ECOLOGY AND REDESCRIPTION OF THE ARIZONA GRAPE BRUCHID, *AMBLYCERUS VITIS* (COLEOPTERA)

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ABSTRACT

A synonymy and redescription are provided for *Amblycerus vitis* (Schaeffer). Eggs of *A. vitis* are attached to mature fruits of *Vitis arizonica* by a unique peripheral flange with adhesive at its margin. Similar eggs have been described for 6 other bruchids, most of which are in the Amblycerinae. A larva usually enters the fruit directly, consumes the contents of a single seed, and pupates inside that seed. *A. vitis* apparently has 1 generation per year, is confined to 1 host, and its distribution is limited to central and southeastern Arizona. Because of its low rate of infestation of the seeds of the Arizona grape (less than 1%), it is doubtful that it has much effect on the host's population dynamics. A species of *Urosigalphus* (Braconidae) is a parasite of *A. vitis*. Figures are provided of the dorsal and lateral habitus of the adult, scutellum, pronotum, male genitalia, method of attachment of the egg, dorsal and ventral surfaces of the egg, cross section through the egg, and a dried fruit of *V. arizonica* showing an adult exit hole.

Most species of seed beetles feed in seeds of the Leguminosae, but about 28 other plant families are also known to be hosts for them (Zacher 1952; Johnson 1970). While most genera of seed beetles which feed in seeds of non-legumes are relatively host specific (i.e., palms, morning glories, etc.), members of the genus *Amblycerus* feed in a wide diversity of host plants, often showing no particular preferences. Many feed in seeds of the Leguminosae, but several non-legume families are infested as well. *Amblycerus vitis* is 1 of these species that feeds in non-legumes.

Schaeffer (1907) described the Arizona grape bruchid as *Spermophagus vitis* and reported that it was found exclusively on grapevines in Arizona, but he did not report it as breeding in the seeds of grapes. Essig (1958) did report it as breeding " . . . in the seeds of wild grape in Arizona," although no report of its host had appeared to that time in the primary literature.

The species is rare in collections and is only occasionally collected by sweeping. It was not until 1956 that L. J. Bottimer reared a specimen from a grape seed, thus firmly establishing *Vitis arizonica* as its host. In 1971 we learned of this rearing and during 1972 and 1973 seeds of Arizona wild grapes were collected to reaffirm that they are indeed host for a bruchid. As specimens were reared it was evident that the ecology of this bruchid was of interest and should be studied more intensively. The results of that study are reported here.

Because few specimens of *A. vitis* have been available for study, no redescription has appeared in the literature. We now have adequate specimens and present below a detailed description of its external morphology and the male genitalia.

Amblycerus vitis (Schaeffer)
(Fig. 1-6)

Spermophagus vitis Schaeffer 1907:293 (Huachuca Mts., Arizona; Location of type: U. S. National Museum of Natural History); Cushman 1911:505; Leng 1920:306; Essig 1958:487.
Amblycerus vitis: Johnson 1968b:1269; Bottimer 1968:1012, 1038.

ADULT

Length (pronotum-elytra): 2.6-3.7mm; width: 1.6-2.5mm; thoracic depth: 1.25-1.75mm.
Color dark reddish brown, eyes black. Vestiture of fine yellowish setae evenly distributed over body, not mottled. Body broadly ovate, convex above, elytra widest at middle (Fig. 2); pronotum trapezoidal, sides perceptibly curved, apex truncate, base sinuate, basal lobe broad. Head subtriangular; eyes prominent (Fig. 1), coarsely faceted, widely separated;

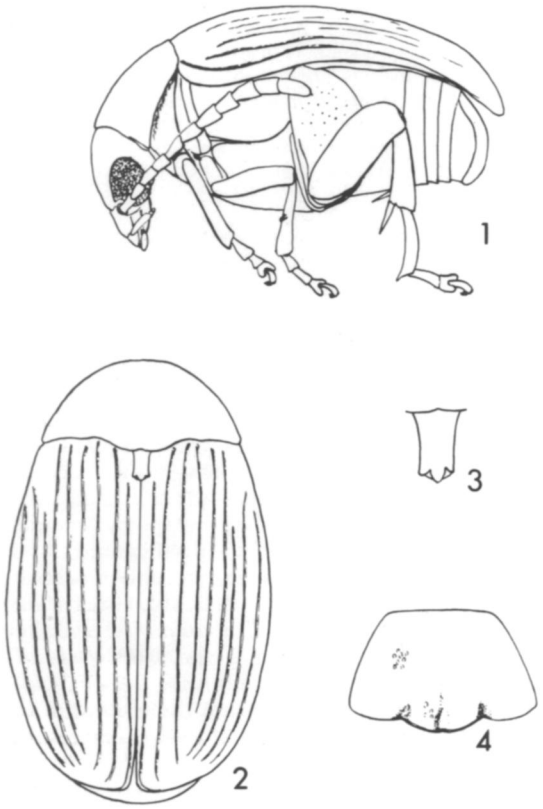

Fig. 1-4, *Amblycerus vitis*: 1) habitus, lateral; 2) habitus, dorsal; 3) scutellum; 4) pronotum, dorsal, showing approximate spacing of foveolae.

frons trapezoidal, convex, finely, evenly punctulate, without median carina or impunctate line, clypeus irregularly punctulate; antennae long, slender, reaching anterior margin of hind coxa, flagellar segments except terminal subserrate (Fig. 1). Pronotum (Fig. 4) trapezoidal, convex above, disk finely, evenly, densely foveolate, the foveola discrete, not merging, separated by 0.5 diameter to 2 diameters of a foveola; submarginal sulcus traceable at basal lobe but absent in lateral portion of basal margin, traceable along each lateral margin joining cervical sulcus at anteriolateral corner of pronotum, cervical sulcus interrupted at middle 0.33 of apical margin; cervical setae 2; pleural region of pronotum strongly concave beneath for reception of front femur; intercoxal piece narrow, constricted at middle. **Elytra** (Fig. 2) widest at middle, evenly convex above, apical margin evenly arcuate; striae regular, moderately deep, nearly concealed by vestiture, 4th and 5th striae abbreviated by convergence of 3rd and 6th striae, intervals transversely striolate. **Scutellum** (Fig. 3) about 2 times as long as wide, flat, trilobed apically. Mesosternal lobe not prominent; metasternum with postcoxal sulcus prominent, complete at middle, continuous laterally with parasutural sulcus, the latter extending to hind coxal cavity, disk of metasternum finely punctulate; metepisternum sparsely punctate with parasutural sulcus reaching half-way along pleural suture, extending dorsad anteriorly about 0.66 along intersegmental suture. Hind coxal face pubescent and sparsely foveolate in lateral 0.75, proximal 0.25 glabrous except for anterior marginal row of fine setae, cluster of about 16 punctures near trochanteral insertion; hind tibia with outer calcar 0.33 as long as basitarsus, inner calcar 0.66 as long as outer calcar. **Abdominal** sterna with scattered fine punctures along dorsal margin, last sternum slightly emarginate in both sexes, apex of 8th tergite usually visible in male. **Pygidium** evenly convex in lateral aspect, disk evenly, finely punctate, without spots of lines.

Male genitalia: (Fig. 5, 6.) Median lobe constricted at middle; ventral valve broad at base, attenuate to acute apex; internal sac with large, pointed median sclerite flanked by clusters of fine spicules, and a pair of curved, denticulate sclerites, sac near apex with an X-shaped sclerite in a cluster of very fine spicules, apex bulbous and sparsely lined with fine spines. Lateral lobes (Fig. 6) strap-like, expanded apically, shallowly emarginate on apical margin, emargination flanked by dense tufts of setae.

Host Plants

Old Record: Essig 1958: "wild grape".

New Records: *Vitis arizonica* Engelm.: Arizona. Cochise Co.: S. W. Research Station, Chiricahua Mts., 24-27-VIII-55, L. J. Bottimer #95w; Carr Canyon, Huachuca Mts., 28-IX-56, L. J. Bottimer #99a; Carr Canyon, ca. 5500′, Huachuca Mts., 2-VIII-72, #43-72 and 6-X-72, #110-72, C. D. Johnson; Miller Canyon, ca. 5600′, Huachuca Mts., 14-VI-72, #20-72, 2-VIII-72, #47-72 and 6-X-72, #116-72, C. D. Johnson; Coronado National Memorial, Huachuca Mts., 14-VI-72, #21-72, C. D. Johnson; Ash Canyon, ca. 2.5 mi from Hwy. intersection, Huachuca Mts., 2-VIII-72, #44-72, C. D. Johnson; Ramsey Canyon, ca. 5400′, Huachuca Mts., 6-X-72, #105-72, C. D. Johnson; Cochise Stronghold, ca. 5100′, Dragoon Mts., 14-VI-72, #23-72, and 14-X-73, #552-73, C. D. Johnson; Cochise Spring, ca. 1 mi W Cochise Stronghold, 15-X-73, #558-73, C. D. Johnson; ca. 6100′, 1 mi W Bisbee, 6-

X-72, #122-72, C. D. Johnson. Santa Cruz Co.: 6 mi E Ruby, 5-X-72, #102-72, C. D. Johnson; Madera Canyon, Santa Rita Mts., ca. 5400′, 12-VI-73, #513-73, C. D. Johnson. Pima Co.: Bog Springs Camp., Madera Canyon, Santa Rita Mts., 7-X-72, #130-72, C. D. Johnson; ca. 5500′, Box Canyon, Santa Rita Mts., 7-X-72, #123-72, C. D. Johnson. Yavapai Co.: Clear Creek Campground, ca. 8 mi SE Camp Verde, 15-IX-73, #542-73, C. D. Johnson.

The Host: The family Vitaceae is a close relative of the Rhamnaceae (Takhtajan 1969), a family whose seeds are also utilized by bruchids. But while 4 genera of the Rhamnaceae (*Barcena, Condalia, Rhamnus, Ziziphus*) are fairly reliably reported to have bruchids infesting their seeds, the genus *Vitis* has only 2 records reported for a bruchid (Zacher 1952; Essig 1958). Essig's report may have been a misinterpretation of Schaeffer's original record of *A. vitis* being collected *on* grapevines.

According to Kearney and Peebles (1969), canyon grape (*Vitis arizonica*) is common in streams and canyons throughout most of Arizona and is found from southern Utah to western Texas and northern Mexico. The juicy, few-seeded berries are eaten both fresh and dried by Indians, are readily eaten by birds, and are of good quality for jelly and grape juice. According to McDougall (1973) the berries are from 8 to 10mm in diameter but, those collected for this study were smaller (ca. 6.5 to 8mm ripe to 5.0 to 6.0mm dried). When ripe, pulp surrounding the large seeds is about 1.5 to 2.0mm thick. The grapes ripen to a very dark blue, almost black, then the pulp dries and shrivels, leaving a tough coat surrounding the seeds. Very little

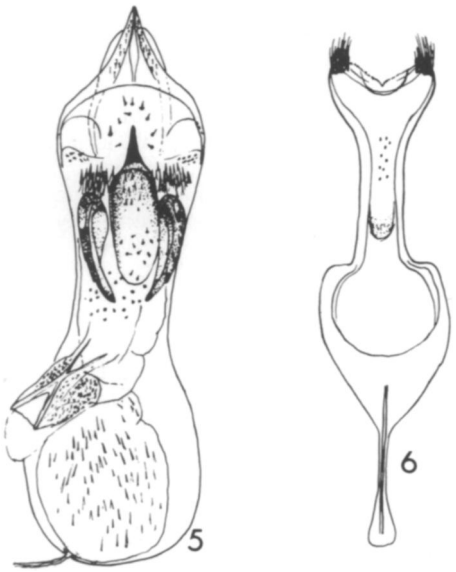

Fig. 5-6, *Amblycerus vitis* male genitalia: 5) median lobe, ventral; 6) lateral lobes, ventral.

pulp remains in these "raisins". Some dried grapes remain attached to the vines, but many fall to the ground.

The grapes examined during this study had from 1 to 4 hard seeds in them, but most had only 1 or 2 seeds. Seeds from fruits with 1 or 2 seeds were rounded on 1 side and flat on the other. Seeds from fruits with 3 or 4 seeds were wedge-shaped on 1 side and rounded on the other.

As with most plants, the amount of fruit produced by individual vines varied considerably. Some vines were very heavily laden with grapes while others had hardly any. Apparently because of the longer growing season, vines in southern Arizona produced more mature fruits than those in northern Arizona.

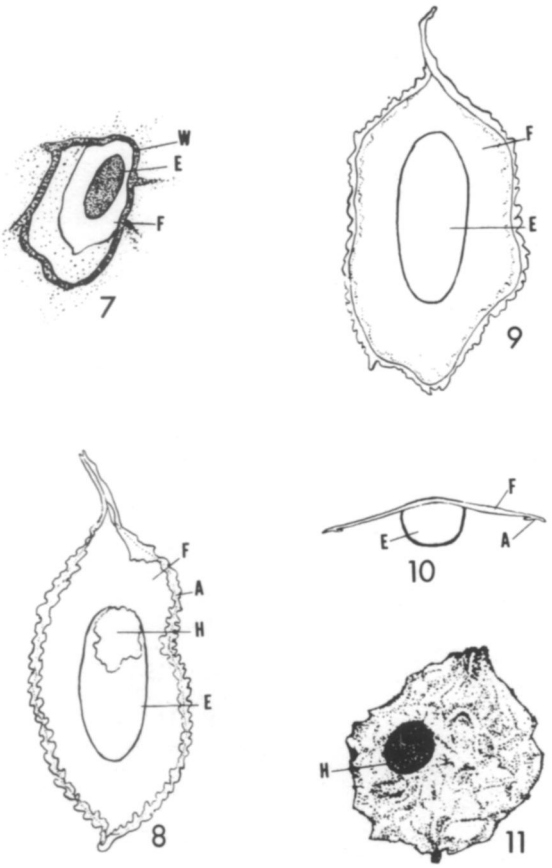

Fig. 7-11, *Amblycerus vitis* [E) egg; F) flange of egg; A) adhesive surface]: 7) egg attached to surface of grape; W) wrinkle on surface of grape; 8) ventral surface of egg; surface on periphery of flange (H = exit hole of larva); 9) dorsal surface of egg; 10) diagrammatic cross section through egg; 11) H, exit hole of adult *Amblycerus vitis* in dried fruit of *Vitis arizonica*.

TABLE 1. COLLECTION AND EMERGENCE DATA, *Amblycerus vitis* IN *Vitis arizonica*.

Culture # (see text)	Date Collection	Date Emerged by	Number Emerged
# 20-72	14-VI-72	3-VII-72	1
		30-V-73	1
# 21-72	14-VI-72	5-VII-73	1
# 23-72	14-VI-72	30-V-73	1
# 43-72	2-VIII-72	7-VIII-72	3
		18-IX-73	4
		24-X-73	5
		14-I-74	3
		15-IV-74	1
# 44-72	2-VIII-72	1-XI-73	2
# 47-72	2-VIII-72	1-IX-73	1
		18-IX-73	1
		11-XII-73	1
#102-72	5-X-72	14-I-74	2
#105-72	6-X-72	18-IX-73	1
#110-72	6-X-72	30-V-73	1
		31-V-73	1
		11-VII-73	1
		7-VIII-73	1
		18-IX-73	1
		1-XI-73	1
#116-72	6-X-72	30-V-73	1
		31-V-73	1
		2-VII-73	1
		18-IX-73	1
#122-72	6-X-72	7-VIII-73	1
		18-IX-73	3
		1-XI-73	1
		14-I-74	2
		6-III-74	1
#123-72	7-X-72	29-V-73	2
		30-V-73	1
		30-VII-73	3
		18-VIII-73	1
		18-IX-73	2
#130-72	7-X-72	29-V-73	2
		30-VII-73	2
		18-IX-73	1
#513-73	12-VI-73	2-VII-73	1
#542-73	15-IX-73	1-VII-74	3
#552-73	14-X-74	16-IV-74	3
		22-V-74	1
#558-73	15-X-73	22-IV-74	20
		24-IV-74	1
		22-V-74	9
		12-VI-74	1

METHODS

Collecting and laboratory procedures of Johnson (1968a, 1970) were followed during this study. Cultures were examined every 3 weeks to 1 month unless large numbers of emerging bruchids were noted; then they were examined daily.

During 1972 both green and mature grapes were collected while they were still attached to vines. In 1973 only mature grapes attached to vines were collected. We consider mature grapes to be those that have turned blue and are still juicy or have dried. Thirty-one lots of grapes from Arizona were collected during the course of this study.

The newly emerged adults used for ovipositional studies were placed in a jar containing dried, mature grapes.

RESULTS AND DISCUSSION

Bruchids were reared from 17 of the 31 lots (Table 1). All of these lots had at least some mature grapes in them. Twelve of the 14 cultures which did not yield bruchids consisted of immature to very immature grapes. Of the other 2 unproductive cultures, 1 consisted of intact grapes and exposed grape seeds collected from the ground beneath grapevines, while the other (same locality as #542-73) consisted of at least 50% mature grapes.

The 2 cultures that yielded by far the greatest numbers of *A. vitis* were #43-72 and #558-73. When collected, most of the fruits in #43-72 were juicy and mature, while those in #558-73 were dried and mature.

The above results indicate to us that most *A. vitis* that breed successfully in seeds of *V. arizonica* oviposit on mature fruits. Because the greatest

TABLE 2. RATES OF INFESTATION OF *Vitis arizonica* FRUITS BY *Amblycerus vitis* AND *Urosigalphus* SP.

Culture #	# *A. vitis* emerged	# fruits	% infestation	# *Urosigalphus* emerged
20-72	2	82	2.44	
21-72	1	532	.19	
23-72	1	156	.64	
43-72	16	2127	.75	
44-72	2	43	4.65	
47-72	3	234	1.28	
102-72	2	414	.48	
105-72	1	152	.66	
110-72	6	2034	.295	
116-72	4	269	1.49	1
122-72	8	290	2.75	1
123-72	9	213	4.23	2
130-72	5	307	1.63	1
513-73	1	9	11.11	
542-73	3	803	.37	
552-73	4	337	1.19	
558-73	31	385	8.05	5
TOTAL	99	8378	1.18	10

number of *A. vitis* was reared from seeds that were mature and dried when collected, and because beetles oviposited freely on mature, dried grapes in the laboratory, we feel that it probably oviposits preferentially on this aged fruits in nature. However, Bottimer (in litt.) indicated oviposition also occurs on green not yet full size grapes, and the bruchids complete their development in them.

Oviposition and Eclosion

Female *A. vitis* usually place their eggs where the peduncle attaches to the fruit, although they occasionally oviposit anywhere on the surface of the fruit. Usually only 1 egg (sometimes 2) is placed on a fruit (Fig. 7). When confined to culture jars, as many as 5 eggs may be oviposited per fruit. Each egg is covered and surrounded by a unique flange (Fig. 7-9). The outer ventral surface of this flange secures the egg to low areas between wrinkles on the grape (Fig. 7). The undulate edge of the flange has an adhesive material on its ventral surface and is the only portion of the egg apparatus that is glued to the substrate (Fig. 8, 9). The egg hangs beneath this cover (Fig. 10). The length of the flange is 1.3-1.7mm and the width is 0.7-0.9mm. The egg is 0.7-0.8mm long and 0.3-0.4mm wide and has the typical shape of a bruchid egg (Fig. 7-9). One end of the flange always has an elongate point.

Eclosion occurs through the lower surface of the egg chorion (Fig. 8). Because this surface is not glued to the surface of the fruit, the larva may travel a short distance to the substrate after it ecloses. Most larvae emerge and enter the fruit just beneath the egg. Sometimes the larva leaves the egg and travels to the edge of the flange before entering the fruit. In most instances whitish frass is pushed back into the egg (and sometimes also beneath the flange) when the fruit is entered. Several empty egg choria contained frass which was stained dark blue, indicating that some of the dark pulp had extruded into the egg. We have no evidence that the extrusion of pulp is an effective device to push larvae of *A. vitis* out when they attempt to enter grapes. Occasionally larvae may burrow through the edge of the flange and leave this covering. We have no evidence that they successfully enter the fruit after leaving.

In laboratory cultures the 1st instar burrows almost directly beneath the egg, through the skin, pulp, and into the seed through the hard, bony covering. We were not able to determine the paths of entry of all of the 1st instars hatching from eggs oviposited on fruit in the field, however, because the subsequent feeding of later instars destroyed these paths.

The covering and flange around the egg of *A. vitis* is not unique to this species. Bondar (1937) described similar eggs for *Amblycerus longissimus* (Pic) and *A. nigromarginatus* (Motschulsky) as did Teran (1962) for *Pseudopachymerina lallemanti* (Marseul) (now *P. spinipes* (Er.)) and *Caryedes* (now *Penthobruchus) germaini* (Pic); the eggs of *Pygiopachymerus lineola* (Chevrolat) as described by Janzen (1972) appear also to be similar to *A. vitis,* as do those of *Caryedon fasciatum* Prevett as described by Prevett (1966). An almost identical egg to that of *A. vitis* was described by Prevett (1967) for *Spermophagus* new species near *gossypii* Chevrolat. Differences are that the egg of *A. vitis* is completely covered by the flange and the flange itself does not have a seam down the center. Prevett suggested that an advantage of an egg attached in this way is that the danger of the egg be-

coming detached during the emergence of the larvae is less than when the egg is attached in the usual way (i.e., lower surface glued to the substrate).

Apparently the host seeds or pods of the species mentioned above are all smooth or relatively so. The wrinkled fruit used by *A. vitis* is certainly not smooth (Fig. 11). We agree that Prevett's explanation for the function of this type of egg is probably correct. We also suggest that this egg type would also serve well if the egg is laid on a smooth surface (i.e., ripe grape) that later wrinkles and shrivels. Therefore, we believe the structure of the egg of *A. vitis* has 2 primary functions: 1) for attachment during eclosion and 2) attachment during shriveling of the fruit of its host.

Because *Amblycerus longissimus, A. nigromarginatus, A. vitis,* and a near relative in the genus *Spermophagus* (all subfamily Amblycerinae) all have eggs with a similar structure, it is possible that this kind of egg is indicative also of their close phylogenetic relationships.

Larval Feeding and Pupation

Nineteen fruits of *V. arizonica* that had been fed upon by *A. vitis* were dissected. Of these, 15 had 1 seed, 2 had 2 seeds, and 2 had 3 seeds. A larva apparently consumes the entire contents of a seed because many of the seeds had holes chewed completely through the hard seed coat but not through the pulp and skin. Pupation occurs inside the hollowed out chamber and emergence is through a typical bruchid exit hole (Fig. 11). About 0.25 of the pupal chamber is filled with frass and exuviae.

In both of the fruits containing 2 seeds, and in 1 containing 3 seeds, only 1 seed had been fed upon, while the other seeds remained completely intact and presumably viable. All 3 seeds had been almost completely devoured in 1 of the fruits with 3 seeds. Neat round holes, slightly larger than adult exit holes, had been chewed between each of the seeds. Apparently the inside of only 1 seed was used as a pupal chamber, however.

Generations per Year and Rates of Infestation

According to the data presented in Table 1, *A. vitis* probably spends at least 6 or 7 months inside a seed before emerging. In most instances the larval life is much longer (i.e., #43-72, #122-72). In only 2 instances (#20-72, #513-73) did an adult emerge from a seed shortly after it was collected. In both these cases where the seeds were collected in June, the seeds were obviously from the previous year's crop, and the emergent adults had spent the winter inside seeds.

We reconstruct the life history of *A. vitis* probably as follows: Eggs are laid by adults that begin to emerge in the spring, but since only seeds from the previous year are available, few bruchids are successful until the new crop ripens beginning in late July. Most adults probably emerge and then oviposit on dried seeds in September and October. It probably takes about 1 year for them to mature.

Rates of infestation are presented in Table 2. The overall infestation rate of the 17 cultures is misleading, because some of the fruits in almost all the cultures were immature. For the most part those fruits that had the greatest infestation rates were those cultures that were composed of mostly mature fruits. Then, the rate of infestation is a reflection of the time when

the seeds were collected and the maturity of the fruit. Obviously, if the fruits remain on the vines for several months there is a greater chance that *A. vitis* will oviposit on them. Many of the fruits naturally fall to the ground and presumably are not attacked by bruchids. Therefore, the infestation rate in Table 2 represents mostly those grapes that have remained on the vines. We believe that *A. vitis* destroys far less than 1% of the total seed crop of *Vitis arizonica*. In any case, with the low rate of infestation, it is doubtful that this bruchid has much effect on the population dynamics of its host.

Distribution

Amblycerus vitis is most abundant in southeastern Arizona (Table 1). Apparently the conditions other than availability of host seeds are most suitable for its survival there because there is an abundant seed crop in the canyons surrounding the Verde Valley in north-central Arizona and, although several seed lots have been collected, only 3 bruchids have been reared from them.

It has been collected as far west in southern Arizona as 6 miles east of Ruby, Santa Cruz County and as far north as Clear Creek Campground, Yavapai County. An emergence hole has been found in a grape collected in Buckhorn Canyon, and specimens collected from the Southwestern Research Station, both Chiricahua Mountains, Cochise County, are the easternmost verified records. One specimen of *A. vitis* in the Canadian National Collection bears the labels "Davis Mts. Tx, VII-9, J. W. Green collector". This record must be verified before it can be considered valid. Although we have no records for this species from Mexico, it probably is found there because *A. vitis* has been collected in Coronado National Memorial on the Mexican border as well as other localities close to Mexico (Ruby, Bisbee).

Associated Hymenoptera

Ten specimens of the braconid wasp, *Urosigalphus* sp., emerged from 5 of the lots. Some seeds from which they emerged were dissected, and exuviae of larval bruchids and parasites were found.

Acknowledgments

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