Chemistry, Goettingen has recently been applied in that Institute to desensitized channels of extra-synaptic membranes of denervated frog muscle. The desensitized form of the channels is an inactive state adopted about 10 sec after the channel has converted from closed to open form in the presence of high concentrations of acetylcholine. Sakmann reported that desensitized channels can suddenly become active again, rapidly fluctuating between open and closed states for less than a second before returning to inactivity. After a very brief delay the cycle may be repeated; after several repeats, there is a prolonged period of inactivity before bursts of activity reappear.

Neher reported the considerable technical achievement of extending single channel recording to potassium channels of the squid axon, although not under normal physiological conditions. This is the first time that the opening and closing of a single channel in a biological membrane, other than those induced by acetylcholine, has been recorded. Currents of 1.7 to 7.0 pA and a mean opening time of 12 msec were recorded. More interesting was the fact that short interruptions could be seen during the open time recording, indicating a temporarily closed condition between the closed and open states. On average there were 1.8 interruptions per open channel recording. According to Neher this refutes the Hodgkin and Huxley model which, for potassium channels, would predict 0.4 interruptions per channel.

Single channel recording is becoming an extremely important technique for confirming and extending what has been learnt from gating currents and fluctuation analysis in the last few years. It is technically demanding particularly in terms of obtaining sufficiently good seals between the recording pipette and the tissue membrane. But there is every reason to believe that the first recordings of single sodium channels will be reported soon and will be followed by those of channels induced by a variety of neurotransmitters.

An utterly different approach to determining single channel currents, but one applicable only to the much studied model of gramicidin A channels induced in lipid bilayers, was reported by D. Urry (University of Alabama Medical Centre). By means of sodium-23 nuclear magnetic resonance he was able to demonstrate two sodium binding sites and to derive the relevant rate constants. From them and using a model based in part upon the X-ray diffraction data of Koppe *et al.* (*Nature* **279**, 723; 1979) Urry then calculated a single channel current which agreed well with observed values. The validity of this approach having been proven to Urry's satisfaction, he expects soon to determine the actual positions of the binding sites within the channel. That will perhaps conclude the exhaustive studies, exhaustingly reported, of the exact way in which sodium ions make their way through the gramicidin channel. □

Peter Newmark is acting editor of Nature.

Climatic perturbations

from A. Henderson-Sellers

REINFORCEMENT of climatic perturbations by the natural feedback mechanisms in the atmosphere was a predominant theme of the First International School of Climatology*.

Probably the most exciting indications of internal feedback response amplifying natural climatic variations were the results presented by J. Namias (Scripps Institution) and W. Broecker (Lamont Doherty Observatory). Namias' theories are the culmination of many years of scientific investigations of synoptic meteorology. He presented examples from the USA of atmospheric reinforcement of anomalous situations in various conditions from arid to arctic. (There is an interesting analogy here with the Northern European Drought of 1975/76 which, it has since been suggested, may have persisted because of the extreme conditions of low soil moisture and high reflectivity which it had itself produced). Perhaps more important for those interested in the onset of ice ages was Namias' further observation that baroclinic development in arctic regions seems to lead to the 'steering' of depression systems along the snow/ice boundary. This gives rise to a positive feedback mechanism in which any precipitation which occurs will 'feed' the snow advance.

The second novel case of an ecosystem response tending to enhance climatic perturbations was described by Broecker. Recent results suggest that the level of carbon dioxide in the Earth's atmosphere was considerably lower (~200 p.p.m.) during glacial epochs compared with the present day (320 p.p.m.). This decreased level of CO_2 would, of course, tend to lower average surface temperatures by decreasing the 'greenhouse effect'. However, the lowered CO_2 level may itself be a result of the onset of continental glaciations. Broecker believes that when sea levels fell as the ice mass on the Northern Hemisphere continents increased there may have been a sudden input of phosphorus to the oceans due to leaching from the then dry continental shelves. The increased phosphorus levels would stimulate increased photosynthetic activity in the oceanic biomass and thus lead to lowered levels of CO_2 in the atmosphere. This mechanism provides a link between Northern Hemisphere glaciations and Southern Hemisphere temperatures and also indicates the importance of internal responses within the biosphere and hydrosphere for the enhancement of climatic anomalies. It does not, however, explain the origin of the decreased temperatures that triggered the original continental glaciations.

The extreme importance for climatic change of the oceans and particularly the biomass within them was re-emphasized by J. Woods (Southampton) and B. Bolin (Stockholm). Woods presented new and exciting data which indicate that there is a large-scale, but previously neglected, interchange of both water and heat between the major world oceans. Bolin's work on the carbon dioxide budget also underlines the desperate need for a fuller investigation of the oceanic contribution to global sources and sinks of CO_2. Bolin and J. Smagorinski (Princeton) both noted a 4-year fluctuation in the observed levels of atmospheric CO_2 which becomes apparent when the annual oscillation forced by industrial output and biospheric uptake is removed. There is a strong possibility that the atmospheric CO_2 levels are responding to increased uptake by the oceanic biomass during periods of enhanced upwelling. This is another link between atmosphere, climate, sea surface temperatures and the biosphere. One is tempted to reconsider these complex interrelationships in the light of Lovelock's 'Gaia Hypothesis' (Oxford University Press, 1979).

In view of the extremely complex nature of the response of the biosphere to climatic changes it was reassuring to hear from H. Fritts (Arizona) that, given a large enough sample size, biological data (especially from tree rings) could be shown to provide satisfactory reconstructions of past climates. The elegance and strength of the mathematical techniques used in this type of reconstruction (which now allows Fritts to draw surface pressure charts for earlier epochs) may lead to biological data superseding the traditional historical data sources for climatic reconstructions. Although the response of trees to climatic variation may be complex, the signal is, at least, not further confused by intentional modification of the true situation (as is known to have occurred in certain mediaeval manorial reports of crop yields written for absent landlords). Climatic reconstruction and monitoring thus cannot be successfully developed without detailed consideration of both anthropogenic and environmental systems with which the atmosphere is intimately linked. □

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