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Original article

No short-term impact of honey bees on the reproductive success of an Australian native bee[1]

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Abstract – The European honey bee was introduced to Australia 180 years ago and feral populations now occupy most coastal environments. Although much debate has taken place regarding the possible impact of honey bees on Australian native bees, there has been little direct research. This study presents the results of a replicated Before-After Control-Impact (BACI) experiment simulating the putative impact of feral honey bees on an undescribed species of Australian solitary bee (*Megachile* sp. M323/F367). Although a large resource overlap occurred between the two species, there was no significant change in the reproductive success of the native bee. The realised precision of the experiment was assessed and showed appropriate sensitivity for three important reproductive variables. The native bee, being better adapted to the high summer temperatures experienced during the period of this experiment, may be able to withstand honey bee competition.

BACI / competition / *Apis mellifera* / *Megachile* / resource overlap / introduced species

1. INTRODUCTION

For thousands of years humans have been translocating animals, either deliberately or accidentally, to countries and ecosystems outside their natural range. Freed from the predatory, parasitic and competitive restraints experienced in their native environments, many of these animals have had severe impacts on indigenous fauna and flora. One way invading animals can impact the natural ecosystem is through competition and there are many examples from around the world of the negative, competitive impact of introduced mammals (Manchester and Bullock, 2000), birds (Miller, 1967), fish (Greger and Deacon, 1988; Zale and Gregory, 1990) and invertebrates (Juliano, 1998; Byers, 2000; Manchester and Bullock, 2000; Kiesecker et al., 2001; Schellhorn et al., 2002).

Honey bees (Apidae: Apinae) were successfully imported to Australia for honey production in 1822 and escaped into the natural environment soon afterwards, becoming feral (Paton, 1996). Today they occur in all states and territories (Paton, 1996) and may be able to maintain viable populations without immigration from commercial hives (Oldroyd et al., 1997). In the last 30 years, there has been a great deal of debate over the impact of honey bees on native fauna (Paton, 1996). Of all fauna, other bees are the most likely candidates for

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competition as many are of a similar size and require the same resources (pollen and nectar) for their progeny.

Subsequently, researchers have investigated honey bee impact on native bees but a recent review of these studies found that most had focused on resource overlap or visitation rates (Paini, 2004a). While these studies indicate the potential for competition between native and honey bees, they do not measure any impacts on abundance or reproductive success of native bees in response to honey bees and subsequently are limited in the conclusions that may be drawn.

Worldwide, few studies have attempted to measure native bee reproductive success in response to honey bees and the results so far have been equivocal (see Paini, 2004a for review). In Australia, only one study has investigated the impact of honey bees on native solitary bees (Paini, 2005). As the majority of Australia's bees are solitary, such an investigation on this richly diverse group would seem paramount. Equally, there has only been one investigation into the impact of feral honey bees on native bees in Australia (Schwarz et al., 1991, 1992a, b). Feral honey bees do not occur in the densities found at apiary sites, where beekeepers can place up to 100 hives for 1–3 months. However, feral honey bees remain at the same location throughout the year and may have a significant impact on native bees when floral resources are limiting.

This paper reports the results of a replicated BACI (Before-After Control-Impact) experiment (Stewart-Oaten et al., 1986) into the impact of feral honey bees on the reproductive success of a native solitary bee, an undescribed species in the genus *Megachile*.

2. METHODS

2.1. Bee biology

The native bee species studied is an undescribed species referred to by its WA Museums register/accession number: M323/F367 (herein referred to as *Megachile* sp. 323) (Megachilidae: Megachilinae). Little is known of *Megachile* sp. 323 biology. Only one paper has been previously published based on trap nest data (Paini, 2004b). Females nest during the spring and summer months from October to April with the peak in nest production in February. As the nesting season progresses larvae enter diapause at increasing rates and do not emerge until the following season. Within a nest, males always occupy the outermost cells and consequently emerge first (protandry). In addition, males are smaller than females and there is a female sex biased ratio in offspring. The reasons for this bias are unclear but may be caused by local resource enhancement as a result of nest clustering (Paini, 2004b).

2.2. Study sites

The experiment was conducted in the Northern Beekeepers Nature Reserve (30°00' S, 115°05' E), approximately 250 km north of Perth, Western Australia, from October 2000 to March 2001. As explained above, female *Megachile* sp. 323 nest during this period when floral resources are minimal. Professional beekeepers only place their hives in this area over the winter period (June–August) and any competition experienced by *Megachile* sp. 323 will be from feral honey bees.

Eleven study sites with similar vegetation profiles and separated by a minimum of 1.5 km were selected. All sites were located within a 55 km^2 area. The study sites were randomly allocated to one of either six control or five treatment sites. Within each study site, two parallel transects 100 m long and 25 m apart were established.

Hive honey bees at low density were used to simulate the impact of feral honey bees and the BACI design assessed the impact of these honey bees by comparing any differences between control and treatment sites before the impact was introduced with any differences after the impact (Stewart-Oaten et al., 1986). Both control and treatment sites were assessed every 4 weeks (repeated measure) throughout the experiment. Assessment occurred on three occasions before honey bees were introduced from 15 November 2000. On 15 January 2001, two honey bee hives were introduced to each treatment site to simulate feral honey bees. Sites were then assessed three more times until 25 March 2001 and the experiment was terminated by removing honey bee hives.

2.3. Honey bee densities

Honey bee densities were assessed before hives were introduced to ensure there were minimal levels of truly feral honey bees present and to measure any existing differences between treatment and control sites. Honey bee densities were monitored after the introduction of hives to ensure treatment sites had higher levels of honey bees than control sites. A census of honey bees was made every 10 m along both trap nest transects by scanning the surrounding area for 30 s and counting all bees sited. Values for each

census point were totalled to give the number of honey bees seen at each site.

The artificial inflation of honey bee densities in this experiment may not be regarded as a test of feral honey bees as the density of honey bees was increased significantly above that of original feral levels (see results). However, feral honey bee hives do not occur in a uniform distribution in this reserve, being limited to limestone caves where as many as ten feral honey bee hives can be found in one cave (DRP personal observation). In the 55 km^2 area in which this experiment was conducted, there were few caves and the number of feral honey bees was considerably lower than expected in other regions of this reserve where limestone caves are more numerous (DRP personal observation). The addition of two honey bee hives per site to simulate feral levels of honey bees was therefore justified.

2.4. Resource overlap

Resource overlap was assessed to determine if honey bees and *Megachile* sp. 323 were utilising the same floral resources. Pollen extracted from nests of *Megachile* sp. 323 was compared with both pollen and the pollen in honey collected by honey bees. One *Megachile* sp. 323 nest from each site and each repeated measure was vigorously flushed with 10 mL of water to extract pollen and larval faeces. The resulting fluid was then acetolysed following the standard technique of Erdtman (1952, 1960) (see also Phipps and Playford, 1984). The extracted pollen was preserved on microscope slides and later matched to a reference collection of pollen collected from plant species in the area. One reference slide contained pollen from two *Melaleuca* spp. (*M. systema* and *M. leuropoma*) (Myrtaceae) and it was not possible to distinguish between these two species.

Honey bees may collect nectar, which is converted to honey, from different plant species than they collect pollen from. Therefore, both honey and pollen were collected from honey bee hives at each treatment site for analysis. Honey bee pollen was collected over a two-day period using pollen traps (Smith and Adie, 1963). A sub-sample (0.5 mL volume) of each pollen sample was mixed with 9.5 mL of water and acetolysed before being preserved on microscope slides. To determine the source of the honey, one hive frame was removed from a hive at each site and replaced with a fresh frame so any honey present would have only been collected in the period since the previous repeated measure. Each frame was scraped for honey, filtered through a container lid punched with holes of approximately 1 mm diameter to remove wax and then diluted by 50% with warm water. This honey/water mixture was centrifuged at 3500 rpm for 3 minutes and the supernatant poured off. The remaining pellet was diluted by 50% with ethanol, heated in a water bath for 5 minutes to fully dissolve the honey before being centrifuged at 3500 rpm for 3 minutes. The supernatant was poured off and the remaining pellet was resuspended in 9.5 mL of water and centrifuged at 3500 rpm for 3 minutes. This last step was repeated two more times before the pollen was acetolysed and preserved on microscope slides.

Each slide was scanned from left to right until 100 pollen grains were counted and the relative frequency of each species of pollen was then calculated. Resource overlap between *Megachile* sp. 323 and honey bees was then calculated according to Colwell and Futuyma (1971):

$$RO_{ih} = 1 - \tfrac{1}{2}\sum_{k} |p_{ik} - p_{hk}|$$

where p_{ik} is the average proportion of pollen type k of species i and p_{hk} is the average proportion of pollen type k in species h. Values of RO range from 0 to 1.0 with 0 indicating no overlap and 1.0 indicating complete overlap. The difficulty in identifying pollen to species level meant that only pollen species identified from *Megachile* sp. 323 nests were identified in honey bee samples. Any other pollen species were classified as 'other species' as this did not affect resource overlap calculations.

2.5. Reproductive success

Female *Megachile* sp. 323 will nest in 'trap nests', drilled sections of untreated pine batons (2 cm × 2 cm × 7 cm). Females build cells in these holes and provision them with nectar and pollen for their progeny, which provides an opportunity to monitor reproductive success in the presence and absence of honey bees.

The preferred hole-diameter of trap nests for this *Megachile* sp. is 7.0 mm (Paini, 2004b). Four drilled batons, each containing a single 7.0 mm diameter hole, were tied together using wire to make a bundle. A bundle of trap nests was placed at 10 m intervals along the two parallel transects, giving 80 trap nests per site. Bundles were hung from shrubs at a height of 10–150 cm. All 11 sites were visited every 4 weeks when all trap nests were removed and replaced with fresh ones. Any trap nests that were partially completed were left until the following visit. Females of *Megachile* sp. 323 cap nests with sand grains and small twigs so completed nests were easily recognised (Paini, 2004b).

The completed nests were returned to the laboratory and held in a constant temperature (CT) room maintained at a light and temperature regime that matched the average environmental conditions for that region, adjusted monthly. After 3–4 weeks all adults that emerged from nests were weighed and then killed by freezing. Progeny from nests collected

at the end of the season delayed development (diapause) and did not emerge until the beginning of the following season. These nests were stored outside between seasons and returned to the CT room just prior to emergence.

Data collected from trap nests were number of progeny, progeny mass, sex, percentage of nests with failed eggs/pupae, percentage of nests in diapause and number of parasitoids. As nest construction was not monitored, it was not possible to determine if the same female laid all eggs in the one nest. In analysing progeny mass, individuals were therefore used as independent data. However, the number of eggs per nest was analysed to give an indication of the population's egg production and the number of nests per site was also analysed to indicate the overall nest production.

2.6. Statistical analysis

A nested repeated measures analysis of variance was used to compare honey bee densities and the reproductive success of *Megachile* sp. 323 between treatment and control sites before and after honey bees were introduced. The initial design comprised three repeated measures before and three after the impact. Subsequent analysis revealed there was no resource overlap between honey bees and native bees during the second and third repeated measures after the introduction of honey bees (see results). For the analysis of reproductive success, the design was then modified to comprise three periods: before impact; after impact (a – resource overlap); and after impact (b – no resource overlap). Data analysis was carried out using SAS version 6 (SAS Institute, 1989). This analysis is a slight modification of the traditional BACI design but still focuses on the after impact (a) period while accounting for natural differences between sites during the other periods. The important interaction was that of period x treatment effect which indicated if there were any differences between control and treatment sites in each of the three periods and therefore if honey bees had an impact on *Megachile* sp. 323.

The realised precision of the experiment was assessed for any reproductive success variables that did not show a significant impact effect by calculating the percentage of change detectable with 95% confidence. This value gives an indication of the sensitivity of the experiment.

$$\%\ \text{detectable change (\%DC)} = \left(\frac{Q \times se}{u}\right) \times 100$$

where Q is the studentized range statistic, se is the standard error and u is the overall mean. These values were compared to the actual % change (%AC).

$$\%AC = \frac{c - (e - f)}{u} \times 100$$

Table I. Mean number of honey bees observed at control and treatment sites (± SE), before and after honey bees were introduced to treatment sites. Honey bee numbers at treatment sites increased substantially after placement of honey bee hives ($F_{1,36} = 51.42$, $P = 0.0001$).

	Before	After
Control	0.58 (± 0.50)	0.38 (± 0.19)
Treatment	0.50 (± 0.34)	8.35 (± 1.16)

where c is the mean difference between the means of treatment and control sites from both before impact and after impact (period b). This gives an estimate of the mean change expected without any influence of honey bees. The value of (e – f) is the difference between the means of treatment and control sites after impact (period a).

3. RESULTS

3.1. Honey bee density

Before honey bees were introduced, there were very few honey bees present at either control or treatment sites further justifying the introduction of bees to simulate a feral load. Honey bee densities were significantly higher in treatment sites than control sites after hives were placed at treatment sites (Tab. I).

3.2. Resource overlap

During the period before the introduction of honey bees, 80% of pollen collected from nests of *Megachile* sp. 323 was from *Jacksonia calcicola*. The other 20% was *Melaleuca systema* and/or *M. leuropoma* (see methods). *Jacksonia calcicola* was the only pollen found in nests of *Megachile* sp. 323 from both control and treatment sites after the introduction of honey bees. *Jacksonia calcicola* pollen was also found in honey bee honey during the first assessment period after their introduction and the niche overlap was estimated to be 0.74. In subsequent assessments, no honey was produced by any of the hives. *Jacksonia calcicola* pollen was not found in honey bee pollen at any assessment time.

3.3. Reproductive success

Megachile sp. 323 constructed a total of 270 nests at the 5 treatment sites and 329 nests at the 6 control sites. The number of completed nests at both control and treatment sites increased from before impact to after impact (a) before decreasing (Fig. 1a) ($F_{2,27} = 26.2$, $P < 0.05$). At control sites, 184 males and 753 females emerged from nests and at treatment sites, 117 males and 680 females emerged.

Throughout the experiment, sex ratio (17% males ±2.0 SE), and percentage of nests with dead progeny (14.2% ±2.8 SE) all remained unchanged ($F_{2,15} = 0.8$, n.s., $F_{2,15} = 0.6$, n.s. respectively). However, both male mass (Fig. 1c) and the number of progeny per nest (Fig. 1d) increased initially then decreased ($F_{2,8} = 4.1$, $P < 0.05$, $F_{2,14} = 9.0$, $P < 0.05$ respectively). Female mass remained unchanged until the final period (after impact b) when it decreased ($F_{2,15} = 6.4$, $P < 0.05$, Fig. 1b). The percentage of nests in diapause increased throughout the experiment ($F_{2,15} = 54.5$, $P < 0.05$, Fig. 1e).

None of the parameters measured for *Megachile* sp. 323 demonstrated a significant impact of honey bees (Tab. II). The percentage detectable change for male and female mass and for the number of progeny per nest was 30% or less (Tab. II). However, for the remaining variables, the experiment was only able to detect medium to large differences between control and treatment sites (70–316%).

Seven nests were parasitized by a *Leucospis* sp. (Hymenoptera; Leucospidae) and one nest was parasitized by a *Gasteruption* sp. (Hymenoptera; Gasteruptiidae). All these nests were parasitized before honey bees were introduced so no analysis was performed.

4. DISCUSSION

The lack of honey production by honey bees in the last eight weeks of this experiment was probably caused by the high daytime temperatures experienced during this period (observed mean maximum for Jan.–Feb., 2001 was 29.9 °C, maximum recorded 41.2 °C, overall mean maximum for Jan.–Feb. was 30.3 °C, overall maximum recorded 45.2 °C; data provided by the Western Australian Bureau of

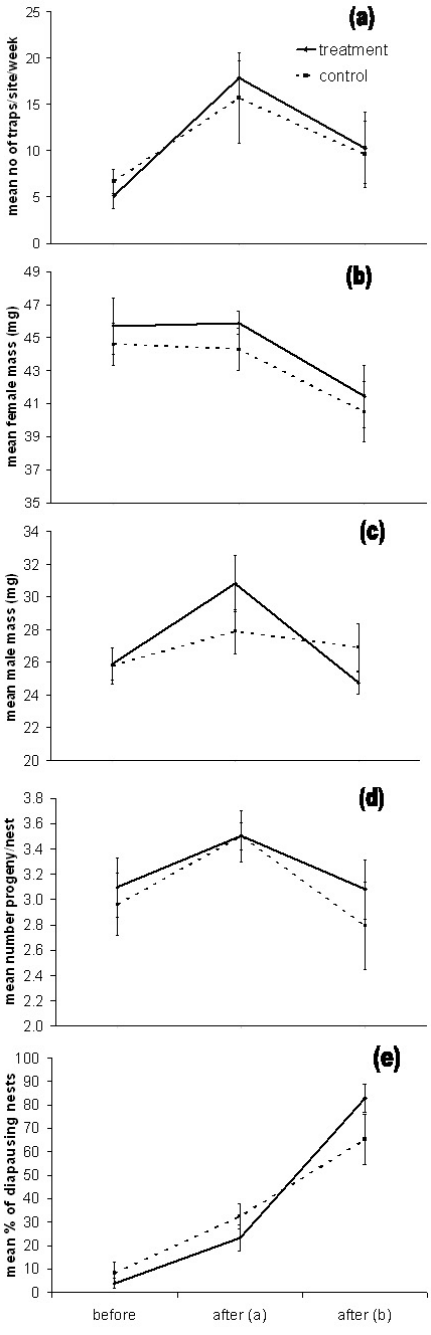

Figure 1. Parameters of *Megachile* sp. 323 measured at control and treatment sites. (a) Seasonal variation in mean nesting, (b) mean female mass, (c) mean male mass, (d) mean number of progeny per nest, (e) and mean percentage of nests in diapause. Error bars are ± SE.

Table II. Results of nested repeated measures analysis of variance (period × treatment) plus the estimated percentage actual change (%AC) and percentage detectable change (%DC) for all reproductive success parameters of *Megachile* sp. 323. Negative values indicate that the mean for treatment sites was smaller than control sites.

Parameter	*F*	df	*P*	%AC	%DC
Female mass	0.13	2,15	0.88	1.3	15.0
Progeny/nest	0.06	2,14	0.94	–7.8	26.6
Male mass	1.52	2,8	0.28	12.2	30.1
No of nests	0.39	2,27	0.68	30.6	70.0
Diapausing nests	2.62	2,15	0.10	39.9	103.6
Sex ratio	0.41	2,15	0.67	–37.7	164.2
Dead progeny	0.17	2,15	0.84	31.2	316.2

Meteorology). At high air temperatures, honey bees use water to cool the hive and workers normally devoted to foraging for nectar are redirected to searching for and collecting water (Heinrich, 1993). During this experiment, honey bees were seen aggregating around nearby water sources and very few were observed collecting nectar (DRP, pers. obs.). This commitment to reducing hive temperature would have reduced foraging times and limited honey production. As honey bee foraging was curtailed during this period, there was no resource overlap during the last eight weeks of the experiment. Hence, only a four-week period of resource competition was actually measured.

To measure resource overlap we counted the relative densities of pollen grains (Colwell and Futuyma, 1971). A more thorough analysis, accounting for pollen volume to generate a Morista-Horn similarity index (Villanueva-G and Roubik, 2004), may have been a more accurate measure of resource overlap. Resource overlap only determines the potential for competition and does not measure competition directly. Consequently we used a simpler measure of resource overlap and focussed on the reproductive success of *Megachile* sp. 323 to evaluate competition.

J. calcicola pollen was only found in the honey of honey bees as they were collecting nectar from this plant, while *Megachile* sp. 323 was collecting pollen. The implication is that these two bee species were collecting different resources and this might explain the lack of competition. While *Megachile* sp. 323 females were clearly collecting pollen from *Jacksonia* it is likely they were also collecting nectar from *Jacksonia* as solitary bees such as Megachilidae commonly collect nectar and pollen from the same plant species (Thomson, 1988; Neff and Danforth, 1991; Scott et al., 1993; Cane, 1996; Goodell, 2003; Williams and Tepedino, 2003). When honey bees were collecting nectar in this experiment, the resource overlap with *Megachile* sp. 323 was 0.74. Previous studies assessing resource overlap between honey bees and native bees have mostly reported values below 0.5 (Roubik, 1996; Wilms et al., 1996; Steffan-Dewenter and Tscharntke, 2000) although Wilms and Wiechers (1997) found values between honey bees and two *Melipona* spp. that varied seasonally between 0 and 0.76. In Australia, Paini (2005) found resource overlap between honey bees and *Hylaeus alcyoneus* (Colletidae: Hylaeinae) varied from 0.52 to 0.97. Therefore, the level of resource overlap between honey bees and *Megachile* sp. 323 in this experiment was high for a short period.

This study found that over a short time period, feral honey bees do not negatively impact on the native solitary bee *Megachile* sp. 323. This lack of competition may have been due to a lack of resource overlap between honey bees and *Megachile* sp. 323, or if there was resource overlap, the resource may not be limiting. In addition, *Megachile* sp. 323 may be better adapted to the prevailing summer temperature regimes experienced in this region and thus able to withstand competition from feral honey bees. However, most feral honey bee colonies in this area are located inside limestone

caves (DRP, pers. obs.). Feral colonies occupying caves experience cooler environmental conditions and the workers would spend less time foraging for water to maintain hive temperature than the hives used in this experiment.

In concluding that there was no apparent detectable impact of honey bees the sensitivity of this experiment should also be considered. This experiment was sensitive enough to detect relatively small (15–30%) changes in three parameters (male and female progeny mass, and number of progeny per nest), which compares favourably with other impact studies (Calver et al., 1999; Strehlow et al., 2002). In attempting to determine the impact of feral honey bees on native bees, these three variables plus the number of nests produced are of most relevance. Male and female progeny mass is directly correlated with provision mass (Frohlich and Tepedino, 1986; Johnson, 1988) and if *Megachile* sp 323 had experienced competition from feral honey bees, provision mass may have been reduced, resulting in a decrease in progeny mass. Alternately, reduced resources may have caused females to produce fewer eggs or to compensate for the reduced resources by foraging longer thereby producing fewer nests in total. Clearly, this design provides adequate sensitivity for the first three variables. Although not as sensitive for detecting a change in nest numbers, it could detect a large (70%) decrease in nest numbers which would result from a high level of competition from honey bees. This design could be improved by increasing the number of sites or more appropriately, extending the experiment over more than one season or extending the overlap period.

The short term nature of this experiment which resulted in a four week period in which honey bees and *Megachile* sp. 323 were in competition may not truly reflect the result of the long term presence of honey bees. Although this experiment could detect as little as a 15% difference between treatment and control, the actual impact of honey bees may be smaller than our detectable limit. If that small effect was aggregated over a long period the impact might still be significant. Future studies should consider methods that will extend the period of time in which this impact occurs. In this way we could predict more accurately the long term impact of honey bees on this native bee species.

Presently, only nine studies worldwide have investigated native bee reproductive success in response to honey bees (see Paini, 2004a for review plus Thomson, 2004; Paini, 2005). In Australia, only one study has investigated the impact of feral honey bees (Schwarz et al., 1991, 1992a, b). Clearly, the impact of feral honey bees on native solitary bees in Australia remains unresolved and further research using a BACI design experiment with either the addition of hive honey bees or the removal of feral honey bees is necessary.

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Résumé – Pas d'impact à court terme de l'Abeille domestique sur la fécondité d'une abeille indigène d'Australie. Les abeilles domestiques ou mellifères (*Apis mellifera* L.) ont été importées avec succès en Australie en 1822 pour la production de miel et se sont échappées dans l'environnement naturel peu de temps après, devenant alors sauvages (Paton, 1996). Durant les 30 dernières années, il y a eu un grand débat sur l'impact des abeilles mellifères sur la faune indigène (Paton, 1996). Cet article présente les résultats d'une expérimentation BACI (impact-avant-après-contrôle), avec répétition, sur l'impact des abeilles mellifères sauvages sur le succès reproductif d'une abeille solitaire indigène, une espèce non décrite de mégachile (Western Australian Museum n° M323/F367, dénommée ici *Megachile* sp. 323). Des abeilles mellifères de ruches ont été utilisées pour simuler les abeilles mellifères sauvages et le dispositif BACI a évalué l'impact de ces abeilles en comparant les différences entre les sites témoins et les sites traités avant l'introduction avec les différences après l'introduction (Stewart-Oaten et al., 1986).
L'expérimentation a été conduite dans la Réserve Naturelle Apicole du Nord (30°00' S, 115°05' E), située à environ 250 km au nord de Perth, Australie Occidentale, d'octobre 2000 à mars 2001. *Megachile* sp. 323 nidifie pendant cette période lorsque les ressources florales sont faibles. Onze sites d'étude (six témoins et cinq traités) possédant des profils de végétations semblables et distants d'au moins 1,5 km ont été retenus.

Les abeilles mellifères n'ont eu aucun impact sur aucun des paramètres mesurant le succès reproductif de *Megachile* sp. 323. (Tab. II). La modification détectable pour la masse des mâles et des femelles et pour le nombre de descendants a été de 30 % maximum (Tab. II). Pour les quatre variables néanmoins l'expérimentation n'a pu détecter que des modifications moyennes ou fortes entre les sites témoins et les traités (70–316 %). L'étude a montré que sur une courte période les abeilles mellifères sauvages n'ont pas d'impact négatif sur l'abeille solitaire indigène *Megachile* sp. 23, qui est peut-être mieux adaptée aux températures estivales de cette région et ainsi plus à même de résister à la compétition des abeilles mellifères sauvages.

***Megachile* / *Apis mellifera* / compétition / espèce introduite**

Zusammenfassung – Honigbienen haben keinen kurzfristigen Einfluss auf den Fortpflanzungserfolg einer einheimischen australischen Biene. Honigbienen wurden in Australien im Jahr 1822 erfolgreich für die Honigproduktion importiert. Bereits nach kurzer Zeit entkamen einige Kolonien in die Naturlandschaft und verwilderten. Aufgrund dieser Tatsache stand in den letzten 30 Jahren verschiedentlich der möglich Impakt von Honigbienen auf die einheimische Bienenfauna zur Debatte (Paton, 1996).

In dieser Arbeit präsentieren wir die Ergebnisse einer wiederholten Vorher-Nachher Kontroll-Impaktstudie (BACI, Before-After Control-Impact, Stewart-Oaten et al., 1986) zum Einfluss wilder Honigbienen auf den Fortpflanzungserfolg einer noch unbeschriebenen einheimischen solitären Biene, *Megachile* sp. (Western Australian Museum, Nummer M323/F367, hier weiter als *Megachile* sp. 323 bezeichnet). Zur Simulierung des Einflusses wilder Honigbienen wurden Völker in Beuten in einem BACI-Design ausgebracht. Dies erlaubte den Vergleich von Kontroll- und Experimentlokalitäten vor und nach dem Ausbringen von Bienenvölkern.

Der Versuch wurde an *Megachile* sp. 323 Nestern im Northern Beekeepers Nature Reserve (30°00' S, 115°05' O), ungefähr 250 km nördlich von Perth in Westaustralien durchgeführt. In der Versuchsperiode zwischen Oktober 2000 und März 2001 waren die floralen Ressourcen sehr gering. Als Untersuchungsorte wurden elf Lokalitäten (sechs Kontroll- und fünf Versuchsorte) mit ähnlichem Vegetationsprofil und einem Minimalabstand von 1,5 km ausgewählt.

In keinem der untersuchten Parameter hatte die Präsenz von Honigbienen einen signifikanten Einfluss auf *Megachile* sp. 323 (Tab. II). Der Prozentsatz sichtbarer Unterschiede in der Männchen- und Weibchenmasse und in der Nachkommenzahl lag jeweils unter 30 % (Tab. II). Für die restlichen Variablen zeigte der Versuch mittlere bis grosse Unterschiede zwischen den Kontroll- und Versuchsorten (70–316 %).

Dieses Ergebnis zeigt, dass, über eine kurze Periode hinweg betrachtet, wilde Honigbienen keinen negativen Einfluss auf die einheimische solitäre Bienen *Megachile* sp. 323 haben sollten. Diese Biene scheint an das im Sommer herrschende Temperaturregime besser angepasst und dadurch in der Lage zu sein, der Konkurrenz von wilden Honigbienen zu widerstehen.

BACI / Konkurrenz / *Apis mellifera* / *Megachile* / Ressourcenüberlappung / eingeführte Arten

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