toxin[16]. It is attractive to imagine that these complementary effects of acetylcholine result from interaction of ligand–muscarinic acetylcholine receptor with a single G protein; the $\beta\gamma$ complex of G_i could mediate the first effect, whereas GTP-bound α_i chain could mediate the second.

In summary, the experiment of Logothetis *et al.*, like all good experiments, raises a host of new questions. The rules that govern macromolecular assembly and cytoskeletal restraints on movement remain mysterious even with respect to membrane proteins much more abundant than components of G-protein signalling systems, and are objects of intense investigation in many laboratories. It seems reasonable to hope that investigators will dispel some of the mystery by exploiting the strikingly interdependent and easily measurable biochemical activites of G proteins, their receptors and their effectors. □

1. Logothetis, D.E., Kurachi, Y., Galper, J., Neer, F.J. & Clapham, D.E. *Nature* **325**, 321 – 326 (1987).
2. Bourne, H.R. *Nature* **321**, 814 – 816 (1986).
3. Pfaffinger, P.J. *et al. Nature* **317**, 536 – 538 (1985).
4. Breitwieser, G.E. & Szabo, G. *Nature* **317**, 538–540 (1985).
5. Liang, B., Hellmich, M., Neer, E. & Galper, J. *J. biol. Chem.* **261**, 9011-9021 (1986).
6. Stryer, L. & Bourne, H.R. *A. Rev. Cell Biol.* **2**, 391–419 (1986).
7. Katada, T., Oinuma, M. & Ui, M. *J. biol. Chem.* **261**, 5215–5221 (1986).
8. Gilman, A.G. *Cell* **36**, 577–579 (1984).
9. Kanaho, Y. *et al. J. biol. Chem.* **259**, 7378–7381 (1984).
10. Tolkovsky, A.M., Braun, E. & Levitzki, A. *Proc. natn. Acad. Sci. U.S.A.* **79**, 213–217 (1982).
11. Schlegel, W., Kempner, E.S. & Rodbell, M. *J. biol. Chem.* **254**, 5168–5176 (1979).
12. Arad, M., Rosenbusch, J.P. & Levictzki, A. *Proc. natn. Acad. Sci. U.S.A.* **81**, 6579 – 14489 (1984).
13. Couvineau, A., Amiranoff B. & Laburthe, M. *J. biol. chem.* **261**, 14482 – 14489 (1986).
14. Sahyoun, N.E., LeVine, H., Davis, J., Hebdon, G.M. & Cuatrecasas, P. *Proc. natn. Acad. Sci. U.S.A.* **78**, 6158 – 6162 (1981).
15. Carlson, K.E., Woolkalis, M.J., Newhouse, M.G. & Manning, D.R. *Molec. Pharmac.* **30**, 463 – 468 (1986).
16. Masters, S.B., Martin, M.W., Harden, T.K. & Brown, J.H. *Biochem. J.* **227**, 933 – 937 (1985).

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Antarctic ozone

Causes and effects of a hole

J.J. Margitan

RECENT measurements in Antarctica have added considerably to our knowledge of the Antarctic ozone hole first identified by the British Antarctic Survey[1]. The cause and significance of the hole remain a mystery, however, and although it is a real phenomenon, the implications for global ozone will not be clear until the mechanism by which it is produced is conclusively identified. So far, none of the proposed explanations, ranging from the effects of chlorofluorocarbons (CFCs) to a natural dynamical process, can be excluded.

Preliminary results from the US National Ozone Expedition (NOZE) to McMurdo Station, Antarctica, were announced via telephone link from Antarctica in October 1986. Observations between August and October had sought to differentiate between the three major theories that explain the formation of the hole: (1) a purely dynamical mechanism[2] in which rising air motions within the polar vortex lead to reduced column densities of ozone; (2) a solar activity theory[3] that odd-nitrogen produced at high altitudes is transported downwards, leading to enhanced odd-nitrogen catalytic cycles that destroy ozone; and (3) several related theories in which ozone loss is caused by enhanced concentrations of odd-chlorine resulting from unusual heterogeneous chemistry associated with polar stratospheric clouds. The ultimate source of the chlorine in these theories is manmade CFCs[4,5].

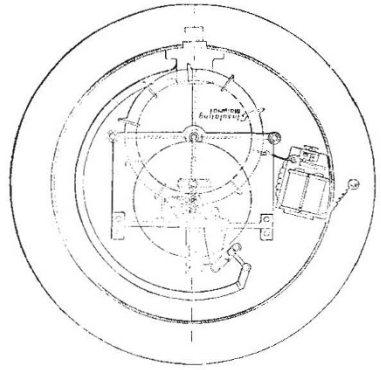
The NOZE team operated four experiments: balloon ozonesonde and aerosol counters (D. Hofmann, University of Wyoming); microwave radiometer (R. deZafra and P. Solomon, State University of New York; A. Parrish, Millitech); ultraviolet spectrometer (S. Solomon and G. Mount, National Oceanic and Atmospheric Administration Aeronomy Laboratory, NOAA); and infrared solar absorption spectrometer (G. Toon and C.B. Farmer, Jet Propulsion Laboratory). The McMurdo site offered the opportunity to make observations both in and out of the hole as the polar vortex shifted around the pole. Satellite data from the Nimbus 7 Total Ozone Mapping Spectrometer confirmed the appearance of the hole in early September, with a maximum ozone depletion similar to but slightly less severe than that in 1985. The NOZE ozonesonde measurements showed significant vertical structure to the hole, with 80 per cent depletion in some of the 1-km layers but only 20 per cent in adjacent layers. The depletion was confined to the 12–20-km region, beginning first at the higher altitude and progressing downwards.

The team believes that this layering is caused by evaporation of polar stratospheric clouds. The layering, and the altitude region of the depletion, are taken as strong evidence against the solar activity theory, which would have predicted depletion at high altitudes (greater than 30 km) and moving down. Only very preliminary information on other chemical species is available, however, and more detailed analyses of data from the other instruments are needed. The infrared instrument obtained high-resolution data for more than 20 days that will require computer analysis. These data are expected to provide information on the stratospheric concentrations of ozone, nitrous oxide, nitric oxide, nitrogen dioxide, nitric acid, hydrochloric acid, chlorine nitrate, methane and CFC-11 and 12, both within and outside the polar vortex.

The microwave instrument produced data on hydrogen cyanide, ClO and nitrous oxide, but the high pressures in the crucial altitude region (below 25 km) greatly reduced sensitivity and so further analysis will be necessary. Preliminary results indicate, however, that the concentration of ClO is no greater than 1 part in 10^9, not inconsistent with the halogen mechanisms but excluding the upper end of their calculated ClO concentration ranges (0.5–2 parts in 10^9). The nitrous oxide data show unusually low concentrations within

100 years ago

A MOST interesting experiment is about to be tried in Birmingham. A Company has obtained Parliamentary powers to supply power from a central station by compressed air through pipes laid in the streets. No fairer field for such an experiment could be found than in Birmingham, which is marked out from all other towns by the enormous number of its small workshops requiring minute amounts of driving-power, and the total turn-over of each of which is too small to enable the owner to afford skilled tendance to his boiler and engine. In these small shops the power is required only intermittently throughout the day. The registrations of all the meters in the whole district are telegraphed to the central station and added up on one large central counter, so that the engineers in charge may have means of continually comparing the actual consumption with the duty of the engines, known from ordinary engine continuous counters, and of detecting any serious leakage that might occur in consequence of breakage of the main or branch pipe. The telegraphing apparatus is shown.



From *Nature* **35**, 278; 20 January 1887.