open invitation to researchers to custom-design not new artificial iron chelators, but new siderophore chelators.

Great resourcefulness is required to capture insoluble iron. In the fight between mammals and microbes for this metal, it seems that, thanks to lipocalin 2, mammals are the winners — at least for now. ■

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Archaeology

Much rowing for fish

Daniel Pauly

A thousand years ago, there was a shift in the fish diet in England from freshwater to marine species. The relevant case history, derived from picking through leftovers, has a contemporary resonance.

Aelfric (AD 955–*c.* 1020), the Abbot of Eynsham, near Oxford, has in his *Colloquy* a master asking a fisherman why he does not fish in the sea. The fisherman answers, "Sometimes I do, but rarely, because it is a lot of rowing for me to the sea"[1]. Yet, in spite of all the rowing this transition required, Aelfric lived during the period when the fish that the English ate changed from mainly freshwater species to mainly marine ones — principally herring (*Clupea harengus*) and representatives of the cod family, the 'gadids', with cod (*Gadus morhua*) dominating. We know this from a study by Barrett and colleagues, just published in *Proceedings of the Royal Society*[2], which documents the contents of 127 'assemblages' (of old fish bones) from settlements around England, covering a period from the seventh to the sixteenth century.

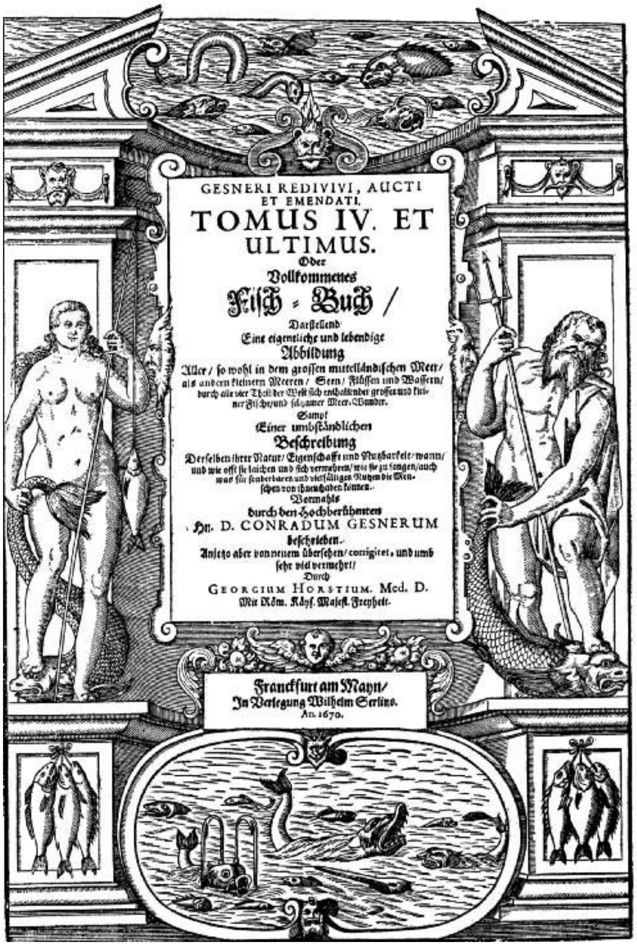
There is a large community of archaeologists and historians working up the material that was left over (in middens, old latrines and so on) from the meals taken by our ancestors. But this literature seems rarely to be used to draw inferences about the historical exploitation of natural resources, at least in the fisheries literature, which is a pity. Using such remains, Barrett *et al.* have identified the origin of intensive marine fishing, and hence a period that should serve as a baseline when evaluating the present state of marine ecosystems — at least in the waters around England.

The transition towards marine species, they suggest, was due to a decline in freshwater species. This decline was perhaps caused by pollution from mills and from agricultural run-off (farming was expanding during that period), and by overfishing of what are, after all, limited resources, relative to the demand from a then-growing urban population.

Barrett *et al.* also point out that the period between 950 and 1050, which brackets the transition from freshwater to marine fishes in the English diet, was relatively warm. Such conditions were not favourable to herring or cod in the seas around England, where both species are near the southern end of their ranges. Hence, only a massive (and historically undocumented) increase of trade with Norway, where the abundance of cod and herring does tend to increase with temperature, could link the observed dietary transition to shifting abundances resulting from environmental change.

In addition, Barrett *et al.* identify a group of 'intermediates' between strictly freshwater species and marine species. These are the flatfishes, which include species that migrate between marine and freshwater environments. And indeed, two flatfish species are mentioned by Aelfric's fisherman, when he lists, upon being asked what he catches in the sea[1]: "Herring and salmon, porpoise and sturgeon, oysters and crabs, mussels, winkels, cockles, plaice and flounders and lobsters and many similar things."

There is another aspect of this study[2] that the authors themselves don't raise, but that I can't resist mentioning here. This is that the analyses not only confirm and narrow down a freshwater-to-seawater transition previously known, though with less precise dates, from other parts of northwestern Europe (see ref. 1 for references), but they deepen our understanding of the last global transition towards the consumption of marine fish. This



Fish for all. Several centuries after the time of Aelfric's fisherman, Conrad Gessner vividly described and depicted various species of European fishes in his *Fisch-Buch*, published in Frankfurt. It was part of the encyclopaedia that encompassed the zoological knowledge of his time.

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transition, in a sense, sent us back to where we were tens of thousand of years ago, before the invention of agriculture, when many (most?) humans were living and migrating along coastlines, relying on shellfish and, starting from Africa, gradually reaching islands as far flung as Tasmania and Tierra del Fuego[3].

These migrations, which brought our African ancestors to Europe and Asia, and thence to Australia and Oceania, and to the Americas, were in most cases followed by migrations inland, driven by hunting of larger animals, and later by agriculture. And interestingly, there is documentation, also from Britain, of a change in diet some 5,200 years ago, at the start of the Neolithic and of British agriculture, from marine animals to inland animals and plants[4].

The transition from eating freshwater fish to eating marine fish, documented by Barrett *et al.*, is thus part of a secondary transition. Marine fisheries catches are declining worldwide[5], and the global demand for fish is increasing. So will another transition back to freshwater fish and inland species occur? Or will we be able to 'row' even more, and maintain our present level of marine fish consumption? ■

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Palaeoclimate

A balmy Arctic

Christopher J. Poulsen

Analyses of sediments retrieved from a drifting ice island suggest that the Arctic Ocean may have been ice free and as warm as 15 °C about 70 million years ago. Therein is a challenge for climate models.

Various lines of evidence show that Earth's climate was much warmer during the Cretaceous period than it is today. Yet that evidence — fossil plants and animals, sedimentary features and geochemical indicators — is sparse, spotty and often inexact, making the magnitude and distribution of Cretaceous temperatures highly uncertain. In a testament to quality over quantity, Jenkyns *et al.*[1] (page 888 of this issue) have produced a single new datum from one of the coldest spots on Earth's surface: their work clarifies the nature of extreme warmth in the Cretaceous, and reveals that the past was radically different from the present.

Ironically, Jenkyns and colleagues' evidence for a warm Arctic climate was retrieved by drilling through an ice island drifting over the Alpha Ridge, one of three submarine ridges that divide the Arctic sea floor (see the map on page 889). Sediments deposited on the modern Arctic sea floor are oxidized, rich in silt and sand, and have only sparse evidence of planktonic life: with nearly 3 metres of sea ice capping its surface, the Arctic Ocean is not a hospitable environment for most organisms. In sharp contrast,

Planetary science

An ill solar wind

On 1 November last year, my father phoned me from Tenerife to ask why he wasn't able to receive the BBC World Service. His concern was not at missing the news bulletins, but rather at what might have happened to his beloved transmitters at Rampisham in the south of England or on Ascension Island in the mid-Atlantic (my father is a chartered electrical engineer). In fact, it was unusually high sunspot activity that was upsetting his reception. Elsewhere in this issue, Daniel Baker and colleagues report exactly how dramatic were the effects on Earth's atmosphere of the solar winds from those sunspots (*Nature* **432,** 878–881; 2004).

Short-wave radio signals are transmitted around the world by refraction and reflection from a layer of ions in the atmosphere; this Appleton layer (named after Edward Appleton, who discovered it in 1926) lies between 150 and 1,000 km above Earth's surface. Higher still, at 3,000–6,000 km and 20,000–25,000 km above the Equator, are the Van Allen belts — two toroidal regions of high-energy ions, mainly electrons and protons, trapped by Earth's magnetic field. The relatively calm region between the belts is a future orbit of choice for artificial satellites. The inner edge of the outer belt also corresponds to the limit of Earth's plasmasphere, which is dense with ions.

Around Halloween in 2003, two spacecraft — the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) and the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) — detected massive distortions in the Van Allen belts and the plasmasphere as the solar winds hit. The gap between the belts was obliterated throughout November, as electrons were 'blown' through into the inner belt, increasing its electron density 50-fold — a situation that has persisted ever since. The effect on the plasmasphere (pictured) was even more dramatic, if shorter-lived. On 28 October, it extended as usual to about 19,000 km above Earth's surface; by 31 October it had contracted to 6,000 km, and in places to as low as 3,000 km, returning to close to normal within a few days.

These changes greatly reduced Earth's natural shields against solar and cosmic radiation. Contact was lost with satellites; astronauts on the International Space Station took cover in a heavily shielded service module; the US Federal Aviation Administration issued its first-ever radiation alert to passengers flying above 7,500 m; and the power system in Malmö, Sweden, failed.

Small wonder, then, that the Appleton layer could not relay the World Service to my father in the Canaries. **Christopher Surridge**