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Distribution of Long-horn Beetles (Cerambycidae: Coleoptera) Within the Fijian Archipelago

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Abstract

Long-horn beetles (Family: Cerambycidae) in Fiji consist of 124 described species within 45 genera, of which 110 (88.7%) species are considered endemic. Despite their conservation value, ecological significance and cultural importance, little scientific research has been conducted on the taxonomy or ecology of Cerambycidae in Fiji. This biogeographical study surveyed Cerambycidae by Malaise trapping on ten Fijian Islands. A total of 438 individuals and 44 species of Cerambycidae were recorded. Thirty three of the species collected are endemic to Fiji; three other species are native and eight species are new records for Fiji and/or new species. Twenty seven species were recorded from only one island and 20 species were recorded only as singletons. There was an expected significant relationship between the number of species collected on an island and the number of sampling events. The highest number of species, 23, was recorded on the largest island, Viti Levu, followed by Gau with 13 species and Vanua Levu and Kadavu with 12 species each. There was a positive relationship between species richness and island size but this was lost if the effect of sample number was taken into account. The results indicate that the species-area relationship may hold for Fijian Cerambycidae, but additional collecting events, over more of the annual cycle, and involving multiple collecting methods may be required to fully catalogue the current Fijian fauna.
Keywords: *Fiji; Island biogeography; Species-Area relationship.*

1. Introduction

The Republic of Fiji consists of around 330 islands, situated 3000 km east of Australia in the Pacific Ocean and spread over an area from 16-20°S latitude and 178°E-178°W longitude. Overall, the archipelago hosts a diverse terrestrial biota typical of a mature continental ecosystem than a collection of oceanic islands (Keast 1996; Evenhuis and Bickel 2005). A number of mechanisms have been suggested as influencing the faunal colonisation of Fijian islands, including long-distance dispersal, island-hopping and “biotic shuttle” (Keppel *et al*. 2009). Viti Levu, the largest and oldest island of the Fijian archipelago, is thought to be the ultimate source of much of the fauna and flora of the other smaller islands (Sarnat and Moreau 2011).

Long-horn beetles in the family Cerambycidae constitute one of the largest groups of insects, with approximately 33000 described species, 5200 genera and seven subfamilies currently recognized (Tavakilian *et al*. 1997; Slipinski and Escalona 2013). The last major work on the Fijian Cerambycidae produced by Dillon and Dillon (1952) contained a comprehensive taxonomic guide, some distribution data, and listed 112 ‘forms’. The more recent checklist provided by Evenhuis (2007) gave 142 species of Cerambycidae for Fiji, in 44 genera. Lingafelter (2007) has since described two new species of the genus Distenia from Fiji, whilst Waqa and Lingafelter (2009) reviewed the tribe Callidiopini and Waqa-Sakiti *et al*. (2015) reviewed the genus Ceresium. In terms of ecology of the group, Waqa-Sakiti *et al*. (2014) reported information on the species of trees used as hosts by 18 species of Cerambycidae on Viti Levu by rearing larvae from timber baits. Fiji has a high level of endemic species for the Family Cerambycidae with an estimate of 88% endemism (Dillon and Dillon 1952).

For herbivorous insects, successful colonization and establishment at an island is dependent upon the prior colonization by suitable host plants (Ackery and Vane-Wright 1984). The current study aimed to provide some initial information on the present distribution of Cerambycidae in Fiji by collecting on ten islands deemed to be representative of the variety of islands in the Fijian archipelago. The data obtained have been used to examine how the number of species recorded is related to sampling effort and, in doing so, provided estimates of the total number of species of Cerambycidae that may now occur in Fiji and what further sampling might be required in order to record this total.

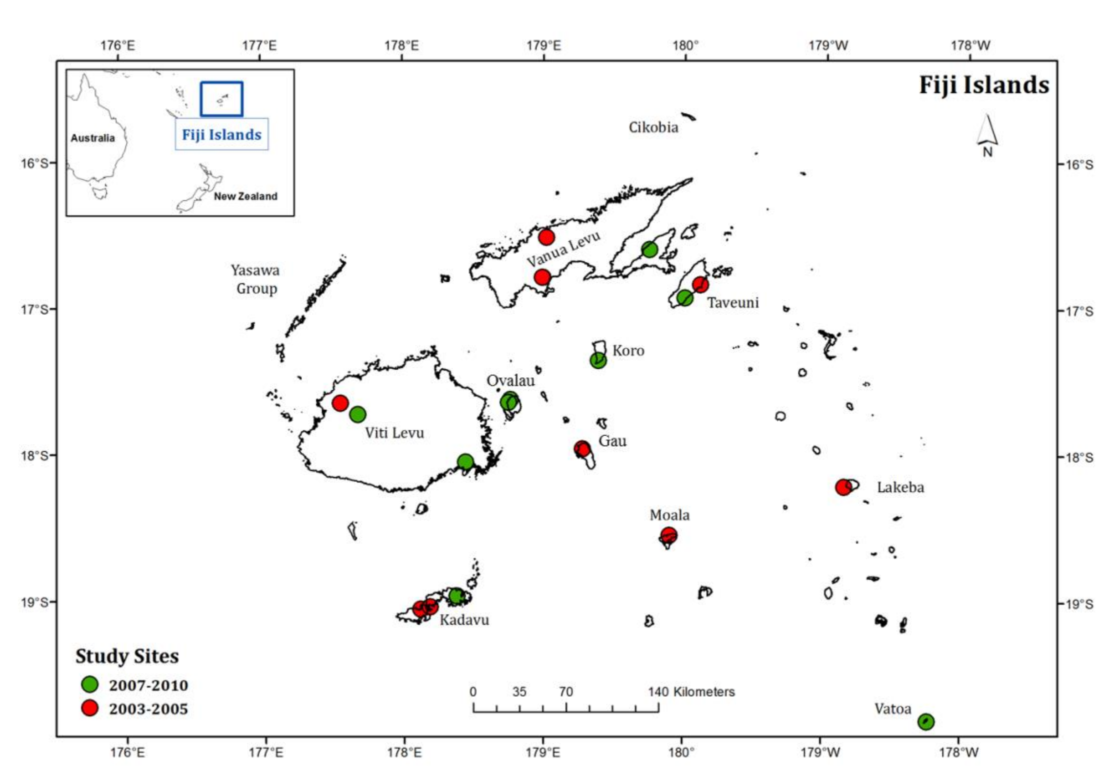

Figure 1. Map of the Fiji Islands indicating surveyed islands and locations of sampling sites.

2. Materials and Methods

2.1. Insect collecting

Cerambycidae were surveyed from ten inhabited islands within the Fijian archipelago: Viti Levu, Vanua Levu, Taveuni, Kadavu, Ovalau, Koro, Gau, Lakeba, Moala and Vatoa (Figure 1; Tables 1 and 2). These islands were selected to represent a range of island sizes, isolation from the main island of Viti Levu and geological types. Island size and distance to Viti Levu were calculated using ArcGIS software V.10.

Beetle collections were undertaken during two periods: June 2004 to February 2006 and from March 2008 to September 2010 (Table 1). Sampling sites were selected within intact lowland forest areas with closed canopy and good accessibility. A Garmin GPSMAP 60CSx handheld GPS navigator was used to accurately locate the sampling sites and record altitude (m above sea level). Cerambycidae were collected using Malaise traps erected at ground level and set for a period of 6-8 weeks in the field (Table 1). The trap targets free flying insects and is considered effective in sampling Diptera (flies), Hymenoptera (ants) and Coleoptera (beetles). The trap is tent-like and erected on the ground, intercepting insects along a vertical hanging 'mid-vein'.

Traps were emptied and specimens stored in 80% ethanol before sorting and identification in the laboratory. Identification to species level was undertaken using Dillon and Dillon (1952) and verified against named specimens in a collection held at The University of the South Pacific, Suva, and specimens borrowed from the Bernice Pauahi Bishop Museum, Hawaii.

2.2. Data analysis

The relationship between the numbers of individuals and species of Cerambycidae with sample number per island was examined using linear regression. The predicted accumulation of species number with additional sampling effort was examined using a bootstrap resampling method (with 1000 iterations) where the species abundance lists for each island were treated as the sample unit. An asymptotic curve of the form shown below, where n = number of islands and a, b and c are constants, with $0 < c < 1$, was utilised.

$$Species = a - b.c^n$$

As the sample number, n, approaches infinity, c^n approaches 0, and the predicted number of species approaches a. Conversely, when $n = 0$, $c^n = 1$ and so $a - b$ is the number of species recorded after zero sampling. Two curves were fitted: the curve of best fit and a curve constrained to the origin (where $a = b$) that enforced a rule where no Cerambycidae could be recorded before any collecting had been performed.

3. Results and Discussion

3.1. Fauna

A total of 438 individuals and 44 species of Cerambycidae were recorded from the ten islands over the two sampling episodes. Thirty three of these species are considered endemic to Fiji, three other species are native and eight species are new records for Fiji and/or new species (Table 2).

Araespor angustulum was the most abundant species with 149 specimens. Only six other species were recorded with ten or more specimens: *Ceresium guttaticolle*, *Nerida gynandropsidis*, *Nerida oblongiguttula*, *Oopsis brunneocaudatus*, *Oopsis nutator* and *Sormida maculicollis.* *Araespor angustulum* was also the most widespread species, being recorded on all ten islands (Table 2), with *Oopsis brunneocaudatus* present on eight islands and *Sormida maculicollis* on six. *Ceresium guttaticolle*, *Nerida gynandropsidis*, *Oopsis nutator* and *Scituglaycytes muiri were* e each recorded on five islands (Table 2).

Table 1. Locations, coordinates, and initiation dates of sample sites in order of descending island size.

Island	Location	Longitude (E)	Latitude (S)	Sampling initiated
Viti Levu	Vaturu	177.676	-17.744	May 2008
	Koroyanitu Ecopark	177.550	-17.667	September 2004
	Savura Forest Res	176.444	-18.071	October 2008
Vanua Levu	Rokosalase	179.018	-15.533	July 2004
	Batiqere Range	178.991	-15.807	June 2004
	Natewa	179.749	-16.614	July 2005
Taveuni	Koronibuabua	-179.890	-15.855	May 2005
	Salialevu Reserve	-179.998	-16.945	March 2008
Kadavu	Solodamu Reserve	178.121	-19.078	March 2008
	Nakasaleka	178.380	-18.987	August 2010
	Namalata	178.187	-19.060	August 2004
Gau	Delaco	179.275	-17.980	March 2005
Koro	Mudu	179.387	-17.376	June 2009
Ovalau	Rukuruku	178.762	-17.644	March 2008
	Viro	178.747	-17.662	February 2008
Moala	Mt. Natuvu	179.857	-18.229	February 2006
Lakeba	Tubou	-178.857	-18.229	September 2005
Vatoa	Vatoa	-178.240	-19.823	September 2009

3.2. Sapling effort

Twenty seven species were recorded from only one island and 20 species - 45% of the total species count - were recorded only as singletons. A number of theories have been suggested as to why tropical arthropod surveys contain a high proportion of singletons, including actual rarity, localized rarity, host plant specificity or individuals acting as 'vagrants' outside of their geographic or specific habitat ranges (Novotny and Bassett 2000; Coddington *et al*. 2009). However, one of the major causes of over representation of singletons in a collection of arthropods is thought to be undersampling (Coddington *et al*. 2009).

There was a significant relationship with the number of species collected on an island and the number of sampling events (Figure 2a; Species = 1.5 + 4.5Samples; r^2 = 0.41; P = 0.028), and also between the number of species recorded and number of individual beetles collected (Figure 2c; Species = 4.11 + 0.126Individuals; r^2 = 0.44; P = 0.021). However, there was no significant relationship between the number of individuals collected on an island and the number of sampling events (Figure 2b; r^2 = 0.11; P = 0.181). These findings suggest that more sampling on all of these islands would yield further species. Additionally, for the sake of consistency, if further islands are examined then at least three Malaise trapping events should be performed on each so that direct comparisons can be made with the Cerambycidae faunas reported in this study.

In terms of total catch, the bootstrap analysis of species accumulation as a function of the number of islands visited was modelled by two asymptotic curves (Figure 3):

Line of best fit:

$$\text{Species} = 55.86 - 54.69 \times 0.864^{\text{Islands}}$$

Constrained to the origin:

$$\text{Species} = 53.56 - 53.56 \times 0.851^{\text{Islands}}$$

The line of best fit and constrained equations produce very similar species accumulation curves, and suggest that if 20 islands had been visited with similar sampling effort then 53 and 51 species would have been collected respectively. By extrapolating to the whole Fijian archipelago, these curves predict a total species count of 56 and 54 species respectively. This number is considerably lower than the 112 'forms' given by Dillon and Dillon (1952) and the 142 species listed by Evenhuis (2007), although we concede that the latter list was produced primarily by reference to the older publication.

Recent studies of other insect groups in Fiji have highlighted how perceived species richness is strongly influenced by sampling effort and sampling method (e.g. flower visiting insects, Prasad and Hodge 2013; forest moths, Tikoca *et al*. 2016a). The estimate of total Cerambycidae richness suggested by the species accumulation curve may be relevant only to the subset of species that would be caught by Malaise trapping as adults, in a forest habitat, at ground level. This suggestion is given some support by comparison with the species collected by Waqa-Sakiti *et al*. (2014) on Viti Levu by rearing from rotting timber. Although there is some uncertainty due to both studies collecting new/undescribed species, of the eighteen Cerambycidae types obtained in the previous study at least eight were not recorded by Malaise trapping in the current study, and 11 (61%) were not captured during the three Malaise trapping events on Viti Levu. The study by Waqa-Sakiti *et al*. (2014) also highlighted seasonal differences in species occurrence and relative abundance. Although sampling in the current study was active over most months of the year, there was no single location that was studied continuously over a 12 month period to give a higher chance of recording species with narrow adult flight periods (Tikoca *et al*. 2016b).

Species distribution modelling (SDM) could be used to identify potential 'hot spots'. A study by Sakiti-Waqa *et al*. (2015) demonstrates the application of SDM using current and future climatic conditions to model areas of habitat suitability for the Fijian giant long-horned beetles. Such analysis can be a useful tool for conservation planning in Fiji and the identification of "hotspot" areas for protection under current and future climatic conditions.

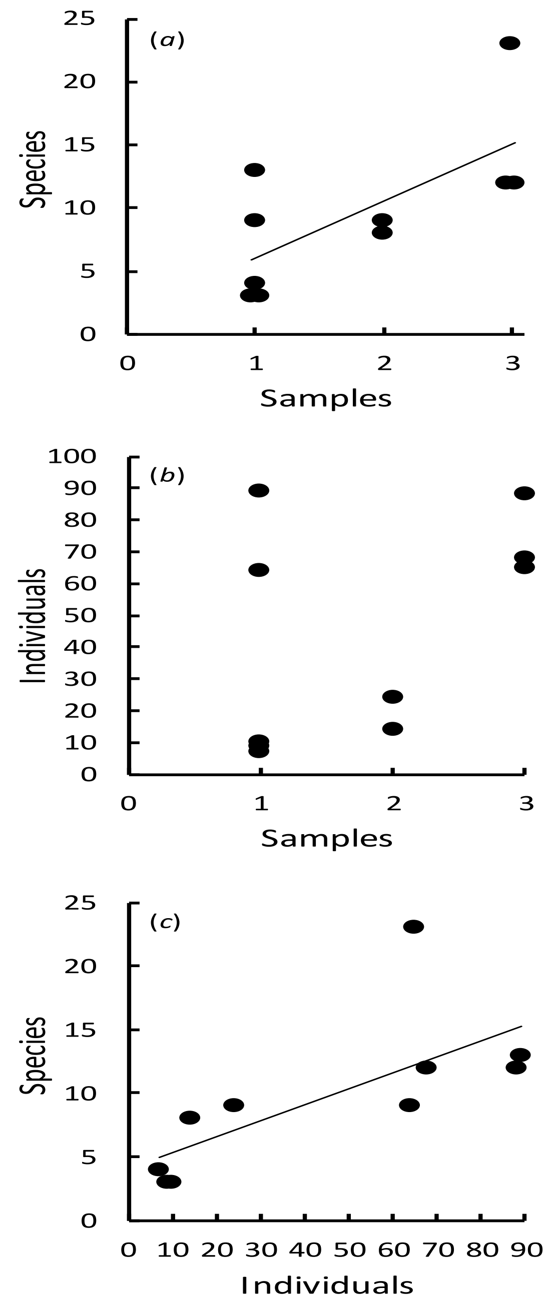

Figure 2. The relationships between numbers of individual Cerambycidae collected, numbers of Cerambycidae species collected, and the numbers of Malaise trap sampling events on ten Fijian Islands.

Table 2. Species of Cerambycidae collected by Malaise traps from ten islands within the Fiji archipelago from June 2004 to September 2010. E - Fiji endemic species; E† - possibly new and endemic species; N - native species. For full island names see Table 1.

						Island							
Species	**Status**	**ViL**	**VaL**	**Kad**	**Tav**	**Gau**	**Lak**	**Moa**	**Vat**	**Ova**	**Kor**	**Total**	**Freq.**
Araespor angustulum	E	36	48	7	11	36	21	6	3	1	4	173	10
Ceresium guttaticolle	N	1	6	13	0	21	8	0	0	0	0	49	5
Ceresium promissum	E	0	0	0	0	0	0	0	1	0	0	1	1
Ceresium tuberculata	E	0	0	0	0	8	0	0	0	0	0	8	1
Crinotarsus plagiatus	E	0	1	1	0	0	0	0	0	0	0	2	2
Crinotarsus sulcatus	E	0	0	0	0	0	0	1	0	0	0	1	1
Cristoopsis poggea	E	1	3	0	0	0	0	0	0	0	0	4	2
Cyrtinoopsis n.sp.a	E†	0	0	0	0	6	0	0	0	0	0	6	1
Diastosphya albisetosa	E	0	0	3	0	0	0	0	0	0	0	3	1
Diastosphya bimaculata	E	0	0	1	0	0	0	0	0	0	0	1	1
Diastosphya fusicollis	E	0	0	0	0	1	0	0	0	0	0	1	1
Diastosphya sp.*a*	E†	1	0	0	0	0	0	0	0	0	0	1	1
Distenia punctulata	E	0	1	0	1	0	0	0	0	0	0	2	2
Euoopsis sp.*a*	E†	1	0	0	0	0	0	0	0	0	0	1	1
Gracilosphya elongata	E	0	0	0	0	0	0	0	0	1	0	1	1
Gracisybra flava	E	1	0	0	0	0	0	0	0	0	0	1	1
Gracisybra fuscoaplicalis	E	1	0	0	0	0	0	0	0	0	0	1	1
Gracilosphya hirtipennis	E	0	0	0	0	0	2	0	0	0	0	2	1
Hestimidius humeralis	E	0	2	0	1	1	0	0	0	0	0	4	3
Moala crassus	E	1	0	0	5	0	2	0	0	0	0	8	3
Moala flavovittatus	E	1	0	0	0	0	0	0	0	0	0	1	1
Moala sp.*a*	E†	1	0	0	0	0	0	0	0	0	0	1	1
Neosciadella quadripustulata	E	1	0	0	0	0	0	0	0	0	0	1	1
Neosciadella spixi	E	0	0	1	0	0	0	0	0	0	0	1	1
Nerida gynandropsidis	N	0	3	14	2	3	0	0	0	2	0	24	5
Nerida oblongiguttula	E	3	3	0	0	5	0	0	0	0	0	11	3
Nerida sp.*a*	E†	3	0	0	0	0	0	0	0	0	0	3	1
Oopsis brunneocaudatus	E	1	14	19	0	4	1	0	2	5	4	50	8
Oopsis nutator	N	1	2	1	1	0	25	0	0	0	0	30	5
Paroopsis eumilis	E	0	0	0	0	1	0	0	0	0	0	1	1
Paroopsis sp.*a*	E†	1	0	0	0	0	0	0	0	0	0	1	1
Prosoplus ochreosparsus	E	2	0	2	0	0	0	0	1	0	0	5	3
Pterolophia ongea	E	0	0	0	0	1	0	0	0	0	0	1	1
Pterolophia singatoka	E	0	0	0	0	0	3	0	0	0	0	3	1
Pterolophia thawathi	E	1	0	0	0	0	0	0	0	1	0	2	2
Pterolophia tholo	E	0	0	0	0	0	1	0	0	0	0	1	1
Pterolophia vitiensis	E	0	0	0	1	0	1	0	0	2	0	4	3
Pterolophia sp.*a*	E†	0	0	0	0	1	0	0	0	0	0	1	1
Scituglaycytes muiri	E	2	2	0	1	0	0	2	0	1	0	8	5
Similosybra discedens	E	2	0	0	0	0	0	0	0	0	0	2	1
Sormida maculicollis	E	0	3	3	1	1	0	0	0	1	2	11	6
Sybra apicespinosa	E	1	0	0	0	0	0	0	0	0	0	1	1
Sybra vitiana	E	1	0	3	0	0	0	0	0	0	0	4	2
Sybroides sp.*a*	E†	1	0	0	0	0	0	0	0	0	0	1	1
		ViL	VaL	Kad	Tav	Gau	Lak	Moa	Vat	Ova	Kor	**Total**	
Species Richness (S)		23	12	12	9	13	9	3	4	8	3	44	
Abundance		65	88	68	24	89	64	9	7	14	10	438	

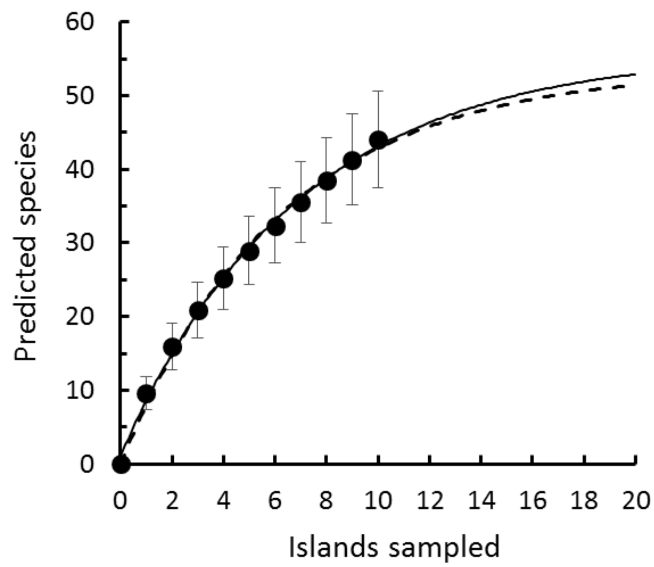

Figure 3. Results of bootstrap analysis of species richness data of Cerambycidae collected on each island, and expressing predicted accumulated species number as a function of islands visited. Black dots are predicted species numbers (± 95% CI); solid line is the asymptotic curve based on line of best fit; dotted line is the asymptotic curve fixed to the origin so that no specimens could be collected when no sampling had occurred.

3.2. Island biogeography

Island biogeography theory suggests that species richness of an island will be positively related to its size and negatively related to its degree of isolation from the mainland (MacArthur and Wilson 1967; Connor and McCoy 1979; Whittaker 1998). In our surveys compromises were made regarding the intensity of sampling on each of the islands: the time window available to sample each island (particularly the more remote ones) was quite narrow, and on some occasions there was only a single Malaise trap available for use. Thus, the islands could not logistically be sampled simultaneously and larger islands were purposely sampled from more than one location to account for the larger area and habitat diversity present. This unequal sampling effort creates a confounding effect where the maximum number of sampling events was performed on the larger islands closest to (and including) Viti Levu. As species number and sampling effort were related (Figure 2a) we can only make speculative statements regarding patterns between island size and species richness.

The highest number of species, 23, was recorded on the largest island, Viti Levu, followed by Gau with 13 species and Vanua Levu and Kadavu with 12 species. The small islands of Moala, Vatoa and Koro yielded only three or four species (Table 2; Figure 1). Thus, there was a positive relationship between species richness (S) and island size (S v log10(area); $r^2 = 0.57$; $P = 0.007$) but this was lost if the effect of sample number was taken into account by regressing the residuals of a regression between species number and sampling events (Resid v log10 (area); $r^2 = 0.09$; $P = 0.392$).

Sampling effort and size did not, however, account for all variation in island species richness. For example, even though the island of Gau is smaller than Taveuni (and had only one sampling event compared to Taveuni's two), it still recorded higher species richness. This finding could be attributed to the degree of isolation of Taveuni (249 km from Viti Levu) compared to Gau (144 km). The fauna on the island of Gau appeared somewhat distinct from the other islands, as six of the 13 species recorded there were not recorded on other islands. Gau is a relatively small volcanic island (136km^2) with a high elevation (i.e. 738m a.s.l.). This greater topographic diversity and consequent habitat diversity within the island may support rare or unique species, especially if the species involved are known to be habitat and/or resource specific (Hart and Horwitz 1991).

4. Conclusions

The current study has added 96 species × island records for Cerambycidae occurring in the Fijian archipelago. Of the 44 species listed, eight are possibly new to science, with one species, Ceresium tuberculata, now described (Waqa and Lingafelter 2009). Although the records presented here represent collections obtained from approximately 120 Malaise trap-weeks, the results suggest additional collecting events, of longer duration, encompassing more of the annual cycle, and involving additional and/ or complementary methods (e.g. rearing; canopy trapping; emergence traps) is required to more fully catalogue the current Fijian Cerambycidae fauna. Similarly, although the mathematical relationships between island properties and Cerambycidae species richness provide an excellent system for exploring classical island biogeographical theory, for these studies to be valid more complete species inventories are required for a greater number of islands.

Finally, Cerambycidae have potential as excellent bioindicators of forest 'health' due to their diversity, range of habitat specificities, and the multiple ecological roles they play, such as pollination, decomposition and as food for forest birds (Hanks 1999; Dajoz 2000). From a practical viewpoint, they can be relatively easy to identify, and there are already studies linking Cerambycidae diversity with floral diversity (Meng *et al*. 2013) and biodiversity 'hot spots' (Holland 2007). Together with other recent papers proposing the use of Fijian invertebrates as bioindicators of habitat integrity and ecosystem 'health' (e.g. Buluta *et al*. 2010; Tikoca *et al*. 2016a), this study provides baseline data of Cerambycidae diversity and community structure for comparison with future monitoring events and for comparison with faunas obtained on other Fijian islands.

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References

Ackery, P.R. and Vane-Wright, R.I. 1984. Milkweed butterflies. *Oryx* **19,** 183-184.

Buluta, S., Finau, I., Brodie, G., and Hodge, S. 2010. A preliminary study into the potential of mayflies (Ephemeroptera: Baetidae and Caenidae) as bio-indicators of stream health in Fiji. *South Pacific Journal of Natural and Applied Sciences* **28**, 82-84.

Coddington, J.A., Agnarsson, I., Miller, J.A., Kuntner, M.Z. and Hormiga, G. 2009. Undersampling bias: the null hypothesis for singleton species in tropical arthropod surveys. *Journal of Animal Ecology* **78,** 573-584.

Connor, E.F. and McCoy, E.D. 1979. The statistics and biology of the species-area relationship. *American Naturalist* **113,** 79-833.

Dajoz, R. 2000. *Insects and Forests. The role and diversity of insects in the forest environments*. Intercept Lavoisier Publishing, London. 668 pp.

Dillon, L.S. and Dillon, E.S. 1952. Cerambycidae of the Fiji islands. *Bernice P. Bishop Museum Bulletin* **206,** 1-114.

Evenhuis, N.L. 2007. Checklist of the Coleoptera of Fiji. *Bishop Museum Technical Reports* **38** (5) p.59.

Evenhuis, N. and Bickel, D.J. 2005. The NSF- Fiji Terrestrial Arthropod Survey: Overview. *Bishop Museum Occasional Papers* **82,** 3-25.

Hanks, L.M. 1999. Influence of the larval host plant on reproductive strategies of cerambycid beetles. *Annual Review of Entomology* **44,** 483-505.

Hart, D.D. and Horwitz, R.J. 1991. Habitat diversity and the species-area relationship: alternative models and tests. **In:** *Habitat Structure: The Physical Arrangement of Objects in Space*. Eds S.S. Bell, E.D. McCoy, and H.R. Mushinsky. Chapman and Hall, London. p.47-68.

Holland, J.D. 2007. Sensitivity of cerambycid biodiversity indicators to definition of high diversity. *Biodiversity and Conservation* **16,** 2599-2609.

Keast, A. 1996. Pacific biogeography: patterns and processes. **In**: *The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes*. A. Keast and S. E. Miller (Eds), SPB Academic Publishing, Amsterdam. p. 477-512.

Keppel, G., Lowe, A.J. and Possingham, H.P. 2009. Changing perspectives on the biogeography of the tropical South Pacific: influences of dispersal, vicariance and extinction. *Journal of Biogeography* **36,** 1035-1054.

Lingafelter, S.W. 2007. Two new *Distenia* Lepeletier and Serville from Fiji with a key to the known Melanesian species (Coleoptera: Cerambycidae: Disteniinae). **In**: Fiji Arthropods VIII. N. L. Evenhuis and D. J. Bickel (Eds). *Bishop Museum Occasional Papers* **93,** 3-11.

MacArthur, R.H. and Wilson, E.O. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton, NJ.

Meng, L-Z., Martin, K., Weigel, A., Yang. X-D. 2013. Tree diversity mediates the distribution of longhorn beetles (Coleoptera: Cerambycidae) in a changing tropical landscape (Southern Yunnan, SW China). *PLoS ONE* **8,** e75481.

Novotny, V. and Basset, Y. 2000. Rare species in communities of tropical insect herbivores: pondering the mystery of singletons. *Oikos* **89**, 564-572.

Prasad, A.V. and Hodge, S. 2013. The diversity of arthropods associated with the exotic creeping daisy *Sphagneticola trilobata* in Suva, Fiji Islands. *Entomologists Monthly Magazine* **149**, 155-161.

Sarnat, E. and Moreau, C.S. 2011. Biogeography and morphological evolution in a Pacific island ant radiation. *Molecular Ecology* **20**, 114-130.

Slipinski, A. and Escalona, H.E. 2013. *Australian longhorn beetles (Coleoptera: Cerambycidae)*. CSIRO publishing, Australia.

Tavakilian, G., Berkov, A. and Meurer- Grimes, B. 1997. Neotropical Tree Species and their Faunas of Xylophagous Longicorns (Coleoptera: Cerambycidae) in French Guiana. *The Botanical Review* **63,** 303-355.

Tikoca, S., Hodge, S., Tuiwawa, M., Pene, S., Clayton, J. and Brodie, G. 2016a. An appraisal of sampling method and effort for investigating moth assemblages in a Fijian forest. *Austral Entomology* **55,** 455-462.

Tikoca, S., Hodge, S., Pene, S., Clayton, J., Tuiwawa, M. and Brodie, G. 2016b. Temporal variation in macro-moth abundance and species richness in a lowland Fijian forest. *Pacific Science* **70**, 447-461.

Waqa, H. and Lingafelter, S.W. 2009. New Fijian Callidiopini (Coleoptera: Cerambycidae). In: Fiji Arthropods XV. N.L. Evenhuis and D. Bickel (Eds). *Bishop Museum Occasional Papers* **106,** 3-15.

Waqa-Sakiti, H., Stewart, A., Cizek, L. and Hodge, S. 2014. Patterns of tree species usage by long- horned beetles (Coleoptera: Cerambycidae) in Fiji. *Pacific Science* **68**, 57-64.

Waqa-Sakiti H, Winder L. and Lingafelter S.W. 2015. Review of the genus *Ceresium* Newman, 1842 (Coleoptera, Cerambycidae) in Fiji. *ZooKeys* **532**: 15-53.

Whittaker, R.J. 1998. *Island Biogeography: Ecology, Evolution and Conservation*. Oxford University Press, Oxford.

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