Three decades of South African science in Antarctica

W R Siegfried

Percy FitzPatrick Institute of African Ornithology
University of Cape Town
7700 RONDEBOSCH
South Africa

INTRODUCTION

South Africa's official programme of scientific research in Antarctica can be said to have begun in 1960, and it has continued uninterrupted since then. However, South Africa's interest in Antarctic science stems from a considerably earlier time. This early interest has influenced the form and direction of the science programme.

Much of South Africa's development, especially in the first half of this century, is owed to the country's exceptionally rich endowment of minerals. The mining industry provided a major springboard for the promotion of South Africa's economy and its scientific research and tertiary educational institutions. Geology, and the earth sciences generally, featured prominently, and still do, in the country's science establishment.

In the 1930s it was hardly fashionable to support the continental-drift and Gondwanaland hypothesis formulated by Taylor and Wegener. There was widespread scepticism and rejection of the hypothesised former connections of portions of Antarctica and Africa. Yet, consistent support for the thesis was forthcoming from a part of South Africa's eminent geological fraternity of the day, especially Du Toit. Today, of course, with the modern understanding of plate-tectonics, there is universal support for the former existence of Gondwana and the links between the southern continents.

The African subcontinent's climate and weather are very much influenced by atmospheric and hydrological events and processes in Antarctica and the Southern Ocean. South Africa has a largely semi-arid climate and weather is a key determinant for the country's production of agricultural crops and livestock. Consequently, South Africa has a longstanding interest in meteorological research and, indeed, until about the 1950s it operated one of the best meteorological services in the southern hemisphere. Antarctic weather-related research was carried out by South Africans in the early 1950s when the then Weather Bureau provided the logistical platform for subsequent operations in Antarctica.

Consequently, it is not surprising to note that meteorological matters were accorded a high priority by South Africa before, and when, it commenced sending scientific expeditions to the sub-Antarctic Prince Edward Islands in 1947. Weather stations were set up on Tristan da Cunha and Gough Islands in 1942 and 1956, respectively. The meteorological stations at the Prince Edward and Gough Islands are still in operation, functioning as monitoring, rather than research, facilities. However, intermittent, mainly biological research was carried out by South African scientists at Marion and Gough Islands before 1961 (Cooper & Headland 1991). The first official South African scientific expedition to Marion Island was made in 1965, concentrating on biology and geology. Subsequently, South African scientific research has continued, almost uninterrupted, at Marion Island.

The first South African national Antarctic expedition overwintered in Norway Station in Dronning Maud Land on Antarctica in 1960, marking the start of South Africa's official national Antarctic scientific programme. Thereafter, in 1962, South Africa's first permanent Antarctic base, SANAE (South African National Antarctic Expedition), was set up some distance away from Norway Station. SANAE was replaced in 1971 and again in 1979. A new base (SANAE IV) on rock, as opposed to the ice shelf on which the previous SANAEs have been buried, is to be constructed some 150 km polewards from SANAE III. South African scientific research has been in continuous operation in Antarctica since 1960. Initially, meteorological activities, glaciology, upper atmosphere physics and earth-science research projects were started there. Biological research, operated from SANAE, began relatively late in 1989 (Cooper & Headland 1991).

Properly planned and operated ship-based oceanographic research was a relatively late starter in South Africa's Antarctic programme, commencing some 15 years ago (Lutjeharms 1991). Throughout its development since then, however, the oceanographic component of the national programme has been hampered by inadequate ship-borne facilities and a relative shortage of funds (Table 1). In 1992, however, the South African polar supply ship, *SA Agulhas*, will be refitted with new laboratories and additional other facilities to permit modern, fully integrated, oceanographic research. In its new form this ship might become a facility for Africa's (not only South Africa's) scientific interests in the Southern Ocean and Antarctica.

This report highlights the scientific achievements of South Africa's involvement with the Antarctic and sub-Antarctic regions. Two interconnected primary perspectives are developed in summary form: the value of the contributions of South African scientists to international programmes and the achievements

Table 1 Financial allocations (RSA rands in millions) of the four science subprogrammes of the South African Antarctic research programme, 1981 to 1993. Note that all logistical costs are excluded.

Science subprogrammes	1981-1985	1986-1989	1990-1993	Totals
Earth	0.921	2.094	2.488	5.503 (21%)
Biology	1.221	1.591	3.543	6.355 (24%)
Atmosphere	2.348	3.391	4.620	10.359 (40%)
Oceanography	0.355	1.446	2.268	4.069 (15%)

of the South African programme in relation to the country's needs for scientific experts and expertise. It is important to appreciate that science is not value-free and that many scientists are not effective proponents for their cause. Hence, the mini-review that follows should be regarded as a personal abridged selection, examination and interpretation of South Africa's Antarctic science programme.

CLIMATE AND WEATHER

Given the benefits of hindsight, it may be regrettable that South Africa neglected to capitalise more fully on the initial interest in climate and weather-related research that prevailed at the start of the country's involvement in Antarctic science. Indeed, true research, as opposed to routine monitoring, climate and weather projects were never developed properly until relatively recently and then only by oceanographers, physicists and biologists, rather than by the meteorological establishment.

This modern change has come about chiefly in response to the both locally and internationally important phenomenon of global environmental change and, more particularly, so-called global warming. A diverse range of South African scientists and scientific disciplines is involved in several international and local programmes that are aimed at addressing the causes, processes and impacts of global warming. However, there is a dearth of South African meteorologists with the expertise and experience necessary for contributing significantly to such international activities and fora as SCAR's (Scientific Committee on Antarctic Research) initiatives as part of the IGBP (International Geosphere-Biosphere Programme). Moreover, this modern scarcity of appropriately trained meteorologists is manifested as well in highly relevant, topical, local climate-change projects in South Africa.

OCEANOGRAPHY

In contrast to meteorology, oceanography is the youngest component of South Africa's current formal Antarctic science programme. The oceanographers, however, very rapidly established for themselves a creditable reputation for innovative research that from the start has continued to attract interest and compliments both nationally and internationally. In addition, among senior scientists in the whole of the South African Antarctic programme, the relatively small corps of experienced deep-sea oceanographers has been responsible for training a disproportionately large number of postgraduate students.

In spite of the prevailing logistical limitations, chiefly and until recently, the condition and operation of ships, South African oceanographic research and researchers played key roles in both the planning and execution of BIOMASS (Biological Investigation of Marine Antarctic Systems and Stocks). BIOMASS has been the most ambitious international scientific research programme initiated and operated by SCAR (Miller 1991) and the largest ever oceanographic research programme in the deep sea. In recent years, the focus of the South African deep-sea oceanographic community has shifted away from krill (*Euphausia* spp.) to research dealing with global climate change (Lutjeharms 1991), but not exclusively so (Miller 1991).

The oceanographic programme was enriched through the involvement of scientists, technicians and ships of the South African Sea Fisheries Research Institute. Without the combination and collaboration of personnel drawn from this institute, the then National Research Institute for Oceanology, and museums and universities, South Africa's performance in BIOMASS and several international statutory fora would have been substantially poorer. In effect, leading contributions were made in the Scientific Committee of the IWC (International Whaling Commission) and in the Scientific Committee of the CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources).

Two main factors have been, and still are, important in promoting the welfare of South African oceanography. First, frequent and extensive exchange, interchange and collaboration of scientists internationally, even during the worst period of cultural and technical sanctions directed at South Africa and secondly, what can be described best as local synergy. The first factor mirrors, in part, the international esteem accorded to South African oceanography. The second factor is one that repeatedly has been identified by foreign peers as something rare and enviable. The South African community of marine scientists has carefully nurtured a remarkable degree of interdisciplinary and interinstitutional cooperation and multidisciplinary collaboration, perhaps because it is relatively small and its members are obliged to share "ship's time", placing them together. This clearly has spilled over, with considerable benefit, to the oceanographic component of the South African Antarctic science programme.

There are three items of special merit among a relatively abundant store of products emanating from the country's youthful oceanographic research programme. Indeed, these items will continue to be useful internationally for some considerable time as "benchmark" books in the Antarctic literature: Hecht's practical *Guide to the Otoliths of Southern Ocean Fishes* appeared in 1987; Miller and Hampton produced a definitive review of the biology and ecology of the Antarctic krill (*Euphausia superba*) in 1989 and the widely acclaimed *Fishes of the Southern Ocean* edited by Gon and Heemstra was published in 1990.

BIOLOGY

Commentary under this head is restricted to scientific activities that have been carried out on land. In other words, the author's perceptions are not based on an inclusion of biological research that has been a part of the oceanographic or ship-board component of the South African Antarctic science programme. Moreover, because biological research on the Antarctic continent is new for South Africa (Cooper & Headland 1991), these impressions cover activities at the Prince Edward Islands only.

In the author's view it is fair to say that during the period 1975 to 1990, the results of biological research at the Prince Edward Islands have made a bigger impact, both nationally and internationally, than any one of the three other major components of the South African Antarctic science programme.

The thrust of the biological research at the Prince Edward Islands in the 1970s and 1980s was aimed at obtaining an improved understanding of the structure and functioning of ecosystems at the islands (Smith 1991). These ecosystems are better known now than are most ecosystems on the African mainland. The studies at the Prince Edward Islands signalled a new wave in South African ecological research and helped substantially in transforming South African ecology generally from an almost purely descriptive endeavour into a quantitative and hypothetico-deductive discipline. Several of South Africa's lead-

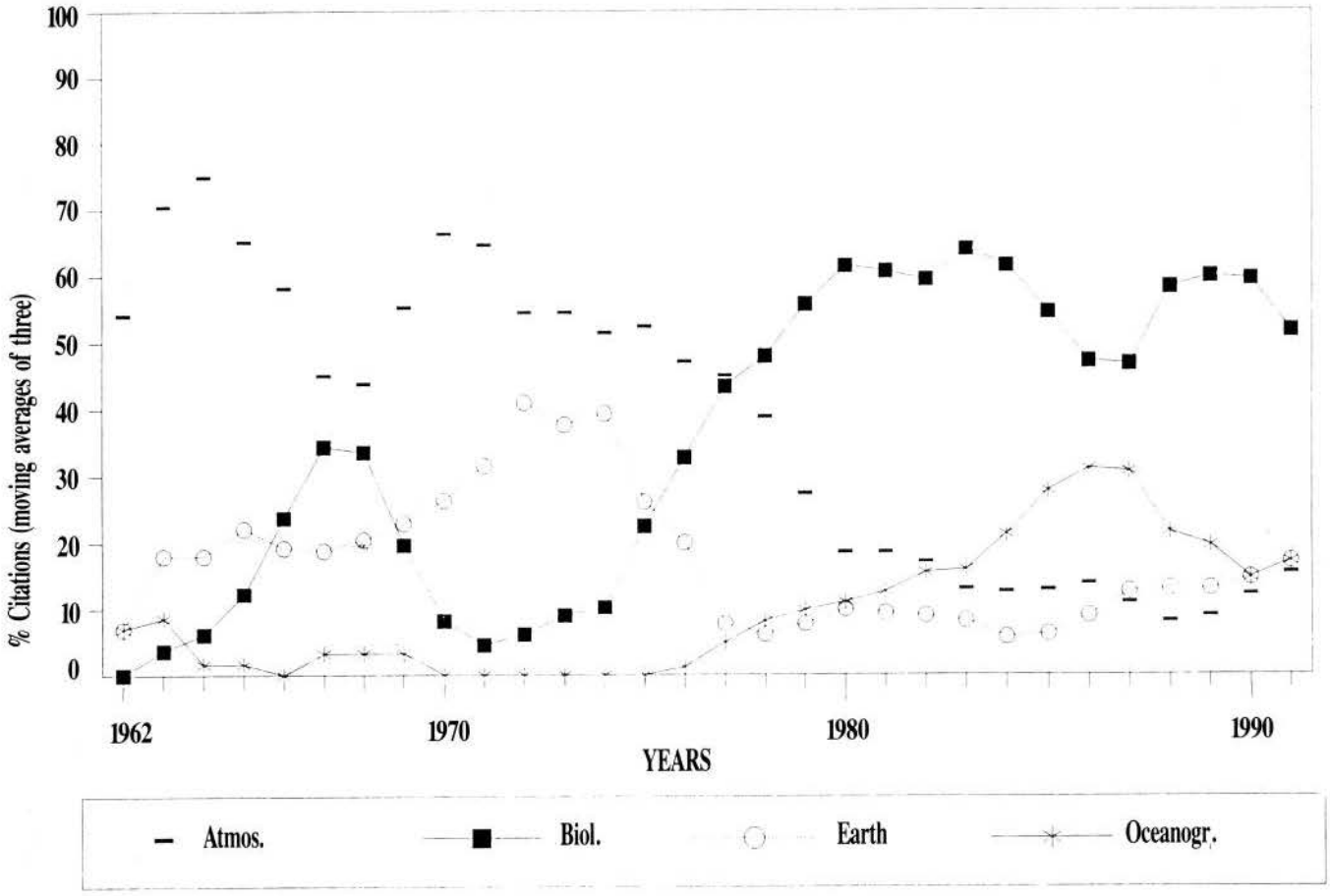


Fig 1 Relative frequency of citable reports listed in South African Reports to SCAR, nos 4 to 33 for the period 1960(61 (no 4) to 1990 (no 33)

ing ecologists today, and others in different parts of the world, started their professional careers with the biological research component of the South African Antarctic science programme. Indeed, more postgraduate students than all other postgraduates in the Antarctic programme as a whole have received their training in the biological component. Moreover, the biologists have produced about an equal number of reports, published in peer-reviewed international scientific periodicals, to that produced by all other scientists combined in the national Antarctic programme (Fig 1).

The emphasis on research dealing with the structure and functioning of ecosystems was serendipitous in the sense that it pre-adapted a corps of South African ecologists for significant participation in such new-priority fields as nature conservation, environmental impact assessment and renewable resource management. These fields began to assert themselves properly in the Antarctic region in the 1980s and, consequently, South African ecologists played prominent roles in several international, ecological science fora concerned with environmental management of one kind or another in the Antarctic and elsewhere as well. This is exemplified by South Africa's pioneering and landmark EIA (Environmental Impact Assessment) for an eventually aborted plan for the construction of an airstrip on Marion Island, the successful campaign to control and ultimately eradicate a large population of feral cats on Marion Island and a significant influence in shaping a joint SCAR-IUCN (International Union for the Conservation of Nature and Natural Resources) undertaking to develop strategies for environmental conservation in the Antarctic and sub-Antarctic regions. Since the author feels that the full benefit of all of this is still to accrue to South Africa locally, he suggests that the biological component of the national Antarctic science programme is providing a satisfactory return on the investment concerned.

EARTH SCIENCES

South African geologists have worked in Antarctica since the beginning of the national Antarctic science programme, but it was not until the late 1970s that an integrated earth-sciences research component was properly structured. Concomitantly, scientists and students attached to geology departments in universities in South Africa began to participate in Antarctic science for the first time. Although much if not all the earlier earth-science research had been a series of stand-alone projects, the thrust of the activities then and thereafter was aimed at refining reconstructions of Gondwana (Hunter *et al* 1991).

Petrologic, structural and radiogenic-isotopic studies of mainly metamorphic rock sequences in western Dronning Maud Land, followed by regional aeromagnetic surveys, have formed the backbone of the South African earth-sciences research effort in Antarctica. These studies have been complemented and supplemented by geochemical investigations of ocean-floor basalts in the Southern Ocean. All of this research has facilitated the training of technicians and postgraduate students as part of South Africa's *corpus* of professional experts. Also worth mentioning

are several land surveyors who have accompanied the geologists in the field. Although the surveyors have been slow in completing maps much needed by South African scientists in Antarctica, their training and experience has been improved through their involvement in the Antarctic science programme.

SPACE PHYSICS

SANAE is ideally placed geographically for several studies involving physical phenomena, such as aurorae and radio waves, in the atmosphere and beyond it in space. Many of these ground-based studies are valuable complements and supplements to space-satellite investigations. SANAE's special location has promoted international liaison and data on a variety of space-related subjects measured at SANAE have been in international demand almost since the inception in the early 1960s of this component of the South African Antarctic science programme. South Africa has benefited in several ways through the international exchange of data facilitated by the research and monitoring activities carried out at SANAE (Hughes & Scourfield 1991).

Recently, physicists in the South African Antarctic science programme have been carrying out research involving the topical so-called hole in the ozone layer. This work is to be expanded soon, to monitor UV-B radiation on the ground at SANAE. These measurements will be of considerable value to the new biological research near SANAE.

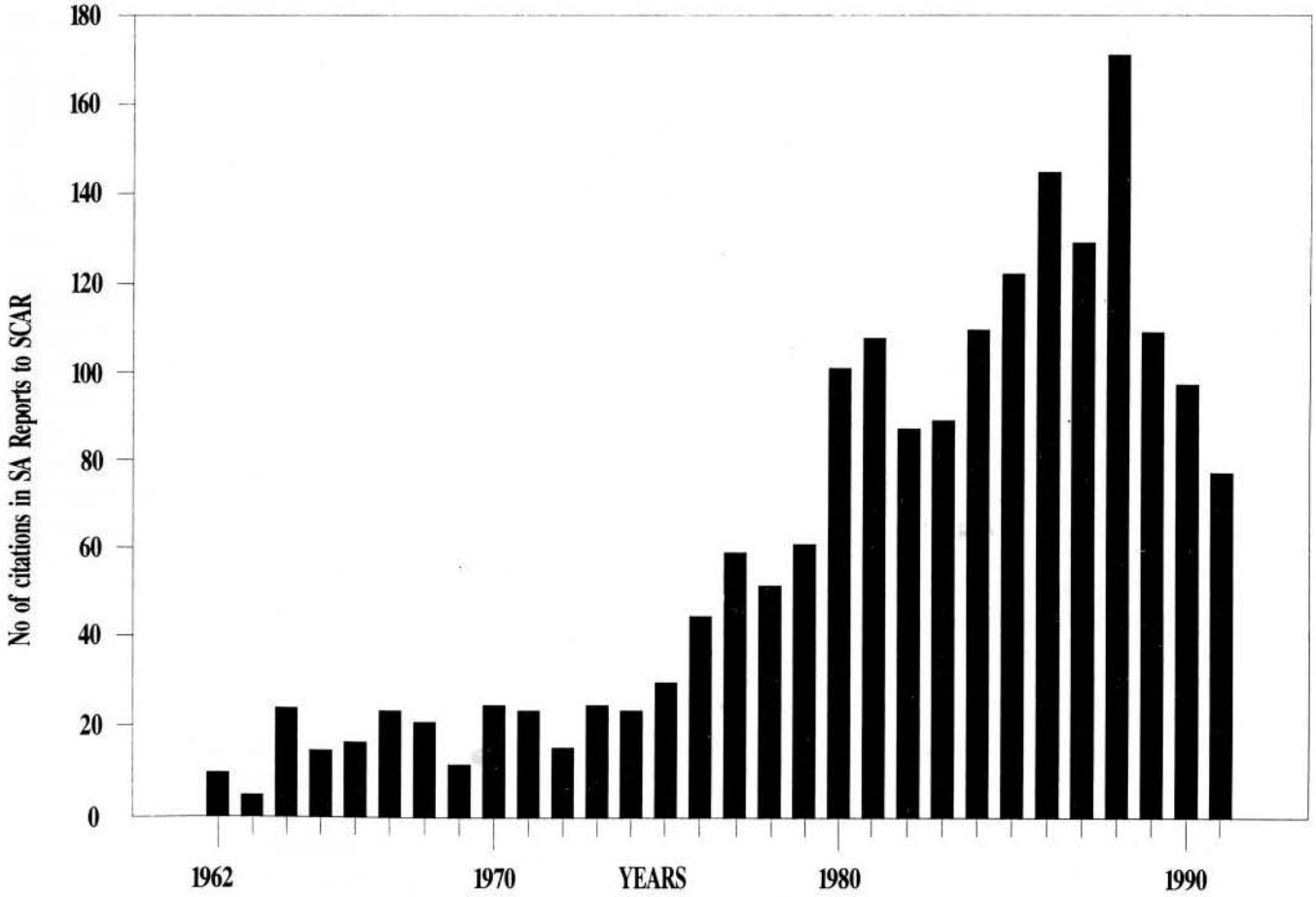
Modern studies of the physical phenomena of the atmosphere and in space beyond it are dependent on international cooperation. South Africa's corps of experts qualified in this field of research is small, but it is viable and the only one of its kind in sub-Saharan Africa. It continues to attract postgraduate students of good quality, and it merits encouragement.

CONCLUSIONS

This brief report has dealt with aspects of the South African Antarctic science programme during the last three decades. All of the scientific work involved was supported financially and logistically by the South African government. It should be appreciated, however, that South African scientists and institutions, outside the formal national programme, have been active independently in Antarctic science during the period under review. Some of these bodies have worked temporarily in collaboration with scientists in the national programmes of other nations. Similarly, the South African national programme has intermittently included and supported scientists from other countries. These interchanges and exchanges are too many to mention here, but it is notable that they occurred throughout South Africa's period of politically inspired isolation. The point that is worth making is that it is unlikely that the international cooperation and collaboration would have taken place on such a wide scale, had the South African scientists not had the knowledge and other attributes necessary to stand them in more than just good stead. This is not to say, however, that South Africa's Antarctic science did not suffer from a degree of isolation during the 1980s. This was the period when the so-called Antarctic question featured prominently for the first time in the halls of the United Nations' Organization, for the first time bringing South Africa's involvement in Antarctica to the notice of many nations.

Until the 1970s, much of South Africa's Antarctic research ef-

Fig 2 Number of citable reports listed in South African Reports to SCAR, nos 4 to 33 for the period 1960/61 (no 4) to 1990 (no 33)



fort involved *ad hoc* projects with very little coordination aimed at developing integrated programmes. There can be little doubt about the importance of the period 1975 to 1985 in revitalising and modernising the nation's Antarctic science programme. In retrospect, it is likely to be revealed as well that this was the period when careful planning and rigorous expert evaluations of both science and financial expenditure significantly improved the cost-effectiveness of operating the national Antarctic science effort. It should be noted that this turning point came about through changes in the attitudes and actions of a majority of the principal scientists themselves, and not through some other agent.

The productivity of the programme, as measured by the number of citable reports, began to increase dramatically in the late 1970s (Fig 2). Much of the credit for this is due to a planned coming together of several gifted and dedicated scientists as leaders and some exceptional administrative managers, who were nurtured and moulded into an effective team by, at first, the South African Council for Scientific and Industrial Research and, subsequently, the Foundation for Research Development.

It remains to be seen whether the new administrative dispensation of the scientific programme, under the Department of Environment Affairs (see Cooper & Headland 1991), will succeed in capitalising on the worthy legacy it obtained in 1989. South Africans should have fair knowledge of the difficulties involved in welding together different cultures — in this case the culture of science and that of public-service bureaucracy. In this context, it should be noted that the transfer of administration did not proceed without some harm being done to the morale of the scientists concerned. Hence, it is crucial that special attention should be given to repairing any such damage by the principals of the new enabling agency. Also, there is a need to promote a new generation of scientific leadership for the programme. At present, there is an undesirably large gap between the "indians" and the "chiefs" of the programme, with several of the latter who entered leadership roles in the 1970s now approaching retirement age.

In similar vein, a question can be raised over the suitability of South Africa's present dispensation for handling a recommendation stemming from the Antarctic Treaty System (ATCM Recommendation XIII-5 of 1985) that has led to a proposal for the establishment of National Antarctic Data Centres (NADC). The absence in South Africa of either (or both) an appropriate governmental agency, such as the British Antarctic Survey in the UK, or a university affiliated body, such as the Scott Polar Research Institute in the UK, is a major stumbling block to the setting up of a local NADC. This touches on a related matter, affecting South Africa's future involvement in long-term environmental monitoring in the Antarctic region, as carried out under the auspices of several international bodies (e g SCAR, IWC and CCAMLR). Clearly, there is cause for an urgent, thorough and wide-ranging review of the South African national Antarctic research programme.

It is doubtful whether the South African government of the near future will be able to find new monies to meet the rising costs of a national programme of Antarctic science. Perhaps the best that can be anticipated is a reallocation of existing financial resources. That being the case, it is desirable that the scientists concerned should engage timeously in debate and agree on what package of limited studies should be funded.

To some extent, this already is happening, but it is being, and has been, spurred chiefly by the fact that much of South Africa's science (as well as other undertakings) in Antarctica has occurred in a policy vacuum. To be fair to the scientists, it must be said that they repeatedly have asked for a policy and a strategic plan that could assist them in setting priorities for the funding of their research. In the continued absence of such a policy, the scientists deserve credit for having adopted a rational approach in their development of integrated research programmes in recent years. In an ironic way, therefore, the nature of these programmes could be instrumental in the formulation of policy and strategic planning. A bit like, but not quite like, the tail wagging the dog.

Finally, South Africa's worthy record of achievements in Antarctic science will come to an end fairly rapidly if not more is done now to attract and maintain a scientific collegium of the best international quality. The recruitment and maintenance of this collegium will depend, not least, on urgent remedial action in response to many, if not most, of the shortcomings, reservations and concerns identified in the preceding narrative. As a start, there is an almost desperate need to improve communication between all the parties involved in the national programme.

REFERENCES

COOPER J & HEADLAND RK 1991. A history of South African involvement in Antarctica and at the Prince Edward Islands. *S. Afr. J. Antarct. Res.* 21 (2): 77-91

GON O & HEEMSTRA PC (Eds) 1990. *Fishes of the Southern Ocean*. J L B Smith Institute of Ichthyology, Grahamstown XVIII + 462 pp, 12 pls

HECHT T 1987. A guide to the otoliths of southern ocean fishes. *S. Afr. J. Antarct. Res.* 17 (1): 87 pp

HUGHES ARW & SCOURFIELD MWJ 1991. SANAE: The Durban connection. *S. Afr. J. Antarct. Res.* 21 (2): 187-192

HUNTER DR, CORNER B, KRYNAUW JR, LE ROEX A, GRANTHAM GH, GROENEWALD PB, MOYES AB, BERGH HW & HARRIS C 1991. A recent history of South African earth science research in Antarctica and adjacent regions. *S. Afr. J. Antarct. Res.* 21 (2): 173-183

LUTJEHARMS JRE 1991. A history of recent South African marine research in the Southern Ocean. *S. Afr. J. Antarct. Res.* 21 (2): 159-164

MILLER DGM 1991a. Conservation of Antarctic marine living resources: a review and South African perspective. *S. Afr. J. Antarct. Res.* 21 (2): 130-142

MILLER DGM 1991b. The impact of BIOMASS-related research on South African Antarctic science. *S. Afr. J. Antarct. Res.* 21 (2): 167-171

SMITH VR 1991. Terrestrial biological research at the Prince Edward Islands. *S. Afr. Antarct. Res.* 21 (2): 118-123