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Crioprosopus magnificus LeConte (Coleoptera: Cerambycidae) in Aguascalientes, Mexico: Biological Observations and Geographical Distribution

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Abstract

Symptoms of wood boring activity and Cerambycidae larvae in living oak trees (*Quercus* L. spp.) were discovered in October 2006 in the Sierra Fria, Aguascalientes, Mexico. Prompted by this finding, we conducted a field study to determine the wood borer species and its host preference and geographical distribution, and to record biological and ecological data. Adult specimens were obtained by caging infested bole samples in laboratory conditions as well as by installing screen emergence cages on infested trees in several locations in the Sierra Fria. Twenty-nine line transects were sampled in search of wood boring symptoms in living oak trees. Forty adult specimens were obtained during the 32-month study. Based on morphology and behavior, the insect was identified as *Crioprosopus magnificus* LeConte (Coleoptera: Cerambycidae), a new geographical record for this species. The main host for this insect is *Quercus potosina* Trel., but it also occasionally attacks *Quercus grisea* Liemb. and *Quercus eduardii* Trel. Wood boring symptoms attributed to *C. magnificus* were found along the Sierra Fria. Beetle emergence was confirmed in four locations. Observations on insect mating, longevity and oviposition are provided.

Key Words: oak borer, longhorn beetle, *Quercus*, insect biology

Resumen

En octubre de 2006, se descubrieron síntomas de actividad de un barrenador de madera y larvas de Cerambycidae en encinos vivos (*Quercus* L. spp.) en la Sierra Fría, Aguascalientes, México. Impulsados por este hallazgo, realizamos un estudio de campo para determinar la especie de barrenador de madera, su preferencia de hospederos, y su distribución geográfica, y para registrar datos biológicos y ecológicos sobre ella. Se obtuvieron especímenes adultos encerrando trozas infestadas dentro de jaulas en condiciones de laboratorio, así como mediante la instalación de jaulas de emergencia, elaboradas con malla, sobre árboles infestados en varias localidades de la Sierra Fría. Se muestrearon 29 transectos de línea en búsqueda de síntomas de barrenación en encinos vivos. Se obtuvieron 40 especímenes adultos durante el periodo de estudio, el cual tuvo una duración de 32 meses. Con base en la morfología y conducta, el insecto fue determinado como *Crioprosopus magnificus* LeConte (Coleoptera: Cerambycidae), siendo un nuevo registro geográfico para la especie. El hospedero principal de este insecto fue *Quercus potosina* Trel., pero ocasionalmente el insecto ataca a *Quercus grisea* Liemb. y *Quercus eduardii* Trel. Se encontraron síntomas de barrenación de madera atribuidos a este insecto a lo largo de la Sierra Fría. La emergencia de escarabajos se confirmó en cuatro localidades. Se proporcionan observaciones sobre el apareamiento, la longevidad, y la oviposición.

Longhorn beetles (Coleoptera: Cerambycidae) in temperate forests are commonly found in dead or damaged tree material, twigs, and branchlets of woody plants (Solomon 1995). On the other hand, certain cerambycid species feed inside the boles of living trees, acting as forest insect pests (Hanks 1999). An example of this is the red oak borer (*Enaphalodes rufulus* Haldeman) which, despite being native to the United States, has contributed to oak decline in Arkansas and Missouri (Lawrence *et al.* 2002; Fierke *et al.* 2005a, 2005b; Heitzman *et al.* 2007). Economic losses caused by this insect have been recorded since the mid-twentieth century (Donley and Acciavatti 1980; Donley 1981). Another example is the Asian long-horned beetle (*Anoplophora glabripennis* Motschulsky), an adventive cerambycid that kills several tree species in eastern United States (Lingafelter and Hoebeke 2002).

Few references about longhorn beetles attacking living oak trees exist for Mexican temperate forests. *Tylcus hartwegii* White feeds in branches of *Quercus* L. spp. in Nuevo León, but causes no serious damage (Cibrián Tovar *et al.* 1995). In October 2006, we found wood-boring symptoms in living oak trees in the Sierra Fria, Aguascalientes, Mexico. Two round-headed, wood-boring larvae were found inside a living *Quercus potosina* Trel. tree. Wood boring symptoms were observed in apparently vigorous trees as well as in decrepit trees. Prompted by these findings, we conducted a field study with the following objectives: 1) to determine the wood borer species attacking living oak trees in the Sierra Fria; 2) to determine the species' host preference and geographical distribution; and 3) to record biological and ecological data.

Material and Methods

The study was conducted in the Sierra Fria, a mountain range located in western Aguascalientes in the center of Mexico. Oak trees in this area grow at elevations between 1,800 and 2,900 m. Seventeen oak species are known in this mountain system, including *Q. potosina*, *Quercus eduardii* Trel., *Quercus laeta* Liemb., *Quercus grisea* Liemb., *Quercus resinosa* Liemb., and *Quercus sideroxyla* Humb. and Bonpl. (de la Cerda 1999).

Adult Captures and Identification. Two approaches were taken to obtain adults. The first approach consisted of felling and sectioning *Q. potosina* trees having symptoms of active wood boring. Tree bole sections collected from La Angostura (22°05′57″N 102°41′49″W) and La Sauda (21°58′53″N 102°34′6″W) were kept under laboratory conditions at Campo Experimental Pabellón, a research station of the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), in Pabellón de Arteaga, Aguascalientes. Stem sections (30–50 cm long) were placed inside insect cages at ambient temperature. Thirty bole sections were observed from late November 2006 to late September 2007, and 20 sections from May to August 2008. Bole sections were discarded after we estimated that the adult emergence period had ended, initially taking the life cycles of *E. rufulus* (Fierke *et al.* 2005b) and *Crioprosopus magnificus* LeConte (Solomon 1995) as references, because the boring symptoms resembled those caused by these species. The second approach consisted of using screen emergence cages, which surrounded a 1.0–1.5 m portion of infested tree bole, using feeding holes and frass accumulation as a guide to select the place for cage location. From May to July 2007, 16 fiberglass screen emergence cages were installed on infested trees at five locations. Except for one *Q. grisea*, all caged trees were *Q. potosina*. Unfortunately, most of these cages were damaged by cattle. In early May 2008, we installed 32 new fiberglass screen emergence cages on 31 infested *Q. potosina* trees and one *Q. eduardii* tree on forested land at the Los Alamitos Environmental Education and Research Center (22°10′28″N 102°35′15″W), an area which has human access control and cattle exclusion. Another 10 emergence cages were installed on a group of infested *Q. potosina* trees at La Sauda, surrounded by poultry spike wire to protect them from cattle grazing. Because we observed that at least two adult beetles escaped in 2008 by chewing through the fiberglass screen, in mid-May 2009 we replaced all fiberglass screen cages with metallic screen cages on all caged trees that showed no insect emergence in 2008 and still had boring activity by April 2009; a few other screen emergence cages were placed on newly selected *Q. potosina* trees. In 2009, 44 screen emergence cages were installed at Los Alamitos and 19 at La Sauda.

During all years of observation, screen emergence cages were sampled biweekly in May, weekly in June, and biweekly in July and August. Collected adult beetles were placed inside plastic jars provided with host foliage and apple pieces. Jars were closed with a screen mesh cap to prevent escape and allow air flow. Adults were maintained in observation until they died, and then they were pinned, labeled, and deposited in the forest insect collection of Campo Experimental Pabellón.

Species determination was based on Leng (1886), Hovore (1983), Solomon (1995), and the Photographic Catalog of the Cerambycidae of the New Worldd (Bezark 2010). Two photographic series of adult specimens (male and females) were sent to Steven W. Lingafelter (Systematic Entomology Laboratory, Plant Sciences Institute, ARS, USDA) for species confirmation.

Host Preference and Geographical Distribution. Twenty-nine line transects were sampled along the Sierra Fria from July 2007 to March 2009, in search of wood boring symptoms in living oak trees. Line transects were variable in length to include 20 oak trees. Most of the forested land in the Sierra Fria has a private land tenure system, and land owners maintain their land properties fenced and locked. For this reason, sampling of wood boring symptoms was done in areas where the land owner's permission for access could be obtained, and we tried to cover as much area as possible. Once in a stand, we arbitrarily selected a starting point and randomly selected a direction for sampling. Each line transect included the first 20 oak trees from the starting point. At each sampling site, we recorded the geographic coordinates and elevation with a Magellan eXplorist XL GPS unit configured with WGS84 Datum, the slope with a

Suunto clinometer, and aspect with a Brunton compass. We recorded the host species name, tree vital condition (healthy appearance, diseased, or dead), and presence or absence of wood boring symptoms indicated by feeding and exit holes along the stem and frass accumulation at the base of the trunk. In some cases, we did destructive sampling in search of wood boring larvae. Sampling sites included four locations with proven adult cerambycid emergence. When a particular oak tree could not be identified to species, a botanical sample was taken to the herbarium of the Universidad Autónoma de Aguascalientes for identification. Geographic coordinates and wood borer occurrence data were converted to shape files to display the geographic extent and insect infestation with ArcView V. 3.2 (ESRI). In addition, the geographic coordinates of those sites where adult emergence occurred were recorded.

Biological Observations. All aspects of longhorn beetle biology and behavior that were observed under field and laboratory conditions were recorded in this study.

Results

Adult Captures and Identification. Forty adult specimens were collected during the study: five in 2007, seven in 2008, and 28 in 2009. The species was determined as *C. magnificus*. The morphology of this species was described by Leng (1886) and Solomon (1995), except that we found sexual variation in elytral coloration. Female elytra range from almost totally black to yellowish orange with dim dark spots (Fig. 1A). Male elytra are deep red, immaculate, or with black spots anteriorly and medially (Fig. 1B).

Host Preference and Geographical Distribution. Our sampling scheme allowed searching for wood boring symptoms in a variety of site conditions in terms of elevation, slope, and host plant species composition. We found wood boring damage at elevations from 2,360 to 2,710 m, but most damage occurred in pure *Q. potosina* stands at elevations between 2,500 and 2,642 m with low slopes (Table 1). *Quercus grisea* and *Q. eduardii* were occasionally attacked, but no other oak species growing at lower or higher elevations were attacked by the oak borer (Table 1). On the other hand, all adult specimens collected in the study emerged from *Q. potosina*, except for one that emerged from *Q. eduardii*. Wood boring damage was found in apparently healthy as well as weakened trees with diameter at breast height (dbh) from 6.5 to 30.0 cm (mean = 13.4 cm, SD = 4.5, n = 77), and height from 2.0 to 8.0 m (mean = 3.9 m, SD = 1.2, n = 77).

We therefore conclude that *Q. potosina* is the main host of *C. magnificus* in the study area, and its distribution follows the geographical distribution of its host. Figure 2 shows the geographical extent of oak wood boring symptoms and those sites with proven emergence of *C. magnificus* in the Sierra Fria.

Biological Observations. The attack symptoms of *C. magnificus* consist of entrance holes along the main stem, with profuse dark brown exudation and abundant frass accumulation at the base of the stem (Fig. 3A, B). These symptoms correspond to an advanced stage of the attack, when the larvae are deep inside the xylem causing structural damage (Fig. 3C, D). Another symptom of attack is the presence of exit holes, round or slightly elongated, and clean, about 12 mm in diameter (Fig. 3E). The attacks occur along the tree bole, from 0.4 to 4.0 m above ground level.

Living adults trapped in cages on standing trees were collected on 28 June 2007 at La Angostura (one male and an adult of undetermined sex that escaped at the time of collection), on 16 June 2008 at Los Alamitos (four females), and on 11 June (one male) and 14 June at Los Alamitos (two males), 23 June (11 males and three females at Los Alamitos and six males and one female at La Sauda), and 27 June 2009 at La Sauda (one male). Living adults were collected during the day. One specimen was emerging from a caged tree at the time of sampling at 12:15 pm, whereas a pair inside the cage was mating at that time. Dead adults trapped in cages on standing trees were collected on 28 June 2007 (one male) at Mesa de los Sapos (22°14′43″N 102°29′11″W), on 16 June (one male) at Los Alamitos and 30 June 2008 (one female) at La Angostura, and on 27 June (two males) at La Sauda and 6 July 2009 (one male) at los Alamitos. After June of any of those three years, no living adult was found in cages on trees; however, abundant frass accumulation continued inside several cages, even those that were caged on May of the previous year, indicating larval activity at the same time as adult emergence. Except for one adult that emerged from *Q. eduardii*, all specimens emerged from *Q. potosina*, a white oak.

Under laboratory conditions, one adult female emerged on 22 May 2007 from a bole section collected on 13 November 2006. Furthermore, on 18 June 2007, one adult male emerged from a bole section collected on 4 June 2007. In 2008, only one adult male emerged, but it was found dead, trapped between the face of the bole and the insect cage, therefore we were unable to record the emergence date. Larval activity was observed under laboratory conditions from June to August 2007 and 2008.

From these observations we conclude that adult emergence occurs from mid- to late June, that overlapping generations occur, and that the full life cycle takes from two to three years. Our observations at Los Alamitos and La Sauda also suggest

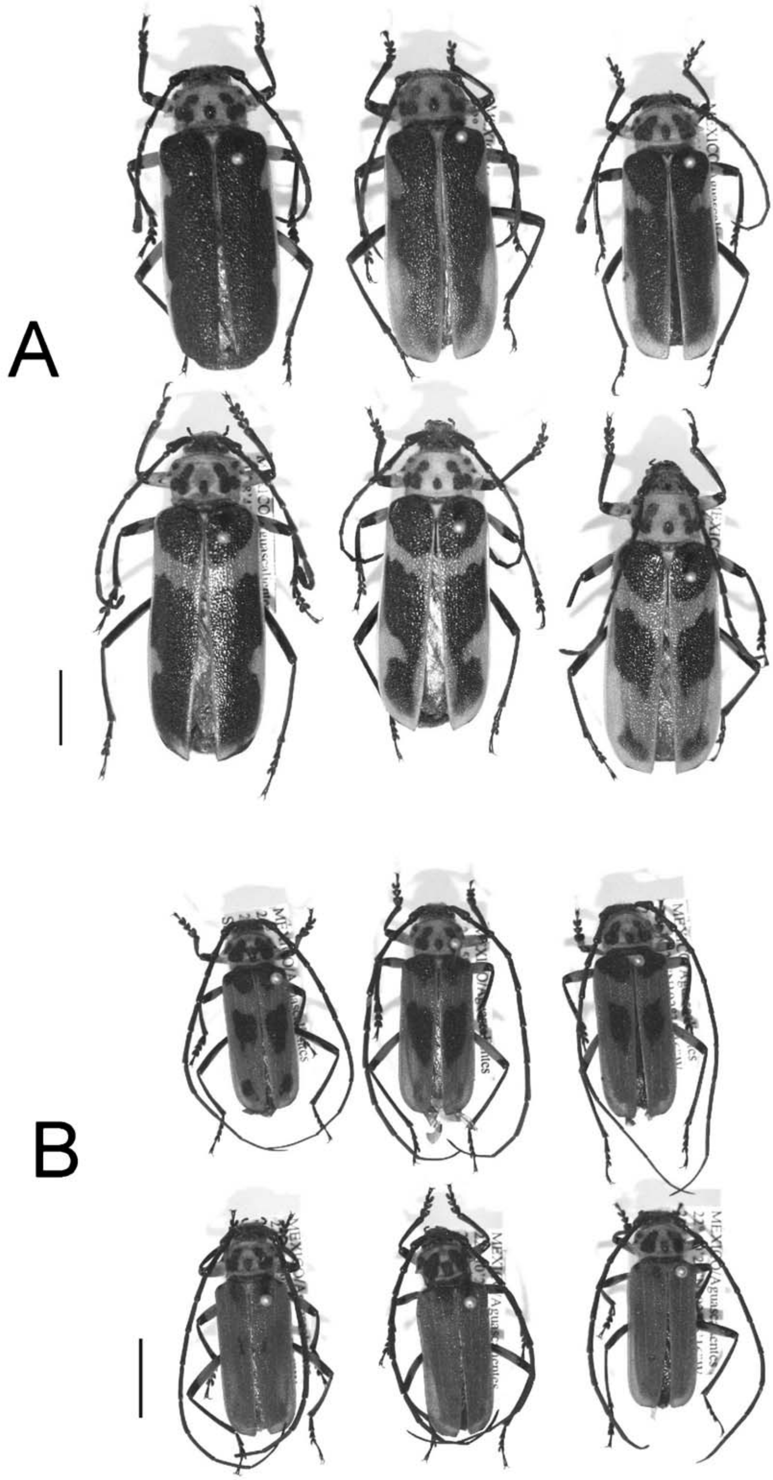

Fig. 1. Adult *Crioprosopus magnificus* that emerged from *Quercus potosina* in the Sierra Fria, Aguascalientes, Mexico. A) Females, B) Males. Scale bars = 1 cm.

Table 1. Wood boring occurrence attributed to *Crioprosopus magnificus* along the Sierra Fria, Aguascalientes, Mexico, based on a sample of 29 line transects that included 20 oak trees each.

Transect	Elevation (m)	Slope (%)	Oak species composition*	Wood borer occurrence (%)
El Ocote	1960	18	19 *Q. resinosa*	0
			1 *Q. eduardii*	
Los Alisos	2221	10	9 *Q. obtusata*	0
			6 *Q. gentry***	
Barranca Oscura	2129	16	13 *Q. resinosa*	0
			7 *Q. potosina*	
Gracias a Dios	2052	26	20 *Q. resinosa*	0
Peñon Blanco	2297	14	15 *Q. resinosa*	0
			5 *Q. eduardii*	
El Pilar	2553	14	15 *Q. eduardii*	0
			5 *Q. potosina*	
Mesa del Aguila1	2595	2	20 *Q. potosina*	0
Barranca Piletas	2511	50	13 *Q. sideroxyla*	0
			7 *Q. rugosa*	
Barranca J. Fco. SE	2701	36	10 *Q. potosina*	0
			7 *Q. eduardii*	
Barranca J. Fco. NE	2711	49	19 *Q. rugosa*	0
			1 *Q. sideroxyla*	
Montegrande	2974	5	18 *Q. sideroxyla*	0
			2 *Q. potosina*	
El Huarache	2360	5	12 *Q. potosina*	5
			8 *Q. eduardii*	
La Sauda2	2496	30	20 *Q. potosina*	10
Barranca Verde	2625	23	16 *Q. potosina*	5
			3 *Q. eduardii*	
			1 *Q. resinosa*	
La Angostura 2	2710	4	20 *Q. potosina*	5
El Colorín	2466	3	20 *Q. potosina*	20
La Sauda1	2491	3	20 *Q. potosina*	25
La Ciénega 2	2572	14	15 *Q. potosina*	25
			4 *Q. eduardii*	
			1 *Q. sideroxyla*	
Los Alamitos 2	2589	14	20 *Q. potosina*	20
Los Alamitos1	2598	12	20 *Q. potosina*	50
La Ciénega	2572	14	20 *Q. potosina*	60
El Tejamanil	2643	11	20 *Q. potosina*	30
La Angostura1	2710	0.5	20 *Q. potosina*	35
Mesa de los Sapos	2374	22	19 *Q. potosina*	55
			1 *Q. grisea*	
La Congoja 3	2500	15	14 *Q. grisea*	65
			6 *Q. potosina*	
La Congoja 2	2540	3	20 *Q. potosina*	70
La Congoja	2565	5	20 *Q. potosina*	65
Mesa del Águila 3	2637	10	20 *Q. potosina*	75
Mesa del Águila 2	2642	5	20 *Q. potosina*	70

*The number to the left of the species name indicates the number of trees for that species.
**Five tree samples were missing from this site.

that adult emergence was more abundant in 2009 compared with 2008, suggesting years of mass emergence; however, this premise needs to be tested. In all three years, adult emergence occurred at the time new leaves started growing on the host plants. At this time of the year, the foliage is orange to reddish, resembling the elytral color of *C. magnificus*.

An analysis of climate data from an automated station near our study sites suggested that adult emergence occurred during the early rainy season once the average relative humidity reached 50% or higher.

We observed adults mating the same day they were captured on 23 June 2009. One male displayed courtship behavior, before copulation, by positioning his last abdominal segment in front of the female. Mating lasted a few hours.

We observed oviposition by two females under laboratory conditions. Oviposition occurred between 2:30 and 5:15 pm on 24 June, a day after mating.

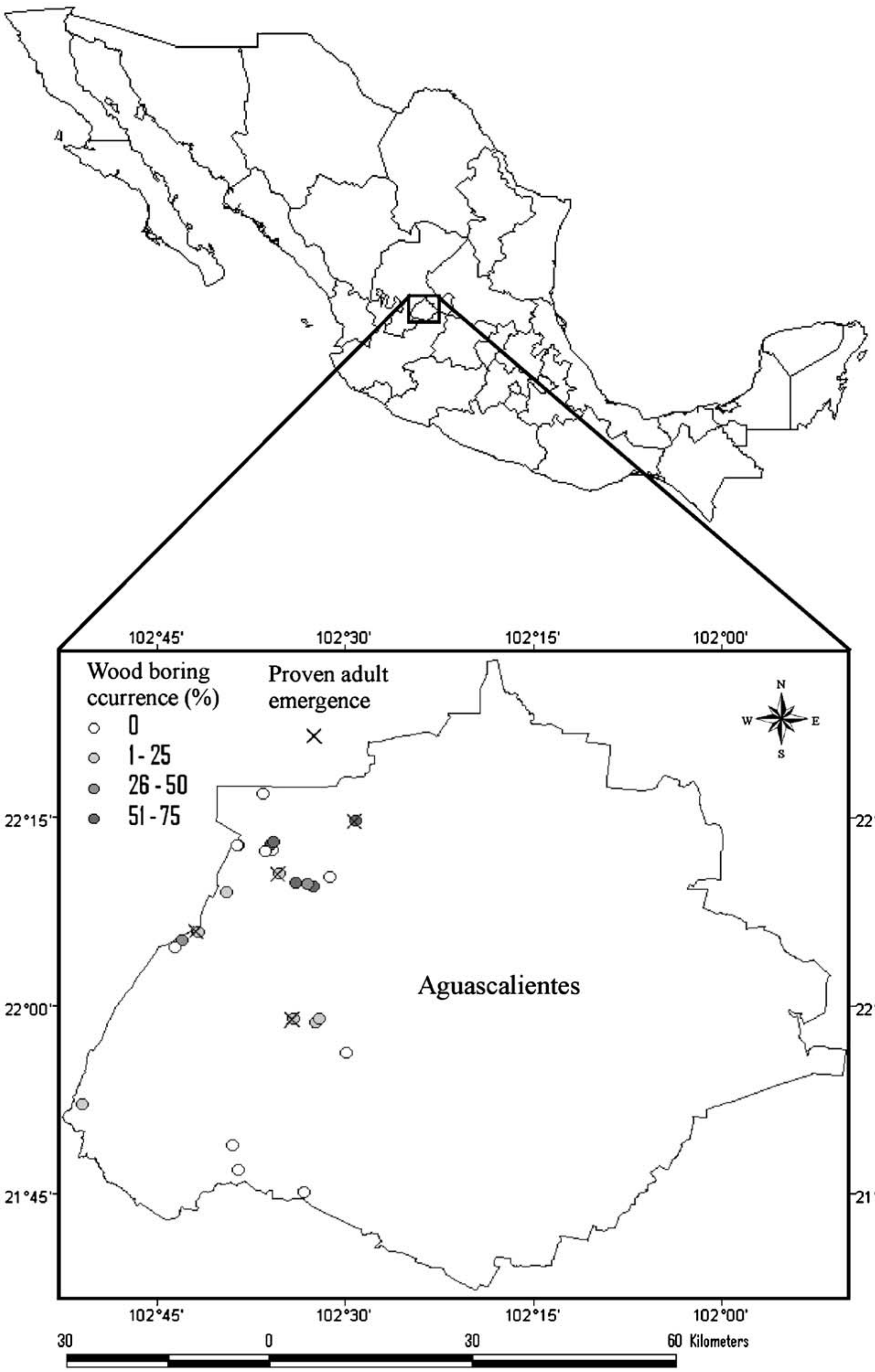

Fig. 2. Geographical extent of wood boring symptoms in oak trees and proven *Crioprosopus magnificus* adult emergence in Aguascalientes, Mexico. Wood boring occurrence is based on a sample size of 20 trees per site.

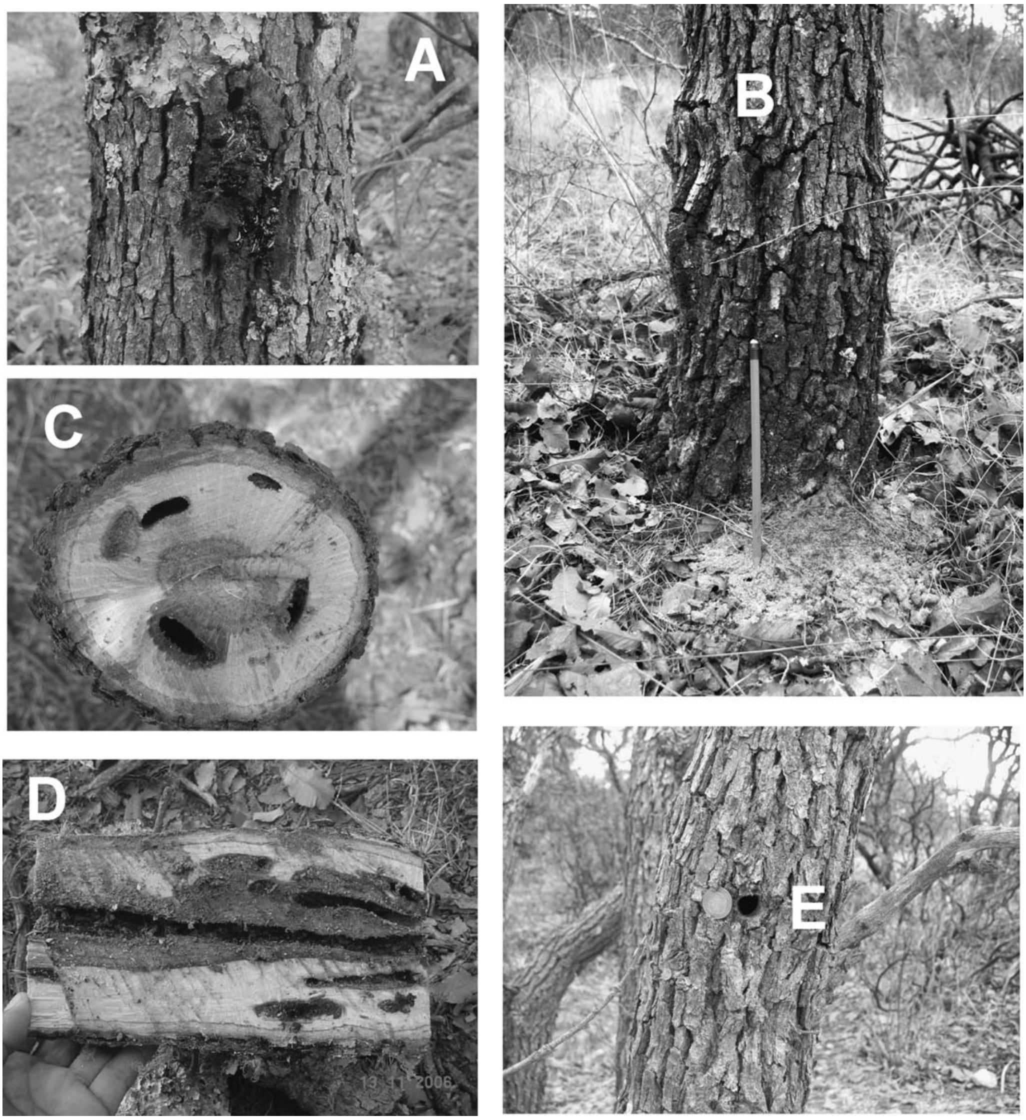

Fig. 3. Attack symptoms of *Crioprosopus magnificus* on *Quercus potosina*, *Quercus grisea*, and *Quercus eduardii* in the Sierra Fria, Aguascalientes, Mexico. A) Entrance hole, B) Abundant frass accumulation at the base of the tree, C) Transverse bole section showing larval galleries, D) Longitudinal bole section showing larval galleries, E) Exit hole.

Females stridulated and actively walked and brushed the bark surface with the setal fringe on the terminal abdominal segments while searching for oviposition sites. After a few minutes, they stopped brushing, adopted a horizontal position, deposited a single egg, and sealed it with a sticky substance that resembles the bark color (Fig. 4A). Oval eggs (3.0 × 4.5 mm, n = 20) were deposited on the bark surface without chewing a preoviposition notch (Fig. 4B). Egg laying lasted 80–170 secs (n = 7). As soon as the female covered the egg, she immediately resumed brushing the surface to lay the next egg.

Females were observed until completion of oviposition. One female laid a total of 27 eggs and another laid 23 eggs. Eggs were very difficult to detect without close examination because they resemble a tiny piece of bark. Sixteen hours after ovipositing and although still alive, females appeared weak and died 24–30 hrs after ovipositing. Males died 3–5 d after mating.

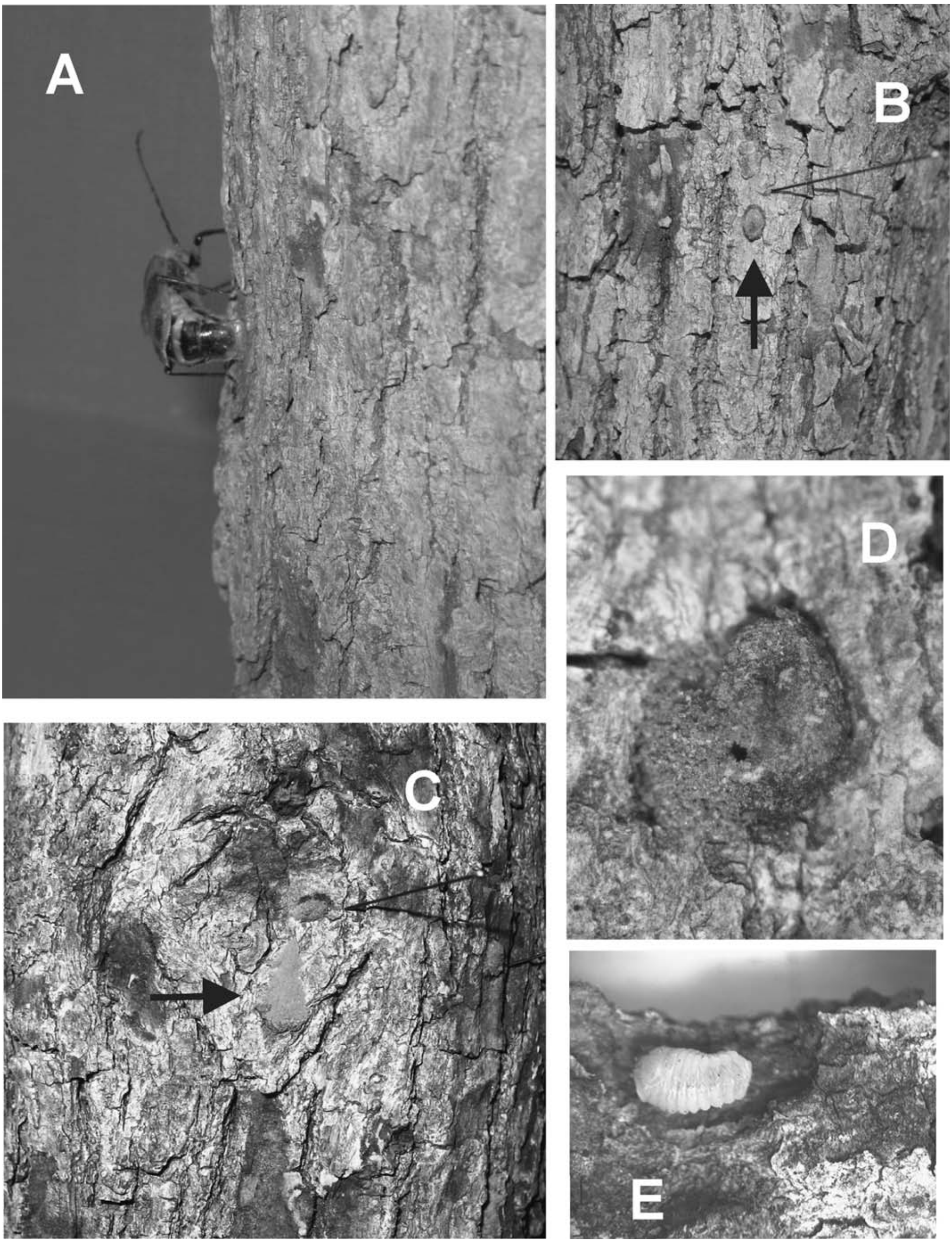

Fig. 4. Oviposition and egg hatching by *Crioprosopus magnificus*. A) Female ovipositing, B) Individual egg, C) Fine, red frass beneath the egg shell indicating egg eclosion, D) Close-up of the egg shell showing a small hole from which frass is expelled, E) Uncovered first instar.

Eggs eclosed on 8 July, 14 d after oviposition. First instars started boring into host material the same day they hatched, expelling fine red frass from the inner bark through a small opening in the egg shell (Fig. 4C–E). The second day after hatching, larvae bored directly into the wood, expelling fine, whitish frass. By dissecting a bole 12 d after larvae hatching, we confirmed that larvae do not consume the phloem, but bore directly into the wood. The bark surface is discretely covered with fine, whitish dust, however, at this time it is still difficult to observe the attack symptoms.

Unmated male and female adults, maintained on apple pieces, remained alive 25–39 d after emergence. However, males that mated the same day of emergence lived only 3–5 d, and females that mated the same day of emergence and laid eggs lived only 3 d. Beetles did not entirely consume the apple pieces, rather they seemed to use them as a source for water and possibly sugar.

Discussion

The results obtained in our research represent new findings in terms of host range and geographical distribution of *C. magnificus*. Previously, it was known only in general terms that this insect had been found in Arizona and northern Mexico (Hovore 1983; Solomon 1995; MacRae and Rice 2007), approximately 8–10° north and 6° west of Aguascalientes. The population in the Sierra Fria is disjunct from these more northerly populations, yet it is not known if this species is more widely distributed in North America. Chemsak *et al.* (1992) and Bezark (2010) list *Crioprosopus divisus* Bates, *Crioprosopus gaumeri* Bates, *Crioprosopus nieti* Chevrolat, *Crioprosopus nigricollis* Bates, *Crioprosopus saundersii* White, and *Crioprosopus servillei* Serville as other congeners of *C. magnificus* in Mexico. Unfortunately, information regarding the biology and precise geographical distribution of those species is lacking. Therefore, our study provides valuable baseline information on the distribution and biology of a poorly known forest insect species. Further research is required to more fully elucidate the distribution, biology, and ecology of *C. magnificus* and to determine whether the variation in geographical distribution and elytral coloration may indicate a distinct subspecies.

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