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A Preliminary Checklist of Flower-visiting Insects from *Syzygium floribundum, Syzygium smithii* and *Tristaniopsis laurina*: three members of the Myrtle Rust-vulnerable plant family Myrtaceae.

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Abstract: Insects visiting flowering trees of *Syzygium floribundum, Syzygium smithii* and *Tristaniopsis laurina* (Myrtaceae) were recorded in lowland subtropical rainforest communities in the Manning Valley, mid-north coast of New South Wales. These species are visited by a taxonomically broad assemblage of insects, many of which are known to frequent other rainforest- and open forest- flowering plant species. Consequently there is likely to be a regional pool of potential pollinators found throughout the range of each plant.

Key Words: *Syzygium floribundum, Syzygium smithii, Tristaniopsis laurina,* Myrtaceae, endangered ecological communities, subtropical rainforest, wet sclerophyll forest, pollination, anthophilous insects, Myrtle rust, *Austropuccinia psidii*, extinction events.

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Introduction

Despite the historical interest in the conservation, ecology and diversity of Australia's subtropical rainforests (Adam, 1987, 1992, Floyd, 1990, Werren & Kershaw, 1987, Williams, 1993, 2002, 2003, Kitching *et. al.,* 2010) relatively little is known about the ecological relationships between individual plant species and their associated biota; not least with their potential pollinators (Williams & Adam, 2010, 2013). When extinction events occur, as is threatened for Australian Myrtaceae by the introduced Myrtle rust fungus *Austropuccinia psidii* (NSW Scientific Committee, 2017, Makinson, 2018a, 2018b), the consequent lack of knowledge of basic interactions between species makes it difficult to adequately formulate recovery action plans or predict any secondary outcomes.

The purpose of this paper is to provide an overview of the known diversity of the insect fauna that frequents mass-flowering *Syzygium floribundum* (F. Muell.) B. Hyland*, Syzygium smithii* (Poiret) Merr. and Perry and *Tristaniopsis laurina* (Smith) Peter G. Wilson and Waterhouse (Myrtaceae) trees in subtropical rainforest; and from which a suite of pollinators may be recruited. We do not claim it is exhaustive, for no sampling regime, regardless of how temporally or spatially extensive, is likely to account for *all* possible associated anthophilous insects, regardless of their degree of behavioural or morphological adaptation to the role. Minute and certain 'rare' species will be consistently overlooked. Nevertheless the records tabled here (Table 1) represent a species list not otherwise collectively available, and in many instances unpublished. It is hoped that this will contribute to a better understanding of the interacting invertebrate biota and encourage additional investigation of the reproductive ecology of Australia's subtropical rainforest myrtaceous flora in advance of any further Myrtle rust pathogen impacts.

Study Species, Sites and Methods

The investigation of anthophilous insect-flower relationships of *Syzygium floribundum, Syzygium smithii,* and *Tristaniopsis laurina* was part of a much larger study of the reproductive ecology and flowering phenology of lowland (i.e. <600m elevation) subtropical rainforest remnants undertaken from 1990 to 1994 (Williams, 1995, see also Williams & Adam, 1995, 1997, 1998, 1999a, 1999b, 2001, Williams *et al.,* 2001, Adam & Williams, 2001); within which these three species constitute a small subset. Records acquired from this have been supplemented by additional later studies of subtropical rainforest plants (Williams, 1998, Williams & Walker, 2003), as well as casual field observations of general subtropical rainforest insect-plant relationships that have continued to this day. Collectively over this period, field investigation amounted to many hundreds of hours. Statistical analyses and interpretation of the 1990-1994 study data (resulting from the collection, sorting and identification as morphospecies/ recognizable taxonomic units [RTUs] of more than 60,000 insects representing >100 families and >500 genera) are given in Williams (1995).

The study sites are situated within the Manning Valley (approx. 31°52' S, 152°52' E) on the mid-north coast of New South Wales, and comprise rainforest communities variously listed as *Endangered Ecological Communities* under New South Wales State (*Biodiversity Conservation Act 2016*) and Federal (*Environmental Protection and Conservation Act 1999*) legislation. An overview of the extent of rainforest and its associated biota, within the Manning Valley, is given in Williams (1993). Harrington (32°52'30" S, 152°41'00" E) and Manning Point (31°53'30" S, 152°40'00" E) are littoral rainforest remnants located immediately north and south of the northern opening of the deltaic Manning River estuary. Lansdowne Nature Reserve (31°47'30" S, 152°32'30" E) is a small floodplain remnant located near Lansdowne village, and Wingham Brush Nature Reserve (31°52'40" S, 152°31'30" E) is located on the banks of the Manning River adjacent to Wingham township. Lorien Wildlife Refuge (31°45'00" S, 152°32'30" E) is situated north of Lansdowne village, forming part of the Lansdowne-Comboyne Escarpment, and includes both rainforest and eucalypt-dominated wet sclerophyll forest formations. Woko National Park (31°49'00" S, 151°47'00" E) is located further inland, northwest of Gloucester; the distinctive riparian (rheophytic) small-leaved form of *Syzygium smithii* (Harden *et al*. 2006) occurring there providing a comparison to the same species in sites situated to the east.

Syzygium floribundum (Fig. 1)*, Syzygium smithii* (Fig. 2.) and *Tristaniopsis laurina* (Fig. 3) are small to medium-sized trees (Harden, 1991) commonly found growing in the region on forest margins. However, *Syzygium floribundum* is normally restricted to the riparian zone of lowland freshwater streams where it may constitute the dominant canopy species. *Tristaniopsis laurina* also can be encountered alongside streams as a dominant canopy-forming tree, but usually at slightly higher elevations where it may form narrow 'gallery' rainforests. The flowers of *Syzygium floribundum* and *Syzygium smithii* are coloured white to creamish-white, those of *Tristaniopsis laurina* are bright yellow. *Syzygium floribundum* produces very prominent bright red juvenile leaf flushes but this generally does not overlap with flower production. Annual flowering patterns vary slightly during spring and summer months, and some populations have failed to flower during drought conditions (Williams, 1995, G. Williams pers. obs.). There is only minor overlap in some seasons with flowering events. All produce copious quantities of nectar. The three species conform to the 'general entomophilous' flower structure in which individual flowers are small with little depth effect in the corolla, normally do not possess nectar guides, and are actinomorphic in form allowing entry by numerous ecologically-unspecialised flower visiting insects (Faegri & van der Pijl, 1979, Williams & Adam, 2010, Willmer, 2011).

Information about floral characteristics of the three species is given below.

Floral descriptions of plant species.

Syzygium floribundum (F. Muell.) B. Hyland (Fig. 1.)

Flowers are bisexual but generally self-incompatible (Adam & Williams, 2001), numerous and in panicles, exposed and massed, rarely obscured by foliage. Flower presentation is similar to that in *Eucalyptus* spp. Flowers white or creamish-white, strongly and sweetly scented like honey. Number of petals not recorded. Receptacle diameter approximately 3mm, corolla (stamen 'brush') diameter 12-14mm. Stamens numerous, long, free, variable in length (3-8mm). Anthers dehiscent at flower opening. Ovary ½ inferior. Stigma narrow, pointed, at end of long style and appears receptive at flower opening. Freshly open flowers do not possess nectar. Stamens readily absciss following pollination. Exine sculpture indistinct-smooth (Williams & Adam, 1999). Mean flower longevity 6 (range 4-8) days (Williams, 1995). Distribution: Williams River, New South Wales to Mackay, Queensland (Floyd, 1989).

Syzygium smithii (Poiret) Merr. and Perry (Fig. 2.)

Flowers bisexual, slightly self-compatible (Adam & Williams, 2001), exposed and massed in panicles, sparse on outer crown margin or recessed below foliage. Flowers white or creamish-white, scented without nectar guides, 3-4mm wide. Petals usually 6, these absciss on first day of anthesis. Stamens generally 2-ranked, longer outer stamens approximately 26, inner shorter stamens approximately 36. Stamens free, filaments approximately 10 times longer than anthers. Ovary ½ inferior, style robust, rigid, +/ shorter than stamens. Stigma small, stigmatic surface 'fleshy' in appearance, formed as an apical extension/continuum of the style rather than as an obviously discrete surface or structure. Flowers protogynous, stigma appears receptive at flower opening. Anther dehiscence sequential, longer outer rank dehisce first, inner shorter rank dehisce later, generally following loss of stigma receptivity and during initial flower senescence. Pollen white, sticky. Exine sculpture indistinct-smooth (Williams & Adam, 1999). Nectar not present in unopened flowers, but present on or shortly after flower opening as discrete droplets on surface of hypanthium. Partly chewed flowers still produce nectar. Flower opening sequential, diurnal, mean floral longevity 6 (5-7) days (Williams, 1995). Distribution: Wilsons Promontory, Victoria to Bundaberg, Queensland. (Floyd, 1989).

The small-leaved form of *Syzygium smithii* is normally associated with river flats and streams. Flowering episodes are distinctive in that flowers on individual trees are massed and prolific, rather than the frequently sparse and obscured (by foliage) flowers produced by typical *S. smithii*.

Tristaniopsis laurina (Smith) Peter G. Wilson and Waterhouse (Fig. 3.)

Flowers bisexual but self-incompatible (Adam & Williams, 2001), in small cymes, massed but partially obscured by foliage. Flowers strongly scented, honey-like. Corolla diameter 11-5mm (hypanthium 6mm). Petals and stamens bright yellow, receptacle and sepals yellowish-green. Petals 5, and absciss in senescent stage. Stamens fused into 5 antepetalous cluster, each cluster possessing approximately 21 stamens. Stamens variable in length, fused staminal clusters shed as a unit on abscission. Anthers small. Ovary ½ inferior. Hypanthium pentangular, inner surfaces slightly convex, basal nectiferous gland granulose. Style long and retained in infructescent stage. Pollen slightly sticky, exine sculpture indistinct-smooth (Williams & Adam, 1999). Mean flower longevity 5 (range 4-6) days. Receptacles that have shed perianth segments do not produce nectar. Distribution: Bairnsdale, Victoria to Eumundi, Queensland (Floyd, 1989).

Collection of insects visiting *Syzygium floribundum, Syzygium smithii* and *Tristaniopsis. laurina* inflorescences was undertaken throughout the flowering seasons (between October – February). Details of flowering events, flower presentation, sampling dates, sample sizes and composition, and the days on which individual insect species were collected on each plant species are given in Williams (1995).

Fig. 1. *Syzygium floribundum.*

Fig. 2. *Syzygium smithii* with *Castiarina producta* (Buprestidae). (photo credit Allen Sundholm)

Fig. 3. *Tristaniopsis laurina*.

During daily field work it was observed that sudden events of intermittent cloud cover, or a seasonally atypical drop in temperature, resulted in immediate reduction (often complete absence) of insect activity. Moderate-heavy rainfall resulted in the washing (or dilution) of nectar from inflorescences, and was followed by marked reduction for several days in insect abundance and diversity. Thus sampling was only carried out on consistently sunny, warm (>25^o C.) days. Equally, during excessively hot (>35^o C.) times insect activity also dropped dramatically, and for this reason samples were only collected morning and afternoon when extremes of heat had yet to arise or had abated. Independent of environmental influences large mobile flower-frequenting insects, such as cetoniid beetles, butterflies and eumenine wasps, occurred in much fewer numbers, and so their presence at individual inflorescences was usually infrequent over hourly scales of time.

Flower visiting insects were either hand-netted individually, or mass sampled by quickly placing a net over individual flower masses and vigorously shaking; the net mouth being closed by rotating the handle to minimise loss of fast flying insects. The net was then detached from the handle, placed in a plastic container, sprayed with commercial pyrethroid insecticide and sealed. After 10-20 minutes the contents were then emptied into individually labelled containers for later sorting, measurement and identification (Williams, 1995). This technique was used to acquire the data presented in Appendix 1 (as well as the more extensive data set in Williams, 1995), and allowed the collection of most insects frequenting inflorescences at the sampling times (between 9 am to 3 pm), but inevitably this resulted in collecting some specimens (e.g., Dolichopodidae) associated with foliage rather than flowers; the distinction based on familiarity with taxa from many years of field experience and observation, discussions with colleagues, and extensive reference to the entomological literature for known, principally foliage-eating, groups such as Orthoptera, Lepidoptera larvae and various Coleoptera (especially Chrysomelidae and certain Buprestidae). Later sorting established that these were minimal in abundance and diversity. This supports the findings of Wardhaugh *et al*. (2013) that there may be little overlap of species between different rainforest microhabitats. Voucher specimens were placed with the Australian Museum (Sydney) with a subset held in the field reference collection at Lorien Wildlife Refuge (Lansdowne). However, all the microhymenoptera and Thysanoptera material was deposited with the Australian National Insect Collection (Canberra). Detailed data records, including field notes, from the 1990-1994 study remain with the senior author.

Table 1. Preliminary checklist of insects collected from mass-flowering *Syzygium floribundum, Syzygium smithii* and *Tristaniopsis laurina*.

Key: Records given as single '1' presence scores for species, actual number of species indicated in cells where determinations beyond genus are uncertain. '?>1' = single species or more than 1 species present. 'sp./spp.' = 1 or more species may be present in row. Undetermined genera clumped as 'undet. sp./spp.', with number of species given in cell. '*' = placed after family indicates included species generally strongly or partly adapted to a floricolous habit, '+' indicates incidental non-anthophilous species. Anthophilous relationship for family not indicated where species are either poorly adapted, or plant interaction is uncertain or included species are likely incidental visitors. '#' = large species observed to undertake long distance inter-plant movements.

Plant species.	**Sites**
1. *Syzygium floribundum*	A. Harrington.
2. *Syzygium smithii*	B. Manning Point.
3. *Syzygium smithii* small leaf form	C. Lansdowne Nature Reserve.
4. *Tristaniopsis laurina*	D. Lorien Wildlife Refuge (rainforest).
	E. Lorien Wildlife Refuge (wet sclerophyll forest).
	F. Wingham Brush Nature Reserve.
	G. Woko National Park.

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
BLATTODEA								
Ectobiidae								
Ellipsidion sp.							1	
Gisternia australis							1	
undet. sp./spp.							1	
COLEOPTERA								
Aderidae								
Aderus spp.	2	1					1	1
?Aderidae								
undet. sp.	1							
Anobiidae								
undet. sp.	1							
Anthicidae *								
Anthicus sp./spp.	1	?>1	1	1	1			1
Egestriomima albolineata						1		1
Egestriomima ?albolineata		1						
Egestriomima sp. nr. *griseolineata*		1				1		
Egestriomima sp.						1		
Macratia ?analas		1						
Macratia victoriensis		1						
Attelabidae								
Auletobius sp.	1							

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
?*Euops* sp.			1					
Belidae								
Belus tenuis								1
Boganiidae								
Athertonium sp. nov.		1			1	1		
Buprestidae *								
Calodema regale #							1	
Castiarina acuminata								
Castiarina alternecosta	1					1		
Castiarina amplipennis						1		
Castiarina analis	1							
Castiarina australasiae	1							
Castiarina beatrix	1							
Castiarina bella	1							
Castiarina brutella	1							
Castiarina decemmaculata				1				
Castiarina deliculata	1							
Castiarina delta	1					1		1
Castiarina gentilis					1			
Castiarina harrisoni	1							
Castiarina humeralis	1							
Castiarina insignis	1	1			1			1
Castiarina kanangara	1							
Castiarina liliputana	1	1				1		1
Castiarina luteipennis	1							
Castiarina maculipennis	1							
Castiarina minuta		1				1		1
Castiarina oblita	1							
Castiarina octospilota	1							
Castiarina praetermissa	1							
Castiarina producta	1	1			1	1	1	1
Castiarina pulchripes						1		
Castiarina rufipennis						1		
Castiarina scalaris	1							
Castiarina ?sexcavata		1				1		
Castiarina sexguttata		1				1		1
Castiarina sp. nr. *spectabilis*	1							
Castiarina spinolae	1							
Castiarina sulfurea	1							
Castiarina tyrrhenia	1							
Castiarina undulata	1							
Castiarina variegata	1							
Castiarina ?vicina		1						
Castiarina warningensis	1							
Castiarina williamsi	1	1						
Diphucrania sp.						1		
Maoraxia aureoimpressa +					1			
Melobasis splendida +		1						
Melobasis sp. +								1
Metaxymorpha grayi #	1						1	
Neocuris ?coerulans						1		
Neocuris spp.						2		
Pseudanilara cupripes		1						
Selagis aurifera		1						
Selagis splendens	1	1				1		
Torresita cuprifera	1	1						
Cantharidae *								
Chauliognathus flavipennis				1	1	1		1
Chauliognathus inconstans		1						

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
Chauliognathus lugubris						1		
Chauliognathus sp.			1					
Heteromastix spp.		1		2	1	1	1	1
Pseudananca sp./spp.	1							
Selenurus sydneyensis	1	1		1	1		1	1
Carabidae								
Amblytelus amplipennis			1					
Sarcothrocrepis sp.		1						
Cavognathidae								
Cavognatha sp.			1					
Cerambycidae *								
Arideus thoracicus #		1				1	1	1
Ceresium australe +		1						
Demonisis spp.		1			2	2		1
Distichocera superba #	1	1					1	
Earnis sp./spp.						1		1
Eroschema poweri		1						
Hesthesis sp. nr. *bizonata*							1	
Oroderes sp.						1		
Psilomorpha ?apicalis		1						
Psilomorpha divisus						1		
Psilomorpha tenuipes		1						
Psilomorpha ?tenuipes					1			
Pytheus sp./spp.		1				1		
Stenocentrus ostricilla		1	1					
Stenocentrus ?ostricilla		1				1		
Stenocentrus suturalis						1		
Syllitus sp./spp.	1		1		1	1		1
Iphra ?moestula +				1				
Titurius intonsodorsalis					1			
Tragocerus spencei #	1							
Tropocalymma dimidatum			1					
Chrysomelidae								
Aporocera iridipennis								1
Aporocera ?iridipennis		1						
Ceratia hilaris						1		
Crepidodera sp./spp.		1		1	1	1		
Ditropidus concolor		1						
Ditropidus sp. nr. *lentulus*	1	1						1
Ditropidus sp./spp.		1	1					
Edusella glabra					1			
?*Edusella* spp.							2	
Monolepta australia	1	1			1		1	1
Monolepta sp. nr. *cognata*		1		1				1
Monolepta miniuscula			1					
Monolepta sp. nr. *miniuscula*	1			1				1
Monolepta spp.	7	3		1		2	3	1
Pepila sp.		1						
Poneridia mastersi		1						
Pyrgo complicata						1		
Rhyparida sp.				1				
?*Rhyparida* sp.nr. *satelles*						1		
?*Rhyparida* sp.						1		
Clambidae								
Clambus sp.			1					
Cleridae *								
Cleromorpha novemguttata						1		
Elaele pulchra		1					1	
Elaele sp. nr. *viridicollis*	1	1			1	1		1

Taxa	Sites							
	1D	1F	2A	2B	2C	3G	4E	4F
Lemidia concinna	1							
Lemidia pictipes		1			1	1		
Lemidia ?pictipes	1							
Lemidia sp. nr. *purpurea*	1							
Lemidia sp.		1						
Phlogistus conspiciendus					1	1		
Phlogistus ?erimita						1		
Phlogistus sp. nr. *erimita*		1						1
Phlogistus eximus		1			1			1
Phlogistus ?eximus						1		
Phlogistus plutus						1		
Phlogistus sp./spp.				1	1			
Scrobiger splendidus	1					1		
Tarsostenodes simulator	1	1			1			
Zenthicola australis						1		
Zenthicola funestus						1		
Coccinellidae								
Archegleis edwardsi						1		
Coccinella repanda		1						1
Coccinella ?repanda	1	1						1
Diomus notescens	1	1						1
Epilachna spp.		2						1
Halmus chalybeus		1				1		
Harmonia testudinaria							1	1
Micraspis frenata					1			
Rhizobius sp./spp.			1					1
?*Rhizobius* sp.	1							
?*Scymnus* spp.		1			1	1		1
Corylophidae								
Ortopterus sp.	1							
Sericoderus spp.	2	1	1		?>1	?>1	1	1
Cryptophagidae								
Anichera lewisi		1						
Curculionidae								
Baris angophorae	1						1	1
Cyttalia sydneyensis	1	1			1	1		1
Cyttalia ?sydneyensis							1	
Eristinus eucalypti		1						
Haplonyx spp.	1	2						
?*Ipsichroa* sp.		1						
Meriphus spp.			2	1		2		
Neomelanterius carinicollis				1	1			
Orthorhinus sp.					1			
Storeus spp.			2		1	2		1
Tychiini spp.		4	2	1	1	2		1
undet. spp.	1	1			1			2
Dermestidae								
Anthrenocerus spp.	1	?>1	2	1				>1
?*Anthrenocerus* sp./spp.				1	1		1	
Orphinus sp.		1						
Trogoderma ?froggati				1				
Trogoderma spp.		1	1	2				
?*Trogoderma* spp.	2	2						
Elateridae *								
Anilicus sp.							1	
Drymelater aulacoderus						1		
Drymelater ?aulacoderus		1						1
Drymelater australis						1	1	
Drymelater ?australis		1						1

Taxa	Sites							
	1D	1F	2A	2B	2C	3G	4E	4F
Drymelater basalis					1			
Drymelater ?basalis		1						1
Drymelater sp./spp.					1	1		
?*Lacon* sp.							1	
Microdesmes angulatus			1		1			
Microdesmes collaris				1		1		
Microdesmes ?collaris					1			
Microdesmes pubescens	1					1		
Megapenthes futilis	1	1			1	1	1	1
Melanoxanthus lativittis	1							
Ophidius histrio #	1						1	
Paracardiophorus bicolor						1		
undet. sp.								1
Latridiidae								
Aridius sp.			1					
?*Bicava* sp.			1					
Corticara japonica		1						
Cortinicara spp.	1	1	1		1	1	1	3
Lycidae *								
Metriorrhynchus ?lateralis					1			
Metriorrhynchus rhipidius						1		
Metriorrhynchus spp.		?>1	2	1		?>2		1
Melyridae *								
Balanophorus ?rhagonychinus		1						
Balanophorus sp./spp.		1				1		
?*Balanophorus* sp./spp.	1	1						
Carphurus sp.								1
Dastyes sp./spp.	1							1
Dicranolauis ?cinctus						1		
Helcogaster spp.	2	3			?>1	2	1	2
Neocarphurus ?angustibasis						1		1
Neocarphurus sp.			1					
Mordellidae *								
Mordella humeralis		1				1		
Mordella sydneyana								1
Mordella spp.	>1	>1	2	2	>1	?>2	1	>1
Mordellistena spp.	2	1	1		1		1	1
Tomoxia sp./spp.						1		1
Mycteridae								
?*Trichosalpingus* sp.						1		
Nitidulidae *								
Aethina sp./spp.	1	1						
Epuraea eyrensis					1			
Epuraea ?ocularis				1	1			
Epuraea uniformis					1	1		
Epuraea sp./spp.	1	1				1		1
?*Epuraea* sp.	1							
Notobrachypterus sp./spp.		1	1			1		
Oedemeridae *								
Copidita ?pachymera	1							
Ischnomera sp.	1							
?*Ischnomera* spp.	2	1						
Pseudolycus haemorrhoidalis						1		
Pseudolycus spp.	2	1					1	1
Sessinia nigronotata		1						
Phalacridae								
Litochrus ?maculatus	1	1					1	1
Litochrus sp./spp.			1	1	?>1			
?*Litochrus* spp.		>1	2		1			?>1

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
Olibroporus spp.			3					1
?*Olibroporus* sp.				1				
Phalacrinus ?*corruscans*		1						
?*Phalacrinus* sp./spp.	1		1					
?*Phalacrus* sp.		1						
undet. sp.								1
Pselaphidae								
?*Eupines* sp./spp.	1	1						
Pyrochroidae								
Paromarteon constans					1			
?*Paromarteon* sp.	1							
undet. spp.		2						
Ripiphoridae								
Macrosiagon sp.	1							
Pelecotomoides sp.	1	1						
Salpingidae								
?*Lissodema* sp.								1
Scarabaeidae *								
- Melolonthinae								
Anthotocus ?*fugitivus*							1	
Anthotocus luridus							1	
Automolius ?*poverus* +							1	
Automolius sp. nr. *valgoides* +			1					
Cheiragra ruficollis		1	1	1		1		
Diphucephala pygmaea +	1	1						
Diphucephala ?*sericea* +						1		
Diphucephala sp.		1						
Phyllotocus australis			1					
Phyllotocus macleayi		1						
Phyllotocus marginipennis		1				1		
Phyllotocus ?*marginipennis*		1						1
Phyllotocus navicularis		1				1		1
Phyllotocus ruficollis					1			
Phyllotocus ?*ruficollis*						1		
Phyllotocus scutellaris		1			1	1		1
- Cetoniinae #								
Aphanasthes gymnopleura	1						1	
Chondropyga dorsalis	1						1	
Eupoecila australasiae	1	1					1	1
Glycyphana brunnipes							1	
Neorrhina ?*octopunctata*							1	
Neorrhina punctata	1	1				1	1	1
Schizorhina atropunctata	1							
Storeyus fasciculatus	1							
- Rutelinae								
Repsimus ?*aeneus* +		1						
- Valginae								
Microvalgus nigrinus	1							
Microvalgus ?*squamiventris*					1			
Microvalgus vagans	1				1			
Scraptiidae								
Scraptia spp.	1	2				1		
Staphylinidae								
Anotylus sp.		1						
?*Leucocraspedum* sp.								1
?*Myllaena* sp./spp.					1			1
?*Oedichirus* sp.					1			
?*Tachinus* sp.		1						
undet. spp.	?>1	>1						3

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
Tenebrionidae								
- Alleculinae *								
Aethyssius fuscus						1		
Aethyssius ochracea						1		
Aethyssius pallida							1	
Aethyssius pascoei		1			1		1	
Aethyssius viridis	1							
Aethyssius ?*viridis*						1	1	
Aethyssius sp. nr. *viridis*						1		
Aethyssius sp.						1		
Atoichus sp.				1				
DIPTERA								
Acroceridae								
Ogcodes sp.		1						
Bibionidae								
Bibio imitator		1				1		
Bombyliidae *								
Geron spp.	2	1	2	1		1	2	
undet. sp.						1		
Calliphoridae *								
Amenia chrysame			1					
Amenia sp.							1	
Calliphora hillii					1			
Calliphora sp.				1				
Chlororhinia exempta	1							
Lucilia sp.		1						
?*Lucilia* sp.		1						
Paramenia sp.			1					
Stomorhina spp.	1	>1				1		2
undet. sp.								1
Cecidomyiidae								
undet. sp.	1							
?Ceratopogonidae								
undet. sp.		1						
Chironomidae								
undet. sp./spp.		1	1					
Chloropidae								
Apotropina sp.			1					
undet. sp.		1						
?Chloropidae								
undet. sp.	1							
Conopidae *								
Microconops sp.						1		
Culicidae								
undet. sp.	1							
Dolichopodidae								
?*Austrosciapus* sp.		1						
Krakatauia macalpinei			1	1				
Drosophilidae								
Drosophila flavohirta		1						
Drosophila spp.	1	?>1	1				2	1
Scaptomyza australis	1	1						
Empididae								
Hemerodromia sp.		1						
undet. spp.	2	3			1		?>2	>1
Lauxaniidae								
Homoneura sp.		1						
Melanina spp.	1	2		1	1		2	
?*Melanina* sp./spp.	1	1						

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
Sapromyza ?*nigriceps*				1				
Sapromyza sp./spp.		1	1				1	
?*Sapromyza* spp.	2	1	1					
Steganopsis melanogaster	1	1		1		1		
Steganopsis ?*melanogaster*								1
?*Tephritisoma* sp.		1						
Trypetisoma sp./spp.					1	1		
?*Trypetisoma* sp.							1	
Muscidae								
Musca sp./spp.		1						1
?*Musca* sp.							1	1
Mycetophilidae								
undet. sp.	1							
Nemestrinidae *#								
Trichophthalma costalis		1				1		
Trichophthalma ?*punctata*		1						
Phoridae								
undet. spp.	2	2	2	1			2	1
Platystomatidae								
Duomyia spp.			2					
Microepicausta sp.			1	1				
Pogonortalis doclea			1					
?Rhagionidae								
undet. sp.			1					
Scatopsidae								
?*Scatops* sp.			1					
undet. sp.			1					
Sepsidae								
Lasionemapoda hirsuta					1			1
?*Parapalaeosepsis plebeia*	1	1		1	1	1	1	
Sepsis dissimilis		1			1	1	1	1
?*Sepsis* sp.					1			
undet. sp.							1	1
Stratiomyidae								
Odontomyia sp.		1						
Syrphidae *								
Eristalinus maculatus		1						
Psilota sp./spp.	1		1	1		1	1	
?*Syrphus* sp.		1						
?*Xanthogramma* sp.		1						
Tabanidae								
Cydistomyia nigropicta		1						1
Scaptia auriflua	1							
Scaptia sp.							1	
?*Tabanus* sp.								1
Tachinidae								
?*Rutilia* sp.							1	
Senostoma ?*pallidihirtum*							1	
Tritaxis sp.		1						
undet. sp./spp.			1	1				
Tephritidae								
Spathulina sp. 1						1		1
Spathulina sp. 2						1		
Spathulina sp. 3		1						
?*Tephritis* sp.								1
Trupanea sp.	1							
Therevidae								
undet. sp.								1

Taxa	**Sites**							
	1D	1F	2A	2B	2C	3G	4E	4F
Tipulidae								
undet. sp.			1					
HEMIPTERA								
Cicadellidae								
Ishidaella angustata						1		
undet.sp.							2	
Flatidae								
Siphanta ?*acuta*								1
Siphanta sp.			1					
undet. sp.						1		
Lygaeidae								
Arocatus sp. 1				1	1	1		
Arocatus sp. 2					1	1		
Arocatus sp. 3		1						
Membracidae								
Pogonella bispinus								1
Miridae								
Felisacus sp.						1		
undet. spp.	4	5	1					1
Orsillidae								
Nysius sp./spp.	1	1	1					
Pentatomidae								
undet. sp.		1						
Psyllidae								
undet. spp.		2						1
Scutelleridae								
Scutiphora pedicellata							1	
Tingidae								
Teleonemia scrupulosa				1				
Teleonemia sp.							1	
?*Teleonemia* sp.								1
undet. sp.			1					
HYMENOPTERA								
Agaonidae								
undet. sp./spp.		?>1	1				1	
Bethylidae								
undet. sp./spp.	?>1	1	?>1					1
Braconidae								
?*Rogas* sp./spp.								
undet. sp./spp.	?>1	?.1	?>1	?>1	1	?>1	?>1	?>1
Ceraphronidae								
undet. sp./spp.								?>1
Chalcididae								
undet.spp.	?>1	?>2	?>1				1	?>4
Crabronidae								
Bembicinus sp.				1				
Bembix ?*kamulla*							1	
Bembix sp.				1				
Cerceris ?*australis*								1
Cerceris minusculis						1		1
Cerceris sp./spp.							1	1
?*Ectemnius* sp.		1						
Spilomena sp.	1							
Encyrtidae								
undet. sp./spp.	?>1	?>1		?>1	1	?>1	?>1	?>1
Eulophidae								
undet. sp./spp.	?>1	?>1	?>1	?>1	1	?>2	?>2	?>2

Taxa	Sites							
	1D	1F	2A	2B	2C	3G	4E	4F
Eupelmidae								
undet. sp./spp.				?>1			?>1	
Eurytomidae								
undet. sp./spp.						?>1		
Evaniidae *								
Evania sp./spp.	1		1	>1				
Figitidae								
undet. sp./spp.	?>1	?>1					?>1	?>1
Gasteruptiidae								
Gasteruption ?pallidicus			1					
Gasteruption ?raphidioides				1				
Gasteruption sp. nr. *raphidioides*								1
Gasteruption spp.	1	2					1	
Ichneumonidae								
?*Echthromorpha* sp.								1
Megaspilidae								
undet. sp./spp.								?>1
Mymaridae								
undet. sp./spp.	?>1				1			
Mymarommatidae								
undet. sp./spp.	?>1							
Mutillidae								
Euphutomorpha sp.								1
Pergidae *								
?*Neoeurys* sp./spp.	1		1			1	1	
Perga cincta +			1					
Perilampidae								
undet. sp./spp.							?>1	
Platygastridae								
undet. sp./spp.	?>2	?>2		?>1	?>2	?>2	?>2	?>2
Pompilidae *#								
Calopompilus defensor	1	1						
Calopompilus raptor							1	
Calopompilus spp.	1							3
Heterodontonyx bicolor								1
?*Heterodontonyx* sp.		1						
undet. spp.			3					
Proctotrupidae								
undet. sp./spp.							1	
Pteromalidae								
undet. sp./spp.	?>1	?>1	?>1	?>1	?>1	?>1	?>1	?>1
Scoliidae								
Pseudotrielis zonata							1	
Scolia verticalis							1	
Scolia ?verticalis								1
Scolia sp. nr. *Verticalis*						2		1
Scolia sp./spp.						?>1		1
Sphecidae *#								
Sceliphron laetum								1
Sphex globosus	1							
Sphex ?luctuosus							1	
Thynnidae *#								
Anthobosca australasica		1						
Anthobosca signata							1	
?*Anthobosca* sp.							1	
Agriomyia maculata								1
Agriomyia manifesta						1		
Agriomyia variegata		1						
Dimorphathynnus dimidiatus			1	1				
Epactiothynnus ?tasmaniensis			1					
Eirone ?parca								1
Eirone sp. nr. *parca*		1				1	1	1
Eirone schizorhina								1
Hemithynnus apterus				1				
Hemithynnus rufiventris							1	
Lestriocothynnus frauenfeldianus							1	
Rhagigaster sp. nr. *kiandrensis*			1					
Rhagigaster ?mutatus								1
Rhagigaster ?unicolor		1						
Tmesothynnus dispersus								1
Tmesothynnus iridipennis								1
Thynnoturneria sanguinolentus								1
Thynnoturneria sp. nr. *umbripennis*								1
Zeleboria ?contigua			1	1				
Zeleboria xanthorrhoei			1	1				
Torymidae								
undet. sp./spp.	?.1	?>1	1			?>1	?>1	?>1
Vespidae *								
Polistes humilis	1		1					
Ropalidia sp. +							1	
- Eumeninae *								
Abispa splendida #							1	
Abispa ?splendida								1
Bidentodynerus bicolor	1							1
Deuterodiscoellus ephippium #	1							
Elimus australis	1							
?*Epiodynerus* sp.							1	
Paralastor sp./spp.	1		1			1		
?*Paralastor* sp.								1
Pseudabispa confusa #								1
Apiformes								
Apidae *								
Amegilla bombiformis #							1	
Amegilla sp. nr. *bombiformis*							1	
Apis mellifera	1	1	1	1	1	1	1	1
Exoneura spp.	1			2	1	1	3	
?*Exoneura* sp.		1						
Thyreus lugubris							1	
Trigonula carbonaria								1
Xylocopa aeratus #	1	1						
Colletidae *								
- Colletinae								
Leioproctus amabilis		1						
Leioproctus ?amabilis	1							
Leioproctus carinatus	1							
Leioproctus sp. nr. *irroratus*	1							
Leioproctus spp.	1	2				1	3	
Paracolletes sp.		1					1	
- Euryglossinae								
Euryglossa ephippiata	1	1				1	1	1
Euryglossa sp. nr. *occidentalis*		1						
Euryglossa subsericea							1	1
Euryglossa ?subsericea	1	1						
Euryglossa terminata							1	
Euryglossa sp./spp.	2	5				1		2
?*Euryglossella* sp./spp.						1	1	
Pachyprosopis sp./spp.		1				1		1
Sericogaster fasciata						1	1	

Taxa	Sites							
	1D	1F	2A	2B	2C	3G	4E	4F
undet. spp.							1	2
- Hylaeinae								
Amphylaeus ?nubilosellus				1				
Heterapoides sp. nr. *exleyae*	1			1	1			
Heterapoides sp./spp.	2			1				
Hylaeus amiculiformis		1						
Hylaeus sp. nr. *cyanophilus*							1	
Hylaeus elegans		1						1
Hylaeus euxanthus		1						1
Hylaeus sp. nr. *euxanthus*		1						
Hylaeus microphenax				1				
Hylaeus sp. nr. *nubilosus*	1							1
Hylaeus ofarrelli	1							
Hylaeus perhumilis	1							
Hylaeus primulipictus	1	1			1		1	1
Hylaeus ?primulipictus								1
Hylaeus proximus								1
Hylaeus rotundiceps		1						1
Hylaeus turgicollaris								
Hylaeus sp./spp.		2						
Palaeorhiza sp.								1
undet. sp.								1
Halictidae *								
Homalictus brisbanensis	1						1	
Homalictus ?brisbanensis	1	1						1
Homalictus sp. nr. *flindersi*		1						
Homalictus megastigmus				1				
Homalictus punctatus	1							
Homalictus sphecodoides						1		
Homalictus sp.				1				
?*Homalictus* sp.		1						
Lasioglossum bicingulatum	1	1					1	1
Lasioglossum ?bicingulatum		1					1	
Lasioglossum spp.	1	1			1		3	3
?*Lasioglossum* spp.	1	?>2					1	
Nomia sp.		1						
Megachilidae *#								
Megachile deanii								1
Megachile lucidiventris							1	1
Megachile maculariformis							1	
Megachile ?mystacea							1	
Megachile ?pictiventris							1	
Megachile punctata						1	1	
?*Megachile* sp.		1						
undet. sp.		1						
Formicoidea								
Formicidae								
Camponotus sp.	1							
Crematogaster sp.				1				
?*Crematogaster* sp.		1						
Iridomyrmex spp.		1	1	2	1			4
?*Iridomyrmex* sp.		1						
Myrmecia nigrocincta	1			1				
Paratrechina sp.						1		
Podomyrma sp. nr. *inermis*	1							
Podomyrma sp.					1			
Rhytidoponera metallica				1				
undet. spp.								2

Taxa	Sites							
	1D	1F	2A	2B	2C	3G	4E	4F
LEPIDOPTERA								
Erebidae *								
Amata sp./spp.	1	2	2			1		
?*Amata* sp./spp.			1					
Asura sp./spp.							1	
Nyctemera amica							1	
Lycaenidae *								
Zizina labradus labradus						1		1
Nymphalidae								
Hypocysta metirius							1	
Papilionidae *#								
Graphium macleayanus	1							
Pieridae *#								
Delias nigrina							1	
Noctuidae								
undet. spp.	2							
?Oecophoridae								
?*Snellenia* sp.							1	
NEUROPTERA								
Chrysopidae								
undet. sp.	1							
Hemerobiidae								
undet. sp.		1						
Mantispidae								
Spaminta sp.	1							
?*Spaminta* sp./spp.	1	1						1
undet. sp.		1						
ORTHOPTERA								
Gyrllacrididae								
undet. sp./spp.							1	
PSOCOPTERA								
Caecilidae								
Caecilius ?lineatus				1				
Caecilius spp.	1					1		
Ectopsocidae								
Ectopsocus albiceps				1				
Ectopsocus sp. nr. *briggsi*		1						
Pseudocaeciliidae								
Cladioneura pulchripennis					1			
THYSANOPTERA *								
Aeolothripidae								
Andrewarthaia kellyana		1						
Desmothrips sp./spp.		1				1		
Erythridothrips cubilis	1							
Phlaeothripidae								
Haplothrips ?victoriensis		1						
Haplothrips sp./spp.	1	1	1		1	1	1	1
Thripidae								
Thrips australis	1	1	1					
Thrips ?australis		1						
Thrips hawaiiensis	1							
Thrips imaginis			1					
Thrips setipennis		1	1					
Thrips sp./spp.	1	1			1	1		1

Results and Discussion

Composition of anthophilous insect assemblages can be profoundly influenced by season, variation in rainfall patterns, time of day, daily cycles of temperature and humidity, daylight length, wind, cloudiness, resource availability and foraging behaviour (Barth, 1991, Basset, 1991, Devoto *et al.,* 2009, Norgate *et al*., 2010, Williams & Adam, 2010, Willmer, 2011, Pacini & Dolferus, 2016). The availability and distribution of sun flecks also influences daily activity patterns, and increases in 'sunniness' are known to result in significant increases in insect visitation and consequent fruit set (Gross 1993). The population size of individual insect species that can be sustained within available habitat is likely to be affected by habitat fragmentation and fragment size; which have been widely shown to lead to impoverished faunas, as well as local fauna extinction (Howden & Nealis, 1975, Campbell & Brown, 1994, Aizen & Feinsinger, 1994, Didham, 1997, Laurance & Bierregaard, 1997, Aizen *et al*., 2002, Harris & Johnson, 2004, Huang & Fenster, 2007).

The anthophilous insect assemblages sampled were dominated by Coleoptera, Diptera and Hymenoptera (largely wasps and bees) (Appendix 1). Although numerous taxa >9mm in length were frequently recorded by hand-netting or by visually observing individuals (Table 1), the assemblages, with regard to both species diversity and abundance of individuals, were dominated by insects less than 6mm in length (Williams 1995, Appendix 1). Some of these (e.g., species of Elateridae, Phalacridae, Staphylinidae) were present in large numbers (Williams, 1995, G. Williams unpubl. data). The ubiquitous introduced honey bee *Apis mellifera* was recorded from all species, its presence strongly associated with peak flowering events. Native bees often do not occur in either great diversity or abundance in subtropical rainforest (Williams & Adam, 1997), however, Euryglossinae (Colletidae) were abundant in samples collected on *Syzygium floribundum* and *Tristaniopsis laurina* at Wingham. Colletidae comprise many species (especially Hylaeinae) considered pollen 'thieves' or inefficient pollination agents. Bees of the colletid subfamilies Hylaeinae and Euryglossinae, carry pollen internally in the crop, and may possess specialised brush-like structures on the forelegs with which pollen is swept into the mouth (Michener & Houston, 1991, Exley *et al*., 1993, Houston, 2018); the pollen being harvested for the nutritional benefit of the insects, with few grains incidentally caught on their bodies potentially available for pollination. Buprestidae are well represented, with the speciose and almost endemic Australian genus *Castiarina* known for its co-association (if not co-evolution) with xeric- and mesic-adapted Myrtaceae (Barker, 2006, Bellamy *et. al.,* 2013). The higher incidence of *Castiarina* species (Fig. 2.) recorded from *Syzygium floribundum* in rainforest at Lorien Wildlife Refuge (Table 1) possibly reflects more intensive observation and sampling at that site. However, this diversity was not shared with adjacent co-flowering *Tristaniopsis laurina*; although overlaps in flowering did not occur in each season. Species recorded include a number of predators and parasites (e.g., Eumeninae, Sphecidae, Gasteruptiidae), which as adults also feed on nectar (Naumann *et al.,* 1991, Williams & Adam, 1995). 'Flower wasps' (now Thynnidae, but the species observed were previously placed in Tiphiidae [Johnson *et al.,* 2013]), were at times numerous. Birds were rarely observed, though we do not dismiss their occasional role as pollinators.

Although most anthophilous insects are nectar feeders, a number eat pollen (e.g., certain Chrysomelidae, Coccinellidae, Colletidae, Thysanoptera) but are capable of transporting small pollen loads between flowers (e.g., Appanah & Chan, 1981, House, 1985, 1989, Suetsugu *et al*., 2018). Thysanoptera (e.g., *Thrips setipennis*) are known pollinators of plants in subtropical rainforests (e.g., *Wilkiea huegeliana,* Monimiaceae, *Maclura cochinchinensis*, Moraceae) and in other types of vegetation and on other species (Williams *et. al.*, 2001), such that their potential as pollination agents should not be dismissed.

Pollination generalism by suites of small-sized insects is widely recorded among flowering plants (e.g., Bawa, 1994, Waser *et al*., 1996, Sakai *et al*., 1999, Fontaine *et al*., 2009, Maldonado *et al*., 2013, Hasegawa *et al*., 2013, Grant *et al*., 2017, Webb, 2018), and is a strategy considered ancestral in angiosperms (e.g., Shusheng *et al*., 2008). In addition to being on *Syzygium floribundum, Syzygium smithii* and *Tristaniaopsis laurina* small-sized Coleoptera-, Diptera- and Hymenoptera-driven pollen transfer strategies are commonly exhibited by other mass-flowering rainforest trees and shrubs (Williams 1995, Williams & Adam 2010, 2013), in temperate Australia (Ettershank & Ettershank, 1990), and tropical rainforests world-wide (Bawa & Hadley, 1990, Devy & Davidar, 2003, Corlett, 2004). It is a strategy employed by other local lowland rainforest- and wet sclerophyll-associated Myrtaceae (e.g., *Rhodomyrtus psidioides, Rhodamnia rubescens, Backhousia myrtifolia, Syzygium oleosum* [Williams, 2018, G. Williams pers. obs.]), as well as by Myrtaceae in other south-eastern Australian plant communities (Hawkeswood, 1981, 1987, Webb, 1986a, 1986b, 1987, 1989, Griffin *et al*., 2009). However, in our study region, local populations of non-myrtaceous rainforest species (e.g., *Alphitonia excelsa*, Rhamnaceae), whose flowers are otherwise frequented by numerous small insects, may be visited in some years by abundant larger-sized pollinators such as aculeate wasps (Williams & Adam, 1995, 2001, 2010).

General entomophily is exhibited by subtropical *Syzygium floribundum* and *S. smithii* populations, but more ecologically-specialised adaptation to vertebrate and invertebrate pollinators (partly reflected by ramiflorous and cauliflorous positioning of flowers, as in *Syzygium cormiflorum*) is strongly expressed in several Australian tropical species, for example *Syzygium sayeri, S. cormiflorum* and *S. tierneyanum* (Hopper, 1980, Crome & Irvine, 1986, Nic Lughadha & Proença, 1996, Boulter *et al*., 2005). However, general entomophilous pollination strategies are also present in tropical species of *Syzygium*; such as *S. syzygioides* from the lowland rainforests of Sulawesi (Lack & Kevan, 1984), North Queensland's *S. gustavoides* (Kitching *et al*., 2007), and *S. alternifolium, S. heyneanum*, and *S. travanocoricum* from the Western and Eastern Ghats of India (Raju *et al*., 2014, Kuriakose *et al*. 2018).

The populations of individual tree species in mid-north coast NSW lowland rainforests are usually widely dispersed within stands, with a high proportion being obligate out-crossers and existing at low population densities; often few or single trees (Williams, 1995, Williams & Gerrand, 1998a, 1998b, Adam & Williams, 2001). Most flower between October to February (Williams, 1995) and therefore, if present in the same stand, would be competing for pollinators from the same pool of species as that from which the three study species recruit. Species at this latitude are predominantly insect-pollinated, with wind-pollination being a strategy employed by only a few (e.g., *Podocarpus elatus,* Podocarpaceae, *Streblus brunonianus,* Moraceae [Williams & Adam, 1993, 2010]), and vertebrate-adapted species (see Williams & Adam, 2010) being represented solely by *Banksia integrifolia* (Proteaceae) in littoral rainforest remnants (Law, 1993) (and very tall examples associated with elevated hinterland cool temperate rainforest [Adam 1992]). However, the small suite of trees discussed in this paper share a broad spectrum of putative pollinators (Table 1) and this may facilitate ecological resilience and flexibility (e.g., from perturbations of pollinator webs) in achieving pollen transfer and fertilization (Memmott *et al*., 2004, Williams & Adam, 2013, Weismann & Schaefer 2017). Though numerous insects (e.g., some bees and beetles) exhibit resource foraging constancy when flowering events (floral resources) peak, the attendant native anthophilous insect fauna overwhelmingly comprises species with no known fidelity to particular tree or shrub species (Williams, 1995, Williams & Adam, 2010). With the exception of a few bees (e.g., *Amegilla, Xylocopa*) known to exhibit trap-lining foraging patterns (Gross, 1993), individual insects generally are promiscuous in their recruitment habits, being attracted to whatever mass-flowering trees are seasonally in bloom. Consequently co-flowering general entomophilous trees compete for pollinators, with pollen flow between dispersed trees within populations predicted to be non-directional and uncertain. This may have important consequences for the reproductive success and survival of obligate out-breeders and the evolution of floral traits (Renner & Feil, 1993, Bawa, 1994, Minnaar & Anderson, 2019).

The variation in numbers between taxa listed in the checklist (Table 1) in part reflects marked differences in the number and timing of samples and observations undertaken, and the reduced ability to identify species in certain taxa beyond that of order or family (though this did not obstruct recognition of RTUs [given fully in Williams 1995, and in part here in Appendix 1]). However, sampling of mass-flowering canopy trees is unlikely to record the 'total fauna'. 'Rare' species are inherently elusive, and others will be unsampled. We have no sound understanding of the total available pollinator fauna (see discussion in Wardhaugh, 2015). Diptera, in particular, are significantly under-represented in Table 1 (compare with Appendix 1) due to the paucity of available taxonomic expertise with the time required to confront the enormity and taxonomic scope of mass samples produced from studies such as this (e.g., > 20,000 Diptera, approx. 75 percent of which were less than 5 mm in length). In addition, taxonomists rarely concentrate their interests on more than a few families. Consequently, the list is indicative of the wide taxonomic range of species and families that may be encountered, but suggests a rich fauna from which pollinators can be recruited throughout the broader extent of subtropical rainforest found along Australia's eastern seaboard. The list includes numerous larger insects (e.g., various Cetoniinae, Cerambycidae, Papilionidae, aculeate wasps) that undertake frequent and relatively long distance inter-plant movements that may facilitate out-crossing among otherwise self-incompatible Myrtaceae (such as *Syzygium floribundum, Syzygium smithii* and *Tristaniopsis laurina*) (Williams & Adam, 1998, Adam & Williams, 2001). Where species are self-incompatible, the long term survival of single individuals may be tenuous for they are functionally extinct unless populations can be enhanced, or they are agamospermous and able to reproduce by non-sexual means. The limited sampling of a single population of *Syzygium smithii* at the inland Woko site does not allow us to attribute any differences in the insect assemblage between the small-leaved form of that species and the more widespread broad leaved form. However, it is interesting that there are differences.

When our study commenced the advent of the South American pathogen *Austropuccinia psidii* was not anticipated, and its consequent impact on Australian Myrtaceae thus unforeseen; not least the possibility of one of the original Williams 1995 study plants, the related myrtaceous tree *Rhodomyrtus psidioides,* becoming extinct (Makinson, 2018b, Williams, 2018). Anthophilous insects associated with this species are given in Williams (2018).

A native to South America, and possibly Central America, Myrtle rust was first discovered on the New South Wales Central Coast in 2010 and has since spread rapidly reaching far northern Queensland and Melville Island in the Northern Territory by 2015 (Makinson, 2018b). It is now widely established in mesic vegetation communities along the east coast and coastal escarpment, has penetrated onto parts of the tableland in Queensland, and poses a high risk to Australia's natural, social and economic assets. The pathogen has been recorded on a large number of Myrtaceae and is now believed to threaten the survival of numerous susceptible tree and shrub species and genera (e.g., *Angophora, Archirhodomyrtus*, *Callistemon, Corymbia, Decaspermum, Leptospermum, Melaleuca, Syzygium* and many others) (Simpson *et al*., 2006, Invasive Species Council, 2011, Carnegie *et al*., 2016, NSW Scientific Committee, 2017, Pegg, 2017, Pegg *et al*., 2017, Makinson, 2018a, 2018b). Myrtaceae comprise about 10 percent of Australia's native plant species and the family is an important component of Australia's ecosystems, being structurally and floristically dominant in many (Pegg *et al*., 2017, Makinson 2018b). Makinson (2018b) notes that Myrtle rust has already proved capable of affecting at least 358 native plant species or subspecies (in about 49 genera). He stresses this is only an interim assessment, but illustrates the pathogen's potential to initiate wide scale declines in the extent and abundance of highly susceptible native species, the risk of regional or total extinctions, invasion of currently uninfected areas, the consequent loss of ecological functions within ecosystems, as well as secondary declines of plants and animals closely associated with affected organisms and habitats. As an example of the pathogen's threat level Pegg *et al*. (2017) observed that in wet sclerophyll forest and rainforest sites in south-eastern Queensland there was a massive floristic change with the prior 94 percent dominance of Myrtaceae, in the forest mid-storey being reduced to 63 percent and 37 percent in the 'regeneration' layer.

As a result of the pathogen's wide establishment within Australia, several rainforest-associated trees and shrubs, for example *Rhodomyrtus psidioides* (G. Don) Benth and *Rhodamnia rubescens* (Benth.) Miq. (NSW Scientific Committee, 2017, Pegg *et al*., 2017, Makinson, 2018b, Williams, 2018), are threatened with extinction in nature unless successful recovery strategies can be implemented (Makinson, 2018a, 2018b). Although *Syzygium floribundum, S. smithii* and *Tristaniopsis laurina* in the Manning Valley do not appear to be affected by Myrtle rust, possible extinction events more generally within the Myrtaceae may potentially initiate catastrophic 'landscape-scale' ecological impacts on native plant and animal communities (Pegg *et al*. 2017, Makinson, 2018a).

Many of the larger Coleoptera and Hymenoptera recorded during our study have distributions extending well beyond the New South Wales North Coast, and are known to frequent an array of non-myrtaceous plants growing in open forests, woodland and shrub complexes (Brooks, 1948a, 1948b, 1965, Williams & Williams, 1983, Walton, 1985, Houston, 1992, Cardale, 1993, Braby, 2000, Bellamy *et al*., 2013). This implies a broad pool of putative pollination agents available to the rainforest Myrtaceae flora: but maintenance of the regional generalist pollinator fauna requires the retention of macro- and microhabitats, as well as host resources, for immature insect stages (which are generally poorly known), as well as adult populations. Therefore, should conservation translocations of threatened Myrtaceae be required to avoid Myrtle rust-induced extinction events, as may be the case for *Rhodomyrtus psidioides* (Makinson 2018a), a need to translocate obligate pollinators seems unlikely to arise. Possible obligate host plant-invertebrate herbivore associations and their potential vulnerability to co-extinction (see Moir *et. al*., 2012, Moir, 2013), however, remain to be investigated.

It is possible that more Myrtaceae may be listed as endangered as a result of susceptibility to Myrtle rust, although there is the potential that in some species there may be variation in susceptibility, as has been regionally noted for *Rhodamnia rubescens* (G. Williams pers. obs.), such that under the strong selection pressure imposed by the pathogen less susceptible plants may be selected for so that over time populations may become resistant. However, will the decline or loss of some species have consequences for their associated anthophilous insect community? Reduction in the size of the Myrtaceae population might reduce the resources available for insects, so that the total insect population that can be sustained will be reduced. None of the insect species recorded from the three Myrtaceae species discussed in this paper have obligate associations with flowering plants, so loss of resources, while affecting population size, is unlikely to be directly responsible for reducing the conservation status of individual insect species.

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Appendix 1. Selected examples of numbers of individual insects and taxa (as morphospecies/RTUs) from mass-collected samples (after Williams, 1995). Key:'Ind./spp.' = number of individuals/ number of insect species (RTUs). Date of sample cited. 'T' = tree. Month of collection follows day. Where cited 'm' = sample collected in morning (between 9-11am), 'a' sample collected in afternoon (between 1-3pm)

Syzygium floribundum **LorienWildlife Refuge**	Ind./spp. T1. m. 29.11.1991	Ind./spp. T1. a. 29.11.1991	Ind./spp. T1. m. 5.12.1991	Ind./spp. T1. a. 5.12.1991		
total Coleoptera	288/23	104/15	118/15	153/17		
total Diptera	153/30	149/19	106/17	95/26		
total all Hymenoptera	69/46	55/42	12/9	30/21		
s/total bees	31/19	26/13	1/1	11/6		
total visitors	529/108	325/82	240/44	284/70		
total individuals <6mm	524	314	227	275		
total individuals >9mm	5	5	1	1		
Syzygium floribundum **LorienWildlife Refuge continued.**	Ind./spp. T2. m. 29.11.1991	Ind./spp. T2. a. 29.11.1991	Ind./spp. T2. m. 5.12.1991	Ind./spp. T2. a. 5.12.1991		
total Coleoptera	161/20	58/14	482/27	186/31		
total Diptera	477/24	235/18	139/26	103/17		
total all Hymenoptera	48/35	41/25	31/19	31/23		
s/total bees	27/17	21/12	13/7	20/14		
total visitors	705/88	345/62	675/83	327/75		
total individuals <6mm	691	326	665	314		
total individuals >9mm	4	1	5	5		
Syzygium floribundum **Wingham Brush Nature Reserve**	Ind./spp. T2. m. 19.11.1991	Ind./spp. T2. a. 19.11.1991	Ind./spp. T2. m. 27.11.1991	Ind./spp. T2. a. 27.11.1991	Ind./spp. T2. m. 3.12.1991	Ind./spp. T2. a. 3.12.1991
total Coleoptera	11/7	40/14	44/16	39/19	27/16	83/29
total Diptera	166/14	366/26	257/21	766/39	428/26	508/25
total all Hymenoptera	15/11	23/15	31/12	107/34	45/19	83/29
s/total bees	9/6	11/7	11/5	14/7	18/6	21/9
total visitors	202/36	449/63	343/53	980/105	542/72	707/92
total individuals <6mm	189	415	313	949	517	657
total individuals >9mm	3	4	6	10	12	28
Syzygium floribundum **Wingham Brush Nature Reserve continued.**	Ind./spp. T2. m. 10.12.1991	Ind./spp. T2. a. 10.12.1991	Ind./spp. T2. m. 17.12.1991	Ind./spp. T2. a. 17.12.1991		
total Coleoptera	27/14	70/32	54/22	28/16		
total Diptera	627/24	406/25	253/26	274/25		
total all Hymenoptera	75/22	73/28	57/22	58/26		
s/total bees	53/12	14/8	31/9	20/10		
total visitors	755/63	569/97	380/81	365/72		
total individuals <6mm	737	530	331	342		
total individuals >9mm	8	13	28	10		
Syzygium smithii **- Lansdowne Nature Reserve.**	Ind./spp. T1. 6.11.1990	Ind./spp. T1. 12.11.1990	Ind./spp. T1. 15.11.1990			
total Coleoptera	157/35	308/51	155/26			
total Diptera	265/18	273/19	87/19			
total all Hymenoptera	21/17	29/17	9/9			
s/total bees	4/4	5/4	2/2			
total visitors	491/84	696/107	261/54			
total individuals <6mm	471	656	234			
total individuals >9mm	3	2	2			

***Syzygium smithii* -** **Manning Point.**	Ind./spp. T1. 3.11.1990	Ind./spp. T1. 8.11.1990	Ind./spp. T1. 15.11.1990	Ind./spp. T2. 8.11.1990	Ind./spp. T2. 15.11.1990	
total Coleoptera	25/13	107/17	34/7	79/28	1199/12	
total Diptera	43/12	64/15	35/11	86/16	95/23	
total all Hymenoptera	16/11	15/6	25/4	18/8	8/8	
s/total bees	10/5	10/1	1/1	11/5	0/0	
total visitors	98/41	193/41	99/27	188/55	1318/51	
total individuals <6mm	83	184	96	177	1318	
total individuals >9mm	0	7	1	8	2	
***Syzygium smithii* –Woko** **National Park.**	Ind./spp. T1. m. 25.11.1990	Ind./spp. T1. a. 25.11.1990	Ind./spp. T1. m. 5.12.1990	Ind./spp. T2. m. 25.11.1990	Ind./spp. T2. a. 25.11.1990	Ind./spp. T3. m. 5.12.1990
total Coleoptera	83/26	131/34	214/32	61/35	34/19	1425/56
total Diptera	130/17	60/19	51/16	38/14	25/16	139/23
total all Hymenoptera	7/6	31/16	22/12	21/11	33/21	29/14
s/total bees	0/0	6/6	1/1	0/0	2/2	2/1
total visitors	341/57	309/81	338/73	157/71	180/72	1663/104
total individuals <6mm	242	258	320	145	167	1464
total individuals >9mm	11	38	7	4	5	15
***Tristaniopsis laurina* –** **Lorien Wildlife Refuge.**	Ind./spp. T1. m. 26.12.1991	Ind./spp. T1. a. 26.12.1991	Ind./spp. T1. m. 3.1.1992	Ind./spp. T1. a. 3.1.1992	Ind./spp. T1. m. 6.1.1992	Ind./spp. T1.a. 6.1.1992
total Coleoptera	24/16	10/9	40/9	35/12	42/13	18/10
total Diptera	107/21	28/7	80/29	49/14	311/26	163/20
total all Hymenoptera	32/28	19/15	18/13	45/34	33/25	33/23
s/total bees	11/10	11/7	3/3	27/18	5/1	5/4
total visitors	197/69	57/31	140/52	133/64	402/71	221/59
total individuals <6mm	180	45	131	108	394	215
total individuals >9mm	12	6	4	12	6	2
***Tristaniopsis laurina* –** **Wingham Brush Nature Reserve** **continued.**	Ind./spp. T3. m. 2.1.1992	Ind./spp. T3. a. 2.1.1992	Ind./spp. T3. m. 2.1.1992	Ind./spp. T3. a. 2.1.1992	Ind./spp. T4. m. 7.1.1992	Ind./spp. T4. a. 7.1.1992
total Coleoptera	62/17	99/14	85/15	90/17	390/16	194/9
total Diptera	168/18	319/19	283/20	120/24	169/20	121/20
total all Hymenoptera	31/17	102/35	45/25	43/14	26/12	38/15
s/total bees	11/5	22/13	14/5	7/5	6/3	6/3
total visitors	274/59	531/72	421/66	260/59	592/52	358/52
total individuals <6mm	253	487	399	236	585	353
total individuals >9mm	0	7	10	9	2	2