

Instar 1



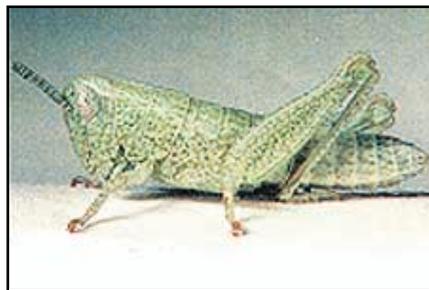
1. BL 5.5 mm FL 2.4 mm AS 11.

Instar 2



2. BL 5.2-8.3 mm FL 3-3.7 mm AS 13-15.

Instar 3



3. BL 8-10.5 mm FL 4.7-5.4 mm AS 17-18.

Instar 4



4. BL 9.6-12.6 mm FL 5.8-6.7 mm AS 18-20.

Instar 5



5. BL 11-18.2 mm FL 7.8-9.8 mm AS 21-22.

Figures 1-5. Appearance of the five nymphal instars of *Hypochlora alba* - their sizes, structures, and color patterns. Notice progressive development of the wing pads. BL = body length, FL = hind femur length, AS = antennal segments number.

runs behind the eye on the side of the head and continues onto the lateral lobe of the pronotum and the sides of the meso and metanotum. Dry, pinned specimens change color, turning dull yellowish tan. The male cercus is broad at the base and slender apically, the furcula is short and slender, and the subgenital plate bears an apical tubercle (Fig. 8). Infrequently the female is long-winged.

The nymphs are identifiable by their shape, structures, and color (Fig. 1-5).

1. Head pale green and spotted brown, antennae of instar I blue and each segment with anterior pale annulus, antennae of instars II to V green and segments with anterior pale annuli, segments of instars III to V with brown spots or suffusions of brown.
2. Pronotum pale green and spotted brown, median carina paler green, this dorsal line runs from median carina onto meso and metanotum and the abdomen; medial area of hind femur pale green and spotted brown or medium green; hind tibia pale green.
3. Abdomen pale green and spotted brown.

Collections of grasshoppers from rangeland may include nymphs of *Hypochlora alba* and *Hesperotettix viridis*. Both species are spurthroated grasshoppers and green. The two can be separated by the following characteristics. 1. *H. viridis* is medium green, *H. alba* pale green. 2. Antennae of *H. viridis* are black with segments having a pale anterior annulus, *H. alba* have green antennae and may be spotted or suffused with brown in the older instars. 3. *H. viridis* has medial area of hind femur medium green and spotted black in instars I and II, and medium green with black chevrons in instars III to V, *H. alba* has the medial area of hind femur pale green and spotted brown or medium green.

Hatching

Hatching about one month after *Ageneotettix deorum*, the cudweed grasshopper belongs to the late-developing group of grasshoppers. In the tallgrass prairie of eastern Kansas, eggs may begin to hatch as early as May 15 (Table 1). In southeastern North Dakota and in northern Colorado, they begin to hatch June 1. Hatching continues for approximately one month.

Nymphal Development

For a rangeland species that spends most of its time above ground on the host plant, the nymphs develop relatively fast. In a mixedgrass prairie site in northcentral

Figures 6-9. Appearance of the adult male and female of *Hypochlora alba*, end male abdomen, and egg pod and eggs.

Colorado, late instars and adults have been discovered from morning to evening sitting 5 to 11 inches above ground on stems of cudweed and fringed sagebrush. For many ground-dwelling grasshoppers this height serves as a refuge from extremes of high temperature.

As measured from first hatch to first adults, the nymphal period lasts 44 to 46 days (Table 1). Both males and females require five instars to achieve adulthood.

Adults and Reproduction

Adults remain in the same habitat in which the eggs hatch and nymphs develop. In the mixedgrass prairie the majority of adults congregate in patches of cudweed. Some adults, however, rest on isolated host plants and also on isolated non-host plants. This fact indicates limited dispersal and the mixing of individuals in a population among host-plant patches.

No investigation of maturation and courtship have been conducted. Observations of two pairs in copulo were made 12 August 1994 at 6:46 a.m. and at 9:25 a.m. DST in a mixedgrass prairie site of northcentral Colorado (altitude 5,400 feet). One pair rested 1.5 inches from the tip of a 10-inch tall cudweed plant; the other pair inhabited a cudweed patch, but its position was not noted. Adults were observed in this Colorado site from July 31 to October 4, 1993. The population dwindled in density as the season progressed. Females oviposit in the interspersed bare areas of grassland. During oviposition, the female holds on to an upright plant, and with hindlegs held high, works her ovipositor into the soil. A record of one complete oviposition revealed that drilling began at 3:10 p.m. and egg laying finished at 4:25 p.m. The female then devoted several minutes to movement of soil particles over the cavity with her ovipositor. The pod is slightly curved, 5/8 to 3/4 inch long, and contains 8 to 12 eggs (Fig. 9). The eggs are tan and 3.8 to 4.9 mm long. In the ground, the eggs are oriented nearly vertically.

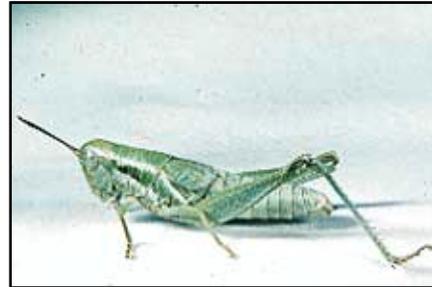
Population Ecology

An important population characteristic of an organism is its dispersion. The term refers to the distribution or spacing of individuals in the habitat. Because in its nymphal and adult stages the cudweed grasshopper almost continually occupies the host plant, the dispersion of the plant determines that of the grasshopper. Where cudweed is abundant and scattered as in the tallgrass and sand prairies, the grasshopper is relatively abundant and scattered. But in the mixedgrass prairie, the cudweed plant is less abundant and grows chiefly in clumps in well-watered situations such as sandy loam slopes and ravine bottoms. These clumps of cudweed plants serve as the main residential sites of the grasshopper and cause the



Male

6. BL 14.5-16.6 mm FL 9.7-10.5 mm AS 21-25.



Female

7. BL 17-22 mm FL 10.1-11.7 mm AS 22-23.



Cercus

8. End of male abdomen showing cerci, furcula, and supraanal plate.



Eggs

9. Egg pod and three exposed eggs

dispersion of the grasshopper to be clumped. Measurements of density of young adults were taken both in patches of cudweed plants and in the general area of a sandy slope site in northcentral Colorado. The sampled density of cudweed grasshoppers in the general area amounted to 0.8 young adults per square yard but in clumps there were six young adults per square yard confirming the general impression of the clumped nature of cudweed grasshoppers.

The steady persistence of the cudweed grasshopper in sites with an abundance of their host plants was shown in a study of grasshopper assemblages inhabiting the sand prairie of southeastern North Dakota. The study revealed the presence of populations of the cudweed grasshopper every year from 1959 to 1969. The relative abundance of the species fluctuated from 7.3 percent of the grasshopper assemblage in 1959 to 2.2 percent in 1964. The study also showed that the cudweed grasshopper was an important member of the forb-feeding group in the sand prairie. Studies in Kansas have shown this species to be numerically important also in the tallgrass prairie. Of 8,100 grasshoppers collected methodically by sweep net from 1982 to 1986 at six sites in native tallgrass prairie (Konza Prairie Kansas), the cudweed grasshopper was fourth in abundance. Ranks of the five dominant species were the following: *Phoetaliotes nebrascensis* comprised 54 percent of the total; *Melanoplus scudderi*, 14 percent; *Orphulella speciosa*, 11 percent; *Hypochlora alba*, 7 percent; and *Melanoplus keeleri*, 6 percent. Of the forb feeders, *M. scudderi* ranked first, *H. alba* ranked second, and *M. keeleri* third.

Daily Activity

The cudweed grasshopper is a phytophilous species. Nymphs and adults spend almost all of their time on the primary host plant, cudweed sagewort. They may, however, also rest on other plants, particularly fringed sagebrush and silver sagebrush. Before sunrise, individuals have been observed resting vertically, head-up on main stems of cudweed at heights of 8 to 12 inches. They have occasionally been found on the top leaves resting in a horizontal position. Presumably both orientations are their nighttime positions.

As soon as the rays of the rising sun strike them, they adjust their positions on the plant to take full advantage of the warming rays. Still in a vertical, head-up orientation, they turn a side perpendicular to the sun's rays and lower the associated hindleg to expose the abdomen more fully. After basking for approximately two hours, they begin to stir,

move, and feed. Although mating pairs have been observed as early as 6:45 a.m. DST, the specific time of courting and joining is unknown. Also unknown is the time of day in which oviposition occurs. During the day most individuals observed on the host plant are resting quietly. A few observations have been made of their movements. For example, a female was observed at 10:13 a.m. basking 6 inches above ground on the north side of a cudweed stem; at 10:15 a.m. she backed down 2 inches, then pivoted 45° to the east side of the stem and climbed 2 inches, and then she turned to the west side of the stem; at 10:17 a.m. she fed briefly; by 10:26 a.m. she had moved to the top of the plant (8 inches) in a vertical head-up orientation; at 10:30 she was flushed by the observer in attempting to get a closer look. Adults have also been observed to jump appetitively 2 to 8 inches from one stem to another or to a higher position on the same stem.

When disturbed, both nymphs and adults often jump 2 to 8 inches from one stem of cudweed to another, retaining a vertical head-up orientation. They may jump just once or several times before settling down. Occasionally they may jump as much as 2 feet and land on the ground, but then almost immediately they jump back onto a nearby host plant. Unlike *Chorthippus curtippennis*, they do not drop to the ground to evade a potential predator. To avoid overheating at high air temperatures (100°F and above) cudweed grasshoppers already several inches above the hot soil surface simply move to the shady side of the plant stem in their usual vertical, head-up orientation. For night shelter they stay and rest on the main stem of the host plant in the same characteristic orientation.

Table 1. Phenology of *Hypochlora alba* in selected sites of its geographic range.

Site	Altitude feet	First Nymphs	First Adults	Nymphal period days
Kansas (eastern)	1,200	May 15	July 1	46
North Dakota (southeastern)	1,100	June 1	July 15	44
Colorado (Boulder)	5,450	June 1	July 15	45
Colorado (Chautauqua)	5,750	June 12	July 28	46

Selected References

- Alexander, G. and J.R. Hilliard, Jr. 1969. Altitudinal and seasonal distribution of Orthoptera in the Rocky Mountains of northern Colorado. *Ecol. Monogr.* 39: 385-431.
- Campbell, J.B., W.H. Arnett, J.D. Lambley, O.K. Jantz, and H. Knutson. 1974. Grasshoppers (Acrididae) of the Flint Hills native tallgrass prairie in Kansas. *Kansas Agr. Exp. Stn. Research paper* 19.
- Criddle, N. 1935. Studies in the biology of North American Acrididae: development and habits. *Proc. World's Grain Exhibition and Conference, Regina, 1933. Can. Soc. Agriculturists* 2: 474-494.
- Evans, E.W. 1988. Community dynamics of prairie grasshoppers subjected to periodic fire: predictable trajectories or random walks in time. *Oikos* 52: 283-292.
- Knutson, H. 1982. Development and survival of the monophagous grasshopper *Hypochlora alba* (Dodge) and the polyphagous *Melanoplus bivittatus* (Say) and *Melanoplus sanguinipes* (F.) on Louisiana sagewort, *Artemisia ludoviciana* Nutt. *Environ. Entomol.* 11: 777-782.
- Mulkern, G.B. 1980. Population fluctuations and competitive relationships of grasshopper species (Orthoptera: Acrididae). *Trans. Am. Entomol. Soc.* 106: 1-41.