Terrestrial biological research at the Prince Edward Islands

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The islands' role in South African and international Antarctic research

Terrestrial biological research conducted within the South African National Antarctic Research Programme has until recently focussed on Marion and Prince Edward Islands. Despite the fact that the two islands occur outside what is generally accepted to be the Antarctic zone, and are not in the area covered by the Antarctic Treaty, the research has received widespread recognition by, and enjoys considerable esteem within, the international Antarctic research community. It has contributed substantially to symposia and workshops organised by the Scientific Committee on Antarctic Research (SCAR), the body responsible for advising the treaty and its consultative parties on scientific matters. The research results have been published in nearly 400 papers in scientific journals and five monographs and have been favourably reviewed in several volumes on Antarctic biology and ecology. The good reputation enjoyed by South African "Antarctic" biologists (several have been invited to chair international workshops, symposium sessions and even whole symposia and some serve on Specialist and Working Groups of SCAR) stems, in most cases, from their research efforts at Marion and Prince Edward Islands.

In the account that follows I have not attempted to describe the individual research projects that have been carried out within the Biological Research Programme at the islands, or to summarise their results. Rather, I have tried to trace the evolution of the programme as a whole, by pointing out the changes that have occurred in its structure, philosophy and objectives. I also list the projects carried out at the islands in the order of the date of their initiation to illustrate the changes in emphasis of the research.

Early days

R W Rand, a biologist of the Government Guano Islands Division, was a member of the seventh meteorological relief team to Marion Island during October 1951 to April 1952. He collected birds, seals, invertebrates and plants and also conducted a preliminary ecological survey (including the first census) of the birds and seals. Biological studies were also carried out by members of other meteorological teams to the island, the ones by A B Crawford and J J la Grange being perhaps the most notable since, like Rand's studies, they were reported in the scientific literature. However, South Africa's formal involvement in biological research at Marion and Prince Edward Islands originated with the approach in 1952 by E M van Zinderen Bakker to the Department of Transport for support to carry out botanical and palaeobotanical studies there. Van Zinderen Bakker was then lecturer in botany at the University of the Orange Free State and the Department of Transport was the South African government department then charged with administering the islands.

Van Zinderen Bakker's initiative was met with widespread interest and support, not only from the Department of Transport but also from the Council for Scientific and Industrial Research (CSIR), the Botanical Research Institute, the South African Geological Survey and the Zoological Society of Southern Africa. The latter tasked J M Winterbottom, then Director of the Percy FitzPatrick Institute of African Ornithology, University of Cape Town, to draw up a programme of ornithological research at the islands. The South African Scientific Committee for Antarctic Research (SASCAR, appointed by the CSIR to advise on South Africa's participation in Antarctic scientific activities) established a Biological Panel with a mandate to plan and carry out a research expedition to Marion and Prince Edward Islands. The panel consisted of Van Zinderen Bakker, Winterbottom and the then Chief Director of the Botanical Research Institute, R A Dyer. The expedition would also carry out topographical and geological surveys of the islands and responsibility for these was given to W J Verwoerd of the Geological Survey. Van Zinderen Bakker and his son carried out a short reconnaissance of Marion Island in December 1963 to assess the logistical and technical requirements and implications of the contemplated expedition.

In January 1965 the "First Biological and Geological Expedition to Marion and Prince Edward Islands" landed at Marion Island. It consisted of two botanists, a marine biologist, a geologist, a surveyor and an ornithologist. They spent three months on the island and then several days at Prince Edward. Two members stayed on at Marion Island until March 1966, when they were joined for a month by two geologists and two biologists.

Developments in the programme's philosophy and objectives

The reconnaissance phase

The first expedition's main objective was to elucidate the systematics and biogeography of the islands' biota and to study the origin and history of the vegetation. Two ecological investigations were also carried out; one to define the main types of plant communities and their environmental determinants and another on the habitat preferences of the islands' bird species. Extensive collections were made of lichens, plants, fish, birds, and soil-, freshwater- and marine invertebrates. It took four years for taxonomic specialists to work through the collections and in 1971 the results of the expedition were published as a monograph (Van Zinderen Bakker *et al* 1971), edited by the three members of the SASCAR Biological Panel.

The "whole island" systems approach

Shortly after the first expedition's return, SASCAR established a

Biological Subcommittee to plan the next phase of biological research at the islands. This planning was heavily influenced by the systems approach of the International Biological Programme's Biome Project, which at the time was dominating ecological science worldwide (for a description of the tundra ecosystems component of the IBP's Biome Project see Rosswall & Heal 1975, or Bliss *et al* 1981). Consequently, it was decided to concentrate on a study of the Marion Island ecosystem as a whole, especially concerning the flow of energy and minerals through the terrestrial ecosystem and between the terrestrial ecosystem and the surrounding ocean. A second research expedition, consisting of personnel of the University of the Orange Free State and again organised by E M van Zinderen Bakker Sr, arrived at Marion Island in December 1971 to start this study. This expedition, and a third one in the summer of 1972/1973, were primarily concerned with the influence of birds, seals and saltspray on the primary production and chemistry of the island's freshwater bodies and on the chemical composition of the vegetation and soils. In addition, a descriptive ecological investigation was carried out in the intertidal zone and a palynological study that was started in 1965 continued.

While these expeditions were underway, SASCAR held a series of workshops and meetings that resulted in the proposal of a "whole island" ecological model. This model was used to further define the objectives of the Biological Research Programme. The full set of objectives, formally adopted by SASCAR in 1973 as the criteria against which project proposals would be evaluated, was:

- An understanding of the structure and functioning of the Marion and Prince Edward Islands ecosystems;
- The conservation of the natural environment of Marion and Prince Edward Islands and in particular the control of exotic fauna and flora;
- An understanding of the distribution and food availability of Antarctic and sub-Antarctic seals in the South Atlantic and South-West Indian Oceans;
- An understanding of the distribution and food availability of sea birds in the South Atlantic and South-West Indian Oceans;
- An understanding of the palaeo-ecology of Marion and Prince Edward Islands.

It was obvious that intensive bird and seal studies were necessary to meet these objectives and in 1973 an ornithological programme and a mammalogical programme were initiated by the Percy FitzPatrick Institute of African Ornithology and the Mammal Research Institute, University of Pretoria, respectively. Both, but especially the ornithological programme, had as their principal objectives the mineral and energy contributions of the particular organisms to the terrestrial ecosystem of Marion Island. By December 1973 SASCAR had a team of eight biologists on the island, representing three institutions and covering most aspects thought to be important in the island's ecology. Since then, biologists have been permanently present on Marion Island. Because of the emphasis on land-sea interactions, the functional approach of the terrestrial programme was extended to the nearshore marine system in 1978, when intertidal and subtidal studies were started by the School of Environmental Studies of the University of Cape Town.

Although the development of a "whole island model" *per se* was never formally adopted as the ultimate goal of the biological research effort, the systems approach philosophy continued to dominate project proposals and funding of biological research at the two islands until the late 1970s. The extent of its influence is shown by the fact that 13 of the 17 papers presented at the Symposium on the Biology of Marion Island held at the CSIR in 1978 dealth with aspects of energy and/or nutrient flow in the island's ecosystem (proceedings of this symposium were published in the *South African Journal of Antarctic Research*, volume 8, 1978).

The "national priorities/academic excellence" phase

Also in 1978, SASCAR published a review of Antarctic and sub-Antarctic scientific activities planned for 1978 to 1982 (SASCAR 1978). The same objectives were listed for the Marion and Prince Edward Islands Biological Research Programme as those adopted in 1973. However, it was becoming clear that whereas there was some merit in adopting a major single goal at which to direct the research effort, this was imposing restrictions on the degree to which the unique research opportunities offered by the islands could be exploited. Consequently, in 1979 SASCAR tasked two non-involved members (i e not leaders of an island research project) of the Biological Subcommittee to visit all institutions carrying out biological research at the islands, to review the overall composition of the research programme and to make recommendations to SASCAR regarding possible directions for future research.

This task group found that there was a divergence of opinion amongst the project leaders as to the importance of research aimed at developing a "whole island" ecological model, or even whether such an objective could be achieved. It recommended that the original aims and objectives of the biological programme be reconsidered. They urged especially that:

- Projects that did not fit into the overall systems approach umbrella but were of exceptional academic merit should be supported; and
- Investigations of Southern Ocean processes using the island as a convenient base should also be encouraged.

These recommendations resulted in a workshop held in June 1980 to review current knowledge of the island biology and to define future objectives of the SASCAR Biological Research Programme. Persons not connected with the island research were invited, so that 11 of the 19 workshop participants were not members of the SASCAR Biological Sciences Subcommittee. Based on the workshop discussions and recommendations, a new approach for the biological programme was formulated and published by SASCAR (SASCAR 1981). This document defined the directions the future research was expected to take.

The philosophy behind the new approach was that proposals to conduct research at the two islands would be evaluated in the light of the full spectrum of national research needs in the fields of biology, with due consideration of the unique opportunities presented by the islands and their role in national and international biological research programmes. It was recognised that, although the islands were outstanding subjects for community and ecosystem level studies, special opportunities also exist for autecological studies on plants, birds, mammals and invertebrates. Introductions of alien organisms to Marion Island had also created a range of research challenges that could profitably be addressed. It was envisaged that future activities would fall under one of five components:

- palaeo-ecological and biogeographical studies
- ecosystem studies

- autecological studies
- alien biota studies
- monitoring.

Key questions were listed for all of these components, showing where workers who choose to participate in these studies should concentrate their efforts.

An important consequence of the workshop and the resulting document was that, although terrestrial invertebrates are mentioned only twice in the document, many of the studies and key questions listed concern components of the islands' ecology and biology that are dominated by insects or other soil invertebrates. This resulted in 1983 in the commencement of entomological studies by the Department of Entomology, University of Pretoria.

Another important consequence of the workshop was that it stimulated research into invasive alien species on Marion Island. The results of this research were reviewed at a workshop held in June 1985 and published in the *South African Journal of Antarctic Research* (volume 16, No 3, 1986).

The National Scientific Programmes Report No 50 (SASCAR 1981) effectively formed the position document of the SASCAR Biological Research Programme between 1982 and 1988 and its effect can be seen in the changing emphasis of projects undertaken from 1983, especially in the ornithological and botanical fields (Addendum 1).

The 1990s: the "climate change" era

Until 1989 responsibility for biological research at the islands had rested with SASCAR, a body contained first within the Cooperative Scientific Programmes (CSP) Division of the CSIR, and later as a National Programme within the Foundation for Research Development (FRD) of the CSIR. In 1988 profound changes took place regarding the mission and strategy of the FRD, whereby a series of Special Programmes were set up to replace the CSP/National Programmes structure. A series of workshops and meetings was held by the four SASCAR Subcommittees (Southern Ocean, Biological Sciences, Earth Sciences and Physical Sciences) to develop the Antarctic Research Programme into a FRD Special Programme, which would comprise a number of "thrusts", each led by a researcher appointed by the FRD. It was envisaged that each leader would form a thrust steering committee and that the various steering committees would replace the present SASCAR Subcommittees.

Two thrusts were identified by the Biological Sciences Subcommittee; one on the biological and ecological implications of climate change at the Prince Edward Islands and the other on the biology and ecology of an Antarctic nunatak. Project proposals for these thrusts were evaluated within the FRD's Special Programme screening procedure in 1989. However, in August 1989 the FRD's role in planning, coordinating and evaluating Antarctic and sub-Antarctic scientific research was taken over by the Department of Environment Affairs (DEA), which had assumed the administrative, logistic and financial responsibilities for Antarctic activities from the Department of Transport in 1985.

The adoption of the Special Programme's approach by the FRD and the almost contemporaneous takeover by the DEA of the scientific component of the Antarctic Research Programme has had a profound influence on the structure and objectives of biological research at Marion and Prince Edward Islands. In the first communication sent out (in October 1989) to Antarctic scientists by the DEA in its new role, it was stated that "The most important deficiency in the Antarctic Research Programme is the lack of a clear South African mission and policy in respect of the RSA's involvement in the Antarctic and Islands". It proposed that an independent research committee would be reinstituted to judge and direct the Antarctic Research Programme on behalf of the department. This committee, the Scientific Committee for Antarctic Research (SACAR) has since been established and, concerning terrestrial biological research, is served by a Biological Sciences Task Group. The mission of this task group is "to improve the understanding of those biological phenomena and the factors affecting them, that can best be studied from land in the Antarctic and sub-Antarctic, especially in relation to improved management of the conservation of resources". The terms of reference of the group are:

- To develop a programme of land-based Antarctic and sub-Antarctic research, taking cognisance of South Africa's own requirements, including its sovereignty over the Prince Edward Islands and participation in international treaties, conventions and research programmes;
- To promote and direct the programme to ensure high-quality scientific endeavour;
- To advise SACAR on various aspects related to scientific research.

SACAR, or its Biological Sciences Task Group, has yet to define specific (or even general) *scientific* objectives for the Biological Research Programme as a whole, but has identified the two thrusts screened through the FRD's Special Programme structure as being important components of SACAR's activities. Both have been refined and developed into truly multidisciplinary projects. The one dealing with the biological and ecological implications of climate change at Marion and Prince Edward Islands is envisaged to last until at least 1997 and encompasses the following studies:

1 An identification of which climatic variables are changing, an analysis of the extent to which they have changed and an assessment of the seasonal contributions to the change;
2 A detailed characterisation of the microclimatic regimes to which the various organisms are subjected;
3 Short and long-term effects of increasing atmospheric CO_2, nutrients, temperature and dryness (soil and atmosphere) on the ecophysiology, phenology and growth of bryophytes and vascular plants, including exotics;
4 Population dynamics and bioenergetics of the mouse population and the influence of increasing temperature on these features;
5 Influence of mouse activities, increasing temperature and aridity on vegetation, soil nutrient status and rates of nutrient-cycling;
6 The role of the soil macrofauna in nitrogen-cycling;
7 Bioenergetics of soil invertebrates, including alien species;
8 Ecophysiological responses of soil invertebrates and microflora to changing temperature and soil moisture;
9 Monitoring of alien plant and animal species.

In addition to these studies, separate projects are examining the effects of climatic change on the demography of selected sea bird and seal species on Marion Island.

Epilogue

In many respects the objectives listed above, taken as a whole,

hark back to the "whole island" systems approach of the 1970s, while retaining the strong emphasis on the "autecological" approach of the 1980s. However, it is due to the information yielded by these earlier approaches that one is able to address the current objectives of examining the functional responses of the islands' biota and ecosystems to perturbations caused by invasive alien organisms and a changing climate. The past research has yielded an unsurpassed understanding of ecosystem structure and function, which forms the framework against which the effects of these perturbations are being assessed.

The project on the biological and ecological implications of climate change at the islands has been recognised as a component of the BIOTAS (Biological Investigations of Terrestrial Antarctic Systems) Programme of SCAR. It has the potential to contribute significantly to the type of understanding being aimed at by large international programmes such as the Global Change Project of the International Geosphere Biosphere Programme (IGBP) and the Invasive Alien Programme of the Scientific Committee on Problems of the Environment (SCOPE). There is therefore every reason to believe that South Africa's current biological research effort at the Prince Edward Islands will continue to enjoy the same high level of international interest and recognition as it has in the past.

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ADDENDUM 1

Biological research projects undertaken at Marion and/or Prince Edward Islands as part of the South African Antarctic Programme. The periods for which the projects were funded and the initials of the project leaders and researchers are given. A key to the initials is given in Addendum 2.

Biological survey of Marion and Prince Edward Islands	1965–71	EMvZB (Sr), JMW, BJH, EMvZB (Jr), NRF
Palynology of Marion Island	1971–72	EMvZB (Sr)
Limnology of Marion Island	1971–74	EMvZB (Sr), JUG, OBK
Plant and soil chemical composition on Marion Island	1971–75	EMvZB (Sr), VRS, RLC
Intertidal ecology of Marion Island	1972–75	EMvZB (Sr), AFdeV, JRG
Phytosociology of Marion and Prince Edward Islands	1973–76	EMvZB (Sr), NJMG
Seed dispersal by birds on Marion Island	1973–74	EMvZB (Sr), OBK
Marion Island seal research programme	1973–77	JDS, PRC
Population dynamics and biology of selected sea birds at Marion and Prince Edward Islands, with particular reference to their mineral and energy contributions in the terrestrial ecosystem	1973–87	WRS, AJW, AEB, AB, JC, MS, SRF, PGF
Research on the house-cat *Felis catus* population at Marion Island	1974–81	JDS, RJvA, DH
Glacial history of Marion Island	1976–79	EMvZB (Sr), KJH, JAC
Chemistry and biology of the nitrogen cycle on Marion Island	1976–78	EMvZB (Sr), DFT, HJL, VRS
The influence of the fluvirus *Feline panleucopaenia* on the house cat *Felis catus* population at Marion Island	1976–80	JDS, RJvA, MNB, BHE, PGH
Biology, population dynamics, spatial and temporal distrubution of seals in the King Haakon VII Sea, the Prince Edward, Gough, Crozet and Kerguelen Islands	1977–80	JDS, PRC, RJvA, MNB
Marion Island marine biology	1978–81	RG, PH, WOB
Palynology and long-distance dispersal on Southern Ocean islands	1978–84	EMvZB (Sr), DFT, LS
Plant ecology of Marion Island	1978–83	VRS, SR, NJMG, DFT
The genetic and ecological relationship between the fur seals *Arctocephalus tropicalis* and *Arctocephalus gazella* on Marion Island	1979–83	JDS, PRC, GIHK
Ecology of the housemouse on Marion Island	1979–81	JDS, RJvA, JPG
Nitrogen-cycling on Marion Island	1979–84	DFT, VRS, HJL, MGS
Population ecology of the Amsterdam fur seal *Arctocephalus tropicalis*	1980–82	JDS, MNB

Influence of southern elephant seals *Mirounga leonina* on the coastal terrestrial ecology of Marion Island	1980–82	JDS, KP
Relationships between the population dynamics of selected species of sea birds (chiefly penguins) and their prey (chiefly krill) at the Prince Edward and Gough Island groups	1980–84	WRS, NJA, CRB, JS
Intertidal community structure on Marion Island	1981–82	JRG, WOB
Biogeography of the marine flora of Tristan da Cunha, Gough and Marion Islands	1981–82	JRG, CH
Spatial and temporal distribution of pinnepeds	1981–83	JDS, MNB, JPG
The biology of *Durvillaea antarctica* on Marion Island	1981–83	JRG, PH
Decomposition studies on Marion Island	1981–84	VRS, DFT, DDF, DCG
Marion Island littoral dynamics	1982–83	JRG, GMB
The influence of the feral house cat population on Marion Island and the effectiveness of hunting as an additional measure for its control	1982–84	JDS, PJJvR, PGH, GAR, MNB
Multivariate synopsis of Marion Island soil, climatic and botanical data	1983–84	VRSM DDF
Autecology of *Agrostis magellanica* and *A. stolonifera* on Marion Island	1983–84	VRS, NWP
Migration of southern elephant seals *Mirounga leonina* from Marion Island	1983–85	JBS, MNB
Energy flow and biological interactions in the littoral of Marion Island	1983–85	JRG, GMB
Population ecology of the southern elephant seal *Mirounga leonina* at Marion Island	1983–86	JDS, MNB
Ecology of the dominant insects involved in decomposition processes on Marion Island	1983–87	CHS, DFT, JEC
The feeding ecology of four species of avian predators at Marion and Prince Edward Islands	1983–87	WRS, JC, MdeLB, SH
Physiology and energetics of burrowing petrels at the Prince Edward and Gough Islands in relation to their roles as predators in the Southern Ocean	1984–88	WRS, JC, CRB
Physiology and energetics of surface-nesting birds at the Prince Edward and Gough Islands in relation to their roles as predators in the Southern Ocean	1984–87	WRSM JCM NJA
Production and nutrient ecology of a fjaeldmark and fernbrake succession	1985–86	VRS
Peat development and vegetation succession on a Marion Island lava flow	1986–88	VRS, LS
Influence of soil invertebrates on nutrient mineralisation at Marion Island	1986–89	VRS, MaS
Long-term monitoring of surface-nesting birds at the Prince Edward Islands	1986–90	WRS, JC
Factors affecting reproductive success of southern elephant seals *Mirounga leonina* at Marion Island	1986–90	JDS, RJvA, ISW
Energy flow through the terrestrial invertebrate decomposer guild on Marion Island	1986–90	CHS, JEC, SLC
Bacterial production and organic carbon-cycling in the lakes of sub-Antarctic Marion Island	1986–90	RDR
Migration (satellite tracking) of the southern elephant seal *Mirounga leonina* from Marion Island	1986–91	JDS, MNB
The effects of artificial control on the cat population (*Felis catus*) on Marion Island	1986–91	JDS, PGH, MNB, JPB
Cryptogram ecophysiology at Marion Island	1987–88	VRS, MC
Prey identification service	1987–91	GJBR, NTWK
Influence of salinity on ultrastructural, biochemical and gas exchange characteristics of *Poa cookii* at Marion Island	1988–90	VRS, NWP
The breeding cycle of the king penguin at Marion Island	1988–91	WRS, JC, CJdP, YMvH, PJS
Marion Island habitat, climate and decomposition potential analyses	1990–91	VRS, DDF, MaS

Herbivore-saprivore-carnivore-vegetation interactions and nutrient-cycling under a changing climatic regime on Marion Island	1991– (on-going)	VRS, JDS, RJvA, SLC, MaS, BJB, NLA, DM, WN
Atmospheric CO_2 levels at Marion Island	1991– (on-going)	VRS
Resource use and allocation in pinnipeds breeding at the Prince Edward Islands	1991– (on-going)	JDS, MNB
Monitoring of the cat population on Marion Island	1991– (on-going)	JDS, MNB
Demography, climate change and life-history styles of surface-nesting sea birds at Marion Island	1991– (on-going)	WRS, JC

ADDENDUM 2

Key to the initials of project leaders and researchers listed in Addendum 1. The institutions that received the funding and were responsible for the project shown against these persons are (PFIAO): Percy FitzPatrick Institute of African Ornithology, University of Cape Town; (UOFS): Department of Botany, or Institute for Environmental Sciences, University of the Orange Free State; (MRI): Mammal Research Institute, University of Pretoria; (DE): Department of Entomology, University of Pretoria; (SES): School of Environmental Studies, University of Cape Town; (PEM): Port Elizabeth Museum; (DWT): Division of Water Technology, Council for Scientific and Industrial Research.

AB	A Berruti (PFIAO)
AEB	A E Burger (PFIAO)
AFDeV	A F de Villiers (UOFS)
AJW	A J Williams (PFIAO)
BJB	B J Blake (UOFS)
BJH	B J Huntley (UOFS)
BHE	B H Erasmus (MRI)
CH	C Hay (SES)
CHS	C H Scholtz (DE)
CJdP	C J du Plessis (PFIAO)
CRB	C R Brown (PFIAO)
DCG	D C Grobler (UOFS)
DDF	D D French (UOFS)
DFT	D F Toerien (UOFS)
DH	D Hay (MRI)
DM	D Matthewson (MRI)
EMvZB(Jr)	E M van Zinderen Bakker (Jr) (UOFS)
EMvZB(Sr)	E M van Zinderen Bakker (Sr) (UOFS)
GAR	G A Robinson (MRI)
GIHK	G I H Kerley (MRI)
GJBR	G J B Ross (PEM)
GMB	G M Branch (SES)
HJL	H J Lindeboom (UOFS)
ISW	I S Wilkinson (MRI)
JAC	J A Coetzee (UOFS)
JC	J Cooper (PFIAO)
JEC	J E Crafford (DE)
JDS	J D Skinner (MRI)
JMW	J M Winterbottom (PFIAO)
JPB	J P Bloomer (MRI)
JPG	J P Gleeson (MRI)
JRG	J R Grindley (SES)
JUG	J U Grobbelaar (UOFS)
KJH	K J Hall (UOFS)
KP	K Panagis (MRI)
LS	L Scott (UOFS)
MaS	Marianna Steenkamp (UOFS)
MC	Marieta Cawood (UOFS)
MdeLB	M de L Brooke (PFIAO)
MGS	M G Steyn (UOFS)
MNB	M N Bester (MRI)
MS	M Schramm (PFIAO)
NJA	N J Adams (PFIAO)
NJMG	N J M Gremmen (UOFS)
NLA	N L Avenant (UOFS)
NRF	N R Fuller (UOFS)
NWP	N W Pammenter (UOFS)
NTWK	N T W Klages (PEM)
OBK	O B Kok (UOFS)
PGF	P G Frost (PFIAO)
PGH	P G Howell (MRI)
PH	P Haxen (SES)
PJJvR	P J van Rensburg (MRI)
PJS	P J Seddon (PFIAO)
PRC	P R Condy (MRI)
RDR	R D Robarts (DWT)
RJvA	R J van aarde (MRI)
RLC	R L Croome (UOFS)
SH	S Hunter (PFIAO)
SLC	S L Chown (DE)
SR	S Russell (UOFS)
SRF	S R Fugler (PFIAO)
VRS	V R Smith (UOFS)
WN	W Niemandt (MRI)
WOB	W O Blankley (SES)
WRS	W R Siegfried (PFIAO)
YMvH	Y M van Heezik (PFIAO)