Occurrence of Nitidulid Beetles (Coleoptera: Nitidulidae) in Texas Oak Wilt Centers

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ABSTRACT In 1984–85 free-flying nitidulids were trapped in centers of oak wilt, *Ceratocystis fagacearum* (Bretz) Hunt, for 1 year at six locations in central Texas. Two of the 10 species identified, *Cryptarcha concinna* Melsheimer and *Colopterus maculatus* (Erichson), accounted for 57 and 35%, respectively, of the total number (3,397) of beetles trapped. Peak nitidulid activity occurred during March–May at all sites. Beetles exhibited some preference for tree location within a trapping site, visiting healthy live oaks, *Quercus fusiformis* Small, in greater numbers than dead Spanish oaks, *Quercus texana* Buckley.

KEY WORDS nitidulids, oak wilt, vectors, live oak disease

SAP-FEEDING NITIDULIDS are long-distance vectors of the oak wilt fungus, *Ceratocystis fagacearum* (Bretz) Hunt (Dorsey & Leach 1956, Gibbs & French 1980). Nitidulids inhabit fungal mats, an inoculum source formed by *C. fagacearum* beneath the bark of diseased red oaks (Erythrobalanus) (True et al. 1960). Infectious beetles emerge from fungal mats (Juzwick & French 1983) and deposit viable spores in wounds on healthy trees during feeding (Norris 1953, Jewell 1956). *C. fagacearum* is comprised of two mating types (a and b). Beetles transmit the fungus from mats formed by one type to those of the opposite type, completing the sexual cycle of the fungus (Leach et al. 1952). An oak wilt epidemic, therefore, depends on the presence of nitidulids or similar vectors, a viable source of inoculum, and suitable infection courts to increase the incidence of new centers of infection.

Fungal mat formation and wounding are generally considered to limit the spread of *C. fagacearum* (Dorsey & Leach 1956, MacDonald & Hindal 1981). Viable mats last only a few weeks, and their formation depends on the extent of colonization, temperature, and moisture levels in a diseased tree (Gibbs & French 1980). The ephemeral nature of mat formation contributes to inefficiency of vectors and the lack of catastrophic losses to an otherwise virulent pathogen (MacDonald & Hindal 1981). The scarcity of fungal mats on diseased red oaks in Arkansas and Missouri was reported to be evidence for a limitation in the southern distribution of *C. fagacearum* (Tainter & Gubler 1973).

Recently, oak wilt was found in epidemic proportions at several locations in central Texas, considerably extending the southern range of the pathogen in the United States (Lewis & Oliveria 1979, Appel et al. 1985). This unexpected occurrence of oak wilt reveals the susceptibility of semievergreen live oaks to the pathogen, as well as the ability of *C. fagacearum* to survive high summer temperatures (Lewis 1985). Further, the high incidence of oak wilt at diverse locations implicates the presence of a long-distance vector. Fungal mats for inoculum acquisition have been found in Texas and nitidulids may be involved in disease transmission (Appel & Maggio 1984). Here we describe the distribution and seasonal abundance of nitidulid species present in centers of oak wilt in Texas.

Materials and Methods

Six sites with 12 traps per site in three Texas counties were used during 1984–85. The flight trap of Skalbeck (1976) was used with some modifications. A wide-mouth, screw-cap jar (0.5 liter) was suspended from the trunk or major limb of a tree with angle iron (10 by 10 cm). A plastic bottle (50 ml) containing liquid bait (30 ml) was placed in the screw-cap jar. The jar opening was covered with 7-mm wire screen and a paper funnel. The screen deterred large insects and small animals from entering the trap. The funnel allowed nitidulids to enter the trap but made it difficult for them to escape. A masonite "hat" was suspended over the jar to prevent rain from entering. Bait consisted of a mixture of corn syrup, water, and baker's yeast (0.5 liter, 0.5 liter, and 5.0 g, respectively) prepared 24 h before placement in the field. The lid on the bottle containing bait was fitted with 60-gauge brass cloth to prevent insects from contaminating the bait.

Three trapping sites were located at Burnet, Tex.

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Table 1. Total numbers and nitidulid species trapped at six locations in central Texas

Nitidulid species	Trapping site						Total
	Burnet A	Burnet B	Burnet C	Kerrville	Austin	Round Rock	
C. concinna	632	442	344	246	119	148	1,931
C. strigatula	44	21	8	3	2	3	81
C. maculatus	500	342	205	42	29	84	1,202
C. truncatus	17	8	11	15	3	25	79
L. undulata	9	10	7	22	0	0	48
C. lugubris	19	8	2	0	0	2	31
Other	6	3	2	2	7	5	25

Traps were collected weekly and bimonthly during 4 October 1985 through 24 April 1985 at Burnet C and Round Rock, and 19 April 1984 through 24 April 1985 at the remaining sites.

(A, B, and C); the remaining sites were at Kerrville, Austin, and Round Rock, Tex. The rural Burnet disease center was large (60.7 ha) and contained both diseased live oaks and Spanish oaks. The three sites at Burnet were collected during 19 April 1984–24 April 1985 (A and B) and 4 October 1984–24 April 1985 (C) on 49, 49, and 24 occasions, respectively. In Burnet sites A and B, four traps were placed on a dead, mat-bearing Spanish oak (tree no. 0) and two traps were located on four trees (no. 1–4) located 36.7 m in cardinal directions around tree 0. A similar number of traps were used in Burnet C, where the four trees (two traps/tree, no. 1–4) were ca. 25 m apart around a perimeter of the oak wilt center and 18–55 m from a mat-bearing Spanish oak (tree no. 0, four traps). The traps in all three Burnet sites were arranged to study nitidulid populations near assumed inoculum sources.

The Kerrville site was also a rural oak wilt center (18.2 ha) and was comprised of diseased live oaks and Spanish oaks. The three trap trees (no. 1–3, four traps per tree) were randomly dispersed, ca. 102 m apart through the center, and were collected on 19 occasions during 19 April 1984–24 April 1985. A similar trap arrangement was used in the urban, Austin site; traps were collected 49 times during the same period. The Round Rock site was a 36-ha, rural oak wilt center with only diseased live oaks. Twenty-four collections were made at Round Rock during 4 October 1984–24 April 1985. Six trees were used (no. 1–6, two traps per tree) which were located in healthy trees at increasing distances away from the disease perimeter.

Collections were made weekly except during January–February, when traps were collected once each month. Kerrville traps were collected bimonthly due to the long distance (336 km) between the laboratory and the study area.

Results and Discussion

A total of 3,397 nitidulid beetles were caught in the 72 traps at the six sites. Most belonged to six species in four genera (Table 1). Of the nitidulids consistently trapped, *Cryptarcha concinna* Melsheimer (57%) and *Colopterus maculatus* (Erichson) (35%) composed the largest numbers at each site. Very few specimens of *Stelidota geminata* (Say), *Carpophilus ligneus* Murray, *C. discoideus* LeConte, and *C. floralis* Erichson were caught.

Each species found in Texas oak wilt centers is known to occur in other states (Connell 1956, Skalbeck 1976, Juzwick & French 1983). For example, the most numerous of the 10 free-flying nitidulids caught in Texas, *C. concinna*, was found visiting wounds on healthy oaks, *Quercus* spp., in Delaware (Connell 1956). This species was also trapped in low numbers with odor baits in a Minnesota oak wilt center (Juzwick & French 1983). The second most abundant species found in Texas, *C. maculatus*, was previously reported as an inhabitant of oak wounds, found in fungal mats, or traps with odor baits in Wisconsin and West Virginia (True et al. 1960, Skalbeck 1976). Of the remaining beetles caught in Texas, *C. truncatus* also has been trapped on fungal mats, with odor baits, or on wounded trees in disease centers throughout the range of oak wilt in the midwestern and northeastern United States. This species was found only in very low numbers in Texas. The relative importance of the various species as vectors of *C. fagacearum* is difficult to determine without further studies.

Live oaks, *Q. virginiana* Miller and *Q. fusiformis* Small, are the primary hosts of *C. fagacearum* in Texas (Appel & Maggio 1984), the only state reported to have oak wilt in a natural live oak population. Climatic conditions where oak wilt is found in Texas are warmer than those conditions found throughout the previously accepted range of the disease. These factors represent considerable differences between oak wilt in Texas and the occurrence of the disease elsewhere, and might influence the nitidulid species responsible for vectoring the pathogen. *Glischrochilus quadrisignatus* (Say) and other *Glischrochilus* species have been associated frequently with *C. fagacearum* in the Midwest and Northeast (McMullen et al. 1955, Dorsey & Leach 1956, Juzwick & French 1983) and are considered to be likely vectors there. These

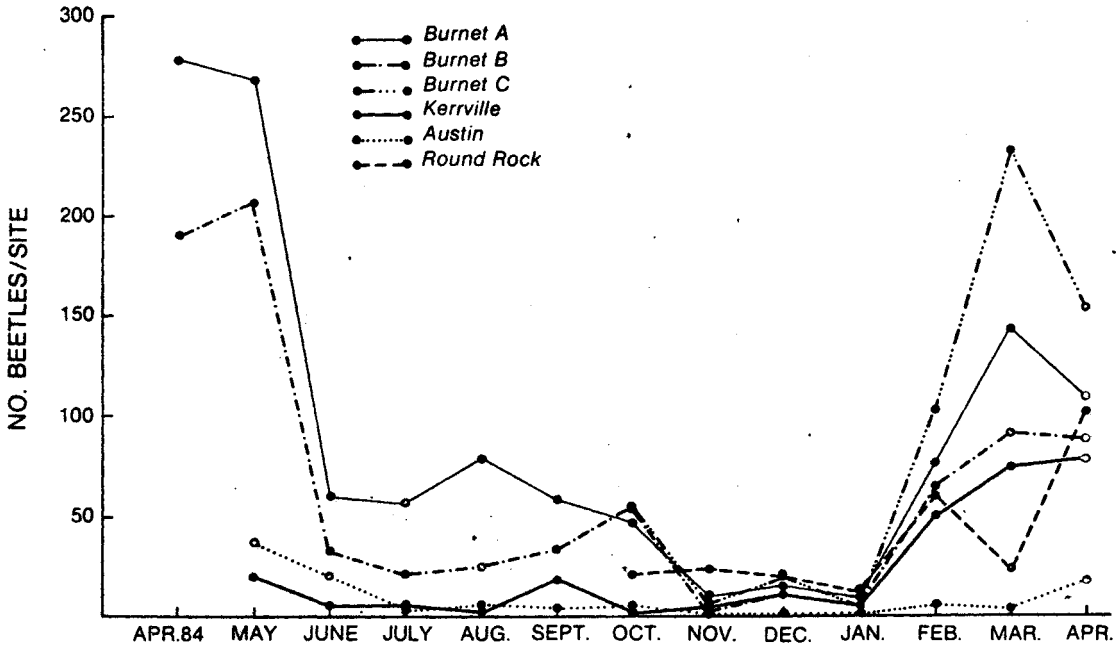

Fig. 1. Monthly number of nitidulids in six study sites in central Texas.

species were never collected in the Texas survey. *C. concinna* and *C. maculatus* are prime suspects for vectoring *C. fagacearum* in Texas because they were the most numerous and active nitidulids found in the disease centers.

In general, the largest numbers of beetles caught at each trapping site occurred during February–April (Fig. 1). Populations of beetles decreased during the summer and reached lowest levels during November–January. The summer decrease was expected because temperatures >38°C are known to suppress activity of nitidulids (Skalbeck 1976). The greater nitidulid activity during spring coincides with the expected occurrence of fungal mats (Gibbs & French 1980) and the period of maximum susceptibility of live oaks to inoculation by the fungus (Peters & Appel 1985). Each of these attributes would contribute to the efficiency of nitidulids as vectors of the pathogen.

More nitidulids were trapped at the Burnet sites than in the other three trapping sites (Table 1), probably because all three Burnet sites were located in a conglomerate of many oak wilt centers comprising thousands of dead and dying trees. The other three sites were smaller disease centers and contained fewer dead trees. Stand composition and topography also varied among the trapping sites, but none of these appeared to influence the population sizes directly.

At Burnet sites A and B, fewer nitidulids visited the centrally located dead Spanish oaks than the healthy live oaks on the periphery of the trapping site (Table 2). Also, very few beetles regularly visited the dead live oak used as a trapping tree in the Kerrville site. The dead trees would provide few feeding opportunities for the sap-feeding nitidulids and apparently are less desirable habitats.

The results of this study do not provide a direct relationship between the occurrence of oak wilt and nitidulids as vectors of *C. fagacearum*. Nitidulids do, however, fulfill some of the criteria necessary to make them vectors of the pathogen in Texas (Rexrode 1976). They were found visiting healthy live oaks under conditions conducive to inoculation and infection. Previous research demonstrated that nitidulids are capable of bearing propagules of the pathogen (Juzwick & French 1983). Also, three of the species trapped in Texas, *C. truncatus* (Randall), *Lobiopa undulata* (Say), and *Carpophilus lugubris* (Murray) are known to be capable of acquiring inoculum and directly in-

Table 2. Mean number of nitidulids captured per trap on the individual trees in each of the trapping sites

Tree no.	Trapping site (no. of beetles per trap)					
	Burnet A	Burnet B	Burnet C	Kerr-ville	Austin	Round Rock
0	46.7[ab]	11.3[ab]	34.5[ab]	—	—	—
1	135.0[a]	107.0	64.0	6.5[b]	12.2	19.0
2	123.0	113.5	57.5	40.2[a]	18.5	26.5
3	109.0	110.0	39.0	37.3	11.2	25.5
4	153.0	64.0	42.0	—	—	20.5
5	—	—	—	—	—	20.0
6	—	—	—	—	—	22.0

[a] These trees were Spanish oaks, *Q. texana*; the remaining trees were all live oaks.

[b] These trees were dead during most of the trapping period.

troducing the fungus into wounds on oaks (Dorsey et al. 1953, Norris 1953). Whether they are responsible for the high incidence of oak wilt in central Texas is unknown, but their presence and activities in this extended range of the disease implicates them and other nitidulid species as vectors of *C. fagacearum*. Studies to determine the extent of contamination of the nitidulids with *C. fagacearum*, similar to those of Juzwick & French (1983), would further clarify their role as vectors. This information would aid in formulating recommendations for controlling long-distance spread of the fungus. For example, efforts may be needed to reduce inoculum by locating and destroying diseased Spanish oaks. Also, high levels of contaminated beetles may indicate that spring pruning, a common practice, should be avoided to reduce infection courts. The possibility for additional insect vectors in Texas, such as *Pseudopityophthorus minutissimus* (Zimmerman), still exists and should also be investigated.

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