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Field observations of *Irbisia pacifica* (Hemiptera: Miridae): feeding behavior and effects on host plant growth

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FIELD OBSERVATIONS OF *IRBISIA PACIFICA* (HEMIPTERA: MIRIDAE): FEEDING BEHAVIOR AND EFFECTS ON HOST PLANT GROWTH[1,2]

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Abstract.—The interaction between a grass-feeding mirid, *Irbisia pacifica* (Uhler), and plant growth of intermediate wheatgrass, *Thinopyrum intermedium* (Host) Barkw. & D. R. Dewey, was examined on a field site in northern Utah in 1985. With egg hatch beginning in April, the bug completed its life cycle within two months. Ovarian development was completed by 11 June, a week after all bugs had become adults. The proportion of feeding damage per leaf (35.1%) peaked on the seventh week of the twelve-week study (18 July). Green leaf area per tiller decreased initially from bug feeding and then continued to decrease because of seasonal aging. All plants senesced within three months. Grass bugs predominantly attacked the second and third youngest leaves. Analyses of age-specific leaf cohorts demonstrated that the major effect of bug feeding was the loss of green leaf area and potential foliage production over time. Bug feeding may also exacerbate other physiological stresses on the host plants.

The grass bug, *Irbisia pacifica* (Uhler) (Hemiptera: Miridae), has the widest distribution among all species within the genus (Schwartz 1984). In this univoltine species, all five nymphal instars and the adult stage feed on an assortment of native and introduced grasses (Schwartz 1984, Hansen 1986). At times this insect is a pest of forage grasses in the Intermountain West (Knowlton 1951, 1967).

In spite of its economic importance, very little is known about the interaction between feeding by *I. pacifica* and its impact on host plants. Hansen and Nowak (1985) observed that although chlorophyll concentration in leaves of crested wheatgrass, *Agropyron desertorum* (Fisch. ex Link) Schult., decreased as feeding by *I. pacifica* intensified, specific leaf mass remained about the same. They also suggested that a compensatory response occurred with this feeding. Hansen (1987) showed that adult *I. pacifica* prefer the second and third youngest leaves and that feeding was greatest near the leaf tip. However, these studies did not examine the impact of feeding on plant growth and survival in the field.

The objectives of the present study were to determine in the field the effect of feeding by *I. pacifica* during its life cycle on spring growth of intermediate wheatgrass, *Thinopyrum intermedium* (Host) Barkw. & D. R. Dewey, and to obtain biological information on the development and population changes in *I. pacifica*.

Materials and Methods

The study was conducted during the spring growing season of 1985 at an ungrazed pasture that contained a monoculture of intermediate wheatgrass. This site, ca 3 km NE North Logan, Utah, was selected because of its history of high populations of *I. pacifica*.

Along a fence row, 25 grass tillers (or plants) 50 cm apart were identified by colored wire rings. The plants were examined weekly from the time the insects became active (8 May) to full plant senescence (24 July). For every observation, all leaves on each marked plant were measured for length, width, condition, height from ground, and location on the plant. The amount (expressed as a proportion) of bug-feeding damage for each leaf was visually estimated as described by Hansen and Nowak (1985). Relative bug population densities were obtained by taking 10 full sweeps with a standard (38-cm-diameter) net in the pasture. Adult females were dissected to determine reproductive condition by using the technique of Kamm and Ritcher (1972).

Total leaf area was estimated by multiplying

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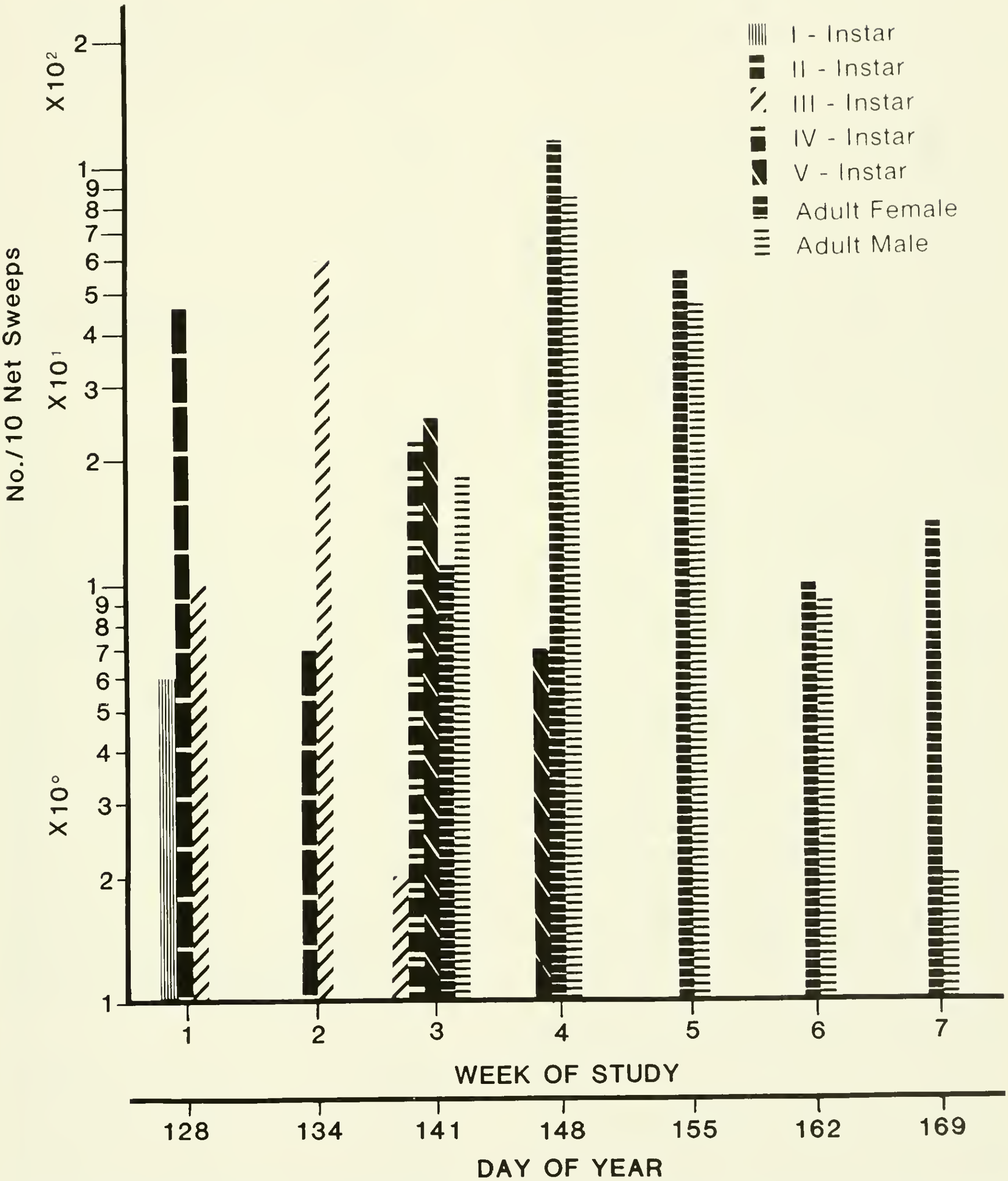

Fig. 1. Weekly collections from 8 May 1985 to 18 June 1985 of all life stages of *Irbisia pacifica* from an ungrazed pasture of intermediate wheatgrass, 3 km NE of North Logan, Utah.

length by width. Undamaged green leaf area (GLA) was estimated by subtracting the area damaged by feeding from total leaf area. Leaf size and relative position of cohorts (leaves of the same age) were followed throughout the study. For each weekly observation the youngest leaves were the most apical, while the oldest were the lowest on the plant.

Data analysis was done at the USDA Washington Computer Center with the Statistical Package SAS (Statistical Analysis System, SAS Institute Inc., SAS Circle, Box 8000, Cary, NC 27511-8000) using the procedure MEANS (SAS User's Guide: Basics, 1982 ed., p. 527). Linear correlation and Student's t-tests were conducted with a Hewlett-Packard HP-11C calculator.

Results

Early instar nymphs of *I. pacifica* were already present when the field study began on 8 May (Fig. 1). Adults appeared in the third week (21 May), and metamorphosis was completed by the fifth week (4 June). The largest weekly collection was in the fourth week. Weekly adult sex ratios favored females, except for the collection during the third week when males outnumbered females by 63.6%. In the seventh week females exceeded males by 700%, and no bugs were found after this collection.

No eggs were found in the first dissection of adult females (week 3). By the fifth week, 87.3% of the adult females contained eggs, and females collected the next week had the greatest proportion of eggs (90.0%). In the last week that females were collected, the fecundity level remained high (78.6% with eggs).

Although some grass bugs were present at the start of the study, grass plants appeared uninjured (Fig. 2). The proportion of feeding damage on green leaves was initially low (7.1%) but increased very rapidly between the third and fourth weeks. After culminating on the seventh week (35.1%), the proportion of feeding damage steadily declined, thus indicating some form of recovery. Only one plant survived to the twelfth week, a factor that resulted in erratic values. Total GLA per tiller increased during the first few weeks of the study and then dropped consistently from the third week to the eleventh. The correlation between average GLA per leaf and week of collection was highly significant (r^2 = .893, slope = −2.36, $P < .01$). Total leaf area per tiller peaked a week after maximum GLA. Most of the grass plants endured to the tenth week, then senesced or died within the remaining two weeks. Seed head production was first observed in the seventh week and continued irregularly during the rest of the study. Only 44% of the plants grew seed heads.

Initially, all plants had at least three green leaves. In the second observation five plants had five green leaves, and in the fourth week one plant had six green leaves. Yet after the

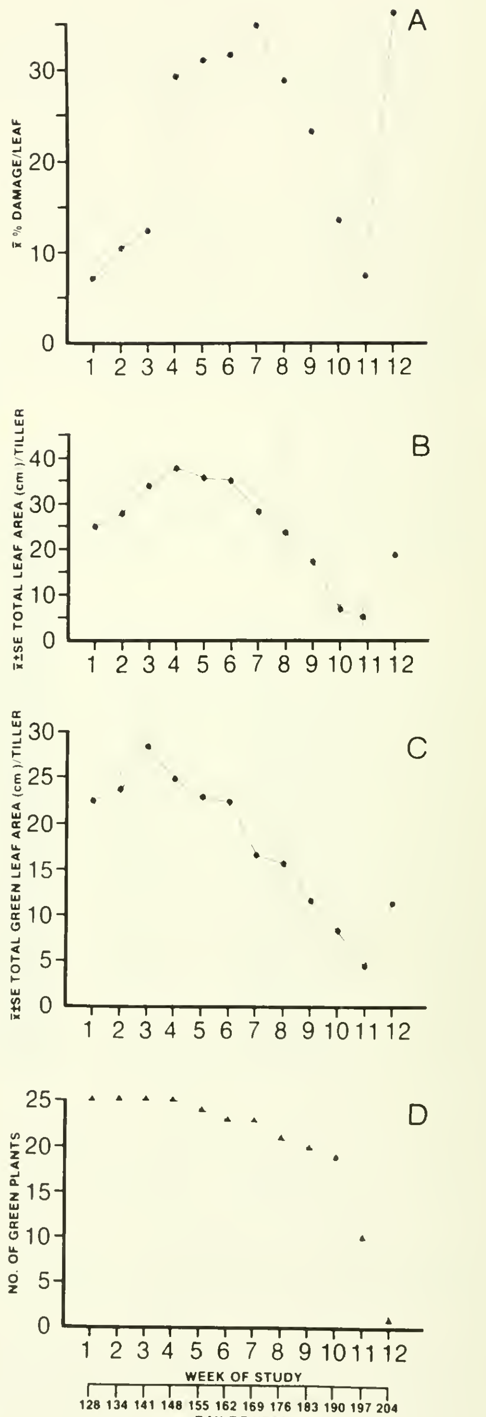

Fig. 2. Summary of weekly measurements of intermediate wheatgrass attacked by *Irbisia pacifica*: A, percent feeding damage/leaf of green leaves; B, total leaf area (cm^2)/tiller; C, total green leaf area (cm^2)/tiller; D, number of green plants.

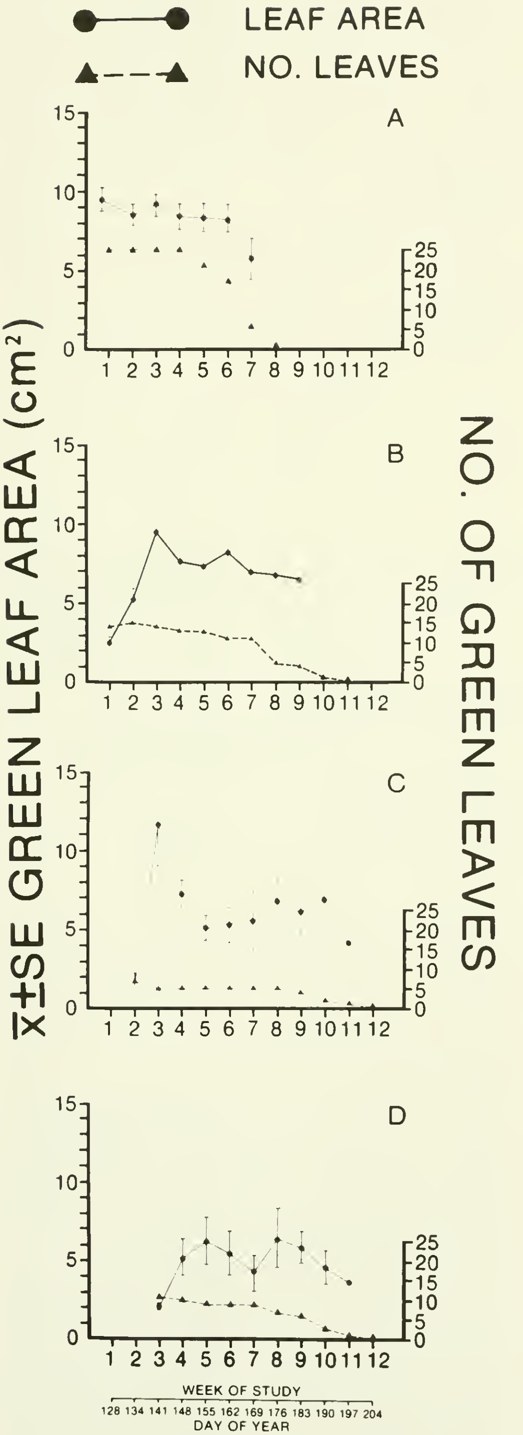

Fig. 3. Weekly green leaf area and number of green leaves of selected age-specific cohorts of intermediate wheatgrass: A, Cohort A; B, Cohort B; C, Cohort C; D, Cohort D.

seventh week, no plant had more than three green leaves.

The greatest damage by leaf position was to the third youngest leaf at the fifth week ($\bar{x} \pm SE = 49.1 \pm 4.2\%$). Excluding the last week, the greatest average damage among leaf-age categories for the entire study was to the second youngest leaf ($\bar{x} \pm SE = 28.4 \pm 4.4\%$), then the third youngest ($\bar{x} \pm SE = 24.4 \pm 5.1\%$), followed by the youngest ($\bar{x} \pm SE = 13.4 \pm 2.0\%$). Paired Student's t-tests showed no significant differences among the weekly damage values between the second and third youngest leaves ($t = 2.023$, $df = 10$), but significant differences between the youngest and the second youngest ($t = 5.125$, $df = 10$, $P < .01$), and the youngest and the third youngest ($t = 2.883$, $df = 10$, $P < .05$). For the remaining leaf positions, the average weekly damage for the fourth youngest leaf ($\bar{x} \pm SE = 19.6 \pm 5.0\%$, eight weeks) was greater than for the next oldest leaf ($\bar{x} \pm SE = 9.6 \pm 2.6\%$, seven weeks.).

The weekly average GLA in the cohorts clearly showed the seasonal changes in plant phenology and the effects of bug feeding (Fig. 3). At the start of the study, Cohort A was the second youngest, fully expanded leaf, while Cohort B was the youngest growing leaf. Two weeks later Cohort B reached maximum growth. By the seventh week, Cohort A was the oldest leaf in some plants (the bottom leaf); Cohort B was the oldest leaf in the ninth week. Cohort C appeared in the second week as the youngest expanding leaf, and Cohort D, also as the youngest growing leaf, in the third week. Cohort C took a week for maximum growth, while Cohort D required two weeks; both cohorts were gone by the end of the study.

Bug feeding affected each cohort differently (Figs. 3, 4). In Cohort A the amount of GLA decreased slightly up to the sixth week, then dropped suddenly. The rate of increase in percent feeding damage in Cohort A was lowest of the four cohorts. After leaf expansion, GLA in Cohort B gradually decreased. The rate of feeding damage increased rapidly for Cohorts C and D before reaching maximum levels at the fifth week.

DISCUSSION

In the intermountain region the single gen-

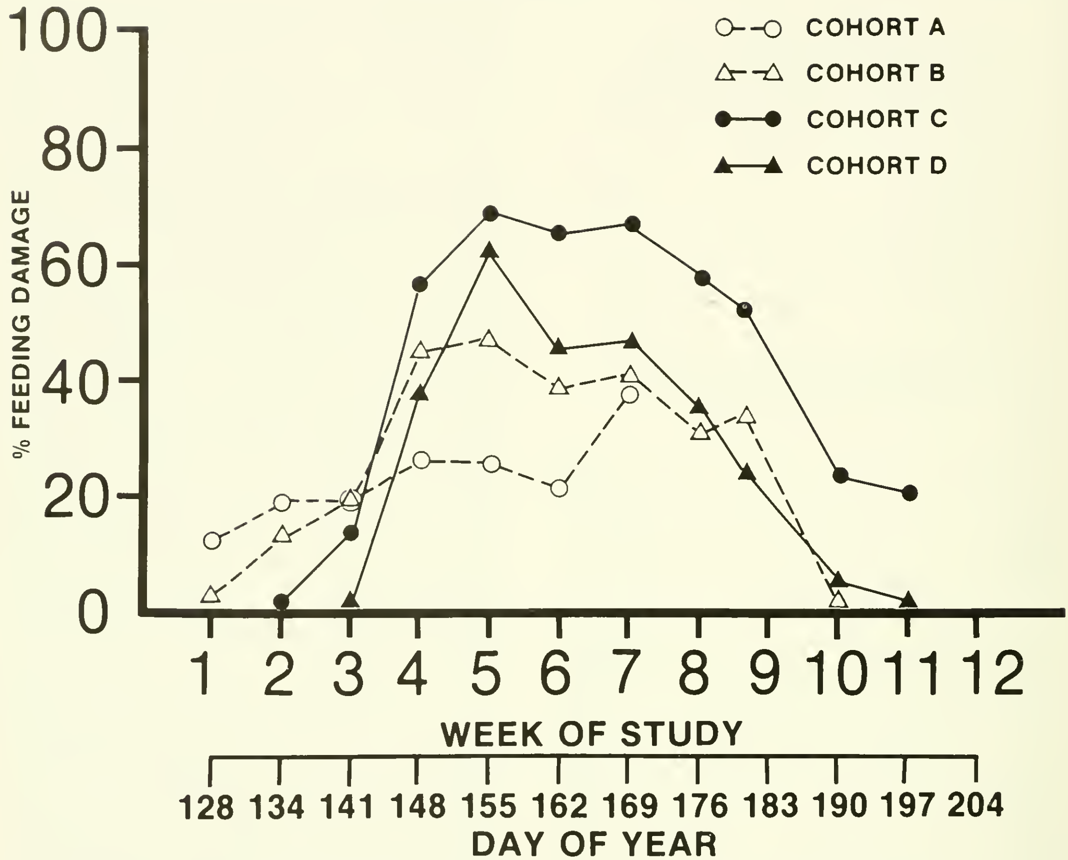

Fig. 4. Weekly percentage of feeding damage of four age-specific cohorts of intermediate wheatgrass.

eration of *Irbisia pacifica* occurs in late spring and early summer. At the study site, development of all nymphal stages was rapidly completed in about a month. Schwartz (1984) estimated the duration of nymphal development in *Irbisia* sp. from western Oregon to be four weeks. The population (Fig. 1) increased until peaking at the fourth week. More likely, however, this apparent increase resulted because either adults were more easily collected than nymphs or adults moved from the middle to the periphery of the pasture.

Female adults of *I. pacifica* generally outnumbered males (Fig. 1). Females also outlived males. These observations were similar to those of Schwartz (1984) for the genus *Irbisia*. Total adult life span at the study site was less than six weeks, but it may differ elsewhere. These insects appear highly sensitive to increased temperatures (Hansen 1987), and a cool summer may conceivably prolong life.

Females apparently required about a week after the adult molt for ovarian development. The oviposition period seemed short, peaking about a week after maximum female population level (28 May). Since most males were gone by the seventh week, mating presumably occurred early.

The amount of GLA is physiologically important to the plant. GLA is a good indicator of the potential for plant growth and maintenance. A leaf in good condition has a large GLA relative to its total size. GLA is also the primary food source for *I. pacifica*.

When GLA is compared to total leaf area, plant damage from different origins can be demonstrated. The greatest proportion of bug-feeding damage occurred between the third and fourth weeks, which coincided with the decline of GLA (Fig. 2). However, total area peaked one week later, suggesting that the grass bugs caused a premature drop in GLA. The percent of feeding damage per leaf declined after the seventh week because the grass bugs were no longer present. Yet, the total GLA per tiller also declined, indicating that other physiological factors, such as drought stress, were also causing senescence. Other grass-feeding mirids and early instar nymphs of grasshoppers were on the study site during this time, but there were too few of these insects to be the primary cause of late-season decline of GLA. Senescence is a common characteristic of intermediate wheatgrass during dry periods. The decline in plant population after the tenth week was not directly due to bug feeding, but feeding damage may have contributed to plant mortality that occurred earlier in the growing season.

Grass bug feeding differed with leaf position. *Irbisia pacifica* clearly preferred the second and third youngest leaves. This feeding preference verified an earlier study on *I. pacifica* feeding-site selection on leaves of field-collected intermediate wheatgrass and other grass species (Hansen 1987). Reasons for this preference are still unknown.

The interrelationship between the host plants and grass bug feeding was best illustrated by the cohort data (Figs. 3, 4). Cohort A, which had mature leaves at the start of the study, was relatively unharmed by *I. pacifica*. As the season progressed and the grass bugs developed, the other cohorts were affected more. The leaves of Cohorts B, C, and D all had an opportunity to expand successfully because the youngest leaves present on a tiller are less preferred (Hansen 1987). Cohort B had less damage than Cohort C because more of the grass bugs were immature at the time of attack. The rapid increase in percent feeding damage for Cohorts B, C, and D between the third and fifth weeks occurred when the bugs became adults. All cohorts exhibited a reduction in GLA and eventual death due to normal aging. Yet, the greatly reduced GLA in the later cohorts (Cohorts C and D) suggested that meaningful damage from bug feeding reduced biomass production.

In summary, grass bug feeding resulted both in less GLA and in less potential foliage. Feeding may also cause presenescent stress that may weaken the grass plant physiologically. Although we did not examine it in this study, other researchers found that seed head production in intermediate wheatgrass was reduced by another grass-feeding mirid, *Labops hesperius* Uhler (Malecheck et al. 1977).

This study suggests several areas for future research with *Irbisia pacifica*. First, the nutritional quality of the host plants, particularly the nitrogenous compounds, should be examined to determine their effect on insect development and egg production (McNeill 1971, 1973). Does *I. pacifica* complete its life cycle before grass senescence because of an intrinsic mechanism, or is it due to nutrition? If nutrition is important, how can intermediate wheatgrass be developed as a good forage crop without encouraging *I. pacifica* population growth? How do grazing practices interact with growth of plants attacked by grass bugs? If monocultural stands of intermediate wheatgrass increase *I. pacifica* populations, what other forage species can be interspersed to reduce bug-feeding damage? Finally, the effect of *I. pacifica* feeding on growth of other host plants needs to be examined.

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