BIOLOGY OF THE AMERICAN GRASSHOPPER IN THE
SOUTHEASTERN UNITED STATES

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INTRODUCTION

The American grasshopper, *Schistocerca americana* (Drury), commonly referred to as the bird grasshopper, has been present for a long time in most areas throughout the South but only rarely in damaging numbers. Injurious outbreaks have been restricted to the sandy upland localities extending from southern Florida northward along the ridge and fanning out into northern Florida, southern Georgia and Alabama.

Occasional reports of grasshopper damage have been received from Florida and Georgia for many years past but injury was usually restricted to widely scattered areas and to small portions of fields. Numerous reports of serious destruction of corn and other crops in north central Florida and south central Georgia by American grasshoppers were received by agricultural workers in June of 1950. Surveys of the affected area in Alachua and surrounding counties in Florida by representatives of the Agricultural Experiment Station and Extension Service at once revealed that the grasshoppers were much more widespread than in former years, the insects were extremely numerous over relatively large areas, and they had caused material damage to late corn and peanuts.

The causes of this extraordinary abundance of *S. americana* in south-central Georgia and north-central Florida during 1950-51 are difficult to ascertain. Popular local opinion attributes the unusual numbers to the mild winters of 1948-49 and 1949-50. Some credence can be placed in this belief, as the official Weather Bureau Station at Gainesville, Florida, did not record a minimum temperature of freezing, or lower, during the winter of 1949-50 and there were only two minimum readings of 32 or lower for the winter of 1948-49. Although the authors did not evaluate the importance of parasitism, it appeared to be a very significant factor in some areas. Since the several areas of highest parasite abundance were located in low-ground situations, and since

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temperatures are usually 3 to 5 degrees colder than on high-
ground, we wonder if the previous mild winters could have been
a deterrent to the development of parasites.

Another factor which could well be of some importance is
the tremendous increase in acreage of winter cover crops grown
in the area. Oviposition occurs most frequently in fields which
were under cultivation the preceding year. There is but little
tendency to oviposit in pastures but early instars are found in
these areas; however, such fields have always been situated close
to a “laid-out” cover crop field.

The grasshoppers were considered of sufficient importance to
warrant study and investigation. Two main phases of investiga-
tions were explored; namely, biology and control. The informa-
tion in this paper is restricted to results of the studies and
observations made on biology.

This insect has a life history somewhat different from the
majority of grasshoppers. It overwinters as an adult and lays
its eggs in March and April, while most other species lay their
eggs in the fall and overwinter in the egg stage. There are two
generations a year. Hereinafter, to avoid confusion, when refer-
ence is made to the first or spring generation, it concerns those
individuals which hatch during April and May from eggs de-
posited by females which live through the fall and winter
months. The second or summer generation consists of indi-
viduals which hatch during August and September. Adults
developing from these nymphs are present during the fall and
winter months and are occasionally referred to as the overwinter-
ing generation.

**DESCRIPTION OF THE EGG AND IMMATURE STAGES**

The eggs of *S. americana* are light orange in color, smooth,
widest in the middle and tapering uniformly to both ends.
Measurement of a series of 25 eggs gave a range in length from
7.14 to 7.59 mm., with an average of 7.56 mm.

Since these biological studies were made incidental to control
investigations time did not permit us to rear individual speci-
mens to determine the number of nymphal instars. It is the
opinion of the writers that there are six instars. This is based
on measurements and morphological differences, such as the
number of antennal segments and the size and shape of the wing
pads. In addition, several first instar “clusters” or “groups”
found in a peanut field were caged in the field and observations made involving development, type of damage, and habits.

The first-instar nymphs when newly hatched are 6-7 mm. in length. They have a slender, fragile looking body and a large head. They are pale green in color with a distinct black middorsal line extending the length of the thorax and abdomen. The antennae have 13 segments and the eighth segment is longest. The eyes are large and dark reddish-brown in color. The posterior femora are usually faintly marked on the exterior side with three black horizontal bars. No trace of wing pads is present in this instar.

The second-instar nymphs average 12-13 mm. in length. The head continues to be relatively large and bears prominent dark eyes. The antennae usually have 17 segments but on occasion there may be 18. Wing pads are now present as small but indistinct lobes. In this and succeeding instars there are two general body colors. One is predominantly black and the other is predominantly green. The dark individuals, while not totally black, are heavily marked with black or dark red lightly interspersed with yellow or green. The green forms are light green in color with one prominent black mid-dorsal line extending the length of the head, thorax and abdomen. Specimens of both colors usually have the horizontal black stripes on the exterior side of the posterior femora, although it is more pronounced in the dark individuals.

Third-instar nymphs average 16-18 mm. in length. The antennal segments vary in number from 19 to 20, with the latter number occurring most often. Wing pads are present as distinct triangular flaps or lobes with the point of the triangle directed obliquely ventrad. The color pattern of the third instar is the same as in the second.

The fourth-instar nymphs have an average length of 22-25 mm. and the antennae have 22 segments. The tegmina and wing pads are inverted in this instar (see Shotwell). The point of the triangular pad is now directed obliquely dorsad. The pads are appreciably larger and the venation is now distinct.

Fifth-instar nymphs average 27-30 mm. in length and have 23 or 24 segments in the antennae. No changes in the color pattern take place.

The sixth-instar nymphs range in length from 35-45 mm. The antennal segments number 26 in this instar.
ADULT CHARACTERISTICS

This is a large, rather slender-bodied species. The body length of the females is often 2.3 inches and of the males 1.5 to 1.7 inches. The overall length of the females measured from the tip of the head to the tip of the tegmina when closed is often 2.7 inches, while that of the males is 2.1 inches. Adult specimens when freshly molted are very handsome creatures. The general body color is a reddish-brown with a slight vermilion tint. The tegmina, thorax, and abdomen have numerous brown patches. A prominent light yellowish mid-dorsal line is present on the head and pronotum and extends posteriorly to midway of the length of the closed tegmina. The basal half to three-quarters of the posterior or anal margin of the tegmina is a light yellowish color. This light band is broadest just beyond the point of attachment of the tegmen to the body, begins to narrow gently about midway of the posterior margin and fades out completely on the distal third of the tegmina. When the tegmina are closed these light margins form a continuous stripe with the mid-dorsal stripe on the head and pronotum.

It was noticed that collections of adults made during August and September 1950 always included specimens of two general body colors. In addition to that described above the general body color of some specimens was a light straw-yellow with the darker area being brown. Considerable speculation existed regarding the reasons for the two color forms. As the season progressed it was noticed that the reddish-brown forms were present in increasing numbers. With the approach of winter the yellowish colored individuals began to disappear. A collecting trip made on February 10, 1951, in Alachua County, Florida, netted an estimated 8000 specimens and all were of the dark reddish-brown color. About the first of March it became apparent that the adults, especially the males, were changing in color from the maroon reddish-brown to a bright yellow interspersed with brownish areas. The color change in the females became noticeable a short time later. As these individuals grew older the yellow color became brighter and all traces of the reddish color were lost. The times of the color change correlated with the development of the gonads and it is believed to be associated with the maturation of the testes and ovaries. In general, the changes in coloration found in S. americana are similar to those found by Uvarov in S. gregaria. The presence of both color
forms at the same time in the adult population during August, September, and October is due to an overlapping of generations, while that in the spring is due to the variation in time of the occurrence of the color change in different individuals.

**Biology**

**Food Preferences.**—One of the most astonishing features observed in this grasshopper is the relatively small amount of food eaten by the adults. Evidence of their feeding could be found wherever the grasshoppers occurred, but this was surprisingly light in view of the enormous numbers of the insects present in some areas. Evidence of feeding was observed in corn, oats, peanuts, rye, and lupine fields and they have been reported damaging tobacco and small vegetable plantings. It was found that much of the damage to rye and oats attributed to the American grasshopper was actually caused by certain small, ground-inhabiting species. In tests where young tobacco plants were offered as food to caged S. americana specimens the plants were fed on sparingly. Other crops injured by American grasshoppers include hairy indigo, sugarcane, hegari, and other grain sorghums. In addition to these cultivated crops, feeding by these grasshoppers was observed on the foliage of oaks, wild cherry, holly, myrtle, ground oak, guinea grass, ragweed, and dog fennel.

**Habits and Behavior.**—The overwintering adults prefer “laid out” or idle fields with a good weedy undergrowth interspersed with numerous tall weeds or bush type trees. In numerous instances adults were found in large numbers along the margins of wooded areas in which the stand was light enough to allow considerable sunlight to penetrate to the ground. Observations indicated that the insects never penetrated densely wooded tracts.

Adults move freely, but aside from the movement from the breeding areas to cultivated fields there has been no indication of migration. Although rather short flights of about 20 to 50 yards appear to be the rule, the grasshoppers may fly considerable distances when disturbed. During the winter months there is a regular daily movement of the insects from the trees and shrubs in the tree line to the open fields in the morning and a return to the trees and shrubs in the afternoon. Sunlight and temperature are probably the most important factors in this
movement. Although the reason for this movement has not been
determined, it appears that the insects might be seeking a warmer
or drier situation than is found near the ground. It has not been
learned what proportion of the grasshopper population makes the
daily journey from trees to field and return but it appears to be
large.

The activity of these insects can be correlated with tempera-
ture and sunlight. It was found that on bright sunny mornings
the grasshoppers could be flushed readily at temperatures of
45-50 degrees F., while on cloudy mornings they did not flush at
temperatures of 62 degrees F.

It was observed on a number of occasions during the fall
and winter that the grasshoppers might be extremely numerous
in a field or other localized area one day and several days later
it might be almost impossible to find any of the insects there.
When first observed it was believed that this might be due to
movement from place to place resulting in a fluctuation in the
population from day to day. Although some type of migration
has not been ruled out, there is reason to believe that the grass-
hoppers were present all the time but were simply being over-
looked. The coloration of these insects presents an excellent
camouflage and readily permits them to go unnoticed on cool,
overcast days when they remain quiet. These insects also have
the habit of moving to the far side of branches, twigs, stems of
grasses and weeds or other resting material so that they face
their pursuer. Invariably, as the observer moves the grass-
hoppers move so as to keep on the opposite side of the object on
which they are resting.

When disturbed the adults take to flight. The flight is
initiated with a coarse rustling sound and it is usually down-
wind. If the disturbance is downwind, a grasshopper may make
a short flight into the wind but after a short distance it usually
turns and then flies with the wind. When the insect comes to
rest on an object it immediately moves to the far side of the
twig and draws its posterior legs into a jumping position.

The American grasshopper is a sun-loving creature. All
stages of nymphs and adults in cages located so as to be shaded
during a part of the day were usually found resting on the sunny
side of the cage. The tendency to congregate in sunny areas was
most evident in the field. In areas with heavy cover the grass-
hoppers tended to congregate by the thousands along the roads
and in open plowed areas. On numerous occasions hundreds of
individuals were observed on the sunny side of a single telephone pole.

Early instar nymphs of both generations are gregarious and invariably group together on plants in the immediate vicinity of the hatching area. Often more than 100 first-instar nymphs were taken with a single sweep of an insect net. When disturbed they dispersed quickly but regrouped in a cluster usually within 30-40 minutes. As the season progressed it was noticed that some individuals remained in clusters until the third and fourth instar, while others dispersed over the field in the first and second instars. For a time it was believed that the dark forms mentioned in the description of the immature stages were the individuals remaining in groups while the green forms tended to scatter. Later, however, both color forms were found in the groups and among the dispersed forms.

HATCHING.—The first hatching of eggs in 1951 was observed on April 23; however, numerous second-instar nymphs were observed on April 26, which suggests an earlier hatch, probably about April 20. On April 25 hatching of twelve egg masses was observed, the majority of these occurring between 9 and 11 A.M. Close examination of several of these hatching masses disclosed that the upper eggs hatch first. The chamber in which the eggs were deposited was cylindrical with firmly packed sides. It was nearly perpendicular to the surface, approximately two inches deep, and extended to within about one-fourth inch of the surface. The first nymphs to hatch break through the surface crust and the remaining nymphs emerge through the same opening. When the nymphs appear at the surface they have already shed the amnion from the anterior portion of the body and after emerging they complete the task by shedding the amnion from the posterior portion of the body. The hatching areas and emergence holes are readily located by the accumulated cast amniotic skins.

With but a few exceptions all hatching of first generation nymphs occurred in areas that had been out of cultivation since the previous summer. Infested areas were not uniformly populated. In some instances restricted spots in a field or around abandoned homestead sites literally would be alive with grasshoppers, while adjacent areas were relatively free of nymphs. Most of the areas in which first generation nymphs were found in largest numbers were on relatively high sandy ridges having
a moderately heavy cover of weeds. These areas were, for the most part, the same fields in which large numbers of overwintering adults had been found.

COURTSHIP AND COPULATION.—Copulation of overwintering adults was first observed on January 24, 1951, at Gainesville, Florida. On March 1, 2, and 3 numerous copulating pairs of adults were observed in Alachua County, Florida. Mating continued throughout the Georgia-Florida area as late as June 1. Courtship-like actions were observed with both males and females appearing very excited. The action is usually initiated by the males at a distance of approximately two feet from the female. The male rustles its wings and darts forward about one-fourth of the distance to the female and then remains quiet for several minutes. This is repeated three or four times before the male finally takes position on the back of the female. The female usually does not move from the original position but does flutter the wings in response to the male's actions. Frequently other males were present and these were observed jostling the mating pairs in what appeared to be an attempt to dislodge the male. Most of the mating females collected had distended abdomens and well developed eggs.

OVIPOSITION.—The first evidence of oviposition in the overwintering generation was observed on March 16, 1951, when a female was found with the tip of the abdomen in the ground apparently laying eggs. Three days later female grasshoppers were observed ovipositing in one of the rearing cages. On March 19 seventeen egg masses were found along the margin of a winter wheat field in Alachua County, Florida. Of the seventeen masses found, eight were recovered whole and examined. The eggs were placed in cavities about two inches deep and were loosely held together by a gummy, frothy material and the top of the hole was plugged with this material. The eggs were not placed in any sort of a pod and the outer eggs were in direct contact with the soil. The eggs are deposited in the lower 1 1/2 inches of the hole. The number of eggs per mass varied from 76 to 100, with an average of 85.

Oviposition continued in the overwintering generation until May 7 but became increasingly rarer after the first week of April. The peak of egg deposition probably occurred during the last two weeks of March.

Oviposition by a first or spring generation female was ob-
served first on July 23, 1951. Examination of several egg masses showed that the range in number of eggs was similar to that found in the overwintering or second generation. The average number of eggs was 83.7 per mass. Oviposition of first generation females was last observed on September 1; however, it is assumed that oviposition took place at later dates, since mating pairs were observed as late as September 17, 1951. The peak of egg deposition probably occurred during the first two weeks of August.

NYMPHAL DEVELOPMENT:—First or Spring Generation.—As mentioned earlier, the first first-instar nymphs were observed on April 23 and the first second-instar nymphs on April 26. Third-, fourth-, fifth-, and sixth-instar nymphs were first observed May 3, 9, 15, and 21, respectively. Adults of the spring generation were first observed on June 7 and at this time occasional first-instar nymphs were still present. Adults of the second or overwintering generation were still relatively numerous at the time when sixth-instar nymphs of the spring generation were first observed. After that the number of second generation adults decreased rapidly, although some overwintering adults were noted as late as June 26. Observations during the spring and summer indicated that there is a definite overlapping of generations. On June 26 it was estimated that 50 percent of the first generation had reached the adult stage and by July 30 approximately 95 percent were adults. Sixth-instar first generation nymphs were last observed on August 27.

Copulation of first generation adults was observed first on July 13. On July 23 and 24 large numbers of copulating pairs were observed in the Alachua County area and mating was last observed on August 27.

NYMPHAL DEVELOPMENT:—Second or Summer Generation.—Hatching of the second generation began the latter part of July. First-instar nymphs were first collected July 30 in 1951 and July 31 in 1950. First-instar nymphs of the first generation were last observed on June 13. Thus, it seems reasonable to assume that any first-instar nymphs observed July 30 would necessarily have to be of the second generation. In addition, the assumption that these first-instar nymphs belonged to the second generation becomes more valid when one considers the large number of mating pairs and ovipositing females observed several weeks earlier. Second-, third-, fourth-, fifth-, and six-instar nymphs
were first observed August 8, 13, 21, 27 and September 5, respectively. On August 21, when the first fourth-instar nymphs were collected, it was believed that the peak of hatch had occurred. Adults of the second generation were first collected on September 12. At the time the first second-generation adults were collected individuals of all instars were present but the majority were in the fourth instar. Some adults of the first generation were also present, so that again adults of both generations were present at the same time.

Predators and Parasites

During the last 10 days of January and the first two weeks of February 1951 robins in large flocks were observed feeding on the overwintering adult grasshoppers in several areas in Alachua County, Florida. The robins congregated in extremely large numbers in pastures and fields which were heavily infested. Observations indicated that the robins broke off the wings and legs before eating the insects and this observation was substantiated by finding large numbers of these remains in the areas where the birds were numerous. Other birds observed feeding on grasshoppers included mocking birds, crows, and red-headed woodpeckers. Similar observations were also made in Georgia during this same period. In several fields where the hoppers were extremely numerous balls of regurgitated material were found which consisted almost exclusively of grasshopper remains. The material was characteristic of the hawks but the species could not be determined.

On April 5, 1951, numerous overwintering adults collected in Florida were dissected and found to contain from 3 to 10 dipterous larvae. Specimens of the larvae sent to the U. S. National Museum were identified by W. W. Wirth as Sarcophaga sp. (probably lambdens) of the family Sarcophagidae. On July 23 and 24 observations made in Brooks County, Georgia, disclosed that nearly all adult American grasshoppers leaving the ground were pursued by from 6 to 12 or more flies. Specimens of these flies were collected and sent to the U. S. National Museum for identification. The flies were identified by C. W. Sabrosky as Sarcophaga sp., of the general group Acridrophaga, which are parasitic on grasshoppers. A specific determination could not be made as all of the specimens collected were females and males are required for identification.
On March 20, 1951, a coleopterous larva was collected on a grasshopper egg mass in Alachua County, Florida. This larva was fed on *S. americana* eggs in the laboratory until April 21 and during this period eight eggs were consumed. Since the egg supply was exhausted the larva was killed and sent to the U. S. National Museum for identification. The specimen was determined by O. L. Cartwright as *Conoderus* sp. of the family Elateridae.

Early in May 1951 blister beetles, identified by W. H. Anderson as *Epicauta* sp. (probably *floridensis* Werner) and bee flies, identified by W. W. Wirth as *Systoeobus vulgaris* Lw. of the family Bombyliidae, were collected in areas where nymphs of *S. americana* were abundant. In several instances it was felt that colonies of grasshoppers could be located by the presence of these insects in their vicinity. No larvae of either of these species were observed feeding on the eggs, but since it is known that they do feed on grasshopper eggs it is considered very likely that the eggs of *S. americana* constituted a large proportion of their diet. This belief is strengthened by the fact that both blister beetles and bee flies were reported more numerous this year than usual.

During August and September second generation nymphs were observed to fall prey to several species of web-spinning spiders. Also during this period several species of mantids were observed to capture and feed on nymphs.

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**REFERENCES**


