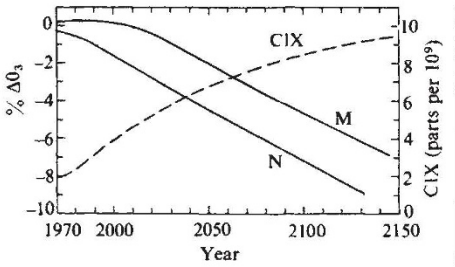

Fig. 2 Ozone changes as a percentage of unperturbed ozone predicted by the two models, M and N, favoured by Cicerone *et al.* Also shown is a previously predicted rise in ClX concentration due to continued use of CCl_2F_2, CCl_3F and CH_3CCl_3. From ref. 4.

trols. Prodigious efforts have been expended in making such measurements.

Which brings us to the most significant result of Cicerone *et al.* Figure 2 shows ozone changes as a function of time predicted by the author's two favoured models based on the predicted releases of chlorine compounds. If model M turns out to be a good representation of the real atmosphere we could be lulled into a false sense of security. There will be no detectable decrease in ozone column until well into the next century. But after that the ozone level will decrease dramatically.

The authors freely admit to the shortcomings of their models. They are all one-dimensional, that is, they treat air motions only in the vertical but not in the latitudinal or longitudinal directions. They assume a constant temperature profile for the atmosphere although there is a temperature feedback resulting from the ozone destruction. There are also other factors which mitigate against decreases in total ozone column. For example, an increase in atmospheric CO_2 resulting from continuing burning of fossil fuels will increase stratospheric ozone. Nitric oxide plays an ambivalent role in the atmosphere. At low altitude it undergoes chemical reactions which produce ozone. There is evidence that the increasing size of the world's fleet of subsonic aircraft, which fly at these altitudes, has added to the total column ozone amount.

However, all modellers agree that the way in which ozone is distributed in the stratosphere will be dramatically altered by the continuing release of chlorine compounds. Ozone may well increase in the lower stratosphere but there will also be large decreases in the upper stratosphere. The largest decrease is predicted at 40 km and it is here that evidence should be sought for the validity of the models. An early warning system should be based on satellite measurements of the ozone trends at this altitude.

The change in ozone distribution adds a note of irony to the ozone controversy. It appears that the decrease in total ozone column may not be as large as previously predicted. This means that the threat of increased ultraviolet radiation at the ground may not be as serious as many thought. However, the change in ozone distribution in the stratosphere is likely to have climatic consequences. The first crash research programme in response to the SST threat was called the Climatic Impact Assessment Program. Many scientists objected to this name because they felt the real focus should be on the increased ultraviolet threat. This view is now being reversed. □

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Invertebrate reproduction

Unique limpet spawning behaviour

from G.B. Picken and D. Allan

LIMPETS are the most conspicuous invertebrates on rocky Antarctic shores. Seasonally migrating to avoid abrasion by winter ice[1] and protected against short-term freezing by a mucous cocoon[2], *Nacella* (*Patinigera*) *concinna* is well adapted to the near-shore environment. It is therefore perhaps surprising that it is the only Antarctic prosobranch known to produce a pelagic larva[3]. This reproductive strategy is uncommon among Antarctic benthic invertebrates, probably because low temperature and scarcity of food increase the difficulty of completing larval development[4].

An adaptation that may enhance *Nacella*'s reproductive success and offset high larval mortality is its unique spawning behaviour. In the austral summer, adults in the shallow sub-littoral form vertical stacks of up to eight individuals, each animal perched on the shell of the one below[5]. Stack formation occurs only at spawning and is not a response to crowding. The obvious explanation for the behaviour is that it significantly increases the likelihood of successful fertilization. It may also help to contain larvae in the preferred coastal environment.

This remarkable behaviour has now been photographed for the first time, at Signy Island, South Orkney Islands[6]. The illustration clearly shows the characteristic posture adopted by animals in the stack during spawning. □

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Stacks of limpets which form during the spawning season.

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