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The terrestrial arthropods of Mauritius: a neglected conservation target

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Abstract Entomology in Mauritius has historically been linked with the agricultural and medical fields but concern should now be directed towards the conservation of native forest insects given that they are key components of the local ecosystem. Despite its young age, small size and remoteness, the island has a well-developed native insect fauna with a high proportion of endemic species. A majority of the insect orders are represented on the island. We document the current state of knowledge for Mauritian arthropods, with particular focus on the Coleoptera. This is the most diverse order locally with 1,032 species. In addition, it is the best catalogued historically, providing a framework for future conservation studies to evaluate the current status of this group. We explore the current threats facing the native insect fauna and highlight the needs for concern on this vital component of local biodiversity. We recognize that the initial step for conserving the native insects will depend largely on the establishment of a local taxonomic knowledge base with international expert input.

Keywords Mauritius · Insects · Biodiversity · Conservation · Taxonomy · Endemic · Beetles

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Introduction

Mauritius, located at 20° S and 57° E in the Indian Ocean, was formed from volcanic eruptions around 7–10 million years ago (Saddul 2002). Together with Rodrigues (574 km east of Mauritius), La Réunion (164 km west-south-west of Mauritius) and the Cargados Carajos shoal, it forms part of the isolated Mascarene Archipelago. Although small (1,850 km^2), the topography and tropical climate has favoured the evolution of diverse habitat types together with their associated fauna on the mainland and surrounding islets (Vaughan and Wiehe 1937; Page and D'Argent 1997 for details on the vegetation types). Over the past decades many aspects of the island's native biodiversity have been studied including: flora (Bosser and Heine 2000), reptiles (Arnold and Jones 1994), birds (Jones et al. 1994), beetles (Vinson 1967), snails (Griffiths 2000) and fungi (Dulymamode et al. 1998). The high level of endemicity revealed by these studies, coupled with the high habitat loss, means that the Mascarene archipelago qualifies as an international biodiversity hotspot (Myers et al. 2000).

Equally importantly, some of these studies have led to successful species recovery as for example the Mauritius kestrel programme (Jones et al. 1994), and forest restoration activities (Mungroo 1997). However, one notable area of neglect in local conservation endeavours has been the lack of attention paid to native insects. Although less charismatic, the importance of this group cannot be underestimated due to the key ecological processes they mediate, including pollination, as agents of seed dispersal, herbivory and in decomposition processes, as well as being a food source for a wide range of animals (Coleman and Hendrix 2000; Curry 1994). In addition, there is a high level of endemicity in this group. The lack of integration can be partly attributed to scarce information of conservation interest on the group since knowledge accumulation on Mauritian native insects was not necessarily geared to suit such activities and relied on the dedication of local and foreign naturalists (e.g. Jean Vinson 1906–1966).

The inclusion of native insects in the formulation of conservation strategies at a global level is faced with similar problems since the group suffers from an acute data deficiency. The magnitude of the problem is especially amplified in tropical areas of the world due to the sheer number of species present. Nevertheless, biodiversity surveys have been initiated in these challenging regions (e.g. Basset et al. 2000; Chung et al. 2000) as well as on smaller remote islands (e.g. Pietsch et al. 2003; Miller and Elredge 1996; Benton 1995). Such studies, as well as providing a better understanding of the native arthropod fauna, can enhance the conservation value of these regions. In Mauritius, the distinct lack of information on the contemporary status of the native insect biodiversity has emphasized the need for such surveys, particularly from a conservation standpoint (Mauremootoo et al. submitted). Here we present baseline data to provide a framework for future studies in terrestrial arthropod biodiversity and conservation in Mauritius through: (a) a review of the literature on native terrestrial arthropods and (b) the identification of potential threats that the terrestrial arthropod fauna is facing.

A historic background of Mauritian entomology

The earliest record of entomology in Mauritius dates back to 1619 through casual observations made by the Dutch settlers (Mamet 1993). Over the following centuries, the progression of the local body of knowledge on insects has tended to grow more in the areas of agriculture and medical entomology (e.g. Moutia and Mamet 1946; Mamet and Webb-Gebert 1980), reflecting the focus of the country's needs for economic growth. Moutia and Mamet (1946) detailed some of the main historic agricultural insect pest problems namely the sugar cane grubs (*Clemora smithi* and *Oryctes tarandus*), the sugar-cane moth borers (*Procera sacchariphagus*, *Sesamia vuteria* and *Argyroploce schistaceana*), the coconut scale insect (*Aspidiotus destructor*), the pineapple mealybug (*Pseudococcus brevipes*), the cochineal insects of the prickly pear (*Dactylopius tomentosus* and *D. indicus*), biting flies (*Stomoxys nigra* and *S. calcitrans*), the ants (*Solenopsis geminata* and '*Technomyrmex detorquens*') and termites (*Kalotermes pallidus*, *K. havilandi*, *Heterotermes philippiensis*, *Coptotermes havilandi* and *Nasutitermes voeltzkowi*). More recent agricultural pest targets include, amongst others, the silverleaf whitefly (*Bemisia argentifolii*), the cypress aphid (*Cinara cupressivora*), the pea leafminer (*Liriomyza huidobrensis*) and the citrus leaf miner (*Phyllocnistis citrella*) (Williams and Ganeshan 2001). All of these, except *O. tarandus* [Scarabaeidae], are exotic. Similarly, insects that are potential vectors of human diseases have been detailed in Mamet and Webb-Gebert (1980) who identified 94 potential pest species. It is unfortunate to note that endemic species such as *O. tarandus* have been considered as an agricultural pest species in the past. Given the recent awareness on the importance of native insects for conservation value, it is hoped that future biological control of such species will be less harmful to the indigenous fauna as compared to the traditional methods used in the past.

The native insect fauna

The insect fauna of the island is well developed given its size, age and isolation and is represented by 1993 recorded species in 22 orders, including 744 endemics (i.e. present only in Mauritius) with an overall endemism of 37% (Tables 1 and 2). The total number of insects for Mauritius is likely to be an underestimate given that many taxa are taxonomically understudied. Compared to Hawaii (Miller and Elredge 1996), the island has a less diverse fauna but compared to Henderson Island (Benton 1995) and Kuril islands (Pietsch et al. 2003), the fauna is more diverse. However, the evidence obtained from the data cannot be directly compared since the islands are from geographically different regions and vary in terms of size and degree of isolation. The orders for which there are no published data in Mauritius are: Protura, Collembola, Diplura, Plecoptera, Grylloblattodea, Mecoptera and Rhaphidioptera. The biogeographical origin of the local native insects is taxon-specific but a large proportion of the species are of either an African or Asian origin. Many of the endemic species have a restricted distribution on the island and tend to be localized in the patches of relatively pristine forests in the upland or mountain-tops since this is the only remaining 'native' habitat left. For instance, one endemic species of dung beetle (*Nesosisyphus rotundatus*) is known from only eight acres on the peak of a mountain in the north of Mauritius (Vinson 1951). The existing literature on the native forest insects is represented in list format with extremely limited ecological or biological details and is largely biased towards Coleoptera (Gueho and Owadally 1998). Because of this bias towards beetles, the information pertaining to this group has been summarized separately (Table 1) from the other insect orders (Table 2) and non-insect arthropods (Table 3). More detailed biblio-

Table 1 Coleoptera recorded on Mauritius (after Gomy 2000; complemented by Ferrer 2000; Freude 2000; Novak 2003; Williams 2000; Johnson et al. 2004; Williams and Cox 2004; Frisch 2005; classification after Beutel and Leschen 2005)

Family	Subfamily	Differing classification in Gomy (2000)	Total N° spp.	Endemic species	% species endemism	Endemic genera
Adephaga						
Carabidae			53	22	42	6
	Cicindelinae	Cicindelidae	3	2	67	–
	Remaining taxa	Carabidae	50	20	40	6
Dytiscidae			36	7	19	–
Gyrinidae			4	1	25	–
Haliplidae			1	–	0	–
Noteridae			2	2	100	–
Polyphaga						
Staphyliniformia						
Histeridae			20	1	5	–
Hydraenidae			3	1	33	–
Hydrophilidae			37	13	35	1
	Spercheinae	Spercheidae	1	–	0	–
	Remaining taxa	Hydrophilidae	36	13	36	1
Ptiliidae			23	5	22	1
Scydmaenidae			13	13	100	–
Staphylinidae			144	60	42	6
	Aleocharinae	Aleocharidae	34	16	47	3
	Osoriinae	Osoriidae	13	4	31	–
	Oxytelinae	Oxytelidae	11	1	9	–
	Pselaphinae	Pselaphidae	3	2	67	–
	Scaphidiinae	Scaphidiidae	14	11	79	1
	Tachyporinae	Tachyporidae	9	5	56	–
	Remaining taxa	Staphylinidae	60	21	35	2
Scarabaeiformia						
Hybosoridae			1	1	100	–
Lucanidae			5	4	80	1
Scarabaeidae			47	25	53	4
	Aphodiinae	Aphodiidae	11	–	0	–
	Cetoniinae	Cetoniidae	3	–	0	–
	Dynastinae	Dynastidae	6	3	50	–
	Hopliinae	Hopliidae	1	–	0	–
	Melolonthinae	Melolonthidae	12	12	100	1
	Rutelinae	Rutelidae	6	4	67	1
	Remaining taxa	Scarabaeidae	8	6	75	2
Elateriformia						
Buprestidae			35	28	80	1
Cantharidae			1	1	100	–
Clambidae			2	2	100	–
Elateridae			29	15	52	–
Eucnemidae		Eucnemididae	10	8	80	–
Heteroceridae			1	–	0	–
Scirtidae		Helodidae	1	1	100	–
Throscidae		Trixagidae	1	1	100	–
Bostrichiformia						
Anobiidae			38	27	71	–
	Anobiinae	Anobiidae	13	6	46	–
	Ptininae	Ptinidae	25	21	84	–

Table 1 continued

Family	Subfamily	Differing classification in Gomy (2000)	Total N° spp.	Endemic species	% species endemism	Endemic genera
Bostrichidae			15	–	0	
	Bostrichinae	Bostrychidae	13	–	0	–
	Lyctinae	Lyctidae	2	–	0	–
Dermestidae			9	1	11	–
	Thorictinae	Thorictidae	1	1	100	–
	Remaining taxa	Dermestidae	8	–	0	–
Jacobsonidae			1	–	0	–
Cucujiformia						
Aderidae			8	7	88	–
Anthicidae			8	1	13	–
Anthribidae			42	28	67	1
Brenthidae			8	4	50	–
	Brenthinae	Brenthidae	5	3	60	–
	Apioninae	Apionidae	3	1	33	–
Cerambycidae			48	22	46	4
Cerylonidae			8	5	63	2
Chrysomelidae			66	41	62	2
	Bruchinae	Bruchidae	10	1	10	1
	Remaining taxa	Chrysomelidae	56	40	71	2
Ciidae			5	1	20	–
Cleridae			7	1	14	1
Coccinellidae			19	1	5	–
Corylophidae			4	–	0	–
Cryptophagidae		Cryptophagidae part.	1	1	100	–
Cucujidae			7	1	14	–
Curculionidae			121	67	55	4
	Platypodinae	Platypodidae	2	1	50	–
	Scolytinae	Scolytidae	21	9	43	–
	Remaining taxa	Curculionidae	98	57	58	4
Discolomatidae		Discolomidae	1	1	100	–
Disteniidae			3	–	0	1
Endomychidae			6	2	33	–
	Merophysiinae	Merophysiidae	2	–	0	–
	Remaining taxa	Endomychidae	4	2	50	–
Erotylidae			3	3	100	–
	Cryptophilinae Toramini	Cryptophagidae part.	1	1	100	–
	Remaining Cryptophilinae	Cryptophilidae	1	1	100	–
	Remaining taxa	Erotylidae	1	1	100	–
Latridiidae			2	–	0	–
Melandryidae			1	1	100	–
Melyridae			22	17	77	–
	Malachiinae	Malachiidae	3	1	33	–
	Remaining taxa	Melyridae	19	16	84	–
Monotomidae		Rhizophagidae	3	–	0	–
Mordellidae			2	1	50	–
Mycetophagidae			2	–	0	–
Nitidulidae			27	6	22	–
	Cybocephalinae		11	2	18	–
	Remaining taxa		16	4	25	–
Phalacridae			2	–	0	–
Pyrochroidae		Pedilidae	2	1	50	–
Pythidae			2	2	100	–

Table 1 continued

Family	Subfamily	Differing classification in Gomy (2000)	Total N° spp.	Endemic species	% species endemism	Endemic genera
Salpingidae		Inopeplidae	1	–	0	–
Silvanidae			9	–	0	–
Tenebrionidae			47	16	34	3
Trogossitidae		Trogositidae	2	–	0	–
Zopheridae			12	5	42	–
	Colydiinae	Colydiidae	11	5	45	–
	Monommatinae		1	–	0	–
All Coleoptera			1032	474	46	38

Table 2 Other insect orders recorded on Mauritius

Order		Total N° spp.	Endemic species	% Species endemism	Source
Lepidoptera		317	99	31	
	Rhopalocera	37	5	14	Vinson (1938), Williams (1989), Davies and Barnes (1991)
	Heterocera	280	94	34	Vinson (1938)
Hemiptera		246	114	46	
	Homoptera	236	107	45	Williams and Williams (1988)
	Heteroptera part.	16	7	44	Miller (1956), Heiss (2004)
Hymenoptera		203	?	N/A	
	Formicidae	41	9	23	Fisher (2005), Fisher et al. (2006), Baroni Urbani and Andrade (2003), Roberts and McGlynn (2004)
	Others	162	?	N/A	Williams (1958)
Diptera		25	8	32	Alexander (1954), Halcrow (1954)
Blattodea		16	3	19	Vinson (1968)
Orthoptera		23	7	30	Vinson (1968)
Dermaptera		10	2	20	Vinson (1968)
Mantodea		2	0	0	Vinson (1968)
Phasmatodea		14	7	50	Vinson (1968), Cliquennois and Brock (2002, 2004)
Odonata		26	2	8	Pinhey (1962)
Isoptera		9	4	44	Vinson (1968)
Neuroptera		16	1	1	Ohm and Hölzel (1997, 2002)
Pscoptera		12	?	N/A	Turner (1976)
Siphonaptera		4–5?	?	N/A	Hopkins and Rothschild (1953)
Trichoptera		7	?	N/A	Jacquemart (1960, 1963), Marlier and Marlier (1982), Malicky (1992)
Thysanoptera		23	7	30	Mamet (1967), Zur Strassen (1993), Mendes (1996)
Phthiraptera		4	3	75	Emerson (1955), Clayton et al.(1996), Price and Clayton (1997)
Ephemeroptera		1	1	100	McCafferty and Mauremootoo (2000)
Zoraptera		1	1	100	Vinson (1968)
Strepsiptera		1	1	100	Westwood (1836)
Embioptera		1	1	100	Vinson (1968)

Table 3 Non-insect arthropod orders recorded on Mauritius

Order		Total N° spp.	Endemic species	% species endemism	Source
Isopoda		27	8	30	Barnard (1964), Taiti and Ferrara (1983)
Chilopoda		4	1	25	Lewis (2002), Lewis and Daszak (1996)
Amphipoda		3	1	33	Barnard (1964)
Diplopoda		28	14	50	Mauriès and Geoffroy (1999)
Araneae		1	1	100	
	Theraphosidae	1	1	100	Gallon (2005)

graphical summaries on particular recorded arthropods in Mauritius can be found in Gueho and Owadally (1998).

Coleoptera

Beetles have traditionally been a favourite study group for a number of reasons ranging from their diversity to functional utility in ecosystems (Grove and Stork 2000). In Mauritius, the recorded species are listed in catalogues compiled by Vinson (1956, 1958, 1960, 1962, 1967). In addition to these lists, some studies have examined the systematics of selected taxa such as longhorn beetles (Vinson 1961, 1963), dung beetles (Vinson 1939, 1946, 1947, 1951) and, more recently, weevils (Williams 2000, Williams and Cox 2004). Vinson (1954) described the distribution, with basic ecological notes, on carabid beetles. Gomy (2000) published a compendium of Vinson's catalogue with updated information on species that had subsequently been recorded.

Currently, 59 of the 167 extant beetle families (Beutel and Leschen 2005) have been recorded from Mauritius. Eleven of these are solely represented by a single species and 13 families do not include any local endemics within their ranks either at the genus or species level (see Table 1). The most speciose family locally is Staphylinidae with 144 species, followed by Curculionidae with 121.

The number of strict Mauritian endemic genera (i.e. genus found only in Mauritius and not on Réunion or Rodrigues) totals 38 (Table 1). Of these genera, six are Carabidae and Staphylinidae each and the genus with the most species is the dung beetle *Nesosisyphus* (four spp.). The overall low diversity of these strict endemic genera [mean sp. = 1, sd = 0.6] may reflect that the island is too young to have allowed extensive intra-island radiation of these genera or that these species have had enough time to become phenotypically different from their nearest relatives on the Mascarene islands to be grouped in separate genera. Mascarene endemic genera represented in Mauritius with more than seven spp. are: *Trichostola* (Chrysomelidae, 23 spp.), *Pelecophora* (Melyridae, 16 spp.), *Trymolophus* (Ptinidae, 10 spp.), *Spathuliger* (Cerambycidae, 9 spp.) and *Syzygops* (Curculionidae, 9 spp.). The largest number of strict Mauritian endemics at the species level (i.e. species found only in Mauritius and not on Réunion or Rodrigues) is found in Curculionidae (67 spp.), followed by Staphylinidae (60 spp.). Other families containing above 20 strict endemic species are Chrysomelidae (41 spp.), Anobiidae (27 spp.), Scarabaeidae (25 spp.), Anthribidae (28 spp.), Buprestidae (28 spp.), Carabidae (22 spp.) and Cerambycidae (22 spp.) (Table 1). Overall, the total number of beetle species currently recorded on the island is 1032 (table 1), representing an overall endemism of 46% (474 spp.). These numbers have increased from Vinson (1967) who recorded 882 spp. and 422 strict endemics (endemism of 48%). In comparison to Rodrigues (176 spp./35% endemism) and Réunion (844 spp./39% endemism) (see Gomy 2000), the Coleoptera fauna of Mauritius has a higher number of total species and species endemism.

Other insect fauna

The knowledge on the other main insect orders (Table 2) is less comprehensive but includes: Diptera (Alexander 1954; Halcrow 1954), Heteroptera (Miller 1956; Heiss 2004), Homoptera (Williams and Williams 1988), Hymenoptera (Williams 1958) and Lepidoptera including both butterflies (Vinson 1938; Williams 1989; Davies and Barnes 1991) and moths (Vinson 1938). Information on the minor orders are more fragmentary: Blattodea (Vinson 1968), Dermaptera (Vinson 1968), Ephemeroptera (McCafferty and Mauremootoo 2000), Isoptera (Vinson 1968), Neuroptera (Ohm and Hölzel 1997, 2002), Odonata (Pinhey 1962), Orthoptera (Vinson 1968), Phasmida (Vinson 1968; Cliquennois and Brock 2002, 2004), Phthiraptera (Emerson 1955; Clayton et al. 1996; Price and Clayton 1997), Psocoptera (Turner 1976), Siphonaptera (Hopkins and Rothschild 1953), Thysanoptera (Mamet 1967; Zur Strassen 1993, Mendes 1996) and Trichoptera (Jacquemart 1960, 1963; Marlier and Marlier 1982). An interesting point is that orders such as Zoraptera (Paulian 1951) and Strepsiptera (Westwood 1836) and Embioptera (Vinson 1968) have been recorded on the Mauritius at all, given that these groups are either represented by a low number of species worldwide (McGavin 2001).

Amongst these higher taxa, perhaps the best studied are the butterflies although it is not a highly endemic group in Mauritius. Of the five species restricted to Mauritius, one is presumed extinct (*Libythea cinyras*) whilst another is considered highly localized (*Cyclyrius mandersi*) (Williams 1989). Apart from Coleoptera, moths and Hemiptera have the highest total number of strict endemic species. The orders with a high percentage of endemic species include Phasmatodea (50%), Hemiptera (46%), Isoptera (44%) and Psocoptera (58%) (Table 2). Orders such as Ephemeroptera, Zoraptera and Strepsiptera have a 100% endemism because they are represented by a single endemic species.

Other non-insect arthropods

The non-insect arthropod fauna taxa covered include: centipedes (Lewis 2002; Lewis and Daszak 1996), spiders (Lehtinen 2004; Gallon 2005), amphipods (Barnard 1964), diplopods (Mauriès and Geoffroy 1999) and terrestrial isopods (Barnard 1964, Taiti and Ferrara 1983) (see Table 3). Four species of centipedes are recorded on Mauritius, one of which is endemic (*Cryptops mauritianus*) and two other species are recorded only from the offshore islets off Mauritius; Round Island and Serpent Island. An endemic tarentula (*Mascaraneus remotus*) has been recently described from Serpent Island (Gallon 2005). Non-insect arthropods such as Acari of importance to agriculture have been covered in Moutia and Mamet (1947).

Rise of concern: problems facing native insects

The native flora and fauna of Mauritius have been under pressure since human settlement, around 400 years ago and its present fragility has already been emphasized (Cheke 1987). For instance, of the 30 species of native birds, 17 are already extinct and of the extant 13 species, seven are classified as vulnerable (C. Jones pers. comm.). It is highly likely that the native arthropod fauna has experienced a similar or even more critical extinction pattern as the native vertebrates. Jones (pers. comm.) explored the plausibility of such a scenario based on the historic and present records of large arthropods now found only on the offshore islets and no longer on mainland Mauritius. One such case was the large tenebrionid beetle *Popolsipus herculeanus* that was recorded by Pike (1870) only on the offshore Round Island. However, the argument is difficult to verify because of the low probability of fossilization of the beetle on the coralline Round Island as well as a lack of data on its previous distribution in historic literature. Irrespective of past trends, the extant endemic insects are still faced with many extinction pressures and the three most immediate issues are:

(1) *Habitat loss and Invasion by exotic plants*: Originally, Mauritius was covered in continuous forest. Over the past centuries, demands from the agricultural and building sectors have reduced the forested areas to 2% of the original cover and the remaining fragments are now heavily invaded by exotic weeds (Vaughan and Wiehe 1941; Page and D'Argent 1997). Such habitat disturbances are known to adversely affect insect populations (Stoner and Joern 2004; Major et al. 2003). Locally, a study on the butterfly species of the upland forests revealed a higher abundance of the natives in managed habitats as compared to invaded forests (J. Mauremootoo unpubl. data). However, this trend is not necessarily representative for insects in general, since butterflies are highly mobile and have been shown to be able to persist even in disturbed and patchy mosaics of forests (Owen 1971). The insect species more at risk in such conditions are the specialized endemics with low mobility, as reflected by the Mauritian carabid beetle fauna where nearly half of the endemic species are characterized by wing atrophy (Vinson 1954).

(2) *Predation*: Because of their insular evolution, resulting in high levels of ecological naiveté, island endemics are particularly vulnerable to predation from exotic species. Roy et al. (1997) identified two main exotic insectivores on Mauritius of relevance to native insects namely the musk shrews (*Suncus murinus*) and tenrecs (*Tenrec ecaudatus*). Shrews found their way on the island probably via colonial transportation in the late 1700s whilst tenrecs were introduced along the same time period as meat supply for slaves (Roy et al. 1997). Another less documented predator of native invertebrates is the exotic toad (*Bufo gutturalis*). All the exotic predators are now well established in the upland forested areas. Being active foragers on the forest floor, the main impact of the predators would be on the native ground insects and Vinson (1935) noted the paucity of once common carabid beetle species and attributed the decline to the increase in toad population on the island. Canopy insects are also likely to be affected by the exotic rodents as indicated by the remains of beetle elytra found in the nests of shrews on trees (D. Hall pers. comm). Documented cases on such invaders on other islands have demonstrated their adverse effects on native invertebrates (Chown et al. 2002; Marris 2000).

(3) *Competition*: Perhaps the most subtle impact on native insects is the competition for niche resources from exotic but taxonomically close taxa. For instance, in southern France, exotic wasps have been shown to compete with native species for local resources (Fabre et al. 2004). In most cases, these taxa are active invaders of new territories but sometimes they are deliberately introduced for biocontrol purposes but then escape and become established. Many insect species have been

introduced in Mauritius especially for biocontrol purposes and it is acknowledged that there have been several misguided introductions (Williams and Ganeshan 2001; Fowler et al. 2000). Of the active colonizers, invasive ants are perhaps the most documented cases. In Mauritius, 56% of the ant fauna is not native. The presence of such invaders in forest ecosystems is likely to impose a heavy cost to the local natives as exemplified by the invasion of *Pheidole megacephala* in tropical forests in Australia, which was correlated with an extremely large decrease in native ant fauna and other invertebrates (Hoffmann et al. 1999). The effects of the crazy ant (*Anoplolepis gracilipes*), for example, have been documented on the Seychelles islands and have been shown to influence composition and density and even exclude local invertebrates (Hill et al. 2003; Gerlach 2004). Unfortunately, *P. megacephala* has already been recorded on Mauritius (Ward 1990) although its effects have yet to be documented on the local fauna.

The effect of insecticides has not been included as a current major threat and although large-scale DDT spraying took place in the 60s and 70s for malarial control (Mamet 1979), its effects on the endemic insects of Mauritius remain undocumented.

Challenges ahead: providing a starting point to build solutions

The importance of conserving insects has been stated (McGeoch 2002; Gibbs 1990; Pyle et al. 1981) and although applied insect conservation projects are still not widespread in the tropics, conservation programmes have been initiated on particular groups such as butterflies (Lu and Samways 2002), dragonflies (Kinvig and Samways 2000) and even flies (Haslett 2001). The importance of insects in a vulnerable ecosystem such as Mauritius is particularly vital because loss of community members at a base level is likely to have repercussions at the top of the food chain, as well as for ecosystem functioning. The restricted patchy distribution of the insectivorous endemic passerines has already been partly attributed to the patchy availability of their insect food source (Safford 1997).

Presently, none of the above threats has been addressed specifically with a view to conserving the insects of Mauritius. Loss of habitat has been minimized through the protection and restoration of forests protected by legislation, whilst predator control measures have been implemented around some of the managed areas with a focus on increasing the endemic bird population. Through such initiatives, it is assumed that insects will be conserved indirectly. Although this is an acceptable approach in the short-term as a coarse-filter approach (Panzer and Schwartz 1998), research points a cautionary finger to such measures especially without documented evidence (Gibbs 1999). Perhaps the clearest example is from New Zealand's Stephens Island whereby the removal of exotic predators such as cats to boost the population of the endemic tuatara lizard yielded an undesired side-effect in the extinction of a large carabid beetle (*Mecodema punctellum*) and reduced the populations of the Cook Strait giant weta (*Deinacrida* sp.), another carabid beetle (*Mecodema costellum*) and the Stephens Island endemic weevil (*Anagotus stephenensis*) (Gibbs 1999). Preliminary studies carried out on an endemic dung beetle (Motala 2004), have pinpointed the need for a micromanagement strategy on these minority interest groups in areas of conservation interests.

It is clear that the quantification of the above threats will contribute directly to choosing the best conservation strategy regarding the endemic insects of Mauritius.

The first logical step will be to establish a sound and functional taxonomic-based inventory which will better support future insect biodiversity work than relying on morphospecies data (Krell 2004). Such an initiative would ultimately enable the development of a long-term monitoring strategy for managing the needs of the vulnerable insect species in Mauritius.

Conclusion

With such a high endemism at stake, the development and implementation of insect monitoring and eventually insect conservation in Mauritius can only serve to further the reputation acquired in the conservation field locally by enlarging the scope of saving our natural heritage. The rediscovery of a locally spectacular large weevil (*Cratopus chrysochlorus*) after 75 years (Williams and Cox 2004) or the discovery of a new population of the endemic dung beetle *Nesosisyphus pygmaeus* (Motala and Krell in press) allows us to remain optimistic about the situation and we recommend that any work on native insects in Mauritius should be initiated sooner rather than later.

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