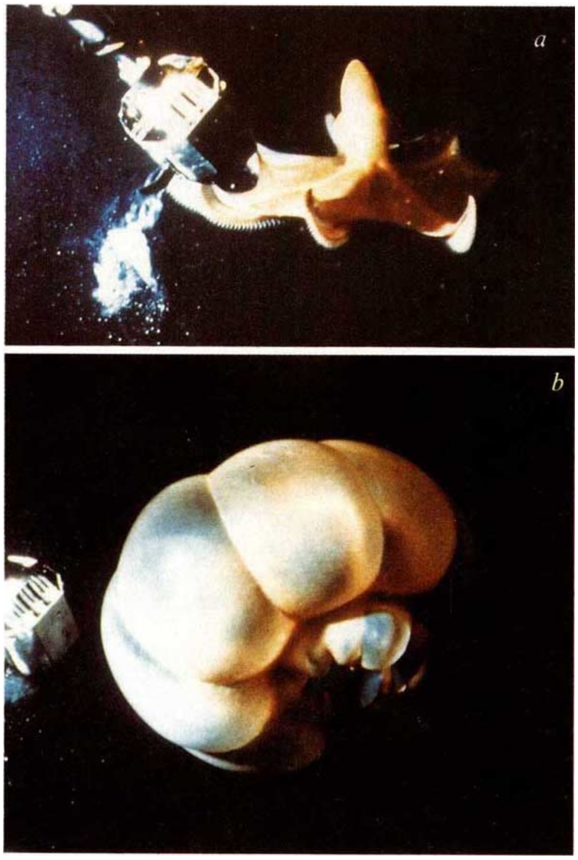
Octopod 'ballooning' response

SIR — Very little is known about the deep-sea octopuses of the order Cirroctopoda[1]. Observations of live animals were rare until recently because aquarium studies were possible only in the case of the flapjack devilfish *Opisthoteuthis*[2]. Deep-sea cameras subsequently allowed cirrate octopods to be photographed in their natural habitat[3,4]. We have now observed these animals from a submersible, providing the possibility for interacting with individual cirrates. This avenue for investigation could be fruitful in investigating the behaviour of other free-ranging, deep-sea animals.

During the French CALSUB programme[5] in February–March 1989 on board the research vessel *Le Suroît* in the southwestern Pacific, the crew (including M. Rio) of the diving saucer *Cyana* (SP 3000) saw a cirrate octopod (possibly of the genus *Cirrothauma*) off the northeast coast of Lifou Island (Loyalty Ridge) at a depth of 2,880 metres, just above the sea floor. The animal hovered in the horizontal 'inverted umbrella' position (see figure) previously observed[3]. The submersible was brought sufficiently close to touch the animal with the grab arm. This contact triggered a spectacular reaction, which we describe as the 'ballooning' response — from the inverted umbrella attitude (*a* in the figure) the animal changed in about 15 seconds to a pumpkin shape. The process is summarized below, based on our video recording of the animal.



a, A cirrate octopod hovering in midwater in the inverted umbrella position; the grab arm of the submersible has not yet made contact with the animal. *b*, The ballooning response at its peak, the outer web being fully extended, with arm tips reappearing at lower right. Note the proximal parts of the muscular arm trunks which are bent to form arcs (visible through the extended membranes).

During hovering, the outer-arm web was not fully expanded so that the so-called intermediate web was visible as a vertical connection between the main (outer) sheet of the web and the curved muscular arm trunk (*a*). On contact, the animal reacted by changing the curvature of the arms and fully expanding the web so that the arm crown took on a bell shape. The arm trunks continued to curve inwards while the web sectors lying between the arms bulged out strongly; the intermediate-web bands became high dividing membranes above each arm trunk. The arm tips then disappeared beneath the web (7 seconds after the beginning of the response). The ballooning increased for another 10 seconds, the curved arms being brought together more closely. The arm tips finally reappeared due to a peristaltic wave generated by a coordinated arm flexion moving backwards from the arm tips (*b*). While the animal remained stationary, some water must have escaped as the surface of the web smoothed; 30 seconds after the beginning of the response, the grooves between the web sectors disappeared and the body of the animal reappeared above the shrinking web sphere. After 43 seconds the fins, which had remained immobile during hovering and ballooning, were lifted, starting the backwards swimming movement: this completely 'emptied' the trailing arm crown.

We can only guess the function of the ballooning response. In an environment where downwelling light does not penetrate, tactile stimuli are likely to be important. The 'transformation' achieved by the ballooning response might have a stunning or disorientating effect on a potential predator in a first (possibly accidental) contact with the cirrate. The ballooning web, by providing 'imprecise' tactile cues, could thus be a defence mechanism.

S. V. BOLETZKY

URA 117 CNRS,
Observatoire Océanologique de Banyuls,
Laboratoire Arago,
66650 Banyuls-sur-Mer,
France

M. RIO

Centre Sciences de la Terre,
Université de Lyon I,
69622 Villeurbanne, France

M. ROUX

Laboratoire Sciences de la Terre,
Université de Reims,
BP 347 et URA 157 CNRS,
51062 Reims, France

1. Young, J. Z. *Phil. Trans. R. Soc.* **B325**, 189–237 (1989).
2. Pereyra, W. T. *Pacif. Sci.* **19**, 427–441 (1965).
3. Roper, C. F. E. & Brundage, W. L. *Smithson. Contr. Zool.* **121**, 1–46 (1972).
4. Pearcy, W. G. & Beal, A. *Deep-Sea Res.* **20**, 107–108 (1973).
5. Roux, M. *et al. Bull. Soc. géol. France* **162**, 675–685 (1991).

Vortex air rings

SIR — Commenting on Aref and Zawadzki's simulation-based studies on the linking of vortex rings[1], J. D. S. Jones in News and Views[2] asked whether the vortex-linking could be done experimentally. I recently observed and photographed underwater 'air rings', which I believe to be an example of this linking.

In November 1991 I rode in the submarine *Atlantis*, a commercial sightseeing submarine based at Kailua-Kona, Hawaii. A diver accompanied the submarine to a depth of about 50 feet, feeding fish, watching for sharks and blowing air rings. The diver was facing up when he produced each air ring, so each ring rose purely vertically. On one occasion (left-hand photo over page) the diver produced two air rings in quick succession, followed by a third. As he blew a fourth ring (right-hand photo) and destroyed it with his hand, the second ring caught up with the first and linked with it. The process was fascinating to watch: one portion of the second ring began to rise more quickly than the rest, as if the first ring were pulling it towards it. The corresponding portion of the first ring also began to rise more quickly than the rest of its ring, although not so markedly as in the second ring. Soon the second ring caught and linked to the first ring, forming a single large ring of irregular shape. After a few more seconds the situation became more complicated, with the large ring becoming unstable and the third ring catching up with the other two.

Although this technique seems to be

Underwater air rings. Left, three rings rising vertically; right, top rings become linked.

limited to studying vortices that travel in parallel planes, it does show that vortex linking is easy to demonstrate experimentally.

RONALD L. RIVEST
MIT Department of Electrical Engineering and Computer Science, Cambridge, Massachusetts 02139, USA

AREF REPLIES — I had previously seen pictures of these 'air-rings' (usually called 'vortex ring bubbles' in the fluid mechanics literature) that divers can produce. There is a recent paper by Lundgren and Mansour[3] where such bubbles are studied and these authors mention a photograph in *National Geographic Magazine*[4]. Apparently, whales and dolphins also blow the rings.

I am not sure that what Rivest saw is the same process of linking that we reported in our paper[1]. In our study, the intermediate state of interest consists of two rings connected as successive links in a chain, whereas he reports the formation of 'a single large ring of irregular shape'. The linking that we were interested in is a variant of the more general phenomenon of reconnection, where two rings can, indeed, form a single, irregular ring for a while. I think what Rivest is seeing (see right-hand photo) is more closely related to the type of intermediate state that we have in our Fig. 1*d–e* rather than the linked state in our Fig. 4*d*. We actually believe that the ellipticity of the initial rings is essential for the process. In our simulations we did not succeed in producing linking starting from two circular rings.

I am not sure how one would blow elliptical vortex ring bubbles, but if it were possible, it would make a spectacular real-world analogue of the numerical solutions.

HASSAN AREF
Institute of Geophysics and Planetary Physics, University of California, San Diego, La Jolla, California 92093, USA

1. Aref, H. & Zawadzki, I. *Nature* **354,** 50 (1991).
2. Jones, J. D. S. *Nature* **354,** 21 (1991).
3. Lundgren, T. S. & Mansour, N. N. *J. fluid Mech.* **224,** 177 (1991).
4. Earle, S. A. & Giddings, A. *Natn. geogr.* **149,** 578 (1976).

Neanderthal dates debated

SIR — We cannot agree with some of Stringer and Grün's speculations[1] stemming from the redating of the late Neanderthal from Saint-Césaire. We wonder why a thermoluminescence date of 36,300 years before present (BP), several thousand years older than previously thought, can justify the contention that "Neanderthals probably went out with a whimper, not a bang"[1].

The new date means that 12,500 years or more may separate Saint-Césaire from Cro-Magnon, the site of the earliest definitive 'modern' human crania from western Europe[2], if these burials are Upper Perigordian and not Aurignacian, as has been suggested[3]. How can this new, expanded timespan show an ancestor-descendant relationship to be chronologically untenable in western Europe? We believe that the western European dates may provide the best evidence for a region where there was a transition to modern populations with significant local genetic input from Neanderthals, in that there is now more than enough time for the process of evolution due to natural selection to proceed at a reasonable rate. For instance, the rates of change between Neanderthals and early 'modern' Europeans for a truly diagnostic feature such as anterior tooth size are small relative to other recent evolutionary changes. These rates are one-half those between early and late Upper Palaeolithic samples and one-tenth the rate of change between Europeans of the Mesolithic and Neolithic who are only 3,500 years apart (D.W.F., manuscript in preparation).

There is also no evidence that indicates a "gradual displacement [of Neanderthals] to more marginal and less favorable environments, where their dwindling numbers would have suffered greater attrition from the vagaries of fluctuating climates and food supplies as well as disease"[1]. Earlier, from the same evidence Stringer argued just the opposite[2], that Neanderthals persisted into the Upper Palaeolithic ". . . not just in backward or isolated areas either. Saint-Césaire is, in fact, situated in a region densely occupied during the Middle and Upper Palaeolithic." The marginalization interpretation would not seem to apply to the Neanderthals of western Europe, any more that it applies to the Neanderthals of western Asia, where Neanderthals and their so-called 'modern' contemporaries lived for a period estimated to be as long as 60,000 years, manufacturing identical industries and using the same technology to do so, applying their tools in similar ways (the microwear is identical), burying their dead with the same customs, hunting the same game species and butchering them the same way. Here, these two supposed human species are known to coexist with archaeologically indistinguishable adaptations for a very long time and there is no evidence of banging or whimpering. There simply are no data to support the assertion of a cultural, biological or ecological marginalization of Neanderthals.

Stringer and Grün suppose that Neanderthals may have been a different species, but then they assert that the species "were probably sufficiently closely related to allow hybridization", saying that "mitochondial DNA studies have been used to suggest that there is no trace of a genetic input from Neanderthal females in recent European samples". (We know of no discovery of Neanderthal mitochondrial DNA.) To make sense of these contradictory claims one would have to assume that this new understanding of species is not based on reproductive isolation, and that the "hybridization" was between Neanderthal men and the women of the "anatomically modern" humans who (presumably) replaced them.