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"ESTUDIO TAXONÓMICO DE LAS ESPECIES DE LA FAMILIA BRUCHIDAE (INSECTA: COLEOPTERA) RELACIONADAS CON EL GÉNERO *Desmodium* (FABACEAE) EN EL MUNDO"

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ESTUDIO TAXONÓMICO DE LAS ESPECIES DE LA FAMILIA BRUCHIDAE (INSECTA: COLEOPTERA) RELACIONADAS CON EL GÉNERO *Desmodium* (FABACEAE) EN EL MUNDO

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RESUMEN

La presente investigación se realizó con el propósito de determinar las especies de brúquidos (Coleoptera: Bruchidae) que se alimentan de semillas de plantas del género *Desmodium* Desv. (Leguminosae: Papilionoideae) en el mundo. Se desarrollaron claves dicotómicas para determinar géneros y especies de brúquidos del Nuevo y Viejo Mundo, además de ampliar la información existente sobre la asociación brúquido-*Desmodium* de la base de datos BRUCOL. Se revisaron semillas de *Desmodium* infestadas por insectos en 23 herbarios de México y Belice, las cuales fueron removidas y los ejemplares de referencia determinados y certificados. Se encontraron ocho géneros de brúquidos relacionados con semillas de *Desmodium*: *Acanthoscelides* (14 especies), *Amblycerus* (1), *Bruchidius* (8), *Bruchus* (1), *Callosobruchus* (1), *Conicobruchus* (1), *Meibomeu*s (12), y *Paleoacanthoscelides* (1); en total se identificaron 39 especies. Un total de 47 especies de *Desmodium* fueron suceptibles (17.09%) al ataque por brúquidos. *Desmodium tortuosum* (10 especies) y *Desmodium caum* (9) fueron las más vulnerables al ataque por brúquidos; mientras tanto, *Acanthoscelides biustulus* (14) y *A. desmoditus* (17) fueron las especies polífagas prominentes de *Desmodium*.

Palabras clave: Base de datos BRUCOL, planta hospedera, claves dicotómicas, Leguminosae, gorgojos, taxonomía.

TAXONOMIC STUDY OF THE SPECIES OF THE BRUCHIDAE FAMILY (INSECTA: COLEOPTERA) RELATED TO *Desmodium* GENUS (FABACEAE) WORLDWIDE

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ABSTRACT

This research was conducted to determine the bruchid (Coleoptera: Bruchidae) species that feed on *Desmodium* Desv. (Leguminosae: Papilionoideae) seeds worldwide. Dichotomous keys were developed to determine the genera and species of bruchids from the New and Old World and to expand the current information on the association bruchid-*Desmodium* of the BRUCOL database. Seeds infested by insects in *Desmodium* plants, from 23 herbariums were reviewed in Mexico and Belize, which were removed and the samples reference were determined and certified. There were eight bruchid genera associated with *Desmodium* seeds: *Acanthoscelides* (14 species), *Amblycerus* (1), *Bruchidius* (8), *Bruchus* (1), *Callosobruchus* (1), *Conicobruchus* (1), *Meibomeu*s (12), and *Paleoacanthoscelides* (1); a total of 39 species were identified. In total 47 species of *Desmodium* were susceptible (17.09%) to be attacked by bruchids. *Desmodium tortuosum* (10 species) and *Desmodium caum* (9) were the two most vulnerable species to be attacked; while *Acanthoscelides biustulus* (14) and *A. desmoditus* (17) were the two most prominent polyphagy species of *Desmodium*.

Key words: BRUCOL database, host plant, dichotomous keys, Leguminosae, seed beetles, taxonomy.

“Esta tesis corresponde a los estudios realizados con una beca otorgada por la Secretaría de Relaciones Exteriores del Gobierno de México”

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INTRODUCCIÓN GENERAL

Los insectos de la familia Bruchidae, comúnmente llamados brúquidos o gorgojos de las semillas, está ampliamente distribuida a nivel mundial; el mayor número de especies se encuentra en las regiones tropicales y subtropicales (Romero-Nápoles, 2002). La mayoría de los brúquidos son especialistas alimentándose de ciertas plantas hospederas, la selección del hospedero es exitosamente completada por las hembras cuando ovipositan en vainas o frutos que únicamente están disponibles durante un período corto del año (Huignard *et al*., 1990).

Las larvas de esta familia, sin excepción, se alimentan de semillas de aproximadamente 34 familias de plantas, especialmente de las Leguminosae; sin embargo, los adultos se alimentan de polen, el cual es importante para su reproducción y a menudo se les encuentra alimentándose en flores de plantas diferentes de donde se desarrollan las formas inmaduras (Johnson, 1977; Romero-Nápoles, 2002).

Los brúquidos frecuentemente depositan sus huevecillos adhiriéndolos a las vainas o sobre las semillas aptas que sirven como fuente de alimento para las larvas; y rara vez depositan sus huevecillos dentro de vainas después que la hembra ha terminado de cortar un orificio sobre la pared de la vaina o insertándolos en ranuras o en cavidades viejas (Kingsolver, 2004).

Durante el primer instar, los brúquidos poseen placas dentadas que desaparecen durante la primera muda (Pfaffenberger y Johnson, 1976). Esta adaptación especial, permite a la larva neonata penetrar las vainas o la testa de las semillas hasta alcanzar los cotiledones. Todos los instares larvarios ocurren en la cavidad excavada debido a las actividades alimentarias y subsecuentemente, en la mayoría de los casos, la cavidad se utiliza como cámara de pupación. Al emerger, el adulto requiere realizar un túnel de salida a través de la cubierta de la semilla o bien en algunos casos emerge a través de un túnel de salida hecho por la larva. Los orificios de salida u opérculos de emergencia de los brúquidos, son típicamente circulares y con un corte fino, a diferencia de otros insectos en donde los orificios son irregulares y los cortes burdos (Kingsolver y Decelle, 1979).

Los términos hospedero-brúquido o planta hospedera en la asociación brúquido-*Desmodium*, se refieren a las semillas de plantas, que proveen de alimento a las larvas durante su desarrollo normal de huevecillo a adulto (Bottimer, 1961). La principal asociación conocida entre brúquidos y plantas es con la familia de la Leguminosae. Muchos brúquidos tienen hospederos específicos; sin embargo, la relación más común es la asociación de un brúquido con dos o más especies de un género de planta. Algunos brúquidos son menos discriminantes y pueden estar asociados con plantas de diferentes géneros de plantas o varias familias (Kingsolver y Decelle, 1979). Según Romero *et al.* (2002) una de las especies más polífagas es *Amblycerus spondiae*, ya que existen registros de que se puede alimentar de semillas de cuatro diferentes familias de plantas; otra de las especies más polífagas es *Acanthoscelides obtectus*, el gorgojo mexicano del frijol, en donde se registran como hospederos alrededor de 35 especies de leguminosas (Romero-Nápoles y Johnson, 2004).

Desmodium pertenece a la tribu Desmodieae (Benth.) Hutch. (Leguminosae: Papilionoideae), se encuentra ampliamente distribuido en los trópicos, subtrópicos y regiones templadas del mundo (Africa-Madagascar, Este y Sureste de Asia, Australia y el Continente Americano). Incluye aproximadamente 275 especies, con dos principales centros de diversidad: Sureste de Asia y México (Ohashi, 2005). En México se calculan cerca de 100 especies (Sousa and Delgado1998; Torres-Colín, Comunicación personal 2011).

Especies de *Desmodium* poseen propiedades alelopáticas para el control de malezas, su mecanismo de control permite erradicar las malezas más destructivas. Esta cualidad única descubierta en *Desmodium*, puede ser incorporada en programas de mejoramiento de plantas, a través de la creación de plantas transgénicas, para ambas, agricultura de subsistencia y sistemas de agricultura en países desarrollados (Khan *et al*., 2008).

En Africa, cuando *Desmodium intortum* se sembró intercalado con mijo y sorgo, dio como resultado una supresión drástica de la maleza picapica Africana, conocida como la maleza parasítica más agresiva, así también, aconteció en una reducción en el daño causado por el barrenador del tallo en cereales, simultáneamente; también incrementó la fertilidad del suelo (Khan *et al*., 2006; Midega *et al*., 2010).

Desmodium gangeticum y *Premna tomentosa* contienen antioxidantes (alcaloides, flavonoides, esteroides, taninos y fenoles), identificados como constituyentes fito-químicos comunes, que sientan las bases bioquímicas para tratamientos etanolfarmacéuticos y para la prevención de varias enfermedades y desórdenes (Suriyavathana *et al*., 2010). *Desmodium intortum* es también utilizado como forraje en la ganadería Africana (Midega *et al*., 2010). Además, de sus numerosos beneficios que presenta *Desmodium*; la especie *D. tortuosum* es considerada como una maleza en la parte Central Occidental de Brasil (Bianco *et al*., 2004).

Desmodium adscendens es una planta silvestre rastrera que crece en la selva Amazónica de Perú, Sudamérica y Costa Occidental de África. Los habitantes nativos utilizan esta planta como jugo o té. También, *D. adscendens* es considerada como una planta medicinal de amplio uso en la medicina convencional en diferentes partes del mundo. En la medicina tradicional brasileña, las hojas de esta planta son usadas para tratar leucorrea, dolores de cuerpo, inflamaciones de ovarios, exceso urinario, gonorrea y diarreas (Guarin, 1996). Se han comprobado sus efectos positivos contra la infección de hepatitis en pacientes (Heard, 1994). La medicina tradicional africana está fundamentada ampliamente para tratar asma y otras enfermedades relacionadas con leves contracciones musculares (Gyamfi *et al*., 1999). Los curanderos nativos del Congo lo emplean para curar fiebre, dolores, y epilepsia basándose de extractos acuosos de las hojas de *D. adscendens* (Adjanohoun, 1988).

Actualmente, no se cuenta con un trabajo integral para *Desmodium*; sin embargo, Ohashi (1973), delimita cerca de 60 especies asiáticas de *Desmodium* y las agrupa en siete subgéneros y 15 secciones, además de discutir sus relaciones filogenéticas entre ellas y los géneros aliados. En México, sólo se cuenta con algunas revisiones en floras regionales como son: Flora de Yucatán (Standley, 1930), Flora de Baja California (Wiggins, 1980), Flora Fanerogámica del Valle de México (Rzedowski *et al*., 2005), Flora Novo-Galiciana (McVaugh, 1987), Biodiversidad de Oaxaca (Torres-Colín, 2004), Biodiversidad del Estado de Tabasco (Torres-Colín, 2005), Tribu Desmodieae, *Desmodium*: Flora del Valle de Tehuacán-Cuicatlán (Torres-Colín y Delgado-Salinas 2008), Diversidad Biológica de Sonora (Van Devender *et al*., 2010), Los Géneros *Alysicarpus* y *Desmodium* (Fabaceae) en la península de Yucatán, México (Torres-Colín *et al.* en prensa), así como la inclusión de especies en distintos listados florísticos.

Un extenso conocimiento sobre la relación brúquido-*Desmodium* es imprescindible ya sea, para el control del insecto-plaga o para considerarla como insecto benéfico para el control biológico en programas de manejo integrado de plagas, tomando en cuento lo anteriormente mencionado, se plantearon los siguientes objetivos: 1) Determinar las especies de brúquidos que se alimentan de semillas de *Desmodium* mundialmente; 2) Elaborarción de claves dicotómicas a géneros y especies de brúquidos para su rápida identificación taxonómica y 3) Ampliar la información existente sobre la asociación brúquido-*Desmodium* de la base de datos BRUCOL.

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CAPÍTULO 1

The relationship between bruchids: seed-eating beetles and the leguminous genus *Desmodium* worldwide

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Abstract

This research was conducted to determine the bruchid (Coleoptera: Bruchidae) species that feed on *Desmodium* Desv. (Leguminosae: Papilionoideae) seeds worldwide. Dichotomous keys were developed to determine the genera and species of bruchids from the New and Old World and to expand the current information on the association bruchid-*Desmodium* of the BRUCOL database. Seeds infested by insects in *Desmodium* plants, from 23 herbariums were reviewed in Mexico and Belize, which were removed and the samples reference were determined and certified. There were eight bruchid genera associated with *Desmodium* seeds: *Acanthoscelides* (14 species), *Amblycerus* (1), *Bruchidius* (8), *Bruchus* (1), *Callosobruchus* (1), *Conicobruchus* (1), *Meibomeu*s (12), and *Paleoacanthoscelides* (1); a total of 39 species were identified. In total 47 species of *Desmodium* were susceptible (17.09%) to be attacked by bruchids. *Desmodium tortuosum* (10 species) and *Desmodium caum* (9) were the two most vulnerable species to be attacked; while *Acanthoscelides biustulus* (14) and *A. desmoditus* (17) were the two most prominent polyphagy species of *Desmodium*.

Key words: BRUCOL database, host plant, dichotomous keys, Leguminosae, seed beetles, taxonomy.

Resumen

La presente investigación se realizó con el propósito de determinar las especies de brúquidos (Coleoptera: Bruchidae) que se alimentan de semillas de plantas del género *Desmodium* Desv. (Leguminosae: Papilionoideae) en el mundo. Se desarrollaron claves dicotómicas para determinar géneros y especies de brúquidos del Nuevo y Viejo Mundo, además de ampliar la información existente sobre la asociación brúquido-*Desmodium* de la base de datos BRUCOL. Se revisaron semillas de *Desmodium* infestadas por insectos en 23 herbarios de México y Belice, las cuales fueron removidas y los ejemplares de referencia determinados y certificados. Se encontraron ocho géneros de brúquidos relacionados con semillas de *Desmodium*: *Acanthoscelides* (14 especies), *Amblycerus* (1), *Bruchidius* (8), *Bruchus* (1), *Callosobruchus* (1), *Conicobruchus* (1), *Meibomeu*s (12), y *Paleoacanthoscelides* (1); en total se identificaron 39 especies. Un total de 47 especies de *Desmodium* fueron suceptibles (17.09%) al ataque por brúquidos. *Desmodium tortuosum* (10 especies) y *Desmodium caum* (9) fueron las más vulnerables al ataque por brúquidos; mientras tanto, *Acanthoscelides biustulus* (14) y *A. desmoditus* (17) fueron las especies polífagas prominentes de *Desmodium*.

Palabras clave: Base de datos BRUCOL, planta hospedera, claves dicotómicas, Leguminosae, gorgojos, taxonomía.

Introduction

The Bruchidae family commonly known as bruchids, or seed-eating beetles are widely spread in the world. A high number of species are found in tropical and subtropical regions (Romero 2002). Most of the bruchids are specialists feeding on a given number of host plants; host selection is successfully accomplished by females ovipositing on pods or fruits that are only available during a short period of the year (Huignard et al. 1990). The larval stage of these insects feed on seeds of approximately 34 families of plants, mainly in Leguminosae; however, the adults may feed on pollen, which is important for mating and oviposition, and are often found feeding on flowers of different plants, distinct from their immature forms (Johnson 1977; Romero 2002).

Bruchids frequently lay eggs attached to pods or seeds of a suitable larval food plant; and seldomly deposit them into pods after the female cuts a hole in the pod wall or insert them into crevices or old emergence cavities (Kingsolver 2004).

During the first instar bruchids possess toothed plates, which disappear during the first molt (Pfaffenberger and Johnson 1976). The neonate larva uses this special adaptation to penetrate the pods or the seed testa, and eventually the cotyledons. All larval instars develop in the excavated cavity, due to the nature of its feeding habit. Subsequently, in the majority of cases, the cavity serves as a pupation chamber.

The adult bore an exit tunnel through the integument of the seeds or emerge through a gap created by the same larva. The operculum from where the bruchids emerge is typically circular, with a smooth cut; unlikely in other insects where the cavity is irregular with rough edges (Kingsolver and Decelle 1979).

The terms bruchid-host or host plant in the association bruchid-*Desmodium* is referred to seeds of plants, which furnish food for the larvae, during the normal developmental stages from egg to adult (Bottimer 1961). The main association known between bruchids and plants are with the Leguminosae family. A considerable number of bruchids have specific host plant; nevertheless, the most common relationship is the association of a bruchid with one or more species of a plant genus. Some bruchids are less discriminative and can be related with different genus of plants, or various families (Kingsolver and Decelle 1979). According to Romero et al. (2002) *Amblycerus spondiae* is one of the most polyphagous bruchids; based on records, they feed on species of four different families of plants. Likewise, *Acanthoscelides obtectus*, the Mexican bean seed-eating beetle is another polyphagous species reported on approximately 35 species of Leguminosae (Romero and Johnson 2004).

Desmodium Desv. belongs to the tribe Desmodieae (Benth.) Hutch. (Leguminosae: Papilionoideae) extensively distributed in the tropic, subtropic and temperate regions of the world (Africa, Madagascar, Southeastern and Eastern Asia, Australia and the American Continent). Ohashi (2005) calculated more than 275 species of *Desmodium* in the world, distributed in two main geographical centers of diversity: Mexico and Southeastern Asia. In Mexico close to 100 species are registered (31.00%) (Sousa and Delgado 1998; Torres-Colín, personal communication 2011).

Desmodium spp. possess an allelopathic weed control mechanism, that can effectively eradicate the most destructive weeds. This unique quality discovered in *Desmodium* Desv., is a call for potential exploration in plant breeding programs for creating transgenic plants, for both, subsistence farming systems, and agriculture systems for developed countries (Khan et al. 2008). In Africa, when *Desmodium intortum* was intercropped with finger millet, and sorghum, it resulted in a drastic suppression of African witchweed, known as one of the most aggressive parasitic weed, and accounted for a reduction effect on the damage caused by the cereal stem-borer, simultaneously; also increased soil fertility (Khan et al. 2006; Midega et al. 2010).

Desmodium gangeticum and *Premna tomentosa* contained antioxidants (alkaloids, flavonoids, steroids, tannins and phenols), identified as common phytochemical constituents, providing some biochemical basis for ethanopharmacological treatment and for the prevention of various diseases and disorders (Suriyavathana et al. 2010). *Desmodium intortum* is also used as fodder for livestock production in Africa (Midega et al. 2010). In addition, to its numerous benefits, in central-western part of Brazil *D. tortuosum* is reported as a common weed (Bianco et al. 2004).

Presently, there is no integral work of this genus; nonetheless, Ohashi (1973) delimitates near 60 Asiatic *Desmodium* species and grouped them in seven subgenus and 15 sections; this author also discusses their phylogenetic relationships within them and allied genus. In Mexico, only few revisions have been carried out on regional flora, like for instance, Flora de Yucatán (Standley 1930), Flora de Baja California (Wiggins 1980), Flora Fanerogámica del Valle de México (Rzedowski et al. 2005), Flora Novo-Galiciana (McVaugh 1987), Biodiversidad de Oaxaca (Torres-Colín 2004), Biodiversidad del Estado de Tabasco (Torres-Colín 2005), Tribu Desmodieae, *Desmodium*: Flora del Valle de Tehuacán-Cuicatlán (Torres-Colín and Delgado 2008), Diversidad Biológica de Sonora (Van Devender et al. 2010), Los Géneros *Alysicarpus* y *Desmodium* (Fabaceae) en la península de Yucatán (México) (Torres-Colín et al. in press), as well as the inclusion of species in different floristic checklists.

A thorough knowledge to comprehend the relationship that exists between bruchids and *Desmodium* is vital, to either control of the insect pest, or to consider it, as a biological control agent in integrated pest management programs. Considering these keynotes, this research was planned: to determine the bruchid species that feed on *Desmodium* Desv. seeds worldwide; to develop dichotomous keys for their prompt taxonomic identification, and to expand the information on the relationship bruchid-*Desmodium* of the BRUCOL database.

Materials and Methods

In the present research, the BRUCOL database of Romero and Johnson (2004) was consulted to identify the *Desmodium* plants related to insects of the Bruchidae family. This information was complemented with the inspection of the following 23 herbariums in search of *Desmodium* species with damaged seeds by bruchids:

ANSM	Departamento de Botánica, Universidad Autónoma Agraria Antonio Narro, Saltillo, México.
BRH	The Forest Department Herbarium, Belize.
CFNL	Facultad de Ciencias Forestales, Universidad Autónoma de Nuevo León, México.

CHAP	División de Ciencias Forestales, Universidad Autónoma Chapingo, Chapingo, Edo. de México, México.
CHAPA	Herbario-Hortorio, Centro de Botánica, Colegio de Postgraduados, Montecillo, Edo. de México, México.
CICY	Departamento de Recursos Naturales, Centro de Investigación Científica de Yucatán, A. C., Mérida, Yucatán, México.
CIIDIR	Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Instituto Politécnico Nacional, Durango, México.
EBUM	Escuela de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, México.
ECO-SC-H	Colegio de la Frontera Sur, San Cristóbal de Las Casas, Chiapas, México.
ECO-CH-H	Colegio de la Frontera Sur, Chetumal, Quintana Roo, México.
ENCB	Departamento de Botánica, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, México D. F., México.
HGOM	Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo, México.
HUMO	Facultad de Ciencias Biológicas, Universidad Autónoma del Estado de Morelos, Cuernavaca, Morelos, México.
IBUG	Instituto de Botánica, Universidad de Guadalajara, México.
IEB	Centro Regional del Bajío, Instituto de Ecología, A. C., Pátzcuaro, Michoacán, México.
MEXU	Herbario Nacional, Departamento de Botánica, Instituto de Biología, U.N.A.M., México.
QMEX	Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro, Juriquilla, Querétaro, México.
SLPM	Instituto de Investigación de Zonas Desérticas, Universidad Autónoma de San Luis Potosí, México.
UAT	Instituto de Ecología y Alimentos, Universidad Autónoma de Tamaulipas, México.
UNL	Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, México.

UAMIZ Departamento de Biología, División de Ciencias Biológicas y de la Salud, Universidad Autónoma Metropolitana- Iztapalapa, México D. F., México.

XAL Instituto de Ecología A. C., Xalapa, México.

XALU Facultad de Ciencias Biológicas, Universidad Veracruzana, Xalapa, Veracruz, México.

The infested seeds were collected utilizing an entomological tweezer; individual samples were placed inside an envelope and labeled. The collection data of the specimens were recorded in a research logbook. The botanical material was transferred and processed in the Laboratory of Insect Taxonomy, Colegio de Postgraduados, México.

The insect extraction method entailed the introduction of damaged seeds into a 15 ml beaker containing 10 ml 70% alcohol, subsequently, set on a stove (Model SP 131325, Barnstead/Thermolyn, Iowa, U.S.A.) and heated to 75 °C, during an average time of 30 minutes, to facilitate softening and removal of the insects. Once, the separation was achieved, the bruchids were preserved in 2 ml eppendorf filled with 1.5 ml 70% alcohol, and further stored, until ready for their taxonomic identification.

The species were determined using the technique of the male genitalia described by Kingslover (1970) and Romero and Johnson (1999). All bruchid specimens taxonomically determined were deposited in the Colección Entomológica del Instituto de Fitosanidad (CEAM), Colegio de Postgraduados, México. Finally, the taxonomic data were entered in the BRUCOL database, in order to expand the knowledge of insect distribution and host plants.

The *Desmodium* species registered in the BRUCOL database were corroborated according to ILDIS (2010) and Leticia Torres-Colín *Desmodium* specialist of the Universidad Nacional Autónoma de México; she authenticated all the *Desmodium* species that were related to bruchids in Mexico and Belize.

Results

There were eight registered bruchid genera associated with *Desmodium* seeds: *Acanthoscelides* (14 species), *Amblycerus* (1), *Bruchidius* (8), *Bruchus* (1), *Callosobruchus* (1), *Conicobruchus* (1), *Meibomeu*s (12), and *Paleoacanthoscelides* (1); a total number of 39 species. A high amount of bruchids were found associated to genera from the New World (*Acanthoscelides*, *Amblycerus* and *Meibomeu*s) with 27 species, while the genera from the Old World were represented by *Bruchidius*, *Bruchus*, *Callosobruchus*, *Conicobruchus* and *Paleoacanthoscelides*, with 12 plant species (Table 1). Apparently, the best adapted bruchid species to feed on *Desmodium* seeds were in the genera *Acanthoscelides* and *Meibomeu*s. In the original record of host plant (*Desmodium cinereum* # 770-79) collected by C.D. Johnson, three species of bruchids emerged: *Acanthoscelides desmoditus* (n= 432 specimens), *A. mazatlan* (n= 6) and *Amblycerus perfectus* (n= 1); however, the captured specie of *A. perfectus* is ambiguous, due to the small seed size as compared to the larger body size of the insect; therefore, the information on host plant needs to be verified, with more collections, to prove host plant-insect relationship.

Table 1. Species of Bruchidae found feeding in *Desmodium* seeds.

Bruchidae species	Host plants
Acanthoscelides bisignatus (Horn)	*Desmodium lindheimeri* Vail
Acanthoscelides biustulus (Fall)	*Desmodium angustifolium* (Kunth) DC.
	Desmodium batocaulon A. Gray
	Desmodium cinerascens A. Gray
	Desmodium densiflorum Hemsl.
	Desmodium grahamii A. Gray
	Desmodium hartwegianum Hemsl.
	Desmodium hartwegianum Hemsl.var. *hartwegianum*
	Desmodium leptoclados Hemsl.
	Desmodium lindheimeri Vail
	Desmodium molliculum (Kunth) DC.
	Desmodium neomexicanum A. Gray

	Desmodium nitidum M. Martens & Galeotti
	Desmodium psilophyllum Schltdl.
	Desmodium sericophyllum Schltdl.
	Desmodium tortuosum (Sw.) DC.
Acanthoscelides cuernavaca Johnson	*Desmodium distortum* (Aubl.) J.F. Macbr.
	Desmodium orbiculare Schltdl.
	Desmodium tortuosum (Sw.) DC.
Acanthoscelides desmodicola Johnson	*Desmodium tortuosum* (Sw.) DC.
Acanthoscelides desmoditus Johnson	*Desmodium amplifolium* Hemsl.
	Desmodium angustifolium (Kunth) DC.
	Desmodium cajanifolium (Kunth) DC.
	Desmodium cinereum (Kunth) DC.
	Desmodium conzattii Greenm.
	Desmodium densiflorum Hemsl.
	Desmodium distortum (Aubl.) J.F. Macbr.
	Desmodium grahamii A. Gray
	Desmodium lindheimeri Vail
	Desmodium neomexicanum A. Gray
	Desmodium nicaraguense Oerst.
	Desmodium orbiculare Schltdl.
	Desmodium orbiculare Schltdl. var. *rubricaule* (Rose & Painter) B.G. Schub & McVaugh
	Desmodium orbiculare Schltdl. var. *salvinii* (Hemsl.) B.G. Schub. ex Standl. & Steyerm.
	Desmodium plicatum Schltdl. & Cham.
	Desmodium saxatile (Morton) B.G. Schub. & McVaugh
	Desmodium skinneri Benth. ex Hemsl.
	Desmodium skinneri Benth. ex Hemsl. var. *flavovirens* B.G. Schub. & McVaugh
	Desmodium sumichrastii (Schindl.) Standl.

	Desmodium tortuosum (Sw.) DC.
Acanthoscelides howdenorum Johnson	*Desmodium cinereum* (Kunth) DC.
	Desmodium conzattii Greenm.
	Desmodium densiflorum Hemsl.
	Desmodium sericophyllum Schltdl.
Acanthoscelides longistilus (Horn)	*Desmodium illinoense* A. Gray
	Desmodium caum DC.
Acanthoscelides mazatlan Johnson	*Desmodium cinereum* (Kunth) DC.
	Desmodium distortum (Aubl.) J.F. Macbr.
	Desmodium glabrum (Mill.) DC.
	Desmodium scorpiurus (Sw.) Desv.
	Desmodium tortuosum (Sw.) DC.
Acanthoscelides megacornis Kingsolver	*Desmodium cinereum* (Kunth) DC.
	Desmodium tortuosum (Sw.) DC.
Acanthoscelides modestus (Sharp)	*Desmodium caum* DC.
Acanthoscelides pertinax (Sharp)	*Desmodium tortuosum* (Sw.) DC.
Acanthoscelides puelliopsis Johnson	*Desmodium adscendens* (Sw.) DC.
	Desmodium barbatum (L.) Benth.
	Desmodium caum DC.
	Desmodium intortum (Mill.) Urb. var. *apiculatum* B.G. Schub.
Acanthoscelides schubertae Johnson	*Desmodium caum* DC.
Acanthoscelides sp.	*Desmodium arizonicum* S. Watson
Acanthoscelides stylifer (Sharp)	*Desmodium grahamii* A. Gray
Amblycerus perfectus (Sharp)	*Desmodium cinereum* (Kunth) DC.
Bruchidius alacer Delobel	*Desmodium triflorum* (L.) DC.
Bruchidius anderssoni Decelle	*Desmodium gangeticum* (L.) DC.
Bruchidius brincki Decelle	*Desmodium heterocarpon* (L.) DC.
Bruchidius diversimembris (Pic)	*Desmodium ramosissimum* G. Don
Bruchidius ivorensis Delobel	*Desmodium velutinum* (Willd.) DC.

Bruchidius mendosus (Gyllenhal)	*Desmodium triflorum* (L.) DC.
Bruchidius nebulatus Delobel	*Desmodium heterocarpon* (L.) DC.
Bruchidius vinhanensis Delobel	*Desmodium styracifolium* (Osbeck) Merr.
Bruchus multivariegatus Pic	*Desmodium salicifolium* (Poir.) DC.
Callosobruchus anjaliae Singal & Pajni	*Desmodium* sp.
Conicobruchus caeruleus (Champion)	*Desmodium elegans* DC.
Meibomeus apicicornis (Pic)	*Desmodium caum* DC.
Meibomeus campbelli Kingsolver & Whitehead	*Desmodium glabrum* (Mill.) DC.
	Desmodium tortuosum (Sw.) DC.
Meibomeus desmoportheus Kingsolver & Whitehead	*Desmodium campyloclados* Hemsl.
	Desmodium caripense (Kunth) G. Don
	Desmodium grahamii A. Gray
	Desmodium mollicullum (Kunth) DC.
	Desmodium retinens Schltdl.
	Desmodium sumichrastii (Schindl.) Standl.
Meibomeus dirli Romero & Johnson	*Desmodium cajanifolium* (Kunth) DC.
Meibomeus funebris (Boheman)	*Desmodium caum* DC.
Meibomeus hidalgoi Kingsolver & Whitehead	*Desmodium* sp.
Meibomeus mitchelli Kingsolver & Whitehead	*Desmodium* sp.
Meibomeus musculus (Say)	*Desmodium canescens* (L.) DC.
	Desmodium caum DC.
	Desmodium tenuifolium Torr. & A. Gray
	Desmodium tortuosum (Sw.) DC.
	Desmodium triflorum (L.) DC.
Meibomeus panamensis Kingsolver & Whitehead	*Desmodium caum* DC.
Meibomeus rodneyi Romero & Johnson	*Desmodium glabrum* (Mill.) DC.
Meibomeus serraticulus (Sharp)	*Desmodium bellum* (S.F. Blake) B.G. Schub.

Meibomeus surrubresus (Pic)	*Desmodium caum* DC. *Desmodium tortuosum* (Sw.) DC.
Paleoacanthoscelides gilvus (Gyllenhal)	*Desmodium styracifolium* (Osbeck) Merr.

At the present time, the following bruchid specimens: *Acanthoscelides cuernavaca*, *A. desmodicola*, *A. howdenorum*, *Meibomeus rodneyi* and *M. serraticulus* appeared to be endemic to Mexico; *Acanthoscelides mazatlan* to Mexico and Nicaragua; *A. desmodicola* to Mexico and the United States of America (U.S.A.); *Acanthoscelides longistilus* to U.S.A. and *Meibomeus musculus* to U.S.A. and Canada, respectively; *Meibomeus dirli* to Panama in the New World (Table 2). Species endemism is also detected in the Old World (Asia), specifically in Sri Lanka and Vietnam: *Bruchidius anderssoni* and *B. brincki*; in Vietnam: *Bruchidius mendosus, B. nebulatus, B. vinhanensis* and *B. alacer*; *Callosobruchus anjaliae* and *Conicobruchus caeruleus* in India (Table 2).

Table 2. Bruchidae species related to *Desmodium* seeds and its distribution.

Bruchidae species	Distribution
Acanthoscelides bisignatus (Horn)	Mexico, U.S.A.
Acanthoscelides biustulus (Fall)	Mexico, U.S.A.
Acanthoscelides cuernavaca Johnson	Mexico
Acanthoscelides desmodicola Johnson	Mexico, U.S.A.
Acanthoscelides desmoditus Johnson	Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Venezuela
Acanthoscelides howdenorum Johnson	Mexico
Acanthoscelides longistilus (Horn)	U.S.A.
Acanthoscelides mazatlan Johnson	Mexico, Nicaragua
Acanthoscelides megacornis Kingsolver	Costa Rica, Dominica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Saint Vincent, U.S.A., Venezuela.

Acanthoscelides modestus (Sharp)	Argentina, Brazil, Colombia, Guatemala, Honduras, Mexico, Panama, Puerto Rico, U.S.A.
Acanthoscelides pertinax (Sharp)	Antilles, Belize, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela
Acanthoscelides puelliopsis Johnson	Belize, Brazil, Colombia, El Salvador, Panama, Venezuela
Acanthoscelides schubertae Johnson	Belize, Guatemala, Honduras, Mexico
Acanthoscelides stylifer (Sharp)	Mexico, Nicaragua, U.S.A.
Amblycerus perfectus (Sharp)	Brazil, Costa Rica, Honduras, Mexico, Venezuela
Bruchidius alacer Delobel	Vietnam
Bruchidius anderssoni Decelle	Sri Lanka, Vietnam
Bruchidius brincki Decelle	Sri Lanka, Vietnam
Bruchidius diversimembris (Pic)	Burundi, Ethiopia, Ivory Coast, DR Congo, Rwanda, South Africa, Tanzania
Bruchidius ivorensis Delobel	Guinea, Ivory Coast, Kenya
Bruchidius mendosus (Gyllenhal)	Vietnam
Bruchidius nebulatus Delobel	Vietnam
Bruchidius vinhanensis Delobel	Vietnam
Bruchus multivariegatus Pic	Ivory Coast, DR Congo, Rwanda
Callosobruchus anjaliae Singal & Pajni	India
Conicobruchus caeruleus (Champion)	India
Meibomeus apicicornis (Pic)	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, U.S.A.
Meibomeus campbelli Kingsolver & Whitehead	Costa Rica, El Salvador, Mexico, Nicaragua, Panama
Meibomeus desmoportheus Kingsolver & Whitehead	Costa Rica, Mexico, U.S.A.

Meibomeus dirli Romero & Johnson	Panama
Meibomeus funebris (Boheman)	Argentina, Bolivia, Brazil, Paraguay
Meibomeus hidalgoi Kingsolver & Whitehead	Colombia, Honduras, Mexico
Meibomeus mitchelli Kingsolver & Whitehead	Guatemala, Honduras, Mexico
Meibomeus musculus (Say)	U.S.A., Canada
Meibomeus panamensis Kingsolver & Whitehead	Bolivia, Colombia, Honduras, Mexico, Panama, Trinidad & Tobago, Venezuela
Meibomeus rodneyi Romero & Johnson	Mexico
Meibomeus serraticulus (Sharp)	Mexico
Meibomeus surrubresus (Pic)	Argentina, Belize, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Trinidad & Tobago, U.S.A.,Venezuela
Paleoacanthoscelides gilvus (Gyllenhal)	Afghanistan, Algeria, Bulgaria, France, Greece, Iran, Iraq, Italy, Russia, Sardinia, Sicily, Spain, Tunes, Turkey

The most cosmopolitan species of the New World were: *Acanthoscelides megacornis*, *A. desmoditus*, *A. modestus*, *A. pertinax*, *Meibomeus apicicornis*, *M. panamensis*, and *M. surrubresus*; in the Old World, *Bruchidius diversimembris*, *B. ivorensis*, and *Bruchus multivariegatus* (Table 2).

A total of 47 species of the genus *Desmodium* that were recorded resulted susceptible to attack by bruchids. Actually, this plant genus summed up to approximately 275 species in the world (Ohashi 2005) and from that amount, 47 species are related to bruchids; it is calculated that 17.09% are host plants of this spermophagous group of insects. In Mexico from the 100 species of *Desmodium* officially recorded (Sousa and Delgado 1998; Torres-Colín, personal communication 2011), only 31 resulted susceptible to bruchids, accounting for 31.00%. In the New World, *Meibomeus musculus* feeds on five additional *Desmodium* species (Table 1).

Desmodium tortuosum resulted, the most vulnerable specie to be attacked by bruchids, seven species of *Acanthoscelides* and three of genus *Meibomeus*, followed by *Desmodium caum* with four species of *Acanthoscelides* and five of *Meibomeus*, respectively. The two most prominent polyphagous species of bruchids, in this plant genus were *Acanthoscelides biustulus* and *A. desmoditus*, which were documented feeding on 14 and 17 species, respectively in the New World (Table 1). In general, the majority of the bruchid species feeding on *Desmodium* demonstrated to be specialists or monophagy feeding behavior and a minority ranged from stenophagy or oligophagy to polyphagy from both, the New and Old World (Table 1).

The species of *Acanthoscelides* found in *Desmodium arizonicum* needs to be cross checked with new collections of specimens on the same host plant; as well as the *Desmodium* species from where *Callosobruchus anjaliae* was recovered in the Old World (Table 1), this is because females have been collected and males are required to identify the species.

In 2004, Romero collected *Meibomeus hidalgoi* in the State of Morelos infesting *Desmodium* sp.; however, the species of host plants need to be collected and be further verified by the specialist in this genus. Likewise, the host plant *Desmodium* sp. from where Johnson collected *M. mitchelli* in the State of Oaxaca in 1979 (Table 1).

Key to bruchid genera associated with *Desmodium* in the World.

1. Hind tibia with two long, sharp apical calcaria; with metepisternal sulcus; eyes emarginate at most to 1/3 length ……………....………....................................... *Ambycerus perfectus* (Sharp)
1’. Hind tibia without two long, sharp apical calcaria; without metepisternal sulcus; eyes emarginate at least to 1/2 length ……………………………….........……………..……….. 2
2(1’). Pronotum square or trapezial, usually with lateral denticle; hind femur with blunt or sharp spine on external ventral margin; mid tibia in male with apical spines or plates .... ………………………………………………………...........…. *Bruchus multivariegatus* Pic
2’. Pronotum usually campaniform or conical with distinctly concave sides, usually without lateral denticle; hind femur without, with one or more spines on internal ventral margin; mid tibia usually not sexually dimorphic. ....…… 3

3(2’). Old World genus. ……..……......……………………………………………….............… 4

3’. New World genus ………………………………………………..…………………........... 5

4(3). Hind femur without spines or with one very small subapical spine. 7

4’. Hind femur bicarinate ventrally, both external and internal carina with subapical spine or only with ventral internal carina with one large and two minute subapical spines 6

5(3’). Hind femur incrassate, with pecten having 4-8 large spines, one to three small teeth before pecten; hind tibia arcuate…………….……………..……..................…… *Meibomeus* Bridwell

5’. Hind femur not so incrassate, without pecten, but with one large spines followed by one to three small spines; hind tibia usually straight ………….................…… *Acanthoscelides* Schilsky

6(4). Hind femur bicarinate ventrally, both external and internal carina with subapical spine; lateral lobes deeply divided. .... *Callosobruchus anjaliae* Singal & Pajni

6’. Hind femur only with ventral internal carina with one large and two minute subapical spines; lateral lobes completely fused. .... *Paleoacanthoscelides gilvus* (Gyllenhal)

7(4’). Pronotum conical with distinctly concave sides, hind tibia straight and slender, with carinae obsolete. .... *Conicobruchus caeruleus* Champion

7’. Pronotum capaniform, conical or transverse, without concave sides, hind tibia straight, with 2-4 carinae. .... *Bruchidius* Schilsky

Key to *Acanthoscelides* species of the New World.

1. Mucro at apex of hind tibia 0.16 or less as long as first tarsomere; without sinus at base of mucro ………………………………………………………. 2

1’. Mucro at apex of hind tibia more than 0.16 as long as first tarsomere; with sinus at base of mucro …………………………………………….……………...………………… 3

2(1). Width of eye 2 to 4 times width of frons, hind femur armed with subapical acuminate spine about 1.5 times as long as width of tibial base and 2 smaller spines ..………. *A. modestus* (Sharp)

2’. Width of eye up to 1.5 times width of frons, hind femur armed with subapical acuminate spine about 2 times as long as width of tibial base and 2 smaller spines ………………………
……………………………………………………………………….… *A. megacornis* Kingsolver

3(1’). Mucro at apex of hind tibia up to 0.2 as long as first tarsomere . *A. bisignatus* (Horn)

3’. Mucro at apex of hind tibia 0.4 or more as long as first tarsomere ………………………….. 4

4(3’). Deep sinus at base of mucro of hind tibia ……………………………………………….... 5

4’. Sinus at base of mucro slight or lacking …………………………………………………... 7

5(4’). First abdominal sternum of males with round patch of dense white short setae medially ………………………………………………………………….……………. *A. longistilus* (Horn)

5’. First abdominal sternum of males without round patch of dense white short setae medially ………………………………………………………………………………………………. 6

6(5’). Antennae extending to 0.5 length of elytra …………………....… *A. desmodicola* Johnson

6. Antennae extending to base of elytra……………………………………... *A. biustulus* (Fall)

7(4’). Antennae extending to 0.25 to 0.3 length of elytra …………………………..………… 8

7’. Antennae extending to base of elytra or slightly beyond …………………..……….……… 12

8(7). First abdominal sternum of males with round patch of dense white setae medially or slightly concave medially with long setae at apex …………………………………..….…..……. 9

8’. First abdominal sternum of males not as above, with uniform pubescence … …………….. 11

9(8). First abdominal sternum of males with slightly concave medially, pubescence on cavity, with long setae at apex …………………………………………...….. *A. schubertae* Johnson

9’. First abdominal sternum of males with round patch of dense white pubescence medially ……………………………………………………………………...…………………… 10

10(9’). Body usually black, sometimes varying to brown; elytron with dense white pubescence interrupted by patches of brown pubescence as follows: a small patch between striae 1-4 near base, a large lateral patch about 0.5 from base between striae 4-10, a small patch between striae 2-3 about 0.6 from base and all apex …………………………………… *A. cuernavaca* Johnson

10’. Body usually red orange, sometimes varying to black; elytron with sparse golden pubescence except for patches of dense white pubescence near base between striae 2-5 and a large crescent-shaped patch of dense white pubescence extending from striae 2-9 …………….
…………………………………………………………………….………… *A. mazatlan* Johnson

11(8’). Large subapical spine of hind femur about 1.2 times as long as width of tibial base ……….……………………………………………………….………………...... *A. pertinax* (Sharp)

11’. Large subapical spine of hind femur about 2 times as long as width of tibial base ……….……………………………………………….……………….………… *A. puelliopsis* Johnson

12(7’). First abdominal sternum of males with large median patch of pubescence or an elongate sulcus ……………………………………………...…………………………………… 13

12’. First abdominal sternum of males without patch of pubescence or sulcus. . *A. stylifer* (Sharp)

13(12). Large subapical spine of hind femur about as long as width of tibia base; first abdominal sternum of males with elongate medial sulcus …………………………… *A. desmoditus* Johnson

13’. Large subapical spine of hind femur about 1.5 times as long as width of tibia base; first abdominal sternum of males with large medial patch of pubescence ….. *A. howdenorum* Johnson

Key to *Meibomeus* species of the New World.

1. Hind femur with several basal minute spines; pecten without wide gap, a large tooth and with three to four sub-apical acuminate spines; apical meta-sternal spines. 2

1’. Hind femur with basal minute spines; pecten with-out gap, a large tooth and with three to five much smaller spines. 3

2(1). Tibial mucro inconspicuous or small, sharp $\pm$ 0.1 mm length of first tarsomere. 4

2’. Tibial mucro small approximately 0.1 mm as long as first tarsomere. 5

3(1’). Length (pronotum-elytra) $\leq$ 2.08 mm. …..…....……….......………….......................... 6

3’. Length (pronotum-elytra) more than 2.80 mm. 7

4(2). First abdominal sternum without polished lateral apical band; stria four expressed far before base and ended by strong tooth. .... *M. musculus* (Say)

4’. First abdominal sternum with polished lateral apical band; stria four expressed slightly before base but not ended by tooth. .... *M. campbelli* Kingsolver & Whitehead

5(2). Eyes shiny black; antennae extending less or up to 0.33 mm the length of elytron; hind femur without basal minute spines; pecten with a wide gap, a large tooth and with three sub-apical acuminate spines; apical meta-sternal spines. .... *M. dirli* Romero & Johnson

5’. Eyes dark red to shiny black; antennae extending to close to 1.00 mm the length of elytron; hind femur with several basal minute spines; pecten with a wide gap, a large tooth and with four sub-apical acuminate spines; apical meta-sternal spines .... *M. rodneyi* Romero & Johnson

6(3). Internal lateral margin often with two or three anterior spines on pectin, without gap, and a large tooth followed by four to five spines. 8

6'. Internal lateral margin often with two anterior spines on pecten without gap, a large tooth followed by four to eight spines. 9

7(3). Femur with basal minute spines; pecten with moderately or large tooth, without gap and followed by three to four smaller spines. 10

7'. Femur with basal minute spines; pecten with large tooth, without gap and followed by three to five smaller spines. 11

8(6). Elytral stria four basally starting at the same height of striae three and five; originating from an inconspicuous tooth. ………....................................…...............……... *M. surrubresus* (Pic)

8'. Elytral stria four basally shorter than three and five striae; originating from a conspicuous tooth. ………..……………….. *M. funebris* (Boheman)

9(6). Pygidium with basal band of dense, pale vestiture. .... *M. serraticulus* (Sharp)

9'. Pygidium with basal band of moderately dense, pale vestiture. ....
.... *M. panamensis* Kingsolver & Whitehead

10(7). Elytra striae three and five less pronounced extended basally to approximately 0.5 mm of base, beyond base of stria four; pygidium vestiture with pale dense basal band. ....
.... *M. mitchelli* Kingsolver & Whitehead

10'. Elytral striae three and five extended to close base; pygidium vestiture evenly distributed.
.... *M. hidalgoi* Kingsolver & Whitehead

11(7). Elytral interval three with small intense white spot; median lobe of male genitalia fractured, ventral valve semicircular, truncate and lateral lobe superficially divided. ....
.... *M. apicicornis* (Pic)

11'. Elytral interval three without small intense white spot; median lobe of male genitalia not fractured, ventral valve bluntly circular, not truncated and lateral lobe deeply divided.
.... *M. desmoportheus* Kingsolver & Whitehead

Key to *Bruchidius* species of the Old World.

1. Posterior legs entirely black (sometimes a red tinge on mesal side and/or tarsomeres 3-4 more or less reddish). 2

1’. Posterior legs partly reddish or brown. 3

2(1). Pronotum slightly campaniform; with tubercule at base of striae 3 and 4, with minute tooth visible at base of stria 4; antenna more or less darkened centrally, last segment lighter than previous ones; vestiture black and white or with dark brown setae. .... *B. nebulatus* Delobel

2’. Pronotum wide campaniform; two teeth at base of interstriae 3 and 5; antennal segments 5-8 subrectangular; small species (1.2-1.4 mm), with grey and black vestiture. .... *B. vinhanensis* Delobel

3(1’). Vestiture with black, white or pale hairs. 4

3’. Vestiture with uniform pale colors. 5

4(3). Antennae almost reaching body length (excluding head); without a large black area surpassing middle of elytron. 6

4’. Antennae short ranging between 0.50-0.75 mm body length; with or without a large black area surpassing middle of elytron. ……….. 7

5(3’). Antennal segments 5-10 longer than wide; elytral base without tooth. …..……. *B. mendosus* (Gyll.)

5’. Antennae long and slightly thick; base of antennae black, four anterior legs testaceous, but with the base of the intermediate dark; elytra moderately short, small pygidium. .... *B. diversimembris* (Pic)

6(4). Smaller species (1.2-1.3 mm); with posterior legs partly red and tarsi black; elytra length 1.2 times longer than wide together; with a small basal tooth or a blunt tubercle; its apical segments black. …...…… *B. anderssoni* Decelle

6’. Larger species (1.4-1.7 mm); mesal side of posterior legs partly brown or yellow; fore and middle legs yellow; base of mid femora yellow; elytra length1.12 times longer than wide together; at base of stria 4 a small indistinct bulge; 3 basal segment of antennae yellow, antennal segment 4 reddish and the remaining of antenna dark brown. .... *B. ivorensis* Delobel

7(4’). Elytral vestiture variegated, whitish with dark markings. .... *B. brincki* Decelle

7’. Elytral mainly whitish with square like dots on interstriae 3, 5, 7 and 9; in some specimens, striae 1 and 2 are yellowish. .... *B. alacer* Delobel

Discussion

The Old World was noted for its high richness in bruchid genera (5) distributed in 12 species, but with a limited geographic distribution. The most abundant genus in species was *Bruchidius* (8). In the New World there were only 3 genera, but it was the more diverse in species (27), which had a wider geographical distribution. The most numerous genera in species were *Acanthoscelides* (14) and *Meibomeus* (12). In general, the feeding behavior of bruchids on *Desmodium* species was mostly specialist rather than generalist. The four generalist species in the world were *Acanthoscelides biustulus*, *A. desmoditus*, *Meibomeus desmoportheus*, and *M. musculus*.

In this research the genus *Acanthoscelides* was the most diverse species in the bruchid-*Desmodium* relationship of the New World (Table 1), this result reflects similar findings of a high number of species reported for the Neotropical region (Johnson 1981; Borowiec 1987; Kergoat et al. 2005b); the same tendency was also found in the genus *Bruchidius* of the Old World (Borowiec 1987; Kergoat et al. 2005b). It is interesting, that *Acanthoscelides biustulus*, *A. desmodicola* and *A. mazatlan* shared a common host plant **(***Desmodium tortuosum***) (**Table 1); therefore, it is believed that they are similar to some degree in their parental lineages (Alvarez et al. 2006).

Five bruchid genera (*Acanthoscelides*, *Bruchidius*, *Bruchus*, *Callosobruchus*, and *Meibomeus*) found in this study resulted to be host specific on *Desmodium* species (Table 1); our results seem to coincide with the discovery of Kergoat et al. (2005b) who reported that the genera *Acanthoscelides* and *Bruchidius* are host specific with strong taxonomic conservatism in host plant use and that during their evolutionary process they have experienced various host shifts, which induced them to believe that both genera have undergone parallel evolution, based on the fact, that they colonized similar host plants in their geographical areas. The diversification time-frame was consistent with the hypothesis of contemporary radiation with respect to the diversification of their legume hosts. However, *Amblycerus perfectus* displayed a marginal feeding habit on *Desmodium* plants (Table 1); they showed feeding preferences on members of Myrtaceae (1 sp.); but, these species mostly feeds on family members of Combretaceae (2)

(Table 3); likewise, *Paleoacanthoscelides gilvus* showed also the same feeding trends on *Desmodium* species (Table 1), but they had demonstrated a strong feeding habit towards the genera *Hedysarum* (3) and *Onobrychis* (6) in the Old World.

Acanthoscelides desmoditus, *A. mazatlan* and *A. musculus* demonstrated to be strong feeders on *Desmodium*, these findings were consistent with the results obtained by Kergoat et al. (2005b); the latter bruchids also had *Desmodium tortuosum* and the genus *Aeschynomene* (*A. americana*) (Tables 1 and 3) as their common host plants. Nevertheless, those three *Acanthoscelides* species were marginal feeders on genera *Aeschynomene* (1sp.), *Ornithopus* (1 sp.) and *Lespedeza* (1 sp.), respectively. On the other hand, *Desmodium* species served as marginal host plants of *Acanthoscelides longistilus* and *A. modestus* (Table 1), but separately, each species presented a strong feeding preference towards de genera *Lespedeza* (5 sp.) and on genus *Aeschynomene* (7 sp.), respectively (Table 3). Also, *Acanthoscelides pertinax* prefers *Dalea* species rather than *Desmodium* species; *Meibomeus hidalgoi* feeds indiscriminately on *Desmodium* species and on genus *Aeschynomene* (Table 3). The species in the genus *Meibomeus* seem to follow the same trend on host plants specificity, as reported in other phylogenetic studies of the genera *Acanthoscelides*, *Bruchidius* and *Bruchus* (Kergoat et al. 2004; Kergoat et al. 2005a; Kergoat et al. 2005b).

According to Chapman (2003) insect host plant selection is based on the equilibrium of both phagostimulatory and deterrent inputs in some oligophagy and monophagy species, which is strongly correlated to host plant chemical compounds and the evolutionary process of phytophagy involves a change in the gustatory system in herbivores. Host shifts can be triggered during the adaptation process of bruchids to predominantly secondary metabolites, especially when genetically distant plants share similar secondary compounds (Alvarez et al. 2006). A phylogenetic relationships study using African seed-beetles, host plant taxonomy was in harmony with plant volatile chemical toxin similarity (Kergoat et al. 2005).

Delobel (2010a) reported 14 *Bruchidius* species reared from pod samples of several Desmodieae collected in the southern part of Vietnam. However, in our study, we found eight species related to the genus *Desmodium* in the Old World. *Bruchidius alacer*, *B. ivorensis* and *B. nebulatus* have other alternative host plants (Table 3) (Delobel 2007; Delobel 2010a; Delobel 2010b); however, *Bruchidius alacer* has an alternative host plant (*Desmodium triflorum*) (Delobel 2010b), as well as *B. nebulatus* (*Pycnospora lutescens*), and *Conicobruchus caeruleus* (*Campylotropis stenocarpa*) (Delobel 2010a).

It is important to comment that, according to Ohashi (2005), the two major centers of diversity of the genus *Desmodium* are Southeastern Asia and Mexico; nonetheless, no bruchids were detected in Southeastern Asia (H. Ohashi, Biological Institute, Tohoku University, Sendai, Japan, personal communication 2010). The bruchids registered for the Old World are reported fundamentally from Africa and Europe (Table 2); however, recently three new bruchid species (*Bruchidius nebulatus*, *B. vinhanensis*, and *B. alacer*) were reported feeding on new host record *Desmodium* species (*Desmodium heterocarpon*, *D. styracifolium* and *D. triflorum*) in Vietnam (Delobel 2010a). In Mexico, 31 *Desmodium* species are present, from the 47 totally registered in the world, that are well known food resources for bruchids (Romero and Johnson 2004), this confirms a strong bruchid-*Desmodium* association, which makes it a very interesting subject for future studies.

Table 3. Alternative bruchid host plants.

Bruchids	Host plants	Family
Acanthoscelides desmoditus	*Aeschynomene americana* L.	Leguminosae
Acanthoscelides longistilus	*Lespedeza capitata* Michx.	Leguminosae
	Lespedeza hirta (L.) Hornem.	Leguminosae
	Lespedeza intermedia (S. Watson ex A. Gray) Britton	Leguminosae
	Lespedeza texana Britton	Leguminosae
	Lespedeza virginica (L.) Britton	Leguminosae
Acanthoscelides mazatlan	*Ornithopus* sp.	Leguminosae
Acanthoscelides megacornis	*Aeschynomene americana* L.	Leguminosae
	Aeschynomene sensitiva Sw.	Leguminosae
Acanthoscelides modestus	*Aeschynomene ciliata* Vogel	Leguminosae

	Aeschynomene incana G. Mey.	Leguminosae
	Aeschynomene indica L.	Leguminosae
	Aeschynomene montevidensis Vogel	Leguminosae
	Aeschynomene rudis Benth.	Leguminosae
	Aeschynomene scabra G. Don	Leguminosae
	Aeschynomene sensitiva Sw.	Leguminosae
Acanthoscelides pertinax	*Aeschynomene americana* L.	Leguminosae
	Dalea aff. *submontana* (Rose) Bullock	Leguminosae
	Dalea leporina (Aiton) Bullock	Leguminosae
	Galactia striata (Jacq.) Urb.	Leguminosae
	Marina scopa Barneby	Leguminosae
Amblycerus perfectus	*Callistemon citrinus* (Curtis) Skeels	Myrtaceae
	Combretum farinosum Kunth	Combretaceae
	Combretum fruticosum (Loefl.) Stuntz	Combretaceae
Bruchidius alacer	*Alysicarpus vaginalis* (L.) DC.	Leguminosae
Bruchidius ivorensis	*Pseudarthria hookeri* Wight & Arn.	Leguminosae
Bruchidius nebulatus	*Pycnospora lutescens* (Poir.) Schindl.	Leguminosae
Conicobruchus caeruleus	*Campylotropis stenocarpa* Schindl.	Leguminosae
Meibomeus hidalgoi	*Aeschynomene brasiliana* (Poiret) DC.	Leguminosae
Meibomeus musculus	*Lespedeza hirta* (L.) Hornem.	Leguminosae
Meibomeus surrubresus	*Aeschynomene americana* L.	Leguminosae
	Peltaea sp.	Malvaceae
	Rhynchosia calycosa Hemsl.	Leguminosae
Paleoacanthoscelides gilvus	*Hedysarum coronarium* L.	Leguminosae
	Hedysarum flexuosum L.	Leguminosae
	Hedysarum spinosissimum L.	Leguminosae
	Onobrychis aequidentata d'Urv.	Leguminosae
	Onobrychis radiata (Fisch.) M.	Leguminosae
	Onobrychis sativa Lam.	Leguminosae
	Onobrychis schahuensis Bornm.	Leguminosae

Onobrychis vaginalis C. A. Mey.	Leguminosae
Onobrychis viciifolia Scop.	Leguminosae

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