Fig. 18. Reconstruction of the dolphin and shark from the Pliocene of Italy. Image courtesy of Giovanni Bianucci (Università di Pisa).

Death in the Pliocene: dolphin shark attack

Although thankfully relatively rare, shark attacks on surfers often make the news headlines, but there are relatively few documented examples of ancient shark attacks in the geological literature. In a recent paper in *Palaeontology*, Giovanni Bianucci and colleagues from the Università di Pisa, describe shark bite marks present on a well-preserved fossil dolphin skeleton from the Pliocene of northern Italy (Bianucci *et al*. 2010, *Palaeontology*, v.53, pp.457–470). The distribution of the bite marks enabled the authors to interpret the likely sequence of events. The dolphin skeleton examined was originally collected in the later part of the nineteenth century, and shows a series of bite marks on several ribs and vertebrae (Fig. 17). The well-preserved dolphin is assigned to the extinct taxon *Astadelphis gastaldii*. Its attacker is interpreted to have been a shark, possibly 4 m long, with unserrated teeth, and has been assigned to *Cosmopolitodus hastalis*. Based on the behaviour of modern sharks and the distribution of bite marks on the dolphin skeleton it is interpreted that the shark initially attacked the dolphin on its right hand side at the rear (Fig. 18). This bite probably removed a large area of soft tissue and was probably fatal. A second less strong bite was then made on the dorsal area, when the dolphin, mortally injured, probably rolled to the left. The shark then probably released its prey and other sharks and fishes scavenged the torn body of the dolphin.

Exceptionally preserved Eocene fossil bird

Evolutionary studies suggest that some modern groups of birds may have originated back in the Late Cretaceous, but there are very few fossils which can be used to test this hypothesis. However, several different early Eocene units do yield well-preserved bird fossils, which can be used to examine the evolutionary history of this group. Recently Sara Bertelli and co-workers described an exceptionally preserved fossil bird from the Early Eocene Fur Formation in Denmark (Bertelli *et al*. 2010, *Palaeontology*, v.53, pp.507–531). The Fur Formation is a marine diatomite that was deposited in water depths below storm wave base under anoxic or dysaerobic conditions in the lowermost Eocene. Within the formation, calcareous concretions often encompass very well preserved fossils. The fossil bird is a relatively small (estimated to be slightly smaller than a modern day common sand piper which has a length from tail to tip of beak of 18–20 cm) incomplete, but articulated skeleton. As the fossil was enclosed in a calcareous concretion it was exposed by etching away the carbonate using acetic acid, until the bone was exposed when it was protected from the effects of the acid. The preservation is spectacular (Fig. 19), allowing the comparison of this taxon with modern birds. Morphologically it is generally similar to modern day shoreline birds (the charadriiforms), but the hindlimbs show a style of specialization that is more commonly found in modern day perching birds. So whilst modern day charadriiforms are typically wading birds, this new taxon might have spent some of its time perched in shoreline vegetation. Geological units such as the Fur Formation are exceptionally important in the understanding of the evolutionary history of, as in this case, birds and allow a deep time perspective on the history of taxonomic groups that are at present common.

Reconstructing palaeoclimates using bat guano

In areas that lack some of the more traditionally used archives of climate change, alternative proxy indicators become important. Palaeoclimate records are well known from speleothems, but other deposits in caves might also have a climatic significance. Recently Vanessa Johnston and colleagues presented the results of a study into the palaeoclimatic significance

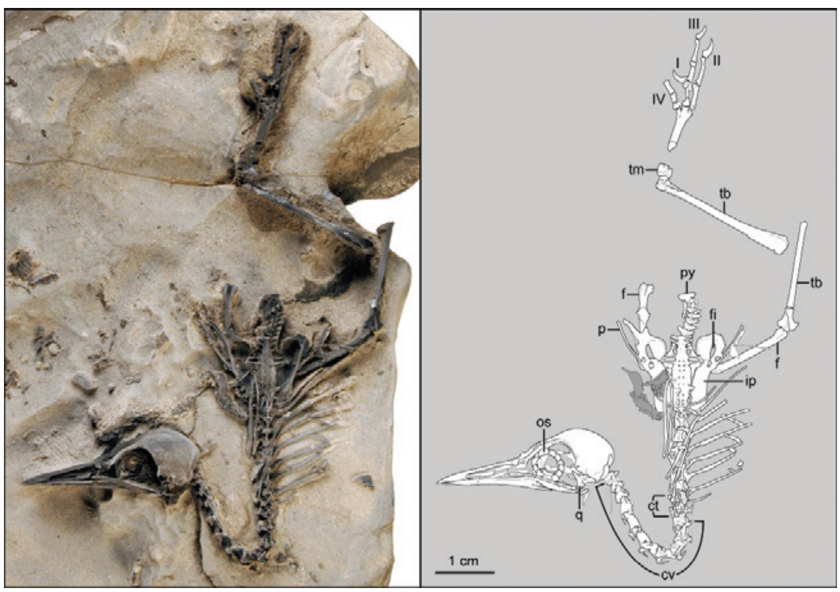

Fig. 19. Exceptional preservation of a fossil bird from the Eocene of Denmark. Image courtesy of Sara Bertelli (Museum für Naturkunde, Berlin).

Fig. 20. The pleasure of field geology. Coring through a pile of bat droppings in Măgurici Cave in northwest Romania to unlock its palaeoclimate record. (Image courtesy of Vanessa Johnston (Natural Science Museum, University of Trento).

of bat guano from a cave system in NW Romania (Johnston *et al*. 2010, *Palaeogeography, Palaeoclimatology, Palaeoclimatology*, v.291, pp.217–227). The study initially aimed at assessing whether bat guano retained a reliable signature of atmospheric $^{36}Cl/Cl$ which can be used as a proxy indicator of solar irradiance. This did not prove to be the case as percolating bat excretions cause considerable mobility of $^{36}Cl/Cl$ through the guano pile. However, detailed radiocarbon dating through the guano pile revealed significant changes in bat habitation in the cave probably as a result of climate change. Radiocarbon dating showed that bats were present in the cave since AD 1195, but not continuously. Bat habitation between AD 1195 and AD 1285 coincided with the Medieval climate anomaly where European temperatures were relatively warm. However, it appears that the bats then vacated the roost site at the start of a regional cold period, linked to the little ice age, returning at approximately AD 1647 when locally the temperature increased. Since AD 1900 there has been an apparent increase in the rate of guano deposition that might reflect increasing temperatures associated with atmospheric warming. Warmer weather probably results in an increased abundance of insects upon which the bats feed. However, coring mounds of cave guano to unlock the palaeoclimate record might not be for the faint hearted! (Fig. 20).

Charcoal significance in geology, botany and archaeology

One of the factors that might suggest that Easter Island wasn't entirely covered by palm forests is the relative absence of charcoal in the sedimentary rock record. Charcoal, most commonly encountered in the UK during summer barbeques, is a relatively common material in both geological and archaeological contexts and scientific papers relating to charcoal consequently appear in a wide range of journals. In an attempt to draw together different workers on charcoal, a major international meeting was held in Belgium in 2008, and key papers arising from the meeting have just been published in a thematic issue of *Palaeogeography, Palaeoclimatology, Palaeoecology*. As an introduction to the thematic issue, Andrew Scott and Freddy Damblon provided an overview of the importance of charcoal (Scott and Damblon, 2010, *Palaeogeography, Palaeoclimatology, Palaeoecology*, v.291, pp.1–10). As illustrated in this conference and the published papers, geologically, charcoal has a range of uses, including chemostratigraphy, dating, fire history, archaeology and in the understanding of the use of charcoal as a fuel.

Landscape evolution and Cenozoic uplift in southwest England

Although originally thought to have been an area of long term crustal stability, the presence of raised beaches and long-term river terrace staircases in southern England have been used to indicate significant uplift in this region. Recently Rob Westaway has applied numerical modelling techniques to unravel the uplift history of southwest England. The uplift history has been unravelled by using a combined dataset from marine and fluvial terraces and data from cave systems. Since the Mid-Pliocene (approximately 3.6 Ma years ago) Westaway estimates that the amount of uplift decreases to the east, with approximately 130 m of uplift in west Cornwall, 135 m in south Devon and 150 m in the Hampshire Basin. However, Westaway also recognized significant Eocene uplift, which increases eastwards, with up to 300 m of uplift in West Cornwall decreasing to 50 m in south Devon. This Eocene uplift can be attributed to magmatic underplating associated with the British Tertiary Igneous Province with, potentially, a mafic layer up to 6 km thick added to the base of the crust at this time in west Cornwall. The influence of uplift on landscape evolution is most pronounced in West Penwith. If one drives west from St Ives along the north coast road towards Lands End there is a very marked flat terrace at approximately 130 m OD bounded inland by what would have been the marine cliffline in the Mid Pliocene (Fig. 23).

Fig. 23. Field photo showing the 130 m surface to the west of St Ives (Image courtesy Bob Westaway).

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