Penguin dispersal after fledging

SIR — Emperor penguins have several attributes that place them in high regard with biologists and others visiting Antarctica. The Ross Sea birds are of special interest because they occur in the last marine frontier that has not been exploited by humans, where biologists have the unique opportunity to do population studies before the pristine conditions are disrupted. Also, the geography of this sea provides a safe haven compared with areas on the outer perimeter of the continent. Two of our purposes in studying these birds were to determine: (1) if the initial foraging range of juveniles overlapped with pre-moult feeding adults, potentially resulting in competition; and (2) if the emperor penguin is to be an effective resource

detector of the Antarctic marine habitat, as proposed earlier¹, then we must know the boundaries of the habitat during all phases of its life cycle. One of the greatest challenges is to determine the needs of the recently fledged juveniles.

Pre-nuptial behaviour of emperor penguins begins on newly formed sea ice in April. From mid-May, when egg laying begins, until mid-July to early August, the male incubates the egg. At hatching the female returns to relieve the male, enabling him to break his 115-day winter fast²⁻⁵. During the next 5 months the parents share feeding of the rapidly growing chick, which weighs about 12 kg when it fledges around the time of the summer solstice. The entire breeding cycle takes

9 months. Shortly before fledging, the juveniles are left to fend for themselves. Once they leave the colony, they are seldom seen, and do not return again for several years^{5,6}.

In 1995 and 1996, using satellite transmitters, we tracked five juveniles for several weeks after departure from their natal colony. The results are surprising (see figure). The juveniles travelled beyond the Ross Sea, and as far north as 56.9° S. On 6 March 1996, the date of the last transmitter reception, one juvenile was 2,845 km from Cape Washington. Five of six birds studied left the Ross Sea and followed similar paths. They all travelled north to the Antarctic Convergence, the boundary of the Southern Ocean⁷, and then seemed to travel east, with the prevailing current and wind of the Westwind Drift. At these low latitudes the juveniles must be in ice-free waters and immersed at all times, a very different situation from that of the adults, which travel and hunt in ice-congested waters of high latitudes where they can rest frequently on ice floes.

Because their parents remain within the Ross Sea, the findings show that juveniles are not competing for the same food resource. We conclude that the critical

habitat of emperor penguins breeding in the Ross Sea is much larger than that sea alone. The extensive travel of the juveniles implies that Ross Sea populations of this species are, at least during one crucial part of their life, exposed to some of the same risks as more northern conspecifics. Of particular concern is the possible impact of commercial fishing around the Antarctic continent. We suggest that if adequate protection is to be given to this species, and perhaps to other Antarctic species as well, the dispersal patterns of the young must be determined. As written, the Antarctic Treaty and the Convention on Antarctic Marine Living Resources extend only to the 60th parallel in this region of Antarctica⁷. These new data suggest that the 60th parallel is probably too limiting to protect adequately even the most familiar symbol of Antarctic wildlife, the emperor penguin.

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Optical fibres in an Antarctic sponge

SIR — The skeleton of demosponges and hexactinellids is generally composed of spicules consisting of amorphous hydrated silica (opal)¹ laid out around a proteic axial filament². Spicules constitute a mechanical support and act as deterrents to predators³. The presence of a filamentous green alga (*Ostreobium*) closely associated with the spicule bundles of a demosponge (*Tethya seychellensis*) suggested to us that light energy might reach the inside of the sponge body via siliceous spicules⁴. Such a natural optical-fibre system could influence sponge/symbiont interactions⁵⁻⁷ and wider aspects of sponge biology⁸.

We showed that siliceous spicules can act as optical fibres by using long spicules of an Antarctic hexactinellid (>10 cm long), whose large size allows easier handling of the very small demosponge

Routes of emperor penguin juveniles obtained from satellite transmitters (Telonics, ST-10; mass 120 g) attached by glue (Loctite 422) to the lower part of the back. From 15 to 19 December 1994 (9068a, 9069a) and 1995 (9066, 9067, 9068, 9069), the birds ranging in body mass from 10.9 to 14.2 kg (mean 12.8 kg $\pm$ 1.3 s.d.) (AND-FW 150 kg $\pm$ 20 g, platform scale) were captured and released near the ice edge of Cape Washington (74° 32' S; 165° 22' E). Within a few hours of release, the birds entered the water. Positions were monitored from 4 January 1995 (9069a) to 6 March 1996 (9069). During this time all birds had reached positions far enough north to be in the Westwind Drift⁸. We expected transmissions to continue during June, but the lack of signal suggests that the birds remained in water north of the pack ice. (Transmitter position on the bird prevents transmissions while the birds are swimming.) The pack-ice edge in this sector of the Southern Ocean based on satellite images was well south of 66° S by 7 December 1995. In the previous year, the pack ice edge on 15 June 1994 determined by direct observation by GLK from a US Air Force KC-10 flying at 11,000 m was at 61° S. General boundaries of the Antarctic Convergence and winter and summer pack-ice edges vary from year to year. Rendering of the inset is based on various figures^{7,8}. Antarctic Convergence (AC, dark blue line); pack-ice edges in July and March 1987 are shown.