in humans, but acknowledge that the mechanisms of this 'hedonic shift' are as yet unclear. They find that chili aficionados are not totally desensitized to the irritants in peppers, but rather have grown to welcome the burning sensations they impart. By contrast, Rozin *et al.*[5] were not able to eliminate the aversion of rats to hot peppers without destroying their capacity to sense chemical irritants, although there have been reports[6] that domesticated animals respond differently under human influence, as do rats through the provision of social inducements between individuals[7].

These considerations do not appear to undermine the potential of pepper products in the protection of cables and other instruments from natural predation.

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Evolution of tetrapod hearing

SIR—Clack's new data[1] on the stapes of *Acanthostega* are interesting, but there are three objections to the conclusion that a tympanum is absent in primitive tetrapods.

First, theoretical work on the possible function of the Rhipidistian spiracular pouch as a pressure transducing device in water[2] shows that, if a gas bubble is trapped in the spiracular pouch, it will be in close proximity to the ear so that any pressure change will result in near-field water motion that can act on inner-ear epithelia sensitive to it. This suggests a spiraculum closed by a tympanic membrane.

Second, there is evidence that, in the Coelacanth *Latimeria*, the epithelium of the inner ear is probably homologous to the basilar papilla of tetrapods[3,4]. Moreover, if the spiracular pouch of *Latimeria*, which is closed by a thin membrane[5], is filled with gas, the theoretical prediction of van Bergeijk[2] for Crossopterygians would also apply to *Latimeria*. That would imply that this evolution took place in water and was perfected in parallel with the pressure-transducing mechanisms found in some bony fish[2,6].

Both theoretical considerations and the data on *Latimeria* thus favour the view that the spiracle was closed by a tympanic membrane in Crossopterygian fish. The lack of evidence for such a membrane in fossils is of little relevance, given the slim chance that a membrane will fossilize at all.

Finally, there is the question of the transformation of a middle ear able to perceive pressure changes in water into one that performs the same task in air. In principle, this can be done for the acquatic middle ear I have postulated provided that there is a sound-conducting element to transmit the displacement of the tympanic membrane to the inner ear. Van Bergeijk[2] proposed the hyomandibular bone for this task. The insertion of this ossicle may have happened in some tetrapods without loss of the tympanic membrane. Given that some aspects of the sound-conducting perilymphatic labyrinth and the basilar papilla were already present[4], it seems reasonable to assume that any change improving impedance matching, even by as little as one decibel[7], would minimize the otherwise inevitable loss of 99.9 per cent of all energy impinging on the inner ear[8] and so help to maintain aquatic hearing in a terrestrial animal.

In summary, I argue that we cannot dismiss the possibility that the otic notch of *Acanthostega* was, as in some Crossopterygian fish, covered by a tympanic membrane and that the slightest benefit in impedance-matching provided even by a massive stapes might have been advantageous[9]. The exciting aspects of *Acanthostega* is the unmistakable connection of the stapes with the otic notch and with the ear as a whole, rather than with the jaws, as is the case with the hyomandibular bone of Crossopterygian fish. Such a changed relationship of the hyomandibular bone is a necessary prerequisite for this bone to start a new function as a sound conducting element in the terrestrial middle ear. In essence, the new finding can be taken to support the old notion of a functional transformation of the hyomandibular bone[10], even if the stapes of *Acanthostega* performed that new function only badly.

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SIR—Clack (*Nature* **342**, 425–427; 1989) describes a stout element in the otic region of the Devonian tetrapod *Acanthostega* as the earliest-known stapes. The author maintained that there was no tympanum in this form, but rather a spiracular opening, and that the element helped to control palatal and spiracular movements during ventilation. As the author allows, this function is comparable to that ascribed to the hyomandibular in air-breathing fishes, and in osteolepiform sarcopterygian fishes (the best-supported sister-group of tetrapods). As no auditory function is demonstrated for the element, and as the interpretation presented is that it acted like a fish hyomandibular, we believe that this bone should be called a hyomandibular, not a stapes.

Given the general agreement that the hyomandibular and stapes are homologous, the use of the term hyomandibular in *Acanthostega* more accurately reflects the function of the element and is phylogenetically consistent. In an analagous situation, we do not refer to the quadrate of certain mammal-like reptiles as an incus before it becomes incorporated into the middle ear.

The name stapes is perhaps best restricted to cases in which it is clear that the bone is contributing to the auditory mechanism by supporting a tympanum — the derived condition within tetrapods could then be stated as "presence of a rod-like stapes supporting a tympanum and having an auditory function". The identification of the element in question as a stapes because it occurs in a tetrapod is circular and therefore is not in itself an adequate criterion.

What appears to have been found in *Acanthostega* is not the earliest-known stapes, but retention of the primitive condition — the continued presence of a hyomandibular in a very early and very primitive tetrapod.

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Levitating gyros too good

SIR—The results of Hayasaka and Takeuchi (*Phys. Rev. Lett.* **63**, 2701–2704; 1989) are indeed remarkable, not least because of the minimal scatter in their data (see Fig. 2; S.H. Salter, *Nature* **343**, 509; 1990). If the errors had been accurately estimated, one would expect approximately one-third of the data points to lie more than one standard deviation from the fitted lines. Yet of 31 data points, none is so far away: the probability of observing zero when one expects about ten is $\sim 4 \times 10^{-5}$. Why did neither the authors nor, apparently, the *Physical Review* referees, address this question? I expect most undergraduate physics students to spot such blunders!

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