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Interactions of selected species of stink bugs (Hemiptera: Heteroptera: Pentatomidae) from leguminous crops with plants in the Neotropics

Lisonéia F. Smaniotto[1] and Antônio R. Panizzi[2,]*

Abstract

Herein we discuss the interactions of selected species of phytophagous stink bug observed on leguminous (Fabaceae) crops in the Neotropics (Neotropical Region) with their associated plants. We included the following pentatomid species: *Nezara viridula* (L.), *Piezodorus guildinii* (Westwood), *Euschistus heros* (F.), *Edessa meditabunda* (F.), *Dichelops furcatus* (F.), *Dichelops melacanthus* (Dallas), and *Thyanta perditor* (F.). Based on a literature review, a list of plants on which these stink bug species were intercepted is included, indicating the reproductive hosts, i.e., plants on which bug can complete development, and incidental records, i.e., plants on which bugs are found occasionally. The change in feeding habits (from fruits/seeds of preferred host plants) to less preferred vegetative structures (stems/leaves of less preferred associated plants) for feeding or shelter, due to change in the landscape by intense multiple cropping and no-tillage cultivation systems is discussed.

Key Words: Sucking phytophagous insects; Fabaceae, feeding habits; cropping systems; Neotropical Region

Resumo

Nessa revisão são discutidas as interações das principais espécies de percevejos fitófagos (Hemiptera: Heteroptera: Pentatomidae) encontradas em leguminosas (Fabaceae) com plantas associadas na Região Neotropical. As seguintes espécies foram incluídas: *Nezara viridula* (L.), *Piezodorus guildinii* (Westwood), *Euschistus heros* (F.), *Edessa meditabunda* (F.), *Dichelops furcatus* (F.), *Dichelops melacanthus* (Dallas) e *Thyanta perditor* (F.). Com base em revisão de literatura, uma lista de plantas onde os percevejos foram interceptados é incluída, indicando os hospedeiros reprodutivos, i.e., plantas nas quais os percevejos completam o desenvolvimento, e records acidentais, i.e., plantas nas quais os percevejos são encontrados eventualmente. A troca de hábitos alimentares (dos frutos/sementes de plantas hospedeiras preferidas) para as estruturas vegetativas menos preferidas (ramos/folhas de plantas associadas menos preferidas) para alimentação ou abrigo, devido à troca no cenário agrícola ocasionada pelos cultivos múltiplos intensos e semeadura direta é discutida.

Palavras Chave: Insetos fitófagos sugadores; Fabaceae, hábitos alimentares; sistemas de cultivo; Região Neotropical

The utilization of host plants depends on several factors such as the variable chemical profile of plants (e.g., primary and secondary metabolites), plant architecture or plant design, and plant availability in time and space (Ehrlich & Raven 1964; Strong et al. 1984). The efficiency of the insect at intercepting the host plant depends on its own ability to do so (e.g., dispersal capability - Bernays & Chapman 1994), and the physical and chemical traits of the plant (Chew & Renwick 1995; Bittencourt-Rodrigues & Zucoloto 2005). Contact with the host plant by the insect may have short term effects (e.g., behavioral changes) and long term effects (e.g., impact on fitness) (Ahmad 1983).

The majority of insects exploit plants from one family, being associated with one or a few genera (Winkler & Mitter 2008), and specific structures on those plants (Bernays 1998). Pest stink bugs (Hemiptera: Heteroptera: Pentatomidae) are, in general, of economic importance due to their impact on plants cultivated for food, fiber or ornamental use (Panizzi et al. 2000a; McPherson & McPherson 2000). They may feed on plant species of several families and show morphological, physiological and behavioral adaptations that allow them to better exploit the host plants (Karban & Agrawal 2002; Després et al. 2007). As an example, the highly polyphagous southern green stink bug *Nezara viridula* (L.) changed its typical feeding habits of utilizing reproductive structures (i.e., seeds or fruits) of preferred food plants to feed on leaf veins of less preferred food plants, such as castor bean, *Ricinus communis* L. (Euphorbiaceae) (Panizzi 2000). It also may eventually feed on corn seedlings (Negron & Riley 1987). This may have a variable impact on the nymphal development and adult reproduction, as has been demonstrated with various species of heteropterans (see references in Panizzi 1997). *Nezara viridula* feeds on an array of plants from different families (Todd 1989; Panizzi 1997).

In this review article, we discuss the interactions among selected species of pentatomids found on legume (Fabaceae) crops in the neotropics and the plants with which they have been associated. For each of the selected species of stink bugs, we list the associated plants documented in the literature from the neotropics, especially from Brazil. As much as possible, we highlight those reproductive hosts, i.e., plants on which bug can complete development, and incidental records, i.e.,

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plants on which bugs are found only occasionally. Finally, we discuss the impact of the intense multiple cropping and the no-tillage cultivation systems upon these interactions. Note: the common names utilized for the stink bugs species discussed are those commonly used in Brazil.

Plants and Feeding of Stink Bugs

NEZARA VIRIDULA (L.)

The southern green stink bug *N. viridula* has a worldwide distribution, including Africa, Americas, Asia and Europe (Lethierry & Severin 1893; Todd 1989; Kaul et al. 2007). In Brazil, it has been reported from the south and central-west regions (Panizzi & Slansky Jr. 1985a; Panizzi & Corrêa-Ferreira 1997) and, more recently, from the Northeast Region (Panizzi 2002). This is most likely due to the expansion of its suitable host plant, soybean (*Glycine max* L. Merrill (Fabaceae), toward the north. Eventually, *N. viridula* will probably be distributed throughout the country, except perhaps for the Amazon Basin. It also occurs in several other countries of the neotropics, such as Argentina, Bolivia, Chile, Ecuador, Paraguay, and Uruguay (Table 1).

Despite the preference of *N. viridula* for legumes and brassicas (Todd 1989), its extreme polyphagy makes it adapted to feed on an array of plants. These include several species of cultivated and non-cultivated plants, weeds, fruit trees, and ornamentals. In Table 1, we have listed all the plants on which *N. viridula* has been recorded feeding and/or reproducing or utilizing as shelter, or as a source of water in the neotropics.

In general, *N. viridula* in the neotropics completes six generations/year. For example, in Paraná, Brazil, Londrina County (S 23° -W 50°) it completes three generations on the soybean crop during spring and summer months. It then moves to weed plants such as *Desmodium tortuosum* (SW.) DC. (Fabaceae), wild radish *Raphanus raphanistrum* L., wild mustard *Brassica campestris,* L. (Brassicaceae), and pigeon pea *Cajanus cajan* (L. Millsp.) (Fabaceae), where it completes two additional generations, during fall and early winter. One more (sixth) generation is completed on the wild weed *Leonurus sibiricus* L. (Lamiaceae), before colonizing soybean again in the next spring (Panizzi 1997). In addition to these plants, *N. viridula* has been observed feeding on seed heads of wheat, *Triticum aestivum* L. (Poaceae), during late winter and early spring (A. R. Panizzi, personal observation).

The list of plants on which *N. viridula* has been recorded in the neotropics includes 70 plant species belonging to 19 families, from which 29 species were considered to be reproductive hosts, i.e., plants on which bug can complete development (Table 1).

PIEZODORUS GUILDINII (WESTWOOD)

The small-green stink bug, *P. guildinii*, has a wide Neotropical distribution (Panizzi & Slansky 1985a; Ribeiro et al. 2009; Zerbino 2007, 2009, 2010). It has existed in Florida for many years without being much of a pest (Kirkaldy 1909; Genung et al. 1964). Recently, it has become a major pest of soybean in Alabama, Georgia, Louisiana, Mississippi, South Carolina, and Texas (McPherson & McPherson 2000; Bauer & Baldwin 2006; Kamminga et al. 2012).

Compared to *N. viridula*, *P. guildinii* feeds on fewer plant species, being confined mostly to legumes (Fabaceae) (Panizzi & Slansky 1985b; Panizzi & Parra 2012). Among the legumes, plants of the genus *Indigofera* seem to be preferred (Panizzi 1992). However, other species of cultivated and non-cultivated plants of different families are at various times used by this pentatomid, either as a source of nutrients or water, or as shelter (Table 2).

Table 1. Cultivated and non-cultivated plants associated with *Nezara viridula* (L.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Amaranthaceae		
Hebanthe eriantha (Poir.) Pederson (8)	—	X
Anacardiaceae		
Schinus molle L. (4)	—	X
Apiaceae		
Foeniculum vulgare Mill. (4)	—	X
Asteraceae		
Acanthospermum hispidum D.C. (14)	—	X
Bidens pilosa L. (4)	—	X
Cynara cardunculus L. (4)	—	X
Eupatorium spp. (4)	—	X
Helianthus annuus L. (18)	—	X
Lactuca sativa L. (2)	—	X
Bignoniaceae		
Adenocalymma comosum (Cham.) DC. (8)	—	X
Pyrostegia venusta (Ker Gawl.) Miers (8)	—	X
Brassicaceae		
Brassica campestris L. (11)	X	—
Brassica kaber (DC.) L. C. Wheeler (17)	X	—
Brassica oleraceae L. (4)	X	—
Raphanus raphanistrum L. (4,11)	X	—
Sinapis alba L. (4)	X	—
Caricaceae		
Carica papaya L. (2)	—	X
Cucurbitaceae		
Cucurbita sp. (21)	—	X
Momordica charantia L. (2)	—	X
Sechium edule (Jacq.) Sw. (2)	—	X
Euphorbiaceae		
Ricinus communis L. (1,8,21)	—	X
Fabaceae		
Cajanus cajan (L.) Millsp. (8)	X	—
Crotalaria sp. (8)	X	—
Crotalaria trichotoma Bojer (2)	X	—
Desmodium tortuosum (SW.) DC. (11)	X	—
Glycine max (L.) Merr. (1-7, 10, 12, 15, 21-24)	X	—
Glycine wightii Verdc. (17)	X	—
Indigofera suffruticosa Philip Miller (17)	X	—
Indigofera truxillensis Kunth (17)	X	—
Lens culinaris Medikus (4)	X	—
Lotononis bainesii Baker (4)	X	—
Lotus corniculatus L. (4)	X	—
Medicago sativa L. (4)	X	—
Phaseolus calcaratus Roxb. (4)	X	—
Phaseolus coccineus L. (4)	X	—
Phaseolus atropurpureum (DC.) Urb (4)	X	—
Phaseolus vulgaris L. (4,21)	X	—
Pisum sativum L. (9)	X	—
Sesbania bispinosa (Jacq.) W. Wight (9)	X	—
Vicia spp. (4)	X	—
Vigna sinensis L. (4)	X	—
Vigna unguiculata (L.) Walp (2)	X	—

* Plants on which bug can complete development.

(1) Rizzo 1968 (Argentina); (2) Silva et al. 1968 (Brazil, MG, PA, RS, SC, SP); (3) Aranda & Granovsky 1971 (Paraguay); (4) Lopes et al. 1974 (Brazil, RS); (5) Panizzi & Smith 1976 (Brazil, PR); (6) Galileo et al. 1977 (Brazil, RS); (7) Miranda et al. 1979 (Brazil, SP); (8) Ferreira & Panizzi 1982 (Brazil, PR); (9) Panizzi 1985 (Brazil, PR); (10) Link & Grazia 1987 (Brazil, RS); (11) Panizzi 1987 (Brazil, PR); (12) Ventura 1988 (Bolivia); (13) Panizzi et al. 1989 (Brazil, PR); (14) Panizzi & Rossi 1991 (Brazil, PR); (15) Panizzi 2002 (Brazil, MA); (16) Panizzi et al. 1996 (Brazil, PR); (17) Panizzi 1997 (Brazil, PR); (18) Malaguido & Panizzi 1998 (Brazil, PR); (19) Panizzi 2000 (Brazil, PR); (20) Panizzi & Grazia 2001 (Brazil, RS); (21) Caceres 2004 (Chile); (22) Boada 2005 (Ecuador); (23) Massoni & Frana 2005 (Argentina); (24) Olivet et al. 2013 (Uruguay).

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Table 1. (Continued) Cultivated and non-cultivated plants associated with *Nezara viridula* (L.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Lamiaceae		
Leonurus sibiricus L. (11,13)	X	—
Nectandria sp. (8)	—	X
Liliaceae		
Smilax brasiliensis Spreng. (2)	—	X
Malvaceae		
Abelmoschus esculentus L. (4)	—	X
Gossypium hirsutum L. (2)	—	X
Malva sp. (4)	—	X
Sida sp. (4)	—	X
Meliaceae		
Cedrela fissilis Vell. (4)	—	X
Oleaceae		
Ligustrum japonicum (=*lucidum*) Thumb. (16,20)	X	—
Ligustrum vulgare L. (4)	X	—
Poaceae		
Avena sativa L. (4)	—	X
Coix lacryma-jobi L. (4)	—	X
Oryza sativa L. (4)	—	X
Sorghum bicolor (L.) Moench (4)	—	X
Triticum aestivum L. (4,8)	—	X
Zea mays L. (4,19)	—	X
Rosaceae		
Prunus persica (L.) Stokes (4)	—	X
Rutaceae		
Citrus sinensis (L.) Osbeck (4)	—	X
Citrus sp. (2)	—	X
Solanaceae		
Datura sp. (2)	—	X
Solanum lycopersicum L. (4)	—	X
Nicotiana tabacum L. (2)	—	X
Piper sp. (2)	—	X
Solanum incarceratum Ruiz & Pav. (2)	—	X
Solanum melongena L. (4)	—	X
Solanum nigrum L. (4)	—	X
Solanum sisymbrifolium Lam. (2,4)	—	X
Solanum tuberosum L. (4)	—	X

* Plants on which bug can complete development.

(1) Rizzo 1968 (Argentina); (2) Silva et al. 1968 (Brazil, MG, PA, RS, SC, SP); (3) Aranda & Granovsky 1971 (Paraguay); (4) Lopes et al. 1974 (Brazil, RS); (5) Panizzi & Smith 1976 (Brazil, PR); (6) Galileo et al. 1977 (Brazil, RS); (7) Miranda et al. 1979 (Brazil, SP); (8) Ferreira & Panizzi 1982 (Brazil, PR); (9) Panizzi 1985 (Brazil, PR); (10) Link & Grazia 1987 (Brazil, RS); (11) Panizzi 1987 (Brazil, PR); (12) Ventura 1988 (Bolivia); (13) Panizzi et al. 1989 (Brazil, PR); (14) Panizzi & Rossi 1991 (Brazil, PR); (15) Panizzi 2002 (Brazil, MA); (16) Panizzi et al. 1996 (Brazil, PR); (17) Panizzi 1997 (Brazil, PR); (18) Malaguido & Panizzi 1998 (Brazil, PR); (19) Panizzi 2000 (Brazil, PR); (20) Panizzi & Grazia 2001 (Brazil, RS); (21) Caceres 2004 (Chile); (22) Boada 2005 (Ecuador); (23) Massoni & Frana 2005 (Argentina); (24) Olivet et al. 2013 (Uruguay).

In the northern state of Paraná, Brazil, in Londrina County, it completes three generations on soybean during the spring and summer months; then it moves to other legume plants such as lanceleaf crotalaria, *Crotalaria lanceolata* E. Mey, and pigeon pea, *Cajanus cajan* (L. Millsp.) (Fabaceae), completing another generation. During the mild winter in this area it moves to indigo legume plants completing a fifth generation, before returning to soybean the following spring (Panizzi 1997).

In cooler areas of the south (e.g., Rio Grande do Sul) it is found on alternate plants such as chickling pea, *Vicia sativa* L. (Fabaceae), wild radish, *Raphanus sativus* L. (Brassicaceae) , and white lupin, *Lupinus albus* L. (Fabaceae) (Silva et al. 2006). Further south in Uruguay, in ad-

Table 2. Cultivated and non-cultivated plants associated with *Piezodorus guildinii* (Westwood) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Amaranthaceae		
Hebanthe eriantha (Poir.) Pederson (4)	—	X
Apiaceae		
Foeniculum vulgare Mill. (5)	—	X
Asteraceae		
Bidens pilosa L. (4)	—	X
Helianthus annuus L. (9)	—	X
Bignoniaceae		
Adenocalymma comosum (Cham.) DC. (4)	—	X
Pyrostegia venusta (Ker Gawl.) Miers (4)	—	X
Brassicaceae		
Brassica napus L. (5)	—	X
Raphanus sativus L. (15)	—	X
Cactaceae		
Peireskia aculeata Mill. (4)	—	X
Cucurbitaceae		
Sechium edule (Jacq.) Sw. (5)	—	X
Euphorbiaceae		
Ricinus communis L. (4)	—	X
Fabaceae		
Cajanus cajan (L.) Millsp. (10)	X	—
Crotalaria lanceolata E. Mey. (11)	X	—
Desmodium intortum Mill. Urb (5)	—	X
Desmodium uncinatum Jacq. DC. (5)	—	X
Glycine max (L.) Merr. (2,3,5,6,12,13)	X	—
Indigofera hirsuta L. (7)	X	—
Indigofera endecaphylla Jacq.(7)	X	—
Indigofera suffruticosa Philip Miller (7)	X	—
Indigofera truxillensis Kunth (7)	X	—
Lens culinaris Medikus (5)	X	—
Lotononis bainesii Baker (5)	X	—
Lotus corniculatus L. (5)	X	—
Lupinus albus L. (5)	X	—
Lupinus angustifolius L. (5)	X	—
Lupinus luteus L. (5)	X	—
Medicago polymorpha L. (5)	X	—
Medicago sativa L. (14,16)	X	—
Phaseolus vulgaris L. (1,5)	X	—
Pisum sativum L. (5)	X	—
Vicia sp. (5)	X	—
Vicia sativa L. (14)	X	—
Trifolium repens L. (5,14)	X	—
Trifolium pratense L. (14)	X	—
Lauraceae		
Nectandria sp. (4)	—	X
Linaceae		
Linum usitatissimum L. (5)	—	X
Malvaceae		
Gossypium hirsutum L. (1)	—	X
Myrtaceae		
Eugenia uniflora L. (8)	—	X
Myrciaria tenella (D. C.) O. Berg (8)	—	X

*Plants on which bug can complete development.

(1) Silva et al. 1968 (Brazil, ES, MG, SP); (2) Panizzi & Smith 1976 (Brazil, PR); (3) Miranda et al. 1979 (Brazil, SP); (4) Ferreira & Panizzi 1982 (Brazil, PR); (5) Link & Grazia 1987 (Brazil, RS); (6) Ventura 1988 (Bolivia); (7) Panizzi 1992 (Brazil, PR); (8) Costa et al. 1995 (Brazil, RS); (9) Malaguido & Panizzi 1998 (Brazil, PR); (10) Panizzi et al. 2000b (Brazil, PR); (11) Panizzi et al. 2002 (Brazil, PR); (12) Lafuente 2004 (Uruguay); (13) Massoni & Frana 2005 (Argentina); (14) Stadler et al. 2006 (Argentina); (15) Silva et al. 2006 (Brazil, RS); (16) Gomez et al. 2013 (Paraguay); (17) Zerbino et al. 2015 (Uruguay).

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Table 2. (Continued) Cultivated and non-cultivated plants associated with *Piezodorus guildinii* (Westwood) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Nyctaginaceae		
Bougainvillea glabra Choisy (4)	—	X
Oleaceae		
Ligustrum lucidum Ait. (14,17)	X	—
Phytolaccaceae		
Phytolacca dioica L. (5)	—	X
Pittosporaceae		
Pittosporum undulatum Vent. (17)	X	—
Poaceae		
Phylllostachys sp. (17)	X	—
Rosaceae		
Fragaria ananassa Duch. (5)	—	X
Rubiaceae		
Coffea arabica L. (1)	—	X
Sapindaceae		
Serjania fuscifolia Radlk. (4)	—	X
Violaceae		
Anchietea salutares A. St. Hil. (4) *Hybanthus atropurpureus* A. St. Hill. (4)	— —	X X

*Plants on which bug can complete development.

(1) Silva et al. 1968 (Brazil, ES, MG, SP); (2) Panizzi & Smith 1976 (Brazil, PR); (3) Miranda et al. 1979 (Brazil, SP); (4) Ferreira & Panizzi 1982 (Brazil, PR); (5) Link & Grazia 1987 (Brazil, RS); (6) Ventura 1988 (Bolivia); (7) Panizzi 1992 (Brazil, PR); (8) Costa et al. 1995 (Brazil, RS); (9) Malaguido & Panizzi 1998 (Brazil, PR); (10) Panizzi et al. 2000b (Brazil, PR); (11) Panizzi et al. 2002 (Brazil, PR); (12) Lafuente 2004 (Uruguay); (13) Massoni & Frana 2005 (Argentina); (14) Stadler et al. 2006 (Argentina); (15) Silva et al. 2006 (Brazil, RS); (16) Gomez et al. 2013 (Paraguay); (17) Zerbino et al. 2015 (Uruguay).

dition to reproducing on soybean, at least two generations occur on cultivated forage legumes (*Medicago sativa* L., *Trifolium pratense* L., *Lotus corniculatus* L. - Fabaceae) during the spring and summer. Other associated plants include *Pittosporum undulatum* Ventenat (Pittosporaceae), *Ligustrum lucidum* Aiton (Oleaceae), and *Phyllostachys* sp. (Poaceae) on which they do not reproduce but seek shelter and may eventually feed. Adults are found underneath eucalyptus litter during autumn and winter, peaking in July (Zerbino et al. 2015).

The list of plants on which *P. guildinii* has been recorded in the neotropics includes 49 plant species belonging to 22 families, of which 24 species were considered to be reproductive hosts (Table 2).

EUSCHISTUS HEROS (F.)

The Neotropical brown stink bug *E. heros* was considered uncommon in the neotropics until the 1970's (Williams et al. 1973; Panizzi et al. 1977). Today it is the most abundant stink bug pest of major commodities in Brazil, feeding on Fabaceae, Solanaceae, Brassicaceae and Compositae (references in Panizzi et al. 2000a). More recently, it has been recorded feeding on Malvaceae (cotton), and is becoming wide spread on this plant in central-west Brazil (Soria et al. 2010).

Despite its polyphagy, the number of recorded host plants is smaller than recorded for the former two species (Table 3). This might be explained because of the habit of *E. heros* to overwinter under dead leaves (Panizzi & Niva 1994). It may stay on the ground for up to six months during the fall-winter and the beginning of spring in partial dormancy without feeding (Panizzi & Vivan 1997).

E. heros historically completed four generations per year in northern Paraná State, Brazil (Panizzi 1997). However, two main factors favored its biology, adding additional generations and increasing its numbers: the widespread adoption of the no-tillage cultivation systems, and the introduction of multiple cropping. These allowed the species to expand in the Brazilian territory and into Argentina (Saluso et al. 2011).

In the southern-most state of Rio Grande do Sul (RS) in Brazil *E. heros* is now the most abundant species of pentatomid on soybean, reaching over 80% of the total number of stink bugs collected in Passo Fundo, RS, latitude S 28° 15' 46" (A. R. Panizzi, unpublished). A survey in the state indicated its presence on *Amaranthus retroflexus* L. (Amaranthaceae), *Solanum megalochiton* Mart., *S. mauritianum* Scop., and *Vassobia breviflora* (Sendtn.) Hunz. (Solanaceae) (Medeiros & Megier 2009). Elsewhere, it has begun feeding on seedlings of soybean (Corrêa-Ferreira et al. 2010b) and corn (Rosa-Gomes 2010).

The list of plants on where *E. heros* has been recorded in the neotropics includes 21 plant species belonging to 11 families, from which 6 species were considered to be reproductive hosts (Table 3).

Table 3. Cultivated and non-cultivated plants associated with *Euschistus heros* (F.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Amaranthaceae		
Amaranthus retroflexus L. (10)	—	X
Asteraceae		
Acanthospermum hispidum D. C. (8)	—	X
Helianthus annuus L. (4)	—	X
Brassicaceae		
Brassica napus L. (5)	—	X
Brassica oleraceae L. (5)	—	X
Euphorbiaceae		
Euphorbia heterophylla L. (6)	X	—
Fabaceae		
Aeschynomene rudis Benth. (3)	X	—
*Glycine max (*L.) Merr. (1-3,11-13)	X	—
Lupinus albus L. (5)	X	—
Lupinus angustifolius L. (5)	—	X
Phaseolus vulgaris L. (5)	X	—
Pisum sativum L. (5)	X	—
Lauraceae		
Nectandria sp. (4)	—	X
Malpighiaceae		
Malpighia glabra L. (9)	—	X
Malvaceae		
Gossypium hirsutum L. (11)	—	X
Ranunculaceae		
Clematis dioica L. (4)	—	X
Salicaceae		
Casearia sylvestris Sw. (7)	—	X
Solanaceae		
Nicotiana tabacum L. (5)	—	X
Solanum mauritianum Scop. (10)	—	X
Solanum megalochiton Mart. (10)	—	X
Vassobia breviflora (Sendtn.) Hunz. (10)	—	X

*Plants on which bug can complete development.

(1) Williams et al. 1973 (Brazil, SP); (2) Panizzi et al. 1977 (Brazil, PR); (3) Link 1979 (Brazil, PR); (4) Ferreira & Panizzi 1982 (Brazil, PR); (5) Link & Grazia 1987 (Brazil, RS); (6) Pinto & Panizzi 1994 (Brazil, PR); (7) Costa et al. 1995 (Brazil, RS); (8) Mourão & Panizzi 2000 (Brazil, PR); (9) Albuquerque et al. 2002 (Brazil, PR); (10) Medeiros & Megier 2009 (Brazil, RS); (11) Soria et al. 2010 (Brazil, MS); (12) Chiaradia et al. 2011 (Brazil, SC); (13) Saluso et al. 2011 (Argentina).

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EDESSA MEDITABUNDA (F.)

The brown-winged stink bug *E. meditabunda* is a Neotropical pentatomid found in Argentina, in several states of Brazil, in Paraguay, in Uruguay, and in several islands of the Caribbean (see distribution map in Panizzi 2014). It is reported as a pest of many species of Solanaceae (e.g., tomato, potato), and Fabaceae (peas, soybean, alfalfa); it may also be a pest on cotton, eggplant, tobacco, sunflower, papaya, and grapes (Silva et al. 1968; Rizzo 1976; Lopes et al. 1974).

Beginning in the 1970's, this species was reported as occurring in and damaging soybeans in Brazil (Costa & Link 1974; Galileo et al. 1977). These early studies seemed to indicate that this species had a minor impact on soybean yield; however, it was later demonstrated that it can cause significant damage to seed quality, reducing the potential of seed germination (Silva et al. 2012). *Edessa meditabunda* is also known to colonize sunflower, *Helianthus annuus* L. (Asteraceae), in several areas in Paraná state, feeding on the stems and seed heads (Panizzi & Machado-Neto 1992; Malaguido & Panizzi 1998; Frota & Santos 2007).

In general, phytophagous stink bugs prefer to feed on the reproductive structures (seeds/fruits) of their hosts. *Edessa meditabunda* is also known to commonly feed on alternate vegetative plant tissues, such as soybean and sunflower stems, and potato and tomato growing tips (references in Panizzi et al. 2000a). Recently, this bug has been reported feeding on leaves of lettuce, *Lactuca sativa* L., and chicory, *Cichorium intybus* L. (Asteraceae) in the central-western and northern states of Brazil (Krinski et al. 2012; Krinski & Pelissari 2012; Krinski 2013). It is also commonly found feeding on vegetative alfalfa, *Medicago sativa* L. (Fabaceae) in southern Brazil (L. F. Smaniotto, unpublished).

The list of plants with which *E. meditabunda* was reportedly associated in the neotropics includes 40 plant species within 13 families, from which 19 species were ranked as reproductive hosts (Table 4).

DICHELOPS FURCATUS (F.)

Dichelops furcatus, known as the green-belly stink bug, occurs in Argentina, Bolivia, Brazil, Paraguay and Uruguay (Grazia 1978). Apparently, it is more common in areas with lower temperatures. For example, in Brazil it is recorded more often in the cooler southern states of Rio Grande do Sul, Santa Catarina, and Paraná (Lopes et al. 1974; Grazia 1978; Chocorosqui 2001; Chiaradia et al. 2011).

Dichelops furcatus has been reported as a pest of soybean for some time (Rizzo 1976; Panizzi et al. 1977). More recently, it has become a pest of wheat, *Triticum aestivum* L., and common oat, *Avena sativa* L. (Poaceae) (Pereira et al. 2010), reducing seed germination (Rosa-Gomes 2010); on another Poaceae (corn, *Zea mays* L.) it causes the plant to wilt, and eventually the young plants may die (Chocorosqui 2001). The increase in its abundance has been attributed to the adoption of no-tillage cultivation systems in southern Brazil, where the bug is found underneath crop residues during colder months. As temperatures rise, it moves out to feed on wheat; it may feed subsequently on seedlings of soybean and of corn, increasing its abundance during the pod development of soybean (A. R. Panizzi, unpublished).

In Rio Grande do Sul, Brazil, *D. furcatus* has been reported feeding on sunflower heads (Frota & Santos 2007). In this area it may be found on trees such as *Buddleja thyrsoides* Lam. (Scrophulariaceae), *Myrciaria tenella* (D. C.) Berg (Myrtaceae) (Costa et al. 1995), *Eugenia uniflora* Berg. (Myrtaceae), *Gochnatia polymorpha* Less. (Asteraceae), *Miconea cinerascens* Miq. (Melastomataceae) (Garlet et al. 2010), and on *Prunus myrtifolia* (L.) Urb. (Rosaceae) (L. F. Smaniotto, unpublished).

The list of plants on which *D. furcatus* has been recorded in the neotropics includes 32 plant species belonging to 13 families, from which 7 species were considered to be reproductive hosts (Table 5).

Table 4. Cultivated and non-cultivated plants associated with *Edessa meditabunda* (F.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Amarantaceae		
Beta vulgaris L. (1)	X	—
Asteraceae		
Cichorium intybus L. (10)	X	—
Dahlia sp. (1)	—	X
Helianthus annuus L. (1,4,5)	—	X
Lactuca sativa L. (9)	X	—
Cariaceae		
Carica papaya L. (1)	—	X
Commelinaceae		
Tradescantia virginica L. (2)	—	X
Cucurbitaceae		
Cucumis melo L. (1)	—	X
Cucurbita sp. (1)	—	X
Momordica charantia L. (1)	—	X
Sechium edule (Jacq.) Sw. (1)	—	X
Euphorbiaceae		
Manihot esculenta Crantz (1)	—	X
Fabaceae		
Crotalaria spectabilis Roth. (8)	X	—
Glycine max (L.) Merr. (1,2,7)	X	—
Medicago sativa L. (2)	X	—
Phaseolus atropurpureus DC. (2)	X	—
Phaseolus calcaratus Roxb. (2)	X	—
Phaseolus vulgaris L. (2)	X	—
Pisum sativum L. (1,2)	X	—
Vicia spp. (2)	X	—
Lamiaceae		
Plectranthus barbatus Andrews (6)	X	—
Malvaceae		
Gossypium hirsutum L. (1)	—	X
Sida sp. (1)	—	X
Poaceae		
Lolium multiflorum Lam (2)	—	X
Lolium perene Lam (2)	—	X
Oryza sativa L. (1)	—	X
Zea mays L. (2)	—	X
Rutaceae		
Citrus sp. (1)	—	X
Solanaceae		
Capsicum sp. (1)	—	X
Capsicum annuum L. (2)	X	—
Datura sp. (1)	—	X
Lycopersicon sculentum Mill. (1,2)	X	—
Nicotiana tabacum L. (1)	—	X
Solanum gracile Otto ex W. Baxter (1)	—	X
Solanum melongena L. (1)	X	—
Solanum nigrum L. (1,2)	X	—
Solanum paniculatum L. (1)	X	—
Solanum sisymbrifolium Lam. (2)	X	—
Solanum tuberosum L. (1,2)	X	—
Vitaceae		
Vitis vinifera L. (3)	—	X

*Plants on which bug can complete development.

(1) Silva et al. 1968 (Brazil, AM, ES, MG, PA, PE, RJ, RS, SP); (2) Lopes et al. 1974 (Brazil, RS); (3) Rizzo 1976 (Argentina); (4) Panizzi & Machado- Neto 1992 (Brazil, PR); (5) Frota & Santos 2007 (Brazil, RS); (6) Gonçalves et al. 2008 (Brazil, RJ); (7) Ribeiro et al. 2009 (Brazil, PR); (8) Golin et al. 2011 (Brazil, MT); (9) Krinski & Pelissari 2012 (Brazil, PA); (10) Krinski 2013 (Brazil, PA).

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Table 5. Cultivated and non-cultivated plants associated with *Dichelops furcatus* (F.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Asteraceae		
Bidens pilosa L. (2)	—	X
Conyza bonariensis L. (6)	—	X
Gochnatia polymorpha (Less.) (9)	—	X
Helianthus annuus L. (7)	—	X
Brassicaceae		
Brassica napus L. (4)	X	—
Brassica oleracea L. (4)	X	—
Raphanus sativus L. (6)	X	—
Cucurbitaceae		
Citrullus lanatus (Thunb.) Matsum. & Nakai (4)	—	X
Fabaceae		
Glycine max (L.) Merr. (3,4,8,10)	X	—
Lotus corniculatus L. (2,8)	—	X
Lupinus albus L. (4)	—	X
Macroptilium atropurpureum Urb. (4)	—	X
Medicago sativa L. (3)	X	—
Phaseolus vulgaris L. (4)	X	—
Pisum sativum L. (4)	—	X
Rhynchosia corylifolia Mart. (4)	—	X
Vicia spp. (2)	—	X
Vigna sinensis L. (2)	—	X
Lamiaceae		
Gossypium hirsutum L. (10)	—	X
Linaceae		
Linum usitatissimum L. (2)	—	X
Melastomataceae		
Miconea cinerascens Miq. (9)	—	X
Myrtaceae		
Eugenia uniflora L. (9)	—	X
Myrciaria tenella (DC) Berg (5)	—	X
Oleaceae		
Olea europaea L. (11)	—	X
Poaceae		
Avena sativa L. (6)	—	X
Lolium multiflorum Lam. (6)	—	X
Triticum aestivum L. (4)	X	—
Rosaceae		
Fragaria hibrida (2)	—	X
Prunus myrtifolia (L.) Urb. (12)	—	X
Scrophulariaceae		
Budleja thyrsoides Lam. (5)	—	X
Solanaceae		
Nicotiana tabacum L. (2)	—	X
Solanum tuberosum L. (10)	—	X

*Plants on which bug can complete development.

(1) Silva et al. 1968 (Brazil, SP); (2) Lopes et al. 1974 (Brazil, RS); (3) Rizzo 1976 (Argentina); (4) Link & Grazia 1987 (Brazil, RS); (5) Costa et al. 1995 (Brazil, RS); (6) Gassen 2001 (Brazil, RS); (7) Frota & Santos 2007 (Brazil, RS); (8) Ribeiro et al. 2009 (Uruguay); (9) Garlet et al. 2010 (Brazil, RS); (10) Chiaradia et al. 2011 (Brazil, SC); (11) Ricalde 2013 (Brazil, RS); (12) Smaniotto, L. F (unpublished) (Brazil, RS).

DICHELOPS MELACANTHUS (DALLAS)

A second species of stink bug, also known as the green-belly stink bug, *D. melacanthus* has a wider distribution in the neotropics compared to the former species. It occurs in at least 13 Brazilian states; it is also found in Bolivia, Colombia, Paraguay, Peru, Uruguay, and Venezuela (Grazia 1978; see distribution map in Panizzi 2014).

The majority of the population is concentrated on field crops (corn, soybean, and wheat) and it stays in the field during the off season underneath crop residues (Chocorosqui 2001). Since its first report on corn in Mato Grosso do Sul (Ávila & Panizzi 1995), *D. melacanthus* has become widespread on this crop, particularly in the central-west and southern states of Brazil. On soybean, nymphs and adults are found mostly during the crop's reproductive period (Silva et al. 2013). On wheat, and on other winter cereals, nymphs and adults are found on the soil, feeding on fallen soybean seeds of the previous crop, and then feeding on stems of seedlings of these cereals (Pereira et al. 2010).

In northern Paraná, Brazil, nymphs and adults of *D. melacanthus* feed and reproduce on the weed lanceleaf crotalaria, *Crotalaria lanceolata* E. Mey (Fabaceae), and adults peak in July (Silva et al. 2013). Although there is high mortality of nymphs on pods of lanceleaf crotalaria (> 70%) (Chocorosqui & Panizzi 2008), this seems to be an important alternate food plant for *D. melacanthus* in this area since it is widespread.

Another important weed that is used by *D. melacanthus* is the tropical spiderwort *Commelina benghalensis* L. (Commelinaceae), on which nymphs and adults are commonly found in Paraná and Mato Grosso do Sul (Carvalho 2007; Silva et al. 2013). Chocorosqui (2001) tried to raise nymphs in the laboratory on seedlings of the tropical spiderwort, but no nymphs completed development. The same was observed when seedlings of corn, soybean or wheat were tested; on soybean and wheat seeds they complete development, but on seeds of corn they do not (L. F. Smaniotto, unpublished); no attempts were made to raise nymphs on tropical spiderwort seeds.

The list of plants on which *D. melacanthus* has been recorded in the neotropics includes 29 species belonging to 10 plant families, from which 5 species were considered to be reproductive hosts (Table 6).

THYANTA PERDITOR (F.)

This Neotropical pentatomid occurs in several countries of South America, West Indies, Mexico, and U.S.A. (Florida, Texas, and Arizona) (references in Panizzi et al. 2000a). It has been frequently reported as a pest of soybean in Colombia (Waldbauer 1977) and Trinidad (Fennah 1935).

In Brazil, *T. perditor* has been referred to as a minor pest of soybean in several states (Rosseto et al. 1978; Kishino 1980; Panizzi & Herzog 1984). Also, it has frequently been associated with Gramineae (= Poaceae) such as sorghum, rice and wheat in several states (Rosseto et al. 1978; Panizzi & Herzog 1984; Ferreira & Silveira 1991; Amaral-Filho et al. 1992).

Perez et al. (1980) provided data on the nymph and adult biology of *T. perditor* on wheat. Laboratory and greenhouse studies, however, suggested that soybean and wheat were not suitable hosts for nymphal development and reproduction of *T. perditor*; in contrast, on the weed plant *Bidens pilosa* L. (Asteraceae), nymphs developed well and adults reproduced (Panizzi & Herzog 1984). Despite the damage of this bug to wheat seed yield and quality (Ferreira & Silveira 1991), and to its occurrence on soybean fields, apparently these two plant species only provide some nutrients, whereas *T. perditor* populations are in fact reproducing on the weed *B. pilosa*.

In northern Paraná, Brazil, *T. perditor* is commonly found feeding on sunflower, but no reproduction on this plant has been recorded (Malaguido & Panizzi 1998). Recently (2013) it was observed feeding on seed heads of barley, *Hordeum vulgare* L. (Poaceae) in Rio Grande do Sul state, Brazil (L. F. Smaniotto, unpublished).

The list of plants on which *T. perditor* has been recorded in the neotropics includes 15 plant species belonging to 8 families, of which 3 species were considered to be reproductive hosts (Table 7).

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Table 6. Cultivated and non-cultivated plants associated with *Dichelops melacanthus* (Dallas) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental record
Amaranthaceae		
Amaranthus viridis L. (6)	—	X
Gomphrena globosa L. (6)	—	X
Asteraceae		
Bidens pilosa L. (6)	—	X
Emilia sonchifolia (L.) DC. ex Wight (6)	—	X
Tridax procumbens L. (6)	—	X
Commelinaceae		
Commelina benghalensis L. (3,7)	X	—
Convolvulaceae		
Ipomoea indica (Burm.f.) Merr. (6)	—	X
Fabaceae		
Crotalaria pallida Ait. (5)	—	X
Crotalaria lanceolata E. Mey. (7)	X	—
Glycine max (L.) Merr. (1,3)	X	—
Indigofera hirsuta L. (5)	X	—
Lamiaceae		
Leonotis nepetifolia (L.) R.Br. (6)	—	X
Leonurus sibiricus L. (6)	—	X
Stachys arvensis L. (6)	—	X
Malvaceae		
Malvastrum coromandelianum (L.) (6)	—	X
Sida rhombifolia L. (6)	—	X
Poaceae		
Avena strigosa Schreb. (3)	—	X
Brachiaria decumbens Stapf (5)	—	X
Brachiaria plantaginea (Link) Hitchc. (6)	—	X
Cenchrus echinatus L. (6)	—	X
Chloris gayana Kunth (6)	—	X
Eleusine indica (L.) Gaertn. (6)	—	X
Panicum maximum Jacq. (6)	—	X
Triticum secale Wittmack (3)	—	X
Triticum aestivum L. (3, 4, 8)	X	—
Zea mays L. (2,3)	—	X
Rubiaceae		
Spermacoce alata Aubl. (6)	—	X
Richardia brasiliensis Gomes (6)	—	X
Solanaceae		
Solanum americanum Mill. (6)	—	X

*Plants on which bug can complete development.

(1) Galileo et al. 1977 (Brazil, RS); (2) Ávila & Panizzi 1995 (Brazil, MS); (3) Bianco & Nishimura 1998 (Brazil, PR); (4) Gomez 1998 (Brazil, MS); (5) Bianco 2005 (Brazil, PR);

(6) Carvalho 2007 (Brazil, MS), (7) Chocorosqui & Panizzi 2008 (Brazil, PR); (8) Silva et al. 2013 (Brazil, PR).

Table 7. Cultivated and non-cultivated plants associated with *Thyanta perditor* (F.) in the neotropics. Numbers in parentheses indicate references and localities given at the end of the table.

Host plant (Family/Species)	Reproductive hosts*	Incidental Record
Asteraceae		
Baccharis trimera (Less.) DC. (6)	—	X
Bidens pilosa L. (3)	X	—
Helianthus annuus L. (4)	—	X
Brassicaceae		
Brassica napus L. (6)	—	X
Nasturtium officinale W. T. Aiton (6)	—	X
Fabaceae		
Crotalaria juncea L. (1)	—	X
Glycine max (L.) Merr. (1-3,6)	X	—
Linaceae		
Linum usitatissimum L. (6)	—	X
Oleaceae		
Ligustrum lucidum W. T. Aiton (5)	—	X
Pedaliaceae		
Sesamum indicum L. (1)	—	X
Poaceae		
Hordeum vulgare L. (7)	—	X
Oryza sativa L. (2,6)	—	X
Sorghum vulgare Pers. (1,6)	—	X
Triticum aestivum L. (2,3)	X	—
Solanaceae		
Solanum paniculatum L. (6)	—	X

*Plants on which bug can complete development.

(1) Rosseto et al. 1978 (Brazil, SP); (2) Kishino 1980 (Brazil, MS); (3) Panizzi & Herzog 1984 (Brazil, PR); (4) Malaguido & Panizzi 1998 (Brazil, PR); (5) Panizzi & Grazia 2001 (Brazil, PR); (6) Garbelotto 2008 (Brazil, SC); (7) Smaniotto, L. F (unpublished) (Brazil, RS).

Discussion

Results of this literature survey indicate that the selected species of stink bugs (pentatomids) found on leguminous crops (Fabaceae) in the neotropics use an array of plants, on which they may or may not reproduce. The cosmopolitan southern green stink bug, *N. viridula* is by far the most polyphagous species (Fig. 1A,B) with 70 spp. of plants recorded from 19 families, but they reproduce on only 41% of them (Fig. 1 C). These reproductive hosts are, except in three cases, leguminous or brassicaceous plants. This means that on most plants on which they are found, they are there looking for nutrients or water, or seeking shelter. This occurs more often during periods when the preferred hosts are unavailable in time or space, or both.

The abundance of *N. viridula* in Brazil and in other countries of South America (e.g., Argentina) apparently has been decreasing in the last five years, mostly on the soybean crop (Kuss-Roggia 2009; Corrêa-Ferreira et al. 2010a; R. Vicentini, INTA, personal communication). This might be due to the action of the egg parasitoid *Trissolcus basalis* (Wollaston), which occurs in natural areas and has been artificially spread into soybean fields (Corrêa-Ferreira & Moscardi 1995; Medeiros et al. 1998; Liljesthröm et al. 2013). Also, global warming may affect *N. viridula* abundance and distribution (Musolin & Numata 2003). In addition, the widespread use of herbicides on major commodities in the neotropics has eliminated weeds that are potential hosts of the southern green stink bug, and this might have impacted the populations. Finally, the cropping systems using no-tillage cultivation favor species that are able to spend part of their lifetime on the ground, such as *E. heros*, which generates interspecific competition detrimental to *N. viridula*.

The small-green stink bug, *P. guildinii*, was the second most polyphagous species. Similar to *N. viridula*, from the 49 plants of 22 families, only 49% of those were recorded as reproductive hosts (Fig. 1 A,B,C). Among the reproductive hosts, the majority (21 out of 24 plants) were legumes. Therefore, is not surprising that all records estimating number of generations of *P. guildinii*, such as in Paraná (Panizzi 1997) and Rio Grande do Sul (Silva et al. 2006) in Brazil, and in Uruguay (Zerbino et al. 2015) are completed on legumes. Other species on the same genus, such as *P. hybneri* Gmelin in the Oriental Region and *P. lituratus* (F.) in the Paleartic Region are also mostly associated with legumes (references in Panizzi et al 2000a).

The Neotropical brown stink bug, *E. heros*, much less polyphagous than the former two species, reproduces on only 29% of the 21 plants

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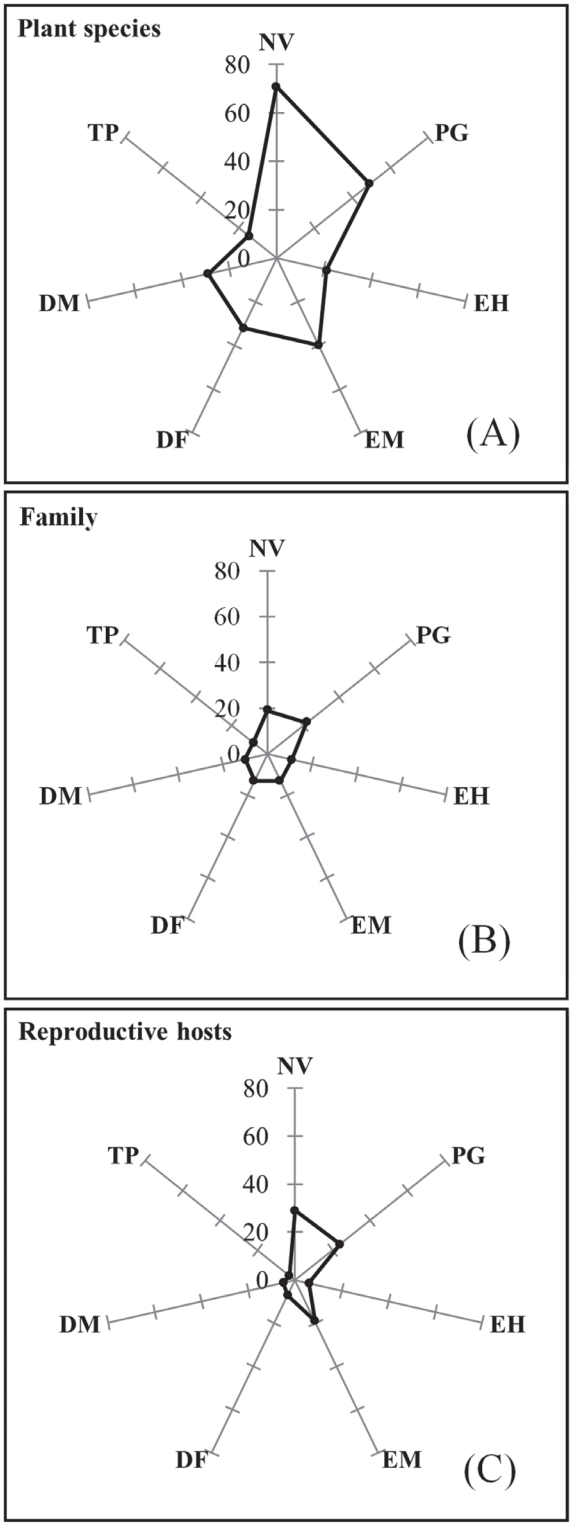


Fig. 1. Total records of plants associated with different species of stink bugs pests of legumes (Fabaceae) in the neotropics based on literature review. The dark line links the different values as follows: (A) = number of plant species on where each stink bug species was observed; (B) = number of plant families on where each species of stink bug was observed; and (C) = number of reproductive hosts (plants on which bug can complete development) on where each species of stink bug was observed. Note that the area for total plant species in (A) is much greater that the one for reproductive hosts in (C), indicating that on the majority of the plants the bugs are observed they do not reproduce. NV = *Nezara viridula*; PG = *Piezodorus guildinii*; EH = *Euschistus heros*; EM = *Edessa meditabunda*; DF = *Dichelops furcatus*; DM = *Dichelops melacanthus*; and TP = *Thyanta perditor*.

species from 11 families on which they were recorded (Fig. 1A, B, C). Perhaps, the main reason for that is the fact that this species is greatly restricted to legumes as reproductive hosts, mostly soybean, and the majority of incidental records are plants grown nearby soybean fields from which they disperse as the crops mature. At the end of the soybean season, and with a drop in temperatures in many places in Brazil they are found seeking shelter not only in trees, but in human constructions as well (A.R. Panizzi personal observation).

The brown-winged stink bug, *E. meditabunda*, which feeds and reproduces mostly on leguminous and solanaceous plants (ca. 80% of the reproductive hosts), was found to reproduce on about half of the plants recorded (Fig. 1 C). Apparently this species is greatly adapted to feed and reproduce on vegetative plant tissues of several hosts, compared to the other species of pentatomids analyzed. There has been some speculation about that feeding habit, which might be related to their shorter mouthparts (Panizzi & Machado-Neto 1992) that prevent reaching seeds inside the fruits. Also, their habit of feeding in the upside down position on plant stems has also been speculated to increase sap uptake, but this has never been proven to be true.

Dichelops furcatus and *D. melacanthus*, along with *T. perditor* were the species with the lower values for reproductive hosts considering the total records of associated plants (22, 17 and 20%, respectively, Fig. 1C). The first two species are most commonly associated with legumes (*D. furcatus* also with brassicaceous plants), while the last species does not have a clear host preference. Although there are various records of the occurrence of *T. perditor* on poaceous plants, it apparently does not reproduce on the majority of them.

The impact of the intense multiple cropping and the no-tillage cultivation systems in the neotropics upon the interactions of these species of stink bugs with their associated plants has been dramatic. First, the introduction of crops all year round, particularly in the savannahs of central-west Brazil, and, to a less degree, in other regions of the country, has provided bugs with a never ending source of food. Second, the no-tillage cultivation system that has been adopted by growers provides bugs with shelter (i.e., crop residues year round) and food (fallen seeds from the previous crop). These two factors, plus the appearance of weeds in abundance in these intense cropping systems has favored species that have the habit of overwintering on the soil surface underneath debris, such as *E. heros*, *D. furcatus* and *D. melacanthus*.

Concluding Remarks

There are several definitions of host plant, and its concept includes a plant on which the insect feeds, reproduces and shelters (see Bernays & Chapman 1994). In most cases, these three features - feed-reproduce-shelter - do not occur simultaneously, hence the difficulty to fully characterize a plant as host. In certain instances adults will feed and seek shelter on plant A but nymphs will not develop on plant A; in other cases, nymphs will feed and develop on plant B, but emerging adults will not lay eggs on plant B; and finally nymphs and adult may feed on plant C, females lay eggs, but adults soon abandon plant C because it offers no shelter (greater exposure to abiotic factors – rain, sunlight – or to biotic factors – predators/parasites). In all cases there is a cost/benefit and the *ideal* host plant, the one to fulfill the three features, is seldom encountered by pentatomids.

The long lists of plants mentioned in this paper are those on which the stink bugs were observed. Most of them cannot be ranked as a host plant, considering host plant the one that fulfills the requirements of feed-reproduce-shelter, hence, the term used associated plants. Therefore, always when observing a stink bug on a plant, laboratory studies coupled with field observations should be conducted, for one to be able to characterize it as a host plant or not.

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The introduction of multiple cropping and no-tillage cultivation systems previously discussed are perhaps the two main factors driving the increase in numbers of stink bugs pests of major commodities in the neotropics. The multiple interactions of stink bugs with their associated plants is therefore a dynamic ongoing process that stands as a challenge to our understanding of the biological processes in nature.

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