

## A comparison of macro-moth assemblages across three types of lowland forest in Fiji

SITERI TIKOCA<sup>1\*</sup>, SIMON HODGE<sup>2,3</sup>, MARIKA TUIWAWA<sup>1</sup>, SARAH PENE<sup>1</sup>, JOHN CLAYTON<sup>4</sup>, GILIANNE BRODIE<sup>2</sup>

<sup>1</sup>Institute of Applied Sciences, University of the South Pacific, Suva, Fiji.

<sup>2</sup>School of Biological & Chemical Sciences, University of the South Pacific, Suva, Fiji.

<sup>3</sup>Faculty of Agriculture and Life Sciences, Lincoln University, Canterbury, New Zealand.

<sup>4</sup>15 Whinny Brae, Broughty Ferry, Dundee, United Kingdom.

*stikoca@gmail.com*

**Abstract.** Although many studies have shown a relationship between forest type and quality on resident lepidopteran assemblages, there appears to be an absence of such studies in Pacific island countries. This study compared nocturnal macro-moth assemblages in a native rainforest, mixed forest and a plantation of exotic trees (mahogany) near Suva, Fiji Islands. Four nightly surveys (4 h from dusk) were performed in each forest type using a mercury vapour light. A total of 491 macro-moths belonging to 92 species in nine families were collected. No statistically significant differences in abundance, species richness and various diversity indices were observed across the different forest types. Endemic species were collected in all three locations, although significantly more endemic individuals were collected in the native forest compared to the exotic plantation. When examining species composition, 'analysis of similarity' (ANOSIM) and non-metric multidimensional scaling suggested that the faunas observed in the mixed forest and the exotic forest might be different, with the fauna in the native forest intermediate between these two. Although we found no major differences in the moth assemblages in these three sites, the results collected provide baseline data for future studies and comparisons with other localities. The results also reinforce previous findings which demonstrate that exotic plantations and semi-degraded forests may still provide useful refuges for endemic insect species of conservation value.

**Key words:** Ecological monitoring, indicator species, Lepidoptera, South Pacific.

### INTRODUCTION

Herbivorous insects, such as Lepidoptera, have a close functional relationship with the vegetation they utilize, and hence often respond sensitively to deforestation and subsequent forest regeneration (Hilt 2005). The distribution and quality of plant communities, in terms of host plants for larvae and floral resources for adult insects, can have immediate

effects on the abundance and composition of the co-occurring lepidopteran fauna (Robinson 1975; Fisher 2011). Because of their sensitivity to habitat quality, nocturnal moths have long been considered valuable indicators for monitoring the ecological effects of forest change and for providing a surrogate measure of forest 'health' (Willott 1999; Schulze et al. 2000; Beck et al. 2002; Axmacher et al. 2004; Summerville et al. 2004).

The destruction of native forests remains a serious threat to endemic terrestrial fauna and flora of Pacific islands. Since 1967 an estimated 19% (140,000 ha) of Fiji's forests have been lost, principally due to conversion to commercial agriculture, rural development projects, spread of small settlements and the development of urban growth (Evenhuis & Bickel 2005; Prasad 2010). A comprehensive study of the Macro-Lepidoptera of Fiji was produced by Robinson (1975) and a later checklist provided by Evenhuis (2013), with new species records for Fiji regularly being reported (e.g. Clayton 2002, 2008, 2010, 2011, 2015; Tikoca et al. 2016a). However,

\* Corresponding author

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as far as we can ascertain, in South Pacific islands there have been few, if any, comparisons of moth assemblages among forest types, nor any work utilizing macro-moth communities as indicators of habitat change, habitat degradation or restoration success.

Fiji still contains a wide range of forest types, from pristine native cloud and rain forests to highly managed plantations containing exotic tree species (Prasad 2010; Sue 2010). The aim of this study was to examine the assemblages of nocturnal macro-moths across three secondary lowland forests near Suva, Viti Levu: a native forest, an exotic plantation and a mixed forest containing regeneration of native species after commercial use. The relationships between forest type and macro-moth abundance, species richness, patterns of endemism, and species composition were assessed. In addition, two moth-based 'Forest Quality Indices', as proposed by Kitching et al. (2000), were evaluated for their potential and applicability as conservation tools in a Pacific island setting.

## MATERIALS & METHODS

### Study sites

Macro-moth assemblages were compared in three secondary lowland forest types, namely: (i) native forest (Savura), (ii) exotic plantation forest (Mt. Korobaba) and (iii) mixed forest (Colo-i-Suva). The three sites are located on the south-eastern part of Fiji's largest Island, Viti Levu, at elevations < 300 m above sea level (a.s.l.). Savura (-18.070, 178.448) consists of 397 ha of native forest located in the province of Naitasiri, 14 km west of Nausori. The site was established as a forest reserve in 1963 and has not been logged since that time. A total of 587 plant species have been recorded from the area, of which 560 (96%) were considered native to Fiji, with 29% considered endemic. The dominant plant families present include Myristicaceae, Cyatheaceae and Clusiaceae (Keppel et al. 2005).

Mahogany (*Swietenia macrophylla*) plantations cover a considerable area of the south-eastern parts of Viti Levu (Tuiwawa et al. 2013). Mt. Korobaba is located 8 km west of Suva (-18.097, 178.388), and was cleared and systematically planted and managed for the mahogany timber trade from the late 1950's to 1970's (Kirkpatrick & Hassall 1985). The sampling sites within Mt. Korobaba were in elevations <200 m a.s.l., in areas which contained mature unlogged mahogany forest with a 90% relative dominance of mahogany.

Colo-i-Suva is located in the province of Naitasiri, 7 km north-west of Suva, (-18.328, 178.274). Sampling sites were within a two and a half square kilometre of tropical rainforest that was set up as a reserve in 1964 (soon after mahogany stands were planted in the area) and established as the Colo-i-Suva forest park in 1970 (Paine 1991). The vegetation at Colo-i-Suva contains a mixture of both exotic timber species and native species at various growth stages in the understorey, and approximately 70 native plant species have been recorded from the site (Tuiwawa & Keppel 2013).

### Light trapping and insect identification

Moths were collected using a manual light trapping system, consisting of a 125W mercury vapour lamp powered by a portable generator and a 2 x 2 m white sheet positioned in front of the light source which was spread out and secured onto nearby trees or branches. All moths that landed on the white sheet were collected and placed into jars charged with ethyl acetate as a killing agent. Each sample consisted of the individuals collected in one night in the four hours after dusk.

Previous research comparing light trap efficiency at one of the field sites (Colo-i-Suva) indicated that four nights of sampling would obtain a good proportion (c. 90%) of the estimated moth species present (Tikoca 2016c). Therefore, sampling was carried out on four nights within each site, performed over six nights in October 2012 with two sites being randomly selected for sampling on each occasion.

Specimens were assigned to species level by reference to keys, images and nomenclature provided by Robinson (1975), Holloway (1998), Clayton (2004), CSIRO (2011) and Evenhuis (2013), with family designations as revised by Zahirri et al. (2011). Species were classified as being 'endemic' if they have only been recorded from Fiji. This classification is based on taxa at the species level, and no account is taken of possible endemic sub-species. We accept that any designation of a species as endemic has to be made with some reservations given the incomplete knowledge of occurrences in different island groups in the South Pacific, and the relatively unstable taxonomy in some groups. Individuals of the large genus *Cleora* were not identified to species level and '*Cleora* sp.' was treated as a single taxon. Of the ten species belonging to the genus *Cleora* in Fiji only *C. injectaria* and *C. samoana* are not considered endemic. However, as neither of these species was recorded in this study, '*Cleora* sp.' was considered as an endemic taxonomic unit in our analyses.

## Measures of community structure

For each sample, macro-moth abundance (N), species richness (S) and rate of endemism were obtained. Species diversity was defined using the Shannon-Weiner index [ $H' = -\sum p_i \cdot \log(p_i)$ ] and evenness index [ $J' = H' / \log(s)$ ], where  $p_i$  = proportion of individuals consisting of the  $i$ th species.

Kitching et al. (2000) proposed an index to measure forest quality in terms of the abundance of certain moth families, calculated as:  $100 \times [\text{Geometridae} / (\text{Arctiidae} + \text{Noctuidae})]$ . However, due to taxonomic revisions at family level, Arctiidae and some Noctuidae are now placed in the family Erebidae (Zahiri et al. 2011). Therefore we calculated the Forest Quality Index (FQI) proposed by Kitching (2000) using previous taxonomy, and then a second FQI ('Tikoca FQI') based on current family-wise designations calculated as:  $100 \times [\text{Geometridae} / (\text{Erebidae} + \text{Noctuidae})]$ . Each FQI was calculated for each of the twelve samples separately and also based on the overall catch from each forest using pooled data.

## Statistical analysis

All statistical analyses were performed using Minitab (v17, Minitab Inc, USA) and Community Analysis Package (v4, Pisces Conservation Ltd, UK). Forest types were compared using a one way analysis

of variance (ANOVA) test with *post-hoc* Tukey's tests used for pairwise comparisons after a significant result. Abundance of moths and species richness data were  $\log_{10}$  transformed prior to analysis to help reduce the effects of the relationship between mean and variance (Tikoca 2016c), and prior to ANOVA being performed, homogeneity of variance was verified for all variables examined using Levene's test. Due to a prevalence of zero scores, the abundances of each family at the three sites were compared using a non-parametric Kruskal-Wallis test.

The species-sample matrix obtained was extremely sparse, with 79% of cells equal to zero. Legendre and Gallagher (2001) indicated that, with sparse matrices such as this, principle components analysis on raw data might be inappropriate because samples that actually contain no common species may appear similar due to a prevalence of shared absences. Therefore we compared the compositions of the moth faunas among the three forest types using non-metric multidimensional scaling (NMDS) and 'analysis of similarity' (ANOSIM) using square root transformed data (Community Analysis Package; Henderson & Seaby 2008). For the NMDS, a Bray-Curtis similarity measure was employed and principal components analysis used to give initial positions of the samples. The ANOSIM procedure examines whether samples from within pre-defined groups are more similar in composition than samples from different groups, again using a Bray-Curtis

**Table 1.** Abundance of individuals and number of species in macro-moth families collected at three forests near Suva, Viti Levu, Fiji, produced by four hours trapping on four separate nights using an MV light.

Family	Individuals				Species			
	Savura	Colo-i-Suva	Mt Korobaba	Total	Savura	Colo-i-Suva	Mt Korobaba	Total
Cossidae	1	0	0	1	1	0	0	1
Erebidae	99	50	63	212	20	19	21	32
Geometridae	81	39	30	150	9	10	11	21
Limacodidae	7	6	3	16	4	4	2	7
Noctuidae	22	29	13	64	10	15	16	19
Nolidae	2	7	6	15	1	3	4	5
Sphingidae	3	1	1	5	2	2	1	3
Thyrididae	5	3	7	15	2	2	2	3
Uranidae	4	4	5	13	1	1	1	1
Grand Total	224	139	128	491	50	55	48	92
No. of singletons					21	27	24	34
Proportion of Singletons (%)					42.0	49.1	50.0	37.0

**Table 2.** Abundance and species richness of macro-moths and levels of endemism at three forests near Suva, Viti Levu, Fiji, produced by four hours light trapping (mean  $\pm$  se; n = 4). Samples with different letter codes (**a** or **b**) were separated by Tukey test at  $P < 0.05$ . \* - ANOVA performed on  $\log_{10}$  transformed data

Site	Savura	Colo-i-Suva	Mt Korobaba		
Forest type	Native	Mixed	Exotic	$F_{2,11}$	P
Abundance (N)	56.0 $\pm$ 13.8	34.8 $\pm$ 10.4	32.0 $\pm$ 9.9	0.86*	0.457
Species richness (S)	20.5 $\pm$ 4.2	20.8 $\pm$ 6.0	17.2 $\pm$ 4.3	0.13*	0.881
Species diversity ( $H'$ )	2.36 $\pm$ 0.23	2.61 $\pm$ 0.35	2.54 $\pm$ 0.25	0.21	0.815
Evenness ( $J'$ )	0.80 $\pm$ 0.06	0.91 $\pm$ 0.01	0.93 $\pm$ 0.02	3.39	0.080
Endemic abundance (EN)	37.2 $\pm$ 8.0 <sup>a</sup>	14.5 $\pm$ 4.4 <sup>ab</sup>	10.0 $\pm$ 1.4 <sup>b</sup>	5.06*	0.034
Endemic abundance (EN %)	69.4 $\pm$ 6.5	42.5 $\pm$ 6.6	40.5 $\pm$ 10.4	4.03	0.056
Endemic richness (ES)	7.8 $\pm$ 1.1	7.5 $\pm$ 2.4	5.2 $\pm$ 0.9	0.36*	0.708
Endemic richness (ES %)	40.2 $\pm$ 6.1	33.5 $\pm$ 7.1	35.2 $\pm$ 8.5	0.23	0.799
Site total Kitching FQI	118.6	57.4	40.5	-	-
Site total Tikoca FQI	68.6	49.4	39.5	-	-
Mean sample Kitching FQI	156.8 $\pm$ 64.2	54.9 $\pm$ 16.0	95.7 $\pm$ 68.1	0.87	0.450
Mean sample Tikoca FQI	65.9 $\pm$ 6.2	46.3 $\pm$ 15.6	94.3 $\pm$ 68.6	0.95	0.423

measure of similarity. The test statistic produced,  $R$ , ranges from -1 to +1, with +1 indicating all the most similar samples are within groups, and -1 indicating that all the most similar samples are never in the same group. Both of these multivariate procedures were performed three times: on a matrix including the abundance of all species, a matrix including only species with total abundance  $\geq 3$ , and on a sample-by-family matrix.

## RESULTS

### Moth abundance and diversity

A total of 491 macro-moth individuals belonging to 9 families and 92 species were collected. Three families - Erebidae, Geometridae and Noctuidae - made up the majority of individuals (87%) and species (78%) collected (Table 1; Appendix).

The total number of species collected at each site was similar: 55 species were recorded at Colo-i-Suva, 50 species at Savura and 48 species at Mt. Korobaba. There were no significant differences in abundance among the three sites for any of the families recorded (Kruskal-Wallis tests,  $P > 0.180$  in all cases) (Table 1). There were also no statistically significant differences among the three forests in terms of total moth abundance, species richness, species diversity and evenness of moth assemblages (Table 2).

A considerable proportion (c. 35%) of the total catch in each forest type consisted of endemic species, although there were no statistically significant differences among the three forests in terms of numbers of species or proportions of endemic species in the individual collections (Table 2). However, there were clear differences in the abundances of endemic species among the three forests. The exotic forest at Mt Korobaba had significantly fewer endemic individuals than the native forest at Savura, with the mixed forest at Colo-i-Suva being intermediate between these two extremes (Table 2).

### Comparison of macro-moth assemblage composition

When comparing the three forests in a pairwise fashion, the ANOSIM procedure identified no significant differences among the moth faunas in the three locations when considering family-level identifications ( $R < -0.10$ ;  $P > 0.35$ ). However, the ANOSIM procedure indicated there was moderate evidence that the moth assemblages in the mixed and exotic forests exhibited some differences when considering all species ( $R = 0.19$ ;  $P = 0.07$ ) and when considering only those species with abundances  $\geq 3$  ( $R = 0.18$ ;  $P = 0.10$ ). The findings from the ANOSIM were supported by the results of the NMDS (Figure 1), where no obvious clustering of the samples from the three forests occurred when the analysis was based

on families (Figure 3c). However, some separation of the groups was observed along NMDS Axis 1 when the analysis was based on species-level identifications, especially between the moth samples taken from the mixed and the exotic forests (Figure 1a,b).

Twenty percent of the total species recorded in this study were found in all three forest types (Figure 2; Appendix). In addition, a further 27% of species were shared by at least two of the sites (Figure 3). However, this indicates that over half of the species recorded (53%) were only found at a single site, and thus may have potential as indicators of certain habitat types. Unfortunately 34 of these 49 site-unique species were represented by singletons and thus could not be considered as indicator species. Similarly, a further six of the site-unique species were only recorded in a single night's trapping and thus exhibited no consistency of capture within that location. Indeed, no species were found that were unique to a single site and occurred in all of the samples taken from that site.

However, based on the results of the NMDS analysis, there appeared some tendency for the abundances of *Ericaea leichardtii* and *Ericaea inangulata* (Erebidae), and less so *Sasunaga oenistis* (Noctuidae) and *Rusicada nigritasis* (Erebidae), to be correlated (rank correlation) with the NMDS Axis 1 score, indicating a positive association with the exotic forest. Also, by examining the raw data, it was found that two endemic taxa, *Cleora* sp and *Calliteara fidjiensis*, made up approximately 50% of the individuals in the native forest at Savura, and so it might be speculated that a high abundance of these taxa may indicate high quality forest in a Fijian setting.

### Forest quality indices

The values of the FQI proposed by Kitching *et al.* (2000) and the alternative 'Tikoca FQI' proposed here were highly correlated across the 12 moth samples ( $r_s = 0.944$ ,  $P < 0.001$ ). When considering the FQIs based on the total catch at each site, both FQIs exhibited a similar pattern: the FQIs for the native forest at Savura were considerably higher than that seen in the exotic forest at Mt Korobaba, with the mixed forest at Colo-i-Suva intermediate between these two (Table 2).

However, there were some discrepancies, and a difference in the ranking of sites, when using FQIs based on the total catch and those based on the sample means (Table 2). These anomalies resulted primarily because some samples consisting of small numbers of individuals (e.g. 10, 14 and 16) produced some extreme FQI values, such as an FQI of 300 for

one sample from the exotic forest at Mt Korobaba. This value was given equal weighting when the mean FQI values for Mt Korobaba was calculated (95.7 & 94.3), but the small number of individuals meant the effect of this sample on the pooled FQI estimates (40.5 & 39.5) was much reduced.

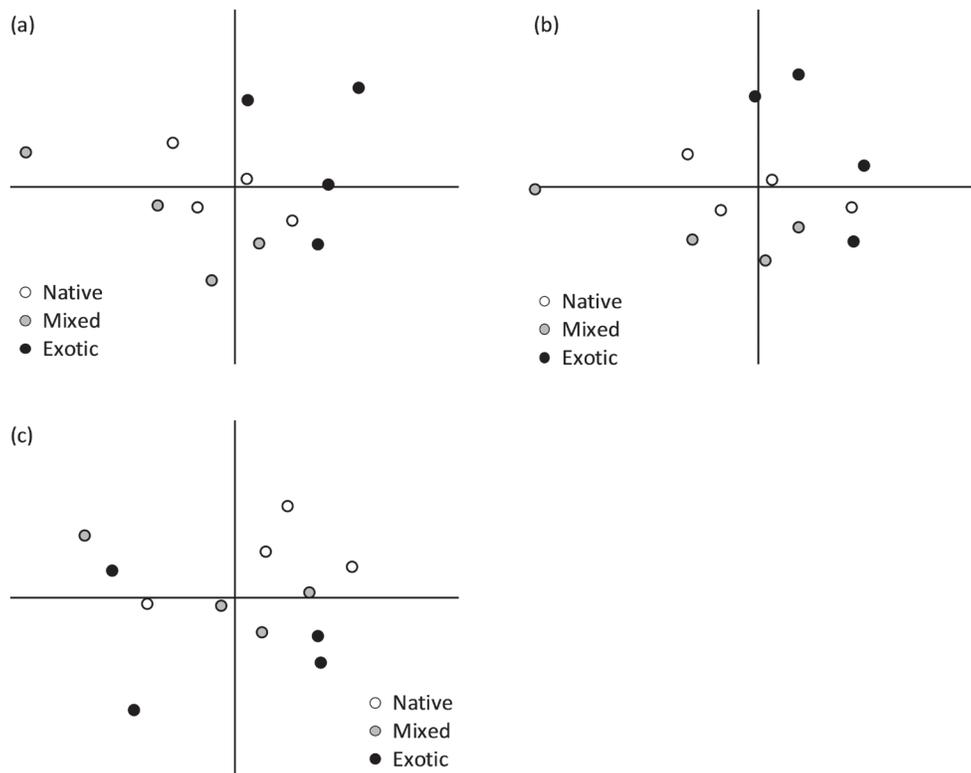
## DISCUSSION

### Moth abundance, diversity and composition

Many previous studies have examined macro-moth community patterns in forests as a response to the state of the forests studied, including logging and recovery regimes (Fisher 2011; Hilt 2005; Willott 1999), natural disturbance (Chaundy 1999), reforestation age (Taki *et al.* 2010), native and agricultural habitats (e.g. Ricketts *et al.* 2001), and plantations (Hawes *et al.* 2009). Often there are clear negative relationships between moth abundance and species richness with increasing habitat degradation and forest disturbance (Hawes *et al.*, 2009; Ricketts *et al.* 2001). However, only slight differences were found in the abundance and species diversity of the moth faunas in the three different Fijian forests investigated here. The lack of distinctiveness may be due to the forests we examined all being geographically close to each other and in recent years they have all suffered similarly low amounts of disturbance in terms of logging management. Also, this study was performed over a relatively narrow time period. Recent work has identified considerable seasonal fluctuations in Fijian moth populations, and it is possible that clearer differences do occur between forest types at different times of the year (Tikoca *et al.* 2016b).

The proportion of singletons was high for each location (> 40%), and for the total catch (37%), which suggests that, even though the moth sampling regime was based on previous appraisals of suitable sampling effort (Tikoca 2016c), the number of samples used per site was insufficient in this case (Coddington *et al.* 2009). However, given the various summary statistics used to compare abundance and diversity of the moth assemblages in each forest type, we do not believe that the lack of statistically significant results occurred due to a lack of statistical power, and was more a reflection of the small differences that actually occurred between sites.

Although there are few data on host plant specificity for Fijian moth species, we can assume that endemic moth species primarily utilize native host plants, and that diversity of endemic plants should be associated with high incidence of endemic



**Figure 1.** Scatter plots of NMDS Axis 2 versus NMDS Axis 1 scores of twelve macro-moth samples. NMDS was performed on square-root transformed data of moths collected during one nights sampling in a native (Na; Savura), a mixed (Mi; Cool-i-Suva) and an exotic (Ex; Mt Korobaba) forest on Viti Levu, Fiji Islands: (a) based on NMDS on data for all species, (b) based on NMDS on data for species represented by  $\geq 3$  individuals and (c) based on the abundance of each family in each sample.

moths (Miller & Hammond 2007). This turned out to be the case: Savura had much higher abundance (threefold) of endemic individuals than the other two forests studied, and Savura is also the most floristically diverse forest with the highest degree of indigenous plant species and composition (Keppel et al. 2005). Conspicuous numbers of endemic moths were also recorded at Colo-i-Suva and Mt. Korobaba which suggests that these moth species are finding adequate resources in these habitats. The value of plantations of exotic tree species for providing habitats for native invertebrates has been observed previously (e.g. Pawson et al. 2010, 2011), but until more is known of the specific life history requirements of Fijian endemic moth species no explicit management actions can be taken in order to increase their numbers at these, and other, locations.

In terms of species composition, only 20% of species were found at all three sites, and the multivariate methods suggested there could be

dissimilarities in the compositions of the moth assemblages at the different sites. However, this separation was not between the exotic and native forest as might have been predicted, and thus did not indicate any gradient of change in moth assemblages from high quality native forest to low quality exotic plantation, with mixed forest having a fauna intermediate between these two. Although the data obtained suggested that a few species might show some weak associations with certain forest types, we could not identify any strong candidates as indicators of habitat quality or class.

The moth-based Forest Quality Index proposed by Kitching et al. (2000) utilized family-level identifications, and in upland rainforests in Queensland, Australia, FQI values of 98.7 for uncleared remnants, 68.2 for regrowth remnants and 18.6 for 'scramberland' remnants were obtained. The values we obtained using the pooled catches for each site were of similar magnitude: 118.6 for the native forest at Savura, 57.4 for the mixed forest

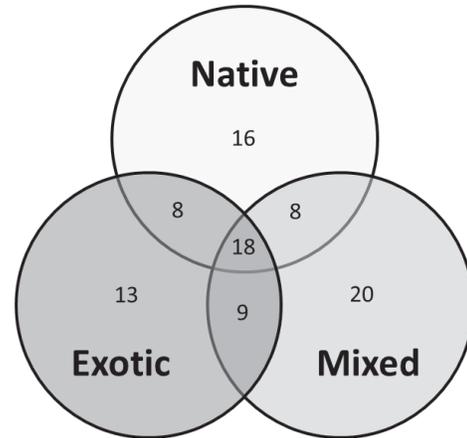
at Colo-i-Suva and 40.5 for the exotic plantation at Mt. Korobaba. The ranking of the sites by these pooled-data FQI scores appeared sensible, in that the FQI ranks matched the sequence of habitat quality we had notionally pre-determined: exotic → mixed → native forest. However, the values we obtained when using the sample averages suggest that these indices can produce some highly anomalous values when sample sizes are small, and might only be of value when a large number of individuals (> 100) has been recorded at each location.

### Changes of macro-moth community composition with forest structure over time

The abundance and diversity of macro-moths in Colo-i-Suva revealed an interesting development in this community over the last 50 years or so. One of Robinson's (1975) primary collecting sites in the 1960s and 1970s was Colo-i-Suva, where he identified the dominant species as *Nola fijiensis* (Nolidae), *Progonia micrastis* (Noctuidae), and *Hypenagonnia* spp. (Noctuidae). In the current study, none of these species were encountered at the Colo-i-Suva site at all (although additional collections made by the authors at Colo-i-Suva have since revealed a few occurrences of *Hypenagonnia* spp. but neither of the other two species). The dominant taxa in our collections from Colo-i-Suva were *Cleora* sp. (Geometridae), *Calliteara fidjiensis* (Lymantridae) and *Spodoptera mauritia* (Noctuidae) (Appendix). The Colo-i-Suva area was cleared to aid the mahogany trade from 1950–1960 (Tuiwawa et al. 2012), which means Robinson's collecting was conducted during the late 1960s/70s on a disturbed forest system, and consequently *Nola fijiensis* was described by Robinson (1975) as a species typical of a disturbed lowland forest. The forest at Colo-i-Suva has changed considerably over the last 50 years: the understory of largely native forest plant species has been allowed to develop and remnant mahogany plants have matured. Robinson (1975) suggested that moth faunal composition develops with forest structure and age, and the absence of *N. fijiensis* in Colo-i-Suva during the current study suggests that the recovery of the forest may have caused a shift in macro-moth species composition and the loss of this species.

### CONCLUSIONS

Although this study showed that the three forest types sustain similar macro-moth communities in terms of abundance and species richness, the major difference identified was the ability of the native



**Figure 2.** Venn diagram illustrating the number of moth species (total = 92) collected in a native (Savura), a mixed (Cool-i-Suva) and an exotic (Mt Korobaba) forest on Viti Levu, Fiji Islands. The numbers are based on total catches obtained on four sample nights in each forest using a MV-lamp combined with hand collecting of specimens.

forest to sustain higher populations of endemic species than the exotic forest. Over two thirds of the total macro-moths collected in the native forest belonged to endemic species, and this relatively large population of endemic moths in the native forest may be explained by the high frequency of indigenous plant species that presumably support them, although this hypothesis requires further research on host plant usage for confirmation.

With a caveat that sample numbers must be large to avoid anomalous values, the use of forest quality indices appears to have some potential as a tool to compare the quality of Fijian forests in terms of their moth assemblages. Endemic moth species were also found in considerable numbers in both the mixed and exotic forest, and management of these sites to enhance their ability to sustain native invertebrate species should be further explored.

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**APPENDIX.** Species of moths recorded using a mercury vapour lamp for four nights at each of three forest sites near Suva, Fiji Islands, October 2012.

Family	Species	Savura	Colo-i-Suva	Mt. Korobaba
Cossidae	<i>Acritocera negligens</i>	1	0	0
Erebidae	<i>Achaea robinsoni</i>	1	0	1
	<i>Adetoneura lentiginosa</i>	0	0	1
	<i>Aedia sericea</i>	0	2	0
	<i>Argina astraea</i>	0	3	0
	<i>Asota woodfordi</i>	0	1	0
	<i>Bocana manifestalis</i>	2	0	1
	<i>Calliteara fidjiensis</i>	52	11	2
	<i>Dysgonia duplicata</i>	2	1	0
	<i>Dysgonia prisca</i>	1	2	1
	<i>Ericaea inangulata</i>	3	2	7
	<i>Ericaea leichardtii</i>	10	3	10
	<i>Euchromia vitiensis</i>	1	0	0
	<i>Eudocima fullonia</i>	1	0	0
	<i>Hydrillodes surata</i>	2	7	2
	<i>Hypenagonia emma</i>	3	0	0
	<i>Hypocala deflorata</i>	0	0	4
	<i>Mecodina variata</i>	2	0	1
	<i>Mocis trifasciata</i>	0	0	1
	<i>Neogabara plagiola</i>	0	1	0
	<i>Nyctemera baulus</i>	1	0	0
	<i>Oeonistis delia</i>	6	2	3
	<i>Oxyodes scrobiculata</i>	4	1	13
	<i>Palaeocoleus sypnoides</i>	2	2	1
	<i>Polydesma boarmoides</i>	0	3	5
	<i>Rhesalides curvata</i>	0	2	2
	<i>Rusicada nigritasis</i>	1	0	3
	<i>Rusicada vulpina</i>	0	1	0
	<i>Serodes mediopallens</i>	0	1	2
	<i>Serodes campana</i>	1	0	0
<i>Simplicia cornicalis</i>	1	2	1	
<i>Thyas coronate</i>	0	0	1	
<i>Thyas miniacea</i>	3	3	1	
Geometridae	<i>Agathia pisina</i>	1	0	0
	<i>Anisodes gloria</i>	0	1	0
	<i>Anisodes monetara</i>	5	6	4
	<i>Anisodes niveopuncta</i>	0	0	1
	<i>Anisodes oblivaria</i>	2	1	0
	<i>Bulonga philipsi</i>	6	2	1
	<i>Chlorochaeta cheromata</i>	0	0	1
	<i>Chloroclystis encteta</i>	0	2	0
	<i>Cleora sp.</i>	59	21	14

## APPENDIX. Cont.

Family	Species	Savura	Colo-i-Suva	Mt. Korobaba
	<i>Gelasma stuhlmanii</i>	0	0	1
	<i>Gymnoscelis sara</i>	0	1	0
	<i>Horisme chlorodesma</i>	0	3	0
	<i>Mnesiloba eupitheciata</i>	0	0	2
	<i>Nadagara irretracta</i>	0	1	0
	<i>Polyclysta gonycrota</i>	0	0	2
	<i>Pseuderythrolopus bipunctatus</i>	0	1	1
	<i>Pyrrhorachis pyrrhogona</i>	1	0	2
	<i>Thalassodes pilaria</i>	3	0	0
	<i>Thalassodes chloropis</i>	0	0	1
	<i>Thalassodes figurate</i>	1	0	0
	<i>Thalassodes liquescens</i>	3	0	0
Limacodidae	<i>Beggina alba fasciata</i>	0	1	2
	<i>Beggina bicornis</i>	0	1	0
	<i>Beggina mediopunctata</i>	2	0	0
	<i>Beggina minima</i>	2	1	0
	<i>Beggina unicomis</i>	1	0	0
	<i>Beggina zena</i>	0	3	1
	<i>Beggina sp.</i>	2	0	0
Noctuidae	<i>Aegilia vitiscubens</i>	0	2	0
	<i>Agrotis ipsilon</i>	0	1	0
	<i>Athetis thoraicica</i>	0	0	3
	<i>Chasmania tibialis</i>	1	1	0
	<i>Chrysodeixis eriosoma</i>	8	1	3
	<i>Condica conducta</i>	0	1	0
	<i>Condica illecta</i>	1	3	2
	<i>Dactyloplusia impulse</i>	0	1	0
	<i>Gyrtonia purpurea</i>	0	1	0
	<i>Leucania venalba</i>	1	0	0
	<i>Leucania yu</i>	1	1	0
	<i>Penicillaria jocosatrix</i>	0	1	0
	<i>Sasunaga oenistis</i>	2	0	3
	<i>Spodoptera litura</i>	0	1	0
	<i>Spodoptera mauritia</i>	4	10	0
	<i>Stictoptera stygia</i>	0	1	1
	<i>Stictoptera vitiensis</i>	1	2	1
	<i>Targalla delatrix</i>	1	0	0
	<i>Tiracola plagiata</i>	2	2	0
Nolidae	<i>Austrocarea albipicta</i>	2	0	1
	<i>Barasa triangularis</i>	0	2	1
	<i>Earias flavida</i>	0	4	0
	<i>Maceda mansueta</i>	0	0	1
	<i>Maceda savura</i>	0	1	3

## APPENDIX. Cont.

Family	Species	Savura	Colo-i-Suva	Mt. Korobaba
Sphingidae	<i>Macroglossum godeffroyi</i>	2	1	0
	<i>Theretra nesus</i>	1	0	0
	<i>Theretra silhetensis</i>	0	0	1
Thyrididae	<i>Banisia anthina</i>	0	1	0
	<i>Banisia messoria</i>	4	0	6
	<i>Striglina navigatorum</i>	1	2	1
Uraniidae	<i>Urapteroides aneres</i>	4	4	5