bahiagrass, *Paspalum notatum* (Poaceae), occurs abundantly in all habitats sampled. The improved pastures were nearly bahiagrass monocultures. The citrus groves were also invaded by weeds such as beggar-tick, *Bidens alba* (L.) DC (Asteraceae); dayflower, *Commelina diffusa* Burm. (Comelinaceae); marsh pennywort, *Hydrocotyle umbellata* L. (Apiaceae); West Indian chickweed, *Drymaria cordata* (L.) Willd. ex Roem. & Schult. (Caryophyllaceae); and Indian hemp, *Sida rhombifolia* (L.) (Malvaceae). The ditchbanks included the vegetation found in the groves, and also additional flora such as the umbrella sedge, *Cyperus brevifolius* (Rottb.) Hassk. (Cyperaceae); tropical carpetgrass, *Axonopus compressus* (Sw.) Beauv. (Poaceae); and the madder *Richardia braziliensis* (Moq.) Gomez (Rubiaceae). Emergent vegetation is found in some ditches, and consists of such flora as cattail, *Typha* spp.(Typhaceae); rushes, *Juncus* spp. (Juncaceae); arrowhead, *Sagittaria* sp. (Alismataceae) and primrose willow, *Ludwigia peruviana* (L.) Hara (Onagraceae). Ditch vegetation is quite variable, because ditches periodically are dredged or treated with herbicide.

Sampling

Selected sites were sampled monthly during spring, summer, and autumn months (March-October) for the years 1993-1995 except when adverse weather prohibited access to the sites. Two replicate sites of improved pasture (bahiagrass; at least 50 ha each), mature (>10 years old) orange grove (bahiagrass and weed understory; 60 ha), and ditchbank (various weeds and grasses) were sampled. Because there is only one citrus grove on the MAERC property, a commercial grove (80 ha) immediately adjacent to the MAERC, and an associated ditch area, were included to obtain 2 replicates for each habitat type. The commercial grove occupied a higher, drier site, and also differed in that insecticides were sometimes applied. The bahiagrass pastures were randomly selected from, and immediately adjacent to, 16 other bahiagrass pastures measuring 50-130 ha in area. The citrus groves also exceeded 50 ha in area. Thus, the size of the plots alleviates problems with edge effects.

Sampling was conducted using a standard 40 cm diameter sweepnet. We assumed that vegetation did not greatly influence our ability to capture a representative proportion of grasshoppers at each sampling location, but this is an imperfect assumption because the heavier vegetation of the ditchbanks sometimes impeded sampling. Each site was swept for a 3 min period in each of 6 locations; these subsamples were pooled and the grasshoppers were counted and identified to species. Some immature grasshoppers are very difficult to identify, principally acridids in the subfamily Cyrtacanthacridinae (Melanoplinae), so immatures were reared to the adult stage to facilitate identification. A single sampler collected grasshoppers from all pastures and sampling dates during each year of the study, but different samplers were employed in each year.

Results and Discussion

We observed 26 species of grasshoppers at the research site: 16 species in the family Acrididae, 7 species in the family Tettigoniidae, and 3 species in the family Tetrigidae (Table 1). These pasture, citrus, and ditchbank habitats contained about 22, 11, and 23% of the species in the families Acrididae, Tettigoniidae, and Tetrigidae, respectively, known to inhabit Florida (Peck et al. 1992). They also represent 59, 18, and 43% of the species in the families Acrididae, Tettigoniidae, and Tetrigidae, respectively, known to inhabit south Florida. *Melanoplus bispinosus* Scudder was heretofore not known from Florida, although recently we have also collected it from Quincy, in

TABLE 1. INVENTORY OF GRASSHOPPERS FOUND AT MACARTHUR AGRO-ECOLOGY RESEARCH CENTER, LAKE PLACID, FLORIDA, AND THEIR RELATIVE ABUNDANCE AND HOST PREFERENCE DURING 1993-1995.

Taxa (family, subfamily, species)	Abundance[1]	Habitat[2]
Acrididae: short-horn grasshoppers		
Crytacanthacridinae (Melanoplinae): spur-throated grasshoppers		
Aptenopedes aptera Scudder	+	P
Aptenopedes sphenarioides Scudder	+	G
Melanoplus bispinosus Scudder	+	D
Melanoplus propinquus Scudder	+++	G,D
Paroxya atlantica Scudder	++	D
Paroxya clavuliger (Serville)	+	D
Schistocerca americana (Drury)	+++	G,D
Schistocerca obscura (Fabricius)	+++	G,D
Stenacris vitreipennis (Marschall)	++	P,G
Gomphocerinae: slant-face grasshoppers		
Achurum carinatum (F. Walker)	+	P,D
Amblytropidia mysteca (Saussure)	++	P,G
Dichromorpha elegans (Morse)	++	P,G,D
Dichromorpha viridis (Scudder)	+++	P,G,D
Orphulella pelidna (Burmeister)	++	P,G,D
Oedipodinae: banded-wing grasshoppers		
Chortophaga australior (Rehn and Hebard)	+++	G,D
Romaleinae: lubber grasshoppers		
Romalea guttata (Houttuyn)	+	G,D
Tettigoniidae: long-horn grasshoppers		
Conocephalinae: meadow grasshoppers		
Conocephalus fasciatus (DeGeer)	+++	P,G,D
Orchelimum agile (DeGeer)	++	D
Copiphorinae: cone-headed grasshoppers		
Neoconocephalus triops (Linnaeus)	++	D
Phaneropterinae: katydids		
Amblycorypha floridana Rehn and Hebard	+	G,D
A. rotundifolia (Scudder)	+	G
Scudderia furcata Brunner	++	G,D
Scudderia texensis Saussure and Pictet	+	D
Tetrigidae: pygmy and grouse locusts		
Batrachideinae		
Tettigidea lateralis (Say)	++	G,D

[1](+ indicates rare; ++ indicates occasional; +++ indicates frequent)
[2](P indicates pasture; G indicates citrus grove; D indicates irrigation ditch)

TABLE 1. (CONTINUED)INVENTORY OF GRASSHOPPERS FOUND AT MACARTHUR AGRO-ECOLOGY RESEARCH CENTER, LAKE PLACID, FLORIDA, AND THEIR RELATIVE ABUNDANCE AND HOST PREFERENCE DURING 1993-1995.

Taxa (family, subfamily, species)	Abundance[1]	Habitat[2]
Tetriginae		
Neotettix femoratus (Scudder)	+	G,D
Paratettix mexicanus (Saussure)	++	G,D

[1](+ indicates rare; ++ indicates occasional; +++ indicates frequent)
[2](P indicates pasture; G indicates citrus grove; D indicates irrigation ditch)

northwest Florida, and it has long been known from Alabama (Dakin & Kirby 1970). Certainly more species would be found with additional collection, or collection from nearby xeric pine and oak-dominated habitats.

Nymphs predominated in the early collections, but by June most of the acridids and tetrigids were adults, whereas the tettigoniids were predominantly nymphs. A mixture of nymphal and adult tettigoniids could be found until October, but the proportion of nymphs was consistently higher in the pastures than elsewhere. There are several possible explanations for the high proportion of nymphs in pastures, including: (1) pastures may be more, or less, favorable for growth and reproduction of the tettigoniids; (2) avian predation may be higher in the pastures, with the birds feeding principally on the larger, more visible adults; and (3) adults may disperse from pastures to more preferred feeding or oviposition sites.

Family and species dominance varied among habitats. Figure 1 shows the abundance of acridids and tettigoniids at the various sample sites for 1994; the other 2 years exhibited very similar trends. Grasshopper abundance was highest in citrus groves and ditch margins, and these habitats had proportionally more acridids. Pastures supported fewer grasshoppers, and they were principally tettigoniids. Tetrigids were infrequent in all habitats.

Grasshopper populations in the citrus grove adjacent to MAERC were suppressed in mid-summer, following application of insecticides, during all years of the study. Chemical applications were particularly frequent in 1994 because a new insect pest, citrus leaf miner, *Phyllocnistis citrella* Stainton, had been introduced to Florida. The grove in MAERC did not receive insecticide applications, and grasshopper abundance remained high throughout the year.

The most abundant grasshoppers were the acridid *Dichromorpha viridis* (Scudder) and the tettigoniid *Conocephalus fasciatus* (DeGeer), grass-feeding species that were abundant in all habitats sampled. In the pastures, these were sometimes the only species collected. *Dichromorpha viridis* is the most common grasshopper associated with bahiagrass and St. Augustine grass throughout the state, whether the grass is used for forage or as turfgrass. *Conocephalus fasciatus* tends to be associated with these grasses, and other grasses, when they are taller, and not regularly cut, because grass seedheads are a preferred food (Gangwere 1961). Tettigoniids are common elements of eastern meadows (Osborne 1939), but infrequent in western grasslands where most grasshopper research has been conducted (Capinera & Sechrist 1982a).

Additional species that were found frequently were *Melanoplus propinquus* Scudder and *Chortophaga australior* Rehn and Hebard. These two species are present in Florida wherever broadleaf weeds occur, and are common in agricultural fields and other disturbed sites (Blatchley 1920). Thus, they were found in the citrus groves and

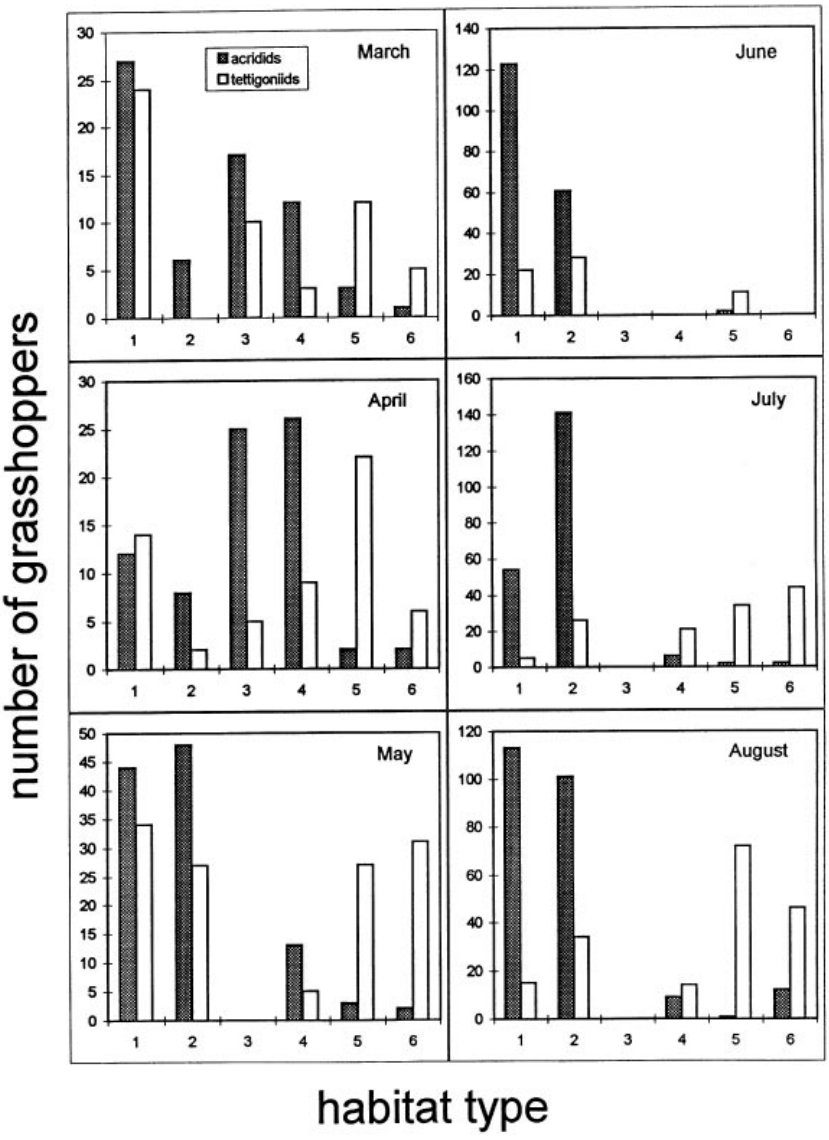

Fig. 1. Distribution pattern and abundance of acridid and tettigoniid grasshoppers at MacArthur Agro-Ecology Research Center (MAERC), summer 1994. Habitat designations are: 1 = understory of MAERC citrus grove; 2 = vegetation of MAERC irrigation ditch; 3 = understory of commercial citrus grove adjacent to MAERC; 4 = vegetation of irrigation ditch adjacent to commercial citrus grove; 5 = bahiagrass pasture 1; 6 = bahiagrass pasture 2.

ditchbank areas, but were absent from the bahiagrass pastures. The other abundant species were *Schistocerca americana* (Drury) and *S. obscura* (F.). These are polyphagous species that generally prefer broadleaf plants. They also tend to be arboreal in perching behavior. These species also were limited to citrus groves and ditchbanks in this study, but *S. americana* nymphs are sometimes found in pastures (Capinera 1993).

Habitat associations of some of the less abundant grasshoppers are also noteworthy. *Stenacris vitreipennis* (Marschall) and *Paroxya atlantica* (Drury) are found in wet habitats, often associated with emergent vegetation (Blatchley 1920). Although they were commonly found in the ditchbank areas, they also were recovered from groves. This is somewhat indicative of the moist environs of the MAERC, where standing water was not infrequent in both pastures and grove. However, it also reflects the highly dispersive nature of the grasshoppers. Without the moist habitat provided by irrigation ditches to serve as a source of inoculum, the citrus groves probably would not contain these species. Similarly, *Paratettix mexicanus* (Saussure) is found only in wet habitats, although *Tettigidea lateralis* (Say) inhabits a wide range of environments (Rehn & Grant 1961).

There is a rich literature documenting the effects of resource availability and land management on grasshopper populations. In arid and tropical environments grasshopper population density increases in proportion to rainfall and plant biomass (Capinera & Horton 1989, Fielding & Brusven 1990, Joern & Gaines 1990). The principal exception is when a shift in plant suitability is effected. For example, if a plant that is a relatively unsuitable host for grasshoppers, such as bluestem, *Andropogon* spp., is replaced by a more suitable plant, such as broadleaf weeds, grasshopper numbers may increase markedly despite the lack of change in biomass (Capinera & Sechrist 1982b, Capinera 1987, Olfert et al. 1994). This information has been used to promote vegetation replacement in weedy roadsides and fence rows with perennial grasses that are relatively unsuitable for grasshopper growth and reproduction and thereby reduce breeding by grasshoppers that disperse to nearby crops (Davis 1949, Olfert et al. 1994). The data collected from MAERC are consistent with these general observations about grasshopper population dynamics. However, the trends in abundance and diversity would have been even more pronounced were it not for the abundance of tettigoniids in pastures. The phenomenon of tettigoniid abundance is not usually observed in western grasslands except when decticine tettigoniids such as Mormon cricket, *Anabrus simplex* Haldeman, occur. Conocephaline tettigoniids, which were quite abundant in these studies, are an eastern phenomenon. The MAERC data also reflect the benefits of a rich floral understory. Some citrus producers keep their groves weed-free, or planted to bahiagrass; such groves would have a relatively depauperate grasshopper species assemblage, and relatively low abundance of grasshoppers.

The agroecosytems most common in south Florida, pastures, citrus groves, and accompanying drainage ditches, all were found to support abundant grasshopper populations. Grasshopper species assemblages were richer in citrus groves and drainage ditchbanks, which is undoubtedly related to the more diverse flora and greater biomass found in these habitats. On average, grasshopper populations were lower in pastures, but it is not certain whether this habitat is less suitable for grasshoppers, or more suitable for foraging by avian predators. Several bird species, including eastern meadowlark, *Sturnella magna magna* (L.); redwing blackbird, *Agelaius phoeniceus phoeniceus* (L.); cattle egret, *Bulbulcus ibis* L.; northern bobwhite, *Colinus virginianus virginianus* (L.); and northern mockingbird, *Mimus polyglottos polyglottos* (L.); frequent pastures at MAERC during the breeding season (Champe 1993). It remains to be determined whether birds make effective use of the grasshopper food resource available to them in the more diverse floral communities of the citrus groves and

ditchbanks, or whether they are deterred from feeding there by the density and architecture of the flora. Research conducted at MAERC by Champe (1993) suggests that birds take advantage of the food resources in citrus groves. Her studies showed that the most abundant birds in citrus groves are northern cardinal, *Cardinalis cardinalis*; cattle egret; mourning dove, *Zenaida macoura*; redwing blackbird; white-eyed vireo, *Vireo griseus*; and common yellowthroat, *Geothlypis trichas*. In addition to supporting a greater diversity of avifauna than pastures, Champe's (1993) studies showed that citrus groves supported a bird density more than twice that of pastures, and nearly as great as that occurring in natural forest. Thus, properly managed (minimal insecticide use, diverse understory) groves introduce habitat that increases insect and bird biodiversity in the south Florida grazing ecosystem.

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