Kuwait oil lakes as insect traps

SIR — During the Gulf War in early 1991, Iraqi occupation forces blasted oil wells and pipelines in the desert of Kuwait, forming hundreds of oil ponds. These still exist[1], and continue to trap a variety of different animals[2]. From October 1994 to May 1995, one of us (J.Z.) regularly visited two ponds north of Kuwait City, at Al-Muddayarah, along the road to As-Subiyah (47° 55′ E, 29° 40′ N)[2]. Reductions in the oil level due to evaporation and percolation into the ground created distinct bands of insect carcasses at their edges. Bands of dead dragonflies, damselflies and ground beetles may reflect arrivals of migrating insects in autumn and spring. We witnessed such arrivals of aeschnid dragonflies in October 1994 and February 1995, many females being trapped while attempting to lay eggs in the oil. We suggest that these insects are attracted by the strong polarization of light reflected from these pools.

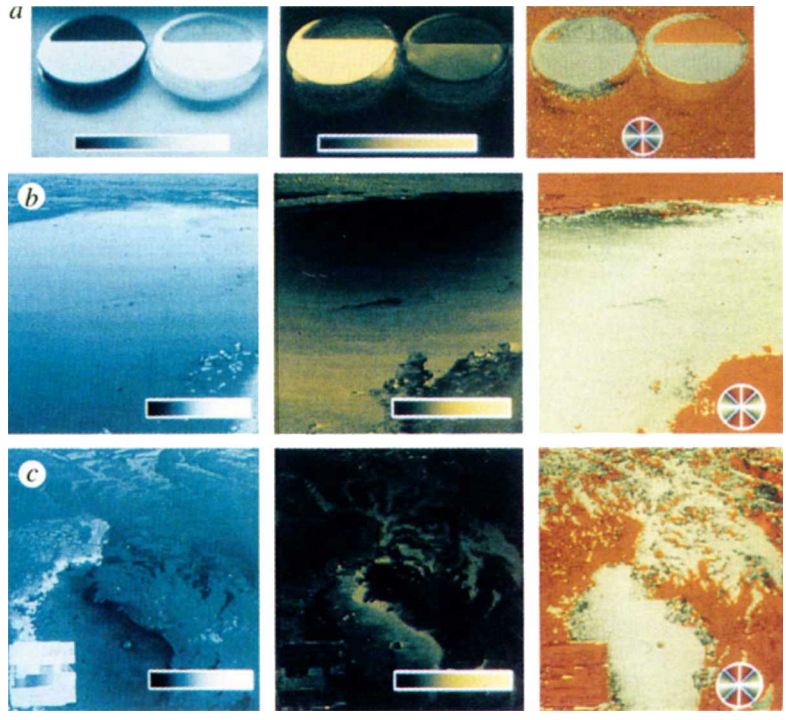
Oil lakes trap different animals in different ways. Terrestrial animals become entrapped during foraging or migration, or they may be attracted to the water that overlies the tar during winter and spring. Water-seeking birds and many flying insects land directly on the surface or at the edge of the oil lakes. Water insects can detect water by means of the horizontal polarization of light reflected from the water surface[3,4], and while some insects may crash into the oil, others are clearly attracted to the lakes.

We have compared the polarization characteristics of crude oil and transparent water surfaces by video-polarimetry (*a* in the figure). Oil shows a higher contrast in intensity than water between shaded and diffusely illuminated regions. Light emanating from water is vertically polarized when refracted light dominates[5] (*a* in the figure, top half of dish) and horizontally polarized for surface-reflected light[6,7] (bottom half of dish), but light is not diffracted from oil, penetrating light being absorbed by the dark pigments. Light from an oil surface is therefore always more or less horizontally polarized. For insects that see in the ultraviolet, oil surfaces closely mimic the polarization and reflectivity characteristics of water, differences in transparency being restricted to the visible spectrum. Even for animals sensitive to polarized light at visible wavelengths, oil lakes could appear as exaggerated water surfaces (supernormal stimulus).

The surfaces of real oil lakes, in both summer and winter (when rainwater and oil form complex surface features), are highly polarized, whereas the degree of polarization of sand-covered tar is very low (*b*, *c* in the figure). The direction of polarization is horizontal, while areas with rough surfaces reflect vertically polarized light. The high degree of polarization where oil and water meet (*c* in the figure, centre) again demonstrates the effect of transparency: the sandy bottom lies in the shadow of a floating oil slab and horizontally polarized reflection thus dominates. The degree of polarization is reduced in bright areas of water puddles (*c* in the figure, lower left), because the polarization of surface-reflected light is degraded by the refracted, vertically polarized light returning from the sandy bottom.

The Kuwait oil lakes can be considered as an upscaled version of Schwind's experiments[3,4]. As disastrous as they are, they offer unique research opportunities. They are massive animal traps that could be used to monitor the distribution, seasonal occurrence and movements of desert animals. Because they also mimic water surfaces, they attract water insects and birds on migration that are otherwise difficult to record, and could help to monitor changing migration patterns caused by the draining of marshlands in southern Iraq.

Like the contemporary oil lakes in Kuwait, the palaeontologically important Rancho La Brea tar pits at Hancock Park in Los Angeles[8], and tar pools at Starunia in western Ukraine[9,10], trapped a variety of water insects and birds during the Pleistocene epoch. Most animals found at Rancho La Brea and Starunia are thought



a, The polarization characteristics of crude oil (left dish in each picture) and water (right) measured with a video-polarimeter. The top half of the dishes was in the shadow, the bottom half was illuminated by unpolarized diffuse light from an overcast sky. Insets show the grey-level and colour codes for intensity, degree of polarization and **E**-vector alignment. Left, brightness distribution. Brightness, *I*, varies from black ($I = 0$) to white ($I = 255$). Centre, degree of polarization, *d*. Black, $d = 0\%$; bright yellow, $d = 100\%$. Right, direction of polarization. Red symbolizes vertical, green, horizontal **E**-vectors. Viewing direction was 55° to the vertical. *b*, Reflection–polarization pattern of oil lake on 9 May 1995 looking north and at 75° relative to the vertical. The surface consisted of smooth, clean, homogeneous, low-viscosity oil. *c*, Oil lake on 15 January 1995 looking east and at 70° relative to the vertical. The surface is not smooth. Rainwater has accumulated during the winter months; slabs of oil swim on the surface of the water and sand has settled on some of them. The scenes were filmed with a video camera through a linear polarizing filter which was turned in 15° steps during recording. The films were subsequently digitized frame-by-frame and the modulation of the intensity was determined from a series of video pictures as a function of the alignment of the polarizer.

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to have stumbled accidentally across these tar pools, but we suggest that some animals were deceived by and attracted to the pits by the strong reflection–polarization of the oil surface mimicking a body of water.

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Hidden quasars reddened by dust?

SIR — Webster *et al.*[1] argue for a large population of dust-reddened quasars, on the basis of the optical–infrared colour diversity in their new sample of radio-loud quasars with flat radio spectra. If their sample is representative of the quasar population, then their results imply that optical surveys miss about 80% of quasars, and that these missing quasars could account for the observed X-ray background. We argue that there is a simple way of avoiding these radical conclusions. Their results are influenced by an additional red, optical synchrotron component peculiar to flat-spectrum radio-loud quasars, with its own resulting colour diversity caused by the range in relative contributions of the 'normal' quasar and synchrotron components.

Flat radio spectra in quasars are caused by enhancement of synchrotron emission from compact regions within a jet by relativistic beaming in the direction of its motion[2]. Selecting by flat radio spectral index should therefore bias strongly in favour of quasars whose radio jets lie very close to the line of sight. In the context of Unified Schemes[2] in which the jet emerges along the relatively unobscured poles of an anisotropic distribution of material, or in which the jet itself clears material along its path, flat-spectrum quasars should be subject to very little intrinsic reddening .

It has been known for many years, however, that flat-spectrum quasars can have unusually red optical–infrared colours (for example, ref. 3). In several cases there is direct evidence from time variability that these colours are the result of a non-thermal source of red light which is superimposed on the normal blue quasar continuum (for example, ref. 4) and which is likely to be an extension of the synchrotron emission that dominates in the radio; many other studies also suggest the presence of a beamed optical–infrared component (for example, ref. 5). Indeed, many of the Webster *et al.* quasars are classified optically as blue stellar objects, despite their red optical–infrared colours[6]. This argues strongly against a reddening interpretation, but is consistent with a beamed, red synchrotron component.

Such a beamed component of optical emission may also explain the unusually large range of broad-line equivalent widths amongst flat-spectrum quasars (compare ref. 7 with Webster *et al.*'s Fig. 2; see also ref. 5). An observable anti-correlation of broad-line equivalent widths with *B–K* colour is not a firm prediction of the beaming model because the combined dispersion in the equivalent widths, the unbeamed continuum slope, and the slope of the (variable) beamed component may be very large. However, Jackson *et al.*[8] have demonstrated an anti-correlation between the dominance of flat-spectrum radio emission and the equivalent widths of the emission lines. This is strong evidence for an additional source of continuum emission in flat-spectrum quasars which, if red (as expected for synchrotron emission), provides a simple explanation for the colour diversity reported by Webster *et al.*

Some quasars may be reddened by the mechanism favoured by Webster *et al.* The well-known population of red quasars associated with steep-spectrum radio sources, in which the red beamed optical component is not expected to dominate, have broad lines sometimes only revealed by near-infrared spectroscopy[9]. Nevertheless, complete surveys at low radio frequencies[10], which are insensitive to beamed objects, contain few red quasars, again suggesting that the incompleteness in optical quasar surveys is much less dramatic than concluded by Webster *et al.*

Perhaps a more pertinent question is whether narrow-line objects constitute a population of obscured quasars. Studies of steep-spectrum radio sources[2] are consistent with the hypothesis that narrow-line radiogalaxies are quasars whose nuclei are obscured by material with column densities orders of magnitude higher than those invoked by Webster *et al.*

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New photosynthesis or old?

SIR — Greenbaum *et al.*[1] have described the light-induced hydrogen and oxygen evolution in a mutant strain of the green alga *Chlamydomonas reinhardtii* lacking photosystem I (PSI). As the mutant cells consumed carbon dioxide in the light, Greenbaum *et al.* suggested that reduced NADPH (nicotinamide adenine dinucleotide phosphate, obligatory for carbon fixation and normally formed by PSI) was generated by the direct reduction of $NADP^+$ by pheophytin, the low-potential electron acceptor of photosystem II (PSII)[2]. The authors claimed "a new type of photosynthesis being performed by the PSII light reactions exclusively".

Transient photosynthesis has been reported from a *Chlamydomonas* mutant lacking PSI (for example, ref. 3), as has direct reduction of $NADP^+$ by pheophytin in various PSII-enriched preparations (for example, refs 4, 5). The quantum yields were low in the latter case[6]. Apparently, the forward electron transfer from the reduced pheophytin to $NADP^+$ was not competitive with its backreaction (occurring in a few nanoseconds[7]) with the oxidized primary electron donor of PSII. The experiments with the PSI-lacking mutants, however, yielded a high rate of carbon dioxide consumption, comparable to that in wild-type cells. This high quantum yield may point to another mechanism of $NADP^+$ reduction.

The photosynthetic reaction centre of purple photosynthetic bacteria is evolutionarily and functionally related to PSII[8] (except for its inability to oxidize water). Bacteriopheophytin, with the same low redox potential as its counterpart in PSII[9], does not directly reduce nicotinamide dinucleotides. Instead, they are formed by reversed electron flow through the NADH:ubiquinone oxidoreductase complex. The driving force of the reversal consists of the scalar reducing potential of the ubiquinone/ubiquinol redox pair plus the electrochemical potential difference of the proton across the photosynthetic membrane[10]. *Chlamydomonas reinhardtii* incorporates an active NAD(P)H:plastoquinone oxidoreductase in its thylakoid membrane[11,12]. Thus, we propose a more traditional interpretation of the data by Greenbaum *et al.*, namely, that electrons provided by PSII first reduce the plasto-

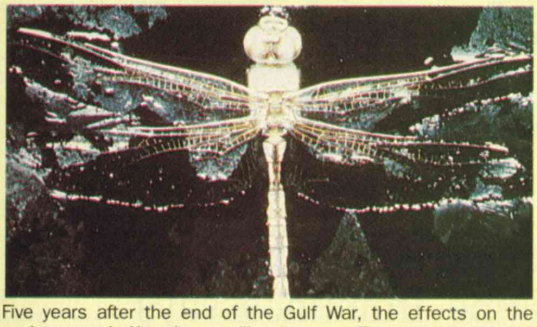
Footprint of the gods

Jupiter and the closest of its large moons, Io, have a unique relationship. Io's volcanoes eject material — much of it ionized — into the inner jovian system and the motion of Io through Jupiter's powerful magnetic field in turn generates a million ampere current between the moon and the planet. Using the Faint Object Camera aboard the Hubble Space Telescope, Prangé and co-workers have observed the 'footprint' of this current as it first encounters Jupiter's atmosphere and find that, contrary to previous suggestions, most of its energy is dissipated during this initial encounter. Page 323.

Did the Earth move...

Upon contact with the egg during fertilization, the mammalian sperm induces calcium oscillations in the egg. These oscillations are essential for egg activation and early development, but how the sperm produces them is poorly understood. On page 364 Parrington and co-workers report the identification and molecular characterization of oscillin, a soluble protein found in the sperm head which can trigger calcium oscillations in eggs. Defects in human oscillin might play a role in male infertility.

Troubled waters



Five years after the end of the Gulf War, the effects on the environment in Kuwait are still to be seen. The destruction of oil wells and pipelines led to the creation of great oil lakes, which appear to be more attractive than the real thing for the many water insects relying on reflection polarization to identify 'water' surfaces. The resulting massive insect traps provide a unique chance to study insect migration, though at the expense of many insects such as the one pictured here. Scientific Correspondence page 303.

Two-minute warning

Damage to skin collagen and elastin is thought to be responsible for the wrinkled appearance of sun-exposed skin. On page 335, Fisher *et al.* report that low doses of ultraviolet-B (UVB) irradiation, equivalent to two minutes of sunlight, induce production of collagen- and elastin-degrading metalloproteinases in human skin by activating the transcription factors AP-1 and NF-κB. The induction is blocked by all-*trans* retinoic acid, which inhibits AP-1 activity, suggesting that this compound may prevent sun-induced skin damage and premature skin ageing if used before solar exposure. News and Views page 301.

Let there be rabbits

The Old Testament classifies rabbits with ruminants, whereas the Vulgate links them with hyraxes. Most zoologists place rabbits close to rodents by convention, but their phylogenetic position has never been secure. On page 333, Graur and colleagues present the best molecular evidence yet marshalled on the subject, and conclude that rabbits are closer to primates and treeshrews than to rodents. See News and Views page 299.

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