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CONSERVATION OF AN ENDEMIC ODONATE FAUNA IN THE SEYCHELLES ARCHIPELAGO*

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The odonate species richness of the granitic islands of Seychelles, a biodiversity hotspot, is significantly correlated to island size. The larger islands also have the highest elevations and hence the most streams from cloud catching as well as from downpours. The Seychelles odon. fauna can be divided into 2 groups: (1) endemic spp., and, (2) geographically--widespread eurytopic, vagile spp. The endemic spp. are elevational fugitives that need high-elevation forest cover, even if secondary. They are remarkably tolerant of temporary drying out of streams. In contrast, the widespread spp. occur at low elevations, are pool spp., and are tolerant of removal of forest cover. They emigrate when the pools dry out. Conservation of the endemic taxa depends on maintaining cloud-catching forest, although evidence suggests that their populations are maintained even where the forest is partly alien invasive trees or secondary regrowth.

INTRODUCTION

The central, granitic Seychelles archipelago in the western Indian Ocean (4°30' S, 55°30' E) is 1600 km from the African mainland, and forms part of earlier supercontinent Gondwanaland (PLUMMER, 1998). The indigenous biota is a combination of endemic as well as African, Indian and Madagascan species (MATYOT, 1998). It is a biodiversity hotspot deserving conservation priority (MYERS et al., 2000). The islands are mountainous with peaks reaching 905m a.s.l. on the largest island, Mahé. Like so many island biotas, Seychelles wildlife is under threat from anthropogenic disturbance, particularly on the lowlands (GERLACH, 1998).

* Dedicated to Professor Dr Norman W. MOORE for his 80th birthday.

Dragonflies (Odonata) are an ancient group and among invertebrates are relatively well known taxonomically (BRIDGES, 1994). Few modern species are as yet extinct from anthropogenic disturbance (SAMWAYS, 2002), unlike vertebrates on tropical islands. Nevertheless, some island odonates are under pressure from various human impacts (ENGLUND, 1999; POLHEMUS, 2001). Functionally, dragonflies are homogenous, being predators, principally of aquatic and aerial insects. As adults, all are relatively mobile, although their dispersal and migratory ability varies considerably from one species to another. This relative vagility is intimately tied in with their life styles and ultimately with conservation status. Long distance dispersal however, is not always directly related to size, with both large and small species apparently able at times to cover large distances. A further point of note is that, as far as we know, none of the dragonflies in Seychelles have been introduced by humans.

The aim here is to assess the threats to the granitic Seychelles odonates relative to phylogeny, life style, habitat preference and anthropogenic disturbance, and to compare the situation with information available on other islands. Conservation management recommendations are also made.

Table I
Odonata taxa recorded to date on the granitic islands of Seychelles

Taxon	Island											
	Cousine	Cousin	Aride	Cerf	North	Frégate	St. Anne	Curieuse	La Digue	Silhouette	Praslin	Mahé
Allolestes maclachlani[1]										+	+	+
Leptocnemis cyanops[1]										+	+	+
Teinobasis alluaudi[1,6]										+		+
Ceriagrion glabrum[3]	+	+	+	+	+		+	+	+	+	+	+
Ischnura senegalensis[3]			+		+			+	+	+	+	+
Agriocnemis pygmaea[4]			+						+	+	+	+
Anax ephippiger[5]	+		+			+						+
Anax guttatus[4]	+		+		+	+	+		+	+	+	+
Gynacantha stylata[1]										+	+	+
Hemicordulia similis[2]												+
Orthetrum stemmale wrightii[1]	+	+	+	+	+			+	+	+	+	+
Diplacodes lefebvrii[3]									+		+	+
Diplacodes trivialis[4]	+		+	+	+	+	+	+	+	+	+	+
Zygonyx luctifera[1]							+			+	+	+
Rhyothemis semilhyalina[3]			+		+			+	+	+	+	+
Zyxomma petiolatum[4]		+	+		+		+		+	+	+	+
Tholymis tillarga[5]	+		+	+	+	+			+	+	+	+
Pantala flavescens[5]	+		+		+		+	+	+	+	+	+
Tramea limbata[3]	+	+	+	+	+	+	+	+	+	+	+	+

[1] Endemic to the Seychelles archipelago, – [2] Madagascan, – [3] Widespread in Africa, – [4] Widespread in Asia, – [5] Widespread in Africa and Asia, – [6] Requires further taxonomic clarification.

METHODS

Between April 1997 and July 2001 the islands of Mahé (20 sites), Praslin (10 sites), Silhouette (10 sites), Cousin (4 sites) and Cousine (4 sites) were surveyed for a total of eight weeks. Presence/absence data on all Odonata species were gathered, and records kept of point localities. Further data were obtained from the voucher collection of The Nature Protection Trust of Seychelles, maintained on Silhouette, and from observations made by volunteer visitors under the guidance of Dr J. Gerlach. Historical data were obtained from BLACKMAN & PINHEY (1967), SAMWAYS (1998), WAIN & WAIN (1998), WAIN et al. (1999), and BOWLER (2001) (and references therein).

RESULTS

The known Seychelles Odonata taxa are listed in Table I. Island size plays a significant role in determining Odonata species richness ($r = 0.69$, $P<0.001$). Seychelles endemic species are present only on the larger islands (Tab. I). There are five species endemic to the archipelago: *Allolestes maclachlani, Leptocnemis cyanops, Teinobasis alluaudi, Gynacantha stylata* and *Zygonyx luctifera*. SCHMIDT (1951) considered the Madagascan *T. alluaudi berlandi* a subspecies, but it was raised to specific rank by LIEFTINCK (1965). *Orthetrum stemmale wrightii* (Sélys) is also endemic to Seychelles. These phylogenetic features have important conservation implications. Table II lists the endemic taxa and their habitats, and illustrates that these endemics at the level of species (also at the generic level in the case of *Allolestes* and *Leptocnemis*) inhabit forest. As long as streams and deposition pools are present, it does not appear to matter whether the canopy is composed of indigenous or alien trees. In comparison, the less phylogenetically remote taxa (i.e. subspecies or sibling species) are less dependent on full forest canopy (Tab. II).

DISCUSSION

In contrast to the endemic taxa, the remaining species, with the exception of *Hemicordulia similis*, which only occurs in Madagascar and Seychelles, are all widely dispersed in either Africa and/or Asia. Indeed, some are well known migrants. All inhabit the Seychelles coastal plains, and are tolerant of agricultural disturbance. They are pool-inhabiting species, unlike the stream-inhabiting endemic species, with the exception of *O. stemmale wrightii*. They leave the area as soon as the pools dry out.

While it is widely recognized that island biotas are susceptible to disturbance and extinctions (JAMES, 1995), it is not entirely clear whether island biotas are more resistant to invasive organisms than are continental ones (D'ANTONIO & DUDLEY, 1995). For these Seychelles endemic odonates, invasion of the forest by alien invasive trees appears to have little impact. Rather, it is important whether tree canopy per se is present or not. This was also found to be the case on another Indian Ocean island (Mayotte) (SAMWAYS, 2003) where other impacts, such as heavy detergent input, are important. In both situations however, it is canopy presence that is critical rather

than canopy composition.

There has been a call for more island/continental comparions (D'ANTONIO & DUDLEY, 1995) to establish whether phenomena we often attribute to islands is really characteristic of islands or not. The influence of canopy cover over canopy type has been shown to be instrumental in determining odonate assemblages across the sea in continental Africa (SAMWAYS & STEYTLER, 1996), pointing to this being a general rather than an island phenomenon.

The endemic Seychelles odonates fit more with the concept of fugitive radiation of plants than, say, adaptive radiation seen among Darwin's finches of the Galapagos islands (ADSERSEN, 1995). Fugitive species are those which are very local and have to evolve further to avoid extinction (ADSERSEN, 1995). The fugitive nature of these

Table II

Proportionate habitat occupancy (%) by Odonata species on the granitic islands of the Seychelles recorded in this study, and their elevational range recorded here and in the literature

Taxon	Elevation Range (m a.s.l.)	Habitat											
		1	2	3	4	5	6	7	8	9	10	11	n
Allolestes maclachlani	20-750	6	11	21	62	0	0	0	0	0	0	0	53
Leptocnemis cyanops	20-750	12	23	15	50	0	0	0	0	0	0	0	93
Teinobasis alluaudi	0-400	0	0	33	67	0	0	0	0	0	0	0	6
Ceriagrion glabrum	0-50	0	0	11	6	6	11	11	6	32	6	11	18
Ischnura senegalensis	0-50	NR											
Agriocnemis pygmaea	0-50	NR											
Anax ephippiger	0-0	NR											
Anax guttatus	0-50	0	0	0	0	0	0	0	0	17	66	17	6
Gynacantha stylata	50-300(?)	NR											
Hemicordulia similis	50(?)	NR											
Orthetrum s. wrightii	0-50	0	0	0	0	0	0	0	0	0	64	36	22
Diplacodes trivialis	0-50	0	0	0	0	0	0	0	0	0	95	5	41
Zygonyx luctifera	0-400	57	43	0	0	0	0	0	0	0	0	0	7
Rhyothemis semihyalina	0-50	NR											
Zyxomma petiolatum	0-100(?)	0	0	0	100	0	0	0	0	0	0	0	2
Tholymis tillarga	0-50	0	0	0	0	0	0	0	0	0	100	0	18
Pantala flavescens	0-200(?)	0	0	0	0	0	0	0	0	0	51	49	47
Tramea limbata	0-200(?)	0	0	0	0	0	0	0	0	0	67	33	63

1 = Stream with pools in primary forest with no alien trees, – 2 = Stream with pools in primary forest with some alien trees, – 3 = Stream with pools in secondary forest with no alien trees, – 4 = Stream with pools in secondary forest with some alien trees, – 5 = Artificial pool in primary forest with no alien trees, – 6 = Artificial pool in primary forest with some alien trees, – 7 = Artificial pool in secondary forest with some alien trees, – 8 = Artificial pool in secondary forest with some alien trees, – 9 = Stream in agricultural area, – 10 = Pool in agricultural area, – 11 = Away from water, – NR = Not recorded in this study. – For further details on vegetation structure, see GERLACH et al. (1997) and GERLACH (1998).

Seychelles Odonata species is primarily because of topography, with the endemic species confined to the larger islands with peaks over 360 m a.s.l. These cloud-catching peaks have generated the stream habitats of these species.

Interestingly, in the dry season, stretches of streams that cease flowing and leave only muddy pools (e.g. Grande Rivière, Silhouette) males of *A. maclachlani*, *T. alluaudi* and, to a lesser extent, *L. cyanops* remaining in the area, and showing agonistic behaviour. This suggests a long history of relative drought tolerance, and is a feature of these endemic genera. Teneral individuals emerge as the streams dry out, pointing to the resident adult as a strategy for surviving on these islands. Arguably, these species have already progressed beyond simply fugitive status and have evolved a strategy which is convergent, and has had considerable survival value.

The endemic Seychelles odonates depend on a forest canopy. But more importantly they, and many other organisms, require an extensive forest to capture precipitation and cloud condensation. Also of significance is that regenerated, secondary forest on Silhouette today has populations of the two endemic genera. This has come about because the human population on this island dropped from 1000 to 130, with concurrent release of agricultural pressure.

Survival of montane endemic odonates in Hawaii has also been the result of maintenance of high-elevation, indigenous forest (POLHEMUS & ASQUITH, 1996). This contrasts with Mayotte, where the streams in the dry season arise only on the middle slopes where various synergistic human impacts are jeopardizing the endemic odonates (SAMWAYS, 2003). Although the coastal lowlands of Seychelles is highly disturbed, this only impacts on the geographically widespread, vagile species. In contrast, the irreplaceable endemic odonates are protected in montane reserves on all of the three largest islands. This pattern now needs to be tested for other endemic invertebrate taxa.

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