Impact of a White Grub (*Phyllophaga crinita*) on a Shortgrass Community and Evaluation of Selected Rehabilitation Practices

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Abstract

During the spring of 1973, white grubs, *Phyllophaga crinita* (Burm.)[1], at a density of 46.3/m², reduced cover of perennial grasses by 88% in localized areas of a shortgrass community in Scurry County, Texas. Forbs and broom snakeweed were not affected. Chlordane applied to the soil surface at 3.36 kg/ha did not control white grubs. Chlordane, nitrogen fertilization (112 kg/ha of N), and a combination of the insecticide-fertilization treatments did not appreciably enhance rehabilitation of white grub-denuded rangeland. Seeding with introduced grasses was not successful because of inadequate precipitation, heavy grazing by lagomorphs on the small areas, and competitive effects of buffalograss. Forbs and broom snakeweed were not important in the early seral stages of secondary succession on the study site, but common broomweed and common sunflower were dominants on other denuded sites in the area. Most plant species had recovered by the end of the second growing season without fencing to control livestock grazing.

White grubs (Coleoptera: Scarabaeidae), the larvae of June beetles, are among the most destructive of soil-dwelling insects (Hewitt et al. 1974). However, no quantitative evaluations of their effects on rangeland vegetation have been published. The adult June beetles feed on foliage of broadleaf and coniferous trees and cause little damage, but the larvae feed largely on the roots of grasses. Large acreages of rangeland in the northwestern Texas panhandle, northeastern New Mexico, Colorado, Kansas, and Nebraska have been severely damaged by white grubs (Saylor 1940; Schumacher 1959; Daniels 1966; Anon. 1971a; Anon. 1971b). Moderate damage by white grubs is often attributed to drought or low levels of soil fertility. However, high population densities of white grubs can kill rangeland vegetation, crops, pastures, and lawns (Anon. 1959; Randolph and Garner 1961). Feeding by white grubs can also provide a mode of entry for disease organisms which can eventually kill infected plants (Drake 1964). Graber et al. (1931) reported that liberal fertilization and favorable growing conditions reduced the degree of injury by white grubs to Kentucky bluegrass (*Poa pratensis* L.) pastures.

Most species of white grubs have a 3-year life cycle, and most of the damage to plant roots occurs during the 2nd year. White grubs may cause damage every year if several broods co-occupy the same area, but usually the severe injury occurs in 3-year cycles (Anon. 1959).

A localized die-off of range vegetation in the southwestern Rolling Plains resource area of Texas during the spring of 1973 was attributed to severe root-feeding by the white grub *Phyllophaga crinita* (Burm.). This study was initiated to quantify white grub damage to rangeland vegetation and to evaluate fertilization, insecticide treatment, and seeding for rehabilitation of rangeland severely damaged by white grubs.

Methods and Materials

This study was initiated in May, 1973, and continued through September, 1975, on the Lefors Ranch, 3 km west of Dermott in Scurry County, Texas. Average annual precipitation of the area is 48 cm. About 70% of the annual precipitation falls during the April to September growing season.

Soils are of the Mansker and Potter series and textures are loams to clay loams. Topography is rolling with 1 to 5% slopes. The major grasses in this shortgrass community include buffalograss (*Buchloe dactyloides* Nutt.), red threeawn (*Aristida longiseta* Steud.), and hairy tridens [*Erioneuron pilosum* (Buckl.) Nash]. Major forbs include common broomweed [*Xanthocephalum dracunculoides* (D.C.) Shinners] and leatherweed croton [*Croton pottsii* (Klotzsch) Meull. Arg.]. Broom snakeweed [*Xanthocephalum sarothrae* (Pursh) Shinners] is a common half-shrub or shrublet. Localized honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*) occurs on deeper soils.

On May 22, 1973, the following treatments were applied to grub-denuded plots: (a) 3.36 kg active ingredient (a.i.)/ha of chlordane

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[1] Coleoptera: Scarabaeidae.

(octachloro-4,7-methano tetrahydroindane); (b) 112 kg/ha of nitrogen as ammonium sulfate; (c) 3.36 kg a.i./ha chlordane + 112 kg/ha nitrogen as ammonium sulfate. Untreated check plots were established on a grub-denuded and adjacent undisturbed rangeland. Each treatment was replicated three times in a randomized complete block design. Plot size was 6.1 by 13.4 m. The insecticide was applied to experimental plots with a 203-cm boom, with nozzles on 50-cm centers, mounted on bicycle wheels. Fertilizer was applied with a whirl-wind type hand spreader. The experimental plots were not fenced and were grazed continuously during the study at a moderate stocking rate with a cow-calf herd.

Population density of *P. crinita* was determined before application of treatments and on June 6, 1973, May 21, 1974, and June 19, 1975, by excavating soil in ten, 30.5- by 30.5-cm quadrats to 20 cm deep. Soil was sieved over 0.5-cm mesh hardware cloth to facilitate counting of larvae, pupae, and adults.

Below ground plant biomass was determined on May 10, 1973, by extracting roots from ten randomly selected soil cores (81.07 cm^2 by 30.5 cm) taken from grub-denuded rangeland and from ten similar cores taken from adjacent undisturbed rangeland. Each soil core was washed over a soil sieve (0.42-mm mesh) to separate the soil and roots. Root samples were oven-dried, weighed, and ashed to determine an ash-free weight for each sample.

Foliar cover was determined on May 24, 1973, and subsequently on October 18, 1973, October 25, 1974, and September 25, 1975, by the point-frame technique (Levy and Madden 1933). One hundred points were observed in each plot on each sampling date. Readings were taken at ten equidistantly spaced intervals along a permanent line transect across the diagonal of each plot. Any above-ground plant part hit by the pin point was recorded as a hit. Differences between treatments in foliar cover for major plant species and vegetation categories were determined by analyses of variance of total hits per plot.

An auxiliary study was conducted to evaluate seeding with introduced grasses for rehabilitating white grub-denuded rangeland. Plots 6.1- by 13.4-m were tilled to 8 cm deep on May 23, 1973, on white-grub denuded rangeland. Kleingrass (*Panicum coloratum* L.) and Ermelo weeping lovegrass [*Eragrostis curvula* (Schrad.) Nees var. *Ermelo*] were seeded in single plots at 3.4 kg P.L.S./ha and 3.1 kg P.L.S./ha, respectively, in rows on 50-cm spacings. Seeded plots were fenced to exclude livestock.

Results and Discussion

Initial Impact on Plant Community

White grub-infested areas were localized and did not constitute a major range management problem in Scurry County, although ranchmen who had patches of dead grass were concerned that infestations might spread and become a major problem. Most white grub-denuded areas were 0.1 ha or less in area, but some covered 1 ha or more. In early May, 1973, all grass plants in infested areas appeared to be dead. Grass roots had been completely severed at 2 or 3 cm below the soil surface, and most grass plants had fallen to a horizontal position, exposing the severed roots. Foliar cover of perennial grasses had been reduced 88% compared to adjacent undisturbed rangeland, while cover of all live herbaceous plants was reduced 83% (Table 1). Litter cover increased 63% on white grub-denuded areas compared to adjacent undisturbed rangeland, because of the deposition of dead perennial grasses. Bare soil increased 20%. Cover of forbs and half-shrubs was not affected by the white grubs (Table 1). Below-ground plant biomass in the upper 30.5 cm of soil in white grub-denuded areas was reduced to 3,478 kg/ha compared to 6,143 kg/ha on adjacent undisturbed rangeland (43% reduction).

In late May, 1973, the mean population density of *P. crinita* was 46.3/m^2 in the upper 20 cm in white grub-denuded areas. No larvae, pupae, or adults were found at depths greater than 20 cm. Last instar larvae comprised 86% of the *P. crinita* population in late May, 1973, whereas 11.6% were pupae and 2.3% were adults. No adult beetles were found on the soil surface. These data suggested that the *P. crinita* population was near the end of its 3-year cycle and that only one brood was inhabiting the area. On May 21, 1974, the population density of *P. crinita* was 4.3/m^2 in the surface 20 cm (75% larvae; 25% adults). On June 19, 1975, there were no larvae, pupae, or adults in the upper 20 cm of soil.

Table 1. Cover (%) of vegetation, litter, and bare soil on white-grub infested rangeland and adjacent undisturbed rangeland in Scurry County, Texas on May 24, 1973.

	Percent cover	
Cover category	Undisturbed rangeland	Grub-infested rangeland
Bare soil	0.0 a[1]	20.0 b
Litter	5.3 a	68.3 b
Perennial grass	90.7 a	3.0 b
Perennial forbs	3.0 a	4.7 a
Annual forbs	0.7 a	3.7 a
Live vegetation	94.3 a	11.3 b

[1] Means within a row followed by similar lower case letters are not significantly different at $P<0.01$.

Effect of Insecticide and Fertilization

Application of 3.36 kg/ha of chlordane to the soil surface, 112 kg/ha of nitrogen as ammonium sulfate, or 3.36 kg/ha chlordane + 112 kg/ha nitrogen had no effect on secondary plant succession, based on foliar cover, at the end of the first, second or third growing season following severe white grub damage in the spring of 1973 (data not shown). Recovery of perennial grass cover tended to be increased by the treatments in this order: denuded (no treatment) < chlordane < nitrogen < chlordane + nitrogen. However, treatment differences were not significant ($P < 0.05$).

Chlordane at 3.36 kg/ha, applied to the soil surface, had no significant effect on population density of *P. crinita*. On June 6, 1973, the population density was 40.9/m^2 in the upper 20 cm on sprayed rangeland compared to 38.8/m^2 on untreated rangeland. Incorporation of the insecticide into the soil at rates recommended for control of white grubs on cropland was not considered economically feasible for use on rangelands. Chlordane is not currently registered for rangeland insect control in most states.

Secondary Succession

Live plant cover was reduced from 94% on undisturbed rangeland to 11% on the white grub-infested area in May, 1973. Live plant foliar cover had doubled by the end of the first growing season (October, 1973) and had attained the level on the adjacent undisturbed rangeland by the end of the second growing season (October, 1974) (Fig. 1a). Foliar cover of perennial grasses was initially reduced from 91% to 3% by white grubs, but recovered to 14% by the end of the first growing season. Foliar cover of perennial grasses was not significantly different from that on adjacent undisturbed rangeland at the end of the second growing season (Fig. 1b). Buffalograss cover, reduced by white grubs during the spring of 1973 from 20% to 0%, had increased to 11.7% by the end of the first growing season and was at equilibrium after two growing seasons (October, 1974) (Fig. 1c). Red threeawn cover, reduced from 60% to 0.3% by white grubs, did not become re-established by the end of the first growing season, but recovered to equilibrium during the second growing season (Fig. 1d). Cover of hairy tridens, reduced during the spring of 1973 from

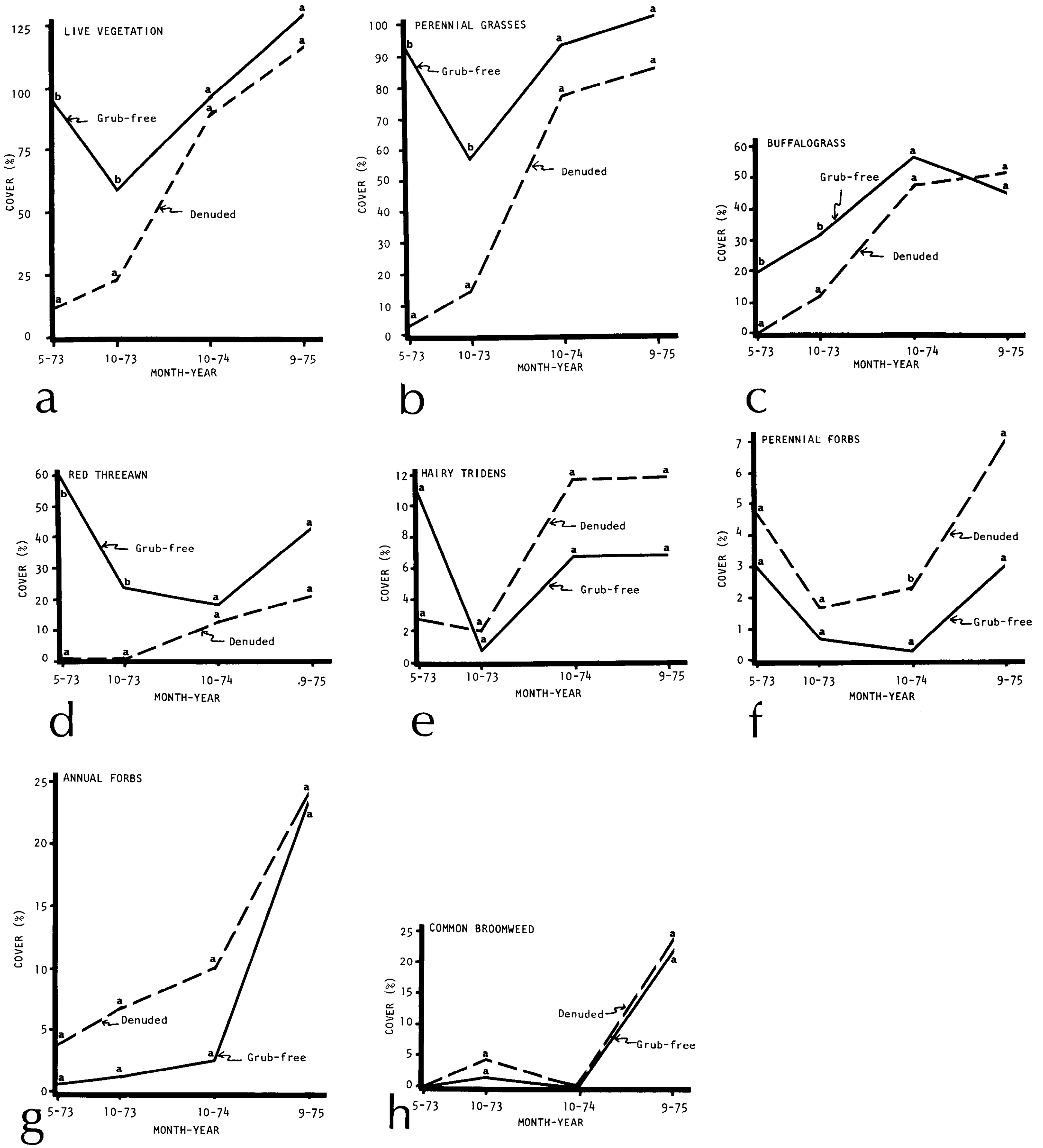

Fig. 1. *Percent cover of (a) live vegetation, (b) perennial grasses, (c) buffalograss, (d) red threeawn, (e) hairy tridens, (f) perennial forbs and half-shrubs, (g) annual forbs, and (h) common broomweed on shortgrass rangeland in Scurry County, Texas, denuded by white grubs (*Phyllophaga crinita*) during the spring of 1973 and on adjacent undisturbed rangeland. Mean cover values for a specified date with similar lower case letters are not significantly different at* $P<0.05$.

10.7% on undisturbed rangeland to 2.7% on white grub-infested rangeland, was at equilibrium by the end of the first growing season, probably because of a natural decline of the species on the undisturbed rangeland (Fig. 1e). Cover of hairy tridens increased rapidly during the second growing season and exceeded that on adjacent undisturbed rangeland at the end of the second and third growing seasons, but the cover values were not significantly different ($P<0.05$).

Cover of perennial forbs and half-shrubs was not significantly affected initially by the white grub infestation (Fig. 1f). However, by the end of the second growing season (October, 1974), cover of these plants was significantly greater ($P<0.05$) on the white grub-affected area. This trend was evident at the end of the third growing season, but the values were not statistically different ($P<0.05$).

Cover of annual forbs was not significantly affected by the white grub infestation. However, there was a trend toward more annual forb cover on white grub-denuded rangeland during the first and second growing seasons following white grub damage (Fig. 1g). Common broomweed, the major annual forb on the study area, was not significantly affected by the white grub activity (Fig. 1h). However, common broomweed and common sunflower (*Helianthus annuus* L.) dominated the first growing season seral stage in white grub-denuded areas on other soil types.

Seeding for Rehabilitation

An excellent stand of Kleingrass and a fair stand of Ermelo weeping lovegrass established on the seeded plots by the end of the first growing season, in spite of heavy grazing by lagomorphs. Many of the seedlings of both species had died by the spring of 1974, probably due to dry conditions of the winter of 1973-74. The exclosure was removed in the spring of 1974. A poor-to-fair stand of both grass species was present in June, 1975. Both species had been heavily grazed but appeared in good vigor. A dense cover of buffalograss had established on both plots. Competition with buffalograss may have also contributed to poor establishment of the seeded grasses.

Conclusions

White grubs can decimate stands of perennial range grasses by feeding on their roots, but do not appear to feed on roots of forbs or half-shrubs. Foliar cover of perennial grasses was reduced 88% by white grubs in localized areas in Scurry County, Texas, during the spring of 1973. The population density of *P. crinita* was 46.3/m^2 in the upper 20 cm of soil. Most plant species recovered, relative to foliar cover of adjacent undisturbed rangeland, by the end of the second growing season without fencing to control grazing by livestock. Forbs were of minor importance in the early seral stages of secondary succession on the study site, but common broomweed and common sunflower dominated the first growing season seral stage on white grub-denuded areas on other ranches. Chlordane sprayed on the soil surface at 3.36 kg a.i./ha did not effectively control the white grubs, and chlordane and/or nitrogen fertilization did not appreciably affect secondary plant succession following the white grub infestation in this plant community. Seedbed preparation and seeding white grub-denuded areas with introduced grasses was not feasible because of the small areas involved, but possibly would be a desirable rehabilitation practice on large acreages, especially if a seed source of desirable native forage plants was not present.

Literature Cited

Anon. 1959. Control of common white grubs. U.S. Dep. Agr. Farmers Bull. 1798. 12p.

Anon. 1971a. White grubs-Nebraska. U.S. Dep. Agr. Cooperative Econ. Insect Rep. 21:373.

Anon. 1971b. White grubs-Colorado. U.S. Dep. Agr. Cooperative Econ. Insect Rep. 21:488.

Daniels, N.E. 1966. The association of a rangeland grub, *Phyllophaga koehleriana* (Coleoptera: Scarabaeidae), with asilid larvae and with mites. Ann. Entomol. Soc. Amer. 59: 1021.

Drake, C. 1964. The relationship of white grubs, facultative fungi, and bacteria on the decline of birdsfoot trefoil. Plant Disease Rep. 48:406-408.

Graber, L.F., C.L. Fluke, and S.T. Dexter. 1931. Insect injury of bluegrass in relation to the environment. Ecology 12:547-566.

Hewitt, G.B., E.W. Huddleston, R.J. Lavigne, D.N. Ueckert, and J.G. Watts. 1974. Rangeland Entomology. Range Sci. Ser. No. 2. Soc. Range Manage. Denver, Colorado. 127p.

Levy, E.B., and E.A. Madden. 1933. The point method of pasture analysis. New Zealand J. Agr. 46:267-79.

Randolph, N.M., and C.F. Garner. 1961. Insects attacking forage crops. Texas Agr. Ext. Serv. Bull. B-975. 26p.

Saylor, L.W. 1940. Revision of the scarabaeid beetles of the phyllophagan subgenus Listrocheles of the United States, with discussion of related subgenera. Proc. U.S. Nat. Mus. 89 (3095): 99-101.

Schumacher, C.M. 1959. White grubs in bluestem hills. The Kansas Stockman, May, p. 12-13.

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