

Hydrology and bio-oceanography of the Prince Edward Islands (southwest Indian Ocean)

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Results are presented from a hydrographic survey of the Prince Edward Island group (46°45'S; 37°55'E) during September 1982. These provide additional information about the hydrodynamics of this little-studied region. The distribution of conservative properties (temperature, salinity, density and oxygen) showed little vertical stratification, indicating that water around the islands is well mixed. It is postulated that topographical effects and the close proximity of the islands to the Antarctic Polar Front may combine to influence significantly biogeographic affiliations nearby. Such effects may also operate in concert with ephemeral run-off from the islands (particularly of nitrates) to affect marine productivity in the region.

Introduction

Some of the main bio-oceanographic features prevalent in the sub-Antarctic, south-western Indian Ocean have been outlined by American (Gordon & Goldberg 1970), Japanese (Fukuchi 1980) and French (Plancke 1977) surveys. Nevertheless, detailed investigations of the region as a whole are sparse (El-Sayed *et al.* 1979a). This is particularly true for the Prince Edward Island Group (46°45'S; 37°55'E) where only two detailed (El-Sayed 1979; Parker & Allanson 1982) and one superficial survey (Deacon 1937; 1983) have been reported to date.

Like many islands in the Southern Ocean, the Prince Edward Group is characterised by a large land-based predator population, supposedly dependent on the surrounding oceans for food (Williams *et al.* 1975; Anon. 1978; Skinner *et al.* 1978; Van Zinderen Bakker 1978). The obvious importance of the marine ecosystem to these predators (El-Sayed 1977; Anon. 1978) has prompted considerable interest in the biological oceanography and productivity of a little-studied region. This paper presents some results from 23 hydrological stations occupied in the nearshore waters of the Prince Edward Island Group during September 1982. It forms part of an overall investigation into predator-prey relationships at selected localities in the Southern Ocean (Miller 1982a; 1982b).

Results and Discussion

A lack of vertical stratification in the conservative properties of temperature, salinity, density (σ_t) and oxygen, demonstrated a well-mixed water mass around the islands (e.g. Fig. 1). However, shoal minima in salinity were visible at two stations in the lee of Marion Island. These may be attributed to effects of freshwater run-off from the numerous rivers draining the island (Van Zinderen Bakker 1978).

A cell of water in the south possessing the characteristics of Antarctic surface water ($T=2,31^\circ\text{C}$; $S=33,87\text{‰}$; $\sigma_t=27,06$) suggests that periodic advection of Antarctic surface water

into the region may explain previously reported appearances of an Antarctic faunal component (Grindley & Lane 1979) in what is usually considered to be a sub-Antarctic neighbourhood. In conjunction with a topographical influence on neighbouring hydro-dynamic events (Planke 1977; Allanson *et al.* 1985), the sporadic proximity of the Antarctic Polar Front to the Prince Edward islands may result in considerable interchange across the Front and hence preclude the persistence of a permanently rigid biogeographic boundary (Deacon 1983; Miller 1985).

Nutrient salt concentrations and productivity were low, although directly comparable with available data for the region (Table 1). The mean silicate concentration, however, was higher than previously reported although the peak value was considerably lower than that obtained by David (1979). Elevated reactive nitrate concentrations were observed close to the southeastern seaboard of Marion Island (Fig. 2). Thus it is theorised that both substantial nutrient salt run-off from breeding bird colonies on the island (Burger *et al.* 1978; Siegfried *et al.* 1978; Williams *et al.* 1978) and the advection of extra-insular water may affect nutrient salt levels close inshore. Such effects are likely to be ephemeral and the result of interaction between hydrological and meteorological phenomena (Allanson *et al.* 1985). Acting either individually or in concert these may significantly influence both the productivity of inshore waters and the faunal character of insular plankton.

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Table 1
Mean and observed ranges of reactive nutrient salts and chlorophyll-*a* at the Prince Edward Island, compared with results from other surveys of the region prior to 1982.

Parameter	Mean	Range	Data Source
PO ₄ ($\mu\text{g-at/l}$)	1,43	1,07–1,94	This survey
	0,59	0,38–1,10	Parker & Allanson 1982
	1,20	1,17–1,74	David 1979
NO ₃ ($\mu\text{g-at/l}$)	18,95	14,79–24,44	This survey
	21,19	17,29–22,57	Parker & Allanson 1982
	19,62	17,60–22,90	David 1979
SiO ₂ ($\mu\text{g-at/l}$)	6,12	4,84–9,30	This survey
	2,50	0,29–5,59	Parker & Allanson 1982
	4,16	0,50–18,90	David 1979
Chl- <i>a</i> (mg/m^3)	0,28	0,01–0,50	This survey
	0,93	0,48–1,82	Parker & Allanson 1982
	0,12	—	Plancke 1977
	0,45	0,09–1,47	El-Sayed <i>et al.</i> 1979b

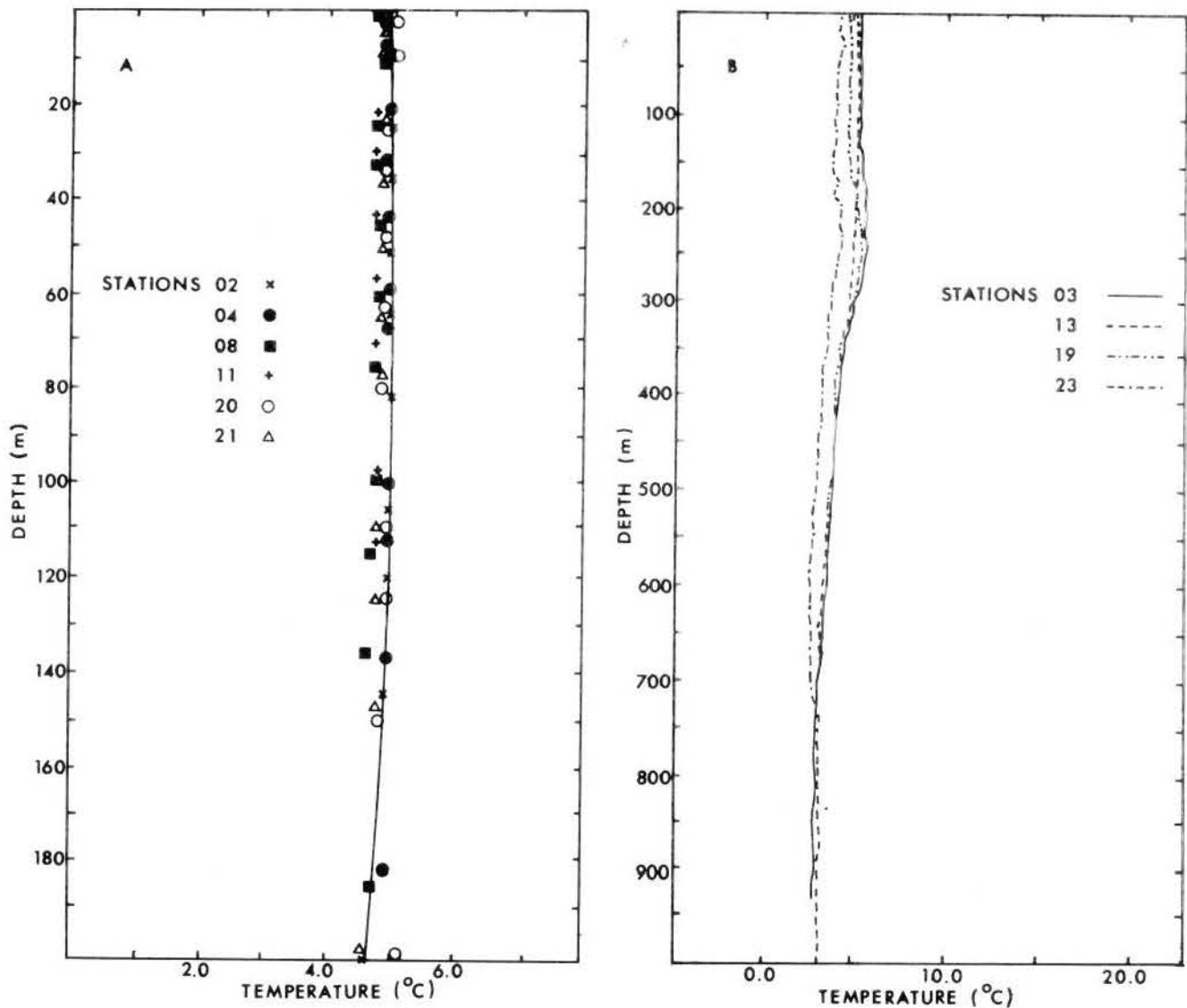


Fig. 1. Vertical distribution of temperature at stations around the Prince Edward Islands demonstrating absence of any formal stratification.

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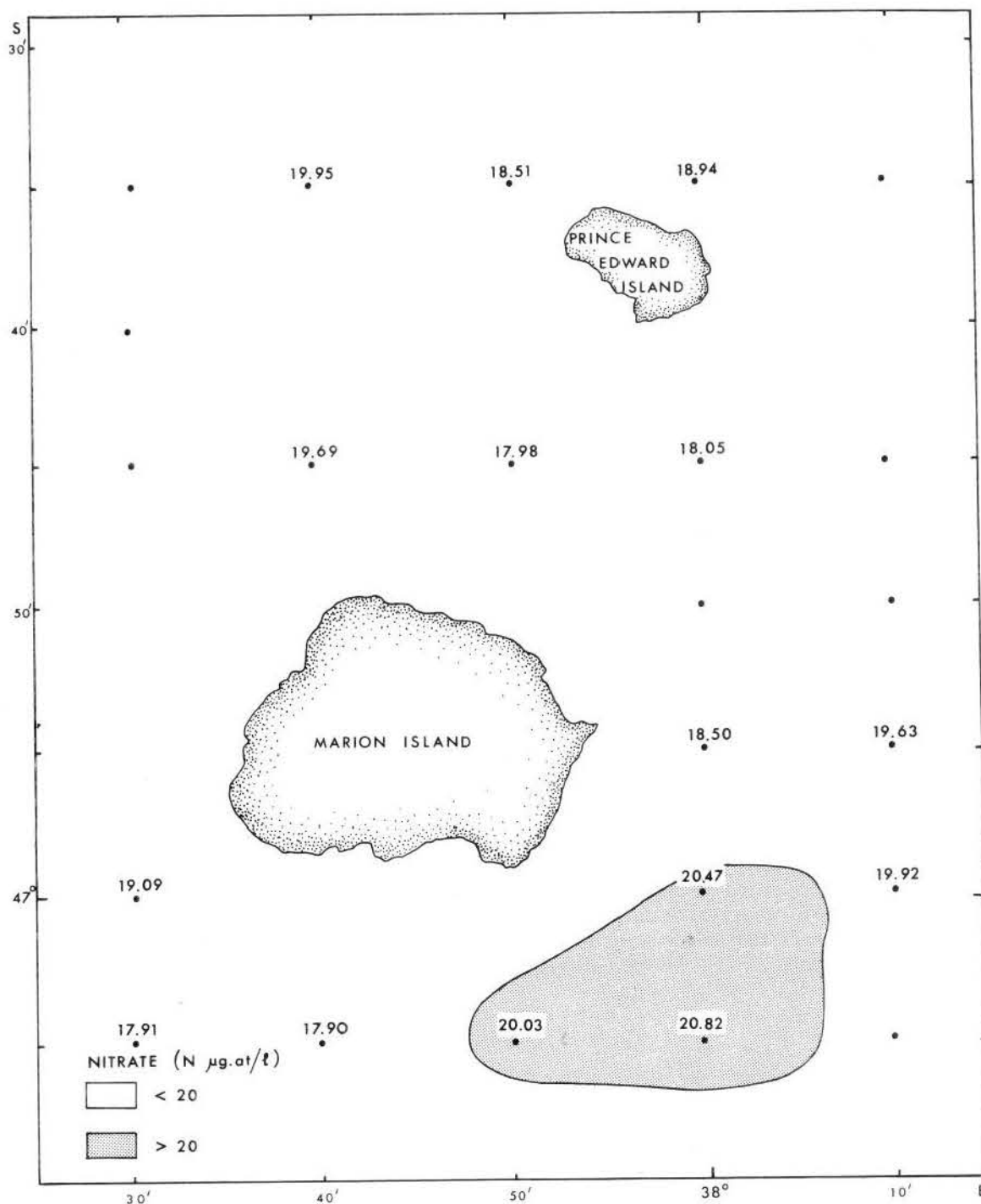


Fig. 2. Horizontal distribution of integrated reactive nitrate (0-200m) highlighting an area of higher concentration near the south-east tip of Marion Island.

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