Swarming Dates and Distribution of *Zootermopsis laticeps* Banks (Isoptera: Termopsidae) Alates in El Paso County, Texas

Harry N. Howell, Jr., James W. Austin, and Roger E. Gold

ABSTRACT  Limited information is available concerning the dispersal and frequency of swarming behavior of *Zootermopsis laticeps* Banks (Isoptera: Termopsidae) in Texas. Almost all information known about this termite species in Texas comes from the extreme western part of the state around the El Paso area. During 1983–1986, light traps were placed at 10 sites within El Paso County to collect *Z. laticeps* alates during the annual swarming season. Percentage recovery and location of this poorly understood termite were measured. During 1983–1985, 1731 alate termites (97% of the catch) were collected from only two light traps located along the Rio Grande River. Few termites were collected from other collecting sites away from the Rio Grande River. There was no relationship between precipitation and swarming of *Z. laticeps*. Environmental considerations are discussed for the occurrences of this species in west Texas.

KEY WORDS  Dampwood termite, swarming, *Zootermopsis laticeps*, El Paso, Texas

The termite family Termopsidae (Isoptera) possesses several characteristics in common with the related families Hodotermitidae and Kalotermidae. For example, the radius sector of the forewings is branched at least three times with the first branch occurring in the basal half of the vein. Mandibles of the soldier caste possess irregular dentations along the medial margin. The shape and position of the subsidiary tooth of all non-soldier castes enables the precise identification of all three described species in North America in the genus *Zootermopsis* Emerson (Thorne & Haverty 1989). All three species in the genus *Zootermopsis* are restricted to western North America (Weesner 1970, Thorne et al. 1993) and are not generally considered to be significant structural pests (Banks & Snyder 1920, Castle 1934, Nutting 1965, Weesner 1970). The three species of *Zootermopsis* are *Z. angusticollis* (Hagen), *Z. nevadensis* (Hagen), and *Z. laticeps* (Banks). The range of *Z. laticeps* does not generally overlap with those of *Z. nevadensis* or *Z. angusticollis* (Sumner 1933).

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Investigations of the *Zootermopsis* group are relatively straightforward for non-reproductive caste members (Thorne & Haverty 1989), but recent studies employing non-morphological means, such as near-infrared reflectance, may suggest the presence of unknown subspecies (Aldrich et al. 2007). This finding is supported by cuticular hydrocarbon data, but not with genetic evaluations, as two subspecies of *Z. nevadensis* identified by cuticular hydrocarbons could not be distinguished (Korman et al. 1991, Broughton 1995). Termopsidae can usually be differentiated from these two related families (Hodotermitidae and Kalotermitidae) by the following characteristics: the Termopsidae and Hodotermitidae possess two or three mucrons, defined by Torre-Bueno (1989) as having pointed processes or terminating in a sharp point or mucro, on the shaft of the hind tibia, while the Kalotermitidae lack these spines. Termopsidae possesses a subsidiary tooth on the anterior margin of the first marginal tooth in the right mandible, while that tooth is always absent in the Hodotermitidae.

*Zootermopsis laticeps* is the only species in the family Termopsidae that has been collected in Texas. This is the largest and most primitive termite in North America and probably the least understood (Nutting 1965). The physical characteristics of *Z. laticeps* include winged kings and queens that measure 20 to 35 mm from head to wingtips, with a wingspan up to 48 mm (Weesner 1970). Their bodies are dark brown to yellow. Soldiers measure approximately 15 to 23 mm in length. Their flattened heads are widest at the back, and they have very long and roughly toothed jaws. Workers, soldiers, and other castes are whitish yellow or cream in color.

Occasionally, *Z. laticeps* is a structural pest in the El Paso area of Texas (Howell et al. 1987). However, one would discount the presence of a species from a group popularly known as “the rottenwood termites” in an area with an average annual precipitation of only 198 mm. Other members of this genus are restricted to areas with an annual precipitation of 1300 mm. The El Paso *Z. laticeps* population is most probably a relic isolated during the uplift of the Sierra Madre mountain ranges to form the Chihuahuan Desert beginning in the Cretaceous period. *Zootermopsis* spp. have not been collected in the Big Bend National Park (van Pelt 1993), so the Sierra Madres seem to have continued to restrain the species. These suppositions are supported by Nutting (1965), who collected specimens immediately east of the Sonoran Desert in eastern and central Arizona and as far east as Las Cruces, New Mexico. Nutting (1965) also noted that specimens were recovered from El Paso, Texas by F. D. Parker from a pecan tree (*Carya illinoensis* (Wangen.) K. Koch) (Weesner 1970), and from an area on the northeastern range of the Chihuahuan desert. Likewise, Thorne et al. (1993) also documented specimens collected from pecan trees in New Mexico (near Las Cruces, five miles south of Mesilla). The degree to which these termites might pose any commercial threat to pecan trees remains unknown. Other termite species have been documented to attack pecans in the southwest (Affeltranger et al. 1987, Austin & Glenn 2005), but given their limited eastern distribution in Texas, *Z. laticeps* are an unlikely threat to the pecan industry.

El Paso, Texas, envelops the east and west sides of the Franklin Mountains and extends southwestward along the east bank of the Rio Grande River. The highest peak in the Franklin Mountains is 1818 m. Developed areas extend about five miles to the east of the riverbank. The elevation along the river drops from 1130 m to 1114 m at the southeastern end of the city. To the east of the Rio
Grande River, the elevation rises to 1212 m at the eastern city limits. The El Paso area has a mean annual precipitation of 198 mm, a mean maximum July temperature of 35.5°C, and a mean minimum January temperature of −1.7°C. Nutting (1965) suggested that the swarming behavior of *Z. laticeps* follows temperature gradients more than precipitation events as the major stimulus for initiating flight periods.

The natural deciduous vegetation of the area are mixed cottonwood (*Populus* spp.) and willow (*Salix* spp.) (Fig. 1). As the area has been developed over the past 400 years, cultivated areas of trees, turf and flowers have replaced the natural vegetation. Due to the low rainfall and the xeriscape form of landscaping that is common throughout the city, these termites are more geographically isolated than perhaps during earlier periods of time when human cohabitation was less disruptive.

It was hypothesized that most of the colonies of *Z. laticeps* would be concentrated in the areas of native vegetation along the Rio Grande River and that alates of the species would be more abundant in this area. This paper documents the results of this distribution study, determines the influence of weather on swarming behavior of *Z. laticeps* from this region, and provides important insights into this lesser known species in Texas.

**Materials and Methods**

Between June and August of 1983 through 1986, light traps were placed at ten sites within El Paso County, Texas to collect *Z. laticeps* alates during the annual swarming season (Fig. 2). The sites were representative of the high Chihuahuan Desert ecosystem, which is a lesser-known desert in North America, lying east of the Continental Divide between the Sierra Madre Occidental in the west and the Sierra Madre Oriental in the eastern part of Mexico (Gutierrez & Whitford 1987). These mountain ranges extend to the mountains in the Mexican states of Zacatecas and San Luis Potosi in the south. To the north, the Chihuahuan Desert opens onto broad valleys, basins, and high plains in New Mexico and west Texas.

Not all 10 sites were used for collection every year. Each year some of the traps were in the same locations, some eliminated, and others were added in new locations (Fig. 2). One site was located on the property of the Texas A&M Research and Extension Center in the town of Ysleta, south of El Paso. All the other sites were located in residential areas of the City of El Paso (Fig. 2). To the west and south of, and contiguous with El Paso, is the city of Juarez, Mexico. The combined population of the two cities exceeds 2 million, creating an urban area of about 760 sq. km.

In 1983, five trap locations were used. Traps were positioned from the southwestern tip of the Franklin Mountains (location “P”) to 10.5 km down river (Location “J”) and to 10.5 km east of the Rio Grande River (Location “G”). Traps “P,” “J,” “L,” and “S” were placed in residential areas, while “G” was located on the property of the Texas A&M Research and Extension Center, Ysleta, Texas. In 1984, locations “J” and “L” were not used, and location “H” was added 11.5 km east of the Rio Grande River. In 1985, only locations “G” and “P” were used. These two locations had caught over 90% of the alates trapped during the previous two years. In 1986, none of the previously used light trap locations was
Fig. 1. Natural habitat of *Zootermopsis laticeps* found in El Paso County, Texas; recovery of *Z. laticeps* from (A) willow (*Salix* spp.), and (B) mixed cottonwood (*Populus* spp.) trees in the greater El Paso area.
evaluated, as we opted to see if more termites could be accounted for in different areas. Four locations in 1986 were designated as “HN,” “D,” “B,” and “R” (Fig. 2). Samples were collected daily, removed from traps, and brought back to the laboratory for counting. The termite abundance data were analyzed by location and date to determine the geographical location and the number of alates (swarmers) of *Z. laticeps* present. Metrological data for the same periods were obtained from the National Weather Service. These data consisted of daily

**Fig. 2.** Percent capture and location of adult alate *Zootermopsis laticeps* by light traps in El Paso County, Texas during peak swarming season (June–August) from 1983 to 1986.
precipitation, daily maximum and minimum temperatures, and daily noontime relative humidity. These data were used to estimate the effects of temperature and precipitation on the initial swarming of _Z. laticeps_ during each of the four years of the study (Table 1). A regression analysis of daily mean precipitation and degree-day on daily mean swarm counts for _Z. laticeps_ were estimated applying the PROC REG® procedure (V9.1) (SAS 2004) (Table 1). Voucher specimens were deposited in the insect museum at Texas A&M University, College Station, Texas, and at the Center for Urban and Structural Entomology in the Department of Entomology at Texas A&M University.

**Results and Discussion**

Two light traps located along the Rio Grande River (“P” and “G”) caught 1731 termites, accounting for 97% of the total catch during the first three years of collections (Figs. 2 and 3). During this same period, two light traps situated away from the river (“H” and “S”) caught a total of 16 termites (Fig. 2). In 1986, a trap (“HN”) installed on the east side of the Franklin Mountains accounted for 14% of the termites caught that year (Fig. 2).

Swarming began during the first days of June and ceased during the latter days of August for each surveyed year (Fig. 3). Figure 3 presents the mean daily catch numbers from the first day of swarming until the last day. With the exception of 1986, the distributions are close to normal with the mean number trapped per day numerically similar. However, in 1986, two of the days had large trap catches. For this reason, tremendous variability in the occurrences of _Z. laticeps_ would be anticipated based on timing of collecting endeavors and subtle seasonal variation of climate.

There were a reduced number of swarming alate _Z. laticeps_ in 1985. The only climatic condition that corresponded to this reduced swarm was rainfall during the two months prior to the first swarm. Every other year had rain a few days before the first swarm. In 1983, the rain was five days prior to the first swarm. The next year, the swarm was early in June following a rain in May about two weeks earlier than normal. In the year of the weakest swarm (1985), rain was sparse all spring with only 0.25mm of rain in May and only 1.77 mm in April. In 1986, 22 mm of rain fell during the four days prior to the first swarm. These general observations contradict Nutting (1965) who suggested that swarming is more closely related to temperature than to rainfall. However, regression analyses of both precipitation and degree-days on swarming behavior did not demonstrate either parameter as significant indicators to the chronology of swarming for _Z. laticeps_. The microallopatry of this species’ preference for riparian habitat among desert ranges, suggests that other intrinsic and extrinsic factors may be involved. The poor relationships of swarming to either precipitation or daily temperature may also simply be an artifact of the sporadic placement of light traps throughout the area during these years (Fig. 2). Alternatively, it may actually be the absence of water that induces alate swarming for _Z. laticeps_. This was similarly observed by Nutting (1970), who noted that colonies of _Z. laticeps_ produce larger proportions of alates when the colonies are under water stress, with reproductive castes often comprising 40–60% of individuals within a colony.
Table 1. Relationships of degree-day and daily mean precipitation (mm) on daily swarming activity of *Zootermopsis laticeps* in El Paso County, Texas, obtained from light trap collections from June through August, 1983–1986.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Mean degree day temperature (°F) ± SD</th>
<th>Mean daily precipitation (mm) ± SD</th>
<th>Mean no. alates caught/day ± SD</th>
<th>Slope equation for degree day on alate catch</th>
<th>$R^2$</th>
<th>Slope equation for degree day on precipitation</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>June</td>
<td>77.13 ± 3.90</td>
<td>0.23 ± 0.03</td>
<td>1.43 ± 2.80</td>
<td>$y = 0.196x + 74.09$</td>
<td>0.197</td>
<td>$y = 26.70x + 1.23$</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>82.89 ± 2.13</td>
<td>0.44 ± 0.05</td>
<td>18.61 ± 15.98</td>
<td>$y = 0.002x + 82.86$</td>
<td>0.000</td>
<td>$y = 2.98x + 18.18$</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>81.72 ± 2.12</td>
<td>0.97 ± 0.09</td>
<td>2.87 ± 5.99</td>
<td>$y = 0.098x + 83.30$</td>
<td>0.181</td>
<td>$y = 1.62x + 2.92$</td>
<td>0.001</td>
</tr>
<tr>
<td>1984</td>
<td>June</td>
<td>79.40 ± 3.82</td>
<td>1.10 ± 2.07</td>
<td>10.87 ± 16.86</td>
<td>$y = 0.155x + 76.99$</td>
<td>0.128</td>
<td>$y = 1.5x + 12.19$</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>80.93 ± 3.38</td>
<td>0.02 ± 0.10</td>
<td>11.30 ± 15.07</td>
<td>$y = 0.014x + 83.67$</td>
<td>0.094</td>
<td>$y = 2.6x + 0.71$</td>
<td>0.133</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>80.45 ± 3.31</td>
<td>0.19 ± 0.39</td>
<td>1.49 ± 2.42</td>
<td>$y = 0.034x + 79.79$</td>
<td>0.109</td>
<td>$y = 2.26x + 0.71$</td>
<td>0.133</td>
</tr>
<tr>
<td>1985</td>
<td>June</td>
<td>79.03 ± 5.20</td>
<td>0.10 ± 0.01</td>
<td>3.71 ± 4.59</td>
<td>$y = 0.187x + 76.14$</td>
<td>0.100</td>
<td>$y = 3.57x + 3.42$</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>80.11 ± 2.55</td>
<td>1.32 ± 0.14</td>
<td>5.57 ± 6.87</td>
<td>$y = 0.029x + 80.58$</td>
<td>0.011</td>
<td>$y = 11.9x + 8.06$</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>80.72 ± 2.26</td>
<td>1.46 ± 0.20</td>
<td>0.73 ± 1.01</td>
<td>$y = 0.067x + 81.68$</td>
<td>0.070</td>
<td>$y = 0.31x + 0.52$</td>
<td>0.004</td>
</tr>
<tr>
<td>1986</td>
<td>June</td>
<td>77.80 ± 4.56</td>
<td>0.10 ± 0.26</td>
<td>16.33 ± 48.81</td>
<td>$y = 1.423x - 5.72$</td>
<td>0.066</td>
<td>$y = 1.00x + 6.02$</td>
<td>0.290</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>79.98 ± 3.29</td>
<td>0.09 ± 0.19</td>
<td>7.35 ± 14.18</td>
<td>$y = 0.314x + 85.19$</td>
<td>0.563</td>
<td>$y = 0.08x + 8.00$</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>80.33 ± 3.68</td>
<td>0.02 ± 0.04</td>
<td>0.53 ± 1.14</td>
<td>$y = 0.036x + 1.09$</td>
<td>0.078</td>
<td>$y = 0.02x + 0.58$</td>
<td>0.005</td>
</tr>
</tbody>
</table>

*A Mean annual precipitation is 223.5 mm; relative humidity 28% with the maximum mean temp of 35.5°C in July and the lowest minimum mean temp of −1.7°C in January; growing season is 248 d.*
For subterranean termites, such as *Reticulitermes* spp., rainfall just prior to swarming is necessary to provide high relative humidity and free water, which appears to drive the swarming behavior of these termites (Furman & Gold 2002). Rain also softens the soil, permitting easier excavation by the reproductive adults. However, for a termite that nests within the living parts of a woody plant, rainfall should not be a prerequisite to swarming. Possibly, a biologically significant rain during the days preceding swarming provides more free water within host plants, thus allowing the termites to devote more energy to molting than to gaining sustenance. As pseudergates molt to brachypterous nymphs, the food and water gathering ability of the colony decreases proportionally to the loss of workers. Nymphs cannot feed themselves efficiently and do not participate in colony maintenance.

Recent investigations into the *Zootermopsis* genus designed to identify subtle differences among species and subspecies have been performed (Thorne & Haverty 1989, Aldrich et al. 2007). Most accounts of *Z. laticeps* in the southwest have been offered by Townsend (1893), Banks (1906), and Banks & Snyder (1920). Biogeographic studies have paid little attention to the presence of *Z. laticeps* in Texas (Thorne et al. 1993), rather focusing on populations west of El Paso (Korman et al. 1991, Broughton 1995). There are few studies that have investigated the complete biological, physiological, or genetic constraints that

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dictate dispersion events of *Z. laticeps* due to its cryptic lifestyle and locations in remote habitation.

The time required to molt from worker to the apterous form is poorly understood for this species; however, this would likely be a brief matter of days. Brachypterous and apterous individuals do not participate in the direct substance of the colony and, in fact, are responsible for net energy losses. The swarming cycle of *Z. laticeps* in El Paso appears to be consistent with dates that have been described from locations further west, ranging from July to August, and are generally nocturnal (Light 1933, Light & Weesner 1948, Nutting 1965, Weesner 1965).

*Z. laticeps* is among the more interesting species for North American *Zootermopsis* in that it possesses caste-specific setal differences compared to either *Z. nevadensis* or *Z. angusticollis*, thus allowing it to utilize a form of caste-mimicry to conceal its identity to potential rivals (Hahn & Myles 1994). Lenz (1985) has noted the short-lived nature of adult worker intercastes in *P. adamsoni*, and this closely related group would likewise support the short life span, particularly when the setal pattern in replacement reproductive adults is apparent immediately after the molt (Hahn & Myles 1994). This appears to be supported by a census conducted by Nutting (1970) whereby seven colonies of *Z. laticeps* were found to possess no replacement reproductives. Myles (1988) and Hahn (1994) surveyed 16 colonies of *Z. laticeps* and found only one colony with a single pair of replacement reproductives. Recent genetic investigations have demonstrated that there is no evidence that neotenics (of *Z. angusticollis*) are attacked or injured by other reproductives or larval helpers, suggesting little if any reproductive competition among sibling queens. This implies that physiological responses of neotenics to the increasing queen/worker ratio may have the benefit of enhancing colony growth at the cost of fecundity of individual queens (Brent et al. 2008), an important necessity based on the one-piece colony structure of these termites (Light & Ilg 1945). Owing to these subtle differences between the less studied *Z. laticeps* and other *Zootermopsis* congeners from the western Nearctic, future studies on the genetic composition should be considered. Coupled with location and timing of populations of *Z. laticeps* from Texas, future colony composition studies may provide important clues to less understood termite species. This simple study provides the collecting framework for further investigation into this intriguing termite species.

**Acknowledgments**

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**References Cited**


