

collapsed in a squashy heap on the ground.

What I needed was a bit more sensitivity, so I devised a much more sophisticated experiment involving a vice, a razor blade, a 1-foot ruler (white), a saucepan, two desk lamps, and some sheets of red and blue plastic film. I fixed the razor blade in the vice, and balanced the ruler across it. (Have you any idea how difficult it is to balance a plastic ruler on a razor blade?) I then stuck some red plastic film over each of the desk lamps and carefully positioned them so that one shone on each end of the ruler. I forget what the saucepan was for. I then switched on the lamps and both ends of the ruler glowed red as it hung there on the razor's edge. I waited about a minute, during which the ruler remained balanced, and then I suddenly replaced one of the red plastic sheets with a blue one. For about twenty seconds the ruler remained where it was, one end red, the other blue. Then slowly the red end began to sink, and the ruler fell off!

Of course, I could not let the problem drop there. All sorts of questions clamoured to be answered, for instance, what is the order of weight of the colours? I set out to determine this by repeating the balancing experiment a number of times with differently coloured plastics, and after many hours of delicate balancing I managed to discover the relative weights of the colours. In order of weight, lightest first, they are: white, yellow, green, blue, orange, pink, red, black.

I have other experiments under way now, some involving coloured balloons filled with hydrogen sulphide, others involving the production of coloured bubbles from a mixture of detergent and Dulux emulsion, and, although the neighbours are beginning to complain, the results are looking very promising.

WILLIAM HICKMOTT

3 Lambourn Way, Chatham,
Kent MG5 8PU, UK

The hand of *Archaeopteryx*

SIR — Hecht and Tarsitano¹ defend their interpretations of the homologies and morphology of the hand of the protobird *Archaeopteryx* against what they believe are distorting and misrepresentative criticisms by Howgate². However, Howgate is essentially correct on the issues. It is Hecht and Tarsitano who are misreading the data.

The hands of *Archaeopteryx* appear to be very similar to those of their potential ancestors, the predatory theropod dinosaurs. Hecht and Tarsitano suggest this resemblance is only superficial because "the digits of birds must be 2-3-4 based on embryological work"^{1,3-5}, while palaeontologists identify the digits in derived theropods as 1-2-3. Hecht and Tarsitano then ask "do the similarities observed by palaeontologists have greater weight than the evidence derived from

ontogeny by embryologists?"¹. What they fail to note is that Hinchliffe, whom they repeatedly cite in support of their argument, has cautioned that, "the embryological convention that digit I is missing (in bird embryos) is not based on firm evidence"⁶. Even bird embryos never have more than four digits, so there is no way to establish which digits really are present. Such unreliable data cannot be used to disprove the homology of theropod and bird hands, hence the palaeontological evidence does outweigh the embryological work. If theropods are bird ancestors, then the progressive loss of the outer digits from early dinosaurs to derived theropods shows that *Archaeopteryx* and birds retain digits 1-2-3.

Hecht and Tarsitano also continue to defend the possibility that the disarticulated joint between phalanges 1 and 2 on manus digit III is actually a break^{1,3-5}. The problem is that there is no evidence to support this idea. Having examined the Berlin specimen, I can confirm that the particular surfaces at this joint are well preserved. Besides, this joint is present in all five of the articulated hands preserved in three specimens. Howgate was caustically critical of Tarsitano and Hecht's speculations on how these hands came to be "broken"². This is understandable, for the idea that all these hands suffered identical injuries is simply beyond reason.

The criticisms that Hecht and Tarsitano direct at the theropod-bird hypothesis are based more on procedural grounds than on the data. This is annoying since Hecht and Tarsitano are not themselves innocent of such methodological errors. It is also putting the cart before the horse. How the theropod-bird hypothesis has been erected and defended is not nearly as important as its validity. As for the hand of *Archaeopteryx*, palaeontological evidence shows it to be theropodian in design and homology.

GREGORY S. PAUL

Department of Earth and Planetary
Sciences,

The Johns Hopkins University,
Baltimore, Maryland 21218, USA

1. Hecht, M.K. & Tarsitano, S. *Nature* 309, 588 (1984).
2. Howgate, M. *Nature* 306, 644 (1983).
3. Hecht, M.K. *Evol. Biol.* 9, 335 (1976).
4. Tarsitano, S. & Hecht, M.K. *J. Linn. Soc. Zool.* 69, 149 (1980).
5. Hecht, M.K. & Tarsitano, S. *Geobios mem. spec.* 6, 141 (1982).
6. Hinchliffe, J.R. in *Vertebrate Limb and Somite Morphogenesis*, 293 (1977).

Scientific Correspondence

Scientific Correspondence is intended to provide a forum in which readers may raise points of a rather technical character which are not provoked by articles or letters previously published (where Matters Arising remains appropriate).