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Authors: Squitier, Jason M., and Capinera, John L.

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OBSERVATIONS ON THE PHENOLOGY OF COMMON
FLORIDA GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE)

JASON M. SQUITIER AND JOHN L. CAPINERA

Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611-0620

ABSTRACT

Grasshopper occurrence and abundance in several natural and anthropogenic habitats found in north Florida were surveyed for a one-year period to determine periodicity of adult and nymphal stages. Thirty species were sufficiently abundant to assess at least some elements of their phenology. A high proportion (36%) of the species overwintered as adults, and 27% of the species overwintered as nymphs. Three species were found to overwinter in both the adult and nymphal stages. The period of peak nymphal abundance varied among species and was found to include spring, summer, autumn, and winter. The method of data collection used in this study was inadequate to ascertain definitively the number of generations, but six species are suspected of being multivoltine in Florida.

Key Words: life cycle, voltinism

RESUMEN

La presencia y abundancia de saltamontes en varios hábitat naturales y antropogénicos presentes en el norte de Florida fueron inspeccionados por un periodo de un año para determinar la periodicidad de los estados adultos y ninfales. Treinta especies fueron lo suficientemente abundante para evaluar por lo menos algunos elementos de su fenología. Una alta proporción (36%) de las especies invernarón como adultos, y 27% de las especies invernarón como ninfas. Se encontró que tres especies invernarón en ambos estados adultos y ninfal. El periodo máximo de abundancia ninfal varió entre las especies y se encontró que incluía primavera, verano, otoño e invierno. El método de recolección de datos utilizados en este estudio fue inapropiado para asegurar definitivamente el número de generaciones, pero se sospecha que seis especies están presentando multivoltinismo en Florida.

Most North American grasshoppers display a consistent life history pattern. They typically survive the winter in the egg stage, hatch the following spring and grow and reproduce during the summer and early autumn. In this life history model, the egg stage exhibits prolonged diapause, and is typical of temperate or continental climates where there are strongly contrasting seasons (Uvarov 1977). There are at least three rare but interesting variations of the egg diapause model. In the first, there is not sufficient warm weather for complete development in the first year of the grasshopper's life, and the nymph overwinters the first winter, thus requiring two years for completion of the life cycle. The egg stage is the overwintering form only in alternate years. This type of life history is reported from high elevations and northernmost latitudes. The second variation occurs when eggs do not hatch after the first winter, instead remaining in diapause through a second winter and hatching the second spring. The third variation occurs in southern latitudes, where the abundance of warm weather allows the grasshopper to complete two or more generations each year, with egg diapause occurring only during the winter.

In contrast to the egg diapause model, some species pass the winter as partly grown nymphs or as non-reproducing adults, maturing in the spring

and reproducing in the summer. The eggs of such grasshoppers lack a prolonged diapause and hatch the year in which they are deposited. Such species occur at various latitudes, and normally are an infrequent component of most North American grasshopper assemblages. The diapausing nymph and adult model (using the term loosely because it is not always certain that true diapause is involved) also serves to promote survival during inhospitable periods, but is more common in areas with cool rather than frigid winters.

Grasshoppers have been infrequently studied at southern latitudes in North America, and the dearth of information is particularly pronounced in the southeastern states. However, W. S. Blatchley (1920) conducted extensive taxonomic surveys of Florida Orthoptera, and though failing to study ecology and life history systematically, observed that adults of a number of species could be collected during the winter "if only one will search for them in the proper places" and also noted that "a number of other species winter there as nymphs." Friauf (1942) also noted overwintering by a few species in central Florida. Here we report the results of a year-long study that documents the phenology of 30 common Florida grasshoppers. In this study we were able to determine the overwintering stage, and gained some insight into

the period of peak occurrence and number of annual generations present in Florida.

MATERIALS AND METHODS

Grasshopper phenology was monitored by periodic sampling of plant habitats. The Florida habitats that were used in this phenological study included common natural habitats including salt marsh, freshwater marsh, lakeside, flatwoods, oak hammock, scrub, and sandhill, as well as common anthropogenic habitats including roadsides, crops, pine plantations, pasture, disturbed areas (formerly sandhill) and old fields (formerly crop or pasture). The classification systems of the Florida Natural Areas Inventory (1990) and the Soil and Water Conservation Society (1989) were used to define the natural habitats. Collections were made once or twice per month depending on ease of access, for the period of April 1997 to April 1998, in order to track grasshopper abundance and development. Thus, most habitat types in Alachua County were sampled at nearly equivalent intervals throughout the study, whereas more distant sites were sampled in summer and autumn, when grasshoppers were expected to be most abundant. The counties and the number of samples for each habitat follow: sandhill (Clay 4, Highlands 2, Hernando 2, Levy 12, Leon 1, Marion 1, St. Johns 1); freshwater marsh (Alachua 3, Clay 2, Levy 1, Marion 2, Orange 1); scrub (Highlands 2, Lake 1, Levy 4, Marion 4, Polk 1); roadside (Alachua 30, Levy 1); lakeside (Alachua 14, Clay 1, Leon 1); disturbed (Alachua 11, Marion 1); pasture (Alachua 23, Clay 1); pine plantations (Alachua 31); old field (Alachua 10, Levy 1); flatwoods (Alachua 11, Highlands 1); salt marsh (Levy 12); oak hammock (Alachua 10); crops (Alachua 10). Sites were sampled by sweep-netting the habitat for about 50 minutes (by JMS). The grasshoppers were identified and their abundance and developmental stages were recorded. When necessary, immatures were reared in the laboratory to confirm their identity. The proportional data obtained from sweep net samples and the abundance data from the 100 m transect were combined to estimate the abundance of each species at each sampling interval. Such sampling is imperfect due to different densities of vegetation and grasshoppers, and different behaviors displayed by grasshoppers. However, it is the most practical and widely used approach to grasshopper population estimation. Phenological trends were assessed by examining the trend by habitat, and by combining the data from all of the habitats in order to determine the overall trend in species development throughout the year.

RESULTS AND DISCUSSION

These studies revealed evidence of 52 of the 70 species known to occur in Florida. However, many

species were collected infrequently, so only information on the 30 most abundant species is presented. For three grasshoppers associated with semi-aquatic vegetation, *Leptysma marginicollis* (Serville), *Paroxya clavuliger* (Serville), and *Stenacris vitreipennis* (Marschall), complete monitoring was not possible due to extraordinarily high rainfall in the winter of 1997-98 that made it impossible to collect from freshwater marshes and lakes. However, even with incomplete data it is possible to see the general pattern of occurrence for these species.

The species that survived the winter (December and January) in northern Florida as adults were *Achurum carinatum* (F. Walker), *Amblytropidia mysteca* (Saussure), *Aptenopedes aptera* Scudder, *Aptenopedes sphenarioides* Scudder, *Arphia granulata* (Saussure), *Chortophaga australior* (Rehn & Hebard), *Eritettix obscurus* (Scudder), *Leptysma marginicollis*, *Melanoplus rotundipennis* Scudder, *Schistocerca americana* (Drury), and *Schistocerca damnifica* (Saussure). Blatchley (1920) also reported that *Amblytropidia mysteca*, *Aptenopedes aptera*, *Aptenopedes sphenarioides*, *Arphia granulata*, *Eritettix obscurus*, *Leptysma marginicollis*, *Schistocerca americana* and *Schistocerca damnifica* survive the winter in Florida in the adult stage, and Dakin and Hays (1970) reported adult overwintering by *Amblytropidia mysteca* and *Schistocerca americana* in Alabama. In a study conducted in northern Florida, *Aptenopedes aptera* was reported to overwinter in the nymphal stage (Friauf 1942).

The species that survived the winter as nymphs in northern Florida were *Achurum carinatum*, *Arphia granulata*, *Chortophaga australior*, *Eritettix obscurus*, *Paradalophora phoenicoptera* (Burmeister), *Paroxya atlantica* Scudder, *Psinida fenestralis* (Serville), and *Spharagemon marmorata* (Harris). Blatchley (1920) also found *Eritettix obscurus* and *Paradalophora phoenicoptera* nymphs throughout the winter. Friauf (1942) documented overwintering by nymphs of *Achurum carinatum*, *Aptenopedes aptera*, *Arphia granulata*, and *Paradalophora phoenicoptera* in northern Florida.

The grasshoppers in this study also can be classified according to the period in which nymphs were most abundant. Species in which nymphs were most abundant in the spring months were *Melanoplus rotundipennis* (Fig. 3c), *Orphulella pelidna* (Burmeister) (Fig. 3f), and *Spharagemon crepitans* (Saussure) (Fig. 5b). Species in which nymphs were most abundant during summer months were *Aptenopedes aptera* (Fig. 1c), *Aptenopedes sphenarioides* (Fig. 1d), *Dichromorpha elegans* (Morse) (Fig. 2a), *Dichromorpha viridis* (Scudder) (Fig. 2b), *Melanoplus keeleri* (Thomas) (Fig. 3a), *Schistocerca alutacea* (Harris) (Fig. 4e), *Schistocerca damnifica* (Fig. 5a), *Spharagemon cristatum* (Scudder) (Fig. 5c), *Sten-*

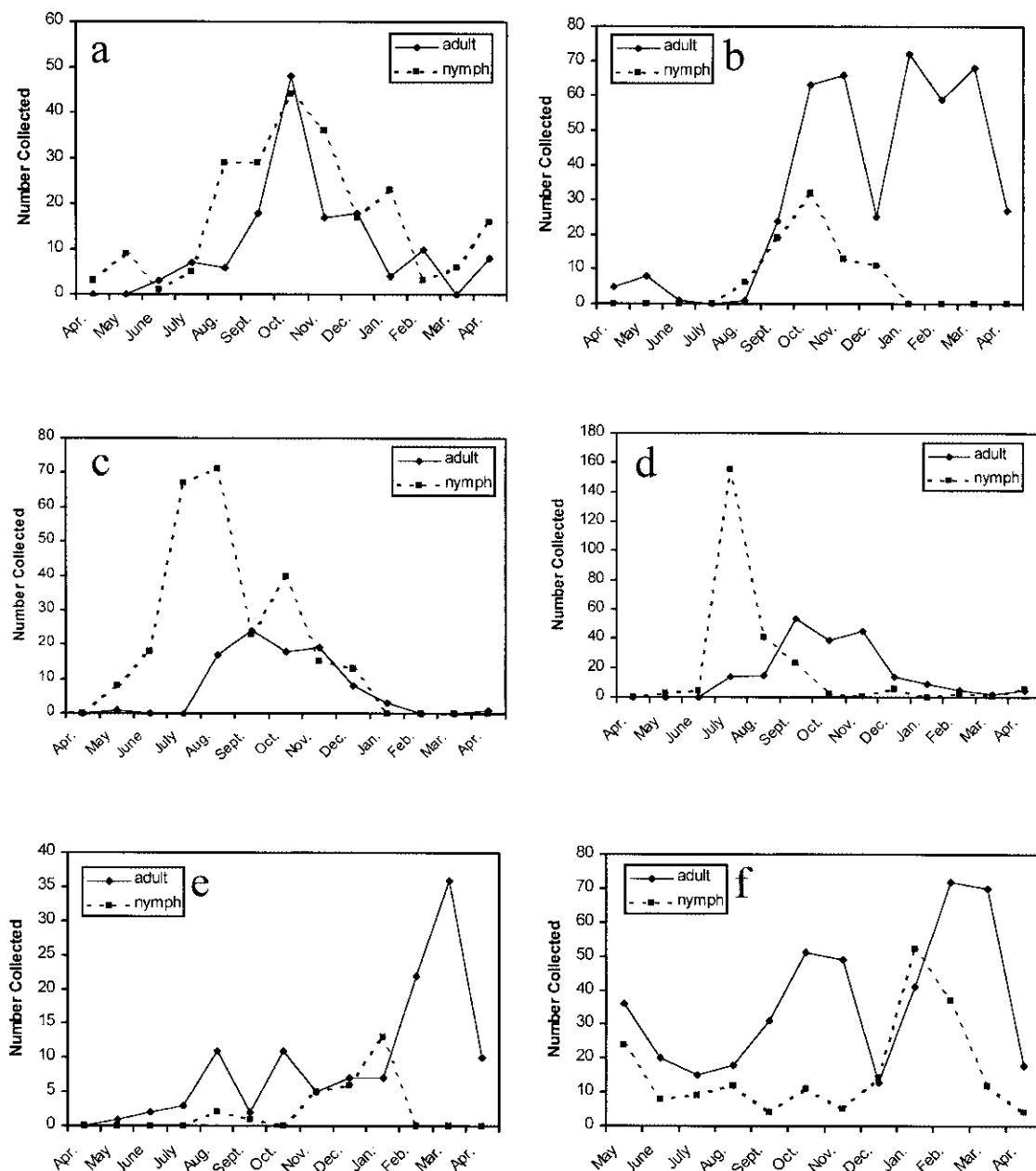


Fig. 1. (a) Phenology of *Achurum carinatum*. (b) Phenology of *Amblytropidia mysteca*. (c) Phenology of *Aptenopodes aptera*. (d) Phenology of *Aptenopodes sphenarioides*. (e) Phenology of *Arphia granulata*. (f) Phenology of *Chortophaga australior*.

acris vitreipennis (Fig. 5e), and *Syrbula admirabilis* (Uhler) (Fig. 5f).

It proved to be difficult to determine the number of generations displayed by several species based on collection data. Although many species were univoltine, with a single discrete period of nymphal development, for many species the nymphs were present throughout the year or

nearly so (Figs. 1-5). For example, nymphs of *Achurum carinatum*, *Chortophaga australior*, *Eritettix obscurus*, *Melanoplus propinquus* Scudder, *Melanoplus sanguinipes* (Fabricius), and *Paroxya atlantica* Scudder could be collected nearly any time of the year, and often lacked discrete periods of greater abundance. The species that seemingly displayed multiple generations in this

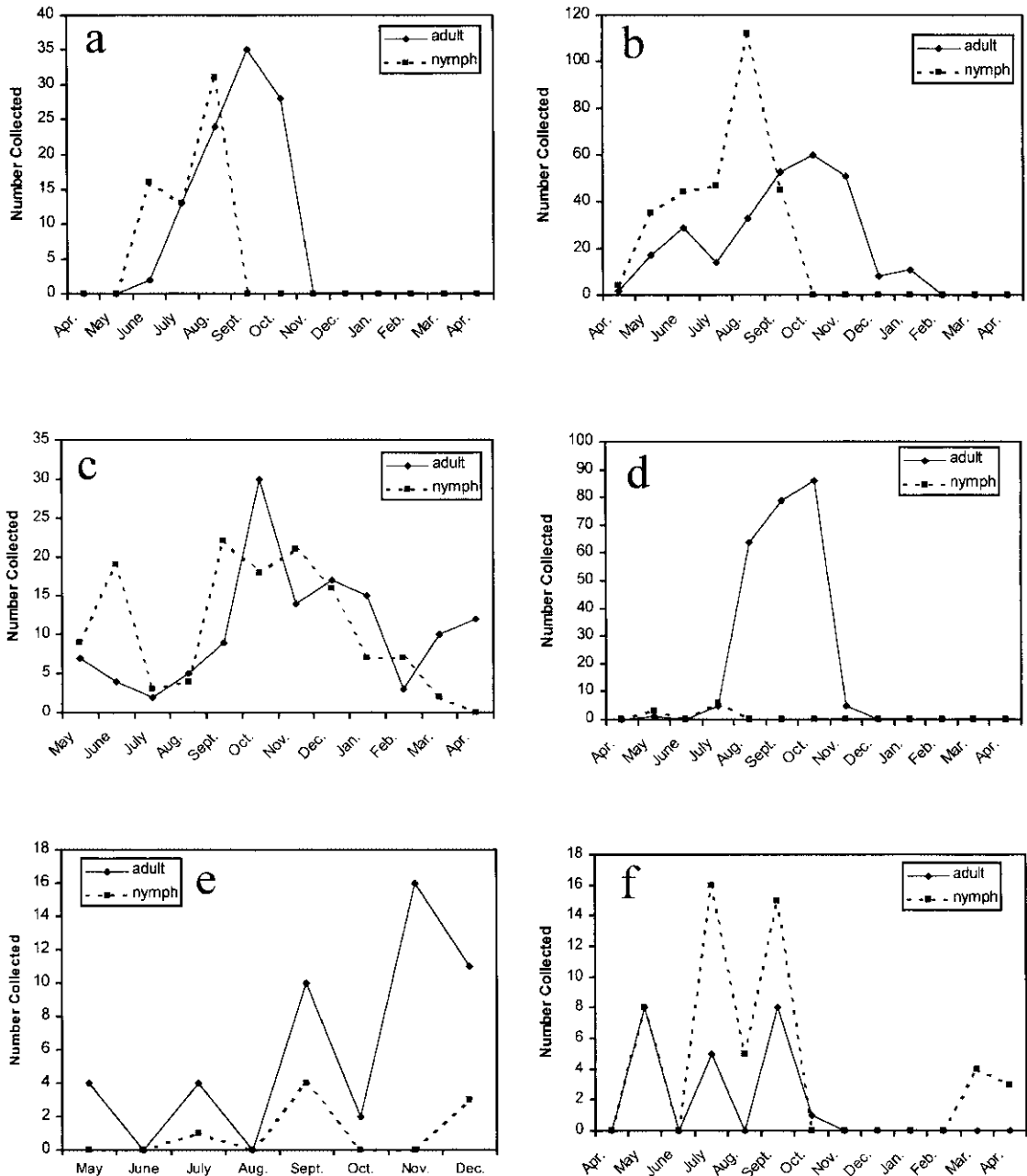


Fig. 2. (a) Phenology of *Dichromorpha elegans*. (b) Phenology of *Dichromorpha viridis*. (c) Phenology of *Eritettix obscurus*. (d) Phenology of *Gymnoscirtetes pusillus*. (e) Phenology of *Leptysma marginicollis*. (f) Phenology of *Melanoplus bispinosus*.

study were: *Chortophaga australior* with periods of nymphal abundance during spring and autumn in roadside, pasture, and old field habitats; *Melanoplus sanguinipes* with periods of nymphal abundance during summer and autumn in roadside and pasture habitats; *Melanoplus propinquus* with periods of nymphal abundance

during spring and summer in roadside, pasture and old field habitats; *Melanoplus sanguinipes* with periods of nymphal abundance during spring and autumn in roadside and crop habitats; *Paroxya atlantica* with periods of nymphal abundance during spring and summer in salt marsh, pasture, and old field habitats; and *Schistocerca*

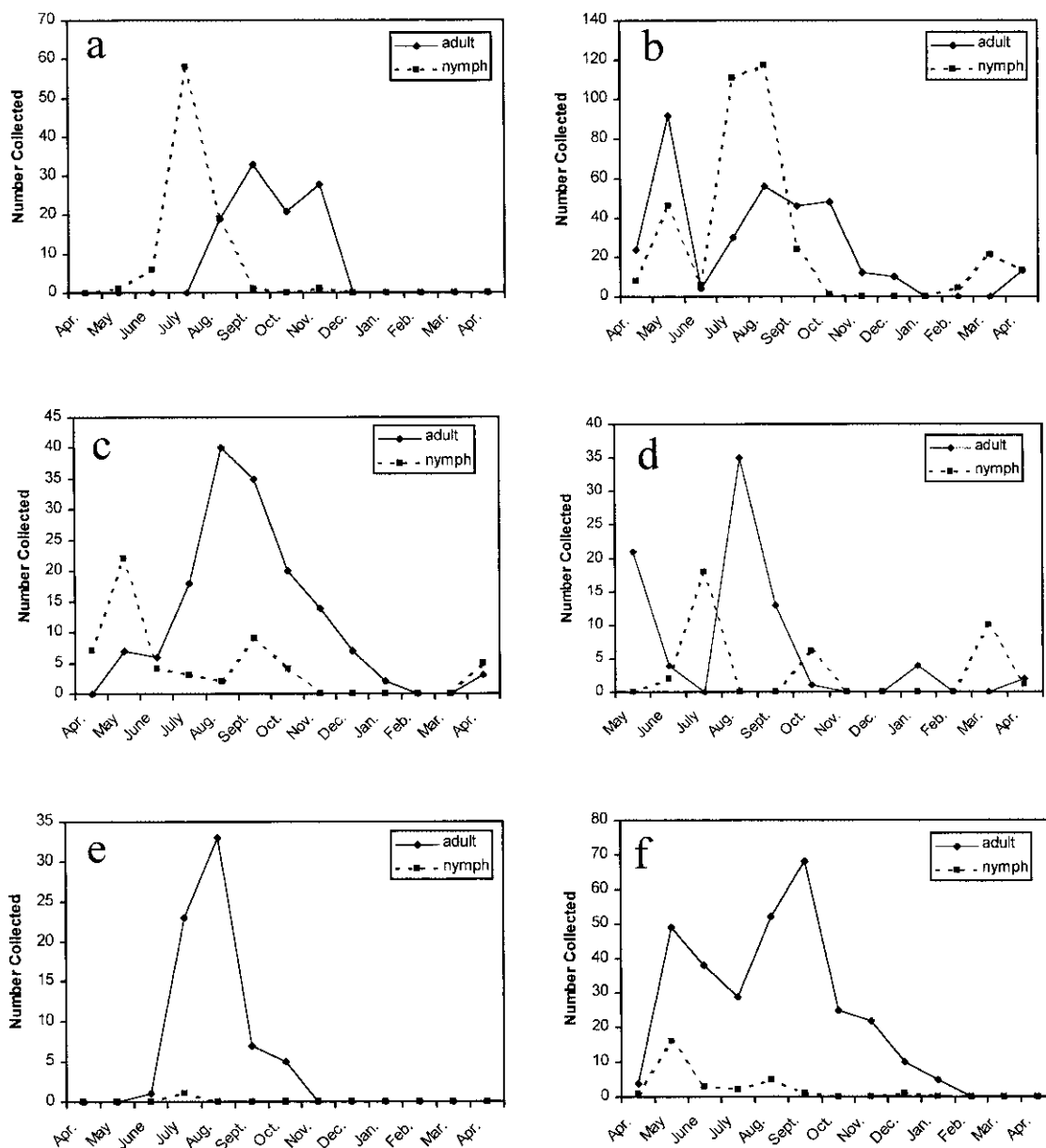


Fig. 3. (a) Phenology of *Melanoplus keeleri*. (b) Phenology of *Melanoplus propinquus*. (c) Phenology of *Melanoplus rotundipennis*. (d) Phenology of *Melanoplus sanguinipes*. (e) Phenology of *Mermeria intertexta*. (f) Phenology of *Orphulella pelidna*.

americana with periods of nymphal abundance in early summer and autumn in roadside, pasture, and pine plantation habitats. However, because nymphs and adults often were present for protracted periods, the number of generations could not be ascertained with any degree of certainty. The difficulty in measuring generation number by alternate periods of abundance and scarcity is best shown by *Schistocerca americana*. Although

there is little evidence from the species abundance data for multiple generations, this abundant and economically important species is well known to have a spring or early summer generation followed by an autumn generation in Florida (Kuitert & Connin 1952). In Florida, asynchronous egg hatch results in some nymphs being present throughout the warm months of the year. Other Florida species known to be multivoltine

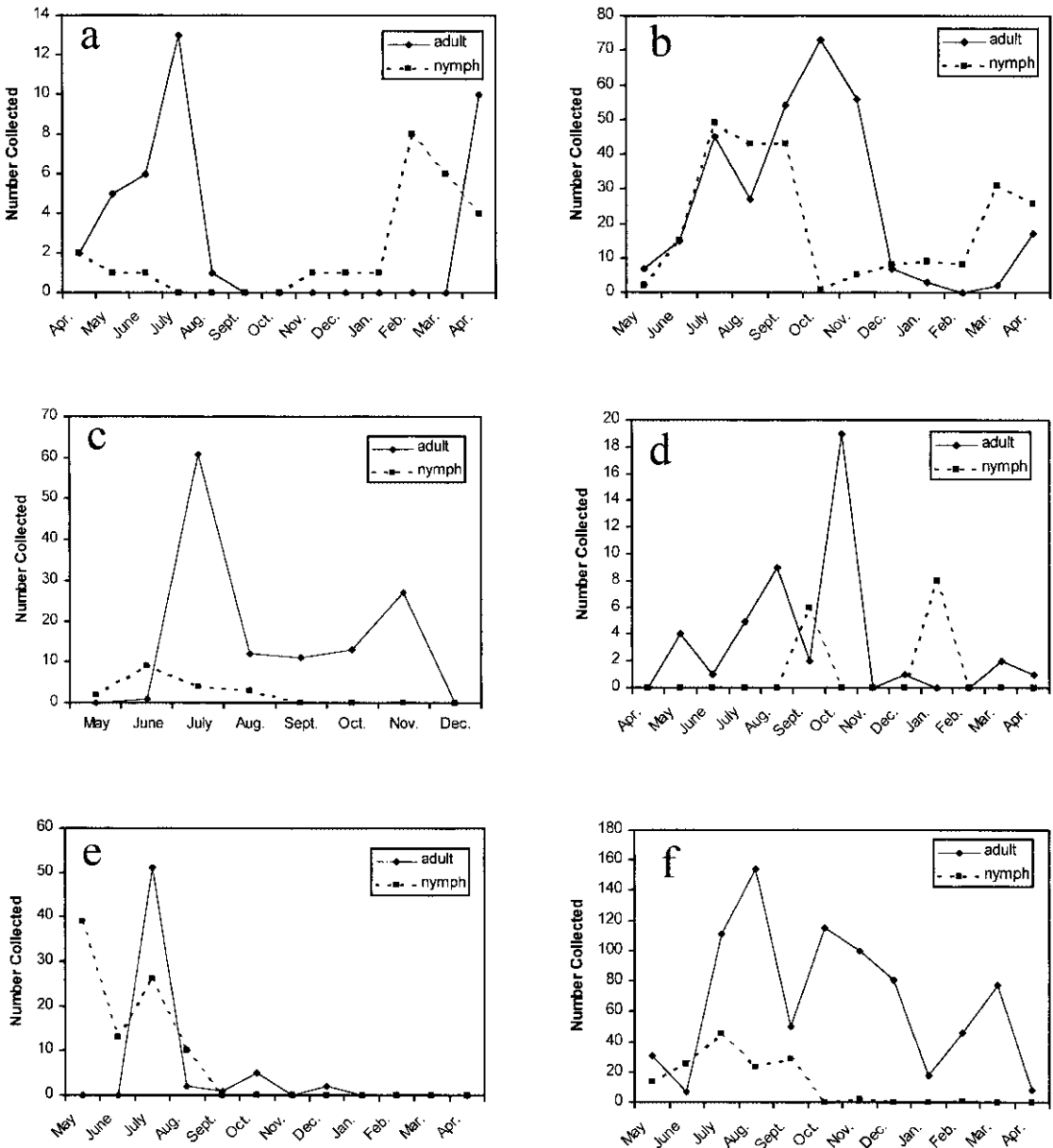


Fig. 4. (a) Phenology of *Pardalophora phoenicoptera*. (b) Phenology of *Paroxya atlantica*. (c) Phenology of *Paroxya clavuliger*. (d) Phenology of *Psinidia fenestralis*. (e) Phenology of *Schistocerca alutacea*. (f) Phenology of *Schistocerca americana*.

elsewhere in the United States are *Melanoplus sanguinipes* and *Melanoplus propinquus* (as *M. femurrubrum*) (Pfadt 1985).

Surprisingly few of the grasshopper species assessed in this study had "typical" life cycles with egg diapause during the winter months. The high proportion of Florida species (36%) with overwintering adults is unknown among the well-known rangeland and crop-feeding grasshopper assemblages of temperate North America (Shotwell

1941, Parker 1957, Capinera and Sechrist 1982), but appropriate for the mild-winter coastal regions of the southeast. Less startling is the level of nymphal overwintering, 27% of the species, but even this level is high relative to northern areas. Also surprising is the ability of both nymphs and adults of *Arphia granulata*, *Chortophaga australior* and *Eritettix obscurus* to overwinter, because typically only one stage of an insect species survives the winter months.

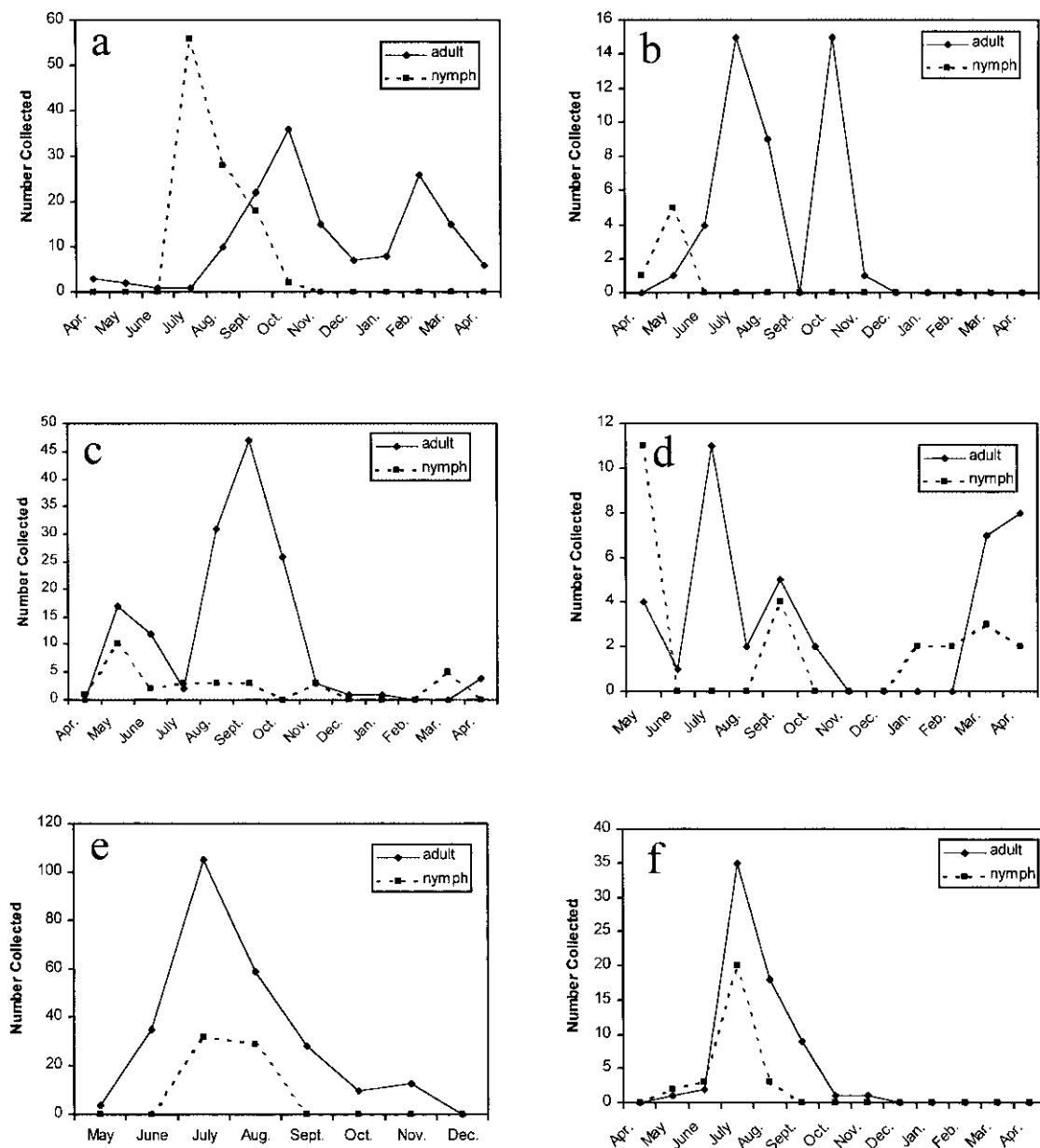


Fig. 5. (a) Phenology of *Schistocerca damnifica*. (b) Phenology of *Spharagemon crepitans*. (c) Phenology of *Spharagemon cristatum*. (d) Phenology of *Spharagemon marmorata*. (e) Phenology of *Stenacris vitreipennis*. (f) Phenology of *Syrbula admirabilis*.

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