

from around 2200 to 1200 BC, have been proposed for the Exodus tradition and emergence of Israel in Canaan, based on different interpretations of the archaeological dataset (ref. 16). Nevertheless, although they are powerful tools, archaeology and pottery are not the sole avenues that can be used to unravel the human past. Environmental events, high-precision radiocarbon dating and precise regional dendrochronologies may provide information unobtainable through archaeological associations¹⁷. New, high-precision ¹⁴C data series of XVIIIth Dynasty Egypt and Levantine Middle Bronze Age

sites are required. Wiggle-matching linkages with the Aegean dendrochronology¹⁴ may lead to truly absolute dating.

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sea water.

In the case of *N. succinea*, we identified inosin as the main component of the ERP-complex. (We are investigating the complete composition of the ERP complex separately.) We are now trying to identify the SRP of *N. succinea* and the ERP of *P. dumerilii*, so that we can compare males and females in the same species. Our preliminary results suggest that both uric acid and inosin are species- and sex-specific. They represent the first identified gamete-release pheromones in marine invertebrates. Remarkably, the purine ring system has not as yet been reported to be a feature in sex pheromones.

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Marine gamete-release pheromones

SIR — In contrast to the large body of experimental evidence for the existence of sex pheromones in marine invertebrates, only a few chemical structures of these compounds have been elucidated^{1,2}. Here we report the isolation and identification of two gamete-release pheromones of marine invertebrates. By bioassay-guided fractionation and purification, we identified uric acid as the sperm-release pheromone of *Platynereis dumerilii* and inosine as the main component of the egg-release pheromone complex of *Nereis succinea* (Annelida, Polychaeta). These compounds contain the purine ring system, which has not as yet been identified in sex pheromones of any species.

Within the marine invertebrates, the Nereidae are well suited for chemical investigation of sex pheromones because of their distinctive breeding behaviour. In both species, reproduction strictly depends on an exact spatial and temporal synchronization. High population densities within restricted areas and the synchronization in time are responsible for the formation of swarms.

The reproduction process occurs as follows: (1) in these swarms mate recognition is achieved by chemical signals³. (2) At the moment of recognition the male discharges the egg-release pheromone (ERP)^{4,5}. (3) The female is stimulated to swim with high velocity in narrow circles surrounded by swarming males. After an

induction period of 10–40 seconds the female spawns. The discharged egg cloud contains the sperm-release pheromone (SRP). (4) Males achieve immediate fertilization by circling around the eggs and emitting sperm clouds.

It is known that the coelomic fluid of the opposite sex is the source of the gamete-release pheromones^{6,7}. With reference to the well-examined volatile sperm attractants in marine brown algae⁸, we first investigated volatile compounds of the coelomic fluid. These studies led to the elucidation of substances responsible for mate recognition in both species^{2,3,9,10}. However, none of these compounds elicited the gamete release, in contrast to the natural pheromone-containing coelomic fluid. Hence, in the present study we analysed the non-volatile, water-soluble compounds of the coelomic fluid for pheromonal activity.

To follow the target substances during isolation and purification, we developed a reliable behavioural bioassay. We injected samples with a microlitre syringe just in front of a mature specimen swarming in a glass dish. The release of a visible sperm cloud or loss of the total amount of eggs represented a positive pheromone response. We tested chromatographic fractions of the coelomic fluid both singly and in combination. (Details of methods are obtainable directly from the authors.)

In the case of *P. dumerilii*, we identified the bioactive single peak fraction finally obtained as uric acid. This SRP is effective at a threshold concentration of 0.6 μ M (solubility of uric acid in sea water, 32%, pH 8.2, 23 °C: 180 μ M). We measured the total amount of uric acid in the coelomic fluid of one female as 1.0 ± 0.1 μ g. When we dissolved this quantity of uric acid in 2 cm³ sea water (egg cloud volume) we found an actual pheromone concentration of 3.0 ± 0.3 μ M. This five-fold excess is essential to ensure successful fertilization taking into account natural conditions such as the effects of dilution by turbulence and currents in

A silicon sensor for SO₂

SIR — Initially synthesized about 30 years ago, porous silicon is now attracting considerable attention because it both photoluminesces¹ and electroluminesces² in the visible portion of the optical spectrum. Although much of the recent interest in porous silicon is related to the possibility of generating an electroluminescent device having applications in the areas of display technology and information storage, we here suggest that the photoluminescent properties of this material make it attractive as a highly sensitive sensor for sulphur dioxide. Our suggestion is based on our recent observation that the photoluminescence of oxide-coated porous silicon is rapidly and reversibly quenched on a selective basis by gas-phase SO₂.

It is well documented that exposing freshly etched porous silicon to various organic reagents results in non-selective quenching of the observed photoluminescence³. We have also previously reported selective quenching by gas-phase and aqueous Brønsted bases when a thin surface oxide is present⁴. The observed quenching is reversible; subsequent exposure to a Brønsted acid restores the photoluminescence to its initial intensity. Partial quenching of the photosensitive luminescence by Brønsted bases results in a blueshifting of approximately 40 nm in the emission maximum. As with the photoluminescence intensity, exposure to acid returned the emission maximum to its initial position. The base-quenching/acid-restoration cycle can be repeated many times.

We now report that SO₂ gas is another effective quencher of oxidized porous sili-

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