The published article can be found at the Journal of Apicultural Research 52(2): 1-7 (2013)

ORIGINAL RESEARCH ARTICLE

The Australian stingless bee industry: a follow-up survey, one decade on.

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Received 16 April 2012, accepted subject to revision 25 September 2012, accepted for publication 11 November 2012.

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Summary

In 2010, an online survey was conducted to assess the current status of the Australian stingless bee industry and its recent development. This was a follow-up survey conducted approximately one decade after the first study, by Heard and Dollin in 1998 / 99. It showed that the Australian industry had grown over the past ten or so years but is still underdeveloped. There was a 2.5-fold increase in the number of bee keepers and a 3.5-fold increase in the number of domesticated colonies. Seventy-eight percent of bee keepers were hobbyists, 54% of whom owned only one colony. Most colonies were kept in suburban areas. Two species, *Tetragonula carbonaria* and *Austroplebeia australis*, dominated the relatively short list of species kept. There was a high demand for Australian stingless bee colonies and their honey, but with less than 250 bee keepers currently propagating colonies, and many of them on a small scale, it is difficult to meet this demand. Pollination services were provided by less than 4% of the major stakeholders within the industry. Further research and development in the area of colony propagation may see this industry grow more quickly.

Key words: Meliponiculture, pollination, sugarbag, colony, propagation, *Tetragonula*, *Austroplebeia*

Introduction

Stingless bees (Hymenoptera: Apidae) are in the tribe Meliponini (Michener, 2000). The culture of Meliponine bees (meliponiculture or stingless bee keeping) is the practice by which bee keepers maintain, reproduce and utilize stingless bee colonies, of various species, for profit. Colonies can be managed within artificial hives which enables bee keepers to propagate colonies as well as produce hive products such as honey, pollen, cerumen and propolis. They can also provide pollination and educational services (Heard and Dollin, 2000). The level of development of meliponiculture varies around the world, with it being most advanced in tropical American countries (Cortopassi-Laurino *et al.*, 2006), where there are many more species (Michener, 2000; Camargo and Pedro, 2012) and where ancient forms of meliponiculture exist (Quezada-Euán *et al.*, 2001).

In the northern regions of Australia, stingless bees have been highly regarded by indigenous Australians for many centuries and hive products have played an important part in their culture (Akerman, 1979, Souza *et al.*, 2006). Today, bee keepers manage bees in artificial hives and sustainably harvest products such as honey, known as 'sugarbag', and cerumen, a plant resin and beeswax mixture. These products are sold to tourism centres, gift shops, health food stores and restaurants as well as being sold online. There has been increasing awareness and demand for 'bush tucker' and stingless bee honey is one of the prized foodstuffs (Cortopassi-Laurino *et al.*, 2006; Souza *et al*., 2006). *Tetragonula carbonaria* Smith honey possesses a peculiar fermented odour and aroma, making it an unusual but appealing product (Vit *et al.*, 2011).

When work first began with *T. carbonaria*, in 1984, the Australian stingless bee industry was almost non-existent (Heard and Dollin, 2000). Since then, interest in stingless bee keeping has increased, and conservation groups have also been established, especially along the eastern regions of the country. Various groups successfully sought permission to remove and relocate nests under threat from tree clearing. These naturally occurring colonies were transferred to artificial hives and later used for production of domesticated colonies. Husbandry techniques developed by Heard (1988) and others (Klumpp, 2007) as well as educative publications by the Australian Native Bee Research Centre (ANBRC), New South Wales, helped to facilitate the growth of this industry.

In 1998-99, a survey to ascertain the status of the industry at that time, found that it was very much in its infancy but was growing and had potential for

expansion over the next few decades. The survey concluded that 62 bee keepers used their 317 colonies for crop pollination (Heard and Dollin, 2000), but it was not clear how many of those bee keepers provided those services professionally, charging service fees. Heard and Dollin (2000) predicted that 24,000 colonies would be domesticated by the year 2010. No further research had been conducted in this area and it was unclear as to whether the Australian stingless bee industry had developed over the last decade.

In this study we report on a follow-up survey; a little more than one decade on, which was conducted to elucidate how the Australian stingless bee industry had changed. Information obtained from the new survey conducted in 2010 allowed for a comparison between it and data obtained in 1998-9. One of the key intended outcomes of the survey was to identify areas within the industry needing research for its further development.

Materials and methods

The follow-up survey design was based on the original 1998-9 survey, with 11 multiple choice or short answer questions. Additional questions were included in the 2010 survey in an effort to optimise the data comparisons. Therefore, the first question asked if the participant had completed the 1998-9 survey. One additional question regarding honey production and 15 additional questions pertaining to pollination were also included, to gain a more detailed picture of the services provided by stingless bee keepers in these activities.

An online survey was designed and produced through 'Survey Monkey' (www.surveymonkey.com). Participants with aggressive firewalls were only able to access and complete the first page of the survey. While it was not possible to overcome the download problems the first page of the survey generated basic, useful data which helped to obtain an overview of the industry, such as stingless bee species, location and colony numbers. The survey proceeded with the knowledge that a small percentage of respondents would be unable to complete the entire survey. **A copy of the original survey form can be downloaded from www.beesbusiness.com.au or by contacting the corresponding author.**

The online survey was made available for public access from 4 July to 31 August 2010. A press release resulted in the advertisement of the survey in over ten rural and metropolitan newspapers or magazines throughout New South Wales, Queensland and the Northern Territory during the survey period. An on-air interview with presenters on Australian national radio Australian Broadcasting Commission Sydney radio 702 increased the profile of the survey noticeably. The survey was also advertised through the ANBRC *Aussie Bee Email Update* newsletter (www.aussiebee.com.au/emailupdate.html), which is sent to over 2,000 recipients, as well as the Australian Native Bees Yahoo Group (www.australiannativebees.com/). Email notification containing the online survey link and an electronic version of the survey were sent to known bee keepers. More than 80 mail-out packages were posted to bee keepers who were not internet users. All surveys remained anonymous and data obtained from returned postal survey data were manually entered into the on-line survey. Survey data were downloaded weekly. The final data, downloaded on 31 August 2010, were used in the comparative analysis of industry growth.

Results

Overall comparison between surveys

The first page of the survey included questions pertaining to previous survey participation, bee species and nest numbers. The total number of respondents (n = 637) completing the first page showed that over the last decade stingless bee keeper numbers had increased 2.5-fold, from 298 to 635, and the number of nests they kept had increased almost 3.5-fold, from 1,429 to 4,935 (Table 1).

The most commonly 'kept' bee species were *T. carbonaria*, *Tetragonula hockingsi* Cockerell and *Austroplebeia australis* (Friese). Of these, *T. carbonaria* (61.5% of colonies) was the most popular species, which was kept by 74% of the survey respondents, with *A. australis* (22.9%) the second most popular, followed by *T. hockingsi* (8.8%) (Table 1). The remaining 6.8% was made up of *Tetragonula clypearis* Friese, *Tetragonula sapiens* Cockerell, *Tetragonula davenporti* Franck, *Austroplebeia symei* (Rayment) and unknown species.

In 1998-99, 10% of stingless bee keepers owned *A. australis* colonies and these accounted for only 9% of the total number of colonies. In 2010, however, 16% of bee keepers owned *A. australis* colonies. The number of colonies kept by bee keepers ranged from 1 to 476, and single-colony ownership accounted for 57% of respondents (n = 361). Only 5.3% of the bee keepers (n = 35) owned more than 20 colonies, four bee keepers owned between 100 and 200, whereas five bee keepers owned more than 200 colonies each (Fig. 1).

Table 1. Comparative differences between the survey data collected in 1998-99 and in 2010.

Parameters	**1998-99**	**2010**
Number of beekeepers	298	635
Residing in New South Wales (%)	29	38
Residing in Queensland (%)	71	61
Residing in Northern Territory (%)	< 0.5	< 0.5
Number of stingless bee nests	1425	4935
Located in New South Wales (%)	9	16
Located in Queensland (%)	91	84
Stingless bee species kept (%)		
Tetragonula carbonaria	50	61.5
Tetragonula hockingsi	7	8.8
Austroplebeia australis	9	22.9
Other	34	6.8
Nest locations (%)		
Suburban areas	56	67
Rural	24	20.5
Near bush	20	12.5
Honey production		
Number of stingless bee keepers	26	63
Number of stingless bee hives	542	1725
Total honey production (kg / year)	90	254
Stingless bee colony propagation		
Number of stingless bee keepers only transferring nests	58	99
Number of nests involved	1240	5093
Number of stingless bee keepers only dividing colonies	17	139
Number of nests involved	857	6328
Number of stingless bee keepers manipulating nests	119	238

Detailed analysis and comparisons

Eighty-nine percent (n = 568) of respondents were able to progress past page 1, and these respondents owned a total of 4,086 stingless bee colonies. Detailed data from these respondents were compared to the data from the previous 1998-99 survey. All but three survey respondents, with stingless bee hives in the Northern Territory, resided in New South Wales or Queensland.

Summary of bee keepers and their stingless bee colonies

The following information pertains to the comparison of data collected in the 1998-99 and 2010 surveys. The number of bee keepers increased in both Queensland (208 to 346) and New South Wales (83 to 215); however, there was an almost 10% shift, with New South Wales bee keepers increasing from 29% to 38% of the overall number (Table 1). Nest numbers also demonstrated an increasing shift to New South Wales, but only by 7% (Table 1). Forty-three percent (n = 241) of bee keepers owned more than one hive, but only 15% of these kept two or more bee species.

Enjoyment and conservation were, by far, the most popular reasons for keeping stingless bees (Table 2) and 80% of single-colony owners kept their colonies for these purposes. Over two-thirds of bee keepers maintained their colonies on suburban blocks (Table 1), although 41% of these also lived within half a kilometre of some form of native vegetation (Postcodes of residents who stated they lived near bushland were used to locate residential areas on Google Earth®, and verify the existence of remnant bushland in the area).

Newcomers, those bee keepers with less than one year of experience, accounted for 25% of respondents and those with less than three years' experience accounted for 40% of bee keepers (Fig. 2). Thus, 57% of the bee keepers owned just one colony and a quarter of those had less than three years' experience. Only 8% of respondents reported that their nests remained in the original cavity, compared to 18% in 1998-9.

Table 2. Reported reasons for keeping stingless bees.

Reasons for keeping stingless bees	**1998-99 (%)**	**2010 (%)**
Enjoyment	81	78
Conservation	68	67
Pollinate bushland	27	29
Pollinate crops	24	24
Honey production	8	11
Hive sales	5	3
Education	5	12
Research	2	4
Other hive products (resin, wax)	2	2
Professional crop pollination services	---	1

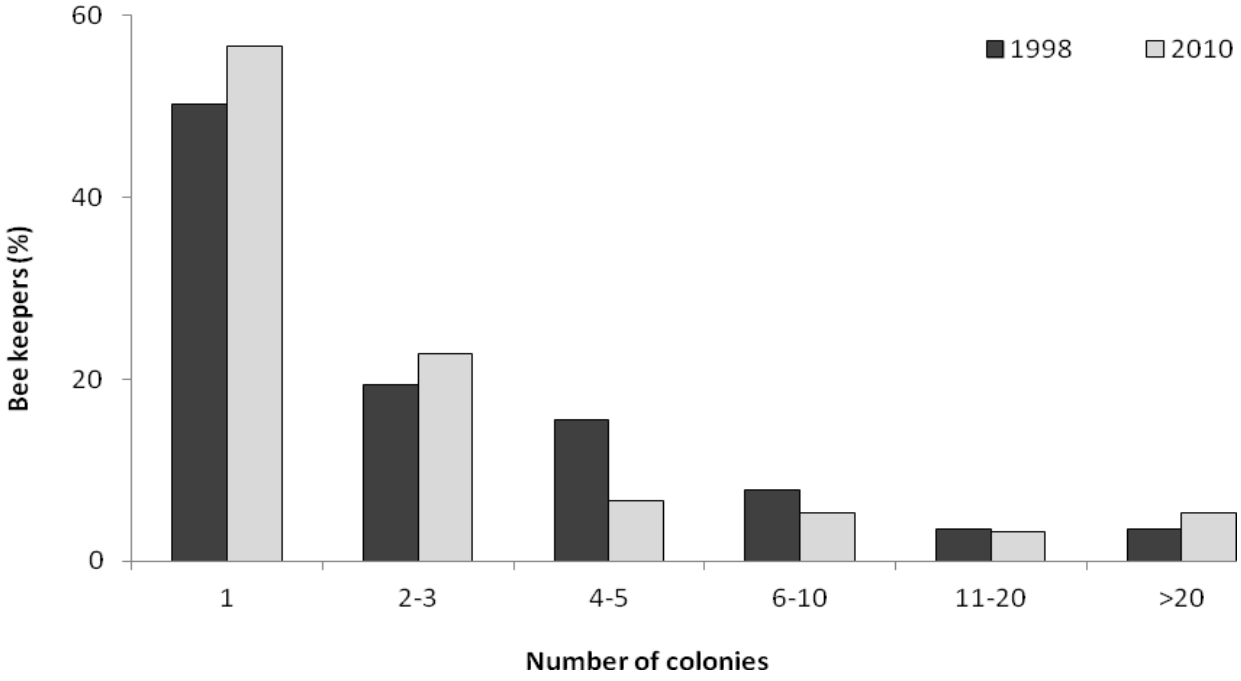

Fig. 1. Number of stingless bee colonies reported to be owned by bee keepers in the 1998-9 and 2010 surveys.

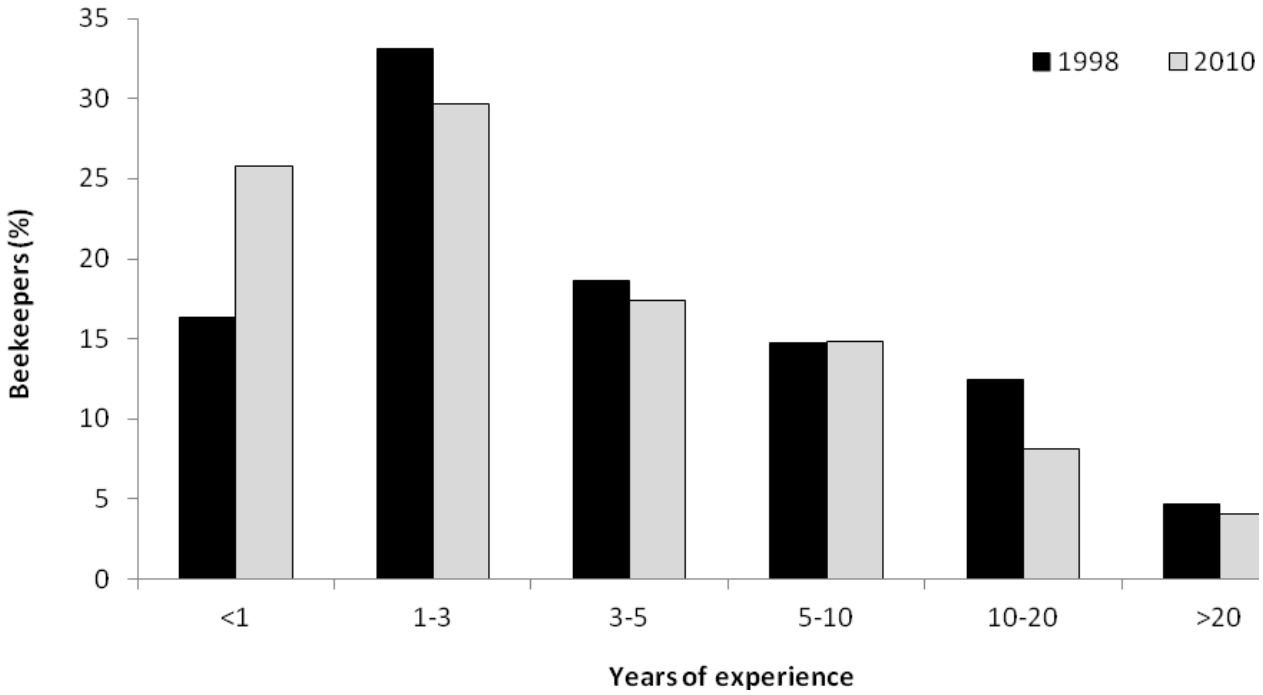

Fig. 2. Number of years of stingless bee keeping experience of respondents.

Honey production

The number of bee keepers harvesting honey had more than doubled (26 to 63), resulting in an almost three-fold increase in annual honey production (90 to 254 kg / yr) (Table 1). Of the 63 bee keepers who stated they harvested honey, only five reported selling their product, and this group accounted for approximately half of the overall production. Those who sold their product distributed it through local markets, restaurants and via the internet, and two producers exported to Japan.

Colony propagation

Since 1998-99, the number of stingless bee keepers involved in colony manipulation had doubled (119 to 238); however, the number of bee keepers practicing colony divisions had increased eight-fold (17 to 139) (Table 1). In 2010, 238 bee keepers reported they had produced a total of 11,421 colonies through nest / hive manipulation. Fifty-five percent of these colonies were produced by division (Table 1), compared to 29% in 1998-9. Over the past decade, the number of bee keepers selling colonies more than doubled (10 to 25); however, the number of colonies sold each year had more than quadrupled (103 to > 460 / yr). Approximately 18% of bee keepers made their own hives in 2010; most of them being based on the original Australian *Trigona* hive (OATH) (Dollin and Heard, 1999) design or similar, with 7 to 10 L internal capacity.

The overall annualised growth, through colony propagation, was 12% per year (i.e. 1,429 in 1998-9 to 4,935 in 2010). In Question 1 of the 2010 survey, respondents were asked if they had participated in the original 1998-9 survey and only 28 answered 'yes' to this question. Based on the colony ownership (n = 1,757) of these 28 bee keepers, the following information was used to estimate annual colony propagation by some of the original survey respondents. In 1998-9, 84 bee keepers predicted a 15% per year growth in colony numbers over ten years. These 84 bee keepers owned an average of nine colonies each. In 2010, the 28 stingless bee keepers who completed the original survey owned an average of 63 colonies each (1,757 / 28). Thus, these bee keepers actually increased their colony ownership from nine colonies each to 63 colonies each, an increase of 19% per year.

Pollination

In 2010, eight bee keepers reported that they provided pollination services on a professional basis; and of these, only four charged a service fee. One bee keeper charged $AU10 per colony while the other three charged from $AU35 to 40 per colony. Pollination service providers reported a variety of crops which benefited from the introduction of stingless bees or which were undergoing trials with stingless bee pollinators (Table 3).

Table 3. Crops reported to benefit from stingless bee pollination services.

Common name	Genus and species	Pollination service district
Macadamia	*Macadamia tetraphylla, M. integrifolia*	North coastal New South Wales (NSW) & southern / central Queensland (Qld)
Lychee	*Litchi chinensis*	North coastal NSW, southern / central Qld
Watermelon	*Citrullus lanatus*	North coastal NSW, southern / central Qld
Avocado	*Persea americana*	North and mid-north coastal NSW & southern / central Qld
Blueberry	*Vaccinium* spp. (under trial)	North and mid-north coastal NSW
Mango	*Mangifera indica*	North coastal NSW, southern / central Qld

Question 27 of the 2010 survey was an open-ended question which asked participants to nominate areas where they thought the industry needed most research and development support. The respondents who were active in colony reproduction expressed a need for research in the areas of queen breeding, colony multiplication, colony stocking rates for pollination and swarm capture. They also identified a need for education in all of these areas. Many of these respondents reported that demand for colonies and honey was high and that they were unable to keep up with this demand.

Discussion

The Australian stingless bee industry is still small, but it has grown over the past decade or so. Reported bee keeper numbers have increased by 114% since 1998, a much greater rate of growth compared to the Australian honey bee industry which increased membership by only 3% between 2000 and 2006. Stingless bee colony numbers have increased by 245% whereas honey bee colony numbers have increased by only 17% for this same period (Rodríguez et al., 2003, Crooks, 2008).

Single-colony ownership accounts for over half of the domesticated colonies, and a quarter of those bee keepers have less than three years' experience. Additionally, 80% of single-colony owners obtained their colony for the purpose of conservation or enjoyment, demonstrating that there is still a high novelty value in the industry (Heard and Dollin, 2000). Similarly, of the 9,900 registered honey bee keepers in Australia, 8,200 (83%) are hobbyists (Crooks, 2008). The keeping of stingless bees as "pets" is supported by

the reported increase in *A. australis* colony ownership. This species is not, as yet, utilised in crop pollination, and is seldom used in honey production, as are *T. carbonaria* or *T. hockingsi*. Ninety percent of *A. australis* owners stated they kept their colonies for enjoyment. *Austroplebeia* colonies do not store as much resin in their nests and are less aggressive than *Tetragonula* species. As a result, it is possible to more easily observe in-hive activities and gain greater enjoyment. Stingless bees as 'pets' is a market which could be well exploited by colony producers. In ten years, the retail value of a strong stingless bee colony in Australia has increased from $AU200 to approximately $AU400 per colony (R Zabel, T Carter, personal communication). Taking into account the 327 single-colony owners in this survey, that is over $AU130,000 in revenue from hobbyists alone.

In 2010, many of the survey respondents listed conservation as a major reason for keeping their colonies. There has been a boost in conservationist bee keeper numbers, probably as a result of community awareness programmes. These programmes increase understanding of wildlife and encourage conservation of various native species, including stingless bees (www.kmc.nsw.gov.au/www/1190-wildthings.asp; www.wildthings.org.au).

Based on overall colony ownership (i.e., 637 bee keepers with 4,939 colonies) the Australian stingless bee industry has experienced a growth rate of 12% per year, which is close to that predicted (15%) by bee keepers who took part in the 1998 / 99 survey (Heard and Dollin, 2000). However, if figures were derived from survey participants who took part in both the 1998-9 and the 2010 studies (i.e., 28 bee keepers with 1,757 colonies), increased colony propagation achieved by those bee keepers is 19% per year. This figure is closer to that predicted (30%) by Heard and Dollin (2000), who themselves actively manipulated nests for colony propagation. No matter how the growth is calculated, there has clearly been an increase in colony propagation over the last decade. None-the-less, this industry is tiny compared to the well established Australian honey bee industry, whose 1,702 commercial bee keepers (excluding the large number of amateur bee keepers) own 571,968 colonies (Crooks, 2008).

As previously stated, surveyed bee keepers owned 4,939 colonies; however, this number conflicts with the reported number of colonies propagated (11,421) by the 238 bee keepers who manipulate nests. Whilst every effort was made to obtain responses from as many stingless bee keepers as possible, it is likely that a number could have been missed. Another reason for the conflict in colony propagation vs. ownership may be due to colony death. In the 2010 survey, 13 bee keepers reported colony losses due to pesticide poisoning, starvation, pest infestation or for reasons unknown.

Both surveys were useful in obtaining information on specific areas of Australian meliponiculture. The number of bee keepers involved in colony manipulation has doubled since 1998-9, and the practice of colony division has increased eight-fold, opening greater opportunities for rapid future colony increase. *Tetragonula carbonaria*, *A. australis* and *T. hockingsi* were the most popular species of stingless bees kept in Australia. Bee keepers producing honey used mostly *T. carbonaria*, although a small number used *T. hockingsi* or *A. australis*. Eleven percent of bee keepers reported that they produced honey; however, only five producers sold their product. All bee keepers who were able to harvest ≥ 1kg of honey per year resided in Queensland, where colonies were able to forage for most of the year. Sugarbag honey has become popular as a 'bush tucker' and caters to a niche market in Australia. The wholesale price has increased from $AU40 per kg in 1999 to $AU70 per kg in 2010 (taking inflation into account, this is an increase of $AU20 per kg, http://www.rba.gov.au/calculator/) but the retail price remains the same, at approximately $AU160 per kg (Heard, 2010) (an actual decrease in value of $AU42.50 per kg). This is still a high price when compared to *Apis mellifera* L. honey, which currently sells for only $AU7.80 per kg (Archibald, 2010) and is indicative of its rarity. Total stingless bee honey production is less than 300 kg per year, compared to the Australian honey bee industry's 27,800 tonnes (Crooks, 2008).

Sugarbag honey annual production of less than 300 kg is well below that produced by meliponiculture industries overseas. For example, a single cooperative in Mexico produces 1,500 kg per year using *Scaptotrigona mexicana* Guérin-Méneville (Durán Olguín, personal communication) and a group of ten bee keepers, using *Melipona fasciculata* Smith in the Amazonian region of South America, expect to harvest 500 kg per year from 2012 (G Venturieri, personal communication). Given the right infrastructure, the Australian sugarbag honey industry could also be developed to a more commercial level. Improved methods of harvesting honey and postharvest storage are areas that would also benefit from further research (Cortopassi-Laurino *et al.*, 2006). High demand and prices for hives also suppresses honey production as bee keepers are currently focussing on supplying the hive market rather than the honey market.

In both the 1998-9 and 2010 surveys, pollination of nearby vegetable and flower gardens, as well as bushland, was reported to be of considerable benefit. In 2010, only eight respondents reported they provided pollination services on a professional basis. The number of colonies owned by these service providers ranged from ten to 130 each, and totalled only 423. Compared to 102,000 honey bee colonies used annually for paid pollination (RIRDC, 2009), this is a tiny proportion of Australia's managed pollinators.

Pollination service providers reported good crop pollination by stingless bees in a variety of sub / tropical crops (Table 3) and one service provider reported increased yields in lychee, *Litchi chinensis* (Sapindaceae), avocado *Persea americana* (Lauraceae) and watermelon *Citrullus lanatus* (Cucurbitaceae) (T. Carter, personal communication). However, this information was generally anecdotal, with no supporting quantitative data. Compared to honey bees, stingless bees have been proven to be superior pollinators of macadamia and may be more suited to pollinating tropical plants with which they have evolved (Heard and Exley, 1994). Further research in this area is needed if there is to be any likelihood of expanding pollination services within the Australian stingless bee industry.

Stingless bee keepers reported obtaining up to $AU40 per colony for pollination services. In Australia, honey bee keepers are paid pollination fees of $AU25 to 35 per colony in inland New South Wales (Gibbs and Muirhead, 1998). Paid honey bee pollination services were estimated to be worth $AU3.3 million in Australia in 2001 (Rodríguez *et al.*, 2003). Stingless bees may be able to provide some of the predicted shortfall in honey bee hive numbers.

The only truly scientific studies carried out on pollination by Australian stingless bees have been in macadamia *Macadamia integrifolia* Proteaceae (Heard and Exley, 1994; Heard, 1994) and mango *Mangifera indica* Anacardiaceae (Anderson *et al.*, 1982). Their efficacy as pollinators of a variety of other crops warrants further investigation (Halcroft *et al.*, 2012).

Many bee keepers reported the need for research into queen rearing, as queen availability is the major limiting factor for colony multiplication. Queen breeding and artificial insemination have been practiced with honey bees for decades (Woyke, 1960). Limited research has been conducted in this area of meliponiculture overseas, except for Menezes and Imperatriz-Fonseca (2010), and none has been conducted in Australia.

Acknowledgements

We thank the University of Western Sydney media unit, especially Danielle Roddick and Kristy Gleeson, for their efforts to broaden the survey media releases. A sincere thank you to the many bee keepers who participated in the survey, and particularly to those who gave generously of their time and knowledge to assist, including Allan Beil, John Klumpp, Thomas Carter, Frank Adcock, Mark Grosskopf, Russell Zabel, Bob Luttrell and Peter Clarke.

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