Reviews

THE BEHAVIOUR, POPULATION BIOLOGY AND PHYSIOLOGY OF THE PETRELS. John Warham. 1996. London: Academic Press. vii + 613 p, illustrated, hard cover. ISBN 0-12-735415-8. £60.00.

This is the second volume of John Warham's magnificent treatise on those sea-bird wanderers of the heaving oceans, the petrels. And the first thing to say is that it is just as good as the first volume, which was published in 1992 and reviewed in *Polar Record* (29 (168): 69). What a shame, then, that the price will intimidate many enthusiasts from buying a book that is up-to-date, accurate, and astonishingly comprehensive. Warham has assembled a bibliography of the petrels amounting to approximately 11,000 items. And, by assembled, I do mean precisely that; he has collected the hard copies of the papers that are now deposited in the Alexander Library of Oxford University's Edward Grey Institute.

While the first volume documented the species in the petrel order, the Procellariiformes, and their breeding biology, the new volume covers population dynamics and our fast-improving knowledge of how petrels pass their time at sea and what they eat there. It then proceeds to detail studies of behaviour and vocalisations. Calls are particularly prominent at the colonies of the many nocturnal species where sound necessarily replaces sight as the main means of communication between individuals. Four chapters deal with physiology and energetics, biochemistry, locomotion, and anatomical matters. Finally, what is known of the evolutionary radiation of the petrels is discussed, and there is a chapter on the numerous impacts that man has had and is having. Meanwhile petrels have had an impact on man. Not only have they provided food, they have also provided flotation. There is the delightful tale of a seaman, lost overboard in the Southern Ocean on 24 October 1881, who, despite the encumbrance of seaboots, was recovered an hour later clinging to an albatross.

As this book was being written, so the results of new techniques were becoming available. Satellite tracking is revealing the precise sea areas used by foraging albatrosses during the breeding season. Black-browed albatrosses feed relatively near to the colony, whereas wandering albatrosses go further afield. The female wanderers tend to forage north of the males and are therefore more exposed to the dangers of the tuna long-line fishery (more of that below). The foraging radii revealed by such new technology generally exceed those calculated from energetic considerations. Either the energetic calculations are wrong, or the birds are more skilled at exploiting the tailwinds and possible other energy-saving tricks at sea than we realise. John Warham doesn't offer an opinion and this leads to a small grumble. After a mass of data is presented, he sometimes fails to provide a clear statement of the current position.

Nowadays the satellite data can be coupled with data on diving depths. As these data accumulate, it is becoming evident that petrels are more adept at diving than many anticipated. Who would have guessed that such a buoyant species as the sooty albatross could reach five metres underwater, or that a sooty shearwater's mean diving depth would be as great as 38.7 m? The satellite data can also be married to information on the time the bird is actually ingesting food, gleaned from a swallowed temperature recorder that notes a fall in temperature when the bird consumes a squid whose temperature is that of sea water at, say, 7°C. The potential for understanding how the timing and position of sea bird feeding is related to oceanographic conditions, submarine topography, and local weather is immense. This will be all the more true if 8-gram satellite transmitters, now available, are successfully deployed on smaller species.

Because John Warham is so scrupulous in presenting what earlier authors have reported, he is reluctant — unduly reluctant in my view — to speculate on the significance of various observations. For example, the petrels, along with the penguins and ratites, maintain body temperatures some two degrees lower than the generality of birds. Despite this, the petrels appear not to maintain their eggs during incubation at a temperature any lower than other birds. Why is this so? No suggestion is proffered, although 150 pages later there is the throwaway remark that the low body temperature may be a primitive character retained from reptilian ancestors. Or it turns out that the intestinal arrangements of the diving petrels allow food to pass through much more rapidly than occurs in other petrels where slow passage permits separation of stomach oils. This is presumably related to the diving petrels' inshore habits that, compared to more wide-ranging petrel species, reduce the advantage of lipid storage. These plausible correlations are not pointed out.

There is little doubt that mankind has been bad news for petrels. Colonies have been devastated by disastrous introductions of alien species, such as cats, pigs, and rats. Now we are in a position to undo at least some of that damage. Witness the eradication of cats on Marion Island. And birds have been drowned at sea in their hundreds of thousands by drift nets, a practice now stopped. But no sooner is one threat eliminated than another appears. The threat of the moment is long-lining, which is seriously damaging albatross and other petrel populations. The birds are caught and then drowned as they snatch baited hooks when these are cast overboard. Norwegian ship designers have shown how the problem can be eliminated, albeit at a cost, by shooting the line underwater. Increasing international pressure, for instance a resolution at the recent IUCN conference in Montreal, gives some slight

hope of a solution. But any solution is as likely to be the result of economic pressures as a desire by fishery managers and the wider fish-buying public to put the conservation of petrels ahead of fish on the dinner plate. I cannot improve on John Warham's closing sentence: 'The target animals, tuna, albacore, swordfish, etc. are so valuable that, as with whales, the stocks may have to be considerably depleted before the fishery becomes uneconomic, by which time the birds may have been even more depleted.' (M. de L. Brooke, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ.)

GLACIAL GEOLOGY: ICE SHEETS AND LANDFORMS. Matthew R. Bennett and Neil F. Glasser. 1996. Chichester, New York, Brisbane, Toronto, Singapore: John Wiley. xi + 364 p, illustrated, soft cover. ISBN 0-471-96345-3. £19.99.

Those interested in glacial geology and geomorphology were for a long time served by only one dedicated text, David Drewry's *Glacial geologic processes* (1986). Furthermore, the mathematical approach of this text did not suit all readers. However, two new texts have lately been published in this field: *Glacial environments*, by Michael Hambrey (1994), and, now, *Glacial geology: ice sheets and landforms*.

In their preface, the authors state that the text arises from their enthusiasm for glacial geology and a perceived need for a student text with which to stimulate this enthusiasm in others; their aim is to provide an accessible account of glacial geology at the undergraduate level. The authors have indeed produced a text that both undergraduates and their teachers will find a useful learning and teaching resource. However, it is also likely that this text will continue to be useful for reference at postgraduate level and beyond.

Early chapters provide a glacier dynamics context: 'The history of ice on Earth,' 'Mass balance and the mechanism of ice flow,' and 'Glacial meltwater.' The main part of the text is concerned with the processes and products of glacial erosion and deposition: 'The processes of glacial erosion,' 'Landforms of glacial erosion,' 'Glacial debris transport,' 'Glacial sedimentation on land,' 'Landforms of glacial deposition on land,' 'Glacial sedimentation in water,' and 'Landforms of glacial deposition in water.' The emphasis is on the interpretation of glacial landforms and sediments for former ice dynamics. The final chapter, 'Interpreting glacial landscapes,' synthesises information on the processes and products of glacial erosion and deposition from previous chapters to deal with the pattern of landform–sediment distribution produced at the ice-sheet scale.

The text is attractively presented and, as might be expected, profusely illustrated with diagrams and black-and-white photographs. The examples given partly reflect the authors' field experience in Argentina, Great Britain, Greenland, Iceland, and Svalbard, although examples from other parts of the world are also cited. The writing style is clear and non-mathematical. A novel and useful feature is the use of discrete information 'boxes' providing concise stand-alone information on key topics, such as glacial history and the oxygen isotope record, the structure of glaciers, grain-size distributions and transport distances, eskers and sub-glacial deformation, and the measurement and analysis of till fabric.

A feature of this text is the presentation of material in summary form, which enhances the value of the text for reference at all levels. Concise tables at the ends of chapters on 'Landforms of glacial erosion,' 'Landforms of glacial deposition on land,' and 'Landforms of glacial deposition in water' summarise the morphology of the principal erosive, direct depositional, glaciofluvial, glaciolacustrine, and glaciomarine landforms and their significance for glacier reconstructions. For instance, p-forms are described as smooth-walled, 'sculpted' depressions and channels cut into bedrock, indicative of warm-based ice, abundant meltwater, and low effective normal pressures, and typical of thin ice; flutes are described as low, linear sediment ridges formed in the lee of boulders or bedrock obstacles, indicative of local ice-flow directions, thin ice, and the presence of warm-based ice; and plough marks are described as linear furrows or depressions on the seabed, indicative of iceberg grounding. Another good example from the chapter 'Glacial sedimentation on land' is a table summarising diagnostic criteria for the recognition of common diamicton lithofacies in the field, which is followed with examples of facies models with typical vertical logs for different glacier thermal regimes. The same chapter also provides a great deal of detail on the various till types, and additional material on fluvial sedimentation, and includes a table summarising the principal sedimentary characteristics of the main types of till (described as lodgement, sub/supraglacial melt-out, deformation, flow, and sublimation) in terms of particle shape, size, fabric, packing, lithology, and structure.

It is difficult to identify significant shortcomings in this text. Neither of the chapters on 'Glacial meltwater' nor on 'Glacial debris transport' consider fluvial sediment transport, such as suspended sediment or bedload: readers seeking up-to-date material on this subject could refer to the *Annals of Glaciology* proceedings of the Reykjavik symposium on glacial erosion and sedimentation (volume 22). Given the unavoidable profusion of terminology, a glossary might have been helpful, but several summary tables to some extent serve this purpose and the index is comprehensive. There are a small number of typographic errors, the most obvious of which is the substitution of the prefix 'austra' for 'Austre' in Norwegian glacier names.

Inevitably, comparisons will be made between this text and Hambrey's. At 364 pages, Bennett and Glasser's text is longer than Hambrey's (296 pages), but both provide useful and stimulating treatments of glacial geology, and neither is clearly better nor worse than the other. There are some differences in emphasis: Bennett and Glasser tend to emphasise landforms and the results of ice-sheet modelling, whereas Hambrey tends to emphasise the description of sedimentary facies and marine environments, although