could extend the spectral range have not yet been experimentally elaborated. In comparison, charge transfer processes within ion pairs produce radical intermediates without the necessity of covalent bond breakage. The energetic limitations are much lower, the utilizable spectral range broader. Of such systems, those with Br^- have some advantages in spectrum, electric potential, or quantum yield over systems with other halides or other ligands.

SCHOEN-NAN CHEN
NORMAN N. LICHTIN
Department of Chemistry,
Boston University,
Boston, Massachusetts 02215
GABRIEL STEIN
Casali Institute of Applied Chemistry
and *Department of Physical Chemistry,*
Hebrew University, Jerusalem, Israel

References and Notes

1. E. Rabinowitch and W. H. Stockmayer, *J. Am. Chem. Soc.* **64**, 335 (1942); E. Rabinowitch, *Rev. Modern Phys.* **14**, 112 (1942).
2. M. G. Evans, N. S. Hush, N. Uri, *Q. Rev. Chem. Soc.* **6**, 186 (1952); N. Uri, *Chem. Rev.* **50**, 391 (1952).
3. J. Jortner and G. Stein, *Bull. Res. Counc. Isr. Sect. A Chem.* **6**, 239 (1957); J. Jortner, G. Stein, A. Treinin, *J. Chem. Phys.* **30**, 1110 (1959); G. Stein, *ibid.* **42**, 2986 (1965).
4. H. G. C. Bates and N. Uri, *J. Am. Chem. Soc.* **75**, 2754 (1953); M. K. Saha, A. R. Mukherjee, P. Ghosh, S. R. Palit, *J. Polym. Sci.* **16**, 159 (1967).
5. For a review, see N. N. Lichtin, Ed., *The Current State of Knowledge of Photochemical Formation of Fuel* (National Science Foundation, Washington, D.C., September 1974).
6. I. Iwazaki, Y. Nakai, A. Tomonari, I. Morita, K. Shioda, *Nippon Kagaku Zasshi* **80**, 56 (1959).
7. G. Stein, *Isr. J. Chem.*, in press; in (*5*), p. 59; ——— and A. Zeichner, in preparation.
8. V. Balzani, in (*5*), p. 46; ———, L. Moggi, M. P. Manfrin, F. Bolletta, M. Gleria, *Science* **189**, 852 (1975).
9. Supported by NSF/RANN grant SE/AER 72-03597 to Boston University. We wish to express our appreciation to M. Z. Hoffman for many helpful discussions.

13 August 1975

Shanidar IV, a Neanderthal Flower Burial in Northern Iraq

Abstract. *The discovery of pollen clusters of different kinds of flowers in the grave of one of the Neanderthals, No. IV, at Shanidar cave, Iraq, furthers our acceptance of the Neanderthals in our line of evolution. It suggests that, although the body was archaic, the spirit was modern.*

What was originally thought to be a simple Neanderthal burial at Shanidar cave (number IV in the series of skeletons) has proved of singular importance. The death had occurred approximately 60,000 years ago (*1*), yet the evidence of flowers in the grave brings Neanderthals closer to us in spirit than we have ever before suspected. The flower pollens discovered by Leroi-Gourhan, a palynologist (*2*), in the soil samples that I had taken from around the skeleton emphasize the rich dividends of interdisciplinary research in studies of prehistory.

The Neanderthal finds made at Shanidar cave in 1960 were initially described by Stewart (*3*) and, at about the same time, by me (*4*). At that time, the palynological analysis of the soils was still to be made.

Shanidar IV and associated remains from three other individuals were found about 15 m from the cave mouth at a depth of about 7.5 m below the cave floor. The skeletons were crammed in a niche of stones measuring about 90 cm north to south by 150 cm east to west and covered by a widespread rockfall.

The discovery of Shanidar IV was made in the course of trimming a dangerous-looking bulge in the east wall of the excavation. Included in the bulge zone was a relatively small remnant of unexcavated soil left over from an earlier season. It was during this trimming operation that we encountered the first bones, heavily encrusted with a coating of limestone deposit. After identifying the bones as human, Stewart assumed supervision of the exhumation of the find, which proved to be an adult male. While he was engaged in this operation, another Neanderthal, Shanidar V, was brought to light only yards away.

By cleaning away the loose soil in front of Shanidar IV, Stewart found the crushed parts of a new individual, Shanidar VI, an adult female. Rather than trying to take up Shanidar IV bone by bone in order to expose the new find, it was thought best to box the extremely fragile remains en bloc for removal to the laboratory in Baghdad.

In his laboratory examination 2 years later, Stewart (*3*) discovered that among the bones which had been identified in the field as Shanidar VI were the bones of yet another individual, a second adult female, which should technically be given the find designation of Shanidar VII. He could not be sure which of the female bones belonged to which individual, and thus provisionally lumped them both together as a unit which we call Shanidar VI–VII. The bones of a baby, which were found below Shanidar IV and VI–VII, are designated as Shanidar VIII. The remains of these three individuals (Shanidar VI–VII and VIII) seem to have been only partially complete, according to Stewart's findings. From the position of the skeletal remains, it would appear that the baby had been laid in first, followed by the two females. Finally, room was made for the male, who was evidently an important man.

I took a number of soil samples from around Shanidar IV, with a special note that samples 313, 314, and 315 were specifically for pollen analysis. These were sent for examination by Leroi-Gourhan in Paris. She processed the six soil samples that were taken from around Shanidar IV and the immediately adjacent area, and much to her surprise found that among others, samples 313 and 314 were especially rich in flower pollen (*2*). The humid condition of the soil undoubtedly contributed to the good preservation of the pollen grains, although it had a bad effect on the skeletons.

The recovery of pollen grains around the Neanderthal burial was in itself unusual and without precedent to our knowledge, but to find flower pollen, and in quantity, was an added extraordinary dividend. The association of flowers with Neanderthals adds a whole new dimension to our knowledge of his humanness, indicating that he had "soul."

The flowers identified by Leroi-Gourhan can still be found in Iraq (*5*). Even more importantly, by coincidence, seven of the eight flower species are cited by Al-Rawi and Chakravarty (*6*) for their herbal and medicinal properties, which raises some fine points for speculation with regard to their associations in Neanderthal burial.

When reviewing the list of flowers, we start with the Compositae, the family of flowers collectively and commonly known as the daisies. In this family at least six species of the *Achillea* genus are found in the Shanidar area today (*5, 7*). The common name of *Achillea* is yarrow, or milfoil. Yarrow is an Anglo-Saxon derivation meaning healer. In addition to its specific use in the past for wounds, it has been widely used in herbal medicine. In Iraq, Al-Rawi and Chakravarty (*6*) inform us that the herb of *Achilles santolina* Linn. possesses insect repellent properties, and its leaves are useful against dysentery, intestinal colic, "expulsion of gases," and as a general tonic and carminative. Leroi-Gourhan also found pollens of the *Centaurea* genus, also of the Compositae family, among the burial soils. Al-Rawi and Chakravarty (*6*) note that the *Centaurea cyanus* Linn. (commonly known as the cornflower, blue bottle, or blue bonnet), which is found farther south in Iraq today, has uses as a diuretic, emmenagogue, tonic, pectoral, stimulant, astringent, febrifuge, and collyrium.

Centaurea solstitialis, commonly known as St. Barnaby's thistle, is a conspicuous plant that I have observed in great numbers at Shanidar. It is mentioned as one of the wild plants of Iraq by Al-Rawi (*5*), and of the eastern Mediterranean in general by Polunin and Huxley (*8*). It has white cot-

tonlike leaves and long yellow needlelike spikes which spread outward from the rounded heads of yellow flowers. This unlikely looking flower is used by peasants to make herbal remedies, and I have seen Shanidar inhabitants eat the head of the plant after first picking away the thistles.

Of the *Senecio*-type flowers, at least four species are still found in northern Iraq (*6*). These flowers, commonly known as ragwort or groundsels (the name groundsel comes from the Anglo-Saxon word meaning pus swallower), are characterized by a large and brilliant yellow flower (*Senecio vernalis* w. and K.). During its long flowering season, which lasts until late spring, this flower produces a great quantity of fruit. Another species of the *Senecio*-type, *Senecio vulgaris* Linn., found farther to the south in Iraq, is used, for example, as an herb, emetic, diuretic, and purgative. It is said to have a soothing effect on the female genital system, with an action that resembles that of ergot (*6*).

The *Muscari*, or grape hyacinth, in the Liliaceae family, is a very lovely flower with a dark blackish-blue color. At least four different species of this flower have been identified in northern Iraq (*5, 7*). It also is described by Polunin and Huxley (*8*) for the eastern Mediterranean area as a whole. The *Muscari* has diuretic and stimulant properties, and its bulb is poisonous (*9*).

In the Gnetaceae family, the *Ephedra* is represented by six species in the northern area of Iraq, as well as two others that are found farther south (*6*). *Ephedra* is commonly called joint pine or woody horsetail. According to Al-Rawi and Chakravarty (*6*), the *Ephedra alata* Decne is used as a cure for asthma, a cardiac stimulant, and for epidemic dropsy. It contains ephedrine, a nerve stimulant. It is also used for rheumatism (*9*). Leroi-Gourhan's *Ephedra altissima* may be like the woody horsetail (*Ephedra foliata* Bois and Kotschy) (*5, 6*) that is found in the Iranian foothills. Polunin and Huxley (*8*) describe the *Ephedra fragilis* ssp. *camyloda* as a switchlike plant, with many branches that end in tufted sprigs. The ramose branches of this flower lend it to the fabrication of a network or woven bedding.

The Malvaceae (or Mallow) family is represented among the pollen samples by the flower *Althaea*, which is the Greek word for healer, and is commonly known as hollyhock. This is a distinctive plant with a tall, wandlike stem and large, conspicuous flowers (*8*). The flower colors can be white, yellow, red, or purple. The plant is used as a food as well as for medicinal purposes. From the roots, leaves, flowers, and seeds, a variety of medicines with a great many uses can be made. These range from relief of toothache and inflammation to its uses for poultices and for spasms. It seems to be the poor man's aspirin. We are told that the boiled seeds and flowers of *Althaea rosea* Linn., or rose mallow, from northern Iraq are useful applications against spasms, toothaches, and inflammations (*6*), while the flower has such diverse uses as a coloring agent for wine and as an emollient, demulcent, diuretic, expectorant, and mucilage. The root is used for more of the same medical applications and as an astringent. Another representative of this flower in northern Iraq, *Althaea officinalis* Linn., has uses in the making of an emollient, and for the manufacture of absorbent pills and pastilles. The decoction of the root is used to combat irritation and inflammation of the mucous membrane. When bruised and boiled, the plant is sometimes used as a poultice.

One thing is certain from Leroi-Gourhan's discovery. These flower pollens were not accidentally introduced into the grave, and hence must represent bouquets or clumps of flowers purposely laid down with the Shanidar IV burial. The hollyhock is especially indicative of this since it grows in separate individual stands, and cannot be grasped in bunches like the others. Some person or persons once ranged the mountainside, collecting these flowers one by one. We wonder what kind of flowers would have been buried with Shanidar IV if he had died a month or two earlier, before the flowering season of those that were found interred with him. Possibly the *Ranunculus asiaticus* L. (turban buttercup), or *Ranunculus orientalis*, and the anemone, which last until April, are likely alternatives. It would be very instructive to find out if there was a conscious selection of flowers for the burial. Obviously, more case studies like this are needed for a proper evaluation of this phenomenon.

None of the soil samples from the other Shanidar skeletal finds that were examined by Leroi-Gourhan yielded similar concentrations of flower pollens. Of course, death knows no season, and perhaps the other individuals found at Shanidar died during nonflowering seasons. Then again, it could be that even if the other individuals had died during a flowering season, for one reason or another they were not accorded the same treatment as Shanidar IV. One may speculate that Shanidar IV was not only a very important man, a leader, but also may have been a kind of medicine man or shaman in his group.

From the Neanderthal finds made elsewhere and at Shanidar itself (*10, 11*), we know that Neanderthal man must have had a concept of the spirit, since he practiced funerary rites over his dead (*12*). The presence of flowers with Neanderthal burials raises the question of where else in the annals of prehistory is there a parallel. The studies on Stone Age cultures yields nothing. Actually, the puzzle is deepened in that, with the apparent exception of an image interpreted by Marshack (*13*) as a flower scratched on a bone, none of the books on paleolithic art shed any light on the matter. For later periods there is abundant evidence, such as the lotus flower in Egypt from about at least 5000 years ago.

Naturally we cannot be sure that whoever buried Shanidar IV was aware of the economic and medicinal properties of the flowers that were interred with him. But it is extremely likely that, as practicing naturalists (and early-day ecologists?), the Neanderthals must have known and appreciated all of their environment, since their very existence depended on it. Bad experiences with poisonous plants would have been passed down as oral lore, and such plants, including their flowers, would have been avoided. If they recognized the flowers for their useful properties, then they surely also collected the more obvious edible vegetal foods to supplement their diet, such as the acorns that abound in the mountains of the Near East.

Since this is a unique case of flowers associated with a prehistoric burial, we have no examples for comparison. It may be simply coincidence that the flowers found with Shanidar IV have medicinal or economic value (at least in our present knowledge), but the coincidence does raise speculation about the extent of human spirit in Neanderthals.

RALPH S. SOLECKI
Department of Anthropology, Columbia University, New York 10027

References and Notes

1. This age estimation is based on a soil accumulation rate which may have occurred in the cave. Estimate was extrapolated from carbon-14 dates presented in R. S. Solecki, *Science* **139**, 179 (1963).
2. A. Leroi-Gourhan, *ibid.* **190**, 562 (1975); *Bull. Soc. Prehist. Fr.* **65**, 69 (1968).
3. T. D. Stewart, *Sumer* **29**, 8 (1963).
4. The original supposition that these Neanderthals were killed by a rockfall (*1*) is negated by additional evidence.
5. A. Al-Rawi, *Wild Plants of Iraq, with Their Distribution* (Iraq Ministry of Agriculture, Directorate General of Agricultural Research and Projects, Technical Bulletin No. 14, Baghdad, 1968).
6. _____ and H. L. Chakravarty, *Medicinal Plants of Iraq* (Iraq Ministry of Agriculture, Directorate General of Agricultural Research and Projects, Baghdad, 1964).
7. G. S. Hassawy, S. A. Tammimmi, H. Al Izzi, *Weeds in Iraq* (Iraq Ministry of Agriculture, Botany Division, Technical Bulletin No. 167, Baghdad, 1968).
8. O. Polunin and A. Huxley, *Flowers of the Mediterranean* (Chatto & Windus, London, 1970).
9. D. Martin, personal communication.
10. R. S. Solecki, *Smithson. Inst. Ann. Rep. 1959* (1960), p. 603.
11. _____, *Shanidar; the First Flower People* (Knopf, New York, 1971).
12. F. M. Bergounioux, in *Hundert Jahre Neanderthaler*, G. H. R. Von Koenigswald, Ed. (Kemink en Zoon N.V. Uitgevers-Mij., Utrecht, 1958), pp. 151–166.
13. A. Marshack, *Nat. Hist.* **79**, 57 (1970).

29 May 1975; revised 10 September 1975