REVIEW OF PHYTOPHAGOUS PENTATOMIDS (HEMIPTERA: PENTATOMIDAE) ASSOCIATED WITH SOYBEAN IN THE AMERICAS

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ABSTRACT

Published research on stink bugs (Pentatomidae) associated with soybean in the Americas is compiled and reviewed. Emphasis is placed on *Nezara viridula* (L.), *Acrosternum hilare* (Say), *Piezodorus guildinii* (Westwood), and *Euschistus heros* (F.). Nymphs and adults feed via stylet insertion primarily in seeds, reducing seed yield and quality and sometimes causing prolonged leaf retention and development of abnormal leaflets and pods. Colonization of soybean by pentatomids typically starts during preblooming and peaks by late pod-filling stage. As plants senesce, movement to alternate hosts occurs. Economic thresholds in soybean differ throughout the Americas and normally control measures are required.

Important natural enemies of phytophagous pentatomids include the hymenopteran egg parasites *Trissolcus basalis* (Wollaston) and *Telenomus mormideae* Lima, and the tachinid adult parasites *Trichopoda pennipes* (F.) and *Eutrichopodopsis nitens* Blanchard. Cultural and chemical control strategies and host plant resistance to stink bugs are discussed. Opportunities for future research within the philosophy and methodology of Integrated Pest Management (IPM) are suggested.

RESUMO

Dados publicados sobre percevejos (Pentatomidae) associados com soja nas Américas foram compilados e revisados. Foi dado ênfase para *Nezara viridula* (L.), *Acrosternum hilare* (Say), *Piezodorus guildinii* (Westwood), e *Euschistus heros* (F.). Ninfas e adultos alimentam-se através da inserção dos estiletes nas sementes, reduzindo o rendimento e a qualidade, e em alguns casos causando retenção foliar prolongada e desenvolvimento anormal de folíolos e vagens. A colonização da soja por pentatomídeos inicia tipicamente durante a pré-floração alcançando o máximo no final do período de enchimento da vagem. A medida que a soja enesce, os insetos deslocam-se para outras espécies de plantas hospedeiras. Níveis de danos econômicos para a soja diferem através das Américas, e normalmente medidas de controle são necessárias.

Inimigos naturais importantes dos pentatomídeos fitófagos inclui os micro-himenópteros parasita de ovos *Trissolcus basalis* (Wollaston) e *Telenomus mormideae* Lima, e os taquinídeos parasitas de adultos *Trichopoda pennipes* (F.) e *Eutrichopodopsis nitens* Blanchard. Medidas de controle cultural, químico e uso de plantas resistentes aos percevejos são discutidas. Oportunidades para pesquisa futura dentro da filosofia e metodologia do Manejo Integrado de Pragas (MIP) são sugeridas.

Phytophagous pentatomids (stink bugs) are of special importance among the insect pests that attack soybean, *Glycine max* (L.), because they feed primarily on pods, causing irreversible direct damage to developing seeds. This is contrasted with the damage caused by defoliating caterpillars, from which the plant may recover with minimal reduction in seed yield (Turnipseed 1972). In the Americas, a few key stink bug species are of substantial economic importance (Turnipseed 1980). However, as soybean production continues to expand, an increasing number of species are being discovered feeding on this crop. Thus, there is a need to better understand the biology and impact of these insects in the soybean agroecosystem.

In this review we present information on the phytophagous pentatomids associated with soybean in the Americas, including the composition of species, their biology and host plants, the nature of damage they cause, economic thresholds, and control strategies. This review should facilitate exchange of information between North and South American scientists, because many of the papers included here on South American species are published in Portuguese or Spanish in local journals with restricted circulation and have thus not been readily available to North American researchers. In addition, we suggest directions for future research, particularly within the context of management of these important pest species.

Species Composition in North and South America

Many species of phytophagous pentatomids have been recorded from soybean fields in North America (NA) and South America (SA; Table 1). In NA, the species with the greatest economic impact is *Nezara viridula* (L.), although other species may achieve economic importance in some areas of the United States (US). These include *Acrosternum hilare* (Say), *Euschistus servus* (Say), and *E. tristigmus* (Say) (Herzog et al. 1985). Todd and Herzog (1980) presented a generic key for field identification of the adult stink bugs known to occur on soybean, including 45 phytophagous species (most are found in NA).

In SA, much research has been done in Brazil where phytophagous pentatomids are the major pests of soybean. Silva et al. (1968) found four species on soybean in different states of Brazil. In the most southern state (Rio Grande do Sul), species composition has been more thoroughly studied and more than 20 species have been recorded on soybean. However, only *N. viridula* and *Piezodorus guildinii* (Westwood) are abundant, and their impact varies from one portion of Rio Grande do Sul to another (Corseuil et al. 1974, Heinrichs 1976). *Dichelops furcatus* (F.) and *Edessa meditabunda* (F.) are reported to be moderately abundant, and the others infrequently observed (Heinrichs 1976).

In other regions of Brazil the species composition changes. In Paraná state as well as in the more northern states of São Paulo, Minas Gerais, and Goiás, and the western state of Mato Grosso do sul, *Euschistus heros* (F.) is of special importance. In Paraná, a survey of phytophagous pentatomids was initiated in 1973 and more than 25 species have been collected (A. R. Panizzi and B. S. C. Ferreira, unpublished). In Goiás (central Brazil), Kishino (1980) reported 10 species, including a new record (*Agroecus* sp.) and *Thyanta perditor* (F.), which was previously found on soybean by Rossetto et al. (1978) and Gomez (1980) in São Paulo and Mato Grosso do Sul, respectively. Panizzi and Herzog (1984) studied the

TABLE 1. PHYTOPHAGOUS PENTATOMIDS ASSOCIATED WITH SOYBEAN IN NORTH AND SOUTH AMERICA AFTER HAYWARD 1942, RIZZO 1972, BERTELS AND FERREIRA 1973, LOPES ET AL. 1974, HEINRICHS 1976, GALILEO ET AL. 1977, PANIZZI ET AL. 1977b, WALDBAUER 1977, KISHINO 1980, TODD AND HERZOG 1980, GRAZIA ET AL. 1982, HERZOG ET AL. 1985, AND A. R. PANIZZI UNPUBLISHED.[1]

Species	Geographical Distribution North America	South America
Acledra fraterna (Stal)		X
Acrosternum acutum (Dallas)	X	
Acrosternum armigera (Stal)		X
Acrosternum erythrocnemis (Berg)		X
Acrosternum hilare (Say)	X	
Acrosternum impicticorne (Stal)		X
Acrosternum marginatum (Palisot de Beauvois)	X	X
Acrosternum pennsylvanicum (De Geer)	X	
Agroecus sp.		X
Arvelius albopunctatus (De Geer)	X	X
Banasa dimidiata (Say)	X	
Banasa euchlora (Stal)	X	
Banasa sp.		X
Brachystethus geniculatus (Fabricius)		X
Dendrocoris fruticola (Bergroth)	X	
Dichelops furcatus (Fabricius)		X
Dichelops melacanthus (Dallas)		X
Edessa bifida (Say)	X	
Edessa meditabunda (Fabricius)		X
Edessa ruformarginata (De Geer)		X
Euschistus atrox (Westwood)		X
Euschistus cornutus (Dallas)		X
Euschistus crenator (Fabricius)		X
Euschistus euschistoides (Vollenhoven)	X	
Euschistus heros (Fabricius)		X
Euschistus ictericus (Linnaeus)	X	
Euschistus impictiventris (Stal)	X	
Euschistus obscurus (Palisot de Beauvois)	X	
Euschistus picticornis (Stal)		X
Euschistus quadrator Rolston	X	
Euschistus servus (Say)	X	
Euschistus tristigmus (Say)	X	
Euschistus variolarius (Palisot de Beauvois)	X	
Holcostethus limbolarius (Stal)	X	
Hymenarcis nervosa (Say)	X	
Loxa deducta (Walker)		X
Loxa flavicollis (Drury)	X	X
Mayrinia curvidens (Mayr)		X
Mormidea lugens (Fabricius)	X	
Mormidea sp.		X
Mormidea v-luteum (Lichtenstein)		X
Nezara viridula (Linnaeus)	X	X

TABLE 1. (Continued)

Species	Geographical Distribution North America	South America
Oebalus ornatus (Sailer)		X
Oebalus poecilus (Dallas)		X
Oebalus pugnax torridus (Sailer)	X	X
Oebalus ypsilon-griseus (De Geer)		X
Piezodorus guildinii (Westwood)	X	X
Proxys punctulatus (Palisot de Beauvois)	X	
Proxys sp.		X
Thyanta antiguensis (Westwood)	X	X
Thyanta calceata (Say)	X	
Thyanta custator (Fabricius)	X	
Thyanta pallidovirens accera (Stal)	X	
Thyanta perditor (Fabricius)	X	X

[1]All species occur in soybean fields, but some may feed on weeds in the field rather than on soybean.

biology of *T. perditor* in Paraná and found that it fed and reproduced on wheat and on the weed *Bidens pilosa* L. (Compositae). On soybean, reproduction did not occur and longevity was drastically reduced. Another species, *Euschistus cornutus* (Dallas), occurs sporadically on soybean in Paraná and Santa Catarina (A. R. Panizzi, unpublished).

Records of pentatomids on soybean in other countries of SA include several species in Argentina, with *N. viridula* being the most important (Hayward 1942, Rizzo 1972, and Vicentini and Jimenez 1977). In Palmira, Colombia, Waldbauer (1977) found 10 species infesting soybean; *P. guildinii* was collected in greatest numbers. This is also the most common species on soybean in Peru (Irwin et al. 1981).

MAJOR SPECIES: GEOGRAPHICAL DISTRIBUTION, HOST PLANTS, LIFE CYCLE AND PHENOLOGY

Nezara viridula

The southern green stink bug is the most important phytophagous pentatomid pest of soybean in NA and SA. It is probably the most studied pentatomid due to its worldwide distribution and its importance as a pest of several economically important plants. *N. viridula* is the most cosmopolitan of the pentatomids attacking soybean, occurring throughout the tropical and sub-tropical regions of Europe, Asia, Africa, and the Americas (Lethierry and Severin 1893). A distribution map published by the Commonwealth Institute of Entomology was reproduced by DeWitt and Godfrey (1972).

In the US, *N. viridula* occurs south of a line extending from Texas in the west through southern Arkansas to Virginia in the east (Turnipseed and Kogan 1976). In SA, it occurs in Argentina (Bosq 1937), Uruguay (Ruffinelli and Piran 1959), and Brazil, where it is most abundant in the south (Lima 1940, Corrêa et al. 1977). Because soybean production in

Brazil is expanding in the central and western regions, *N. viridula* will probably become more abundant in these areas.

N. viridula feeds on a wide range of both monocots and dicots; Kiritani et al. (1965) mentioned that as many as 145 species within 32 plant families have been recorded as hosts. However, Todd and Herzog (1980) concluded that *N. viridula* seems to prefer only certain plants, particularly some of the legumes. They presented a selected list of host plants including at least 44 plant species within 18 families. Several other lists of host plants of *N. viridula* in different parts of the world have been published (Jones 1918, Drake 1920, Hoffman 1935, Rizzo 1968, Silva et al. 1968).

The life history of *N. viridula* has been studied in different parts of the world (Jones 1918, Drake 1920, Kamal 1937, Cumber 1949, Everett 1950, Kiritani and Hokyo 1962, Rizzo 1968, Mitchell and Mau 1969, Corpuz 1969, Singh 1972, Vélez 1974, Harris and Todd 1980a). Jones (1918), Drake (1920), and Harris and Todd (1980a, b, c, d), present a substantial amount of information on this species in the southern USA. In early spring, adult emergence occurs from over-wintering sites and the bugs begin feeding and mating (Drake 1920). Mate-attraction involves a complex repertoire of songs that are inaudible to the unaided human ear (Harris et al. 1982). Eggs are firmly glued together in rows within compact polygonal clusters. At the time of deposition, eggs are light yellowish-white or cream colored, turning pinkish and reddish as development progresses. Nymphs in early instars are strongly gregarious; this behavior seems to speed the rate of development and reduce mortality (Kiritani 1964, Kiritani et al. 1966). The gregarious habit of nymphs disappears in the fourth instar (Panizzi et al. 1980). Temperature strongly influences developmental time; during the summer the period from egg to adult is about 35 days (Jones 1918, Drake 1920).

Knowledge of the synchronization of host plant and insect phenologies is very important in the characterization of a pest population. Todd and Herzog (1980) presented a generalized scheme for a typical seasonal host sequence of *N. viridula* in the southeastern coastal plain of the US. They mentioned that 5 generations may occur per year and that in late July and August adults move to soybean, which provides the only major source of food in late summer and early fall (late July through November). Stink bug populations of *N. viridula* and *A. hilare* reached peak levels on soybean in late September and October in Mississippi (Buschman et al. 1984); similar trends were reported in Georgia (Schumann and Todd 1982). A comprehensive study of the incidence of nymphs and adults of *N. viridula, P. guildinii* and *E. heros* was carried out in the north of Paraná, Brazil by Ferreira and Panizzi (1982). Adults occurred on soybean from mid-October to mid-May; stink bug populations started increasing on early maturity varieties and successively colonized later varieties, reaching peak abundance on late maturity varieties by the end of March through mid-May (Fig. 1). Adults of the three species were found throughout the year, either on soybean or on other host plants, but *P. guildinii* was the first species to colonize soybean. In general, eggs were found from mid-November to mid-May and nymphs from early December to mid-May, except for *N. viridula,* whose nymphs (5th instar) were found throughout the year.

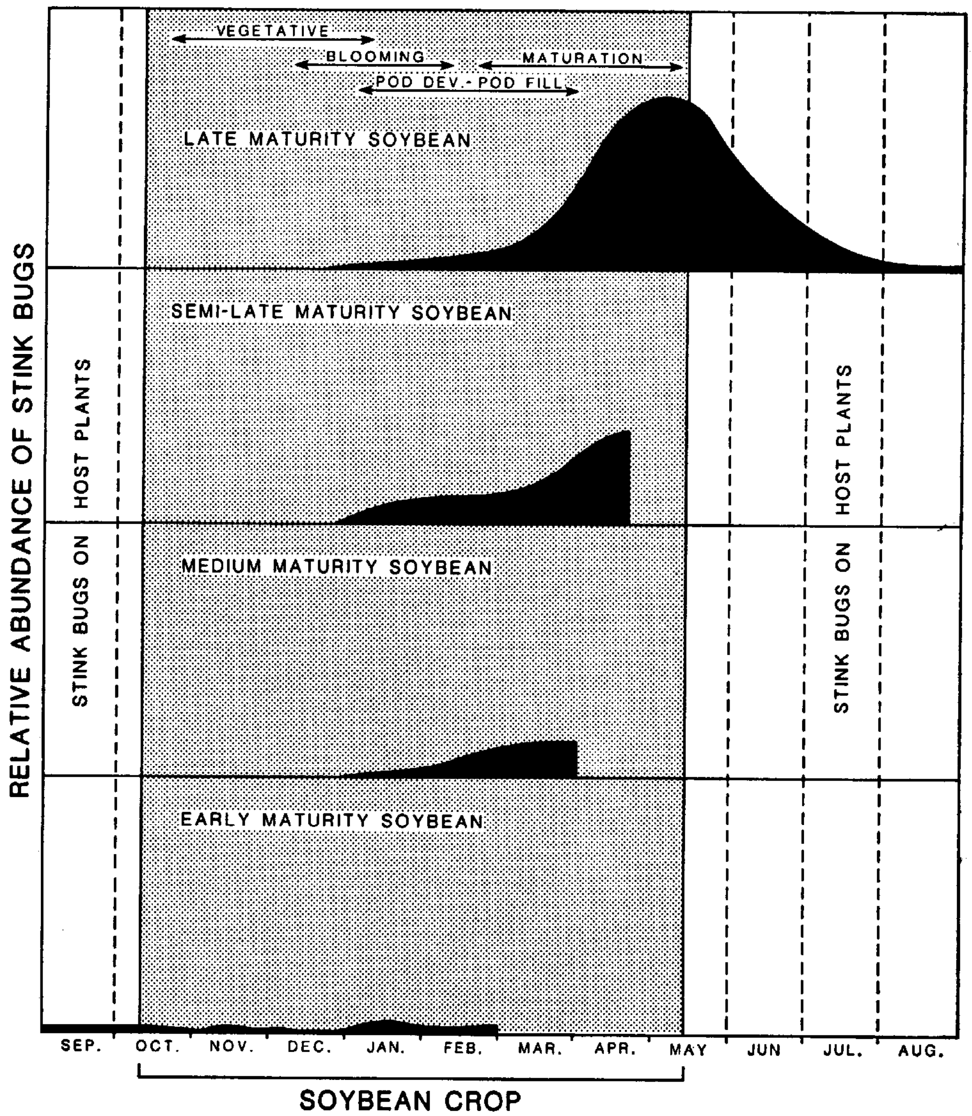

Fig. 1. Phenological relationship between growth stages of soybean plants and typical population trends of stink bug species in northern Paraná state, Brazil (from Ferreira and Panizzi 1982).

Acrosternum hilare

Along with *N. viridula*, the green stink bug *A. hilare* is also common on soybean in NA. In the southern USA both *N. viridula* and *A. hilare* coexist with other pentatomids, and in the northern regions *N. viridula* is rarely found (Turnipseed and Kogan 1976). These two species are very similar in appearance and habits. However, they can be easily distinguished by the color of the distal portion of the antennal segments (reddish on *N. viridula* and blackish on *A. hilare*), by the shape of the first abdominal segment (rounded and pointed, respectively) and by the shape of osteolar canal (short and obtuse for *N. viridula* and long and tapering for *A. hilare;* Miner

1966). *A. hilare* is widely distributed in NA, from Quebec and New England west to the Pacific Coast and south to Florida, Texas and California (Torre-Bueno 1939, McPherson 1982).

Acrosterum hilare, like many of the other phytophagous pentatomids, is polyphagous. Several host plants were reported by Whitmarsh (1917) including 12 preferred wild hosts. Schoene and Underhill (1933) reported that wild hosts were more preferred than cultivated ones, the latter becoming infested only when wild hosts were not available. Underhill (1934) reported several wild host plants of *A. hilare;* the most common cultivated hosts were lima beans, peaches and cotton. Miner (1966) in Arkansas found that the first generation generally was completed on wild hosts, especially on dogwood, *Cornus drummondi* Ashmead. Movement to soybean occurred and a second generation was completed. The abundance of *A. hilare* was often greater in the rows of soybean nearest to the bordering woods containing wild hosts. Jones and Sullivan (1982) in South Carolina found that the sequence of black cherry (*Prunus serotina* Ehrhart) followed by elderberry (*Sambucus canadensis* L.) allowed large populations of *A. hilare* to develop prior to infesting soybean.

Whitmarsh (1917) presented data on the life cycle and phenology of *A. hilare* in Ohio, as well as detailed descriptions and illustrations of the various life stages. In Utah, this species is probably univoltine (Sorenson and Anthon 1936). In Virginia, Woodside (1947) found that hibernation occurred in the adult stage among leaves and brush. Sailer (1953) found a 32 day range in developmental time of nymphs from the same egg batch (resulting from the mating of an Illinois- and a Maryland-field caught individual) reared under the same conditions; he speculated that more than one generation could occur in a season in the Gulf states; this was confirmed by Jones and Sullivan (1982).

Miner (1966) studied the life cycle of *A. hilare* in the laboratory under controlled conditions as well as in the field. He presented data on duration of various stages, habits of nymphs and adults, seasonal life history, and incidence and distribution within soybean fields, and discussed the damage inflicted by feeding activity of *A. hilare* on soybean.

Piezodorus guildinii

Among the phytophagous pentatomids associated with soybean in SA, *P. guildinii* and *N. viridula* are the most damaging species. *P. guildinii* is probably the most widely distributed species because it occurs further north in the neotropical region. In certain soybean production areas of Brazil, *P. guildinii* is the major pentatomid pest. In Argentina it is an important pest of alfalfa (Fraga and Ochoa 1972). Although it is important as a pest, only recently have data become available on its biology and damage potential to soybean. It seems that the expansion of the soybean crop in SA in the 1960's and 1970's was the principal factor for its increase in numbers and importance.

P. guildinii is a neotropical pentatomid found from the southern US to Argentina. It was first described from the island of St. Vincent (Stoner 1922) and has been frequently reported from Central and South America (Table 2). During 1983, it was frequently found on soybean in north-central Florida (A. R. Panizzi, unpublished). Data of Menezes (1981) seem

TABLE 2. GEOGRAPHICAL DISTRIBUTION OF *Piezodorus guildinii* AFTER DISTANT 1880-1893 (D), UHLER 1894 (U), KIRKALDY 1909 (K), COTTON 1918 (C), HUTSON 1918 (H), STONER 1919, 1922 (S), WOLCOTT 1936 (W), BALLOU 1937 (B), MONTE 1937, 1939 (M), LIMA 1940 (L), GENUNG ET AL. 1964 (G), QUINTANILLA ET AL. 1967-68 (Q), SILVA ET AL. 1968 (Si), WALDBAUER 1977 (Wa), AND JONES AND SULLIVAN 1982 (JS).

Place	Authors
Antigua	S
Argentina	Q
Brazil	U, K, M, L, Si
Barbados	S
Colombia	Wa
Costa Rica	B
Cuba	D, U, K
Grenada	K
Guatemala	D, K
Hispaniola	K
Jamaica	U, K
Mexico	D, U, K
Panama	D
Paraguay	U, K
Porto Rico	C, W
San Domingo	U
St. Vincent	D, K, H
Trinidad	U, K
United States (Georgia, New Mexico, South Carolina and Florida)	U, K, G, JS

to indicate an increase in abundance of *P. guildinii* in north Florida. In Brazil, this stink bug was seldom found on soybean until the early 1970's. Subsequently, it has become more common, ranging from Rio Grande do Sul (32° S latitude) to Piauí (5° S latitude). With the expansion of soybean production to the central and west regions, and the possibility of growing this crop in the northeastern region, *P. guildinii* may become the number one pentatomid pest of soybean in Brazil. During 1981, it was the major pest on experimental plots of soybean in Teresina (Piauí) and Bacabal (Maranhão) (5° and 4° S latitude, respectively) (A. R. Panizzi, unpublished).

The list of apparent food plants for *P. guildinii* is broad, and it includes some economically important plants in addition to soybean (Table 3). Some of these may be plants on which the stink bug does not feed but rather uses for shelter. The list of host plants presented by Ferreira and Panizzi (1982) does not include common food plants like soybean and bean because the survey was made during late winter, when these hosts were unavailable. Among the cultivated plants, soybean, alfalfa and bean (*Phaseolus vulgaris* L.) seem to be the most preferred, and severe damage may occur if control measures are not applied. Also, *P. guildinii* is the most important pentatomid feeding on lentil in southern Brazil (Link 1979b).

TABLE 3. CULTIVATED AND WILD HOSTS OF *Piezodorus guildinii* AFTER HUTSON 1918 (H), WOLCOTT 1936 (W), BALLOU 1937 (B), MONTE 1937 (M), GENUNG ET AL. 1964 (G), QUINTANILLA ET AL. 1967-68 (Q), SILVA ET AL. 1968 (S), FRAGA AND OCHOA 1972 (FO), LOPES ET AL. 1974 (L), HALLMAN 1979 (Ha), FERREIRA AND PANIZZI 1982 (FP), AND PANIZZI AND SLANSKY 1985a (PS).

Host Plant	Place	Authors
Amarantaceae		
Pfaffia paniculata	Brazil	FP
Anacardiaceae		
Spondias mombin	Costa Rica	B
Bignoniaceae		
Adenocalymma comusum	Brazil	FP
Pyrostegia venusta	Brazil	FP
Caesalpiniaceae		
Chamaecrista aeschinomene	Porto Rico	W
Cactaceae		
Peireskia aculeata	Brazil	FP
Compositae		
Bidens pilosa	Brazil	FP
Helianthus annuus	Argentina, Brazil	Q, FP
Cucurbitaceae		
Sechium edule	Brazil	L
Euphorbiaceae		
Ricinus communis	Brazil	FP
Gramineae		
Triticum aestivum	Brazil	FP
Lauraceae		
Nectandria sp.	Brazil	FP
Leguminoseae		
Cajanus cajan	Brazil	FP
Crotalaria brevidens	USA	PS
Crotalaria lanceolata	USA	PS
Crotalaria pallida	Colombia	Ha
Crotalaria sp.	Brazil	M, FP
Dolichos lablab	Argentina	FO
Glycine max	Argentina, Brazil, USA	Q, S, L, G
Indigofera hirsuta	Colombia, USA	Ha, PS
Lens culinaris	Brazil	L
Lotononis bainesii	Brazil	L
Lotus corniculatus	Brazil	L
Medicago hispida	Brazil	L
Medicago sativa	Argentina	Q, FO
Phaseolus athyroides	Colombia	Ha
Phaseolus vulgaris	Brazil, Porto Rico	S, L, W
Trifolium repens	Brazil	L
Trifolium spp.	Argentina	Q

TABLE 3. (Continued)

Host Plant	Place	Authors
Vicia sp.	Brazil	L
Malvaceae		
Gossypium hirsutum	Argentina, Brazil, St. Vincent	Q, S, H
Myrtaceae		
Psidium guajava	Costa Rica	B
Nictaginaceae		
Bougainvillea glabra	Brazil	FP
Phytolaccaceae		
Phytolacca dioica	Brazil	L
Piperaceae		
Piper sp. (?)	Porto Rico	W
Rosaceae		
Fragaria hibrida	Brazil	L
Rubiaceae		
Coffea arabica	Brazil	S
Sapindaceae		
Serjania fuscifolia	Brazil	FP
Umbelliferae		
Foeniculum vulgare	Brazil	L
Violaceae		
Anchietea salutaris	Brazil	FP
Hybanthus atropurpures	Brazil	FP

In Argentina, Fraga and Ochoa (1972) found that *P. guildinii* overwinters in the adult stage under objects that offer protection. Active adults were found in alfalfa fields from October to June, eggs from mid-November to April, and nymphs from mid-November to mid-May; greatest abundance was during March-April. They determined that 5 generations per year may occur, and that adults may copulate several times during summer with a female laying as many as 10 egg masses during its 30 day lifespan. Duration from egg to adult ranged from 30 to 55 days, due to variable temperature.

Similar results on the biology of *P. guildinii* on soybean in Brazil were reported by Panizzi and Smith (1977). Link (1979b) and Link et al. (1980) studied some aspects of the biology of *P. guildinii* on lentil and bean, respectively. Results were generally similar to those found on soybean; however, on bean the major oviposition site is the leaf, on lentil, the tendril, and on soybean the pod is preferred.

During the first instar, nymphs cluster on or near the egg shells, and do not feed until the second instar; these are common behaviors among pentatomids. Panizzi et al. (1980a) found that the 2nd and 3rd instars were strongly gregarious and that the 4th and 5th were the principal instars involved in dispersal throughout soybean fields. Costa and Link (1982) found that *P. guildinii* adults have greater mobility than *N. viridula,* and females of both species disperse farther than males in soybean fields.

Fraga and Ochoa (1972) and Grazia et al. (1980) described the diagnostic characteristics of the various stages of *P. guildinii.* The former authors included a description of adult characteristics, and these were later illustrated (Galileo et al. 1977).

P. guildinii, like most of the phytophagous pentatomids associated with soybean, feed primarily on pods. Seasonal abundance of stink bugs, including *P. guildinii,* in relation to crop phenology was reported by several authors in different states of Brazil (Costa and Link 1974, Panizzi and Smith 1976a, Corrêa et al. 1977, Ferreira and Panizzi 1982). In general pentatomids are more abundant during March-April when soybean is in the pod-filling stage or starting maturity.

Euschistus heros

E. heros is a neotropical pentatomid occurring in SA and possibly in Panama (Rolston 1974). Most reports refer to its distribution in Brazil where it is the third major component of the pentatomid-pest complex on soybean. Williams et al. (1973) probably were the first to record *E. heros* on soybean in São Paulo. Initially considered a secondary pest, *E. heros* has more recently increased in numbers and may inflict severe damage to soybean. It is reported as the predominant species on this crop in some regions of São Paulo (Calcagnolo et al. 1977, Rodini and Grazia 1979) and Mato Grosso do Sul (Degáspari and Gomez 1979). This species seems to be adapted to warmer regions, being more abundant from north of Paraná to the central and west regions of Brazil. However, *E. heros* may occur in low numbers in the southern-most state, Rio Grande do Sul (Link 1979a). Corrêa et al. (1977) recorded it in several states, with greatest abundance in Goiás.

Few plants other than soybean are known to be hosts of *E. heros,* probably because of limited study. Link (1979a) found that 'angiquinho', *Aeschynomene rudis* (Leguminosae), was its native host in southern Brazil. Ferreira and Panizzi (1982) found it in Paraná on *Nectandria* sp. (Lauraceae), *Clematis dioica* var. *brasiliensis* (Ranunculaceae) (these two plants are probably not food plants), and on *Helianthus annuus* (Compositae). It also occurs on bean, *Phaseolus vulgaris* (A. R. Panizzi, unpublished).

Data on the biology of *E. heros* are relatively scarce, due to its previous minor importance as a pest of economic crops. However, with increasing incidence on soybean in certain areas of Brazil, its biology on this host has been studied (Villas Bôas and Panizzi 1980). The mean number of eggs per mass was 6.7 and the female oviposited an average 33.6 masses during its lifespan. Males lived longer than females and sex ratio in the field was 1 male: 2 females.

Grazia et al. (1980) described the diagnostic characteristics of the various stages of *E. heros.* Adult *E. heros* can be distinguished from the similar-appearing predator *Podisus nigrispinus* (Dallas), also commonly found on soybean in Brazil, by the lateral expansions of the pronotum. In *E. heros*, these are long spines not perpendicular to the longitudinal axis of the body, whereas in *P. nigrispinus* they are shorter spines perpendicular to the longitudinal axis of the body.

The occurrence of *E. heros* in relation to crop phenology is similar to the other major pentatomid pests.

NATURE OF DAMAGE AND ECONOMIC THRESHOLDS

The nature of damage by stink bugs to soybean has been reviewed by Todd and Herzog (1980) and Herzog et al. (1984). Stink bugs feed on soybean by inserting their stylets in the different structures of the plant. During feeding they inject histolytic agents which liquify the solid and semi-solid portions of the cells, allowing ingestion.

Feeding activity of *N. viridula* was studied by examining their stylet sheaths, which remain after feeding; it was found that first-instar nymphs did not feed (Bowling 1980). Adults of *N. viridula* can cause a significantly greater number of punctures to soybean seed than either the 4th or 5th instar nymphs (Duncan and Walker 1968). However, 5th instar *A. hilare* damaged a greater percentage of seeds than any other stage, including adults (Yeargan 1977).

Feeding punctures on seeds cause minute darkish spots; generally, chalky-appearing air spaces are produced when the cell contents are withdrawn (Miner 1966). Later, dark discoloration may surround the punctures and the inner membrane of the seedcoat may be abnormally fused to the cotyledons (Kilpatrick and Hartwig 1955, Blickenstaff and Huggans 1962, Daugherty et al. 1964, Miner 1966, Turner 1967).

Extent of feeding damage is related to the stage of seed development. Feeding during early pod and seed development generally causes pod-abscission or abortion of young seeds. When attack occurs during pod-fill, only shrivelled and deformed seeds are obtained. During seed maturation, little deformation of the seed is caused by feeding.

Significant reductions in yield, seed quality, and percent germination due to stink bug feeding can occur (Miner 1961, Blickenstaff and Huggans 1962, Daugherty et al. 1964, Duncan and Walker 1968, Jensen and Newsom 1972, Thomas et al. 1974, Todd and Turnipseed 1974, Vicentini and Jimenez 1977, Yeargan 1977, Galileo and Heinrichs 1978a, b, d, Costa and Corseuil 1979, McPherson et al. 1979b, Panizzi et al. 1979b, Link et al. 1982). The location of a puncture is probably more important than the number of punctures; one puncture on the axis of the radicle-hypocotyl can prevent germination (Jensen and Newsom 1972).

Soybean seeds damaged by stink bugs have a higher protein content and a lower oil content than undamaged seeds (Miner 1961, 1966, Daugherty et al. 1964, Hart 1970, Todd and Turnipseed 1974, Thomas et al. 1974, Corso and Porto 1978, Galileo and Heinrichs 1978d, Panizzi et al. 1979b). The oil and protein content may vary among plants from different areas in the same field and among pods at different heights on the soybean plant (Miner 1966). Temperature may also influence the oil and protein content of seeds (Howell and Cartter 1953, 1958). Injury to seeds by stink bugs changes the chemical composition of the soybean oil by changing the percentage of different fatty acids (Hart 1970, Todd et al. 1973). Also, damaged soybean stored for long periods of time at higher moisture levels undergo considerable increase in fat acidity (Miner and Wilson 1966) and are more susceptible to attack by secondary pests (Todd and Womack 1973).

Delayed leaf maturation, foliar retention, and development of abnormal leaflets and pods close to the main stem were found when extensive stink bug injury occurred during seed development (Daugherty et al. 1964, Gomes 1966, Rizzo 1972, Singh 1972, Vicentini and Jimenez 1977, Galileo and Heinrichs 1978c, Link and Storck 1978, Panizzi et al. 1979b). Prevention of normal seed development presumably is the cause of these abnormalities. Hicks and Pendleton (1969), based on artificial removal of soybean plant parts, suggested that if a hormone triggers senescence, then this substance is formed during or after seed formation and also is not translocated throughout the plant.

Along with direct damage to soybean seeds, the transmission of micro-organisms by phytophagous pentatomids can occur. Ashby and Nowell (1926) first used the word 'stigmatomycosis' to describe injury from the inoculation of fungi into fruits by Hemiptera. A common disease associated with stink bug injury is the yeast spot disease, *Nematospora coryli* Peglion, isolated from soybean by Lehman (1943) and Preston and Ray (1943). Later, several authors studied different aspects of this disease in soybean in the USA (Daugherty and Jackson 1967, Daugherty 1967, Clarke and Wilde 1970a, b, 1971), Brazil (Corso and Heinrichs 1974), and Argentina (Vicentini and Jimenez 1977).

A number of different fungi were isolated from healthy and punctured seeds; stink bug injury was apparently not necessary for fungus infection to occur (Kilpatrick and Hartwig 1955). Several bacteria pathogenic to soybean were isolated from *N. viridula* (Ragsdale 1977). In Brazil, several micro-organisms were associated with soybean seeds damaged by *P. guildinii;* among them *Fusarium* sp. infected more than 30% of damaged seeds (Panizzi et al. 1979b). Genung et al. (1964) presented evidence that stink bugs have considerable potential in the spread of pod diseases.

Herzog et al. (1985) reviewed the development of economic thresholds of stink bug pests of soybean in NA. In general, control measures are recommended when populations exceed 1.1 bugs/row-m (up to mid-pod fill) or 3.3 bugs/row-m (mid-pod fill to maturity); when the crop is produced for seed, 1.1 bugs/2 row-m justify control measures (Suber and Todd 1978).

In SA, the first studies to develop economic thresholds for pentatomids (i.e., *P. guildinii* on soybean) were begun in Brazil (Paraná) in 1973 (Panizzi et al. 1979b) and in 1974 Rio Grande do Sul (Galileo and Heinrichs 1978a, b, c, d). At that time a pilot pest management program for soybean pests was in progress in both states (Kogan et al. 1977) and thresholds for stink bugs were based on studies from other countries. Williams et al. (1973) and Turnipseed (1975) published preliminary recommendations in Portuguese for control decisions based on research conducted in the USA. Later, as a result of research conducted primarily with *P. guildinii*, a threshold of 2 adults per row-m was recommended (Panizzi et al. 1977b). However, when the crop is for seed germination will be considerably reduced with 1 adult per row-m and control measures should be applied (Panizzi et al. 1979b).

In Argentina, damage to soybean by various pentatomid species was studied by Vicentini and Jimenez (1977), permitting determination of economic thresholds. In Colombia, Waldbauer (1977) reported damage to soybean by several species of pentatomids but did not recommend economic thresholds.

CONTROL STRATEGIES

NATURAL ENEMIES

Several insects parasitize phytophagous pentatomids that occur on soybean in the Americas. Most of them are egg parasites but some may attack nymphs and adults. Among the hymenopterous egg parasites, the most studied is *Trissolcus basalis* (Wollaston) (Scelionidae). This species is referred to as a polyphagous parasite in Europe, Africa and NA (Miller 1928, Kamal 1937, Cumber 1964). *T. basalis* was introduced in many countries to control *N. viridula,* including Australia (Kamal 1937), New Zealand, Hawaii, and the Pacific islands of Tonga, New Caledonia and Samoa (Cumber 1951, 1964, Davis 1964, Davis and Krauss 1966, DeBach 1974). *T. basalis* was first recorded in Brazil (Paraná) in 1979 in *N. viridula* eggs on soybean (Ferreira 1980) and this is probably the first record for SA. In addition to *N. viridula,* 14 other species of phytophagous pentatomids associated with soybean may serve as hosts (Ferreira 1980, Herzog et al. 1985).

Other egg parasites of *N. viridula* include *Ooencyrtus* sp. (Hymenoptera: Encyrtidae) in the USA (Drake 1920) and the Phillipines (Corpuz 1969), *O. submetallicus* (Howard), which was introduced into the USA from Trinidad (Lee 1979), and *Telenomus nakagawai* Watanabe (Scelionidae) and *Trissolcus* (*Asolcus*) *mitsukurii* Ashmead which occur in Japan (Hokyo et al. 1966).

Yeargan (1979) reared *Telenomus podisi* Ashmead and *Trissolcus euschisti* (Ashmead) from eggs of *A. hilare, E. servus,* and *E. variolarius,* and *Anastasus* sp. nr. *pearsalli* Ashmead from *A. hilare* eggs. *E. servus* eggs are also host of *Telenomus megacephalus* Ashmead (=*T. basalis*) (Miller 1928) and *Trissolcus utahensis* Ashmead (Muesebeck et al. 1951).

In SA, there are several species of egg parasites of phytophagous pentatomids occuring in soybean (Table 4). In Brazil (Paraná), *T. basalis* parasitized 23% of 76 egg masses of *N. viridula* (Ferreira 1980). Substantial parasitism was also reported for *P. guildinii* eggs by *Telenomus mormideae* Lima in Paraná (Panizzi and Smith 1976b) and Rio Grande do Sul (Link and Concatto 1979). For the other major pentatomid pest, *E. heros,* as many as 40.7% of eggs were parasitized by *T. mormideae* in field cages in Paraná (Villas Bôas and Panizzi 1980).

Tachinid flies are the most common adult parasites of phytophagous pentatomids found on soybean; in NA, at least 13 species of tachinids parasitize different species of pentatomids (McPherson 1978, Eger and Ables 1981, McPherson et al. 1982, Herzog et al. 1984). The tachinid *Trichopoda pennipes* (F.) has been extensively studied (Shahjahan 1968, Mitchell and Mau 1971, Eaton 1975, Todd and Lewis 1976, Todd and Harris 1977, McPherson 1978, Harris and Todd 1980b, d). Attraction to *N. viridula* in this species, as well as in the egg parasite *T. basalis,* is mediated by various odors released by the host (Sales et al. 1978a,b, Harris and Todd 1980d).

TABLE 4. EGG PARASITES OF DIFFERENT SPECIES OF PHYTOPHAGOUS PENTATOMIDS ASSOCIATED WITH SOYBEAN IN SOUTH AMERICA.

Parasite	Host Species	Author
Dissolcus paraguayensis Bréthes	*Edessa rufomarginata* (De Geer)	Lima (1948)
Ooencyrtus fasciatus Mercet	*Tibraca limbativentris* Stall	Silva et al. (1968)
Telenomus edessae Bréthes	*E. rufomarginata*	Lima (1948)
Telenomus mormideae Lima	*Euschistus heros* (F.)	Villas Bôas and Panizzi (1980)
	Piezodorus guildinii Westwood)	Panizzi and Smith 1976b)
Telenomus schrottkyi Bréthes	*E. rufomarginata*	Lima (1948)
Telenomus sp.	*Edessa meditabunda* (F.)	Silva et al. (1968)
	T. limbativentris	Lima (1948)
Trissolcus basalis (Wollaston)	*Acrosternum* sp.	Ferreira (1980)
	Dichelops melacanthus (Dallas)	Ferreira (1980)
	Euschistus heros (F.)	Ferreira (1980)
	N. viridula	Ferreira (1980)
	P. guildinii	Ferreira (1980)
	Thyanta perditor (F.)	Ferreira (1980)
Trissolcus caridei Bréthes	*E. rufomarginata*	De Santis and Esquivel (1966)
Trissolcus sp.	*E. meditabunda*	Silva et al. (1968)
Trissolcus (*Microphanurus*) *scuticarinatus* Lima	*P. guildinii*	Lima (1937)
	T. perditor	Panizzi and Herzog (1984)

In SA the most common tachinid in soybean fields is *Eutrichopodopsis nitens* Blanchard. It is the principal tachinid parasite of *N. viridula* in Argentina (Blanchard 1966) and in Brazil, where it parasitized 3rd, 4th and 5th instar nymphs of *N. viridula;* adult *E. nitens* only emerged from 4th and 5th instars and adults (Gastal 1977a, b). This tachinid may also eventually parasitize *P. guildinii* (Panizzi and Smith 1976b). As many as 50.5% of 2663 *T. perditor* adults collected in the field were found to be parasitized by this fly in Paraná (Panizzi and Herzog 1984). A few other species of tachinids have been found to parasitize *N. viridula* in Brazil (Lima 1940, Silva et al. 1968). In Uruguay, Parker et al. (1951-1952) reported the tachinids *Neobrachelia* sp. and *Xenopyxis edessae* Townsend parasitizing *E. meditabunda.*

Few references are found concerning predators of phytophagous pentatomids in soybean agroecosystems due in large part to the difficulty of associating a predator with a specific prey (mainly because of the polyphagous diets of the predators). Stam (1978) found the red imported fire ant, *Solenopsis invicta* Buren, as the predominant predator of *N. viridula* eggs early in the season in Louisiana. Krispyn and Todd (1982) in Georgia found 16 times fewer southern green stink bugs in cages with fire ants than in those from which ants were excluded. They also found that nymphs were more vulnerable than adults to fire ant predation. The predacious stink bugs *Euthyrhynchus floridanus* (L.) and *Podisus maculiventris* (Say) occur on soybean (Whitcomb 1973); they feed on *N. viridula* (Drake 1920), *A. hilare* (Howard 1900, Underhill 1934), *E. servus* (Richman and Whitcomb 1978) and *E. tristigmus* (Kirkaldy 1909). Other predators of *N. viridula* in the USA include *Schistocerca obscura* (F.), *Orchelimum nigripes* Scudder, and *Conocephalus fasciatus* (De Geer) (Orthoptera) feeding on eggs, and *Geocoris* spp., *Reduviolus roseipennis* (Reuter), *Tropiconabis capsiformis* (Germar), *Sinea diadema* (F.) (Hemiptera) and *Lebia analis* Dejean (Coleoptera) feeding on nymphs (Stam 1978). Chewing predators may destroy more stink bug eggs than sucking predators (Yeargan 1979).

In SA, a large entomofauna of predators is present in soybean agroecosystems. However, few records are found concerning predators associated with pentatomids in this crop. De Santis and Esquivel (1966) reported *Bicertes discisa* (Tachenberg) (Hymenoptera: Sphecidae) as a predator of *E. meditabunda* in Argentina. In Brazil, adults and nymphs of the pentatomid *Tynacantha marginata* Dallas were reported as predators of 5th instar nymphs of *P. guildinii* (Panizzi and Smith 1976b).

Very little research has been conducted on diseases of stink bugs. Gastal (1977a) referred to *Beauveria bassiana* (Balsamo) Vuillemim attacking *N. viridula in* Brazil. Tonet and Reis (1979) successfully induced infection in *N. viridula* by *B. bassiana* in the laboratory and studied sporulation of the fungus under several artificial conditions. Another fungus (*Entomophthora* sp.) may infect *N. viridula* and *A. hilare* (Carner 1980) and *Metarhizium anisopliae* (Metsch.) attack *N. viridula* and *P. guildinii* in Brazil (F. Moscardi, Centro Nacional de Pesquisa de Soja, EMBRAPA, Londrina, PR., Brazil, personal communication to ARP).

Cultural Control

Methods of stink bug control on soybean other than insecticides and biocontrol include cultural methods such as early maturity varieties and trap crops. Generally, early varieties escape damage by maturing before stink bug populations cause economic reduction in yield. Early maturity varieties are commonly planted in Brazil where the stink bug complex is the major economic insect problem. Concentrating soybean production on a narrow range of varieties within a particular time of maturity may be a risk to the total production (mainly in years with low water availability) but growers do this instead of using later maturity varieties which will certainly experience increased damage by stink bugs (Ferreira and Panizzi 1982).

Early planted trap crops were used to attract *N. viridula* in Louisiana (Newsom and Herzog 1977). The pest became concentrated in small areas of early planted soybean where insecticide was used to suppress its spread to the surrounding soybean crop. Similar results were reported by McPherson (1978) and Ragsdale et al. (1981) on attractiveness of early planted soybean to stink bug populations.

In Brazil, Panizzi (1980) reported effective control of *N. viridula, P. guildinii* and *E. heros* using early maturity varieties. The pentatomids concentrated on the early soybean at the edge of larger areas with later maturity varieties and properly timed insecticide application that was restricted to the trap area was sufficient to protect the later maturity varieties.

HOST PLANT RESISTANCE

The use of resistant varieties is an important strategy in integrated pest management programs. Studies in the Americas indicate that as the period from blooming to maturation increases, the damage caused by pentatomids also increases(Daugherty et al. 1964, Miner 1966, Link and Costa 1974, Jones and Sullivan 1979). Differences in susceptibility to stink bugs among commercial cultivars have been reported. McPherson et al. (1979b) found that 'Tracy' and 'McNair 600' varieties were significantly more damaged by stink bugs than were other commercial cultivars of the same maturity group, and suggested that host preference may be responsible for the difference in damage. They also indicated that the variety 'Lee 68' might possess some mechanism for tolerance to stink bug feeding.

Link et al. (1971) in Brazil found a lower percentage of damaged seeds for the variety 'Bienville' when compared with 'Santa Rosa' and 'Industrial'. Link et al. (1973) stated that under the same period of infestation 'Industrial' and 'Serrana' were less affected by stink bugs than 'Bienville'. These results appear to be somewhat contradictory with those mentioned in the previous paper. A higher infestation of *P. guildinii* was necessary to cause leaf retention in the variety 'Santa Rosa' than in 'Bragg' (Costa and Link 1977).

Jones and Sullivan (1978) studied damage caused by different species of pentatomids to 5 soybean cultivars among 4 maturity groups in South Carolina, and found that 'Essex', which matured early, escaped severe damage. However, they also found that within varieties, early plantings were more damaged than late ones. Miner (1966) found a higher number of bugs on early than on late planted soybean. However, Suchmann and Todd (1982) in Georgia, reported higher stink bug populations in June than in April and May plantings. Buschman et al. (1984) in Mississippi, found a non-significant effect of planting date on stink bug populations in a factorial analysis of planting date, row spacing and maturity group; the effect of maturity group was significant. A higher number of stink bugs on early planted soybean was found by Panizzi et al. (1979a) for the variety 'Bragg' planted at three different times. This was probably due to concentration of the first generation of the stink bugs in these areas for oviposition. Late planted 'Cobb' and ED 73-371 incurred significantly less seed weight loss than 'Bragg' (Jones and Sullivan 1978). Adverse effects on nymphal development of *N. viridula* feeding on PI's 229358, 227687 and 171451, and ED 73-371 were reported by Turnipseed and Sullivan (1975). Later, Jones and Sullivan (1979) showed that PI 229358 was the most consistently resistant cultivar, causing significantly higher mortality, slower development, and lower weight gain for nymphs as compared to those on 'Bragg'. Gilman et al. (1982) found several soybean PI's with moderate levels of resistance, including PI 171444 with a high level of resistance to *N. viridula*. Kester et al. (1984) suggested that nonpreference, antibiosis and probably escape in time contribute to the high field resistance of this genotype to stink bugs.

In Brazil, Morosini and Porto (1979) artificially infested the soybean varieties 'Bragg' and 'Davis' and the lines SR-209 and RI-173 with *P. guildinii.* They suggested some degree of resistance in these two lines, based on their greater yield compared to that of the two varieties. Panizzi et al. (1981b) found that PI's 227687 and 229358 and lines Chi-Kei n. 1B and IAC 74-2832 had the smallest percentage of damaged seeds among a large number of varieties and lines evaluated in field tests.

Factors like seed hardness and seed size are believed to influence the ultimate degree of damage to soybean by stink bugs (Miranda et al. 1979, Panizzi et al. 1980b, 1981a, Link and Estefanel 1982). They found a reduced percentage of punctured seeds among several small-seeded genotypes compared to genotypes with larger seeds.

Breeding for resistance to *Nematospora coryli,* a pathogen transmitted during feeding by stink bugs, may solve part of the stink bug problem on soybean. Recently, Keeling et al. (1981) found several soybean genotypes that were resistant to this pathogen.

Chemical Control

Insecticides are the most effective control measure available to suppress stink bug populations on soybean on an emergency basis. Miyasaki and Sherman (1966) studied the effect of different insecticides on *N. viridula* in Hawaii, and found that it was resistant to DDT and heptachlor. Miner (1966) stated that dimethoate, methyl parathion and carbaryl give satisfactory control of *A. hilare* in Arkansas. Turnipseed (1967) reported season-long control of *A. hilare* and *N. viridula* in South Carolina with carbofuran granules applied by side-dress in mid-August. Carbaryl sprayed on foliage was found to be effective against *N. viridula* in Georgia (Todd and Canerday 1972).

Methyl parathion is the insecticide most commonly reported as being effective against phytophagous pentatomids. It is recommended in Brazil for control of *N. viridula* (Corseuil et al. 1970). Corseuil et al. (1974) recommended several other insecticides against different species of stink bugs, including dimethoate, which was also found to be effective against *N. viridula* by Fagundes et al. (1973).

Differences in susceptibility of pentatomid species to different insecticides are common. In Louisiana, McPherson et al. (1979a) found differences in susceptibility to methyl parathion among nymphs of several pentatomid species. In Brazil, *P. guildinii* is more susceptible to carbaryl than to methyl parathion, whereas with *N. viridula* the reverse is reported. Thus, which stink bugs are present will determine which material to use; endosulfan effectively controls both species (Gazzoni 1978).

The use of wide-spectrum insecticides may cause resurgence of pest populations, mainly because of harmful effects on natural enemies. For example, in South Carolina the application of chemicals early in the season resulted in later resurgence of various caterpillars (Shepard et al. 1977). In Brazil, *P. guildinii* was captured in higher numbers in plots treated with a mixture of methyl parathion and methomyl than in untreated checks (Panizzi et al. 1977a).

Conclusions

The stink bug complex is a major component of soybean agroecosystems in the Americas. As the amount of land planted to soybean continues to increase, we believe that loss of soybean production caused by the complex of stink bugs, as well as other pests, will also increase. Methods of stink bug control must become more effective and efficient. The philosophy and methodology of Integrated Pest Management (IPM) (Barfield and Stimac 1980) should receive greater attention and application to the stink bug complex in soybean.

Many of the papers published during the 1960's and 1970's have characterized the impact of stink bug feeding on the amount and quality of soybean yield and have determined economic thresholds. Such data are important components of IPM strategies, but full application of IPM strategies to the stink bug complex of soybean will require much more research. For example, critical evaluation of the degree of usage by stink bugs of the many plants listed as their "food plants" is necessary to determine which of these actually serve as important hosts. It is necessary to determine the impact of the important host plants on the biology of nymphal and adult stink bugs and to identify the physical, nutritional and allelochemical characteristics of these host plants that influence stink bug biology. Studies such as that of Kester and Smith (1984) on dietary influences on growth, fecundity and flight behavior of *N. viridula* are highly desirable.

Knowledge of the factors influencing stink bug biology should facilitate the development of methods to reduce stink bug impact on crop production. These methods could include the use of feeding inhibitors and aggregation, growth and reproduction regulators, as well as the use of resistant soybean varieties. Knowledge is required to successfully predict the movement of stink bugs from wild hosts (or other crop fields) into the crop fields of concern and to increase the accuracy of population models. Exploitation of the relative attractiveness of various plants to stink bugs may divert them away from crop fields to trap plants where they can be more easily and efficiently controlled. Of special interest is the development and use of soybean varieties that exhibit various forms of resistance to stink bugs through escape, antibiosis and/or tolerance. Manipulation of planting date and maturity date also seem to be viable components of IPM strategies, as does the use of biocontrol agents (Herzog et al. 1985). For example, introduction of the tachinids *E. nitens* from Brazil or Argentina into the USA, and of *T. pennipes* from the USA into SA should be considered. Attention should be given to the introduction of natural enemies into the expanding soybean production areas, as well as to the augmentation of native beneficial species.

In addition to applied studies on the nutritional ecology of stink bugs, studies of phytophagous pentatomids from a basic viewpoint also seem warranted. For example, the occurrence of two or more species in the same habitat (see above) presents opportunities for research on interspecific interactions. Other opportunities for research on phytophagous pentatomids include characterizing adaptations associated with, and evaluating hypotheses of, dietary specialization, utilization of ephemeral resources, overwintering, dispersal, migration, egg-clumping, and gregarious behavior.

Finally, because of the documented importance of stink bugs in soybean agroecosystems throughout the Americas, continued and expanded interaction and exchange of information among scientists in the Americas is desirable.

NOTE ADDED IN PROOF

Buschman and Whitcomb (1980) found *T. basalis* and *T. podisi* parasitizing one egg mas each of *P. guildinii,* and *Euthera tentatrix* Loew and *T. pennipes* parasitizing on adult each of *P. guildinii* in north central Florida. Panizzi and Slansky (unpublished data, north central Florida, 1983) found one of 300 fifth instar nymphs of *P. guildinii* collected from *Indigofera hirsuta* parasitized by *T. pennipes.* Pods of *I. hirsuta* were a highly suitable food for adult *P. guildinii* compared with pods of *Crotalaria lanceolata* or soybean, mature soybean seeds, or raw, shelled peanuts (Panizzi and Slansky 1985a,b).

ACKNOWLEDGEMENTS

We thank C. S. Barfield, D. C. Herzog, W. A. Jones, Jr., R. I. Sailer, J. R. McLaughlin and two anonymous reviewers for providing helpful comments on early drafts of this manuscript. ARP is affiliated with Centro Nacional de Pesquisa de Soja, Emprêsa Brasileira de Pesquisa Agropecuária (EMBRAPA), Caixa Postal 1061, Londrina, PR. 86.100, Brasil. This work was partially supported by scholarship funds to ARP from EMBRAPA. Florida Agricultural Experiment Station Journal Series No. 5597.

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