Mini review: parasitoids of rice pests and prospects for enhancing biological control.

Red denotes added by jcatindig

Purple denotes added by jacheng – has also added names in Chinese of parasitoids and places but I could not reliably cut and paste them into this document

Summary of published information on insect parasitoids of rice pests.

TABLE 1. ORDER: HYMENOPTERA

Species name	Distribution Country/ region	Hosts	Notes (parasitism rates, alternative hosts, time of year, other information)	Reference (publication in English unless indicated otherwise)
Family: Dryinidae Nymphal-adult parasites and predators, forelegs adapted for holding prey for feeding and ovipositing, on average feed on 3.2 nymphs and parasitize 4-9 nymphs per day, the parasite is brought into an early crop mainly via a parasitised host but also by migration of adults, parasitism increases with crop age but declines quickly when crop is mature. Highest parasitism rates 35-40%, September-October in dryland fields, affecting *Nephotettix virecens* and *S.* furcifera most (Chandra, 1980) This family parasitise nymphs or adults. They develop within a sac on the host's abdomen until ready to pupate. They emerge and pupate in a spun cocoon attached to the rice leaf or other surface (Chiu, 1979). Parasitism of *N. lugens* by dryinid wasps very low under 1-2%, (Kitamura, 1987) Relatively low total parasitism rates by dryinids ((*Echthrodelphax fairchildii, Haplogonatopus* spp. and *Pseudogonatopus* spp.) of *N. lugens* and *S. furcifera*: Wet season = 9.7%, dry season = 6.4% (Peña & Shepard, 1986) Parasitism of *L. striatellus* by dryinid wasps generally low under 10%, highest in August/September (Kitamura, 1987) Parasitism of *S. fucifera* by dryinid wasps was about 10%, most of time but up to 20% in June/July (Kitamura, 1987)				
Dicondylus indianus Olmi (Dryinus) Pseudonym of *Pseudogonatopus flavifemur*	Queensland, Australia Also India, Taiwan and the Philipines (citing Olmi, 1984)	***Nilaparvata lugens*** (Stål)	Needs to feed on host before ovipositing in them (obligate host-feeder/synovegenic). The adult parasitoids feed on first four instars and then lay eggs in all five nymph stages and adults – feeding and oviposition are non-concurrent as feeding usually causes the host to die. Females capture and restrain the host using their chelate foretarsi. Hosts are dropped off the plant if they have been fed upon or placed on their food plant if they have had eggs laid in them. Feeding on the hosts haemolymph is also important for survival. When host density high:	Sahragard et al, 1991 n.b. For more on synovigeny and pro-ovigeny in relation to parasitoids - see Jervis & Kidd In: Theoretical Approaches to Biological Control, Bradford & Cornell (eds) (In CSU Orange library) and Jervis et al

Comment [CSU1]: I don't understand this addition. I cannot find anything to suggest this is a pseudonym or anything under the name *Dryinus indianus* searchi Web of Science, CAB abstracts and google

			• the period of intense egg laying was short – peak egg laying reached sooner • females lived longer • average daily oviposition rate greater Regardless of host density an individual parasitoid did not lay more than 587 eggs	(2001) and Heimpel & Collier 1996 (in 'not used' collection of papers)
		Nilaparvata lugens	Nymph and adult parasite	CAB International, 2005
		Nilaparvata lugens	Nymph and adult parasitoid	Shepard et al, 2000
	Tropical Asia	***Laodelphax striatellus***	Nymph and adult	Reissig et al, 1986
Digonatopus javanus Keiffer		***Nilaparvata lugens***		CAB International, 2005
Echthrodelphax bicolor Esaki & Hashimoto	Japan (citing Esaki & Hashimoto, 1936)	***Nilaparvata lugens***		Chiu, 1979
		Nilaparvata lugens	Nymph and adult parasite	CAB International, 2005
	Shimane, Japan	***Sogatella furcifera***		Kitamura, 1987 (Japanese – English abstract (have full text))
	Tropical Asia	***Nilaparvata lugens***	Nymph and adult parasitoid	Reissig et al, 1986
	Taiwan	***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
Echthrodelphax fairchildii Perkins*	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Nymph and adult parasite	Rhandhawa et al, 2006
		Nilaparvata lugens	Nymph and adult parasite	CAB International, 2005
	Madhya Pradesh, India	***Nilaparvata lugens*** ***Sogatella furcifera*** (Horvath)		Yadav & Pawar, 1989
	Japan	***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus*** Fallen	Daily fecundity about 15-25 eggs	Ito & Yamada, 2007
		Nilaparvata lugens ***Sogatella furcifera***		Barrion & Litsinger, 1994 p.184

		Laodelphax striatellus, *Perkinsiella saccharicida,* Nephotettix *spp.*		
	Japan	***Nilaparvata lugens*** ***Sogatella furcifera***	Semi-solitary – daily fecundity approx 20 To oviposit the female holds the host with its mandibles and chelae and paralyses it by stinging. The egg is oviposited under the wing bud on either side Mating required to produce females	Yamada & Ikawa, 2003
	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***	Relatively low total parasitism rates by dryinids (*Echthrodelphax fairchildii, Haplogonatopus* spp. and *Pseudogonatopus* spp.) Wet season = 7.6%, dry season = 11.2%	Peña & Shepard, 1986
	Mandya (Karnataka), India	***Nilaparvata lugens***	Nymph and adult parasite	Manjunath et al, 1978
	Philippines		Form larval sac on the dorsal side of the host's thorax	Chandra, 1980
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	India (citing Rai, pers. comm,)	***Nilaparvata lugens***		Chiu, 1979
			Hyperparsitised by *Cheiloneurus hawaiiensis* Perkins – Hawaii	Guerrieri & Viggiani, 2005
Echthrodelphax spp.	India, Japan, Korea, Philippines, Taiwan	***Sogatella furcifera*** ***Nilaparvata lugens*** *Nephotettix cincticeps* *Nephotettix virescens*		Greathead, 1982
Gonatopus yasumatsui Olmi		***Nilaparvata lugens***		Barrion & Litsinger, 1994 p.186
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
Gontpopus sp.			Hyperparsitised by *Cheiloneurus exitiosis* Perkins – Australia, Samoa, Fiji, Guam, India, Malysia, Philippines And *Cheiloneurus pachycephalus* Perkins – Ohio, USA	Guerrieri & Viggiani, 2005
Haplogonatopus sp. nr. americanus	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986

Haplogonatopus apicalis Perkins* Chen, 1989 appears to indicate *H. japonicas* is synonymous with *H. apicalis*	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Nymph and adult parasite	Rhandhawa et al, 2006
	Madhya Pradesh, India	***Nilaparvata lugens*** ***Sogatella furcifera***		Yadav & Pawar, 1989
		Nilaparvata lugens	"During larval development, it feeds on the host's body fluid. It protrudes from the abdomen of its host as a black to grayish sac. After 7 to 10 days, the larval sac splits to expose a whitish larva. Pupation occurs outside the host's body."	http://zj.shuidao.cn/IRRI/beneficials/Scientific_name_Haplogonatopus_apicalis_Perkins_78.htm
		Nilaparvata lugens ***Sogatella furcifera*** ***Laodelphax striatellus***		Barrion & Litsinger,1994 p.186
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Japan	***Sogatella furcifera***	The sex ratio of progeny was associated with the age of adult parasitoid, the development of the host (male ratio lowest in third instars) and the sex of the host but not the host density. Oviposition frequency was associated with the development of the host with highest occurring in 3rd-instar nymphs Those ovipositing in females were larger than those ovipositing in males	Kitamura & Iwami, 1998 (Japanese – abstract in English)
	Tropical Asia	***Sogatella furcifera***	Nymph and adult parasitoid	Reissig et al, 1986
Haplogonatopus atratus Esaki & Hashimoto		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
		Laodelphax striatellus		Barrion & Litsinger, 1994 p.188
	Japan	***Laodelphax striatellus***	Host specific Mating required to produce females	Yamada & Kawamura, 1999
		Laodelphax striatellus	Appears to maximise its reproductive capacity by being fecund and laying as many eggs in as many hosts as possible rather than guarding the eggs it has already laid	Yamada & Kitashiro, 2002
	Sinan County, Guizhou, China	***Laodelphax striatellus***	48.2% of total parasitism of delphacids (abstract not explicit about species) by 6 parasitoid species	Chen, 1989 (in Chinese – English abstract)

	Japan	***Laodelphax striatellus*** ***Sogatella furcifera***	The most dominant parasitoid species Predator as well as a parasitoid Observed in the field that the parasite mainly affects *L. Striatellus* In the field although no difference was observed in the lab, 54.9% mortality caused by combined parasitic and predatory action of the parasitoid (mostly due to parasitisation) in the lab – thought to be higher than in the field	Kitamura, 1982
	Shimane, Japan	***Laodelphax striatellus***		Kitamura, 1987 (Japanese – English abstract (have full text))
	Japan	***Laodelphax striatellus***	Solitary parasitoid	Yamada & Miyamoto, 1998
	Tropical Asia	***Laodelphax striatellus***	Nymph and adult parasitoid	Reissig et al, 1986
Haplogonatopus japonicus Esaki & Hashimoto Alternative spellings: *H. japonica, H. japonicas* Chen, 1989 and Zhang & Jin, 1992 appear to indicate *H. japonicas* is synonymous with *H. apicalis*	Japan (citing Esaki & Hashimoto, 1931; Sakai, 1932; Esaki & Mochizucki, 1941)	***Nilaparvata lugens***		Chiu, 1979
	Sinan County, Guizhou, China	***Nilaparvata lugens*** ***Sogatella furcifera***	36.5% of total parasitism of delphacids (abstract not explicit about species) by 6 parasitoid species	Chen, 1989 (in Chinese – English abstract)
	Guangdong Province, China	***Nilaparvata lugens***	A common parasitoid species found in that area	Ying, 1982
	Zhejiang, China	***Sogatella furcifera***	Appears to indicate this is a synonym of *H. apicalis* Malathion, dipterex (trichlorfon) and MTMC (melolcarb) – highly toxic to parasitoid Methamiddophos, chlordimeform hydrochloride and dimethoate – mildly toxic to parasitoid	Zhang & Jin, 1992 (Chinese – English abstract)
	China	***Sogatella furcifera***		Huang, 1994; Chen 1990 (in Chinese – English abstracts)
	Shimane, Japan	***Sogatella furcifera***		Kitamura, 1987 (Japanese – English abstract (have full text))

Haplogonatopus oratorius Westwood		***Laodelphax striatellus***,		Barrion & Litsinger, 1994 p.188
Haplogonatopus orientalis Rohwer	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Nymph and adult parasite	Rhandhawa et al, 2006
	India	***Nilaparvata lugens***	*N. lugens* has a symbiotic relationship with *Candida* sp. The yeast load declined considerably when parasitised by this parasitoid	Shankar & Baskaran, 1992 (abstract only)
		Nilaparvata lugens	Nymphs and adults parasite	CAB International, 2005
	Sri Lanka	***Nilaparvata lugens*** ***Sogatella furcifera***	The age-advanced larva forms an outstanding sac on the dorsal part of the abdomen of the host. 40% parasitism rates reached – but was not persistent and failed to control the population of planthoppers	Ôtake et al, 1976
	India	***Nilaparvata lugens***	Identified from parasitized nymphs and adults collected from the insectary and rice fields. Egg parasitoid – symbiotic yeast (important for the planthoppers nutrition) decrease as parasites grow	Shankar & Baskaran, 1988
Haplogonatopus sp./spp.	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***		Peña & Shepard, 1986
	Mandya (Karnataka), India	***Nilaparvata lugens***	Nymph and adult parasite	Manjunath et al, 1978
	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera*** Nymphs *of Nephotettix virecens*	Form a larval sac on the dorsal side of the host's abdomen of *N. lugens* and *S.furcifera*	Chandra, 1980
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	India (citing Rai, pers. comm.), Sri Lanka (citing Santa et al, unpubl.)	***Nilaparvata lugens***		Chiu, 1979
	Tropical Asia	***Nilaparvata lugens***	Nymph and adult parasitoid	Reissig et al, 1986
	Fiji, India, Japan, Korea, Philippines	***Sogatella furcifera*** ***Nilaparvata lugens*** *Nephotettix virescens*		Greathead, 1982

			Hyperparsitised by *Cheiloneurus exitiosis* Perkins – Australia, Samoa, Fiji, Guam, India, Malysia, Philippines	Guerrieri & Viggiani, 2005
	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982
Monogonatopus orientalis Rohwer	Peninsular Malaysia	***Nilaparvata lugens***	Abundant	van Vreden & Ahmadzabidi, 1986
Monogonatopus sp.	Taiwan	***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
Pseudogonatopus otakei Olmi	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
Pseudogonatopus atratus Esaki & Hashimoto		***Nilaparvata lugens***		
Pseudogonatopus flavifemur Esaki & Hashimoto * Alternative spelling: *P. flavifemus* should be *Dicondylus indianus* Olmi)		***Nilaparvata lugens*** ***Sogatella furcifera*** *Nephotettix* spp.		Barrion & Litsinger, 1994 p.188
	Shimane, Japan	***Nilaparvata lugens***		Kitamura, 1987 (Japanese – English abstract (have full text))
	Japan (citing Esaki & Hashimoto, 1933; 1936; Esaki, 1932; Sakai, 1932)	***Nilaparvata lugens***		Chiu, 1979
	Sinan County, Guizhou, China	***Nilaparvata lugens***	10.8% of total parasitism of delphacids (abstract not explicit about species) by 6 parasitoid species	Chen, 1989 (in Chinese – English abstract)
	Philippines	***Nilaparvata lugens***	4.7% parasitism rate	Dayanan & Esteban, 1996 (abstract only)
	Philippines	***Nilaparvata lugens***	Dryinids feed on hosts killing them and so fewer healthy hosts are available for parasitisation. In their experiments a female parasitoid fed on uo to ten third-instar hosts. They suggest superparasitism is mainly an artefact of laboratory experiments because of the small experimental area and the long time span. Observed	Chua et al, 1984

Comment [CSU2]: I cannot find anything for this species searching Web o Science, Google andCAB abstracts

			superparasitism only once in the field. Females laid fewer eggs when another female was present. Increasing parasitoid density increases 'mutual interference' between them – the area searched was reduced and hosts were handled for longer. In biological control programs host and parasitoid populations stabilise as high searching efficiency reduces the average host density and parasitoids are attracted to the most dense populations where 'mutual interference' reduces oviposition. In addition, mutual interference encourages dispersal of the parasitoid after introduction. Normally in the field parasitism rates are low - <20%	
	Philippines	***Nilaparvata lugens***	Nymphs and adults parasite	CAB International, 2005
	Philippines			Chandra, 1980
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	Taiwan	***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
			Hyperparsitised by *Cheiloneurus exitiosis* Perkins – Australia, Samoa, Fiji, Guam, India, Malysia, Philippines	Guerrieri & Viggiani, 2005
Pseudogonatopus flavifenur Esaki & Hashimoto	Philippines			Chandra, 1980
Pseudogonatopus fulgori Nakagawa		***Laodelphax striatellus*** ***Sogatella furcifera***		Barrion & Litsinger, 1994 p.188
	Japan	***Laodelphax striatellus*** ***Sogatella furcifera***	In *L. striatellus* it took on average 26.1 days for eggs to develop to pupae at 24°C In *S. furcifera* it took on average 25.9 days for eggs to develop to pupae at 24°C Eggs failed to develop in *N. lugens* Development temperature threshold: 13.8°C Development from egg to pupa took from 16 days at	Kitamura, 1989 (Japanese – English abstract)

Comment [CSU3]: flavifemur and flavifenur both listed by Chandra – doesn't look like a typo - searching Web of Science, Google andCAB abstracts

			32°C to 42.5 days at 20°C	
	Shimane, Japan	***Laodelphax striatellus*** ***Sogatella furcifera***		Kitamura, 1987 (Japanese – English abstract (have full text))
Pseudogonatopus hospes Perkins*	Madhya Pradesh, India Also found in Japan and Malaysia (citing Anonymous, 1978 and Chiu, 1979)	***Nilaparvata lugens*** ***Sogatella furcifera***		Yadav & Pawar, 1989
	Hawaii - Kauai; Oahu; Molokai; Maui; Hawaii	***Nilaparvata lugens***	Purposely Introduced	http://www2.bishopmuseum.org/HBS/checklist/species.asp?grp=Arthropod&taxID=-1208574862
		Nilaparvata lugens ***Sogatella furcifera***		Barrion & Litsinger, 1994 p.191
	Thailand (citing Napompeth, unpublished)	***Nilaparvata lugens***		Chiu, 1979
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
	Hawaii	Sugar cane leafhopper	Introduced from China	Sweezey, 1925
			Hyperparsitised by *Cheiloneurus exitiosis* Perkins – Australia, Samoa, Fiji, Guam, India, Malysia, Philippines	Guerrieri & Viggiani, 2005
Pseudogonatopus nudus Perkins*		***Nilaparvata lugens*** ***Sogatella furcifera***		Barrion & Litsinger, 1994 p.188
	Philippines, India, Sri Lanka, Thailand, China, Taiwan, Indonesia and Malaysia	***Nilaparvata lugens*** ***Sogatella furcifera***	Unable to distinguish between *P. sarawaki* and *P. nudus*	Olmi 1991-2
	Philippines	***Nilaparvata lugens***	3.3% parasitism rate	Dayanan & Esteban, 1996 (abstract only)
	Philippines	***Nilaparvata lugens***	Dominant species of dryinid parasitoid of *N. lugens* in Philippines (citing Chandra, 1980)	Chua et al, 1984

		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	Tropical Asia	***Nilaparvata lugens*** ***Sogatella furcifera***	Nymph and adult parasitoid	Reissig et al, 1986
		Nilaparvata lugens	Nymph and adult parasitoid	Shepard et al, 2000
		Nilaparvata lugens	Dominant species on this host	Greathead, 1982
Pseudogonatopus ponomarenkoi Moczar	Tropical Asia	***Sogatella furcifera***	Nymph and adult parasitoid	Reissig et al, 1986
Pseudogonatopus nr. *pusanus* Olmi	Madhya Pradesh, India Also found in Japan and Malaysia (citing Anonymous, 1978 and Chiu, 1979)	***Nilaparvata lugens*** ***Sogatella furcifera***		Yadav & Pawar, 1989
Pseudogonatopus pusanus Olmi		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
Pseudogonatopus sarawaki Moczar*		***Nilaparvata lugens*** *Sogatella* sp.		Barrion & Litsinger, 1994 p.188
		Nilaparvata lugens	Unable to distinguish between *P. sarawaki* and *P. nudus*	Olmi 1992
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Tropical Asia	***Nilaparvata lugens***	Nymph and adult parasitoid	Reissig et al, 1986
Pseudogonatopus sp./ spp.	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***		Peña & Shepard, 1986
	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***	From larval sac on dorsolateral side of the host's abdomen	Chandra, 1980
		Nilaparvata lugens	Common parasitoid	Ooi & Shepard, 1994
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
	Japan, Philippines, Taiwan	***Sogatella furcifera*** ***Nilaparvata lugens*** *Nephotettix cincticeps*		Greathead, 1982

		Nephotettix virescens		
			Hyperparsitised by *Cheiloneurus gonatopdis* Perkins – Australia, Madagascar and Mauritius	Guerrieri & Viggiani, 2005
	Taiwan	***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
Pseudozonatus hospes Perkins	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982
Family: Encyrtidae hyperparasites of Dryinidae (Chiu 1979)				
Cheilonerurus exitiosus Perkins		***Nilaparvata lugens*** ***Sogatella furcifera***	Also a hyperparasite of other parasitoids (*Gonatopus* sp., *Haplogpnatopus* sp., *Pseudogonatopus hospes*, *P. flavifemur*)	Guerrieri & Viggiani, 2005
Chrysopophagus australiae Perkins	Solomon Islands (citing MacQuillan, 1974)	***Nilaparvata lugens***		Chiu, 1979
Echthrogonatopus exitiosus Perkins	Solomon Islands (citing MacQuillan, 1974)	***Nilaparvata lugens***		Chiu, 1979
		Nilaparvata lugens	Nymph and adult parasite	CAB International, 2005
Family: Eulophidae				
Ootetrastichus nr *beatus*	Fiji (citing Hinckley, 1963)	***Nilaparvata lugens***	Egg parasite Parasitism appeared to be rare.	Chiu, 1979
		Nilaparvata lugens	Egg parasite	CAB International, 2005
	Hawaii	Sugar cane leafhopper	Introduced from Fiji	Sweezey, 1925
	South Africa	*Numicia viridis*	More important in control of this host than *Oligosita* sp. because it is more “robust”	Dick & Thompson, 1969
	South Africa and Swaziland	*Numicia viridis*	Associated with sugar cane and wild grasses – along with *Oligosita* sp. effectively controls the pest	Charleston et al, 2003
Ootetrastichus nr. *formosanus Timberlake*	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	Tropical Asia	***Nilaparvata lugens***	Egg parasitoid	Reissig et al, 1986
	Hawaii	Sugar cane leafhopper	Introduced from Formosa	Sweezey, 1925
Ootetrastichus spp.	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens,	Heong et al, 1992

	and Banaue)		Nephotettix nigropictus and Recilia dorsalis)	
Tetrastichus formosanus Timberlake		***Nilaparvata lugens***	Egg parasite	CAB International, 2005
	Peninsular Malaysia	***Nilaparvata lugens***	Common parasitoid	van Vreden & Ahmadzabidi, 1986
	Tropical Asia	***Nilaparvata lugens***	Egg parasitoid	Reissig et al, 1986
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
	Thailand	***Nilaparvata lugens***		Wongsiri et al, 1980
Family: Mymaridae Egg parasites – quick to migrate into crops from alternative hosts in other habitats, quickly establish cause rapid mortality – therefore important as biocontrol agents (Chandra, 1980) Most myramid parasites around in May and June (parasitism rates 11.3-29.6%) and again in September to November (3.3 – 38.1%) (Chiu, 1979)				
Anagrus sp. nr *flaveolus* Waterhouse	Sri Lanka	***Nilaparvata lugens***		Fowler et al, 1991
	Japan (citing Otake 1970a,b); 1976a,b)	***Nilaparvata lugens***	Egg parasite Parasitism rates 44.5% (in Zentuz) and 66.9% (in Kagawa) and influences pest populations in early growth stages (citing Otake, 1976b) Parasitism could be easily detected through the transparent chorion of the host egg when the parasite larva was at least half grown.	Chiu, 1979
	Japan	***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus***	No preference shown between *N. lugens*, *S. furcifera* and *L. striatellus* Have a strong tendency to disperse – important for overwintering away from paddy fields in non-delphacid species Outlines methods for determining parasitism rates	Ôtake, 1977
			Unfertilised eggs all males (citing Otake, 1969) – see also *Anagrus* sp. entry outlines difficulties associated with and methods for sampling egg parasitoid populations in the field and estimating parasitism rates	Chandra, 1980
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981

		Nilaparvata lugens	Reared the parasitoid in the laboratory by designing a new rearing technique	Chandra & Dyck, 1987
	Taiwan	***Nilaparvata lugens***	Egg parasitoid	Ya u-i & Hirashima, 1981
		Nilaparvata lugens	Wasp parasitizes 15-30 eggs a day	Shepard et al, 2000
	Japan	***Laodelphax striatellus***	An overwhelmingly dominant species attacking eggs of *Laodelphax striatellus* on cultivated plots.	Otake, 1970
	India	***Sogatella furcifera***	Parasitization was more on resistant genotype with five times more than with susceptible variety.	Nalini, 2005.
	Tropical Asia	***Sogatella furcifera***	Egg parasitoid	Reissig et al, 1986
Anagrus flaveolus Waterhouse			Unfertilised eggs all females – see also *Anagrus* sp. entry	Chandra, 1980
	China	***Nilaparvata lugens*** ***Sogatella furcifera*** *Tagosodes pusanus*	Dominant species Had significant preference of *N. lugens* and *S. furcifera* when on rice – but on grass preferred *T. pusanus* Non-rice habitats are important for the conservation of the rice planthopper parasitoids	Yu et al, 1998 (Chinese – English abstract)
	China	***Nilaparvata lugens*** ***Sogatella furcifera***	In rice fields and adjacent habitats Population dynamics (sex ratio, body size and parasitoid growth rate) were influenced by: host eggs, host plants of parasitoids and the surrounding habitat. The parasitoids obtained nutrients from nectar and pollen of the non-rice flowers.	Yu et al, 1996 (Chinese – English Abstract)
	China	*Toya* spp. and *Tagosodes pusanus*	Important egg parasitoid of delphacids in rice and non-rice habitats Habitat dominated by grasses close to paddy fields may act as a reservoir of parasitoids of rice planthoppers	Yu 1996 (Chinese – English Abstract)
	Japan (citing Yasumatsu & Watanabe, 1965)	***Nilaparvata lugens***		Chiu, 1979
	San Miguel de Tucumán, Argentina	*Delphacodes kuscheli*		Liljesthröm & Virla, 2004
	India	***Nilaparvata lugens***	Effective parasitoid of *Empoasca* sp. and also parasitised *Amrasca b. biguttula* Activity peaked in July and October-November but active throughout year – paper does not mention *N.*	Singh et al, 1993 (abstract only)

			lugens	
	Saxian county, Fujian province	Planthoppers	Abstract does not identify the host/s involved *Anagrus flaveolus* and two closely related species are main natural control agents of rice planthoppers Graminaceous weeds important for overwintering natural enemies	Lo & Zhou, 1980 (Chinese – English Abstract)
	Japan	***Laodelphax striatellus***	66%-96% parasitism measured by 'trap method' - late June to early August	Hachiya, 1995 (Japanese – English abstract)
	Malaysia	***Sogatella furcifera***	*Anagrus* spp.: • turn host eggs orange or yellow orange and parasitoids can be seen through the transparent chorion 47% maximum parasitism	Watanabe et al, 1992
	India	***Sogatella furcifera***	Egg parasite	Rhandhawa et al, 2006
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981
Angarus frequens Synonyms: *Anagrus armatus, A. cicadulinae*		***Nilaparvata lugens***		CAB International, 2005
	Malaysia	***Sogatella furcifera***	*Anagrus* spp.: • turn host eggs orange or yellow orange and parasitoids can be seen through the transparent chorion 47% maximum parasitism	Watanabe et al, 1992
	India	***Sogatella furcifera***	Egg parasite	Rhandhawa et al, 2006
	Hawaii	Sugar cane leafhopper	Introduced from Australia	Sweezey, 1925
	Queensland, Australia Hawaii, Fiji, Philippines, Taiwan	*Perkinsella saccharicida* (Fiji and Hawaii) *Kelisia sporobolicola* (Hawaii), *Perkinsella maidis (Hawaii) ,* corn leahopper (Philippines), *Perkinsella* sp. (Taiwan)		Triapitsyn & Beardsley, 2000
Anagrus incarnatus Haliday	Piacenza province, Italy	***Nilaparvata lugens***		Chiappini et al, 1999
	Taiwan, Britain,	***Nilaparvata lugens***		Chen & Yu, 1989

	Denmark, Belgium, Japan, Korea, Bangladesh			
	China	***Nilaparvata lugens***		Chiappini et al, 1998
	Japan	***Nilaparvata lugens*** ***Sogatella furcifera*** *N. muiri* and *N. bakeri* (citing Chantarasa-ard, 1984).	*N. lugens* and *S. furcifera* do not overwinter in Japan but spread from overseas each year. *A. incarnatus* capable of overwintering in eggs of *N. muiri*	Chantarasa-ard, 1984
	Japan	***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus*** *N. bakeri* Muir *N. muiri* *Harmalia albicolli* Motchulsky, *Sogatella longifurcifera* Esaki et Ishihara, *S. panicola* Ishihara, *Terthron albovittatum* Matsumura, *Zuleica nipponica* Matsumura et Ishihara, *Nephotettix cincticeps* Uhler *Macrosteles orientalis* Vilbaste	Does not have a preference between S. furcifera, N. lugens and L. Striatellus (70%+ parasitism rates) Can attack eggs at any stage of development. The parasitism was higher and the parasite more abundant in the field in September compared to August. Parasitism rates for alternative hosts: *N. bakeri* Muir (71.4% in lab), *N. muiri* (39.9% in lab; 32.4% in field), *Harmalia albicolli* Motchulsky (93.8% in lab; 0% in field), *Sogatella longifurcifera* Esaki et Ishihara (65.8% in lab; 26% in field), *S. panicola* Ishihara (17.8% in lab; 18.1% in field), *Terthron albovittatum* Matsumura (40% in lab; 64.7% in field), *Zuleica nipponica* Matsumura et Ishihara (8.8% in field) *Nephotettix cincticeps* Uhler (5.3% in lab) and *Macrosteles orientalis* Vilbaste (63% in lab).	Chantarasa-ard & Hirashima, 1984
	Japan	***Sogatella furcifera***	Most dominant egg parasitoid	Chantarasa-ard et al, 1984
	Navarra, Spain England (citing Enoch, 1914), Belguim (citing Debauche, 1948; citing Mathot, 1969), Holland and Austria (citing Soyka, 1946; 1955), Bulgaria, Yogoslavia and Greece (citing	*Cicadella viridis* *Delphacodes fairmairei* and *Juncus effuses* (citing Trjapitsyn, 1997) other Jassidae, Delphacidae and Odonata (citing Bakkendorf, 1926; Whalley, 1956)		Baquero & Jordano, 1999

	Donev, 1978; 1985a; 1985b), Japan, Korea and Bangladesh (citing Shad & Hiroshima, 1984), Poland and Turkmenistan (citing Trjapitsyn, 1997)			
Anagrus longithbulosus Possibly should be *Anagrus longitubulous*			Proposes the synonymy of *A. longitubulous* under *A. (paranagrus) perforator*	Triapitsyn, 2001(abstract only)
	China	***Nilaparvata lugens***	Found to be one of the dominant species in parasitoid communities in terms of numbers and importance as a control agent. All species in the parasitoid community, including the dominant species, fluctuated. Numbers were related to the numbers of the host and stage of rice growth. Parasitism rates in relation to rice growing period: early 76%, middle 70% and late 50%.	Mao et al, 2002b (Chinese – English Abstract)
Anagrus nilaparvatae Pang et Wang		***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus***	Prefers *N. lugens* over *S. furcifera- better survival rates and fecundity when emerging from N. lugens*	Lou & Cheng, 2001
	China	***Nilaparvata lugens***	The parasitoid's host preference is influenced by HIPVs	Xiang et al, 2008
	China	***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus*** *Sogatella vibix* (Haupt), *Soagtella longifurcifera* (Esaki and Ishihara), *Nilaparvata bakeri* (Muir), *Nilaparvata muiri* China, *Toya propinqua* (Feiber) and *Toya tuberculosa* (Distant)	Alternatives hosts are used by the parasite in winter *when N.lugens* is scarce (Citing Wand and Pang, 1986) Most common before early August mainly attacking *L. striatella* and S. furcifera (citing Xu and Cheng, 1988) Ideal temp: 27.41°C – fecundity and survival of immatures greatly reduced at high temperatures (citing Cheng & Xu, 1991)	Chiappini et al, 1998
	China	***Nilaparvata lugens***	Both *N. lugens* and A. *nilaparvata* more attracted to plants treated with jasmonic acid (JA) than to control plants. Treatment with JA also enhanced parasitism	Lou et al, 2005a
		Nilaparvata lugens	Plants had to be damaged by *N. lugens* feeding to be	Lou et al, 2005b

Comment [CSU4]: I cannot find anything searching Web of Science, CAB abstracts and google – assumed it should be *Anagrus longitubulous*

			more attractive to A. *nilaparvata* – females were not attracted to volatiles from undamaged hosts plants or those just mechanically damaged. Parasitoids were attracted most to intermediate host densities. Very high or low densities of host densities did not attract the parasitoids.	
		Nilaparvata lugens	Demonstrates ethylene signalling is involved in induction of plant volatiles by herbivory by *N. lugens.* Ethylene production by the plant is involved in regulating the amount and mix of induced volatiles (citing Huang et al, 2005).	Lu et al, 2006
	South China	***Nilaparvata lugens***	Parasitoid communities were steadier in IPM areas compared to non-IPM areas (presumably using conventional pesticide regimes). Temperature, species, number of species, distance from species pool, the host species present and the control regime employed all influenced the reestablishment and maintenance of the parasitoid communities.	Mao et al, 2002a
	China	***Nilaparvata lugens***	Found to be one of the dominant species in parasitoid communities in terms of numbers and importance as a control agent. All species in the parasitoid community, including the dominant species, fluctuated. Numbers were related to the numbers of the host and stage of rice growth. Parasitism rates in relation to rice growing period: early 76%, middle 70% and late 50%.	Mao et al, 2002b
	Guangdong, China	***Nilaparvata lugens*** ***Sogatella furcifera*** *Toya tuberculosa, Nilaparvata bakeri, Sogitella panicola* [*S. vibix*]*, T. propinqua*	A dominant parasitoid species – peaking in October and June Parasitism rate of *N. lugens*: 20-60% Parasitism rate of *S. furcifera*: 40.3-92.6%	Li & He, 1991 (in Chinese – English abstract)
		Sogatella furcifera	Displayed no preference for eggs of differing age but took longer to develop and body size and fecundity of the adult wasp decreased in older eggs. No effect was observed on sex ratio and emergence rate. Fecundity was associated with body size.	Zhu et al, 1993 (Chinese – English Abstract)

			Preferred *N. lugens* eggs over *S. furcifera* – in which bigger, more fecund wasps were produced – but development was slower.	
Anagrus optabilis Perkins Mao et al, 2002a seems to say that *A. paranilaparvatae* is a pseudonym of *A. optabilis* Triapitsyn, 2001 (abstract only), proposes the synonymy of *A. paranilaparvatae* under *A. optabilis* Synonyms: *Paranagrus optabilis* Perkins, *Paranagrus osborni* Fullway, *Anagrus panicolae* Sahad (Triapitsyn & Beardsley, 2000)	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Egg parasite	Rhandhawa et al, 2006
	Andhra Padesh and Tamil Nadu India Taiwan	***Nilaparvata lugens***		CAB International, 2005
	India	***Nilaparvata lugens***	*N. lugens* has a symbiotic relationship with *Candida* sp. The yeast disappears completely when parasitised by this particular parasitoid	Shankar & Baskaran, 1992 (abstract only)
	China	***Nilaparvata lugens*** ***Sogatella furcifera***	In rice fields and adjacent habitats Population dynamics (sex ratio, body size and parasitoid growth rate) were influenced by: host eggs, host plants of parasitoids and the surrounding habitat. The parasitoids obtained nutrients from nectar and pollen of the non-rice flowers.	Yu et al, 1996 (Chinese – English Abstract)
	China	*Toya* spp. and *Tagosodes pusanus*	Important egg parasitoid of delphacids in rice and non-rice habitats Habitat dominated by grasses close to paddy fields may act as a reservoir of parasitoids of rice planthoppers	Yu 1996 (Chinese – English Abstract)
	Thailand (citing Yasumatsu et al, 1975; Nishida et al, 1976)	***Nilaparvata lugens***	Egg parasite Important species - More abundant than *Paracentrobia yasumatsui* or a few other unidentified parasites. Parasitism rates <10% to 100% (citing Nishida et al, 1976)	Chiu, 1979
	Doi Saket, Lamphun, San Pa Tong, Chom Thong, Hot and Chai Nat, Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***	Parasitism rates varied from 100% in Doi Saket to 14.2% in Chai Nat	Hiroshima, 1979
	Malaysia	***Nilaparvata lugens***	*Anagrus* spp.: • turn host eggs orange or yellow orange and parasitoids can be seen through the transparent chorion • 20-60% parasitism rate	Watanabe et al, 1992
	Sri Lanka	***Nilaparvata lugens***	Parasitism rates of *Anagrus* spp. (*optabilis* and *flaveolus*): site B = 10%	Fowler et al, 1991

			Parasitism rates did not appear to be dependent on batch size and was also unrelated to host egg density at the tiller level but significantly positively related to the number of eggs per plant.	
	Tropical Asia	***Nilaparvata lugens***	Egg parasitoid	Reissig et al, 1986
		Nilaparvata lugens	Wasp parasitizes 15-30 eggs a day	Shepard et al, 2000
	Peninsular Malaysia	***Nilaparvata lugens***	Abundant	van Vreden & Ahmadzabidi, 1986
	Taiwan	***Nilaparvata lugens*** ***Laodelphax striatellus*** ***Sogatella furcifera***	*N. lugens*: 33.88% parasitism rate for egg masses and 19.56% for individual eggs from 9 localities *L. striatellus*: 45.90% parasitism rate for egg masses and 30.54% for individual eggs from 14 localities *S. furcifera*: 20-40% parasitism rate from 7 localities	Miura et al, 1981
	India	***Nilaparvata lugens***	Parasitized eggs collected from the insectary and rice fields. Egg parasitoid – symbiotic yeast (important for the planthoppers nutrition) decrease as parasites grow	Shankar & Baskaran, 1988
	Japan	***Nilaparvata lugens*** ***Laodelphax striatellus*** ***Sogatella furcifera***	*N. lugens*: 86.7% parasitism rate *L. striatellus*: 70.5% parasitism *S. furcifera*: 79.6% parasitism rate	Sahad , 1984
	Thailand	***Sogatella furcifera***	Important egg parasitoid	Miura et al, 1979
	Navarra, Spain Queensland, Australia (citing Perkins, 1905), Hawaii, Japan, Taiwan, Thailand and Bangladesh (citing Sahad & Hirashima, 1984), Malaysia, India, Sri lank, New Guinea, Indonesia, Mauritius, Philippines, Fiji, Samoa and Guam (citing Trjapitsyn, 1997), Ecuador (citing De Santis & Fidalgo, 1994),	***Nilaparvata lugens*** *Nilaparvata muiri* ***Laodelphax striatellus*** ***Sogatella furcifera*** *Saccharosdyne procerus* *Zulieca nipponica* and *Leersia japonica (citing Sahda & Hirashima)* *Perkinsella saccharicida* *Perkinsella thompsoni* and*Pundaloya simplica* (citing Chiappini, et al 1996)		Baquero & Jordana, 1999

	South Africa (citing Triapitsyn, 1997)			
	Thailand	***Nilaparvata lugens*** *Nephotettix* spp.		Wongsiri et al, 1980
	Queensland, Australia Hawaii, Philippines, Taiwan, Indonesia	*Perkinsella saccharicida* (Australia and Hawaii), *Kelisia emoloa* (Hawaii), leafhoppers (Indonesia), *Perkinsella vastatrix,* corn leahopper (Philippines), *Perkinsella* sp. (Taiwan)		Triapitsyn & Beardsley, 2000
	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982
Anagrus paranilaparvatae Pang & Wang Triapitsyn, 2001 (abstract only), proposes the synonymy of *A. paranilaparvatae* under *A. optabilis*	China	***Nilaparvata lugens***	Dominant species after mid-August mainly parasitising *N. Lugens* (citing Xu and Cheng, 1988) Ideal temp: 31.87°C - highest mortality at 18°C (citing Cheng & Xu, 1991)	Chiappini, 1998
	South China	***Nilaparvata lugens***	Parasitoid communities were steadier in IPM areas compared to non-IPM areas (presumably using conventional pesticide regimes). Temperature, species, number of species, distance from species pool, the host species present and the control regime employed all influenced the reestablishment and maintenance of the parasitoid communities. Seems to say that *A. paranilaparvatae* is a pseudonym of *A. optabilis*	Mao et al, 2002a
	China	***Nilaparvata lugens***	Found to be one of the dominant species in parasitoid communities in terms of numbers and importance as a control agent. All species in the parasitoid community, including the dominant species, fluctuated. Numbers were related to the numbers of the host and stage of rice growth. Parasitism rates in relation to rice growing period: early 76%, middle 70% and late 50%.	Mao et al, 2002b

	Jiangsu, China	***Nilaparvata lugens*** ***Sogatella furcifera*** ***Laodelphax striatellus***	Showed a preference for eggs of *N lugens* (I think this is in relation to *S. furcifera* and *L. striatella* but maybe also to *N. lugens* in other parts of the plant – not clear from abstract) located in the upper and middle parts of the plant and in tiller tissue.	Hu, 1992 (Chinese – English Abstract)
	Guangdong, China	***Nilaparvata lugens***		Li & He, 1991(Chinese – English Abstract)
Anagrus perforator Perkins Synoym: *Paranagrus perforator*	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Egg parasite	Rhandhawa et al, 2006
			Proposes the synonymy of *A. longitubulous* under *A. (paranagrus) perforator*	Triapitsyn, 2001(abstract only)
	Andhra Pradesh, India	***Nilaparvata lugens***	Egg parasite	CAB International, 2005
	Malaysia	***Sogatella furcifera***	*Anagrus* spp.: • turn host eggs orange or yellow orange and parasitoids can be seen through the transparent chorion • 47% maximum parasitism	Watanabe et al, 1992
	China	***Sogatella furcifera***		Chiappini, 1998
	China	***Nilaparvata lugens***	Found to be one of the dominant species in parasitoid communities in terms of numbers and importance as a control agent. All species in the parasitoid community, including the dominant species, fluctuated. Numbers were related to the numbers of the host and stage of rice growth. Parasitism rates in relation to rice growing period: early 76%, middle 70% and late 50%.	Mao et al, 2002b (Chinese – English Abstract)
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
	Fiji, Hawaii, Japan, Philippines	***Hirozuunka japonica, (Japan), Megamelus Proserpina, Nephotettix virescens, and Sogatella furcifera*** **(Philippines)**		Triapitsyn & Beardsley, 2000
Anagrus sp./spp.	Guangdong Province, China	***Nilaparvata lugens***	Common parasitoids found in that area	Ying, 1982

	China	***Sogatella furcifera***	Main natural enemy in early rice fields – May-July	Luo & Zhou, 1986 (Chinese – English Abstract)
	Taiwan, Japan (citing Lin, 1974; Fukuda, 1934; Kuno, 1973) Fukuoka, Japan (citing Kuno & Hokyo, 1970) and Malaysia (citing Heong (pers comm..)	***Nilaparvata lugens***	Egg parasite – when the parasite larvae was half grown parasitism can easily seen through the host egg's transparent chorion (citing Otake 1970) Parasitism rates 10%-15% (citing Kuno & Hokyo, 1970)	Chiu, 1979
	Taipai and Pingtung, Taiwan (citing Lin, 1974)	***Nilaparvata lugens***	Most prevalent (93% in Taipei) of egg parasitoids among myramids and trichogrammatids (citing Lin, 1974)	Chui, 1979
	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera*** *Nephotettix virescens* (Distant)	Most common genera of mymarid parasitoid When adult lands on rice plant it walks quickly all over it, drumming on the surface with their antennae. When they find a host egg mass they drum more energetically close to the eggs. Oviposition occurs by the wasp first drilling through the leaf epidermis. The drumming appears to be involved in locating the eggs and finding a suitable place to drill. Failure rate is high: 95% attempts fail to penetrate and of those that do 89% do not successfully oviposit in an egg. When parasite density is high 1-3 eggs laid but only one will develop. The parasitised egg expends rapidly to several times the original size – hatch after 2 days, transparent, instar - moults at one day – turns yellowish which can then be seen within the host egg – pupates within 24hrs – pupa: bright orange-red turning brown, larvae wiggle lots within the egg to break up the host tissue for ingestion - pupation takes 6-7 days – adults emerge from host eggs 11-13 days after oviposition – males emerge first Parthenogentic (whether males or females emerge depends on the species – see also *A. flaveoulus* and *A.* nr. *flaveolus* enteries) and gametogenetic reproduction Females lived 2-6 days in lab conditions – but did not oviposit after 3 days	Chandra, 1980

			Longevity did not affect fecundity because most of the eggs laid within 24hrs.	
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	Indonesia	***Nilaparvata lugens***	Low to higher rates of parasitism in wet season and more uniform higher levels in dry seasons. Several species	Claridge et al, 1999
		Nilaparvata lugens	Common egg parasitoid	Ooi & Shepard, 1994
	Vietnam	***Sogatella furcifera***	Egg parasitoid with 72.5% parasitism	Tao & Ngoan, 1970
	Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***	Dominant egg parasite of *S.furcifera* in north and Central Plain and of *N. lugens* in the Central Plain (found not to attack leafhoppers)	Vungsilabutr, 1981
	India		listed as an important natural enemy of planthoppers	Pasalu et al, 2004
			Studied the effect of Bt transgenic rice on the dispersal of planthoppers, leafhoppers and their egg parasitoid wasps. *Anagrus* spp. tended to disperse towards block of non- transgenic rice	Chen et al, 2003 (Chinese – English abstract)
	India	***Nilaparvata lugens***	Along with *Oligosita* sp. – the most common parasitoids of *N. lugens*	Gupta & Pawar, 1989 (abstract only)
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
	Japan, Fiji, Korea, Malaysia, Philippines, Sri Lanka, Thailand, Taiwan, Vietnam	***Sogatella furcifera*** ***Nilaparvata lugens*** *Nephotettix cincticeps* *Nephotettix nigropicta* *Nephotettix virescens*	Dominant genus of Mymaridae in rice fields Which hosts are affected varies in different countries (see p.375)	Greathead, 1982
	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981

	Zhejiang, China	***Sogatella furcifera***	The draining of rice fields at the 8-9 leaf stage of the first crop and 12-13 leaf stage of the 2nd crop reduced number of eggs laid and hatching and therefore resulted in lower populations of the host and encouraged nautrual enemies - parasitism rates of *S. furcifera* by *Anaphes* sp. was 9.5% lower	Zhang, 1991 (Chinese, English abstract)
Anaphes taprobanicum		***Nilaparvata lugens***	Egg parasite	CAB International, 2005
Anaphes spp/ sp.	Solomon Islands (citing MacQuillan, 1974)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981
Gonatocerus sp.	Thailand (citing Yasumatsu et al, 1975)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979
	Korea (citing Yasumatsu, personal communication)	***Nilaparvata lugens***		Ôtake, 1977
	Philippines	Specific to *Nephotettix virescens*		Chandra, 1980
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
	Thailand	*Nephotettix virescens* *Nephotettix nigropictus*	Was found not to attack *N. lugens* or *S. furcifera*	Vungsilabutr, 1981
	India		listed as an important natural enemy of planthoppers	Pasalu et al, 2004
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
	Thailand	***Nilaparvata lugens***		Wongsiri et al, 1980
	Korea, Philippines, Taiwan, Thailand	*Nephotettix cincticeps* *Nephotettix virescens*	Usually the most abundant mymarid egg parsitoid	Greathead, 1982
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***		Chu & Hirashima, 1981
Lymaenon sp.	Taiwan (citing Lin, 1974	***Nilaparvata lugens***	Egg parasite	Chiu, 1979

Lymaenon longicrus	Saxian county, Fujian province	Planthoppers	Abstract does not identify the host/s involved Graminaceous weeds important for overwintering natural enemies	Lo & Zhou, 1980 (Chinese – English Abstract)
Mymar? Indica Mani	Taiwan (citing Loin, 1974 and Chiu et al, unpubl.)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979
	India			Gupta & Poorani, 2008
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***		Chu & Hirashima, 1981
Mymar taprobanicum Ward	Thailand (citing , Yasumatsu et al 1975)	***Nilaparvata lugens***	Egg parasite Important species (citing Yasumatsu et al 1975)	Chiu, 1979
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	van Vreden & Ahmadzabidi, 1986
	India, East and Far East, Korea and probably many other countries		Suggests *M. indica* is synonymous with *M. taprobanicum*	Subba Rao, 1976
	Sri Lanka			Gupta & Poorani, 2008
	Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***		Wongsiri et al, 1980
Mymar sp.	Philippines	***Nilaparvata lugens***	Rare	Chandra, 1980
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
Polynema sp.	Thailand (citing , Yasumatsu et al 1975)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979
Family: Pteromalidae				
Panstenon sp	Saxian county, Fujian province	Planthoppers	Abstract does not identify the host/s involved Graminaceous weeds important for overwintering natural enemies	Lo & Zhou, 1980 (Chinese – English Abstract)
Family: Scelionidae				
Baeus sp.	Mandya (Karnataka), India	***Nilaparvata lugens***	Egg parasite	Manjunath et al, 1978

Comment [CSU5]: This genus appear mainly to parastise spiders

Gryon sp.	Mandya (Karnataka), India	***Nilaparvata lugens***	Egg parasite	Manjunath et al, 1978
Oxyscella sp.	Mandya (Karnataka), India	***Nilaparvata lugens***	Egg parasite	Manjunath et al, 1978
Family: Trichogrammatidae Egg parasites (Chandra, 1980)				
Alphelinoidae sp.	Taiwan (citing Fukada, 1934)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979
	Taiwan		Egg parasitoid	Ya u-i & Hirashima, 1981
Oligosita aesopi Girault	Malaysia	***Sogatella furcifera***	*Oligosita* spp.: • turn host eggs dark yellow and chorion is dark grey and so parasitoids cannot be seen >5% parasitism rate	Watanabe et al, 1992
	China	***Nilaparvata lugens*** ***Sogatella furcifera***	In rice fields and adjacent habitats Population dynamics (sex ratio, body size and parasitoid growth rate) were influenced by: host eggs, host plants of parasitoids and the surrounding habitat. The parasitoids obtained nutrients from nectar and pollen of the non-rice flowers.	Yu et al, 1996 (Chinese – English Abstract)
	China	*Toya* spp. and *Tagosodes pusanus*	Important egg parasitoid of delphacids in rice and non-rice habitats Habitat dominated by grasses close to paddy fields may act as a reservoir of parasitoids of rice planthoppers	Yu 1996 (Chinese – English Abstract)
		Nilaparvata lugens	Parasitizes 2-8 eggs a day	Shepard et al, 2000
	Tropical Asia	***Sogatella furcifera***	Egg parasitoid	Reissig et al, 1986
Oligosita naias Girault	Tamil Nadu, India	***Nilaparvata lugens***	Egg parasite	CAB International, 2005
	China	*Toya* spp. and *Tagosodes pusanus*	Important egg parasitoid of delphacids in rice and non-rice habitats Habitat dominated by grasses close to paddy fields may act as a reservoir of parasitoids of rice planthoppers	Yu 1996 (Chinese – English Abstract)
	China	***Nilaparvata lugens*** ***Sogatella furcifera***	In rice fields and adjacent habitats Population dynamics (sex ratio, body size and parasitoid	Yu et al, 1996 (Chinese – English Abstract)

			growth rate) were influenced by: host eggs, host plants of parasitoids and the surrounding habitat. The parasitoids obtained nutrients from nectar and pollen of the non-rice flowers.	
	Philippines; Australia-Queensland; India-Andhra Pradesh; India-Karnataka; India-Orissa; India-Tamil Nadu; Malaysia; Peoples' Republic of China-Zhejiang	***Nilaparvata lugens***		http://www.catalogueoflife.org/show_species_details.php?record_id=4533017
	Muda area, Malaysia	***Nilaparvata lugens***	*Oligosita* spp.: • turn host eggs dark yellow and chorion is dark grey and so parasitoids cannot be seen 34-68% parasitism rate	Watanabe et al, 1992
		Nilaparvata lugens	Wasp parasitizes 2-8 eggs a day.	Shepard et al, 2000
	India	***Sogatella furcifera***	Egg parasite	Rhandhawa et al, 2006
Oligosita nepholettica Mani	Saxian county, Fujian province	Planthoppers	Abstract does not identify the host/s involved Graminaceous weeds important for overwintering natural enemies	Lo & Zhou, 1980 (Chinese – English Abstract)
	Indonesia	***Nilaparvata lugens***		Claridge et al, 1999
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Listed in this paper as *Oilogsita nephotetticum* but almost certainly a 'typo' Egg parasite	Chu & Hirashima, 1981
Oligosita Shibuyae	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981
Oligosita tachikawai	Andhra Pradesh, India	***Nilaparvata lugens***	Egg parasite	CAB International, 2005
Oligosita yasumatsuii Viggiani et Subba Rao	Andhra Pradesh, India	***Nilaparvata lugens***	Egg parasite	CAB International, 2005
	Peninsular Malaysia	***Nilaparvata lugens***	Abundant	van Vreden & Ahmadzabidi, 1986
		Nilaparvata lugens	Common egg parasitoid	Ooi & Shepard, 1994

	Tropical Asia	***Laodelphax striatellus***		Reissig et al, 1986
	Indonesia	***Nilaparvata lugens***		Claridge et al, 1999
	Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***		Wongsiri et al, 1980
Oligosita sp./spp.			Drumming the surface of the rice leaves and oviposition occurs in a similar manner to *Anagrus* spp. (see that section). Dissecting the host eggs is not a good method of determining parasitisation because larvae and pupae of the wasp is very delicate and easily destroyed. Larvae within the egss are difficult to observe as they do not wiggle much. Hatched larvae are light yellow, becoming brighter when they pupate – 5 days after oviposition the pupae, with pink eyes and body segments, can be observed easily through the chorion. Parasitised eggs are discernable becasue they retain a lemon yellow colour with a black band at the base. Adults emerge 11-12 days after oviposition – males emerge first. Most of the females eggs laid on first day after emergence Mating results in all females Less active as less fecund than mymarids	Chandra, 1980
	Sri Lanka	***Nilaparvata lugens***	More abundant than the *Anagrus* spp. parasitising the host. Parasitism rates: site A = 18% and site B = 32.7% Parasitism rates did not appear to be dependent on batch size and was also unrelated to host egg density at the tiller level but significantly positively related to the number of host eggs per plant.	Fowler et al, 1991
	Mandya (Karnataka), India	***Nilaparvata lugens***	Egg parasite	Manjunath et al, 1978
	Thailand (citing Yasumatsu, 1975), Taiwan (citing Lin, 1974)	***Nilaparvata lugens***	Egg parasite Effective at suppressing pest populations (citing Yasumatsu, 1975)	Chiu, 1979
	Chiand Dao and Mae Theng, Thailand			Hiroshima, 1979
	Guangdong	***Nilaparvata lugens***		(no citation for this

				addition)
	Peninsular Malaysia	***Nilaparvata lugens***	Less abundant	van Vreden & Ahmadzabidi, 1986
	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
	Indonesia	***Nilaparvata lugens***	50% reduction on egg hatching of BPH when plants were exposed to the activity of the parasitoids.	Claridge, 1996
	Indonesia	***Nilaparvata lugens***	Low to higher rates of parasitism in wet seasons and more uniform higher levels through dry seasons.	Claridge et al, 1999
	Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***	Two species of Oligosita were found, one only affected the leafhoppers (*N. virescens* and *N. nigropictus*) and the otheronly affected the planthoppers	Vungsilabutr, 1981
	India		listed as an important natural enemy of planthoppers	Pasalu et al, 2004
	India	***Nilaparvata lugens***	Along with *Anagrus* sp. – the most common parasitoids of *N. lugens*	Gupta & Pawar, 1989 (abstract only)
	Philippines (Los Baños, Cabanatuan, Bayombing, Kiangan and Banaue)		Not specific about which parsites were affecting which planthoppers or leafhoppers (N. lugens and S.furcifera found in all locations along with Nephotettix virescens, Nephotettix nigropictus and Recilia dorsalis)	Heong et al, 1992
	In all SE Asia areas Fiji, India, Korea, Malaysia, Philippines, Solomon Is.,Sri Lanka, Thailand, Taiwan	***Nilaparvata lugens*** ***Sogatella furcifera*** *Nephotettix cinciteps* *Nephotettix nigropicicta* *Nephotettix virescens*	Of equal importance to *Anagrus* spp. and dominats where there is multiparasitism and can be more abundant (citing IRRI, 2978)	Greathead, 1982
	South Africa	*Numicia viridis*		Dick & Thompson, 1969
	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981
	South Africa and Swaziland	*Numicia viridis*	Associated with sugar cane and wild grasses	Charleston et al, 2003
Paracentrobia andoi Ishii Synonym: *P.*	Taiwan and Japan (citing Suenaga; Lin, 1974)	***Nilaparvata lugens***	Egg parasite Parastism rate extremely low	Chiu, 1979
		Nilaparvata lugens	Egg parasite	CAB International,

japania (Chu & Hirashima, 1981)				2005
	Saxian county, Fujian province	Planthoppers	Abstract does not identify the host/s involved Graminaceous weeds important for overwintering natural enemies	Lo & Zhou, 1980 (Chinese – English Abstract)
	Taiwan	***Nilaparvata lugens***	The female of the parasitoid attacked almost all the eggs when she came in contact with an egg mass of the hopper.	Miura et al, 1979
	Tropical Asia	***Nilaparvata lugens***	Egg parasitoid	Reissig et al, 1986
		Nephotettix cinticeps	Under lab conditions found that the eggs of *N. lugens*, *S. furcifera* and *L. striatellus* were not parasitised	Vungsilabutr et al, 1996 (abstract only)
	Japan and Taiwan		Replaces *Oligosita* spp.	
	Taiwan	*Nephotettix cincticeps* *Nephotettix nigropictus* *Nephotettix virescens* ***Nilaparvata lugens***	Egg parasite	Chu & Hirashima, 1981
Paracentrobia garuda Subba Rao	Thailand (citing Yasumatsu et al, 1975)	***Nilaparvata lugens***	Egg parasite Effective at suppressing pest populations (citing Yasumatsu, 1975)	Chiu, 1979
		Nilaparvata lugens	Egg parasite	CAB International, 2005
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	Van Vreden & Ahmadzabidi, 1986
	Thailand	***Nilaparvata lugens***		Wongsiri et al, 1980
	Thailand	*Nephotettix virescens* *Nephotettix nigropictus*	Was found not to attack *N. lugens* or *S. furcifera*	Vungsilabutr, 1981
Paracentrobia yasumatsui Subba Rao	Thailand (citing Yasumatsu et al, 1975)	***Nilaparvata lugens***	Egg parasite Effective at suppressing pest populations (citing Yasumatsu, 1975)	Chiu, 1979
		Nilaparvata lugens	Egg parasite	CAB International, 2005
	Peninsular Malaysia	***Nilaparvata lugens***	Less common	Van Vreden & Ahmadzabidi, 1986
	Thailand	***Nilaparvata lugens***		Wongsiri et al, 1980
Stephanodes sp.	Philippines	***Nilaparvata lugens***	Reared on BPH	Barrion et al, 1981
Trichogramma sp.	Taiwan (citing Fukuda, 1934)	***Nilaparvata lugens***	Egg parasite	Chiu, 1979

*Major parasites of *N. Lugens* according to Ooi & Shepard (1994)

TABLE 2. ORDER: STREPSIPTERA

Nymphal-adult parasites (Chandra, 1980)

Hosts are not killed quickly but the parasitoid develops within the host allowing it to continue to damage the crop (Chandra, 1980)

Favoured wetland environment – parasitism higher in rainy seasons – but mostly below 10% - higher rates rare and only occurred in *N. lugens* (Chandra, 1980)

Species name	Distribution Country/ region	Hosts	Notes (parasitism rates, alternative hosts, time of year, other information)	Reference (publication in English unless indicated otherwise)
Family: Elenchidae				
Elenchus japonicas Esaki &Hashimoto Alternative spelling: *E. japonicus*	Japan (citing Esaki & Hashimoto, 1932; Esaki, 1932; Sakai, 1932; Okada, 1973; Kuno 1973)	***Nilaparvata lugens***		Chiu, 1979
	Guangdong Province, China	***Nilaparvata lugens***	A common parasitoid species found in that area	Ying, 1982
	Japan	***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
	Shimane, Japan	***Nilaparvata lugens*** ***Laodelphax striatellus*** ***Sogatella furcifera***	Parasitism rate of delphacids (predominantly *S. furcifera*): 0.1-26.7%, staring in July and highest in August	Kitamura, 1987 (Japanese – English abstract (have full text))
	India	***Nilaparvata lugens*** ***Sogatella furcifera***	Nymph and adult parasite	Rhandhawa et al, 2006
Elenchus koebelei Pierce	Fiji (citing Hinckley, 1963)	***Nilaparvata lugens***	Occasionally parasitised *N. lugens*	Chiu, 1979
		Nilaparvata lugens	Nymph and adult parasite	CAB International, 2005
Elenchus yasumatsui Kefune & Hirashima*	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***	In *N. lugens*: parasitism rates of N. lugens relatively low in wet (1.4%) and dry season (5.5%) In *S. furcifera*: highest parasitism rate of 26% in March Overall parasitism rates relatively low in wet (7.4%) and dry seasons (9.8%)	Peña & Shepard, 1986
	Philippines	***Nilaparvata lugens***	10% parasitisation rate	Dayanan & Esteban, 1996 (abstract only)
		Nilaparvata lugens		Ooi & Shepard, 1994
	Thailand (citing Kifune	***Nilaparvata lugens***		

Comment [CSU6]: This genus appear to be very important as control agents

	& Hirashima, 1975; Otake, 1976)			
		Nilaparvata lugens	Females wingless, life-span 1 to 2 months, do not emerge fully from host (just the head outside) Males winged, lifespan 1-2 days, emerge and seek out females Somehow they mate and produce 500 to 2000 triungulins or larvae They do not oviposit in the host but the tiny C-shape triungulins out the host and bore inside	http://www.ctpm.uq.edu.au/software/riceipm/keys/Html/Elenchus.htm
	Sarawak	***Nilaparvata lugens***		Hirashima, 1978
	Thailand and Sarawak	***Sogatella furcifera***		Hiroshima, 1979
	northern Thailand (citing Yasumatsu et al, 1975)	***Nilaparvata lugens***	Plays a significant in control of *N. lugens* (citing Yasumatsu et al, 1975) Parasitism rates 30% - 90% (citing FAO, 1975)	Chiu, 1979
	Philippines	***Nilaparvata lugens*** ***Sogatella furcifera***	Viviparous – females produce 1000-2000 triungulins – 0.15mm long, light yellow, slightly curved, well developed eyes, legs and casudal setae – crawl and jump – in lab most die within an hour – enter host by piercing intersegmental membranes - shrink and transform into cylindrical legless larvae – 7 instars – males pupuate with anterior end poking out of the hosts abdomen – famle pupates within the host – adult males emerge out of the host and mate with adult females via the cepholothrax which is exposed. Parasitised host's have: smaller genitalia, an extended abdomen and discoloured bodies as well as having the male parasitoids extruding from their abdomens and the females cephelothorax visible. Host and females adults die soon after triungulins have emerged. Hosts vacated by males are vulnerable to disease via the hole left. Showed preference for *N. lugens* over *S. furcifera* in the field	Chandra, 1980
	Tropical Asia	***Laodelphax striatellus***	Nymph and adult parasitoid	Reissig et al, 1986
	Thailand	***Nilaparvata lugens*** ***Sogatella furcifera***		Wongsiri et al, 1980

Elenchus sp/spp.	Sri Lanka (citing Santa et al., unpublished)	***Nilaparvata lugens***	Hosts are rendered sterile (citing Kuno, 1973)	Chiu, 1979
	India	***Nilaparvata lugens***	*N. lugens* has a symbiotic relationship with *Candida* sp. The yeast load declined considerably when parasitised by this parasitoid	Shankar & Baskaran, 1992 (abstract only)
	Sri Lanka	***Sogatella furcifera***	The extrusion of a puparium containing a male pupa or the opening of an adult female on the abdomen of the host is conspicuous as an external symptom of its parasitism. 40% parasitism rates reached – but was not persistent and failed to control the population of planthoppers	Ôtake et al, 1976
	Fiji, India, Indonesia, Japan, Philippines, Solomon Is., Sri Lanka, Thailand	***Sogatella furcifera*** ***Nilaparvata lugens*** *Nephotettix virescens*		Greathead, 1982
	Malaysia	***Sogatella furcifera*** ***Nilaparvata lugens***	Claims *S. furcifera* and *N. lugens* were the two main planthoppers causing much damage in Malaysia. Suggests little was known about parasitoids of planthoppers at that time	Ooi, 1982

TABLE 3. ORDER: DIPTERA

Species name	Distribution Country/ region	Hosts	Notes (parasitism rates, alternative hosts, time of year, other information)	Reference (publication in English unless indicated otherwise)
Family: Pipunculidae Nymphal-adult parasites (Chandra, 1980) Favoured dryland environments (Chandra, 1980) No effective pipunculid parasitoid of N. lugens (Greathead, 1982)				
Dorylas sp.	Sri Lanka (citing Santa et al, unpublished)	***Nilaparvata lugens***		Chiu, 1979
Pipunculus javanensis de Meijere	Taiwan (citing Chiui et al, unpublished)	***Nilaparvata lugens***	low parasitism rates (citing Chiu, 1974)	Chiu, 1979
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Taiwan	*Nephotettix cincticeps*	Nymphs and adults parasite	Chu & Hirashima,

		Nilaparvata lugens		1981
Pipunculus mutillatus		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
	India	***Nilaparvata lugens***	Nymph and adult parasite	Rhandhawa et al, 2006
	Thailand	*Nephotettix nigropictus* *Nephotettix virescens*		Wongsiri et al, 1980
	Taiwan	*Nephotettix cincticeps*	Nymphs and adults parasite	Chu & Hirashima, 1981
Pipunculus orientalis		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
Pipunculus roralis		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
Pipunculus Sp.	Sri Lanka, Taiwan	***Nilaparvata lugens*** *Nephotettix cincticeps* *Nephotettix virescens*		Greathead, 1982
	Taiwan	*Nephotettix cincticeps* *Nephotettix nigropictus* *Nephotettix virescens*	Nymphs and adults parasite	Chu & Hirashima, 1981
Tomosvaryella epichalca Perkins	Taiwan (citing Chiui et al, unpublished)	***Nilaparvata lugens***	low parasitism rates (citing Chiu, 1974)	Chiu, 1979
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
Tomosvaryella oryzaetoral Koizumi	India	***Nilaparvata lugens***	Nymph and adult parasite	Rhandhawa et al, 2006
	Taiwan (citing Chiui et al, unpublished)	***Nilaparvata lugens***	low parasitism rates (citing Chiu, 1974)	Chiu, 1979
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Zhejiang, Jiangxi, Fujian, Hubei	Green leafhopper		(no citation for this addition)
	Thailand	*Nephotettix nigropictus* *Nephotettix virescens*		Wongsiri et al, 1980
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981

Tomosvaryella subvirescens Loew	Taiwan, Thailand (citing Chiui et al, unpublished; Yasumatsu et al 1975)	***Nilaparvata lugens***	Important parasite of planthoppers and leafhoppers in Thailand – but population lower than in temperate countries In Taiwan – low parasitism rates (citing Chiu, 1974)	Chiu, 1979
		Nilaparvata lugens	Nymphs and adults parasite	Cab International, 2005
	Thailand	*Nephotettix nigropictus* *Nephotettix virescens*		Wongsiri et al, 1980
	Taiwan	*Nephotettix cincticeps* ***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981
Tomosvaryella sylvatica		***Nilaparvata lugens***	Nymphs and adults parasite	Cab International, 2005
	Taiwan	***Nilaparvata lugens***	Nymphs and adults parasite	Chu & Hirashima, 1981

TABLE 4. ORDER: HEMIPTERA

Species name	Distribution Country/ region	Hosts	Notes (parasitism rates, alternative hosts, time of year, other information)	Reference (publication in English unless indicated otherwise)
Family: Anthocoridae				
Orius tantillus Motschulsky		***Nilaparvata lugens***	Nymph and adult parasite – this is listed in this reference as a parasitoid but other sources suggest it is a predator	CAB International, 2005

Comment [CSU7]: This species was listed by CABI as a parasitoid but other sources suggest it is a predator

Shankar & Baskaran (1988), in India, also report they frequently observed a mite belonging to the family Trombidiidae as a nymph and adult parasitoid of *N. lugens* .

Table 5. Parasitoids of ***Cnaphalocrocis medinalis*** (Guenée).

Species name	Family	Distribution Country/ region	Notes (parasitism rates, alternative hosts, time of year, other information)	Reference (publication in English unless indicated otherwise)
HYMENOPTERA				
Apanteles anagleit	Braconidae	India	Larval parasite	Randhawa et al, 2006
Apanteles angustibasis	Braconidae	India	Larval parasite	Randhawa et al, 2006
Apanteles opacus Ashmead	Braconidae	Peninsular Malaysia	Abundant parasitoid	van Vreden & Ahmadzabidi, 1986
Apanteles cypris	Braconidae	Taiwan	Host stage – larva Present in wet and dry seasons	Chou, 1981
	Braconidae	Peninsular Malaysia	Common parasitoid	van Vreden & Ahmadzabidi, 1986
	Braconidae	India	Larval parasite	Randhawa et al, 2006
Apanteles opacus	Braconidae	India	Larval parasite	Randhawa et al, 2006
Apanteles syleptae	Braconidae	India	Larval parasite	Randhawa et al, 2006
Apanteles sp.	Braconidae	Madurai district, India	Larval parasitoid	Rani et al, 2007
Apanteles sp. ater group	Braconidae	India	Larval parasitoid	Pati & Mathur, 1982
Bracon sp.	Braconidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Bracon gelechiae	Braconidae	India	Larval parasitoid	Randhawa et al, 2006

Bracon hebetor	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Bracon ricinicola	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Cardiochiles philippinensis Ashmead[2]	Braconidae	Laguna, Philippines	Larval parasitoid - Present in wet and dry seasons	de Kraker et al, 1999
			Parasitism peaked at 28°C	Runjie et al, 1996 (abstract only)
			Common in dryland and wetland rice environments	http://www.knowledgebank.irri.org/Beneficials/Scientific_name_Cardiochiles_philippinensis_Ashmead_64.htm
		Philippines	Larval parasitoid	Ooi and Shepard, 1994
		Madurai district, India	Larval parasitoid	Rani et al, 2007
		Philippines	Very important larval parasitoid based on field collection and rearings	Barriion et al, 1991
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			Enters folded leaves and lays a single egg on leaffolder larva	Shepard et al, 2000
		India	Larval parasitoid	Randhawa et al, 2006
Cardiochiles laevifossa	Braconidae	Taiwan	Host stage – larva Present in wet and dry seasons	Chou, 1981
Cardiochiles sp.	Braconidae	Peninsular Malaysia	Less common parasitoid	van Vreden & Ahmadzabidi, 1986
Chelonus munakatae Munakata	Braconidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Cotesia agilis Ashmead	Braconidae		Hosts: hesperiid and rice leaffolder larvae (not sure if this means *C. medinalis or not)*	Barrion & Litsinger, 1994 p.209
Cotesia cypris Nixon	Braconidae	Tropical Asia	Larval parasitoid	Reissig et al, 1986
Cotesia flavipes	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Cotesia opacus Ashmead	Braconidae		Alternative host: *Herpetogramma stultalis*	Barrion & Litsinger, 1994 p.207

Cotesia ruficrus	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Cotesia angustibasis Gahan[2]	Braconidae		Alternative hosts: *Marasmia* spp.	Barrion & Litsinger, 1994 p.207
		Philippines	Larval parasitoid	Ooi and Shepard, 1994
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
		Peninsular Malaysia	Common parasitoid	van Vreden & Ahmadzabidi, 1986
		India	Larval parasitoid	Pati & Mathur, 1982
			Lays more than 10 eggs inside each leaffolder larval host. The hatched wasp larvae feed on the internal tissues of the host larva, eventually killing it. When ready to pupate, they leave the dead host and spin white cocoons nearby.	Shepard et al, 2000
Cotesia spp.	Braconidae	Philippines	Host stage – larva Present in wet and dry seasons	de Kraker et al, 1999
		Philippines	Larval parasitoid	de Kraker, 1996
		Philippines		Barrion et al, 1991

Habrobacon sp.	Braconidae	India	Larval parasitoid	Pati & Mathur, 1982
Kriechbaumerella sp.	Braconidae	India	Pupal parasitoid	Pati & Mathur, 1982
Macrocentrus philippinensis Ashmead[2]	Braconidae	India	Extracts of *Saccharrum offinarum* (sugarcane), *Cajanus cajan* (pigeonpea), *Oryza sativa* (rice), *Ricinus communis* (castor oil plant) and *Vigna sinensis* (field pea) affects parasitism and emergence (I do not know what host was used)	Shankarganesh & Khan, 2006 (abstract only)
			Alternative hosts: *Marasmia* spp.	Barrion & Litsinger, 1994 p.213
			Larval parasitoid	Ooi and Shepard, 1994
		Laguna, Philippines	Larval parasitoid – Present in wet and dry seasons	de Kraker et al, 1999
		India	2.0% parasitism rate	Rani et al, 2007
		Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			Laid single egg on host larva and hatched as a single parasitoid larva	Shepard et al, 2000

Meteorus bacoorensis	Braconidae	India	Larval parasitoid	Randhawa et al, 2006
Opius sp.	Braconidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Orgilus ashmeadii Viereck	Braconidae		Alternative hosts: *Marasmia* spp.	Barrion & Litsinger, 1994 p.205
Orgilus sp.	Braconidae	Philippines	Moderately important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Tropobracon schoenobii Viereck	Braconidae	Philippines	Moderately important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Goniozus indicus	Bethylidae	India	Larval parasitoid	Randhawa et al, 2006
Goniozus nr. *triangulifer* Kieffer[2]	Bethylidae		Alternative hosts: *Marasmia* leaffolders	Barrion & Litsinger, 1994 p.184
		Philippines	Larval parasitoid	Ooi and Shepard, 1994
		Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
			The wasp enters folded leaf and paralyzes the host larva before laying 3-8 eggs outside its body. The early-stage parasitoid larvae feed externally on leaffolder larva and then kill their host .	Shepard et al, 2000
Goniozus triangulifer Kieffer	Bethylidae	India	Larval parasitoid	Randhawa et al, 2006
Goniozus triangulus	Bethylidae	India	Larval parasitoid	Randhawa et al, 2006
Goniozus sp.	Bethylidae	Madurai district, India	Larval parasitoid 4.9% parasitism rate	Rani et al, 2007
		Philippines	Larval parasitoid	de Kraker, 1976
Brachymeria excarinata Gahan	Chalcididae	Peninsular Malaysia	Less common parasitoid	van vreden & Ahmadzabidi, 1986
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			Parasitizes older leaffolder larva	Shepard et al, 2000
		India	Larval /pupal parasitoid	Randhawa et al, 2006
Brachymeria lasus (Walker)	Chalcididae		Parasitizes older leaffolder larva	Shepard et al, 2000
		India	1.5% parasitism on pupal host	Bharati & Kushwaha, 1988
		India	Pupal parasitoid	Randhawa et al, 2006
Brachymeria tacardiae	Chalcididae	India	Pupal parasitoid	Randhawa et al, 2006

Brachymeria sp. cf. *tarsalis* (Motschulsky)	Chalcididae	Peninsular Malaysia	Less common parasitoid	van Vreden & Ahmadzabidi, 1986
Brachymeria sp./spp.	Chalcididae	Madurai district, India	Larval parasitoid 6.5% parasitism rate	Rani et al, 2007
			Parasitizes older leaffolder larva	Shepard et al, 2000
		Philippines	Very important larval-pupal parasitoid based on field collection and rearings	Barrion et al, 1991
Trachichospilus pupivora	Chalcididae	India	Pupal parasitoid	Randhawa et al, 2006
Elasmus brevicornis	Elasmidae	India	Larval parasitoid	Randhawa et al, 2006
Elasmus claripennis	Elasmidae	India	Larval parasitoid	Randhawa et al, 2006
Elasmus philippinensis Ashmead	Elasmidae	Peninsular Malaysia	Larval parasitoid	van Vreden & Ahmadzabidi, 1986
		India	Larval parasitoid	Randhawa et al, 2006
Elasmus sp./spp.	Elasmidae	Philippines	Larval parasitoid	de Kraker, 1996
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			One or two eggs are laid in each young or old larva. They are highly aggressive and will kill other parasitoid larvae, which may be developing inside the leaffolder host.	Shepard et al, 2000
		Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Copidosoma sp.	Encyrtidae	India	Egg parasite	Encyrtidae
Copidosomopsis nacoleiae Eady[1]	Encyrtidae		Alternative hosts: *Marasmia* spp., *Hedylepta indicata*	Barrion & Litsinger, 1994 p.266
		Philippines	Egg-larval parasitoid	Ooi and Shepard, 1994
			Larval parasitoid – present in wet and dry seasons	de Kraker et al, 1999
		Madurai district, India	Larval parasitoid 3.1% parasitism rate	Rani et al, 2007
		Philippines	Egg-larval parasitoid	de Kraker, 1996
		Philippines	Very important egg-larval parasitoid based on field collection and rearings	Barrion et al, 1991

			200-300 wasps are produced from a few host eggs and hundreds of wasp pupae can be seen through the skin of the host larva	Shepard et al, 2000
		Tropical Asia	Egg-larval parasitoid	Reissig et al, 1986
		India	Egg parasite	Randhawa et al, 2006
Tetrastichus ayyari Rohwer[2]	Euplophidae	Philippines	Pupal parasitoid	Ooi and Shepard, 1994
Tetrastichus howardi Olliff (=*ayyari* Rohwer)	Eulophidae	Philippines	Not important pupal parasitoid based on field collection and rearings	Barrion et al, 1991
		India	Pupal parasitoid	Randhawa et al, 2006
Tetrastichus israelensis	Euplophidae	India	Pupal parasitoid	Randhawa et al, 2006
Tetrastichus schoenobii Ferriere	Eulophidae	Philippines	Not important larval-pupal parasitoid based on field collection and rearings	Barrion et al, 1991
Tetrastichus sp.	Eulophidae	Philippines	Pupal parasitoid	de Kraker, 1996
Stenomesius sp.	Eulophidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Aphanogmus fijiensis	Ichneumonidae	India	Larval parasitoid	Randhawa et al, 2006
Barylypa apicala	Ichneumonidae	India	Larval parasitoid	Randhawa et al, 2006
Charops brachypterum Cameron	Ichneumonidae		Alternative hosts: *Marasmia* spp., *S.innotata*	Barrion & Litsinger, 1994 p.227
		Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Charops nigrita Gupta & Maheswary	Ichneumonidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Diatora lissonata	Ichneumonidae	India	Larval parasitoid	Randhawa et al, 2006
Eribborus argenteopilosus	Ichneumonidae	India	Larval/pupal parasitoid	Randhawa et al, 2006
Eriborus sinicus (Holmgren)	Ichneumonidae	India	Larval/pupal parasitoid	Randhawa et al, 2006
		Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Ischnojoppa luteator (Fabricius)	Ichneumonidae	Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		India	Larval/pupal parasitoid	Randhawa et al, 2006

Itoplectis narangae (Ashmead)	Ichneumonidae	Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
			A solitary hunter, can locate larvae inside stems	Shepard et al, 2000
Leptobatopsis indica	Ichneumonidae	India	Larval parasitoid	Randhawa et al, 2006
Stictopisthus sp.	Ichneumonidae	Philippines	Not important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Temelucha basimacula	Ichneumonidae	India	Larval parasitoid	Randhawa et al, 2006
Temelucha biguttula Manakata	Ichneumonidae		Alternative hosts: *C. suppressalis, Naranga diffusa, Bradina admixtalis*	Barrion & Litsinger, 1994 p.225
		Guangdong Province, China	A common parasitoid species found in that area	Ying, 1982
		India	Larval parasitoid	Randhawa et al, 2006
Temelucha philippinensis Ashmead[2]	Ichneumonidae		Alternative hosts: *C. suppressalis, Marasmia* spp.	Barrion & Litsinger, 1994 p.225
		Philippines	Larval parasitoid	Ooi and Shepard, 1994
			Larval parasitoid – present in wet and dry seasons	de Kraker et al, 1999
		Guangdong Province, China	A common parasitoid species found in that area	Ying, 1982
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			Hunts leaffolder larva during the day	Shepard et al, 2000
		Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		India	Larval parasitoid	Randhawa et al, 2006
Temelucha stangli Ashmead	Ichneumonidae		Alternative hosts: *Scirpophaga* spp., *Marasmia* spp.	Barrion & Litsinger, 1994 p.225
		Guangdong Province, China	A common parasitoid species found in that area	Ying, 1982
		Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
		India	Larval parasitoid	Randhawa et al, 2006
Trathala flavo-orbitalis (Cameron)	Ichneumonidae	Philippines	Moderately important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		India	Larval/pupal parasitoid	Randhawa et al, 2006
Trichomma	Ichneumonidae		Alternative hosts: *Marasmia* spp., *Ostrinia furnacalis*	Barrion & Litsinger, 1994

cnaphalocrosis Uchida[2]				p.225
		Philippines	Larval parasitoid	Ooi and Shepard, 1994
			Larval/pupal parasitoid – present in wet and dry seasons	de Kraker et al, 1999
		Madurai district, India	Larval parasitoid 10.4% parasitism rate	Rani et al, 2007
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
		Philippines	Very important larval parasitoid based on field collection and rearings	Barrion et al, 1991
		Tropical Asia	Larval parasitoid	Reissig et al, 1986
			Preferred older larva; a single wasp larva develops and pupates within its host	Shepard et al, 2000
Xanthopimpla flavlineata Cameron[2]	Ichneumonidae		Alternative hosts: *C. supressalis, S. inferens, P. Mathias, Telicota augias*	Barrion & Litsinger, 1994 p.215
		Philippines	Pupal parasitoid	Ooi and Shepard, 1994
		Madurai district, India	Pupal parasitoid 0.7% parasitism rate	Rani et al, 2007
		India	Pupal parasitoid with 20-23.3% parasitism rate	Bharati & Kushwaha, 1988
		India	Pupal parasitoid	Pati & Mathur, 1982
		Philippines	Not important pupal parasitoid based on field collection and rearings	Barrion et al, 1991
		India	Pupal parasitoid	Randhawa et al, 2006
Trichomalopsis apanteloctena (Crawford)	Pteromalidae	Philippines	Not important pupal parasitoid based on field collection and rearings	Barrion et al, 1991
Telenomus digmus	Scellionidae	India	Egg parasite	Randhawa et al, 2006
Trichogramma chilonis Ishii,	Trichogrammatidae	Pakistan	Neem seed kernel extract and *Bacillus thurigiensis* may also be used to enhance its efficacy of the parasitoid	Sagheer et al, 2008
		India	Alternative hosts: *Helicoverpa armigera*, *Spodoptera litura* and *Papilio demoleus* (out of these preferred *H. armigera*)	Budhwant et al, 2008 (abstract only)
		India	Extracts of *Saccharrum offinarum* (sugarcane), *Cajanus cajan* (pigeonpea), *Oryza sativa* (rice), *Ricinus communis* (castor oil plant) and *Vigna sinensis* (field pea) affects parasitism and emergence (I do not know what host was used)	Shankarganesh & Khan, 2006 (abstract only)
		India	Indundative release provided effective protection against *Scirpophaga incertulas* and C. Medinalis with 100,000/ha better than lower doses	Kumar & Khan, 2005 (abstract only)
Trichogramma	Trichogrammati	India	Indundative release provided effective protection against	Kumar & Khan, 2005

japonicum Ashmead[1]	dae		*Scirpophaga incertulas* and C. Medinalis with 100,000/ha better than lower doses	(abstract only)
		Philippines	Egg parasitoid Alternative host: *Chilo supressalis* (citing Sweezey, 1931)	Ooi and Shepard, 1994
		Japan, Hawaii	Alternative host: *Chilo simplex*	Sweezey, 1931
		Guangdong Province, China	A common parasitoid species found in that area	Ying, 1982
		Philippines	Egg parasitoid	de Kraker, 1996
		Philippines	Moderately important egg parasitoid based on field collection and rearings	Barrion et al 1991
Trichogramma poliae		India	Extracts of *Saccharrum offinarum* (sugarcane), *Cajanus cajan* (pigeonpea), *Oryza sativa* (rice), *Ricinus communis* (castor oil plant) and *Vigna sinensis* (field pea) affects parasitism and emergence (I do not know what host was used)	Shankarganesh & Khan, 2006 (abstract only)
Trichogramma sp./spp.	Trichogrammatidae	India	Used for inundative biocontrol – listed as an important natural enemy of leaf folder	Pasalu et al, 2004
		Madurai district, India	Egg parasite 9.3% parasitism rate	Rani et al, 2007
		Tropical Asia	Egg parasitoid	Reissig et al, 1986
		Philippines	Very important egg parasitoid based on field collection and rearings	Barrion et al, 1991
		Philippines	Egg stage mortality in the field averaged about 60% due to parasitism	de Kraker, 1996
DIPTERA				
Megaselia scalaris	Phoridae	India	Larval parasitoid	Randhawa et al, 2006
Megaselia sp.	Phoridae	Philippines	Moderately important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Argyrophylax fransseni Baranov	Tachinidae	Peninsular Malaysia	Reared as parasitoid from *C. medinalis*	van Vreden & Ahmadzabidi, 1986
Argyrophylax nigrotibialis (Baranov)	Tachinidae	Philippines	Moderately important larval parasitoid based on field collection and rearings	Barrion et al, 1991
Chaetexorista javana	Tachinidae	India	Larval parasitoid	Randhawa et al, 2006
Nemorilla floralis	Tachinidae	India	Larval parasitoid	Randhawa et al, 2006
Zygobothria ciliata	Tachinidae	Philippines	Moderately important larval parasitoid based on field	Barrion et al, 1991

Comment [CSU8]: Not sure if this parasitoid affects this pest

(Wulp)			collection and rearings	

[1] Important according to Ooi and Shepard (1994) [2] common according to Ooi and Shepard (1994)

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Comment [CSU9]: Does not distingui between these two references

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