

### Fossil Seabirds and Marine Environments

Sir,—We read with considerable interest Olson's<sup>1</sup> paper on the seabirds from Langebaanweg and, from an ornithological viewpoint, it is welcome to see so many years' hard work by Brett Hendey and his co-workers at last bearing fruit.

We believe, however, that Olson has misinterpreted the palaeoclimatic significance of the Langebaanweg avifauna. As the presence of penguins on the Galapagos Islands shows, seabirds are poor indicators of climate and their distribution is to a large extent controlled by other factors, among the most important of which are suitable breeding and feeding grounds.

As Olson<sup>1</sup> has shown, drowning of the Cape Peninsula to depths of 90 m during the early Pliocene eustatic event would have created rocky islands out of Table Mountain and the Chapman's Peaks. These would have risen, almost sheer-sided, for many hundreds of metres out of the ocean, creating seabird nesting grounds without parallel. In addition, the drowned Cape Flats would have provided quiet, shallow, relatively warm waters which probably abounded in marine life. Most significantly, however, the cold Benguela Current with its nutrient-rich upwelling and high productivity had just come into being during the late Miocene,<sup>2</sup> and provided an adjacent feeding ground with limitless trophic resources. This unique combination of rich feeding grounds and spectacular rocky islands in close proximity attracted a vast array of seabirds which do not occur in the region under present oceanographic conditions. We suggest, therefore, that the composition of the Langebaanweg seabird fauna is purely a reflection of favourable habitats and not marine climates. As the terrestrial fauna shows, climates along the continental margin at this time were subtropical.

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1. Olson S.L. (1983). Fossil seabirds and changing marine environments in the late Tertiary of South Africa. *S. Afr. J. Sci.* 79, 399–402.
2. Tankard A.J. et al. (1982). *Crustal Evolution of Southern Africa*. Springer-Verlag, New York.

#### Dr Olson replies

Unfortunately, I cannot see that Cooper and Stuart Irwin have added much that bears on a discussion of past marine environments in South Africa. They seem mainly to have restated some of the points I made, prefacing them with the remark that penguins are found in the Galapagos and concluding by saying that the *terrestrial* fauna at Langebaanweg indicates a subtropical climate along the continental margin in the early Pliocene, both of which facts are irrelevant to interpreting past *marine* conditions.

I could not agree more that the presence of penguins has little zoogeographical significance for interpreting terrestrial ecosystems, breeding as penguins do (or did) in reasonably close proximity to faunal elements as diverse as flamingos, iguanas, ground sloths, leopard seals, kangaroos, kiwis and ostriches. Rather than facily setting forth the Galapagos penguin as an example of a 'poor indicator of climate', it is more instructive to examine just what the distribution of that bird really signifies. Although there are abundant breeding sites suitable for penguins virtually throughout the Galapagos, *Spheniscus mendiculus* actually nests only around the island of Fernandina and on the adjacent western shores of Isabela (a distribution practically the same as that of the flightless cormorant *Phalacrocorax harrisi*). This coincides with a very local area of upwelling of nutrient-rich cold water. This upwelling has had little perceptible effect on the terrestrial biota of Fernandina and Isabela, which is essentially similar to that elsewhere in the archipelago, but without it there would be no penguins (and probably no cormorants) in the Galapagos. Furthermore, when climatic events such as El Niño cause surface water temperatures to rise, there is a corresponding decrease in nesting success of penguins in the Galapagos.<sup>1</sup>

Clearly the distribution of penguins is severely restricted by the nature of the

marine environment, as would be expected, but has little correlation with terrestrial biotas. Penguins are certainly indicative of cold waters and the enriched marine resources that cold currents and upwelling provide. Whereas at present there is only one species of penguin in South Africa, in the early Pliocene there were four, all of which are now extinct. The modern presence of a breeding species of penguin in South Africa shows that suitable nesting sites obviously still remain, yet the composition and diversity of the penguin fauna in South Africa has completely changed in the past five million years.

The number, size and character of islands suitable for breeding seabirds in South Africa has without doubt changed since the early Pliocene and such changes would very likely have influenced the nature of the marine avifauna in some degree — a point I specifically raised.<sup>2</sup> Procellariiform birds that burrow in soft sediments would have been particularly affected, as very little such habitat remains on the present-day islands. Nevertheless, a number of procellariiform birds nest in exposed situations or in rocky crevices, yet no members of the order persist as breeding birds in South Africa today.

The fossil record indicates a nearly complete turnover in the marine avifauna of the Atlantic coast of South Africa since the

early Pliocene and shows that there were numerous extinctions but far fewer replacements by newly colonizing species. Those elements of the seabird fauna that did not become entirely extinct are now generally characteristic of higher latitudes. As I previously indicated, a similar pattern obtains in the pinnipeds. I do not think that such a pervasive reorganization of the marine vertebrate fauna of western South Africa can be explained on geomorphological changes in the coastline alone. Therefore some long-term alteration in overall oceanographic conditions is probably indicated.

If I am to be accused of misinterpreting the palaeoclimatological significance of the entire Langebaanweg avifauna, it might be fairer to wait until the entire avifauna has been analysed. Meanwhile, my previous remarks were clearly intended to apply solely to marine birds and to the marine environment. As yet, I see no reason to alter the substance of the conclusions presented there.

1. Boersma P.D. (1978). Breeding patterns of Galápagos penguins as an indicator of oceanographic conditions. *Science* 200, 1481–1483.
2. Olson S.L. (1983). *S. Afr. J. Sci.* 79, 302.

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