



Citrus Weevils in Florida and the West Indies: Preliminary Report on Systematics, Biology, and Distribution (Coleoptera: Curculionidae)

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According to general observations, it would appear that: (1) the citrus root weevil problem is more common in bedded groves on the east coast and/or in the flatwoods where groves have limited root systems and are grown under permanent sod culture; and (2) many of the groves showing heavy feeding by adult weevils are adjacent to woods, swamps, or pastures.

Since no registered pesticides are available at this time for larval control of root weevils, the Cooperative Extension Service is limiting their recommendations to the grower with a problem to: (1) maintaining sound fertilizer and water management practices, (2) paying more attention to resets than mature trees as the potential for economic loss is greater, (3) eliminating alternate hosts in and around the grove through sound weed management practices, (4) using 0.5 to 1.0 percent FC-435-66 spray oil in normal spray applications to slough off root weevil egg masses making them more susceptible to desiccation and predation, (5) using Carzol SP® according to the supplemental label for concentrate application when a miticide is required. Carzol will kill adult *D. abbreviatus*.

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CITRUS WEEVILS IN FLORIDA AND THE WEST INDIES: PRELIMINARY REPORT ON SYSTEMATICS, BIOLOGY, AND DISTRIBUTION (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

The following 11 genera of weevils are associated with citrus in Florida and the West Indies: *Artipus*, *Cleistolophus*, *Compsus*, *Diaprepes*, *Epicaerus*, *Exophthalmus*, *Lachnopus*, *Litostylus*, *Pachmaeus*, *Pantomorus*, and *Tanymecus*. This paper is a compilation, listing the known species on citrus, their biology, distribution, taxonomic status, economic importance, and selected references.

RESUMEN

Los 11 siguientes géneros de gorgojos son asociados con cítricos en la Florida y las Indias Occidentales: *Artipus*, *Cleistolophus*, *Compsus*, *Diaprepes*, *Epicaerus*, *Exophthalmus*, *Lachnopus*, *Litostylus*, *Pachnaeus*, *Pantomorus*, y *Tanymecus*. Este ensayo es una compilación donde se listan las especies conocidas en cítricos, su biología, distribución, estado taxonómico, importancia económica, y seleccionadas referencias.

In a series of papers (Woodruff 1962-1982), I treated the Florida weevils associated with citrus. Because one of these weevils, *Diaprepes abbreviatus* (L.), was introduced from the West Indies (Woodruff 1964), considerable effort has been made to learn what other species occur there. This effort has opened a "Pandora's Box" of taxonomic confusion, but it has also provided specimens and data for the following remarks.

The current emphasis on biological control of these weevils has renewed the interest in all aspects of their systematics, distribution, hosts, and biology. This paper is the result of my own experiences over the past 20 years, combined with a preliminary literature search for these data.

Weevils belong to the beetle family Curculionidae (perhaps the largest), containing about 7,500 species in North America (including the West Indies and Central America) and over 3,000 in the U. S. Less than a dozen have been considered pests in all citrus areas of the U. S. However, there are more than double that number in the West Indies. The fauna there is incompletely known and considerable basic data are needed. Because many are abundant and most are serious pests in their native islands, there is potential for introduction to other areas.

ANNOTATED LIST OF GENERA

No thorough study has been made of the entire literature, but the following list is thought to be fairly complete at the generic level. Species listed are those for which specific citrus records are known; this does not preclude other species becoming pests or new species being found on citrus. Because the higher categories (tribes and subfamilies) of weevils are not clearly defined and await a more consistent treatment, I have listed the genera alphabetically here. The numbers of species and their status follow that in the checklist of weevils by O'Brien and Wibmer (1982).

Artipus Sahlberg 1823

Nine species are known: only *A. floridanus* Horn (*in* LeConte & Horn 1876) is known in the U. S., confined there to peninsular Florida (although it is also known from the Bahamas). Other papers in this symposium (Tarrant and McCoy 1985a, b) treat the biology, ecology, and control of this species. The other 8 species are West Indian: 2 from Jamaica, 2 from Hispaniola, 1 from Cuba, 1 from St. Barthelemy, 1 from Mona, and 1 from the Bahamas. The Bahamian and Floridian species are both recorded from citrus, but they also have a great diversity of host plants. There is no modern revision, and some synonymy is suspected. Although many other genera in the Naupactini are wingless and parthenogenetic, *A.*

floridanus is neither. *Selected References*: Rowan 1976; Tarrant and McCoy 1985; Woodruff 1982.

Cleistolophus Sharp 1891

Four species are known, all Central American; 1 only from Belize and Honduras, 1 only from Guatemala, the other 2 widespread in Central America. Several of these are possibly found on citrus, but I have specific records of damage from Honduras and Belize only for *C. viridimargo* Champion. Specimens of this species were recently intercepted on *Draacaena* plants brought into Florida from Honduras. The species resemble those of the genus *Epicaerus*. No information is available on their biology. *Selected References*: Champion 1911.

Compsus Schoenherr 1823

Eleven species are known from Central America and the West Indies, with only 1 (*C. auricephalus* Say) extending to the U.S., where it is recorded from AR, GA, LA, MS, TX, CO. It is also known from Costa Rica, Guatemala, Mexico, Nicaragua, and Panama. Two species are found only in Puerto Rico, and 2 others are recorded from Guadeloupe, 1 (*C. lacteus* Fab.) is also known from Jamaica.

Little is known about most of the species, but *C. auricephalus* was found commonly on citrus in Texas after the 1983 freeze (French 1984). *Selected References*: Champion 1911; Marshall 1922; Wolcott 1924, 1951.

Diaprepes Schoenherr 1823

Nineteen species are currently recognized, 17 West Indian, 1 from Honduras, and 1 from Nicaragua. Only *D. abbreviatus* (Linn.) has been found in the U. S., and it is one of the most destructive known. It is also one of the most variable species, resulting in many synonyms and varietal names. Clarification of many of these names is underway, with large series of specimens and pending type comparisons. *D. fumelicus* (Olivier), recorded from Dominica, Guadeloupe, Martinique, Barbados, Cuba, Antigua, Montserrat, St. Barthelemy, and St. Kitts, is listed as a citrus pest. *D. balloui* Marshall is known only from Dominica where I collected it damaging young citrus. Surprisingly, no *Diaprepes* are known from Jamaica where the related genus *Exophthalmus* has numerous species on citrus. *Selected References*: Beavers, et al. 1979 (bibliography); Hustache 1929; Pierce 1915; Woodruff 1964, 1968, 1979.

Epicaerus Schoenherr 1834

This is one of the larger genera involved, with 91 N.A. species, nearly all Mexican or Central American. Eleven species are known from the U. S., but only *E. mexicanus* Boheman has been found on citrus (especially in Texas after the 1983 freeze, French 1984). *Selected References*: Pierce 1913.

Exophthalmus Schoenherr 1823

This large genus contains 76 species, about equally distributed between

Central America and the West Indies; none is known from the U. S. In the Greater Antilles, species are distributed as follows: Hispaniola (17), Cuba (11), Jamaica (5), and Puerto Rico (3). These are called "fiddler beetles" in Jamaica, where all the species are known to feed on citrus. *E. quadrivittatus* (Olivier) is a pest of many plants, including citrus in Hispaniola. Along with *Diaprepes abbreviatus* it causes serious root damage; the 2 have similar habits, hosts, and parasites.

Great confusion exists about the status of this and several related genera (Vaurie 1961). Synonyms include *Prepodes* and *Exophthalmodes*; the latter was an unjustified replacement name for *Exophthalmus*. *Selected References*: Champion 1911; Cotton 1929; Cockerell 1893; Dixon 1954; Fleutiaux & Salle 1889; Marshall 1934; Vaurie 1961; van Whervin 1968; Wolcott 1929, 1951.

Lachnopus Schoenherr 1840

This name has long been used for a genus of weevils which contains West Indies species feeding on citrus. According to O'Brien and Wibmer (1982) the correct name should now be *Menoetius* Dejean 1821, because it erroneously had been considered as a *nomen nudum*. However, in a later paper (O'Brien & Wibmer 1983) they mention that they had petitioned the International Commission on Zoological Nomenclature to conserve *Lachnopus*.

It appears to be strictly a West Indian genus of 57 known species, 3 recorded in the U.S.: *argus* (Reiche) from Cuba and Florida; *floridanus* (Horn) from Florida only; and *hispidus* (Gyllenhal) from Cuba and Florida. Of these, I am familiar only with the Florida records of *floridanus*, which is known from Homestead (Dade Co.) south, on Solanaceae. Only 2 species, *aurifer* and *gowdeyi* (Marshall), are recorded from Jamaica and apparently both feed on citrus. Because it is such a large genus (57 spp.) and there has not been a modern revision, most literature records refer only to *Lachnopus* spp. Perhaps several other species are citrus pests in the West Indies, but I have personally collected only *inconditus* (Rosen-schoeld) feeding extensively on citrus in the Dominican Republic.

The biology of most species is unknown; those in Jamaica are treated by Van Whervin (1968). *Selected References*: O'Brien & Wibmer 1982; Marshall 1922, 1926, 1933; van Whervin 1968; Wolcott 1941, 1951.

Litostylus Faust 1894

A small genus of 5 species: *bovelli* (Marshall) from Barbados and Dominica; *diadema* (Fabricius) (= *juvencus* (Olivier)) from C. A. and S. A.; *leucocephalus* (Chevrolat) from Guadeloupe; *pu dens* (Boheman) from Antigua, Montserrat, St. Barthelemy, and St. Vincent; and *strangu-latus* (Chevrolet) from Dominica, Guadeloupe, and Montserrat. *L. pu dens* is often recorded on citrus in the West Indies. Little is known of the biology or economic importance of the genus. *Selected References*: Champion 1911; Marshall 1922.

Pachnaeus Schoenherr 1826

Seven species are listed in the genus, 2 in the U. S.: *litus* (Germar) and

opalus (Olivier). The other 5 are West Indian: *azurescens* Gyllenhal from Cuba; *citri* Marshall from Jamaica; *costatus* Perroud from Cuba; *mar-moratus* Marshall from Jamaica; and *psittacus* (Olivier) from Cuba and Puerto Rico.

All those whose habits are known feed on citrus and are among the earliest recorded pests in Florida and the West Indies. They are often referred to as "blue-green notchers" or "citrus root weevils". I have treated the 2 U. S. species in detail (1981b) and van Whervin (1968) has published on the biology of *P. citri* in Jamaica. There is little information on the other species. *Selected References*: Bruner 1934; Marshall 1916; Schwarz & Barber 1922; van Whervin 1968; Wolfenbarger 1952; Wolcott 1951; Woodruff 1981b.

Pantomorus Schoenherr 1840

This huge genus has many species in Central and South America; 44 are recorded from North America, with 11 known from the U. S. (3 introduced). Only one, *P. cervinus* (Boheman), is a regular pest of citrus and is commonly called "Fuller's rose beetle or weevil". Woodruff & Bullock (1979) treated it in Florida, and there is a wealth of economic literature on the species. *Selected References*: Buchanan 1939; Champion 1922; King 1959; Woodruff & Bullock 1979.

Tanymecus Germar 1817

Four species are listed from North America and none from the West Indies. *Tanymecus lacaena* (Herbst), which is recorded from AL, FL, GA, SC, and TX, is an occasional pest of Florida citrus (Woodruff 1981a). This is a complex species (D. R. Whitehead, pers. comm.) some are flightless and may be parthenogenetic.

HOST PLANTS

Since the plant we are most concerned about is citrus, its history is of significance in relation to the weevils in Florida and the West Indies. The origin of citrus has not been positively traced, although it is definitely an Old World plant of the family Rutaceae. Swingle and Reece (1967) stated that it was introduced into the Mediterranean area about 325 B.C., but whether from India or China was questionable. In fact, they suggest that it may be native to southern Arabia (possibly between eastern Hadhramaut and Oman).

Regardless of its origin, none of the known weevil pests in the New World appear to have been introduced with it. The history of citrus in the West Indies was treated by Webber (1967). It appears that Columbus brought seeds from the Canary Islands on his second voyage to the New World, when he established the settlement in Haiti in 1493. Because there are so many weevils in the W.I. which feed on the introduced genus *Citrus*, it is of interest to know what the native hosts are. Some seem to be more abundant on citrus than any other plants, and thus native hosts are difficult to establish. Some of the weevils involved (e.g., *Pachnaeus* spp.) seem to be so commonly associated with citrus that it would appear to be their natural host.

Without a thorough search, I have made some notes on the botany of the Rutaceae in the West Indies and on the taxonomic relationships of some of the known native hosts. In Jamaica, Adams (1972) listed 7 genera of Rutaceae (in addition to citrus): *Ravenia* with 2 species, 1 endemic and the other introduced from Cuba and Hispaniola; *Spathelia* has 2 species (one called mountain pride); *Fagara* (= *Zanthoxylum*) has 14 species, among which are bastard ironwood, prickly yellow, Jamaica satinwood, yellow sanders, Caesarwood, rosewood, toothache tree, satinwood, licca tree, and *Lignum rotum*; *Esenbeckia* has a single endemic species (*pentaphylla*), the wild orange; *Peltostigma* has one species (*pteleoides*), candlewood or cantoo; *Amyris* contains 3 species, commonly called torchwood, candlewood, and W.I. sandalwood; and *Glycosmis* has a single introduced species.

Since the 5 species of *Exophthalmus* in Jamaica are all known to feed on citrus, and 4 are serious pests, one would expect some of the above to be the native hosts. However, the literature (Dixon 1954, Vaurie 1961, van Whervin 1968) indicates mostly introduced, cultivated plants as hosts, and only one of the above (*Zanthoxylum flavum*) is listed. Other native host plants mentioned include: *Comocladia* (4 spp.) or "maiden plums" in the family Anacardiaceae (the family of akee, *Blighia sapida*, an introduced host) and the primary host for the pink-spotted variety of *E. impressus*; bastard cedar, *Guayuma ulmifolia*; red bullet, *Dipholis nigra*; blue mahoe, *Hibiscus elatus*; seagrape, *Coccoloba uvifera*; dogwood, *Lonchocarpus latifolius*; and wild coffee, *Casearia hirsuta*. This is a small number compared to the 23 introduced hosts listed. One of the Jamaican species (*E. farr* Vaurie) is primarily found on the native leguminous tree *Acacia macracantha*.

For *Pachnaeus citri*, an endemic Jamaican species, van Whervin (1968) listed the following hosts: citrus, star apple, avocado, mango, *Pithecellobium dulce*, cherry (*Mulphigia puniceifolia*), and guava. No native hosts were listed.

In the Bahamas, where *Pachnaeus*, *Artipus*, and *Litostylus* occur, 5 genera of Rutaceae are known (Correll & Correll 1982) (including the introduced *Citrus* and *Triphasia*): *Amyris* contains a single species (*elemifera*), torchwood; *Spathelia* with the endemic *bahamensis*; and *Zanthoxylum* which has 5 species, 3 of which also occur in Florida.

One of the most common hosts of species of *Exophthalmus* and *Diaprepes*, based upon literature and personal experience, is *Gliricidia sepium* or "quick stick". Adams (1972:347) stated that it is a native of tropical America, now widespread. Other common names include "Aaron's rod" and "grow stick". It is often used as a living fence, and, as the name implies, it grows easily and fast, making it a favorite wind-break. Since it is often the preferred host, it serves as an attractant to the vicinity of other more commercial crops. When weevil eggs are laid high in these trees, wind dispersal of the first instar larvae may spread an infestation. One cultural practice that might be beneficial, would be to eliminate this host near citrus plantings, or at least keep it trimmed low to avoid wind dispersal of the larvae. This problem has been seen in Jamaica, Puerto Rico, the Dominican Republic, and in many of the Lesser Antilles.

From the above, it is obvious that none of the pests is host specific, and they appear to be adaptable to many introduced plants. More effort

should be made to obtain specific native host records in order to suggest cultural controls.

RECOMMENDATIONS

The identity of any pest is basic to an understanding of its biology, ecology, and behavior. It is essential before an efficient pest management strategy can be developed. In biological control, host specificity and distribution cannot be established without knowing specifically the organisms involved.

Unfortunately, several genera mentioned here (e.g., *Diaprepes*, *Exophthalmus*, *Lachnopus*) are large, and many of the species show great variability in color, morphology, and biology. It appears that many are in a state of evolutionary and genetic plasticity, making interpretation of their variability difficult.

Nevertheless, modern taxonomic studies should be of high priority so that a firm foundation is established for other studies (especially parasite specificity and regulatory considerations). This will require large series of specimens from all geographic areas, from different hosts, and all seasons. These must be properly prepared, studied, and vouchered. Taxonomic studies must involve comparisons with all the relevant holotypes—many of which are scattered and located in European museums.

All modern techniques must be employed to clarify the relationships of known variants. Cytology and electrophoresis have both provided aid in some previous taxonomic studies. However, studies of such a complex and interesting group will require a concerted effort by all specialists involved with these weevils.

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LABORATORY REARING AND SOME ASPECTS OF THE BIOLOGY OF *ARTIPUS FLORIDANUS* HORN (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT

Artipus floridanus Horn adults were reared in the laboratory for 4 years on citrus leaves. Newly-expanded leaves were preferred over mature leaves. Adult feeding was influenced by photoperiod; surface area leaf consumption per adult in total darkness was significantly greater than in a 12 h light/dark cycle, and in constant light. Survivorship of both mated and virgin females averaged 161 days. The ratio of female to male in a laboratory population was 6:4. Preoviposition period for mated and virgin females varied from 11-20 days and 15-27 days, respectively. Virgin females laid 50% fewer eggs in their life span than mated females. Egg viability per mated female was 80-85% during peak production; virgin females laid nonviable eggs.

At 28°C, eggs hatched in about 9 days, larval development to pupation on artificial diet averaged 45 days, and the pupal period lasted approximately 14-20 days. Total developmental time from egg to adult ranged from 70-120 days. Six larval instars were observed; molting occurred every 5-10 days. Survivorship of larvae and pupae on an artificial diet averaged 30%. The moisture content of the medium was critical to survival.

RESUMEN

Adultos de *Artipus floridanus* fueron criados por 4 años en hojas de cítricos en el laboratorio. Hojas nuevas fueron más preferidas que hojas maduras. La alimentación de los adultos fue influenciada por el período de luz; el consumo por adultos de áreas de hojas en obscuridad absoluta fue significativamente más alto que el consumo durante el ciclo de 12 horas de luz/obscuridad y de luz constante. El promedio de sobrevivencia de hembras apareadas y hembras vírgenes fue de 161 días. La proporción de hembras a machos en una población de laboratorio fue de 6:4. El período precedente a la puesta de huevos por hembras apareadas y de hembras vírgenes varió de 11-20 días, y de 15-27 días respectivamente. Durante su