corresponding oligonucleotide probes, and screened brain cDNA libraries by hybridization. Wada *et al.*[2] and Gregor *et al.*[3] have cloned what may well be the frog and chick versions of the same kainate-binding protein (KBP). This protein has a relative molecular mass of about 50,000 (about half that of the kainate receptor channel identified by Hollmann *et al.*) and, again, the hydrophobicity plot typical of the ligand-gated-channel gene family. The KBP exhibits about 25 per cent amino acid similarity to the last (carboxy) half of the kainate receptor channel cloned by Hollmann *et al.*, but the first 350 amino acids of the kainate receptor channel are entirely absent from the KBP. The KBP binds kainate, as it should, but does not function as a channel when expressed in oocytes.

In summary, then, Hollmann *et al.* have cloned at least one subunit of a functional glutamate receptor channel; the other two laboratories have cloned a related protein that binds glutamate (kainate) but whose function is at present unknown. What could this KBP be? One possibility is that it is a subunit of a neuronal kainate receptor and that the channel will only function when other subunits are present. Because the chick KBP is remarkably abundant in cerebellum and is only present on Bergmann glial cells there, other possibilities are likely. The KBP could, for example, be a component of an uptake system or part of a glutamate receptor involved in a signalling that does not use an ion channel. Glia have recently been shown to transmit signals to one another in response to glutamate[4], and this signalling system, which involves changes in intracellular calcium concentration, responds selectively to kainate. Whatever the KBP is, it belongs to a previously undefined family; and because of its abundance in glia rather than neurons, it must play a role in some as yet unknown aspect of brain function.

For neurobiologists, the cloning of a glutamate receptor channel is an exciting event. To understand why, one must appreciate the role of glutamate receptor channels in brain function. First, glutamate is the main excitatory neurotransmitter in the brain, and every neuron — as far as we know — has ion channels with receptors for glutamate. The glutamate receptors are thought to form a complex family because they fall into a rich variety of pharmacological types, and, if past experience is any guide, the gene families will be even richer than the current pharmacology indicates. Second, at least one pharmacologically defined type of glutamate receptor, the one named after the glutamate analogue NMDA (*N*-methyl-D-aspartate) that best activates it, is especially interesting. The NMDA receptor is a site of action of the street drug, 'angel dust', is responsible for excitotoxic nerve cell death and has a key part in long-term potentiation, the phenomenon thought to underlie some forms of memory. Furthermore NMDA receptors have been implicated in certain types of seizure and various neurodegenerative diseases, and in the reorganization of neuronal connections that depends on experience. Heinemann's laboratory, from which the paper by Hollmann *et al.* comes, has already started finding other family members related to their kainate receptor channel, and it is expected that an entirely new family of receptors, one that may include the NMDA receptor, will be identified through homology screening.

Finally, an interesting sociological note. Although the three groups that came first in the race to clone a glutamate receptor worked independently (and competitively), the research of two of them was carried out in different laboratories at the Salk Institute, and one of the co-authors in the third group was in yet another laboratory at the Salk. Something about southern California must be good for research on excitatory amino acids. □

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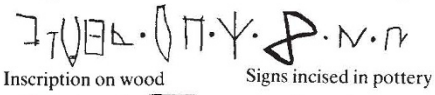
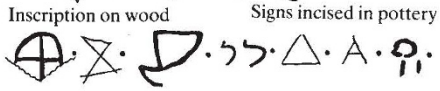
100 years ago

EARLY EGYPTIAN CIVILIZATION.

THOUGH debarred from the richest districts of Egypt — owing to national jealousies — I have been fortunate enough to discover two small towns which have revealed the works of the Middle and New Kingdoms with chronological exactness. Beside the Egyptian interest of these places, they are of prime importance for Mediterranean history, having been colonies of foreign workmen. The most novel discovery of all is the presence of apparently alphabetic signs in use in both towns (figure) at about 2500 B.C. and 1300 B.C. The apparent connection of these signs with some of the mason's marks suggests that they may have been adopted by the foreign workmen from their Egyptian fellow-labourers; and the very lack of literary education among such men would lead to their forming alphabets of their own.



Inscription on wood — Signs incised in pottery



Signs incised on pottery of the twelfth dynasty

From *Nature* **XLI**, 109–111 (1889).

BIOGEOCHEMISTRY

Effects of increased ultraviolet

T.E. Graedel

THE discovery of the Antarctic ozone hole has sparked tremendous discussion about the implications of increased ultraviolet radiation on geochemical and biochemical processes. Because many of the atmospheric and marine chemical cycles strongly interact with those of the biota, changes in any of the systems imply changes in all. These interlocking concerns formed the basis for a recent workshop* which brought together atmospheric chemists and physicists, marine and freshwater chemists, biochemists and biologists.

The effects of changing ultraviolet fluxes can be studied by examining each term of what one might call the photochemical impact equation. For a specific molecule i, the impact I_i can be written as

$$I_i = \int_{\lambda_{min}}^{\lambda_{max}} J(\lambda)\, \sigma_i(\lambda)\, \phi_i(\lambda) \mathrm{d}\lambda$$

in which $J(\lambda)$ is the incident flux, $\sigma_i(\lambda)$ is the absorption cross section and $\phi_i(\lambda)$ is the quantum efficiency (that is, the fraction of absorbed photons that cause the process under study, as opposed to having their energy dissipated in some other way). The integration limits are the atmospheric cut-off at about 290 nm at the short wavelength end, and the longest wavelength capable of producing an effect (generally in the range 350–400 nm) at the upper end.

In the case of absorption by agglomerated particles — poorly characterized dissolved species or organisms, for which molecule-by-molecule approaches are inappropriate — the absorption cross-section and quantum yield terms are replaced by $A_i(\lambda)$. This 'action spectrum' is an experimentally determined measure of the effects of the interaction of light at a particular wavelength with a specific constituent. A quantitative assessment of the effects of changing ozone concentrations requires a relatively complete understanding of each term in these equations; speakers at the workshop presented results related to each term.

Changes in atmospheric ozone are now being monitored widely. It does not follow, however, that even $J(\lambda)$, the present flux of solar radiation to the surface, is known accurately, because clouds play such a large role in the radiation balance. The distribution and physical properties of clouds are not well characterized, particularly over the oceans and

*Effects of Solar Ultraviolet Radiation on Biogeochemical Dynamics in Aquatic Environments, Woods Hole, Massachusetts 23–25 October, 1989.