Variation in species richness among the offshore islands of the southwestern Cape

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Fifteen islands lying off the southwestern Cape coast between the estuary of the Olifants River and Cape Agulhas were faunistically and floristically surveyed in the last few years. The statistical relationships between species richness, island area and distance from the mainland were examined for all visible taxa taken together and for the main taxonomic subsets. Distance from the mainland which never exceeds 9 km has no apparent effect on island species richness. In the species/area regression analysis the slopes have values varying between 0,49 for spiders and 0,77 for plants and the overall slope is 0,80. These values are apparently the highest ever reported in island biogeographic studies. The results are believed to be due to the small size (1 – 222 ha) of the islands studied coupled with a very high incidence of ecological disturbance on the smaller islands.

S. Afr. J. Zool. 1982, 17: 49 – 58

Gedurende die afgelope paar jaar is opnames van die fauna en flora van vyftien eilande na aan die suidwestelike Kaaplandse kus tussen die Olifantsrivier en Kaap-Agulhas gemaak. Die statistiese verwantskappe tussen spesiesverskeidenheid, oppervlakte van die eiland en afstand vanaf die vasteland is ondersoek vir alle sigbare taksa saam en ook vir die hoof taksonomiese onderafdelings. Afstand vanaf die vasteland het nooit 9 km oorskry nie en het blykbaar geen invloed op eilandspesiesverskeidenheid nie. In die spesies/oppervlakte regressie-analise het die hellings waardes getoon wat gewissel het tussen 0,49 vir spinnekoppe en 0,77 vir plante terwyl die algemene helling 0,80 was. Hierdie waardes is die hoogste wat tot dusver vir eiland-biogeografiese studies verkry is. Die resultate kan waarskynlik toegeskryf word aan die klein oppervlakte van die eilande (1 – 222 ha) wat gepaard gaan met 'n hoë voorkoms van ekologiese steurnisse op die kleiner eilande.

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That islands on continental shelves do not have the same faunas and floras as their adjacent mainlands and that smaller islands have lower species richness than larger ones has long been known. In the last 20 years much field and theoretical work has been done on the biogeography of islands, primarily by workers with a strong interest in birds or lizards, but there is no generally agreed theory on why species diversity is different from that found on equivalent areas of the mainland or why there is a rise in diversity with increasing size of islands studied (Gilbert 1980). The same phenomena are found in studies of oceanic islands but diversity is always at a much lower level in view of the problems of plants and animals successfully colonizing such islands.

There are 16 islands, not to mention large rocks, lying off the South African coast between the estuary of the Olifants River in the north and Cape Agulhas in the south (Figure 1). These may properly be referred to as the southwestern Cape islands. Robben Island (Figure 1, no. 16), the largest of the islands, has been excluded from this study because it has had over 300 years of human settlement with numerous deliberate and accidental introductions of plants and animals. RKB noted that there were little data on the biota of the southwestern Cape islands other than on their birds and mammals and decided to make collections of all visible plants and animals to provide a baseline for future studies of faunal and floral turnover. This study is concerned with 15 islands which vary in size from less than 1 ha to 222 ha and which lie from 0,1 to 9 km from the mainland. This paper deals with an analysis of species richness (number of species present) on the islands in relation to their areas and distance from the mainland.

Methods

The period covered by the data analysed in this paper is 1971 – 1981. No cognizance was taken of records made before 1971. For birds, only breeding species were analysed since the data on nonbreeding visitors are greatly dependent on the amount of time spent on each island. A bird species was recorded for an island if it had bred even only once there since 1971. Likewise Cape fur seals *Arctocephalus pusillus* were only recorded when breeding. For all other taxa, both plant and animal, presence alone since 1971 led to inclusion in this study. The great majority of these taxa certainly or probably breed on the islands concerned though some insects like the butterfly *Vanessa*

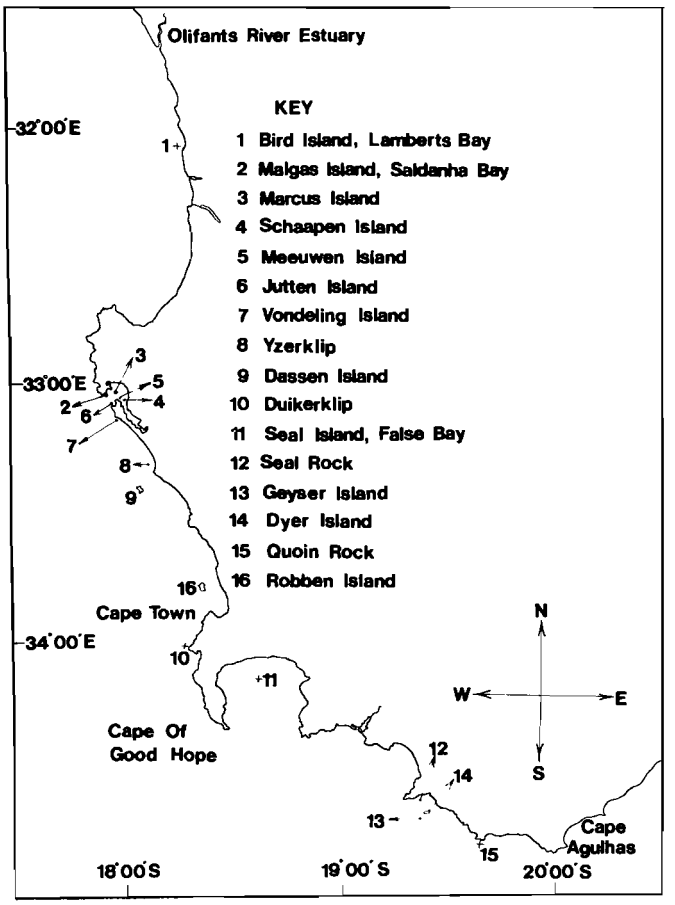

Figure 1 Map of the southwestern Cape showing the islands discussed in the paper.

cardui have been seen to be vagrant visitors.

Throughout the period, Bird Island (no. 1) was joined to the mainland by the Lamberts Bay concrete harbour wall. This relatively sterile modification has had little effect on the diversity of the island's fauna and flora though the presence of *Rattus* sp. is believed to be the result of the wall and therefore the species was excluded from the analysis. In early 1977, Marcus Island (no. 3) was joined to the mainland by a causeway of rock and sand to increase the protection of Saldanha harbour. On completion indigenous plants were planted on it to stabilize and beautify it. Records from Marcus Island were therefore vetted to exclude taxa which almost certainly did not reach the island over water.

Most of the data were obtained by RKB on personal visits, mostly in 1978 and 1979, often in company with staff of the Sea Fisheries Institute. Fourteen of the islands were visited, usually more than once. Reptiles, invertebrates and plants were methodically collected and other taxa studied by observation. The only island not visited was Yzerklip (no. 8) which can be readily studied through binoculars or a telescope from the pier at Yzerfontein. It is also one of the more difficult islands to land on from a boat. A substantial number of records used were provided by our colleague, J. Cooper, and his assistants. The modern literature was also surveyed.

Plants were collected by RKB and separately on some islands by Sue Milton, then of the Bolus Herbarium (University of Cape Town), who identified all the vascular plants. The lichens await determination by a specialist and have been recorded as present or absent and, if present, whether orange or grey. No doubt when studied, the lichen flora will prove to be more complex than this although far less complex than on rocks just above the maximum storm tide line on the mainland (RKB pers. obs.). Visible invertebrates were collected and placed in diluted isopropyl alcohol (*ca.* 3 parts alcohol to 1 of water) which both kills and preserves them. These collections were presented to the South African Museum, Cape Town, where they were identified as far as possible by A. Prins. Further study by specialists will no doubt reveal other species in the collections beyond those already noted, perhaps even innominate taxa. Lizards were also collected in alcohol and presented to the South African Museum where they were identified by G. McLachlan. RKB made extensive notes in the field on all branches of natural history, particularly birds.

All accepted taxa records were computerized for analysis. Linear and log-log simple regression models (Sokal & Rohlf 1969) were used to test for statistical relations between island species richness and area and distance from the mainland. Only the results of log-log models are presented since they almost invariably yielded stronger correlations. It is also the most commonly used method of presentation of results and facilitates comparison with similar studies. In addition to all plant and animal species combined, the following subsets were analysed: vertebrates, birds, invertebrates, spiders, beetles, plants. Flies and wasps were not analysed since the species of these orders were less intensively or completely sampled owing to the method of collection described above.

A correspondence analysis or reciprocal averaging (RA) ordination was also applied to demonstrate correspondences for a number of observations between two kinds of information (Bénzecri 1969) which in this case are islands and plant and animal taxa. Use of correspondence analysis seems to be valid under more conditions than the more usually applied principal components analysis ordination (PCA) (Gauch, Whittaker & Wentworth 1977). Correspondence analysis uses an eigenvector that is similar to PCA (Hill 1973, 1974) but also employs chi-square rather than covariance or correlation distances (Chardy, Glemaric & Laurec 1976).

Results

The list of taxa analysed and the islands from which they have been recorded are given in the Appendix along with data on island size and distance from the mainland. The results of the total species richness analysis are shown in Figure 2 and of the subsets in Table 1. No significant relation was found between island species richness and distance from the mainland (0,1 – 9 km). There is a highly significant relation between island area and species richness both for the total biota and for subsets thereof. A correspondence analysis ordination shown in Figure 3 groups the islands in terms of their departure from expected numbers of each major taxon and reveals the depauperate nature of the smaller islands and those dominated by Cape fur seals.

Ecological history of the islands

Before considering the meaning of the results it is

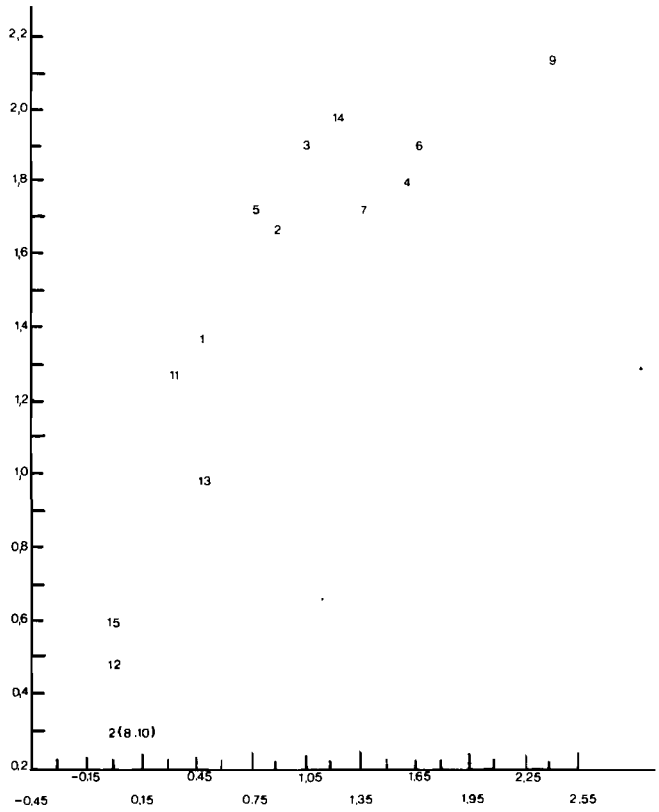

Figure 2 Total species richness/area relationship for 15 southwestern Cape islands: vertical axis log species richness, horizontal axis log area.

Table 1 Summary of the results of log-log regression analyses of biotic species richness against area for 15 southwestern Cape islands

Set	Coefficient of determination (R^2)	Slope (z)	Significance of regression
All species	0,80	0,80	$P < 0,001$
Vertebrates	0,80	0,57	$P < 0,001$
Birds	0,74	0,58	$P < 0,001$
Invertebrates	0,76	0,79	$P < 0,001$
Spiders	0,65	0,49	$P < 0,001$
Beetles	0,77	0,53	$P < 0,001$
Plants	0,75	0,77	$P < 0,001$

necessary to consider the historical ecology of the islands. As noted above, all are continental, and thus were part of the mainland during the last Pleistocene glaciation (Tankard 1976). Originally they possessed a subset of the then fauna and flora of the mainland appropriate to their habitats and kept these as the sea encroached and they became islands. Soon their island status induced changes, primarily as the result of colonization by seabirds and seals and the increasing level in their ecosystems of salt from breaking waves. At the climatic optimum or hypsithermal which ended *ca.* 2 000 years ago some islands only appeared at low tide and most were awash at spring highs accompanied by storms as the mean sea level was at least 3 m higher than at present (Flemming 1977). The only islands to which this did not apply were Schaapen (no. 4), Meeuwen (no. 5), Jutten (no. 6), Dassen (no. 9) and Seal (no. 11) which are high enough to remain above maximum sea level. Since then sea level has been essentially constant at its present level (Flemming 1977).

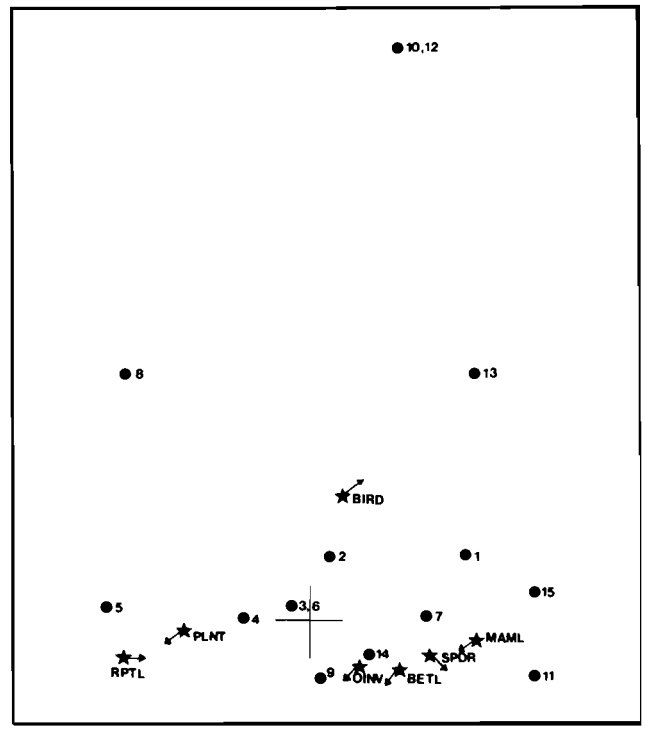

Figure 3 Ordination plot of 15 southwestern Cape islands with plants and six animal taxa by correspondence analysis (reciprocal averaging). The numbers represent islands as in Figure 1 and the Appendix. The arrows indicate the estimated average direction of increase of factors (taxa). The cross indicates the point of origin of the correspondence analysis. BETL = Beetles; Coleoptera. BIRD = Birds, Aves. MAML = Mammals; Mammalia. OINV = Other terrestrial invertebrates. PLNT = Plants; Plantae. RPTL = Reptiles; Reptilia. SPDR = Spiders; Araneae.

Cape fur seals which move on land by dragging themselves over the substrate severely restrict opportunities for plants and smaller animals to establish themselves unless they are dependent on seal products or corpses. Seal breeding grounds are as biologically depauperate as the centres of our conurbations. Sea birds deposit faeces with high ammonia content and combine this with dense breeding colonies leading to many decayed nests and corpses. The result is the accumulation of guano to a depth of several metres which is inimical to most forms of life. Between 1845 and 1850 the accumulated guano of centuries was removed for sale as agricultural fertilizer and for the first time since the hypsithermal, bedrock appeared (Cooper & Brooke 1982). This applies to Bird (no. 1), Malagas (no. 2), Marcus (no. 3), Jutten (no. 6) in part, Vondeling (no. 7), Dassen (no. 9) in part, Seal (no. 11) and Dyer (no. 14) Islands. Dassen Island has always had large areas with shallow sandy soils in which guano becomes dissipated. Yzerklip (no. 8), Duikerklip (no. 10), Seal Rock (no. 12), Geyser (no. 13) and Quoin Rock (no. 15) are too jumbled or too low-lying, or both, to permit the accumulation of guano. Schaapen (no. 4) and Meeuwen (no. 5) are too sheltered inside Saldanha Bay to support large numbers of seabirds from which guano could accumulate. Also their elevation has been sufficient to permit small trees to maintain themselves.

After 1850 guano was collected frequently but not necessarily every year. This scraping allowed the formation of simple soils and invasion by plants and animals which can make use of such soils with their high ammonia and salt contents and poverty of humus. After a

period of unrestricted exploitation the Cape Colonial Government began to regulate access to and exploitation of the islands in the 1880s. After 1970 guano collection has lessened owing to the decrease in number of the three principal guano producers, the jackass penguin *Spheniscus demersus*, the Cape gannet *Morus capensis* and the Cape cormorant *Phalacrocorax capensis*, all endemic seabirds of southwestern Africa. The decrease in these seabird populations is due primarily to competition with commercial exploitation of pelagic shoaling fish (Crawford & Shelton 1978). It appears that the islands have had a chequered history and that their present ecological state is the product of this history with the status quo being of extremely recent formation. Therefore, the islands cannot be regarded as assuredly stable ecosystems which have been allowed to reach equilibrial biotic richness *sensu* MacArthur & Wilson (1967).

Discussion and Conclusions

There is no evidence of a 'distance effect', an inverse statistical relation between island species richness and distance from the mainland. This suggests that all the islands are approximately equally accessible to potential colonists. The maximum distance from the mainland is 9 km.

The very high species/area slope values we have recorded for the species richness of the 15 southwestern Cape offshore islands seem to be owing to three factors: the lack of a distance effect; small size (1 – 222 ha); a very high incidence of disturbance on the smaller (< 5 ha) islands. Most studies of insular species richness have worked with far larger islands (among the exceptions are Nilsson 1977; Rusterholz & Howe 1979; Hnatiuk 1980) and have usually worked with subsets of the biota. Even this study has ignored, for technical reasons, the microfauna. It will be noted that our highest slope value is for total species richness and that taxonomic subsets are all lower (Table 1) though still way above a maximum expected value of 0,34 (Gorman 1979).

The review of the ecological history of the islands has shown that there has been no period in the last 150 years when stability could be assumed. We accept Connell's (1978) view that moderate levels of instability increase species richness and that this applies to all the larger (> 5 ha) islands. For islands with an area of less than 5 ha we consider that the incidence and intensity of disturbance is so great that species richness is depressed. The principal sources of disturbance are storms occurring at spring high tides; the disruptive effects of seal breeding colonies and the lesser disruptive effects of dense seabird colonies.

The correspondence analysis ordination in Figure 3 shows that all seven islands of less than 5 ha (nos. 1, 8, 10, 11, 12, 13 and 15) lie far from the point of origin, i.e. their combinations of species present are far from being a proportional subset of the total fauna and flora of all the islands taken together. Care must be taken in interpreting Figure 3 since it represents in two dimensions a multidimensional reality. Thus Meeuwen Island (no. 5) of 7 ha is not to be included with the small depauperate islands despite its distance from the origin of the analysis. Its place is determined by its relative richness in plants, reptiles and invertebrates other than spiders. The bird factor has a more central position than the origin since this taxon alone occurs on all the islands. Yzerklip (no. 8) has a plant as well as a bird species and so lies on the left of Figure 3, whereas the plantless Duikerklip (no. 10), Seal Island (no. 11), Seal Rock (no. 12), Geyser (no. 13) and Quoin Rock (no. 15) all lie on the right of Figure 3. Other islands on the right of Figure 3 have a relatively poor flora in relation to their fauna. Similar but more complex relationships apply to the other factors; beetles, mammals, other invertebrates, reptiles and spiders. Students of particular groups may wish to examine their section of the Appendix against Figure 3.

We suspect that if all continental island studies of increasing species richness with area were plotted together, the resulting log-log curve would take the form of a logarithmic curve because of the rapid increase among small islands which slows down when bigger islands are reached. Separate but parallel curves should be found for oceanic islands, islands in lakes and habitat islands whether on land or under water, salt or fresh.

Acknowledgments

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References

BENZECRI, J.P. 1969. Statistical analysis as a tool to make patterns emerge from data. In: Methodologies of pattern recognition. (ed.) Watanabe. Academic Press, New York.

CHARDY, P., GLEMARIC, M. & LAUREC, A. 1976. Application of inertia methods to benthic marine ecology: practical implications of the basic options. *Estuar. Coast. Mar. Sci.* 4: 179 – 205.

CONNELL, J.H. 1978. Diversity in tropical rain forests and coral reefs. *Science* 199: 1302 – 1310.

COOPER, J. & BROOKE, R.K. 1982. Past and present distribution of the feral European rabbit *Oryctolagus cuniculus* on southern African offshore islands. *S. Afr. J. Wildl. Res.* 12: 71 – 75.

CRAWFORD, R.J.M. & SHELTON, P.A. 1978. Pelagic fish and seabird inter-relationships off the coast of South West and South Africa. *Biol. Conserv.* 13: 85 – 109.

FLEMMING, B.W. 1977. Distribution of recent sediments in Saldanha Bay and Langebaan Lagoon. *Trans. R. Soc. S. Afr.* 42: 317 – 340.

GAUCH, H.G., WHITTAKER, R.H. & WENTWORTH, T.R. 1977. A comparative study of reciprocal averaging and other ordination techniques. *J. Ecol.* 65: 157 – 174.

GILBERT, F.S. 1980. The equilibrium theory of island biogeography: fact or fiction? *J. Biogeogr.* 7: 209 – 235.

GORMAN, M. 1979. Island ecology. Chapman & Hall, London.

HILL, M.C. 1973. Reciprocal averaging: an eigenvector method of

ordination. *J. Ecol.* 61: 237 – 249.
HILL, M.O. 1974. Correspondence analysis: a neglected multivariate method. *J. Roy. Stat. Soc.* ser. C, vol. 23: 340 – 354.
HNATIUK, S.H. 1980. The numbers of land birds, waders, sea birds, land crustacea, and certain insects on the lagoon islands of Aldabra Atoll. *Biol. J. Linn. Soc.* 14: 151 – 161.
MACARTHUR, R.H. & WILSON, E.O. 1967. The theory of island biogeography. Princeton University Press, Princeton (N.J.).
NILSSON, S.G. 1977. Density compensation and competition among birds breeding on small islands in a south Swedish lake. *Oikos* 28: 170 – 176.
RUSTERHOLZ, K.A. & HOWE, R.W. 1979. Species-area relations of birds on small islands in a Minnesota lake. *Evolution* 33: 468 – 477.
SOKAL, R.R. & ROHLF, F.J. 1969. Biometry. Freeman, San Francisco.
TANKARD, A.J. 1976. Pleistocene history and coastal morphology of the Ysterfontein-Elands Bay area, Cape Province. *Ann. S. Afr. Mus.* 69(5): 73 – 119.

Note added in proof: MARTIN, T.E., Dec. 1981. *Am. Nat.* 118:837, published well after this paper was completed, shows that high z regression slopes as found in this study are to be expected in studies of small islands even though only two of the seven slopes in Table 1 fall below his maximum. This is part of his general thesis that slopes normally change with size range of islands studied.

Appendix Data used for analysis of species richness on the offshore islands of the southwestern Cape

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Island name		Bird, Lamberts Bay	Malagas	Marcus	Schaapen	Meeuwen	Jutten	Vondeling	Yzerklip	Dassen	Duikerklip	Seal, False Bay	Seal Rock	Geyser	Dyer	Quoin Rock
Area to the nearest hectare		3	9	11	41	7	46	21	1	222	1	2	1	3	20	1
Distance from mainland in kilometres		0,18	0,8	1,2	0,5	0,14	0,8	0,8	1	9	0,5	6	0,5	8	7	0,1
Herbs present		x	x	x	x	x	x	x		x					x	
Indigenous woody plants present				x	x	x				x						
Mammalia																
Suncus varilla	(Soricidae)														x	
Oryctolagus cuniculus	(Leporidae)				x		x	x		x						
Homo sapiens	(Pongidae)		x	x			x			x					x	
Mus musculus	(Muridae)									x						
Felis catus	(Felidae)									x						
Arctocephalus pusillus	(Otariidae)										x	x		x		x
Aves																
Spheniscus demersus	(Spheniscidae)	x	x	x			x	x		x		x		x	x	
Pelecanus onocrotalus	(Pelecanidae)									x						
Morus capensis	(Sulidae)	x	x													
Phalacrocorax neglectus	(Phalacrocoracidae)	x	x	x			x	x	x	x	x	x	x	x	x	x
P. carbo	"	x		x			x			x		x	x	x	x	
P. coronatus	"	x	x	x	x	x	x	x		x			x		x	
P. capensis	"	x	x	x	x	x	x	x		x				x	x	
Ardea melanocephala	(Ardeidae)				x	x										
Egretta garzetta	"				x											
E. ibis	"				x											
Threskiornis aethiopicus	(Plataleidae)		x		x	x	x	x		x						
Alopochen aegyptiacus	(Anatidae)		x	x	x	x	x			x						
Haematopus moquini	(Haematopodidae)		x	x	x	x	x	x		x					x	
Charadrius marginatus	(Charadriidae)	x		x						x					x	
C. pecuarius	"			x											x	
Vanellus coronatus	"									x						
V. armatus	"		x	x			x			x						
Larus dominicanus	(Laridae)	x	x	x	x	x	x	x		x				x	x	
L. hartlaubii	"		x	x	x	x	x	x		x					x	
L. cirrocephalus	"			x											x	
Sterna caspia	"			x	x	x									x	
S. bergii	"			x	x	x	x	x		x					x	
S. dougallii	"														x	
Columba guinea	(Columbidae)		x	x	x		x	x		x					x	
Hirundo fuligula	(Hirundinidae)						x									
Motacilla capensis	(Motacillidae)		x	x			x	x		x					x	

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sturnus vulgaris	(Sturnidae)			x			x	x		x						
Spreo bicolor	”						x	x								
Passer domesticus	(Passeridae)						x			x					x	
P. melanurus	”			x	x	x	x									
Serinus flaviventris	(Fringillidae)			x												
Reptilia																
Chersina angulata	(Testudinidae)									x					x	
Phyllodactylus lineatus	(Gekkonidae)				x	x										
P. prophyreus	”			x		x	x			x						
Acontias meleagris	(Scincidae)				x		x									
Seclotes gronovii	”				x	x				x						
Mabuya capensis	”				x										x	
Cordylus cordylus	(Cordylidae)				x		x									
Arachnida																
Acarina										x						
Ornithodoros capensis	(Acaridae)	x	x					x		x					x	
Araneae sp. A															x	
Araneae sp. B															x	
Araneae sp. C															x	
Atypidae sp.					x	x		x								
Dictynidae sp.			x					x		x		x			x	
Eresus sp.	(Eresidae)		x	x	x			x		x					x	
Dysderidae sp				x											x	
Pholcus sp.	(Pholcidae)			x											x	
Sparassidae sp. A		x	x	x						x					x	
Sparassidae sp. B				x						x					x	
Anyphaena sp.	(Anyphaenidae)							x								
Drassidae sp.								x							x	
Salticidae sp.				x			x	x		x					x	
Theraphosidae sp.					x											
Harpactirella lightfooti	(Theraphosidae)					x	x									
Lycosidae sp.			x					x								
Pisauridae sp.			x													
Theridiidae sp.		x					x	x		x		x			x	
Latrodectus sp.	(Theridiidae)							x		x						
Nesticidae sp.						x										
Araneidae sp. A.										x						
Araneidae sp. B.										x						
Araneidae sp. C.										x						
Araneus sp.	(Araneidae)							x		x						
Erigone sp.	(Erigonidae)											x			x	
Pseudoscorpiones sp.												x				
Crustacea																
Porcellio scaber	(Isopoda)		x	x			x	x		x		x			x	
Ligia sp.	”														x	
Deto echinata	”							x							x	
Talorchestia sp.	(Amphipoda)														x	
Insecta																
Hymenoptera																
Braconidae sp.				x						x					x	
Hexachrysis peringueyi	(Chrysididae)			x												
Ichneumonidae sp.										x						
Apis mellifera	(Apidae)						x									
Formicidae sp.				x	x											
Myrmicinae sp.	(Formicidae)					x										
Pheidole sp.	”														x	
P. capensis	”									x						
Tetramorium sp.	”				x		x									
T. capense	”					x		x								

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T. quadrispinosum	(Formicidae)						x	x								
Monomorium delagoensis	”					x	x			x						
Crematogaster peringueyi	”									x						
Messor barbarus	”							x		x					x	
Siphonaptera																
Species															x	
Diptera																
Cheironomidae sp.								x								
Asiliidae sp.				x						x						
Tabanidae sp.										x						
Empidae sp.										x						
Coelopa africana	(Coelopidae)				x		x	x		x					x	
Dipteron sp.		x	x	x	x	x	x	x		x		x			x	
Sarcophagidae sp.				x				x		x						
Sarchophaga maritima	(Sacophagidae)			x												
Calliphoridae sp. A			x	x			x	x		x						
Calliphoridae sp. B				x												
Calliphora croceipalpis	(Calliphoridae)						x			x						
Lucilia sp.	”			x			x			x					x	
Anthomyiidae sp.							x									
Fannia sp.	(Fanniidae)						x									
F. cunicularis	”									x						
Syrphidae sp.							x			x					x	
Xanthogramma rotundicorne	(Syrphidae)									x						
Eristalinus nigricans	”						x									
Betasyrphus intersectus	”									x						
Muscidae sp. A										x		x		x		x
Muscidae sp. B										x		x		x		x
Musca domestica	(Muscidae)		x	x			x			x					x	
Lepidoptera																
Species				x		x	x			x					x	
Vanessa cardui	(Nymphalidae)			x			x			x						
Automolis sp.	(Thyretidae)				x											
Noctuidae sp.							x			x						
Tineidae sp.		x		x			x			x					x	
Zygaenidae sp.															x	
Coleoptera																
Species				x	x			x		x						
Harpalus rufocinctus	(Carabidae)	x														
H. fuscoaeneus	”			x											x	
H. agilis	”				x											
Canthyporus hottentotus	(Dytiscidae)									x						
Cercyon gigas	(Hydrophilidae)							x				x			x	
Xantholinus sp.	(Staphylinidae)		x					x		x					x	
Philonthus sp.	”									x					x	
Oxytelus cafer	”									x						
Aleochara sp.	”									x						
Colpometopus sp.	(Dasytidae)	x														
Corynetinidae sp.															x	
Dermestes maculatus	(Dermestidae)	x	x	x			x			x		x		x	x	
D. peruvianus	”									x					x	
Histeridae sp.		x													x	
Saprinus sp.	(Histeridae)											x			x	
S. bicolor	”									x					x	
Micrambe capensis	(Cryptophagidae)									x						
Meligethes odiosus	(Nitidulidae)			x						x						
Pria raffrayi	”									x						
Soronia variegata	”			x						x						
Olibrus consanguineus	(Phalacridae)									x						

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Anobium punctatum	(Anobiidae)						x									
Coccinellidae sp.					x		x									
Epilachna sp.	(Coccinellidae)				x											
Lioadalia flavomaculata	”						x									
Adonia variegata	”			x	x		x								x	
Tenebrionidae sp.										x						
Psammodes sp.	(Tenebrionidae)									x						
Ograbis sp.	”					x				x						
Gonocephalum arenarium	”	x	x		x		x	x		x					x	
Chrysomela sp.	(Chrysomelidae)					x										
Eremnus sp.	(Curculionidae)		x	x											x	
Trox sp.	(Trogidae)	x	x													
Trox horridus	”									x						
Temnorhynchus retuses	(Scarabeidae)									x						
Coptocheirus excisus	”									x						
Neuroptera																
Mantispoidea sp.							x									
Hemiptera																
Species					x					x						
Jassidae sp.												x				
Miridae sp.										x						
Aphididae sp.					x					x						
Anthocoridae sp.										x						
Lygaeidae sp.				x											x	
Lygaeus militaris	(Lygaeidae)				x											
Oxycarenus exitiosus	”		x	x						x					x	
Nysius sp.	”						x									
Scantius forsteri	(Pyrrhocoridae)			x				x								
Cenaeus carnifex	”			x				x		x						
Coranus papillosus	(Reduviidae)														x	
Psocoptera																
Species										x						
Dermaptera																
Forficulidae sp.										x						
Forficula sp.	(Forficulidae)									x						
Labidura riparia	(Labiduridae)	x														
Euborellia annulipes	(Carcinophoridae)				x							x			x	
Orthoptera																
Species				x			x			x						
Phymateus sp.	(Pyrgomorphidae)				x											
Cophogryllus sp.	(Gryllidae)					x										
C. delalandei	”				x											
Gryllus bimaculatus	”	x														
Dictyoptera																
Blattidae sp.			x	x	x		x	x		x					x	
Deropeltis erythrocephala	(Blattidae)				x											
Thysanura																
Species A		x	x	x	x	x	x	x		x						
Species B								x								
Collembola																
Species															x	
Chilopoda																
Geophilomorpha sp.		x													x	
Cormocephalus sp.	(Scolopendridae)		x	x	x	x		x		x						
Eurytion sp.	(Geophilidae)		x		x			x		x					x	
Lamyctes sp.	(Henicopidae)						x			x						
Scolopendromorpha sp.								x								

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Oligochaeta																
Species															x	
Mollusca																
Pulmonata																
Theba pisana					x					x						
Plantae																
Plasmodium			x	x			x	x		x					x	
Liverwort										x						
Moss										x						
Lichen orange			x	x	x	x	x	x	x	x						
Lichen grey			x	x	x	x	x			x					x	
Angiospermae																
Zantedeschia aethiopica	(Araceae)				x					x						
Asparagus sp.	(Liliaceae)				x											
Albuca sp.	”					x	x			x						
Trachyandra divaricata	”			x						x						
Ferraria sp.	(Iridaceae)					x										
F. crispa	”									x						
Homeria miniata	”									x						
Brachypodium distachyum	(Poaceae)			x		x									x	
Bromus sp.	”			x												
B. gussonei	”					x										
Cynodon dactylon	”														x	
Ehrharta longiflora	”			x						x						
Hordeum murinum	”			x						x						
Phalaris minor	”									x						
Poa annua	”			x						x						
Poaceae sp.					x										x	
Urtica urens	(Urticaceae)				x	x	x	x		x						
Loranthaceae sp.					x											
Emex australis	(Polygonaceae)			x	x		x			x					x	
Atriplex semibaccata	(Chenopodiaceae)		x	x		x	x	x								
A. patula	”		x	x											x	
A. suberecta	”				x											
Chenolea diffusa	”					x										
Chenopodium murale	”	x	x	x		x	x			x					x	
Exomis microphylla	”					x				x						
Sarcocornia sp.	”					x				x						
Tetragonia decumbens	(Aizoaceae)									x						
T. fruticosa	”									x						
T. suffruticosa	”					x										
Disphyma crassifolium	(Mesembryanthemaceae)				x	x										
Drosanthemum marinum	”			x											x	
Mesembryanthemum crystallinum	”		x	x	x	x	x			x						
Prenia pallens	”		x	x		x	x	x							x	
P. vanrensburgii	”														x	
Portulaca oleracea	(Portulacaceae)														x	
Stellaria media	(Caryophyllaceae)									x						
Argemone mexicana	(Papaveraceae)						x									
Cysticapnos vesicarius	(Fumariaceae)									x						
Raphanus raphanistrum	(Cruciferae)														x	
Leguminosae sp.						x										
Acacia cyclops	(Mimosaceae)				x	x	x									
Erodium moschatum	(Geraniaceae)									x						
Oxalis pescaprae	(Oxalidaceae)						x			x						
Zygophyllum morgsana	(Zygophyllaceae)					x										
Lavatera arborea	(Malvaceae)		x	x			x								x	
Malva nicaensis	”									x						

Island number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
M. parviflora	(Malvaceae)		x	x			x	x							x	
M. verticellata	"					x										
Anagallis arvensis	(Primulaceae)									x						
Euclea racemosa	(Ebenaceae)				x											
Asclepias pubescens	(Asclepiadaceae)				x											
Ballota africana	(Lamiaceae)				x	x										
Lycium sp.	(Solanaceae)						x									
L. afrum	"					x										
L. ferocissimum	"			x	x	x										
Nicotiana glauca	"						x			x						
Solanum guineense	"					x										
S. nigrum	"			x												
Myoporum serratum	(Myoporaceae)		x	x	x		x			x						
Cucumis myriocarpus	(Cucurbitaceae)				x	x				x						
Campanulaceae sp.						x										
Lobelia erinus	(Lobeliaceae)									x						
Arctotheca calendula	(Asteraceae)						x								x	
Arctotis sp.	"									x						
Chrysanthemoides incana	"			x												
C. monilifera	"						x									
Cotula cornucopifolia	"									x						
Matricaria sabulosa	"			x	x											
M. suffruticosa	"					x		x								
Senecio vulgaris	"		x	x		x	x			x					x	
Sonchus oleraceus	"			x		x	x			x					x	

x = recorded on an island and included in the species richness analysis.