Survey of Australian Parasitoids of Pink Bollworm, *Pectinophora gossypiella*: a feasibility study for biological control of this pest in the Southwestern USA.

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Pink Bollworm, *Pectinophora gossypiella* is a key pest of cotton in Northeastern Mexico, Arizona, & California (see inset). Pink Bollworm feeds on cotton bolls reducing both yield and quality of the lint. The introduction of transgenic Bt cotton varieties has resulted in more effective control of pink bollworm, while simultaneously reducing broadspectrum insectide use. As a result, classical biological control agents for control of pink bollworm are more likely to establish and be effective. Recent studies by Gordh (Univ. of Queensland) indicate that *P. gossypiella* is native to northern Australia.

Several *Gossypium* spp. are native to northern and western Australia (Table 1). Upland cotton, *Gossypium hirsutum* is not native but naturalized over much of this area. Many new species of cotton have recently been discovered in the Kimberley in Western Australia (Fig 1). Many of these new species are located in Mitchell Plateau of the Kimberley (Fig 2). It is likely that many of these plant species are suitable hosts for *P. gossypiella*. Pink Bollworm could have a suite of undiscovered natural enemies that are associated with native *Gossypium* spp.

Table 1. *Gossypium* species in Australia

Gossypium australe F.Muell
Gossypium bickii Prokh
Gossypium costulatum Tod.
Gossypium enthyle Fryxell,Craven & J.M.Stewart)
Gossypium exiguum Fryxell,Craven & J.M.Stewart
Gossypium exiguum Fryxell,Craven & J.M.Stewart
Gossypium londonerriense Fryxell,Craven & J.M.Stewart
Gossypium marchantii Fryxell,Craven & J.M.Stewart
Gossypium nelsonii Fryxell
Gossypium nobile Fryxell,Craven & J.M.Stewart
Gossypium pilosum Fryxell
Gossypium pulchellum (C.A.Gardner)Fryxell
Gossypium robinsonii F.Muell.

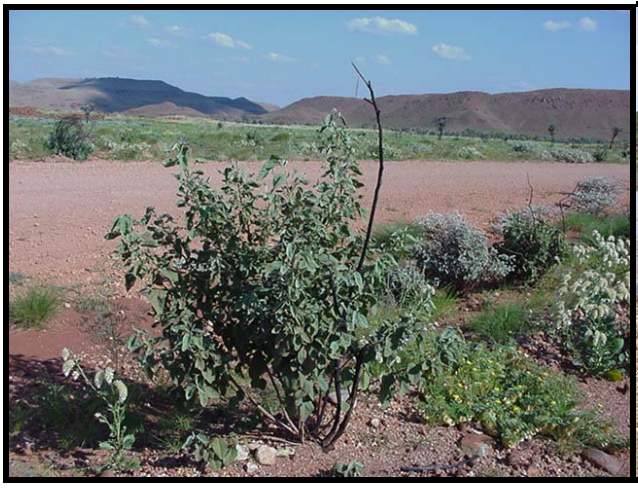
Gossypium rotundifolium Fryxell,Craven & J.M.Stewart
Gossypium sturtianum J.H.Willis

***Gossypium australe*, Darwin, NT**

***Gossypium rotundifolia*, Broome, WA**

***Gossypium sturtiantum*, Exmouth, WA**

***G. hirsutum* as green mulch, Kununura, WA**



***Gossypium australe*, Chichester, WA**

Goolsby & Sands, feral cotton, Woolner Station, NT

Fig. 1. *Gossypium* species in northern Australia that are hosts of pink bollworm, *Pectinophora gossypiella*.

Fig 2. Map of Australia showing major collecting areas in red.

Preliminary field surveys of the parasitoid complex attacking *P. gossypiella* were conducted in Northern Australia. Four surveys were conducted in 2000-01. In October 2000 John Goolsby, Don Sands (CSIRO) collected from feral cotton and wild hosts and in the Darwin and Kimberley regions. Dr. Sands had conducted a similar study in the 1970's for the University of California. Mr. Graham Schultz (Northern Territory DPI, Darwin) traveled with us to several known sites with feral cotton. Mr. Schultz has continued to the feral cotton and makes shipments of infested cotton bolls to ABCL for evaluation. In July 2000 John Goolsby and Alan Kirk (EBCL) surveyed sites in Darwin and Kimberley and across to Broome in northwest Australia. This survey focused on wild hosts including many of the indigenous *Gossypium* species. We were aided by Roweena Eastick (CSIRO Cotton CRC, Kununurra, WA) who monitors the indigenous *Gossypium* spp. for potential hybrids with transgenic cotton. In February 2001

John Goolsby and Ryan Zonneveld surveyed the Kimberley and Darwin Region during the monsoon season. *Pectinophora gossypiella* populations peak during this time as many of the wild host plants are flowering. In Kununurra, WA we collected hundreds of *P. gossypiella* from cotton being grown through the summer as a green mulch. It is unusual to find cotton during this time of year because commercial cotton production has shifted to a winter growing season to avoid pest pressure. Cotton grown in the summer monsoon season represents an excellent opportunity to survey and recover parasitoids of *P. gossypiella.* We were aided in Kununurra by John Moulden, Kimberley Entomologist with Western Australia Agriculture. Mr. Moulden and his colleague Amanda Annells provide research and extension services to local growers and are interested in future collaboration that involves cotton pests. In May 2001, John Goolsby and Alan Kirk surveyed the Pilbara region. Several *Gossypium* species occur in this area including several native species such as *G. australe, G. rotundifolia,* and *G. sturtiantum*. Each species flowers at different times of the year providing a succession of suitable hosts for *P. gossypiella*. In summary, *Gossypium hirsutum* and its native congeners occur across a wide range of habitats and climates in Australia. Quarterly sampling would be needed to target flowering and boll set for each species.

The target, *P. gossypiella* occurs over this entire range moving between wild and feral hosts, but reaching highest densities on *G. hirsutum*. Several species of parasitoids are associated with *P. gossypiella* with a wide range of biologies (Table 2). It is likely that some species attack early larval instars and emerge from late larvae or pupae. Many larvae fall to the ground and pupate. We did not sample pupae in the soil, but expect there would be another suite of parasitoids that attack this stage of the pest. Host exposures at or below the soil surface would be best for sampling parasitoids with this type of biology.

Table 2. Parasitoid reared from pink bollworm in Australia

Host Plant	Host Insect	Parasitoid	Location
Gossypium hirsutum *Gossypium australe*	*Pectinophroa gossypiella* *Pectinophroa gossypiella*	*Apantales* nr. *oenone*	Kununura, WA
Gossypium hirsutum	*Pectinophroa gossypiella*	*Apantales* sp. *novum*	Darwin, NT
Gossypium hirsutum	*Pectinophroa gossypiella*	*Brachymeria* sp.	Woolner Station, NT

Understanding the biology of the parasitoids is critical to predicting their impact in the cotton agro-ecosystem. Another aspect of biology that should be investigated is host range. Only parasitoids with a narrow field host range should be considered in a biological control program. A unique opportunity is available to study field host range of the parasitoids attacking *P. gossypiella*. A related gelechiid moth, *Evippe* sp. originally collected from Mesquite, *Propospis* sp. in the Argentina has been released in northern Australia in the same habitat as *P. gossypiella*. By surveying the parasitoids on both the native and introduced gelechiid moths we can learn a great deal about their host ranges. *Evippe* species in North America would be a critical non-target species if an Australian parasitoid was released in the southwestern U.S. 'mesquite belt'.

Dr. Steve Naranjo and Dr. John Goolsby met in August at the Practice of Biological Control Symposium to discuss future prospects for the research program. It was proposed that future research should entail both field and laboratory studies. Fieldwork would involve continued exploration for *Pectinophora* parasitoids in the Darwin, Kimberley and Pilbara regions. Field research would also include an assessment of field host range for the common parasitoids. Laboratory research would focus on the biology of the key parasitoid species. Standard artificial diets would be used to rear the *Pectinophora scutigera* and/or *P. gossypiella* used in the biological studies of the parasitoid. Evaluation would focus on the ability of *Apantales* sp. and other candidate parasitoid species to parasitize both early instars of *P.*

gossypiella on the surface of the boll and/or latter instars that have tunneled inside. (Parasitoids with this type of biology would be most suited to the cotton agroecosystem in southwestern U.S.) Parasitoid species that target the correct host stage and have a sufficiently narrow host range would be forwarded to collaborators in the US for final quarantine screening and field release. Further research is contingent upon funding.

Appendix

Survey Records for *Pectinophora* program

Coll. #	Date	Host	Site	State	Country
2000854	7/20/2000	Hsp	Berimbah	NT	AUSTRALIA
2000855	7/21/2000	Hsp	18 12th St. and Anzac Mem, Katherine	NT	AUSTRALIA
2000856	7/21/2000	Hsp	Timber Creek	NT	AUSTRALIA
2000857	7/25/2000	Hsp	60km E Fitzory Crossing	WA	AUSTRALIA
2000858	7/25/2000	Hsp	260 Flynn St	WA	AUSTRALIA
2000859	7/24/2000	Hsp	Hall's Creek	WA	AUSTRALIA
2000860	7/25/2000	Hsp	Derby	WA	AUSTRALIA
2000861	7/25/2000	Gau	Derby	WA	AUSTRALIA
2000862	7/26/2000	Hrs	Short St	WA	AUSTRALIA
2000863	7/26/2000	Grt	Barred Creek	WA	AUSTRALIA
2000864	7/26/2000	Hpn	Willie Creek	WA	AUSTRALIA
2000865	7/27/2000	Gau	Thangoo	WA	AUSTRALIA
2000866	7/27/2000	Hpn	Cape Latouche Treville	WA	AUSTRALIA
2000867	7/27/2000	Gau	10km inland from Cape Latouche Treville	WA	AUSTRALIA
2000874	8/20/2000	Ghr	Douglas River	NT	AUSTRALIA
2000875	8/20/2000	Ghr	Douglas River	NT	AUSTRALIA
2000876	8/20/2000	Ghr	Beatrice Hill	NT	AUSTRALIA
2000877	8/20/2000	Ghr	Woolner Station	NT	AUSTRALIA
2000878	8/20/2000	Ghr	Woolner Station	NT	AUSTRALIA
2000879	8/18/2000	Ghr	East Arm Point	NT	AUSTRALIA
2000880	8/21/2000	Ghr	Elsey Station	NT	AUSTRALIA
2000881	8/21/2000	Ghr	Elsey Station	NT	AUSTRALIA
2000882	8/14/2000	Ghr	Bowen Strait	NT	AUSTRALIA
2000883	8/14/2000	Ghr	Smith Point	NT	AUSTRALIA
2000884	8/24/2000	Hrs	Timber Creek	NT	AUSTRALIA
2000891	10/7/2000	Htl	Durack, WA Ag. Station	WA	AUSTRALIA
2000892	10/8/2000	Hsp	Ivanhoe Falls	WA	AUSTRALIA
2000893	10/8/2000	Gau	Kununura	WA	AUSTRALIA
2000894	10/9/2000	Hrs	Timber Creek	NT	AUSTRALIA
2000895	10/9/2000	Gau	East of Timber Creek	NT	AUSTRALIA
2000896	10/11/2000	Ghr	Elsey Station	NT	AUSTRALIA
2000897	10/11/2000	Ghr	Daly River	NT	AUSTRALIA
2000898	10/11/2000	Ghr	Woolner Station	NT	AUSTRALIA
2000899	10/11/2000	Ghr	Lee's Point	NT	AUSTRALIA
2001806	2/26/2001	Hsp	Kununura	WA	AUSTRALIA
2001807	2/26/2001	Ghr	Packsaddle	WA	AUSTRALIA

2001808	2/26/2001	MALV	The Grotto	WA	AUSTRALIA
2001809	2/27/2001	Ghr	Packsaddle	WA	AUSTRALIA
2001810	2/28/2001	Ghr	Woolner Station	NT	AUSTRALIA
2001811	3/1/2001	Ghr	Elsey Station	NT	AUSTRALIA
2001812	3/1/2001	Hpn	Salt Creek	NT	AUSTRALIA
2001813	3/1/2001	Gau	Salt Creek	NT	AUSTRALIA
2001814	3/2/2001	Ghr	Lee's Point	NT	AUSTRALIA
2001815	3/2/2001	Hrs	9 Pinehurst St.	NT	AUSTRALIA
2001828	5/2/2001	TAap	Geraldton	WA	AUSTRALIA
2001829	5/3/2001	ARdo	440 Roadhouse	WA	AUSTRALIA
2001830	5/5/2001	UNDET	Murchison	WA	AUSTRALIA
2001831	5/4/2001	ARdo	Carnarvon Caravan Park	WA	AUSTRALIA
2001832	5/4/2001	ABlp	50 km E Carnarvon	WA	AUSTRALIA
2001833	5/4/2001	UNDET	Ashburton River	WA	AUSTRALIA
2001834	5/5/2001	dung	50km E Nanatarra	WA	AUSTRALIA
2001835	5/5/2001	ABlp	60 km E Nanutarra	WA	AUSTRALIA
2001836	5/5/2001	Grb	Gum Tree Creek	WA	AUSTRALIA
2001837	5/5/2001	ABlp	10km E Gum Tree Creek	WA	AUSTRALIA
2001838	5/5/2001	Grb	Beasley River	WA	AUSTRALIA
2001839	5/5/2001	Grb	Tom Price	WA	AUSTRALIA
2001840	5/6/2001	GDst	Fortescue Campground	WA	AUSTRALIA
2001841	5/6/2001	GDst	Weamo Gorge	WA	AUSTRALIA
2001842	5/7/2001	GDst	Roebourne Rd	WA	AUSTRALIA
2001843	5/7/2001	Hpn	Hooley Station	WA	AUSTRALIA
2001844	5/7/2001	Gau	Python Pool	WA	AUSTRALIA
2001845	5/7/2001	Gst	on road near Exmouth	WA	AUSTRALIA
2001846	5/7/2001	Gst	Shothole Canyon	WA	AUSTRALIA
2001847	5/9/2001	dung	Knife Canyon	WA	AUSTRALIA
2001848	5/9/2001	dung	100 km N Minilya	WA	AUSTRALIA
2001891	10/29/2001	Ghr	Lee's Point	NT	AUSTRALIA

ABlp	*Abutilon lepidum*
ARdo	*Arundo donax*
Gau	*Gossypium australe*
Ghr	*Gossypium hirsutum*
Grb	*Gossypium robinsoni*
Grt	*Gossypium rotundifolia*
Gst	*Gossypium stuartiantum*
GDst	*Goodenia stobbsiana*
Hpn	*Hibiscus panduriformis*
Hrs	*Hibiscus rosa-sinensis*
Htl	*Hibiscus tiliaceus*
Hsp	*Hibiscus* sp.
MALV	Undet Malvaceae
TAap	*Tamarix aphylla*
UNDET	Undet aquatic plant
dung	cow dung