REVIEW

"Evolution of the modern Science in Antarctica "

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Abstract:

The objectives of the Heroic Age expeditions were driven by the continued wish of European countries to 'plant their flag' at the Pole, and although these expeditions saw the beginnings of Antarctic science these were just that compared with 21st century programmes; notable achievements through long sledging journeys were made. Immediately after the Heroic Age, the first cohesive long term planning of scientific work came with the Discovery Committee's work. The Second World War years led to the establishment of the Antarctic's first permanent bases, and the inception of the organisation which led to to-day's British Antarctic Survey. The Commonwealth Trans-Antarctic Expedition 1955-58 made the first crossing of the Antarctic Continent and was the first major mechanised expedition; its primary objectives included scientific study across the continent, and it participated in the programmes of the International Geophysical Year 1957-58; and it was the last expedition that was, in part, funded by members of the public. Through this expedition and its wish to participate in the International Geophysical Year (IGY), New Zealand began its notable contribution to Antarctic science. This review covers the early scientific efforts of the nations involved in Antarctica up to the IGY, commenting on the scientific publications resulting, and relates this to to-day's national Antarctic programmes.

Introduction

With the large number of nations involved in national Antarctic science programmes under the auspices of the Antarctic Treaty System (AST) this review reflects on the origin of organised Antarctic science which led up to the Third Polar Year , the International Geophysical Year of 1957-8. These international efforts had been held every fifty years, but by the early 1950s, science had developed so rapidly, and to the point, that fifty years was just too long to wait. The time was ripe for an even greater international co-ordinated programme to cover the geophysical environment of the whole earth. Nations having participated in this programme were reluctance to give up their new role in science, and, thus were born to-day's National Antarctic Programmes that have discovered many more new facets of a Continent which has such an influence on the earth's physical systems.

The science of the Heroic Age expeditions was superficial as compared with modern programmes; they went to find out what was there, not how to use it for the benefit of mankind. Science was a very necessary feature of these early expeditions to attract the bright young and adventurous minds; to give a philosophical purpose to the endeavour rather than just the aim of territorial gain; and above all to attract finance.

As more facts about the Continent were established, still more questions had to be answered.

Heroic Age

The organisation of the first The First Polar Year 1882-3 was supported by eleven nations, most of which sent expeditions to the Arctic, but two, France and Germany (Fogg 1992), went to Cape Horn and South Georgia respectively. The results of these efforts were to show a connection between the observations in the Arctic and Antarctic. In Britain the interest in polar regions was centuries old, although there were lulls in activity. Through the whaling fleets of the time scientists travelled to Antarctica , but their efforts were generally thwarted by the practical commercial attitudes of the whalers. Specific scientific expeditions needed to be undertaken. Subsequent to the International Geographical Congress of 1995, Sir Charles Markham, President of the Royal Geographical Society, promoted the National Antarctic Expedition , and eventually won his battle to appoint Robert Scott as leader. With Borchgrevink's *Southern Cross* and Scott's *Discovery* expedition the Heroic Age had begun.

The science carried out on these expeditions tends to be overlooked (Huxley, 1913;Wordie & Roberts 1943). The Heroic Age expeditions were generally financed through private sources, and so always short of money, which meant that the scientific results were only published as appendices to the main accounts of expeditions or were published in scientific series with limited circulation. As a result the question must be asked as to whether due consideration as ever been given to the value of the scientific work of these expeditions. Naturally the public and scientific world concentrated on the extraordinary experiences that occurred; ships beset in ice, some never to escape; man-hauling through absolutely appalling conditions, dressed in totally inadequate clothes as compared with to-day's outfits; the sheer audacity of the escapes from incredible misfortune; and of course the tragic deaths that occurred on many expeditions.

There is little doubt that at the time science was a important aim of expeditions, but this was smothered by the territorial imperative that developed; the race to the Pole.

This science concentrated on what existed on the continent, both physical and biologically. The geological work and the results were quite extensive with significant areas being mapped and the petrology and palaeontology of the rocks being examined in detail. The biological environment was well covered, with work on Antarctic fishes, mollusca, Tardigrada, and the microscopic life at Cape Royds to mention but a few examples. Meteorology and magnetic observation were done continuously. It should be noted that the northern parties of these expeditions made geographically widespread and scientifically robust advances. For example the name of the Australian T.W. Edgeworth David is forgotten as compared with his leader, Shackleton. David led the first ascent of Mount Erebus, climbed for scientific reasons as well as the achievement, and he lead the party that reached the South Magnetic Pole travelling large distances manhauling over the continent's Plateau (Fisher 1957).

Immediate Post Heroic Age

In a lecture given to the Royal Geographical Society in December 1920 (Debenham 1920), and with the aim of seeking support for the creation of a polar research institute, Frank Debenham remarked:

'……that all who are interested in polar work should have a clear idea as to why it should consist so largely of the meticulous collection of data in the various branches of science. The only way in which that clear idea can be attained is by visualising the world as a globe of infinite diversity of form, climate, and process, all parts of which are interrelated in the most complicated way, so that whatever happens in one region exerts an influence on all the others…….. ……The science of meteorology perhaps affords the best example of the systematic collection of apparently irrelevant data in polar regions. In all recent expeditions a considerable portion of time, not only of the scientific staff but also of the rank and file, has been employed on the amassing of regular and continuous weather observations. Let us see if it is possible to trace any direct connection between the data thus obtained with infinite trouble and the larger problems of meteorology which affect the habitable portions of the globe'

With these words in mind the emphasis on coherent and consistent scientific records will have been firmly in the minds of those organising expeditions or those who determined to support the ventures. Shackleton attended this lecture before successfully funding his Quest expedition the following year!

It is seems reasonable to assume that the British Colonial Office had such thoughts in mind when they established the Discovery Committee in 1923, with the aim to carry out regular scientific programmes in the Southern Ocean using the RRS Discovery and RRS William Scoresby during the period 1925 – 39 (Hardy, 1928). This work was almost exclusively oceanography around Antarctica, which concentrated on the Falkland Islands Dependencies, but which included work in the Ross Sea. The Discovery voyages were funded by a levy on the whaling industry.

Throughout the 1930s the 'one off' expeditions continued. Notably this period saw the start of the United States interest in Antarctica beginning in the late 1920s and going through to the 1940s with the Byrd expeditions and Lincoln Ellsworth's expedition to Graham Land in 1934-5, when he made his flight across West Antarctica (APS, 1935-1940).

The British Australian New Zealand Research Expedition (BANZARE), led by Mawson 1929-31, and John Rymill's British Graham Land Expedition (BGLE) of 1934-37 kept the UK's and Australia's interests alive in their territorial sectors. In 1925 Argentina had made a counter territorial claim to UK's of 1907, and had later established a base on the Graham Land Penisular.

All these expeditions like those of the Heroic period, made geographical discoveries and accumulated records *inter alia* on weather, geology, geomagnetism, cosmic rays, the ice shelf, the biota, and developed sledging techniques with dogs. But the fundamental reason for these expeditions, even the private ones, was territiorial claims.

Post Second World War

Before the war Germany had made its own territorial claim (Fogg,1992) which had had an influence on other nations thinking. Byrd had completed his third expedition. As the war progressed the likelyhood became obvious that natural harbours could be used for hiding 'raiders' who were preying on shipping.

Britain launched *Operation Tabarin* in 1943, a naval venture with a strong territorial objective as well as a defensive one. With the end of the war the two bases that had been built by the Royal Navy were transferred to the Colonial Office with it civilian title 'The Falkland Islands Dependencies Survey' (FIDS). In October 1948 control passed to the Governor of the Falkland Islands (Sir Miles Clifford, KBE, CMG, ED.) who personally directed the activities of the Survey from Port Stanley with the administrative support coming from the Crown Agents in London.

This was the foundation of the Anatrctic first continuously manned base network. Topographical and scientific work of FIDS was carried out within the sector of the Antarctic which formed part of the Falkland Islands Dependencies which was first subject of a territorial claim in 1908.

BGLE in 1934-7 had established that the Graham Land peninsular was not a series of islands but attached to the remainder of the Antartic but little else was known. A programme of scientific work was not thoroughly planned until 1947 for the eight bases which by then had been built. When V.E.Fuchs was appointed Field Commander, based at Stonington island at the southern end of the Peninsular, this was one of his main objectives (Fuchs, 1953).

From the early years of the bases, topographical surveys, meteorology, geology, glaciology,and marine biology were the main activities. One base was designated as a breeding station for dogs which were used for the extensive journeys from several bases that started in 1948. It was common for sledging parties to be away from base for three months or more, travelling up to 1000 miles.

It was not until 1950 that the FIDS Sccientific Reports series was begun by the Falkland Island Scientific Bureau in London. Later in the mid-fifties the three threads that contributed to Britain's programme in the Antarctic were brought together under one organisation, the Falkaland Islands Dependencies Survey under the leadership of a director who was in the first instance was Sir Raymond Priestley, geologist with Shackleton in 1907-9, and who had been Vice-Chancellor of Melbourne and Birmingham Universities. After organising and leading the Commonwealth Trans-Antarctic Expedition, Sir Vivian returned to FIDS as its Director and led it until his retirement in

1973 (Laws, 2001). By then it was known as the British Antarctic Survey (BAS) and held a world wide reputation as a research organisation, as does to-day, publishing large number of papers annually. It was then, and continues to be, part of National Environment Research Council (NERC) that oversees a large part of Britain's scientific research budget.

Meanwhile the United States continued with its operations after the war with *Operation Highjump* which made major geographical discoveries in Mary Byrd Land and from their base at Stonington Island. Major sledging journeys were made to establish the extent and thickness of ice; the prevailing thesis being that it was thin (Lewis, 1965). Round the continent in the Norwegian sector, the Norweign–British–Swedish Antarctic Expedition 1949-52 (Giaever,1954), was covering new ground inland from the coast through aerial survey, and sledgeing parties, doing glaciological and seismic work, establishing the extent of the floating ice-shelf in that area and the sub-ice topography. This expedition is one of the earliest examples on international co-operation. Argentina had begun to send regular parties into the Penisular in 1942 with Chile following in 1947.

Scientific activity was building up, albeit disguising territorial claims or intentions. A greater understanding of the Continent was emerging, although the overall base of knowledge remained limited for such a large part of the earth, which scientists believed had such a significant role in the earth's mechanisms.

Commonwealth Trans-Antarctic Expedition (TAE)

Whilst sitting out a blizzard in the southern part of the Graham Land Penisular in 1949, Vivian Fuchs conceived plans for a private venture to cross the continent (Fuchs, undated). It was thought possible that a mechanised party with the support of aircraft and dogs could complete such a journey. The initial proposals circulated made the following assumptions:

- *The planned route must begin and end in the Falkland Islands Dependencies… …and the Ross Dependency.*
- *The traverse must pass through the South Pole.*
- *Assistance could be expected from Commonwelth countries…….*
- *This being so, the expedition must include nationals of all the participating countries.*
- *The scientific programme must be sufficient to justify the project.*

At the time of this planning, the American South Pole Station did not exist, and so it was always intended that the crossing party had to be self-suffient between South-Ice, the advanced base at the Weddell Sea end and Depot 700, the depot to be laid nearest the Pole from the Ross Sea by a New Zealand (NZ) party, a distance of around 1200 miles. Nor were the plans for the International Geophysical Year advanced in any way; these were only first conceived in 1950 and planning only first began in 1951 (Dufek,1957; Wilson, 1961).

The science planned included a gravity tranverse and seismic soundings across Antarctica, glaciology, geology of any newly discovered mountains, survey ,meteorology, and the physiology of man under stressful conditions, as well as an extensive programme of survey and geological work in the Trans-Antarctic Mountains bordering the Ross Sea (Fuchs, undated; Quartermain,1964).

This plans were largely carried out, the journey of 2158 miles being completed in 99 days. The achievements (Author's conclusions) of the expedition were:

- A successful multi-national expedition
- The first land crossing of the continent
- The first major mechanised expedition
- The first completed single-engined aircraft crossing of Antarctica.

Also it was the last privately financed scientific expedition of any size, albeit the Commonwealth nations had made a major contribution to its cost. A series of sixteen scientific reports were published.

This expedition like so many had tested the endurance of man; the Advanced Party had had to live in a tractor crate for the whole of the winter, sleeping in ordinary polar tents; and Fuchs had said '*…..in the summer crossing of Antarctica, the worst conditions were 68 degrees below zero with a 45 m.p.h. wind. Poor weather in which to be out driving!'*(Wilson, 1961).

International Geophysical Year (IGY)

The origins of the IGY which have been alluded to above are recorded by most accounts on Antarctic science (Dufek, 1957; Wilson, 1961, Lewis, 1965, Fogg, 1992). It was decided that the IGY would run for eighteen months from 1st July 1957 and until 31st December 1958 so that it would span the peak period of sunspot activity. Initially 20 nations agreed to participate and it was largely related to atmospheric science, but with the USSR finally deciding to join the programme, and suggesting that it should include geotectonics, the final count was 64 countries with around 4000 stations; a truly international and co-operative effort. Of these, 55 stations from 12 countries were in the Antarctic.

With regard to the Antarctic, a conference report said that it represented

' a region of almost unparalleled interest in the fields of geophysics and geography alike. In geophysics, Antarctica has many significant, unexplored aspects; for example, the influence of this huge global mass on global weather; the influence of the ice mass on atmospheric and oceanographic dynamics; the nature and extent of aurora australis……. …These and similar considerations lead the CSAGI to recognise that Antarctica represents a most significant portion of the earth for intensive study during the International Geophysical Year. (Sullivan, 1961, p.31.) (Fogg, 1992).

The venture of the time that was not part of IGY was TAE, but both the UK part and the NZ part of TAE were intimately involved with their respective IGY parties. In the case of NZ, the parties occupied the same hut, the original Scott Base, which the NZ Government had designed and financed as part of its contribution to each venture. In recognition of this contribution to TAE, Scott Base was adopted by the NZ Government after IGY, and has remained the key facility of NZ in the Antarctic. In the case of UK party, it had been intended that the TAE party and the Royal Society (IGY) party would occupy the same site, but the Royal Society vessel was unable to reach far enough south in the Weddell Sea arriving slightly earlier in the season than the TAE vessel. It had been thought that a manned joint base would provide a useful safety factor for TAE should there be insurmountable difficulties in gaining access to the Polar Plateau (Fuchs, undated).

The detailed arrangements within the IGY programme were that there would be a programme of three World Days every month for intensive observations in the related sciences and 10 day Meteorological Intervals; that there would be free exchange of data; and that there would be three World Data Centres each having a complete set of IGY data. Never had there been such a co-operative and positive international event.

Post IGY and towards Modern Programmes.

Even before the end of IGY, thoughts had turned to a new future in the Antarctic, as the US had circulated a note proposing to the other eleven nations with bases there that the Continent should be reserve for science This initiative led to The Antarctic Treaty which came into force on 23rd June 1961.
Other international committees were established to continue the co-operative approach to science; SCAR, the Scientific Committee for Antarctic Research, being one; the others covered oceanography and space research.

Thus with all this international co-operation being initiated by IGY and consolidated by the Antarctic Treaty, scientific research in the Antarctic has become a matter of national pride, reputation, and indeed a driving force for influence at the international table of affairs; not unlike the United Nations, but driven by science in the first place, with an element of territorial claim for some, and a determination not to miss out on 'the goodies bag' for many new signatories to the Treaty.

Conclusions

Since IGY, the national Antarctic Programmes have remained in the providence of national research budgets with a significant degree of national pride and prestige running with them.

Despite periods when national governments have sought to reduce or even withdraw from the expense of working in the Antarctic, most, if not all, parties have developed and expanded their activities.

This seems to be amply justified by the fact that Antarctic research has revealed real dangers to humanity from mankind's activities e.g. the discovery of the hole in the ozone layer, and global warming.

Whatever view is taken on global warming, there can be no certainty that mankind is not busily digging its own grave. The Antarctic, holding the history of the recent past in its ice-cap and in the sediments around its coasts, may well hold the key for the understanding of these and other major concerns of to-day.

It should not be a surprise that the remarks of Frank Debenham in 1920 should have been so perceptive; being as pertinent to-day as they were at the time he made them. Their essence is that consistent and long term scientific observations will lead to sound scientific conclusions from a continent that has immense influence over how the earth's systems work and response of other factors. What better justification can there be for Antarctic Science.

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