Signalling in planktonic larvae

SIR — Berridge[1] points out that cyclic AMP and inositol trisphosphate messenger pathways may interact to enhance odour discrimination. Readers may be interested to learn that a similar interaction can apparently enhance chemosensory responsiveness to chemical signals recognized as morphogens by planktonic marine invertebrate larvae in the ocean.

Many benthic marine invertebrates reproduce to yield large numbers of small larvae that are dispersed in the plankton. In several species, substratum-specific settlement of larvae from the plankton and metamorphosis are induced by chemosensory recognition of exogenous chemical signals associated with specific recruiting surfaces. Site-specific settlement and metamorphosis of *Haliotis rufescens* (red abalone; gastropod mollusc) larvae are regulated by two convergent chemosensory pathways[2,3]. The inducer recognized by these larvae is a GABA-mimetic peptide produced by the algae on which the larvae are induced to settle[4]; binding of the morphogenetic signal molecule by externally accessible chemosensory receptors is apparently transduced by a cyclic AMP- and calcium-dependent pathway leading to the induction of settlement and metamorphosis[3,5].

Lysine dissolved in sea water acts through a separate pathway to increase post-receptor responsiveness of the larvae to the required morphogenetic signal by as much as 100-fold. The binding of lysine to its receptor is transduced by a receptor-associated G protein, which in turn controls the activation of a diacylglycerol-stimulated, calcium-stimulated protein kinase C (refs 2, 3, 6). This interaction between the morphogenetic (cyclic AMP-dependent) and regulatory (inositol trisphosphate/diacylglycerol-dependent) chemosensory pathways, by increasing the responsiveness of the larvae to their morphogenetic cue when threshold concentrations of facilitating amino acid are detected in the water column, may thus increase the propensity of larvae to settle on the recruiting algae in potentially favourable (for example, nutrient-rich) areas[2,3,5]. Such interactions between larval signalling pathways, controlled by different cues from the environment, could provide a capacity for fine-tuning the recognition and selection of habitats favourable for metamorphosis, and could help explain the temporal and spatial variability in recruitment of some marine species.

Daniel E. Morse
Marine Biotechnology Center,
University of California,
Santa Barbara, California 93106, USA

1. Berridge, M. J. *Nature* **361**, 315–325 (1993).
2. Baxter, G. & Morse, D. E. *Proc. natn. Acad. Sci. U.S.A.* **84**, 1867–1870 (1987).
3. Morse, D. E. in *Abalone of the World* (eds Shepherd, S. A. *et al.*) 107–119 (Blackwell, Oxford, 1992).
4. Morse, A. N. C. *Systematics Ass. Spec. Vol.* **46**, 385–403 (1992).
5. Trapido-Rosenthal, H. G. & Morse, D. E. *Proc. natn. Acad. Sci. U.S.A.* **83**, 7658–7662 (1986).
6. Baxter, G. T. & Morse, D. M. *Biol. Bull.* **183**, 147–154 (1992).

Scientific Correspondence
Scientific Correspondence is intended to provide a forum in which readers may raise points of a scientific character. They need not arise out of anything published in *Nature*. In any case, priority will be given to letters of fewer than 500 words and five references.

Not the earliest solar eclipse

SIR — Semitists and historians of astronomy have devoted much discussion to the Ugaritic text RS 12.061 (see ref. 1), generally interpreting it as an account of a solar eclipse, thought to have occurred in the fourteenth or the thirteenth century BC (refs 2–5). In the course of preparing a new edition of the Ugaritic texts dealing with various aspects of ritual, we have concluded that the text cannot refer to a solar eclipse.

The text and our translation are shown in the box.

(1) b tt . ym . ḥdṯ	During the six days of the (rituals of) the new moon of
(2) ḫyr . ʿrbt	(the month of) *Ḫiyyāru*, the sun
(3) špš ⌈ . ⌉ tġrh	set, her gatekeeper (being)
(4)ršp	*Rashap.*
Verso	
(5) ⌈w à⌉ dm ⌈ . ⌉ tbqrn	The men (?) shall seek out
(6) skn	the prefect.

Ugaritic grammar indicates that *b tt ym ḥdṯ ḫyr* should not mean "on the sixth day of the month of *Ḫiyyāru*" (which would be *b yrḫ ḫyr b ym ṯdṯ*), but "during the (first) six days of the new moon (rituals) of the month of *Ḫiyyāru*". This was generally perceived by de Jong and van Soldt[2,3], who noted that *tt*, if a number, must be cardinal, but who chose on no explicit basis to interpret *b tt* as referring to the hour of the day. They interpreted the text as referring to a solar eclipse, though they provided no new philological data to support that interpretation. Indeed, there is no evidence from any of the ancient Semitic languages for the verb *ʿrb*, literally "to enter", having the meaning "to be eclipsed" with "sun" as its subject. The idiom consisting of *ʿrb* plus "sun" is rather the standard idiom for the Sun setting[4]. A relic is preserved in Hebrew where the verb *ʿrb* has been replaced by *bwʾ*, but the noun *ʿereb*, "evening", has been retained.

The simple meaning of *b tt ym ḥdṯ* and of *ʿrbt špš* is therefore that the Sun "set" on the first 6 days of the month in question. This fact in itself being of no significance, the reason for the writing in clay of this text appears to lie in the next clause, according to which the deity *Rašap* was the Sun's gatekeeper as she entered the underworld. *Rašap* is known to be one of the primary deities of the underworld, the West Semitic equivalent of Mesopotamian *Nergal*. The basic question regarding the interpretation of this text is to identify this deity serving as the Sun's gatekeeper. The only solution for which there are presently any data of which we are aware is that which identifies *Nergal*/*Rašap* with Mars[2–4].

We interpret the text as meaning that Mars was visible at the setting of the Sun during the first 6 days after first visibility of the new Moon in the month of *Ḫiyyāru* in an unstated year (a dating system that included the notation of the year is not yet attested at Ugarit), after which the planet was no longer visible. According to this hypothesis, the planet Mars would have appeared in the west with the lunar crescent on the first day of *Ḫiyyāru*, and would have been visible for each succeeding evening until the seventh, when it was not visible. The heliacal setting would, therefore, have occurred on the sixth day. Because within the period ~1400–1200 BC there are about five heliacal settings of Mars in the part of the year corresponding to the month of *Ḫiyyāru*, the text cannot be uniquely dated.

Thus our hypothesis, which insists on the 6-day duration of the observed event, is significantly different from those that consider the possibility of the text referring simply to the heliacal setting of Mars (for example refs 2–4).

D. Pardee
The Oriental Institute,
N. Swerdlow
Departments of Astronomy and Astrophysics and History,
University of Chicago,
Chicago, Illinois 60637, USA

1. Virolleaud, C. *Syria* **28**, 25–27 (1951).
2. de Jong, T. & van Soldt, W. H. *Jaarber. Ex Oriente Lux* **30**, 65–77 (1987–88).
3. de Jong, T. & van Soldt, W. H. *Nature* **338**, 238 (1989).
4. Walker, C. B. F. *Nature* **338**, 204–205 (1989).
5. Mostert, R. *Nature* **341**, 112–113 (1989).