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Bruchid Beetles and Palm Seeds: Recorded Relationships

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ABSTRACT

New World Bruchidae in the tribe Pachymerini, subfamily Pachymerinae, almost exclusively feed in the seeds of palms and are therefore commonly referred to as palm bruchids. We have found that these seed beetles have moderate preferences for different taxa of palms. The bruchid genus *Caryobruchus* shows definite preference for palms in the tribes Corypheae, Phoeniceae, and Hyophorbeae. Seeds of the Phytelephantoideae and Coccoaeae are fed upon by the genera *Caryoborus*, *Speciomerus*, and especially species of *Pachymerus*. Thus palm bruchids do show specificity for host plants, and the records reported in the literature are likely to be fairly accurate.

Among the many threats to the health and life of seeds, bruchid (seed) beetles (Coleoptera: Bruchidae) are some of the most ubiquitous and formidable. These beetles lay their eggs on seeds or fruits, and their larvae feed inside seeds, usually destroying the seeds in the process. From a plant's point of view, a seed has only two purposes: to package the embryo for dispersal and to nurture the embryo until it can establish itself as a seedling. From the bruchid's perspective, a seed is a nursery-cum-cafeteria, rich in food resources and often well protected from the environment. In short, it is the perfect place for bruchid larvae to feed. The conflict between these differing agenda has led to some of the most interesting coevolutionary relationships in biology.

The first taxonomic revision of the bruchid tribe Pachymerini of the New World was recently published by Nilsson and Johnson (1993). Included in their revision were published and unpublished host records for these beetles, probably all of which feed on palm seeds. With better understanding of bruchid taxonomy and relationships, we are now in a position to examine the host records of these

beetles. An examination of bruchids and their palm hosts is the subject of this paper.

A significant barrier to this undertaking is that most host records are not substantiated by seeds or voucher specimens of the palms from which the beetles were reared. Consequently, the accuracy of the historical records cannot be verified. Also, many of the names of the palms have been changed since the original host records were published or placed on insect labels. Many of the published names of the palm hosts are not those in current use.

After assembling the host records and correcting for the outdated bruchid and palm taxonomy, we found, simply by examination, that there were distinct relationships between genera of seed beetles and some of the host genera of palms. Thus, even allowing for some spurious host records, we have probably established that there are distinct host preferences between palm bruchids and their hosts.

Plea for Bruchids Reared from Palm Seeds

We strongly encourage palm growers and specialists to collect the insects that emerge from the seeds of palms and send them along with a sample of the seeds to either CDJ, SZ, or JAN. Now that the classification of palm bruchids has been largely completed, we can identify the bruchids with a high degree of certainty. This is of value to palm growers in controlling the insects. Also, now, more than ever, ecological studies of these interesting plants and insects will be of greater value since names can be applied to both plants and insects.

Bruchid Beetles

Beetles in the family Bruchidae feed in the seeds of about 33 families of plants, but most feed in

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the Leguminosae. The reasons for host specificity to any family are not easily ascertained, but some possible reasons are discussed below.

Bruchids are in the superfamily Chrysomeloidea, a superfamily that includes the leaf beetles and the longhorned wood borers. The larvae of the leaf beetles feed in or mine the leaves, roots, and stems. The larvae of the longhorned wood borers feed in wood and roots. According to Johnson (1981) it is likely that the chrysomeloid ancestors of bruchids radiated onto the seeds of the Leguminosae (or possibly its ancestors) shortly after it arose and then later evolved the ability to feed in seeds of other families. All known seed beetles feed on, and usually live in, seeds.

The family Bruchidae consists of about 1,500 described species grouped in the subfamilies Amblycerinae, Bruchinae, Eubaptinae, Kytorrhinae, Pachymerinae, and Rhaebinae (Southgate 1979). About 80% of bruchid species are in the Bruchinae, 10% in the Amblycerinae, 9% in the Pachymerinae, with the other 1% assigned to the other three subfamilies.

The life histories of bruchids vary considerably in egg laying, larval entry, and larval feeding behavior. The general life cycle is that the adult lays an egg on a fruit or seed, and the first stage (instar) larva bores through the fruit and/or seed coat and enters the seed. The first stage larva is highly modified to enter seeds and has many spines and often well developed legs for this purpose. Once it has entered a seed it molts into a legless grub and begins to feed. A larva usually molts three more times as it continues to feed inside the seed; usually only one, but sometimes several seeds are eaten. Bruchids usually pupate inside the seed that the larva has fed upon, but those that feed on several seeds may build a pupal chamber by gluing several seeds together, or some may leave the seeds and spin a cocoon in which they pupate. The larva starts and usually the adult finishes making a round exit hole in the seed and perhaps the fruit through which the adult exits. Adult bruchids feed on pollen and nectar and are not known to feed on seeds or fruits. Some species of bruchids may complete many generations in a year, but most species of bruchids complete only one or a few generations per year. In the laboratory or in stored seeds, bruchids may complete many generations without the adults feeding; however, it has been shown that adult bruchids will lay more eggs if provided with ample food and water. They are suspected to feed on flowers, pollen, and nectar in the field.

About 84% of the hosts of bruchids are in the Leguminosae (Johnson 1970). Most of the other hosts are in the families Convolvulaceae (4.5%), Arecaceae (4.5%), and Malvaceae (2%). The other 5% are in 29 other families. Of the 5%, the Combretaceae, Rhamnaceae, Sterculiaceae, and especially the Tiliaceae host more bruchids than the other families.

Seed beetles in the subfamily Pachymerinae are medium to large size seed predators consisting chiefly of "primitive" forms. They appear to be naturally distributed in the tropics and subtropics of all continents except Australia, and extend into temperate zones in some areas. Palm bruchids are confined to the tribe Pachymerini, all of which are endemic to the Americas. Two species are now established in Africa as the result of human introductions. Most species of Pachymerini are tropical, but species occur as far north as Texas and as far south as Argentina. The Pachymerini almost exclusively feed in palm seeds and are therefore commonly called palm bruchids. *Pachymerus abruptestriatus* (Gyllenhal), however, has been reported to feed in the seeds of *Diospyros* sp. (Ebenaceae) (Bondar 1941). This record may be spurious. The remaining two tribes of the Pachymerinae are native to the Old World and most feed upon seeds of Leguminosae, some in the Combretaceae, with some questionable reports from the Umbelliferae and Pandanaceae.

Bruchid-Host Interactions

Early coevolutionary studies between bruchids and their hosts were conducted by Janzen (1969) who suggested traits that Leguminosae possess that seem to protect their seeds from seed beetles. Center and Johnson (1974) suggested counter-mechanisms by bruchids to these plant traits. Interactions between bruchids and toxic seeds have been discussed by several authors, but the research of Janzen (e.g., 1977, 1978) and Rosenthal (e.g., 1990) are especially enlightening. Ecological and coevolutionary studies of palm bruchids and palms known to us were made by Janzen (1971), Wilson and Janzen (1972), Smith (1975), Brown (1976), Bradford and Smith (1977), Wright (1983), and Smythe (1989).

Methods

The data we analyzed in this paper are listed in Table 2 and were gathered mostly by CDJ and JAN from specimens and the literature. SZ updated the names in Table 2. The data in Table 2 were

Table 1. Bruchid beetles that have been reported to feed in seeds of *Arecaceae*. Palm taxa are grouped by subfamily, tribe and genus. *Cocos nucifera* (coconut) is an unlikely host for palm bruchids so record is unlikely and must be verified. * = Introduced into the New World. ** = Records are from hosts cultivated outside their native range.

Host Plant	Palm Bruchids
ARECACEAE	
Coryphoideae	
Corypheae—31 genera; Cosmo. (26% of genera attacked)	
<i>Thrinax</i>	
<i>T. morrisii</i> H. Wendl.	<i>Caryobruchus gleditsiae</i>
<i>Coccothrinax</i>	
<i>C. argentata</i> (Jacq.) Bailey	<i>C. gleditsiae</i>
<i>C. martii</i> (Griseb. et Wendl.) Becc.	<i>C. gleditsiae</i>
<i>Livistona</i>	
* <i>L. chinensis</i> (Jacq.) R. Br. ex Mart.	<i>C. gleditsiae</i>
<i>Serenoa</i>	
<i>S. repens</i> (Bartram) Small	<i>C. gleditsiae</i>
<i>Brahea</i>	
<i>Brahea</i> sp.	<i>C. rubidus</i>
	<i>C. veseyi</i>
<i>B. armata</i> S. Wats.	<i>C. veseyi</i>
<i>B. brandegeei</i> (Purpus) H. E. Moore	<i>C. veseyi</i>
<i>Copernicia</i>	
<i>Copernicia</i> sp.	<i>C. gleditsiae</i>
	<i>Pachymerus thoracicus</i>
<i>C. alba</i> Morong ex Morong & Britton	<i>P. thoracicus</i>
<i>C. hospita</i> Mart.	<i>C. gleditsiae</i>
<i>C. prunifera</i> (Miller) H. E. Moore	<i>P. bactris</i>
	<i>P. sveni</i>
<i>C. rigida</i> Britton & Wilson ex Britton	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>C. sueroana</i> León	<i>C. gleditsiae</i>
<i>C. tectorum</i> (Kunth) Mart.	<i>P. cardo</i>
<i>C. macroglossa</i> Wendl. ex Becc.	<i>C. gleditsiae</i>
<i>Washingtonia</i>	
** <i>W. filifera</i> (Linden) Wendl.	<i>C. gleditsiae</i>
** <i>W. robusta</i> Wendl.	<i>C. gleditsiae</i>
<i>Sabal</i>	
<i>Sabal</i> sp.	<i>C. curvipes</i>
	<i>C. gleditsiae</i>
	<i>C. maya</i>
	<i>Speciomerus ruficornis</i>
<i>S. bermudana</i> L. H. Bailey	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. causiarum</i> (O. F. Cook) Becc.	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. domingensis</i> Becc.	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. etonia</i> Swingle ex Nash	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. maritima</i> (Kunth) Burret	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. mauritiiformis</i> (Karst.) Griseb. & H. Wendl.	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
<i>S. mexicana</i> Mart.	<i>C. curvipes</i>
	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.
	<i>Speciomerus ruficornis</i>
<i>S. minor</i> (Jacq.) Pers.	<i>C. gleditsiae</i>
	<i>Caryobruchus</i> sp.

Table 1. Continued.

Host Plant	Palm Bruchids
<i>S. palmetto</i> (Walt.) Lodd. ex J. A. & J. H. Schult.	<i>C. gleditsiae</i> <i>C. marieae</i> <i>Caryobruchus</i> sp. <i>C. curvipes</i> <i>Caryobruchus</i> sp. <i>C. gleditsiae</i> <i>C. veseyi</i> <i>Caryobruchus</i> sp. <i>C. gleditsiae</i> <i>Caryobruchus</i> sp. <i>C. gleditsiae</i> <i>Caryobruchus</i> sp.
<i>S. pumos</i> (Kunth) Burret	
<i>S. rosei</i> (O. F. Cook) Becc.	
<i>S. uresana</i> Trel.	
<i>S. yapa</i> C. Wright ex Becc.	
Phoeniceae—1 genus; African/Asian (100%)	
<i>Phoenix</i>	
* <i>P. sylvestris</i> (L.) Roxb.	<i>C. gleditsiae</i>
Borasseae—7 genera; African/Asian (0%)	
Calamoideae	
Calameae—19 genera; African/Asian (one species in the Americas) (0%)	
Lepidocaryeae—3 genera; American (33%)	
<i>Mauritia</i>	
<i>M. flexuosa</i> L.f.	<i>Caryoborus gracilis</i>
Nypoideae—1 genus; Asian (0%)	
Ceroxyloideae	
Cyclospatheae—1 genus; American (0%)	
Ceroxyleae—5 genera; Cosmo. (0%)	
Hyophorbeae—5 genera; American (20%)	
<i>Chamaedorea</i>	
<i>Chamaedorea</i> sp.	<i>Caryobruchus gleditsiae</i>
<i>C. elegans</i> Mart.	<i>C. marieae</i> <i>C. maya</i> <i>C. gleditsiae</i>
<i>C. seifrizii</i> Burret	
Arecoideae	
Caryoteae—3 genera; Asian (0%)	
Iriarteae—6 genera; American (17%)	
Dictyocaryum	
<i>D. fuscum</i> (Karst.) H. Wendl.	<i>Caryoborus gracilis</i>
Podococceae—1 genus; African (0%)	
Areceae—86 genera; Cosmo. (5%)	
<i>Euterpe</i>	
<i>Euterpe</i> sp.	<i>Pachymerus bactris</i>
<i>E. oleracea</i> Mart.	<i>P. sveni</i>
<i>Oenocarpus</i> sp.	<i>Caryoborus gracilis</i>
<i>O. bataua</i> Mart.	<i>C. gracilis</i>
<i>Areca</i>	
* <i>A. triandra</i> Roxburgh ex Buchanan-Hamilton	<i>Pachymerus cardo</i>
Coccaeae—22 genera; mostly American (3 African) (59%)	
<i>Butia</i>	
<i>B. capitata</i> (Mart.) Becc.	<i>P. bridwelli</i>
<i>Cocos</i>	
<i>C. nucifera</i> L.	<i>P. bactris</i> <i>P. nucleorum</i>
<i>Syagrus</i>	
<i>S. coronata</i> (Mart.) Becc.	<i>P. bactris</i> <i>P. nucleorum</i>
<i>S. flexuosa</i> (Mart.) Becc.	<i>P. bactris</i>
<i>S. romanzoffiana</i> (Cham.) Glassman	<i>P. bactris</i> <i>P. cardo</i> <i>P. nucleorum</i>

Table 1. Continued.

Host Plant	Palm Bruchids
<i>S. schizophylla</i> (Mart.) Glassman	<i>P. bactris</i> <i>P. nucleorum</i>
<i>S. vagans</i> (Bondar) Hawkes	<i>P. bactris</i> <i>P. nucleorum</i>
<i>Attalea</i>	
<i>Attalea</i> sp.	<i>Speciomerus giganteus</i> <i>S. ruficornis</i> <i>P. bactris</i> <i>P. cardo</i>
<i>A. funifera</i> Mart. ex Sprengel	<i>P. bactris</i> <i>P. nucleorum</i>
<i>A. lapidea</i> (Gaerther) Burret	<i>P. bactris</i> <i>P. nucleorum</i>
<i>A. spectabilis</i> (Mart.) Burret	<i>P. cardo</i>
<i>A. tessmannii</i> Burret	<i>P. cardo</i>
<i>A. victoriana</i> Dugand	<i>P. cardo</i>
<i>Scheelea</i>	
<i>S. gomphococca</i> (Mart.) Burret	<i>P. cardo</i>
<i>S. martiana</i> Burret	<i>Speciomerus giganteus</i> <i>Pachymerus bactris</i>
<i>S. brachyclada</i> Burret	<i>P. cardo</i>
<i>S. excelsa</i> Karst.	<i>S. giganteus</i>
<i>S. leandroana</i> Barb. Rodr.	<i>Pachymerus cardo</i>
<i>S. liebmannii</i> Becc.	<i>S. giganteus</i>
<i>S. macrolepis</i> Burret	<i>S. giganteus</i> <i>Pachymerus cardo</i>
<i>S. maracaibensis</i> (Mart.) Burret	<i>P. cardo</i>
<i>S. rostrata</i> (Oersted) Burret	<i>S. giganteus</i> <i>P. cardo</i>
<i>S. zonensis</i> L. H. Bailey	<i>S. giganteus</i> <i>P. cardo</i>
<i>Orbignya</i>	
<i>Orbignya</i> sp.	<i>P. bactris</i> <i>P. nucleorum</i>
<i>O. cohune</i> (Mart.) Dahlgren ex Standley	<i>P. bactris</i> <i>P. cardo</i> <i>P. nucleorum</i>
<i>O. phalerata</i> Mart.	<i>P. bactris</i> <i>P. cardo</i> <i>P. nucleorum</i> <i>S. giganteus</i>
<i>Maximiliana</i>	
<i>Maximiliana</i> sp.	<i>Caryoborus serripes</i>
<i>M. maripa</i> (Correa) Drude	<i>P. cardo</i>
<i>Elaeis</i>	
* <i>E. guineensis</i> Jacq.	<i>P. bactris</i>
<i>E. oleifera</i> (Kunth) Cortes	<i>P. cardo</i>
<i>Acrocomia</i>	
<i>Acrocomia</i> sp.	<i>Speciomerus revoili</i> <i>P. nucleorum</i>
<i>A. aculeata</i> (Jacq.) Lodd.	<i>S. revoili</i> <i>P. bactris</i> <i>P. cardo</i> <i>P. nucleorum</i>
<i>A. totai</i> Mart.	<i>S. revoili</i> <i>P. nucleorum</i>
<i>Aiphanes</i>	
<i>A. aculeata</i> Willd.	<i>P. cardo</i>
<i>Bactris</i>	
<i>B. caryotifolia</i> Mart.	<i>P. sveni</i>

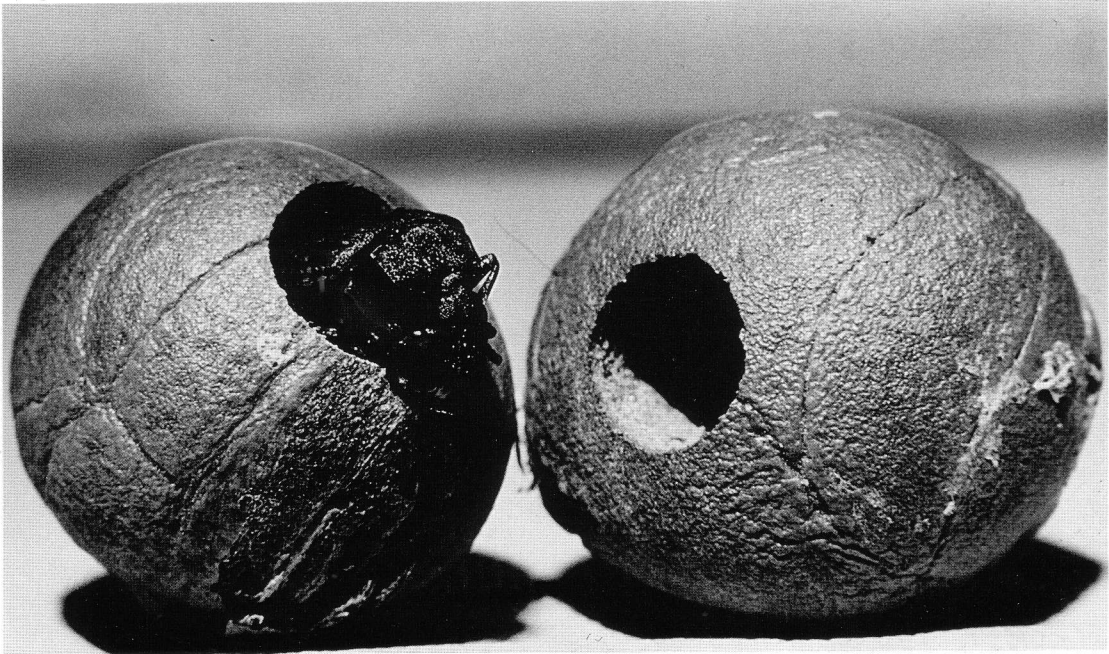
Table 1. Continued.

Host Plant	Palm Bruchids
<i>B. cuesa</i> Crueger ex Griseb.	<i>P. cardo</i>
<i>B. maraja</i> Mart.	<i>P. sveni</i>
<i>B. guineensis</i> (L.) H. E. Moore	<i>S. ruficornis</i>
	<i>P. bactris</i>
<i>B. gasipaes</i> Kunth	<i>P. cardo</i>
<i>Desmoncus</i>	
<i>Desmoncus</i> sp.	<i>P. sveni</i>
<i>D. polyacanthos</i> Mart.	<i>P. bactris</i>
<i>Astrocaryum</i>	
<i>Astrocaryum</i> sp.	<i>Caryoborus serripes</i>
	<i>S. ruficornis</i>
<i>A. huicungo</i> Dammer ex Burret	<i>C. serripes</i>
<i>A. standleyanum</i> L. H. Bailey	<i>P. bactris</i>
Geomeae—6 genera; American (0%)	
Phytelephantoideae—3 genera; American (33%)	
<i>Phytelephas</i>	
<i>Phytelephas</i> sp.	<i>Caryoborus chiriquensis</i>
<i>P. aequatorialis</i> Spruce	<i>C. chiriquensis</i>
<i>P. macrocarpa</i> Ruiz & Pavon	<i>C. chiriquensis</i>

used to produce Table 1. Table 1 shows host preferences even though published data were originally thought to be marginal in validity. These data show relationships between classifications of both bruchids and palms.

Some early host records are meaningless. For

example, species of palms formerly placed in *Cocos* are now disposed in more than five different genera. Thus, "*Cocos* sp." as a host record is rather uninformative. Other puzzling records are those that use names with no botanical standing (viz., *nomina nuda*, invalid combinations, typographical



1. Seeds of *Copernicia* sp. with *Caryobruchus gleditsiae* emerging from an exit hole in the seed on the left and a bruchid exit hole in the seed on the right. Note the typical round exit holes made by these insects. Photo by S. Zona.

Table 2. Recorded hosts for New World species of palm bruchids (Pachymerini). Most host records reported by Nilsson & Johnson (1993) were from seeds and plants collected by and identified by others. Because CDJ has used the host records of Zacher (1952) for studies in bruchids that feed in legumes and has found many of them to be reliable, we feel Zacher's records to be more reliable than most others that have been published. We do not know, however, where he obtained many of his records. The reports by Udayagiri & Wadhi (1989) and other authors are mostly from the literature. In this table, the names of the host plants are as written in the original publications. For ease of reference to the literature we think that the names reported in the literature should be presented here even though some are nomina nuda or invalid. Therefore, we have placed valid names in this table followed by the invalid names in parentheses followed by the literature citation in which the invalid name was reported. Nomina nuda are in quotes and not italicized. Names of palm bruchids are in bold.

Caryoborus chiriquensis Sharp

Host Plants.—*Phytelephas* sp.: Nilsson & Johnson 1993:16. *P. aequatorialis*: Nilsson & Johnson 1993:16. *P. macrocarpa*: Zacher 1952:470; Udayagiri & Wadhi 1989:239.

Caryoborus gracilis Nilsson

Host Plants.—*Dictyocaryum fuscum*: Nilsson & Johnson 1993:17. *Oenocarpus* sp.: Nilsson & Johnson 1993:17 (as *Jessenia* sp.: Nilsson & Johnson 1993:16). *O. bataua*: (as *Jessenia bataua*: Nilsson & Johnson 1993:17). *Mauritia flexuosa* (as *M. flexuosa*: Nilsson & Johnson 1993:16). Palm Seeds: Nilsson & Johnson 1993:17.

Caryoborus serripes (Sturm)

Host Plants.—*Astrocaryum* sp.: Bridwell 1929:154; Zacher 1952:469; Udayagiri & Wadhi 1989:238; Nilsson & Johnson 1993:20. *A. huicungo*: Nilsson & Johnson 1993:20. *Maximiliana* sp.: Zacher 1952:470.

Caryobruchus curvipes (Latreille)

Host Plants.—*Cocos* sp. (?): Bridwell 1918:493. *Sabal* sp.: Bridwell 1929:156; Zacher 1952:470; Zona 1990:614. *Sabal* sp. (as *Inodes* sp.: Bridwell 1929:156; Udayagiri & Wadhi 1989:239). *S. mexicana* (as *Inodes texana*: Bridwell 1918:493; Zacher 1952:470; Udayagiri & Wadhi 1989:239). *S. pumos*: Nilsson & Johnson 1993:23.

Caryobruchus gleditsiae (Johansson and Linné)

Host Plants.—*Chamaedorea* sp.: Nilsson & Johnson 1993:25. *C. seifrizii*: Nilsson & Johnson 1993:25. *Coccothrinax argentata*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *C. martii*: Woodruff 1968:1. *Copernicia* sp.: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *C. hospita*: Nilsson & Johnson 1993:24. "Copernicia inderoglossa": Nilsson & Johnson 1993:25. *C. macroglossa* (as "C. torrans" and *C. torreana*: Nilsson & Johnson 1993:25). *C. rigida*: Nilsson & Johnson 1993:25. *C. sueroana*: Nilsson & Johnson 1993:25. *Livistona chinensis*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *Phoenix sylvestris*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *Sabal* sp.: Riley & Howard 1892:166; Cushman 1911: 504; Zacher 1952:470; Udayagiri & Wadhi 1989:239; Zona 1990:614; Nilsson & Johnson 1993:28. *S. bermudana*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:24. *S. causiarum*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *S. domingensis*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25 (as *Inodes neglecta*: Nilsson & Johnson 1993:25). *S. etonia*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *S. maritima* (as *S. florida*: Nilsson & Johnson 1993:25). *S. mauritiiformis* (as *S. glaucescens*: Woodruff 1968:1; as *S. mauritiaeformis*: Woodruff 1968:1). *S. minor* (as *S. glabra*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:26). "Sabal longipedunculata": Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *S. mexicana*: Nilsson & Johnson 1993:25 (as *Inodes texana*: Zacher 1952:468; Udayagiri & Wadhi 1989:239; as *Sabal texana*: Nilsson & Johnson 1990:53). *S. minor*: Paxson 1961:75; Woodruff 1968:1; Nilsson & Johnson 1990:53. *S. palmetto*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Zona 1990:615; Nilsson & Johnson 1993:25 (as *S. parviflora*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25). *S. rosei*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *S. uresana*: Pfaffenberger & Johnson 1976:34; Nilsson & Johnson 1990:53; Zona 1990:615; Nilsson & Johnson 1993:25. *S. yapa*: Woodruff 1968:1; Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25. *Serenoa repens*: Woodruff 1968:1. *Thrinax morrisii* (as *T. microcarpa*: Nilsson & Johnson 1990:53; Nilsson & Johnson 1993:25). *Washingtonia filifera*: Nilsson & Johnson 1990:53. *W. robusta*: Nilsson & Johnson 1993:26. Palm Seeds: Nilsson & Johnson 1993:25.

Caryobruchus marieae Nilsson and Johnson

Host Plants.—*Chamaedorea elegans*: Nilsson & Johnson 1993:28. *Sabal* sp.: Nilsson & Johnson 1990:55. *S. palmetto* (as *S. parviflora*: Nilsson & Johnson 1990:55; Nilsson & Johnson 1993:28).

Caryobruchus maya Nilsson

Host Plants.—*Chamaedorea elegans*: Nilsson & Johnson 1993:28. *Sabal* sp.: Nilsson & Johnson 1993:28.

Caryobruchus rubidus (Chevrolat)

Host Plants.—*Brahea* sp.: Nilsson & Johnson 1993:31.

Table 2. Continued.

Caryobruchus veseiy (Horn)

Host Plants.—*Brahea* sp. (as *Erythea* sp.: Bridwell 1929:157). *B. armata* (as *Erythea armata*: Nilsson & Johnson 1993:32). *B. brandegeei* (as *Erythaea brandegeei*: Zacher 1952:469 and *Erythea brandegeei*: Bridwell 1929:157; Udayagiri & Wadhi 1989:241; Nilsson & Johnson 1993:32). *Sabal rosei*: Nilsson & Johnson 1993:32.

Caryobruchus sp.

Host Plants.—*Copernicia rigida*: Zacher 1952:470. *Sabal bermudana*: Zona 1990:614. *S. causiarum*: Plant Quarantine Dec. 1932:194; Zona 1990:614. *S. domingensis*: Zona 1990:614. *S. etonia*: Zona 1990:614. *S. maritima*: Zona 1990:614. *S. mauritiiformis*: Zona 1990:614. *S. mexicana*: Zona 1990:614. *S. minor*: Zona 1990:614. *S. palmetto*: Zona 1990:614. *S. pumos*: Zona 1990:614. *S. rosei*: Zona 1990:614. *S. uresana*: Zona 1990:614. *S. yapa*: Zona 1990:614.

Speciomerus giganteus (Chevrolat)

Host Plants.—*Attalea* sp.: Bridwell 1929:150; Zacher 1952:469; Udayagiri & Wadhi 1989:240; Nilsson & Johnson 1993:36. *Orbignya phalerata* (as *O. martiana*: Zacher 1952:469; Udayagiri & Wadhi 1989:240; as *Scheelea phalerata*: Silva 1977:2; as "Babassu nut": Nilsson & Johnson 1993:36). *Scheelea excelsa*: Bridwell 1929:150; Zacher 1952:470; Udayagiri & Wadhi 1989:241. *S. liebmanni*: Nilsson & Johnson 1993:36. *S. macrolepis*: Nilsson & Johnson 1993:36. "Scheelea orbignya": Zacher 1952:469; Udayagiri & Wadhi 1989:240. *S. martiana* (as *Attalea excelsa*: Zacher 1952:469). *S. rostrata*: Janzen 1971:93; Janzen 1980:947; Udayagiri & Wadhi 1989:239; Nilsson & Johnson 1993:36. *S. zonensis*: Zacher 1952:470; Udayagiri & Wadhi 1989:239; Nilsson & Johnson 1993:36.

Speciomerus revoili (Pic)

Host Plants.—*Acrocomia* sp.: Bridwell 1929:150; Zacher 1952:469; Udayagiri & Wadhi 1989:238. *A. aculeata* (as *A. sclerocarpa*: Silva 1977:2). *A. totai*: Nilsson & Johnson 1993:38.

Speciomerus ruficornis (Germar)

Host Plants.—*Astrocaryum*: Bridwell 1929:151; Zacher 1952:469; Udayagiri & Wadhi 1989:240. *Attalea* sp.: Silva 1977:3. *Bactris guineensis* (as *B. minor*: Silva 1977:3; Udayagiri & Wadhi 1989:241). *Cocos* sp.(?): Bridwell 1918:493. *Sabal* sp. (as *Inodes* sp.: Bridwell 1929:156; Udayagiri & Wadhi 1989:239). *Sabal* sp.: Bridwell 1929:156; Zacher 1952:470. *S. mexicana* (as *Inodes texana*: Bridwell 1929:156; Zacher 1952:470; Udayagiri & Wadhi 1989:239).

Pachymerus abruptestratus (Gyllenhal)

Host Plants.—*Diospyros* sp.: Bondar 1941:303; Zacher 1952:469; Prevett 1966b:187; Udayagiri & Wadhi 1989:242; Nilsson & Johnson 1993:45.

Pachymerus bactris (Linné)

Host Plants.—*Acrocomia aculeata* (as *A. sclerocarpa*: Bridwell 1929:160; Zacher 1952:469; Silva 1977:4; Udayagiri & Wadhi 1989:244). *Astrocaryum standleyanum*: Nilsson & Johnson 1993:47. *Attalea* sp.: Bridwell 1929:160. *A. funifera*: Zacher 1952:469; Udayagiri & Wadhi 1989:245. *A. lapidea* (as *Cocos lapidea*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *Bactris guineensis* (as *B. minor*: Zacher 1952:469; Udayagiri & Wadhi 1989:243; Nilsson & Johnson 1993:47). *Cocos nucifera*: Zacher 1952:469; Udayagiri & Wadhi 1989:245. *Copernicia prunifera* (as *C. cerifera*: Bridwell 1918:493; Hoffmann 1945:25; Zacher 1952:469; Udayagiri & Wadhi 1989:243; as Carnauba-Palme: Zacher 1952:470). *Desmoncus polyacanthos*: Zacher 1952:470; Udayagiri & Wadhi 1989:243. *Elaeis guineensis*: Zacher 1952:469; Silva 1977:3; Udayagiri & Wadhi 1989:244, 245. *Euterpe* sp.: Zacher 1952:469; Udayagiri & Wadhi 1989:243. *Orbignya* sp.: Zacher 1952:470. *O. cohune* (as *Attalea cohune*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *O. phalerata* (as *O. martiana*: Zacher 1952:470; Udayagiri & Wadhi 1989:245). *O. speciosa* (?), according to current palm classification, the valid name for this species is either *O. phalerata* or *O. cohune*: Udayagiri & Wadhi 1989:244, 245. *Scheelea martiana* (as *Attalea excelsa*: Zacher 1952:469; Udayagiri & Wadhi 1989:244). *Syagrus coronata* (as *Cocos coronata*: Udayagiri & Wadhi 1989:245). *S. flexuosa* (as *Cocos campestris*: Zacher 1952:469; Udayagiri & Wadhi 1989:243). *S. romanzoffiana* (as *Cocos romanzoffiana*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *S. schizophylla* (as "Licurioba campanemae": Zacher 1952:470; Udayagiri & Wadhi 1989:245). *S. vagans* (as *Cocos vagans*: Zacher 1952:469; Udayagiri & Wadhi 1989:245).

Pachymerus bridwelli (Prevett)

Host Plants.—*Butia capitata*: Prevett 1966a:83; Nilsson & Johnson 1993:49; (as "Butiaca pitata" Udayagiri & Wadhi 1989:238).

Pachymerus cardo (Fähræus)

Host Plants.—*Acrocomia aculeata* (as *A. sclerocarpa*: Nilsson & Johnson 1993:52). *Aiphanes aculeata* (as *Martinezia caryotaefolia*: Nilsson & Johnson 1993:52). *Areca triandra*: Nilsson & Johnson 1993:51. *Attalea* sp.: Nilsson & Johnson 1993:51. *Cohune* palm (= *Orbignya cohune*?): Nilsson & Johnson 1993:52. *Attalea spectabilis* (as *Orbignya spectabilis*: Nilsson & Johnson 1993:52). *A. tessmannii*: Nilsson & Johnson 1993:52. *A. victoriana*: Nilsson & Johnson 1993:52. "Attalea paramaca": Nilsson & Johnson 1993:52. *Bactris cuesa*: Nilsson & Johnson 1993:52. *B. gasipaes* (as *Guiljelma utilis*: Nilsson & Johnson 1993:52). *Copernicia tectorum* (as "Copernicia tectornya": Nilsson & Johnson 1993:52). *Elaeis guineensis*: Prevett 1966b:186; Prevett 1967:5; Prevett 1968:239; Udayagiri & Wadhi 1989:243; Nilsson & Johnson 1993:51. *E. oleifera* (as *Elaeis*

Table 2. Continued.

melanococca: Nilsson & Johnson 1993:51). "Englerophoenix sp.": Nilsson & Johnson 1993:52. *Maximiliana maripa* (as *M. caribaea* and *M. regia* Nilsson & Johnson 1993:52, 51). "Orbignya graciosa": Nilsson & Johnson 1993:51. *Orbignya phalerata* (as *Attalea speciosa*: Nilsson & Johnson 1993:52). *Scheelea brachyclada*: Nilsson & Johnson 1993:52. *S. gomphococca* (as *Attalea gomphococca*: Nilsson & Johnson 1993:52). *S. leandroana*: Nilsson & Johnson 1993:51. *S. macrolepis*: Nilsson & Johnson 1993:52. *S. maracaibensis*: Nilsson & Johnson 1993:52. *S. rostrata*: Janzen 1971:93. *S. zonensis*: Nilsson & Johnson 1993:52. *Syagrus romanzoffiana* (as *Cocos romanzoffiana*: Nilsson & Johnson 1993:51).

Pachymerus nucleorum (Fabricius)

Host Plants.—*Acrocomia* sp.: Nilsson & Johnson 1993:54. *A. aculeata* (as *A. sclerocarpa*: Nilsson & Johnson 1993:54). *A. totai*: Nilsson & Johnson 1993:54. *Attalea funifera*: Zacher 1952:469; Udayagiri & Wadhi 1989:245. *A. lapidea* (as *Cocos lapidea*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *Cocos nucifera*: Zacher 1952:469; Udayagiri & Wadhi 1989:245. *Elaeis guineensis*: Zacher 1952:469; Silva 1977:3; Udayagiri & Wadhi 1989:245. *Orbignya* sp.: Zacher 1952:470; Nilsson & Johnson 1993:54. *O. cohune* (as *Attalea cohune*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *O. phalerata* (as *Attalea speciosa*: Nilsson & Johnson 1993:54, *Orbignya martiana*: Zacher 1952:470; Udayagiri & Wadhi 1989:245 and *O. speciosa*: Zacher 1952:469; Udayagiri & Wadhi 1989:245; and as Babassu nuts: Nilsson & Johnson 1993:54). *Syagrus coronata* (as *Cocos coronata*: Udayagiri & Wadhi 1989:245; Nilsson & Johnson 1993:54). *S. romanzoffiana* (as *Cocos romanzoffiana*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *S. vagans* (as *Cocos vagans*: Zacher 1952:469; Udayagiri & Wadhi 1989:245). *S. schizophylla* (as "Licurioba campanemae": Zacher 1952:470; Udayagiri & Wadhi 1989:245).

Pachymerus sveni Nilsson

Host Plants.—*Bactris caryotifolia*: Nilsson & Johnson 1993:55. *B. maraja* (as "B. masaja": Nilsson & Johnson 1993:55). *Copernicia prunifera* (as *C. cerifera*: Nilsson & Johnson 1993:55). *Desmoncus* sp.: Nilsson & Johnson 1993:55. *Euterpe oleracea*: Nilsson & Johnson 1993:55.

Pachymerus thoracicus Prevett

Host Plants.—*Copernicia* sp.: Nilsson & Johnson 1993:58. *C. alba* (as *C. australis* Zacher 1952:470; Prevett 1966b:190; Silva 1979:249; Nilsson & Johnson 1993:58). "C. orientalis": Prevett 1966b:190; Udayagiri & Wadhi 1989:245; Nilsson & Johnson 1993:58.

errors, etc.). These problematic records are not included in Table 1 but are retained in Table 2 to try to make sense of the names in the palm bruchid literature.

The percentage of genera per tribe that are fed upon by bruchids is in parentheses in Table 1.

Results and Discussion

Interactions between Palms and Palm Bruchids. As the palm bruchids are American, it is not unexpected that they have no host records from those subfamilies and tribes that are African and/or Asian (Borasseae, Calameae, Nypoideae, Caryoteae, and Podococceae). Species of *Phoenix*, an African-Asian genus and the only genus of the Phoeniceae, host bruchids when these palms are cultivated in the Americas. It is curious that some American tribes have seldom or never been reported to host bruchids. Bruchids are not known to feed in the seeds of members of the Cyclospatheae, Ceroyxyleae, or Geonomeae. Host records from the Hyophorbeae, which includes the diverse and widespread *Chamaedorea*, are surprisingly rare. The Areceae are predominantly African-

Asian-Pacific, but four of the ten American genera are fed upon by bruchid beetles.

The bruchid genus *Caryobruchus* shows definite preference for palms in the tribes Corypheae, Phoeniceae (cultivated), and Hyophorbeae. The typical bruchid extreme generalist is *C. gleditsiae* which has been reported to feed in seeds of nine different genera.

The seeds of Phytelphantoideae and especially Cocoeae are fed upon by the genera *Caryoborus*, *Speciomerus*, and especially species of *Pachymerus*. That these three genera of bruchids feed in similar plants may not show any phylogenetic affinities between bruchids and the phylogenetic affinities of palms. Although a thorough phylogenetic analysis was not made of the palm bruchids by Nilsson and Johnson (1993), *Caryoborus* and *Speciomerus* seem to be more closely related to *Caryobruchus* than to *Pachymerus*.

The four groups most fed upon by bruchids, the Cocoeae, Corypheae, Phytelphantoideae and Lepidocaryeae, have seeds that are quite different in terms of seed morphology and chemistry. Most palm seeds contain significant amounts of lipids

(triglycerides) and/or mannans (polysaccharides). Mannans, in one form or another, are characteristic of palm seeds (Daud and Jarvis 1992). Cocoeae have oil-rich endosperms and heavy endocarps. Corypheae have thin endocarps and oil-poor endosperms. Phytelephantoideae have thick, woody pericarps, thin endocarps and oil-poor endosperms. Lepidocaryeae have fruits that are oily and juicy, the endocarp is thin, and the seed not especially oil-rich. The epicarp is covered with hard, shiny overlapping scales. Because species of *Pachymerus* feed predominantly in Cocoeae (Table 1), it may be that most species are adapted to feeding in seeds rich in oil and with heavy endocarps. Apparently *Caryobruchus*, *Speciomerus*, and *Caryoborus* are mostly adapted to seeds with little oil and with thin endocarps.

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LETTERS

Dear Dr. Uhl:

I read with great interest the interview with Ralph Velez in the April, 1994, *Principes*, regarding the growing of tropical palms in temperate environments.

I have long contended that we here in Central Florida can grow almost any palm that can be grown in Southern Florida, provided the grower is willing to spend an average of two to five nights each winter protecting them from the cold.

Enclosed is a list of the palms presently in the ground at my home, the most remarkable probably being a 27' *Roystonea regia* which has been in the ground 14 years.

RONALD L. HUMPHREY
113 Wildwood Avenue
Ormond Beach, FL 32176, USA

History of Palms in the Ground at 113 Wildwood Avenue, Ormond Beach, Florida

Botanical Name	#	Date(s) Planted	Common Name
<i>Serenoa repens</i>	1	Before 1971	Saw Palmetto
<i>Sabal palmetto</i>	2	Before 1971	Cabbage Palm
<i>Washingtonia robusta</i>	1	07-15-72	Washington Palm
<i>Butia capitata</i>	2	09-09-72	Jelly, Pindo
<i>Phoenix canariensis</i>	1	02-03-73	Canary Isle Date
<i>Phoenix reclinata</i>	1	02-22-75	Senegal Date
<i>Roystonea regia</i>	2	08-16-80, 08-28-93	Cuban Royal Palm
<i>Phoenix roebelenii</i>	3	03-31-90, 04-01-90	Pygmy Date Palm
<i>Syagrus romanzoffiana</i>	2	10-08-90	Queen Palm
<i>Cocos nucifera</i>	2	03-02-91, 06-03-94	Coconut Palm
<i>Rhapis excelsa</i>	3	11-23-91	Lady Palm
<i>Chrysalidocarpus lutescens</i>	2	11-23-91	Areca Palm
<i>Ravenea rivularis</i>	3	09-11-92, 05-14-93, 04-06-94	Majesty Palm
<i>Archontophoenix cunninghamiana</i>	2	04-05-93, 03-01-94	Piccabeen Palm
<i>Veitchia merrillii</i>	2	04-30-93	Manila Palm
<i>Chamaedorea radicalis</i>	1	08-28-93	Radicalis Palm
<i>Neodypsis decaryi</i>	1	09-04-93	Triangle Palm
<i>Acoelorrhaphe wrightii</i>	1	09-06-93	Paurotis Palm
<i>Hyophorbe verschaffeltii</i>	2	09-20-93, 06-29-94	Spindle Palm
<i>Livistona chinensis</i>	1	09-30-93	Chinese Fan Palm
<i>Syagrus</i> × <i>Butia</i>	1	03-01-94	Butyagrus Hybrid
<i>Wodyetia bifurcata</i>	1	03-01-94	Fox Tail Palm
<i>Syagrus schizophylla</i>	1	06-30-94	Arikury Palm
Total	38	(23 different species)	