

sea lilies are the only survivors of a wide diversity of stalked echinoderms which thrived in Palaeozoic seas<sup>10</sup>. Although all of these were heavily calcified, there is extraordinarily little evidence for the occurrence of muscles in most of them, even in their feeding appendages (equivalent to the arms of sea lilies)<sup>7</sup>. It is, however, highly unlikely that their lives were spent in a state of perpetual unresponsive rigidity or flaccidity. The stalk of modern sea lilies illustrates how mutable collagenous tissues, in combination with external agents such as gravity and water movements<sup>2,8,9</sup>, could have conferred mechanical adaptability on these animals.

**Iain C. Wilkie**

Department of Biological Sciences,  
Glasgow Caledonian University,  
Glasgow G4 0BA, UK

**Roland H. Emson**

Division of Life Sciences,  
King's College,  
London W8 7AH, UK

**Craig M. Young**

Harbor Branch Oceanographic  
Institution,  
Fort Pierce,  
Florida 33450, USA

## Music and spatial task performance

**SIR** — In the report by Rauscher *et al.* of an improvement in standard age scores after listening to Mozart (*Nature* 365, 611; 1993), the histogram is drawn over only part of the range of experimental values, and lacks a graphical or text indication of the distribution of the observed results about the mean. However, it is possible to make a rough calculation of the maximum value of the standard deviation from the statistical analysis. Assuming that the distribution of the results is normal, the confidence limits within which the population mean is likely to lie can be found. The probability quoted by the authors that the 'music' and the 'relaxation' conditions are different is 0.002, and from this *t* can be estimated. Since *n* = 36, and the difference in means between the two conditions is 8, the standard deviation must be very small for the 'population' mean estimates not to overlap — certainly less than 8. But IQ-related properties generally are more variable than this.

Admittedly this 'back of envelope' calculation is full of assumptions. But it demonstrates the need for variation, as well as central tendency, to be indicated in comparisons of this type.

**John C. McLachlan**

School of Biological and Medical  
Sciences,  
University of St Andrews,  
St Andrews  
Fife KY16 9TS, UK

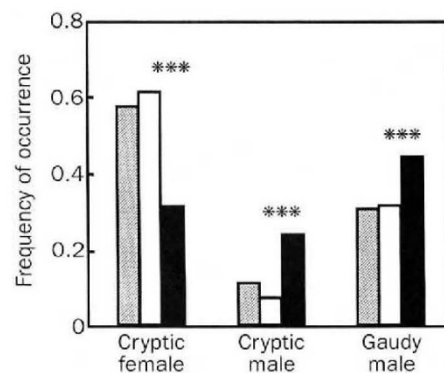
## Risks of alternative mating tactics

**SIR** — Bright colours and conspicuous mating tactics may reduce survival by attracting predators<sup>1,2</sup>. Evolutionary theory proposes that trade-offs between mate attraction and predator avoidance can promote the development of inconspicuous, safer, 'alternative' mating strategies<sup>3,4</sup>. Our study of predation on different male colour morphs of the parrotfish, *Sparisoma radians*, challenges the generality of this supposition.

*S. radians* is a common inhabitant of Caribbean seagrass meadows. Like many other sex-changing fishes, females give rise to different male morphs that display a range of mating tactics<sup>5</sup>. Gaudy males of *S. radians* defend territories in which they actively court and mate singly with females, whereas cryptic males (that resemble females) form small, compact schools ( $\bar{x}$  = 7 fish; *n* = 37 schools) that persistently follow and spawn with single females.

*S. radians* is the primary prey of the yellow jack, *Caranx bartholomaei*, representing 44 per cent numerically and 65 per cent by weight of 991 recognizable prey from 396 jack stomachs we collected in Panama between 1988 and 1992. Before the mid-afternoon spawning period of *S. radians*, females and both male morphs were eaten in relation to their availability in the population. In sharp contrast, both gaudy and cryptic males were found much more frequently than expected in the stomachs of jacks collected during the spawning period. Unexpectedly, cryptic males were 2.3 times more likely to be eaten than gaudy males when compared with their relative abundance. These differences were due neither to size-selective predation by jacks (data and analyses in the figure) nor to differential experience or predator avoidance by older gaudy males: the size range of gaudy males spans that of cryptic males, and large (> 11 cm) gaudy males are actually taken more frequently than small (6–11 cm) ones ( $\chi^2$  = 13.8; *P* < 0.001).

This shift over the course of the day from non-selective predation on sexually inactive *S. radians* to selective predation on spawning males, particularly cryptic males, provides a unique demonstration not only of sexual differences in the predation costs of mating but also of differences in such costs for different male mating tactics. Male mating behaviour, rather than colour pattern, must drive these predation patterns, since both types of males suffered higher predation only when sexually active. Conspicuous courtship and territorial behaviour probably draw attacks on gaudy males. We think that schooling invites predation



upon cryptic males because schools are visually conspicuous and easy to exploit: jacks search for fish hiding in the seagrass and schools of cryptic males produce rich, male-biased 'patches' of prey. Preoccupation with obtaining females and repeated daily spawning by males may also boost their overall risk of being eaten. To conclude, our data strongly support the general prediction that conspicuous male courtship imparts substantial risks<sup>6</sup>. They also reveal, however, that 'alternative' mating tactics by cryptically coloured individuals may actually be the riskiest of those available. This latter result is counterintuitive, given that both schooling and the expression of alternative mating tactics by cryptic morphs are generally thought to lower the relative risk of predation.

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**Kenneth E. Clifton**

**D. Ross Robertson**

Smithsonian Tropical Research Institute,  
Apartado 2072,  
Balboa, Panama

1. Cade, W. H. *Science* **190**, 1312–1313 (1975).
2. Tuttle, M. D. & Ryan, M. J. *Science* **214**, 677–678 (1981).
3. Gadgil, M. *Am. Nat.* **106**, 574–581 (1972).
4. Bell, G. & Koufopanou, V. in *Oxford Surveys in Evolutionary Biology* (eds Dawkins, R. & Ridley, M.) (Oxford Univ. Press, 1986).
5. Robertson, D. R. & Warner, R. R. *Smithson. Contr. Zool.* **255**, 1–26 (1978).
6. Magnhagen, C. *Trends ecol. Evol.* **6**, 183–186 (1991).