Insect Feeding on Sugarcane Smut in Hawaii[1] [2]

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The insect fauna associated with sugarcane smut whips is not well understood. Although various insects have been reported (Hayward, 1943), only *Phalacrus immarginatus* Champion has been well documented as a predator feeding on chlamydospores (Agarwal, 1956). In India this species spends its entire life cycle on the host plant; within smut whips during development (egg and larva) and on the leaves when mature. Extensive insect damage to smut whips on rattoon crops and older stands with secondary lateral whip formation was observed in experimental plots of infected sugarcane in Hawaii. The smut fungus, *Ustilago scitaminea* Syd., is a recent accidental introduction to the Hawaiian Islands (Byther, Steiner, and Wismer, 1971), and this study was undertaken as one of a series of investigations of dispersal and mechanical vectors of the disease.

Materials and Methods

To assess the extent of insect damage to smut whips, fifty whips in each of three approximately one-half acre plots were examined and insect damage was recorded. Insects captured on whips were dissected after being cleaned with repeated ethanol wipes, and their viscera were microscopically observed to determine if chlamydospores were present. Representatives of species containing spores were eviscerated and their stomach contents were plated on the smut selective medium of Anderson and Trujillo (1975). The smut selective medium is prepared with 200 ml. V-8 juice (clarified by filtration or centrifugation), 40 g agar, streptomycin sulfate 500 ppm., tetracycline hydrochloride 300 ppm., neomycin sulfate 650 ppm., thiabendazole 10 ppm. and distilled water to make 1000 ml. Viability (percent germination) can be assessed after 24 hours, and species can be distinguished in culture (incubated at 31°C) after four days.

Results and Discussion

Four species in three families have previously been reported feeding on chlamydospores of sugarcane smut (Table 1). Members of the Phalacridae are known to feed on grass smuts, and *Phalacrus* spp. have been found on

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whips in Argentina and India. An unidentified species of *Phalacrus* occurs in Hawaii; however, this black beetle was not collected on smutted plants by us. Insects utilizing chlamydospores as a food source in Hawaii are listed in Table 1.

Evidence of insect damage to smut whips was pit-like excavations in the whip core (Fig. 1A), complete destruction of the whip base (Fig. 1B), and areas stripped of chlamydospores (particularly in the basal region where the silver membrane was intact). Insect damage was observed on whips of all sizes in three categories of sugarcane (Table 2). The basal region exhibited the most frequent insect activity, both beneath the leaf sheath and above it where the silver membrane had not ruptured. Other damage (pit excavation) occurred above the base where chlamydospores were exposed. *Sybra alternans* (Wiedemann) and *Araecerus* sp., both well camouflaged when on the whip, were found on loose smut and in excavations near the moist basal region or in the mid-whip zone. *Schistocerca nitens nitens* (Thunberg), a relatively recent New World introduction, was common in infected fields and contained large quantities of spores. Larval stages of tineid moths and *Psammoecus desjardinsi* Guerin were abundant beneath the supporting leaf sheath, particularly during the early stages of decomposition. *Chelisoches morio* (Fabricius), the black earwig, was common beneath the basal leaves feeding on moist unexposed chlamydospores. *Amphicerus cornutus* (Pallas), frequently found boring in dead cane, was observed skeletonizing whips.

Since other smut species occur in Hawaii, notably *Ustilago cynodontis* and *U. maydis*, the stomach contents of the larger insects captured were streaked out on the smut selective medium, and were compared with cultures of these species. The smut selective medium is a valuable diagnostic tool in distinguishing smut species from mixed spore samples. On this medium both chlamydospore and sporidial cultures of *U. scitaminea* can be recognized from other species of *Ustilago* (Anderson and Trujillo, 1975). Cultures of *U. scitaminea* were identified from viscera samples of *S. nitens, Araecerus* sp., *S. alternans*, *Euconocephalus nasutus* (Thunberg), and *C. morio*. Since all of the insects sampled contained only sugarcane smut, two individuals of *Araecerus* and *S. alternans* were allowed to feed on bermuda grass inflourescences infected with *U. cynodontis* for 48 hours. Teliospore cultures taken from fore-gut samples were easily recognized as bermuda grass smut. The best results in culture were obtained when the insect viscera were removed and plated out immediately after capture. This unique application of the smut selective medium could prove useful to entomologists in interpreting host-specificity among smut eating species.

In addition to insects utilizing smut chlamydospores as a food source, numerous insects common in uninfected cane fields or indigenous to the study site were seen on diseased plants. Ants, wasps, moths, honey bees, cockroaches, and flies were probably casual in occurrence on host plants. Other species, such as *Stator pruininus* (Horn), *Scymnus* sp., *Ceresium unicolor* (Fabricius), and unidentified mites, are known to consume pollen and fungi, and may occasionally feed on chlamydospores. *Euconocephalus* *nasutus* was seen feeding on whip material; however, other specimens sampled contained only leaf matter. It seems probable that many other species may opportunistically utilize smut.

The wings and body parts of all of the insects examined were contaminated with chlamydospores lodged on the minute hairs covering the body and wings of many insects. Inoculum contamination could arise from direct contact with whips or leaves of infected plants, or from the high concentration of air-borne inoculum inside crop canopies. Weather conditions favorable to diurnal insect activity correspond with those enhancing spore removal. Contaminated insects could transport smut inoculum to local uninfected plants; however, for the pathogen to initiate infection inoculum must be introduced through the bud scale or established through a wound (Antoine, 1961). Although other members of the genus *Schistocerca* are migratory, there is no evidence of *S. nitens nitens* being migratory in Hawaii. Similarly, other insects discussed here are not migratory, but could be displaced considerable distances by strong winds during trivial flight activity (Johnson, 1969). In the area of greatest infection on Oahu, for example, northeasterly trade winds frequently reach velocities of 25 mph. Destruction of habitat during harvest could force displaced insects to invade new regions. Insects serve as mechanical vectors for inflourescence infecting *Ustilago* species, notably *U. violaceae* and probably *U. succisae* (Ingold, 1971).

Although insect damage to smut whips is extensive and in many cases kills them, it seems unlikely that insect predation significantly reduces the number of chlamydospores on a whip or the inoculum load in the air. Agarwal (1956) concluded his discussion of *Phalacrus immarginatus* by suggesting that "although this insect may be somewhat beneficial by its consuming some of the smut spores, it is more likely to assist in their dispersal." Francis (1938) observed spores adhering to the bodies of endomychid beetles, and suggested that they could be vectors in the spread of the disease. Displaced or migratory insects would be apt to transport inoculum to a potential host plant directly, while air-borne inoculum could only make chance contact. The inoculum potential for aerial infection has not been established, and the possible role of insects as mechanical vectors must remain speculative.

Abstract

Schistocerca nitens nitens (Acrididae), *Araecerus* sp. (Anthribidae), *Sybra alternans* (Cerambycidae), *Chelisoches morio* (Chelisochidae), *Scymnus* sp. (Coccinellidae), *Euconocephalus nasutus* (Tettigoniidae), and larval stages of *Psammoecus desjardinsi* (Cucujidae) and an unidentified tineid moth feed on chlamydospores of sugarcane smut (*Ustilago scitaminea* Syd.) in Hawaii. Evidence of insect damage on smut whips included excavations in the whip core, severed whip scions, and areas stripped of chlamydospores. Insect damage was evident on up to 70% of the whips examined in three size classes of infected sugarcane. Identification of the smut species was verified by culturing insect stomach contents on the smut selective medium of Anderson and Trujillo.

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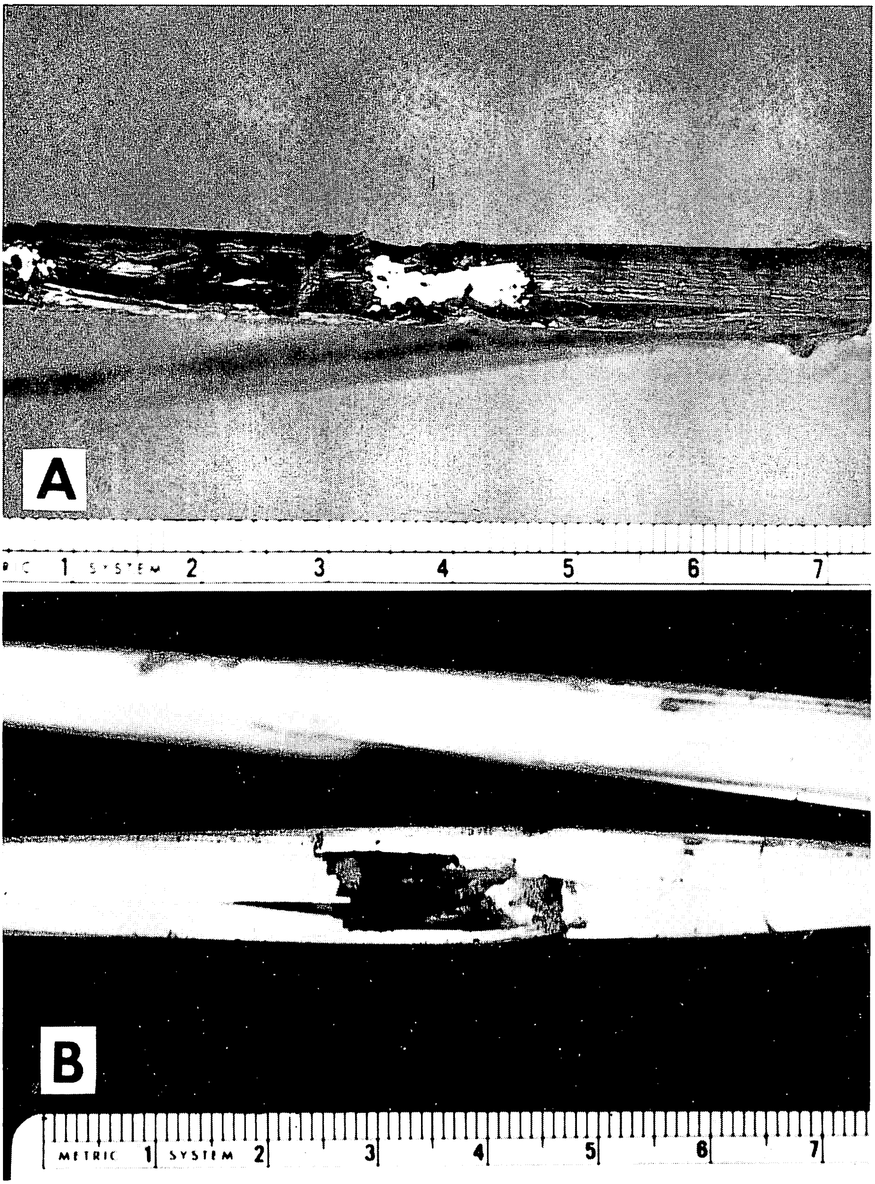

Figure 1.A, Pit-like excavations in the whip core caused by insects eating through the chlamydospore layer. B, Insect damage to a whip base.

TABLE 1. *Insects reported feeding on sugarcane smut chlamydospores with the locality and reference.*

Family and Species	Locality	Reference
Acrididae		
Schistocerca nitens nitens	Hawaii	
Anthicidae		
Anthicus albifasciatus	Argentina	Hayward, 1943
Anthribidae		
Araecerus sp.	Hawaii	
Brachytarsus zeae	Argentina	Hayward, 1943
Cerambycidae		
Sybra alternans	Hawaii	
Chelisochidae		
Chelisoches morio	Hawaii	
Coccinellidae		
Scymnus sp.	Hawaii	
Cucujidae		
Psammoecus desjardinsi (larval stages)	Hawaii	
Phalacridae		
Phalacrus immarginatus	India	Agarwal, 1956
Phalacrus sp.	Argentina	Hayward, 1943
Tettigoniidae		
Euconocephalus nasutus	Hawaii	
Tineidae		
unidentified larvae	Hawaii	

TABLE 2. *Results of an examination of 50 whips in each of three size classes of infected sugarcane.*

Cane height in meters	% Insect Damaged (N = 50 each)	Mean length of damaged whips in cm	Mean whip length in cm
3 - 3.6	70	44.7	74.2
1.2 - 1	18	90.3	46.7
1	32	57.4	56.6

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