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Chapter 7

Insects of the Nakorotubu Range, Ra and Tailevu Provinces, Fiji.

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SUMMARY

In November 2009, an entomological survey of the Nakorotubu Range, Viti Levu was conducted. The entomological quantitative surveys included: leaf litter sampling and pitfall trapping; qualitative surveys included: light trapping to target nocturnal insects, butterfly collections, fruit fly baiting and opportunistic encounters. The surveys were divided into three focal surveys sites averaging three field days per site. Adverse weather conditions on some of the days prevented insect sampling especially at Base camp 3 which limited collections from leaf litter and pitfall traps.

The order Coleopetera (beetles) was the most common insect order encountered throughout the surveys and was the target taxa. Overall Coleoptera recorded a total of 25 families. Rare families encountered during the surveys included: Pselaphidae, Callirhyphidae, Cerambycidae and Cicindellidae. The highlight of the survey was the discovery of the two rare Fijian stick insects *Nisyrus spinulosus* and *Cotylosoma dipneusticum* which were both found at Base camp 2. One of Fiji most unique forest systems, i.e. comprised of upland forest area was identified at this study site.

The uniqueness and isolation of this forest system explains much of the diversity of insects from the Nakorotubu Range.

INTRODUCTION

It is estimated that the Pacific island region is home to about 915,000 species of invertebrates, approximately 15% of the world total with more than half the insect species unknown to science (Allison & Englund 2005). High rates of endemicity are also characteristic of this region, attributed to the extreme geographic isolation of many island groups. However, little is known of the invertebrate fauna of Fiji particularly with respect to their taxonomy, distribution and ecology.

Currently for Fiji and many other Pacific islands, habitat loss (effectively forest loss) remains the most serious threat to the endemic fauna and flora, with deforestation in Fiji continuing (Watling & Chape 1992). However, Fiji is considered one of the best remaining forested areas in the central Pacific with most restricted to the higher and wetter portions of the islands subjected to extensive fragmentation. These upland forested areas are considered to harbour the greatest diversity of native arthropod species and consequently these areas and their constituent native species are most vulnerable to perturbations and possible resulting reductions in populations and even extinctions (Evenhius & Bickel 2005).

The roles of Coleoptera in ecosystems are well known and documented. They are an important food source, recycle vegetation through decomposition and herbivory, provide pollination services and are also regarded as indicators of environmental change. The distribution of Coleoptera in general is related to vegetation types and climatic conditions as a result of changes to landscape forms and altitude. Coleoptera is also known to be the most diverse group. For Fiji alone, a total of 1398 coleopteran species have been recorded and many still await discovery.

Aims and objectives

To date there have been no entomology surveys or records from the Nakorotubu Range. Consequently, the main aims of this survey were to: (a) conduct a baseline entomology survey of the Nakorotubu Range using a variety of survey techniques, (b) identify significant species or taxa (including accurate GPS positions for any significant findings) and (c) collect voucher specimens to be housed at the South Pacific Regional Herbarium (SPRH), University of the South Pacific.

METHODS

Geographic location

The Nakorotubu Range is along a coastal district within the Ra and Tailevu provinces with extensive inland undulating and rugged terrain. The different techniques used at each site are presented in Appendix 7.

Coleoptera (Beetles)

Leaf Litter Surveys

Leaf litter surveys were conducted targeting the altitudinal range (150- 600 m a.s.l.). A 50 m transects marked at 5 m intervals were set up. 1 m2 quadrats were used to sample leaf litter at every 5 m along the transect. Leaf litter was sieved through 12 mm mesh and transferred into Winkler bags. The bags were then hung out for at least 48 hours to dry. Collected specimens were stored in ethanol (80%) in tightly sealed labeled vials for further sorting and identification in the lab (Plates 28 & 29).

Pitfall Surveys

50 m transects were marked at 5 m intervals in which pitfalls were placed into the ground with 80% ethanol as preservative. Samples collected from pitfall traps were collected after 48 hours. Collected specimens were stored in ethanol (80%) in tightly sealed labeled vials for further sorting and identification in the lab (Plate 30).

Nocturnal Surveys

Nocturnal collections for other insect groups were conducted using light traps. These were set up every night where possible when the weather was fine and left to run from 18.00-06.00 hours. Collected specimens were stored in ethanol (80%) in tightly sealed labeled vials for further sorting and identification in the lab.

Other taxa

Opportunistic Surveys

Opportunistic surveys were also conducted whilst carrying out surveys for other taxa. Phasmids (stick insects) and butterflies were sampled opportunistically in open grassland areas and along the Nabavatu and Olou creeks using handheld nets during days with good weather. Voucher specimens were collected for identification. Identification of butterfly species was based on Prasad and Waqa-Sakiti (2007) whilst identification for stick insects was possible through the assistance of Dr. Paul Brock (Natutal History Museum, London) and from reference collections housed at the SPRH. All specimens are currently being curated and catalogued at the SPRH, USP.

Fruit Fly Trapping

Fruit and flower specimens were collected from varying altitudes within the three different campsites. Each specimen was weighed, counted and placed into a sawdust-containing paper bag. The paper bags were then loosely sealed and arranged in cartons, out of reach of ants. The specimens were then transferred into containers at the Koronivia Agriculture laboratory to await dissection.

A second sampling method, fruit fly traps (i.e. using ME and CUE lure) were also set at various locations to trap fruit flies. The trap consists of wire gauze for collecting the fruit flies (it is placed inside the trap like a car mat), dental wicks wired together (white) which are dipped in a mixture of pheromones and insecticide. The pheromones have a 1 km radius strength and last for 3 months.

RESULTS AND DISCUSSION

Taxa results

Coleoptera

1) Leaf litter sampling

Beetles were sampled from 50 m line transects at 5 m intervals from different locations targeting different habitat types. Coleoptera recorded a total of 258 individuals from 13 families (Table 7.1). The most common families encountered included: Zopheridae, Curculionidae and Scolytidae. The families Curculionidae and Scolytidae were evenly distributed across all sampled sites. The family Zopheridae was most dominant in sites sampled from the Base camp 1 area. The rare beetle family Pselaphidae was only found from leaf litter sampled from the Base camp 2 area. Greatest diversity (i.e. 7 coleopteran families) was sampled from transect 7 at a mid altitude of 578 m a.s.l. which confirms that mid-altitudes harbour greatest diversity for insects due to less disturbance and less severe climatic conditions.

2) Nocturnal sampling

Nocturnal sampling was carried out on two nights within the area of each of the three base camps i.e. when weather conditions permitted. A total of 100 individuals representative of 13 coleopteran families were recorded (Table 7.2). The families Elateridae, Scaraebaedae, Carabidae and Eucnemidae were the most common taxa encountered during the nocturnal surveys. Interestingly, the rare family Cerambycidae (i.e. long-horn beetles) were only encountered during nocturnal surveys within the Base camp 3 area. Nocturnal surveys proved that areas within Base camp 2 had the greatest diversty i.e. with an average of 6.5 families sampled.

3) Pitfall Traps

A good number of beetles i.e. 243 were sampled

through pitfall traps (Table 7.3). The beetle family Scolytidae was most abundant from pitfall traps followed by Nitidulidae and Staphylinidae. Overall diversity of Coleopteran families from pitfall trapping were from Base camp 1. Rare families encounted were Cicindellidae and Pselaphidae.

Other Taxa

Phasmida (Stick insects)

Phasmids (stick insects) were sampled opportunistically. A total of 10 individuals from 4 different species were collected (Table 7.4). The area within Base camp 2 yielded the highest diversity for the order Phasmida recording 5 individuals from 3 different species. The endemic Phasmatonea inermis was most commonly encountered of the four species.

Lepidoptera (Butterflies)

Butterflies were also sampled opportunistically. A total of 14 individuals from 6 different species were collected (Table 7.5). The area within base camp 1 yielded highest diversity for the butterflies recording 8 individuals from 4 different species. The species *Euploea biosduvali boisduvali* was most commonly encountered of the six species.

Table 7.1: Coleoptera collected during leaf litter sampling.

Coleoptera Family	BC1_LLT1	BC1_LLT2	BC1_LLT3	BC1_LLT4	BC1_LLT5	BC2_LLT6	BC2_LLT7	BC2_LLT8	BC3_LLT9	Total
Anthribidae	0	0	0	0	1	0	0	0	1	2
Carabidae	0	4	0	0	1	0	0	0	0	5
Chrysomelidae	1	0	0	0	0	0	1	0	0	2
Curculionidae	4	12	13	4	5	10	8	8	3	67
Languridae	0	0	0	1	4	0	0	0	0	5
Nitidulidae	1	0	0	1	0	0	0	0	0	2
Pselaphidae	0	0	0	0	0	3	3	0	0	6
Salpingidae	7	0	2	0	0	0	1	0	1	11
Scirtidae	0	0	0	0	0	0	0	0	1	1
Scolytidae	4	10	0	1	2	7	7	0	1	32
Staphylinidae	0	0	0	3	0	0	1	0	0	4
Tenebrionidae	0	6	0	0	0	0	0	0	0	6
Zopheridae	29	25	43	14	0	2	2	0	0	115
Total	46	57	58	24	13	22	23	8	7	258

Table 7.2: Coleoptera collected during light trap sampling.

Coleoptera Family	BC1_LT1	BC1_LT2	BC2_LT3	BC2_LT4	BC3_LT5	BC3_LT6	Total
Anthribidae	0	1	0	0	0	0	1
Callirhiphidae	0	0	1	2	0	3	6
Carabidae	2	1	4	4	0	3	14
Cerambycidae	0	0	0	0	2	1	3
Chrysomelidae	0	0	3	4	0	0	7
Curculionidae	0	0	3	1	0	0	4
Dytiscidae	1	0	1	0	0	0	1
Elateridae	0	1	0	4	23	1	29
Eucnemidae	1	0	3	5	2	0	11
Oodemeridae	0	0	0	0	0	1	1
Platypodidae	0	0	2	0	2	0	4
Scaraebidae	6	3	0	0	9	0	18
Tenebrionidae	0	0	0	0	0	1	1
Total	9	6	17	20	38	10	100

Table 7.3: Coleoptera sampled from pitfall traps.

Coleoptera Family	BC1_LT1	BC1_LT2	BC2_LT3	BC2_LT4	BC3_LT5	BC3_LT6
Anthribidae	0	0	0	0	0	0
Carabidae	16	3	0	0	0	19
Chrysomelidae	0	0	0	0	0	0
Cicindelidae	0	2	0	0	0	2
Curculionidae	0	2	0	0	0	2
Languridae	0	0	0	0	0	0
Nitidulidae	14	1	9	4	1	29
Pselaphidae	1	0	0	2	0	3
Salpingidae	0	0	0	0	0	0
Scirtidae	0	0	0	0	0	0
Scolytidae	69	34	8	18	13	142
Staphylinidae	16	1	5	1	1	24
Tenebrionidae	2	5	9	5	1	22
Zopheridae	0	0	0	0	0	0
Total	118	48	31	30	16	243

Table 7.4: Phasmida sampled from opportunistic surveys.

Coleoptera Family	BC1_LT1	BC1_LT2	BC2_LT3	BC2_LT4	BC3_LT5
Cotylosoma dipneusticum	0	2	0	1	3
Graeffea crouanii	0	2	0	0	2
Nisyrus spinulosus	0	0	1	0	1
Phasmatonea inermis	1	1	2	0	4
Total	1	5	3	1	10

Table 7.5: Lepidoptera (butterflies) sampled from opportunistic surveys.

Species	BC1_OS	BC2_OS	BC3_OS	Total
Melanitis leda solandra	0	1	1	2
Papilio schmeltzi	2	0	0	2
Euploea biosduvali boisduvali	4	0	2	6
Danaus hamata neptunica	0	0	1	1
Hypolimnas bolina	1	0	1	2
Xois sesara	1	0	0	1
Total	8	1	5	14

Table 7.6: Table showing the trap counts of the fruit flies; *Bactrocera xanthodes*, *B. passiflorae* & *B. distincta*

Date	ME lure	CUE lure	
	B.xanthodes	*B. passiflorae*	*B.distincta*
02/12/09	Nil	4	Nil
06/12/09	Nil	2	6
12/12/09	Nil	nil	Nil

Taxa Discussion

Insecta: Coleoptera

The order Coleoptera (beetles) was the most diverse group of insects sampled from all sampling methods in terms of species richness and abundance. A total of 25 families were recorded from the three sites surveyed. The most diverse beetle families include: Curculionidae (weevils), Zopheridae, Scolytidae, Nitidulidae, Elateridae and Staphylinidae. Greatest diversity for coleopteran families was sampled from Base camp 1. Rare families encountered include: Pselaphidae, Callirhyphidae, Cerambycidae and Cicindellidae. The families Pselaphidae and Callirhyphidae were sampled from Base camp 2.

The high diversity of Coleopteran assemblages and the presence of rare families at the survey sites suggest the forest system within the Nakorotubu Range is still well intact as beetles have been known to be essential drivers of forest ecosystem functions.

Insecta: Lepidoptera

A total of six species of butterflies were sampled from the Nakorotubu Range during this expedition however, it is certain that many more species exist but were not encountered during the survey period. The endemic Fijian swallowtail butterfly, *Papilio schemeltzii* was also encountered along the forest edges which was a good indication that forest systems within the Nakorotubu Range are well intact.

Insecta: Phasmatodea

Phasmida are commonly known as walking, stick or leaf insects due to their remarkable adaptations and resemblance to their immediate environment. Fiji has a relatively rich representation of stick insects with 21 species, from 11 genera. Eight species are endemic to Fiji. Amongst the endemic species are *Cotylosoma dipneusticum* and *Nysirus spinulous* (syn. Cotylosoma) which were both found within the Nakorotubu Range. The current survey collected three specimens of C. dipneuticum (two females and one male, Plates 31 & 32). This is a significant find as little is known of this endemic species. A specimen of the *C. dipneusticum* was found on the native tree 'damanu' (*Calophyllum* spp.). So far only male specimens have been collected for *C. dipneusticum* which has only been recorded from Taveuni and Wailoku (Viti Levu). This is a first record for Nakorotubu Range and from these findings it is suspected that a good population exists within the surveyed area. However, further studies are warranted to confirm this. *C. dipneusticum* occurs in these mountain ranges (17.58902°S & 178.35753°E) where two females and a male specimen were caught in nocturnal surveys using Ultra Violet light traps and through opportunistic encounters.

Other endemic species like *Nisyrus spinulous* and Phasmatonea inermis were also collected in this survey. P. inermis also appears to have a good population within the survey areas with four individuals collected. Both of these species were also recorded for the first time during a recent Nakauvadra Range RAP.

Overall the area surveyed within Base camp 2 proved to be excellent habitat for stick insects as it harbours a good number of endemic species especially for *Colylosoma dipneusticum*. Of the ten individuals found, 5 were caught from within the area surveyed in Base camp 2. The forest system in Base camp 2 is isolated from disturbance and harbours a unique forest system "upland rainforest" which is known as one of the last remaining upland forest systems in Fiji that is relatively intact.

CONCLUSIONS AND RECOMMENDATIONS

Conservation significance

The Nakorotubu Range is an important site for insect conservation. Entomological surveys within the area suggests that forest systems are intact due to (i) the high diversity of Coleoptera which are key elements in the driving of forest ecosystem functions and (ii) some significant finds of Fiji's rare insects such as the stick insects *Cotylosoma dipneusticum*, *Nisyrus spinulousus* and *Phasmatonea inermis*.

Recommendations for conservation and future work

1. A thorough ecological study for the two Fijian stick insect species *Nisyrus spinulousus* (syn Cotylosoma) and *Cotylosoma dipneusticum* be conducted within the survey areas as this is the only known site so far to harbour these two rare Fijian stick insect species. Studies on population, seasonality patterns, behaviour and host plant associations would be essential for conservation measures.
2. There has to be an intensive host fruit collection conducted in the Nakorotubu Range to determine the host fruits of the fruit fly species present there.
3. Weather conditions especially at Base camp 2 were not ideal for insect sampling and because this harbours a unique forest system (i.e. upland forest), a quantitative survey in suitable conditions for leaf litter, pitfall, light trap and malaise sampling within the three campsites are essential to confirm its uniqueness.
4. Environmental awareness workshops should be conducted for resource owners on the significance of the native fauna and the need to conserve forested areas i.e., to minimize activities leading to habitat destruction.

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