part of Lindow II. In other words, there were at least two bodies in this bog, though the actual total may be three or even four.

Preliminary investigation of Lindow III has revealed no evidence of necrophilous elements such as fly pupae or the beetles which feed on them, which implies that the body was not thrown into an open pool but rather was deliberately pushed under the peaty mud immediately after death. But most intriguing are the results of electron probe X-ray microanalysis of a small piece of skin from one shoulder carried out by Pyatt *et al.*[1] — unlike Lindow II's skin, that of Lindow III contains an extremely high level of copper ions together with an abnormally high amount of aluminium.

The investigators believe that these elements cannot be explained as components of normal skin tissue or as the consequence of ions moving in from the surrounding peat. Instead they think it probable that a foreign substance had been applied to the skin surface, and penetrated through the pores. The copper, in particular, suggests a pigment of some kind. Similar analysis of Lindow II was restricted to a search for vegetable substances rather than mineral ones, but a green fluorescence on the fox-hair band around his arm might be the result of copper enrichment.

Written records of painted Ancient Britons start with Caesar, who mentioned that they "stain themselves with *vitrum*, which gives a blue colour and a wilder appearance in battle". Pliny specified that a vegetable dye was used, "from a plant like a plantain called *glastum* in Gaul" — this has usually been translated as woad, though that plant (*Isatis tinctoria*) bears no resemblance to a plantain. Caesar's word *vitrum*, which normally means glass or crystal, has also been translated as woad since the sixteenth century, when the plant was a popular source of blue dye; but the oldest known occurrences of the woad plant in Britain are from the Anglo-Saxon period.

Pyatt *et al.* therefore think that *vitrum* probably refers not to a plant but to a copper-based pigment of the kind they have detected. However be that may, the fearsome blue figure of the Ancient Briton now takes on fresh credibility. □

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1. Pyatt, F. B., Beaumont, E. H., Lacy, D., Magilton, J.R. & Buckland, P.C. *Oxford J. Archaeol.* **10**, 61–73 (1991).
2. Stead, I. M., Bourke, J. B. & Brothwell, D. (eds) *Lindow Man: The Body in the Bog* (British Museum, London, 1986).

ECHOLOCATION

The cost of being a bat

Jeremy M. V. Rayner

THE energetic expense of being a flying and echolocating bat is surprisingly modest, according to the report by Speakman and Racey which appears on page 421 of this issue[1]. The reason is the happy way in which echolocation, respiration and flight in bats are coupled.

Two years ago, Speakman, Anderson and Racey[2] described measurements of echolocation in resting pipistrelles (*Pipistrellus pipistrellus*) and came to the conclusion that the cost of echolocation is of the same magnitude as the large cost of flight itself. But are the energy expenditures involved in flight and in echolocation additive? To answer the question, Speakman and Racey used the same techniques to determine the energy cost of flight in the pipistrelle, and also in the long-eared bat *Plecotus auritus*. These experiments are valuable because measurements of flight costs in microchiropteran bats are scarce; moreover, they combine two commonly used techniques — respirometry and isotopic measurement of labelled water metabolism — and therefore validate both methods, and avoid some of the pitfalls of either in isolation.

The measured flight energy rate of 1.3 W in the pipistrelle is greater than the estimated 0.9 W for echolocation alone[2], but not by as much as if the costs of the two activities were simply added. To confirm that finding, Speakman and Racey determined how the energy cost of flight in echolocating microbats varies with size, and compared the pattern with that for flight in birds and in non-echolocating megachiropteran bats; there was no significant difference between the two groups. The microbat sample is small (the new measurements double its size), and many of the bird measurements were made in wind tunnels, with all the errors of that methodology, so the close agreement is particularly striking. Echolocation while not in flight might be expensive — although, at rest, call pulse rates are low to compensate — but echolocation in flight apparently adds little or nothing to the total energetic cost.

What is the physiological and biomechanical background to this coupling between locomotion and respiration? Terrestrial mammals tend to synchronize breaths with strides[3] — the stride:breath ratio becomes tighter and closer to 1:1 as the animal moves faster, and the energy cost, the forces generated in locomotion and the oxygen demand all increase. This coupling is absent in running lizards, because of their stance and running gait and the 'slow' physiology of the relevant thoracic muscle[4]. Bramble[3] proposed a 'visceral piston' mechanism by which displacements of the gut of a fast-moving animal alternately expand and compress the lungs, driving respiration, but Alexander[5] has shown that the visceral piston cannot explain the observed phasing of respiration

RÉSUMÉ

Copying connection

DOWN'S syndrome, the most common genetic form of mental retardation, is caused by an additional copy of all or part of chromosome 21. But from which parent does the extra copy arise? Results of a study carried out by S. E. Antonarakis *et al.* (*New Engl. J. Med.* **324**, 872–876; 1991), in which 200 Down's syndrome children were examined with 20 polymorphic DNA markers from the long arm of chromosome 21, reveal that it is maternal in origin over 95 per cent of the time; this proportion is significantly higher than had been estimated from previous studies. The predominance of maternal non-disjunction in the pathogenesis of the syndrome supports the notion that most cases are caused by a defect during oocyte meiosis.

Breathless

SANDS deposited in the Witwatersrand basin in South Africa confirm that the atmosphere when the Earth was young had an extremely low concentration of oxygen, argue J. B. Maynard and colleagues (*Geology* **19**, 265-268; 1991). The claim is made because the sand, dating back to 3,000 million years ago, contains samples of uranite, a mineral that is easily oxidized. The idea had been challenged, because uranite has also been found in young sands in the Indus river. But Maynard *et al.* show that the South African sand has been exposed to extremely severe weathering, which would have permitted an oxygen-rich atmosphere to attack the uranite, whereas the Indian sand is in a relatively pristine condition.

Ends and means

ANY number of actin-capping proteins are known — such proteins bind to the 'barbed' (fast) end of the filament, after which all action at this end ceases and growth or shortening are confined to the other ('pointed') end. But one of them, insertin, behaves differently, for although it binds strongly it allows the barbed end to maintain its equilibrium with the monomer pool and growth remains possible. A. Gaertner and A. Wegner (*J. Muscle Res. Cell Motil.* **12**, 27–36; 1991) have investigated how this comes about, and from an analysis of the kinetics they have been able to exclude any model in which the insertin hops off to allow attachment of a new terminal actin subunit and then rebinds. All of the evidence points to a process whereby the terminal subunit can slide in or out under the bound integrin. This is reminiscent of the growth of microtubules from the captive end on a kinetochore and constitutes a new mechanism of length change, allowing perhaps elongation from the plasma-membrane-bound filament end in the cell.