Potential agents for the biological control of *Tecoma stans* (L.) Juss ex Kunth var. *stans* (Bignoniaceae) in South Africa

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Tecoma stans (L.) Juss ex Kunth var. *stans* (Bignoniaceae), known as yellow bells, was introduced into South Africa as an ornamental plant and now invades roadsides, urban open spaces, watercourses and rocky sites in the subtropical and tropical areas of six South African provinces, and neighbouring countries. Although deemed to be an 'emerging weed', *Tecoma stans* has considerable potential to extend its range because it is still common in South African gardens and its seeds are easily dispersed by wind. Mechanical and chemical control methods are not economically feasible as the plant tends to re-grow, thus requiring expensive follow-up treatments. Biological control research on *T. stans* has been ongoing since 2003, when pathogens were the focus as agents, with insects included since 2005. Five candidate agents have so far been tested in South Africa, with one, *Clydonopteron sacculana* Bosc (Lepidoptera: Pyralidae), deemed unsuitable for release, one, *Prospodium transformans* (Ellis & Everh.) Cummins (Pucciniales: Uropyxidaceae), released initially in November 2010, and another, *Pseudonapomyza* sp. (Diptera: Agromyzidae), currently awaiting approval for release by the regulatory authorities. One candidate agent, *Mada polluta* (Mulsant) (Coleoptera: Coccinellidae), is still under investigation in quarantine. The last potential agent, a root-feeding flea beetle, *Dibolia* sp. (Coleoptera: Chrysomelidae), was brought into South Africa but the culture did not establish in quarantine.

Key words: yellow bells, incipient weeds, host specificity, potential impact.

INTRODUCTION

Tecoma stans (L.) Juss ex Kunth var. *stans* (Bignoniaceae) (Fig. 1), commonly known as yellow bells, is an evergreen shrub or small tree that has a wide natural distribution in the tropical and subtropical parts of central Mexico and South Florida, spreading southwards through Central America, the Caribbean and South America as far as northern Argentina (Gentry 1992). In Mexico, *T. stans* flowers have been used to yield honey and the roots have been used to brew beer. It has also been used as a traditional medicinal plant (Pelton 1964).

Tecoma stans is commonly planted as an ornamental in warmer climates throughout the world because of its showy yellow flowers and pinnate foliage (Pelton 1964). It has become invasive in several countries, including Argentina, Brazil, Australia and South Africa (Hussey *et al.* 1997; Henderson 2001; Smith 2002; Vitorino *et al.* 2003). Henderson (2001) regards *T. stans* as a 'potential transformer' which has already invaded natural or semi-natural habitats and has the ability to become dominant or even to form dense monocultures, thereby altering ecosystem structure, integrity and functioning. In Australia, *T. stans* grows in dense stands which inhibit regeneration of indigenous species (Smith 2002), while in south-eastern Brazil it invades pasture land (Vitorino *et al.* 2003).

Introduction and distribution in South Africa

Tecoma stans was introduced into South Africa as an ornamental plant and is now naturalized throughout the country (Fig. 2), occurring frequently in five provinces namely Gauteng, Mpumalanga, Limpopo, KwaZulu-Natal (KZN) and the Eastern Cape, and rarely in the North West and Western Cape. It also occurs in neighbouring countries, *e.g.* Swaziland and Mozambique (Henderson 2001) and has the potential to extend its range because its light, winged seeds are easily dispersed by wind.

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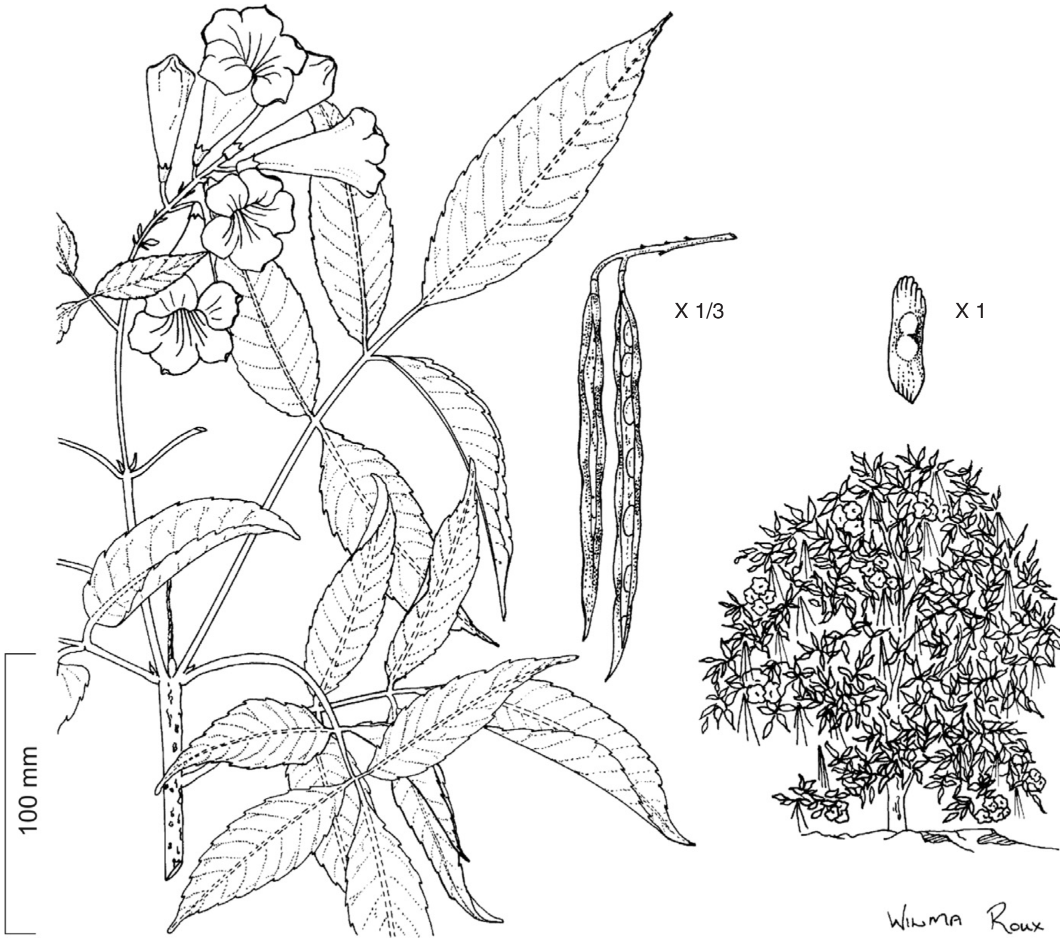

Fig. 1. *Tecoma stans.* (Drawn by W. Roux, first published in Henderson (1995), ARC-Plant Protection Research Institute, Pretoria.)

Origin and taxonomy

The Bignoniaceae is a cosmopolitan family comprising approximately 800 species in 110 genera. The greatest diversity occurs in the Neotropics where five of the eight previously recognized tribes are found, and where the family probably originated (Gentry 1980). The Tecomeae, to which *Tecoma* and all but one African species, *Kigelia africana* (Lam.) Benth., were assigned (Gentry 1980), has recently been shown to be paraphyletic, consisting of four distinct clades: the Neotropic *Jacaranda* and relatives clade; the Tecomeae *s. str.* (predominantly Neotropic); the Neotropic *Tabebuia* and relatives clade; and a Paleaotropic clade (Gentry 1980). The latter includes all African and Madagascan members of the family, except for the two species of *Tecoma* from Africa, *Tecoma capensis* (Thunb.) Lindl. and *Tecoma nyassae* Oliv., and the genus *Podranea* (with two species restricted to southern Africa) which are grouped in the Tecomeae *s. str.* (Olmstead *et al.* 2009). This suggests that African members of the family have originated from at least two distinct natural dispersal events from the Neotropics, one ancient and one relatively recent.

The genus *Tecoma* comprises 14 species, with two in Africa and the rest in the Americas. Two distinct pollination guilds occur in the genus, a bee-pollinated group which includes the wide-ranging and morphologically diverse *T. stans* var. *stans* (hereafter referred to as *T. stans*), and several geographically distinct variants (two given variety status and three separated as species), and a bird-pollinated group consisting of eight species from South

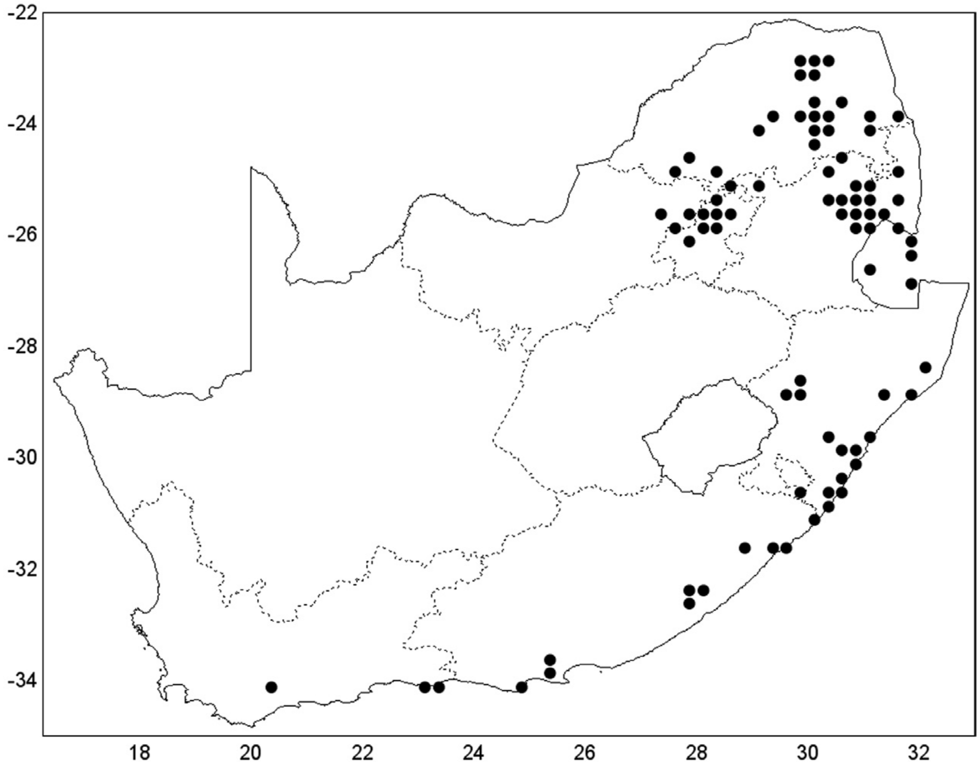

Fig. 2. Distribution of *Tecoma stans* in South Africa. (Drawn by L. Henderson; data source: SAPIA database, ARC-Plant Protection Research Institute, Pretoria.)

America and the two African species (Gentry 1992). The African species have at times been segregated as the genus *Tecomaria,* or as two subspecies of *T. capensis* (*e.g.* Leistner 2005).

Tecoma stans (Fig. 1) is a morphologically variable, densely-leafed shrub to small tree that is approximately 2–6 m tall, occasionally up to 10 m in height and up to 25 cm in stem-diameter (Gentry 1992). Descriptions of the plant are provided by Pelton (1964), Gentry (1992), and Henderson (2001). The leaves are 100–200 mm long with a bright green adaxial surface and a pale abaxial surface. There are 3–13 pinnate leaflets and the margins are serrate. Up to 20 flowers occur in racemes, each bright yellow, showy, faintly striated and trumpet-shaped and up to 58 mm long. The fruits comprise shiny brown, elongated capsules 70–210 mm long (Gentry 1992).

Biology and ecology

Throughout its native and exotic distributions, *T. stans* grows in a wide range of climatic conditions, from the high-rainfall tropics to semi-arid areas, and in various soil types. It generally requires full sunlight and is intolerant of heavy frost, but can invade forest margins and disturbed forest (Pelton 1964; PIER 2010). In South Africa it invades roadsides, urban open spaces, watercourses and rocky sites in subtropical and tropical savanna (Henderson 2001). Flowering of *T. stans* varies from being seasonal to year-round, resulting in the production of large quantities of viable seed. The seeds have papery wings and are effectively dispersed by wind (Pelton 1964; Henderson 2001), sometimes for many kilometres (Pelton 1964). Besides wind dispersal, *T. stans* is spread by down-slope rain-wash, mammals and birds (Pelton 1964). The plant's wide ecological tolerance and high dispersal capability will most certainly enable it to continue to invade and increase in importance in South Africa.

Tecoma stans coppices vigorously when felled and needs to be controlled by a combination of mechanical and chemical means, but this is labour-intensive and expensive and therefore unlikely to be widely applied in South Africa. Furthermore, there are no registered herbicides for *T. stans* in South Africa (Xact Information 2005; The Registrar 2007). Zimmermann *et al.* (2004) consider biological control to be the most sustainable, inexpensive and environmentally-friendly method of controlling *T. stans* in South Africa. Therefore, *T. stans* is among a group of incipient or 'emerging weeds' which have been targeted for biological control by the Plant Protection Research Institute (ARC-PPRI), since 2003 (Olckers 2004). This paper is a review of the biological control programme against *T. stans*, since its inception.

POTENTIAL BIOLOGICAL CONTROL AGENTS

Surveys for potential biological control agents for *T. stans* were initiated in 2003 and continued until 2007 in the southern U.S.A., Mexico, Puerto Rico and northwestern Argentina where a number of natural enemies were identified (Table 1). The following five species were deemed to be the most promising potential biological control agents for *T. stans* in South Africa: *Pseudonapomyza* sp. (Diptera: Agromyzidae); *Prospodium transformans* (Ellis & Everh.) Cummins (Pucciniales: Uropyxidaceae); *Mada polluta* (Mulsant) (Coleoptera: Coccinellidae); *Clydonopteron sacculana* Bosc (Lepidoptera: Pyralidae); and *Dibolia* sp. (Coleoptera: Chrysomelidae). All were investigated, and, with the exception of *Dibolia* sp., were successfully reared under quarantine conditions.

Pseudonapomyza sp. (Diptera: Agromyzidae)

A species of *Pseudonapomyza*, a leaf-mining fly, was brought into quarantine in 2005 from near San Pedro, northwestern Argentina (Table 1). After several attempts to have the fly identified, it was found to be an undescribed species. The flies proliferated and produced a strong colony in quarantine and inflicted substantial damage on *T. stans* plants.

The biology and host specificity of *Pseudonapomyza* sp. was determined in quarantine (Madire 2010). *Pseudonapomyza* sp. females used their ovipositor to puncture holes in the mesophyll tissue of the soft upper leaf surface of *T. stans* and then inserted their eggs. The females then fed on exudates which oozed from the punctures. After hatching, the emerging larvae started feeding, causing linear, whitish mines in the leaf tissue and releasing black frass within the mines as the tunnels increased in volume (width and length) as the larvae developed. At an early stage, the mines were linear, but became curved and twisted as the larvae developed. Eventually, the mines coalesced to form a large dry blotch.

The adults mated within 24 hours of emerging and females laid eggs after a pre-oviposition period of 2–3 days. The egg stage was 2–6 days and the larval period 6–11 days. Pupation occurred within the mine and lasted 8–13 days. Adult longevity was 6–9 days for males and 8–12 days for females, each of which produced 29–47 mines in the next generation.

Host-specificity testing involved adult no-choice tests and adult multiple-choice tests. The no-choice tests were conducted in individual nylon gauze cages with potted plants of 37 test species, in a quarantine greenhouse. The adult multi-choice tests were conducted in a walk-in-cage in a quarantine tunnel with potted plants of six bignoniaceous species: *Kigelia africana* (Lam.) Benth; *Markhamia zanzibarica* (Bojer ex DC.) K. Schum; *Pyrostegia venusta* (Ker Gawl) Miers; *Tabebuia impetiginosa* Mart. ex DC.; *T. stans;* and *T. capensis.* Of the 37 plant species included in the adult no-choice tests, only two species (*T. stans,* as a control, and *T. capensis*) had eggs laid on them by the *Pseudonapomyza* sp. females. There was no larval mine development on *T. capensis.* The adult multi-choice test results showed no feeding or oviposition on tests plants other than *T. stans.*

In a pre-release impact study under quarantine conditions (Madire 2010), high density levels of *Pseudonapomyza* sp. infestation reduced the above-ground biomass of *T. stans* by 55 % compared to the undamaged controls. Below-ground biomass was reduced by 23 % and 48 % under low and high density levels of infestation, respectively.

Because of the demonstrated high level of host specificity and potential efficacy of *Pseudonapomyza* sp. on *T. stans,* an application for its release was submitted to the regulatory authorities and permission for release is pending.

Prospodium transformans (Pucciniales: Uropyxidaceae)

Prospodium is a Neotropical genus of rust fungi with about 50 species parasitizing predominantly members of the Bignoniaceae, but also a few species of Verbenaceae (both Lamiales) (Cummins & Hiratsuka 2003). Until recently, three species of

Table 1. Potential biological control agents for use against *Tecoma stans.*

Order/Family	Potential agents	Locality	Coordinates	Damage inflicted	Year	Status
Pucciniales: Uropyxidaceae	*Prospodium appendiculatum**	Southern U.S.A.	26°05′20″N 97°51′45″W	Galls and leaf pustules	2005	Culture established. No further testing at present.
Pucciniales: Uropyxidaceae	*Prospodium appendiculatum**	Mexico	23°36′41″N 109°46′55″W	Galls and leaf pustules	2005	Culture established. No further testing at present.
Pucciniales: Uropyxidaceae	*Prospodium appendiculatum**	Northwestern Argentina	22°44′42.″S 65°01′49″W	Galls and leaf pustules	2005	Culture established. No further testing at present
Pucciniales: Uropyxidacea	*Prospodium abortivum**	Puerto Rico	18°24′6″N 66°13′59″W	Leaf pustules	2005	Not cultured
	Prospodium transformans	Mexico: South-West of Tuxtla Gutierrez Chiapas	16°37′0″N 93°5′0″W	Galls	2003	Released Nov. 2010
Pucciniales: Uropyxidaceae		Mexico: Jalisco	20°24′39.4″N 102°44′36.2″W	Galls	2007	
		Mexico: Jalisco	20°39′55.5″N 103°24′29.1″W	Galls	2007	
		Mexico: Michoacan	19°58′4.2″N 101°42′35.2″W	Galls	2007	
		Mexico: Guerrero	17°49′16.1″N 99°27′26.5″W	Galls	2007	Released Nov. 2010
		Mexico: Guerrero	17°33′4.1″N 99°25′38.7″W	Galls	2007	Released Nov. 2010
Lepidoptera	Moth*	San Pedro, Mexico	21°10′22″N 99°19′39.″W	Leaf feeder	2005	No culture
Lepidoptera	*Clydonopteron sacculana* larvae# Culture terminated	Mexico: Baja California	23°47′0.85″N 109°55′0.06″W	Seed feeder	2005	
	Clydonopteron sacculana larvae#	Southern U.S.A.	23°52′0.15″N 109°32′0.9″W	Seed feeder	2005	Culture terminated
Lepidoptera: Limacodidae	Moth*	Baja California, Mexico	23°44′0.88″N 109°48′56″W	Leaf feeder	2005	No culture
Hemiptera: Membracidae	Tree-hopper*	Texas, U.S.A.	26°17′30.6″N 98°09′23.7″W	Sap sucker	2005	No culture
Diptera: Agromyzidae	*Pseudonapomyza* sp.	Northwesert Argentina	24°21′86″S 64°56′46″W	Leaf miner	2005	Suitable for release
Coleoptera: Chrysomelidae	*Dibolia* sp.[2]	Guerrero, Mexico	20°53′35.6″N 99°42′30.6″W	Root feeder	2007	Culture failed
Lepidoptera	Moth*	Chilpancingo, Tixtla-Mexico	17°33′04.1″N 99°25′38.7″W	Green seed pods	2007	No culture
					2007	Culture established
Coleoptera: Coccinellidae	*Mada polluta*[1]	Chilapa,Planderio, Guerrero in Mexico	17°35′57.1″N 99°19′04.4″W	Leaf feeder	2007	No culture
Arachnida	Mites*	Mexico	21°03′07.7″N 99°44′25.9″W	Leaves	2007	
Diptera: Agromyzidae	Leaf miners*	Mexico	21°10′22.0″N 99°19′39.4″W	Leaves	2007	No culture

[1]Under investigation in quarantine. [2]No F1 generation adults obtained.*Collected for identification purposes. #Not suitable for release.

Prospodium had been recorded as occurring on *T. stans*, namely a macrocyclic, *Prospodium appendiculatum* (G. Winter) Arthur (Pucciniales: Uropyxidaceae), and two microcyclic species, *P. transformans*, and *Prospodium elegans* (Schroet.) Cummins. The latter two are presumed to be derived by contraction of the life cycle from *P. appendiculatum* (Cummins 1940), both inducing galls on their host plant (Hernández & Hennen 2003). Cummins (1940) recognized two varieties of *P. appendiculatum* which have now been elevated to full species: *Prospodium abortivum* (Cummins) A.A. Carvalho & J.F. Hennen, from the Caribbean and Texas; and *Prospodium aculeatum* (Cummins) A.A. Carvalho & J.F. Hennen, from Ecuador. A third species, *Prospodium mexicanum* A.A. Carvalho & J.F. Hennen, was recently described from Mexico (Carvalho & Hennen 2010). *Prospodium appendiculatum* has been recorded throughout the range of *T. stans* (var. *stans* and var. *velutina* DC.) in the Americas (Cummins 1940; Hernández & Hennen 2003), including areas where this plant is naturalized in Brazil (Vitorino *et al.* 2003). The only other plant on which this rust fungus has been recorded is *Tecoma castanifolia* (D.Don) Melch., which is also a yellow-flowered species with simple leaves from dry coastal parts of Ecuador (Cummins 1940). *Prospodium transformans* has only been recorded on *T. stans* (var. *stans* and var. *velutina*) in Mexico, Florida and the Caribbean, whereas *P. elegans* has been recorded on *T. stans* and *Tecoma garrocha* Hieron. (a bird-pollinated species) from Argentina, Peru and Ecuador (Hernández & Hennen 2003). These two microcyclic species are readily distinguished by the size of their teliospores. Another microcyclic species, *Prospodium manabii* R. Berndt, has been described on an unidentified *Tecoma* species in Ecuador (Berndt 1998), although this could be a synonym of *P. elegans.*

One of these species, *P. appendiculatum*, is adventitious in Brazil and has been assessed for its effectiveness as a biological control agent against *T. stans* in that country (Vitorino *et al.* 2003). During a number of surveys of the plant, undertaken by several researchers from the ARC-PPRI, in the southern U.S.A., Mexico, Puerto Rico and northwestern Argentina, *P. appendiculatum, P. abortivum* and *P. transformans* were encountered and collected. The first was widespread, whereas *P. abortivum* was found only in Puerto Rico, and *P. transformans* was found only in Mexico. Although *P. transformans* was observed in a relatively restricted range, it was common, even on single isolated host plants, and appeared to be highly damaging on plants by causing the formation of numerous galls. Both *P. appendiculatum* and *P. transformans* were readily established as cultures under quarantine conditions, but further work was only undertaken on *P. transformans* because it caused the most damage to the target plant.

Host-specificity testing indicated that *P. transformans* is highly host specific (Wood 2008), and therefore permission was granted to release this rust fungus in South Africa in April 2010. Tests were conducted using two isolates, one from Chiapas Province, Mexico (collected by H.G. Zimmermann), and the other from Guatemala City, Guatemala (collected by S. Neser), both of which were obtained in December 2003. Testing involved 12 plant species in the Bignoniaceae and eight species in related families, with locally-sourced plants of *T. stans* as the controls. The isolate from Chiapas was consistently more damaging on the South African form of *T. stans,* producing larger galls, than the one from Guatemala.

A further five isolates of *P. transformans* were obtained in August 2007 from Jalisco, Michoacan and Guerrero provinces, Mexico. These five isolates differed in their virulence and size of galls produced: two isolates produced both a few tiny galls and apparent hypersensitive reactions (incomplete compatibility) on the South African form of *T. stans* (isolates collected from Jalisco 20°24′39.4″N 102°44′36.2″W); Michoacan 19°58′4.2″N 101°42′35.2″W); another two formed readily compatible galls (Guerrero 17°49′16.1″N 99°27′26.5″W; 17°33′4.1″N 99°25′38.7″W); while no infections were obtained with the last isolate (Jalisco 20°39′55.5″N 103°24′29.1″W) either because it was non-viable or because it was completely incompatible.

Releases of *P. transformans* were initiated from November 2010 using the Chiapas and Guerrero isolates. These initial releases, in the Durban (Ethekwini Metropole) and Nelspruit (Mbombela Municipality) areas are to test several inoculation methods to determine the optimal release strategy for later implementation.

Mada polluta (Coleoptera: Coccinellidae)

Mada polluta, a leaf-feeding beetle, was collected from Guerrero Province (North of Chilpancingo) in Mexico (Table 1) and imported into the ARC-PPRI quarantine facility in Pretoria in August 2007. An insectary colony was established and studies on the biology and host specificity of the beetles were initiated (L.G. Madire, unpubl.).

The adults fed on the upper surface of the leaves whereas the larvae fed on the lower surface. The adults skeletonized the leaf area with their mandibles and fed inside these areas, which then wilted. After eclosion the adults mated immediately and a pre-oviposition period of 5–12 days followed. The females laid eggs in clusters of 3–59 eggs. Each female laid 14–30 egg clusters, giving a total of 301–961 eggs per female. The egg stage lasted for 7–10 days and the emerging larvae started feeding immediately. The larval period lasted for 11–14 days (with four larval instars) and the pupal period lasted for 5–7 days. Adult longevity for both males and females varied from 30–136 days.

According to Gordon (1975), the members of the tribe Madaini are polyphagous and widely distributed, but initial host-specificity tests, involving adult paired-choice trials, in cages with *T. stans* (control) and a Bignoniaceae test plant, have so far indicated that *Mada polluta* displays a strong preference for *T. stans* (L.G. Madire, unpubl.). Of the 26 plant species tested so far, there was minimal adult feeding on *T. capensis* but there was no oviposition or larval or adult development on this species. None of the other plants tested were used at all for feeding or oviposition. Although trials are still in progress, the results achieved so far are promising.

Dibolia sp.
(Coleoptera: Chrysomelidae)

About 30 adults of *Dibolia* sp., a root-feeding flea beetle, were collected from Mexico (Table 1) from leaves of *T. stans* and brought into the ARC-PPRI quarantine facility in Pretoria in 2007. Adults of *Dibolia* sp. feed on leaves, creating small holes with rough edges, while larvae feed on the roots of the plant. The adult female deposits eggs on the surface of the soil from where the neonate larvae burrow downwards and locate roots on which to feed. Rearing of *Dibolia* sp. was unsuccessful, making it necessary to recollect material for future investigations.

Clydonopteron sacculana
(Lepidoptera: Pyralidae)

Clydonopteron sacculana, a seed-feeding moth, was collected in the southern U.S.A. and northern Mexico in Baja California Sur. Fruit capsules containing developing larvae were imported into South Africa in September 2005 and a colony was established in the ARC-PPRI quarantine facility in Pretoria. Larvae of the moth develop in the mature fruits of *T. stans.*

Clydonopteron sacculana was originally described as *Pyralis sacculana* by Bosc d'Antic (1800) but his paper apparently went unnoticed (Cashatt 1969; Landis *et al.* 1992). Riley (1880) described the monotypic *Clydonopteron tecomae,* but this was later considered to be the same species as *P. sacculana,* and Cashatt (1969) placed it in the genus *Clydonopteron.* According to Landis *et al.* (1992), *C. sacculana* is widely distributed throughout the southern U.S.A., from Maryland westwards to Missouri and southwards between the Gulf coast of Texas and Key Largo, Florida. The moth was recorded developing on the fruits of *Campsis radicans* (L.) (Bignoniaceae) (Riley 1880) which is a creeper, native to the southeastern and Gulf coast of region of the U.S.A., where it grows along the fences and edge of woodlands (Floridata 2010).

Following the importation of *C. sacculana* into South Africa, its biology and host range were investigated (H.E. Williams, unpubl.). In the laboratory, the females started to lay eggs between the seeds of the split-open fruit capsule 2–3 days after eclosion, laying 67–210 eggs in their lifetime which lasted 5–10 days. The egg stage lasted 5–6 days and the neonate larvae fed immediately after hatching within the seed. As the larvae developed they moved from seed to seed within the capsule. The larvae spun silken threads between the seeds to secure them within the capsules. Pupation took place in silken cocoons between the tied seeds. The developmental period from egg to adult on *T. stans* was 34–70 days for females and 27–72 days for males.

Host-specificity testing in quarantine involved several trials including: adult paired-choice trials in plastic tubs using fruit capsules of *T. stans* and six other test plants; adult paired-choice trials in a walk-in cage using two species, *T. stans* and *Rhigozum obovatum* Burch. (Bignoniaceae); and adult multiple-choice trials in a walk-in cage using large potted plants (1.5–2 m tall) of six different Bignoniaceae species. In the adult paired-choice tests in plastic tubs, larvae completed their development to adulthood on three of the six Bignoniaceae species that were tested, namely *T. capensis,* *R. obovatum* and *Podranea ricasoliana* (Tanfani) Sprague. In the paired-choice tests in the walk-in cage, oviposition and complete development occurred on both of the test plant species and the control. In the adult multi-choice tests, oviposition and complete development occurred on six bignoniaceous plant species. The host-specificity test results confirmed that this moth is unsuitable for release in South Africa and therefore research on it was discontinued in 2007 and the colony was destroyed.

DISCUSSION

The Bignoniaceae has relatively few members in Africa, with a total of 12 genera and only 30 species native to the continent. There are only six genera with nine species in South Africa, with a further three genera and seven species in southern Africa in the Flora Capensis and Flora Zambesiaca regions (Klopper *et al.* 2006). This is of relevance in the context of further host-specificity testing and the potential for biological control of *T. stans.* Furthermore, recent phylogenetic studies indicate that the majority of African species are not closely related to *T. stans* or even to the genus *Tecoma* (Spangler & Olmstead 1999; Olmstead *et al.* 2009), except for the African members of the genera *Tecoma* (previously called *Tecomaria*) and *Podranea. Tecoma stans* could thus be considered a relatively easy target for biological control.

Prospodium transformans is the first biological control agent to be released against *T. stans* in South Africa, though it is still too early to determine whether this rust fungus has established and, if so, what impact it will have.

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