THE LAST MAJOR DEGLACIATION IN THE ANTARCTIC PENINSULA REGION —A REVIEW OF RECENT SWEDISH QUATERNARY RESEARCH—

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Abstract: During two expeditions 1987/88 and 1988/89 the glacial and climatic history of the Antarctic Peninsula region was studied, using both litho- and biostratigraphic methods. The results show that an early (probably eustatically induced) deglaciation around 10000 y BP cleared some coastal areas, possibly when the marine level stood at 50–60 m above the present. However, large areas which to-day are free from glaciers then still remained covered by ice. There then followed, around 7000 y BP, a sizeable glacial readvance (probably due to increased precipitation). After that, between *c.* 6000–5000 y BP, the major deglaciation of most presently ice-free areas took place—at a marine level between 15–20 m higher than to-day's. That deglaciation is dated by isostatically elevated marine sediments, by the major onset of lake sedimentation in the region and by the start of moss bank growth.

Key words: Antarctic Peninsula, Late Quaternary, palaeoclimate, glacial history, deglaciation

Background

In the early days of detailed Quaternary studies in the Antarctic Peninsula region, initially in the South Shetland Islands, it was envisaged that the timing of deglaciation after the latest major glaciation (Wisconsin), leading to about the present situation with many nunataks and a few rather large ice-free lowland areas, had been roughly similar to that in the northern hemisphere - e.g. with a main reduction in ice cover taking place around 10000 ^{14}C y BP (John and Sugden, 1971; John 1972; Sugden and Clapperton, 1977; Curl, 1980; Clapperton and Sugden, 1988). Later works, both on James Ross Island in the western Weddell Sea (Rabassa, 1983, 1987) and on King George Island in the South Shetlands (Barsch and Mäusbacher, 1986) suggested a much later main reduction in ice cover - which should not have been completed until around 6000–5000 y BP. These rather opposite views also involved the age and altitude of the Holocene marine limit - either put as high as around 50–60 m above present sea level (John and Sugden, 1971; Birkenmajer, 1981), or as low as 15–20 m (Barsch and Mäusbacher, 1986; Mäusbacher *et al.*, 1989).

The actual timing of the deglaciation, e.g. in relation to the global eustatic rise following the Late Wisconsin and Early Holocene northern hemisphere glacial collapse, or in relation to the solar insolation curves for the southern latitudes, is very important for our understanding of the mechanism behind Antarctic glacial fluctuations.

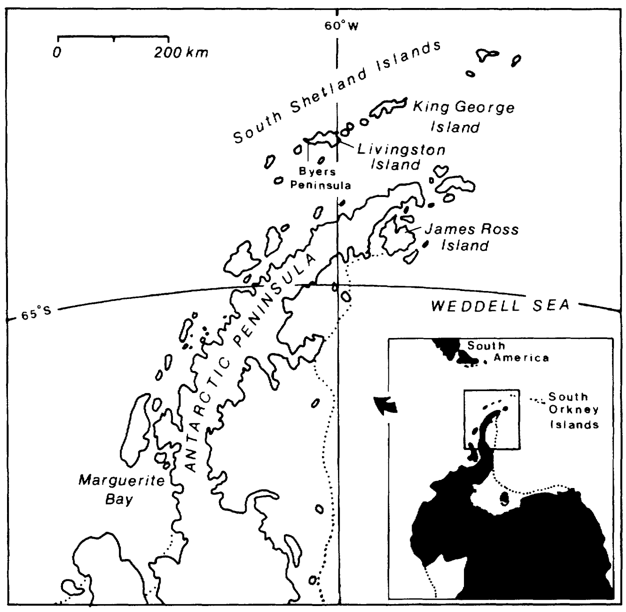

Fig. 1. Location map of the Antarctic Peninsula.

The Swedish Research Program

The above has been one of the main impetuses for the Swedish Quaternary research program in the Antarctic Peninsula region (Fig. 1), so far carried out during two expeditions in 1987/88 and 1988/89, involving the Peninsula itself as far south as Marguerite Bay, as well as the South Shetlands and the islands in the western Weddell Sea (Karlén *et al.*, 1988; Hjort and Ingólfsson, 1990; Björck *et al.*, 1990).

One initial concern was the reliability of Antarctic ^{14}C-datings, where there exist very large and perhaps geographically different marine reservoir effects and empirically very evident methodological constraints on lake sediment datings. It poses important but not unsolvable chronostratigraphical problems (Björck *et al.*, 1991a). In that study, a large set of dated samples was analyzed and it was found that possibly reliable dates were often mixed with obviously erroneous dates, in both marine and lacustrine environments. Thus a critical evaluation of individual ^{14}C-dates is neccessary before using them in chronological reconstructions.

Geologically we have worked with both biostratigraphic and lithostratigraphic methods. Lake cores (Zale and Karlén, 1989; Björck *et al.*, 1991b) as well as moss banks (Björck *et al.*, 1991c) have been used and an alternative Holocene tephrochronology for the region (basically the South Shetland Islands), to that of Matthies *et al.* (1990), have been

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produced (Björck *et al.*, 1991d). The evidence from lake sediments and moss banks in the Antarctic Peninsula region shows that, in most cases, the initiation of organic deposition took place after *c.* 6000 y BP. Whereas the most rewarding area for biostratigraphic work has been the South Shetland Islands (especially lakes on Byers Peninsula on Livingston Island and moss banks on Elephant Island), the best area for lithostratigraphic work has been James Ross Island and its surrounding archipelago east of the Peninsula. From there both older shell-bearing marine sediments (with ^{14}C ages around 35000 y BP and rather high amino acid epimerization values) and Holocene landforms and sediments documenting and dating the glacial fluctuations connected with the latest major deglaciation have been studied (Ingólfsson *et al.*, 1992).

Results and Conclusions

Our main results and conclusions, as documented in the papers referred to above, are: (1) That there was an initial deglaciation and marine inundation of some coastal areas around 10000 y BP, both in the South Shetland Islands and on the islands east of the Peninsula. We suggest that this early deglaciation led to the formation of the rather high marine limit (somewhere between 50 and 60 m) noted by John and Sugden (1971) and Birkenmajer (1981), but it left large presently ice-free areas still covered by glaciers. (2) Around 7000 y BP a glacial readvance of more than 20 km, lasting some 500 years, is documented from northern James Ross Island (Ingólfsson *et al.*, 1992). According to the results of Rabassa (1983, 1987) from the same area, some of the readvanced glaciers persisted until around 5000 y BP. (3) Finally, as late as around 6000–5000 y BP, the great change took place, with a general disappearance of glaciers from the presently ice-free areas, and formation of the main Holocene marine limit around 15–20 m a.s.l. on both sides of the Peninsula. This is indicated by the onset of lake sedimentation in several areas (e.g. Barsch and Mäusbacher, 1986 (partly revised in Mäusbacher *et al.* (1989) and in Mäusbacher (1991)); Björck *et al.*, 1991b), by the start of moss bank growth in the South Orkney Islands and South Shetland Islands (Fenton and Smith, 1982; Birkenmajer *et al.*, 1985; Smith, 1990; Björck *et al.*, 1991c), as well as by the renewed marine inundation of recently deglaciated areas on James Ross Island (Ingólfsson *et al.*, 1992).

This overall pattern may comply with the idea that the onset of Antarctic deglaciation after the latest glaciation (Wisconsin) could have been largely triggered by the northern hemisphere induced global eustatic rise (e.g. Denton *et al.*, 1989), but as both land- and marine-based glaciers on northern James Ross Island advanced around 7000 y BP, that glacial expansion must have had a local/regional climatological background. Possibly it was due to increased precipitation in a warming "interglacial" climate (Ingólfsson *et al.*, 1992). What ultimately caused the final reduction in ice cover around 6000–5000 y BP is still an open question (cf. also Domack *et al.*, 1991).

The problem as to the timing and pattern of deglaciation may thus have been solved now. There were two separate phases of deglaciation!

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