loss via photolysis.

Without the inclusion of reaction (1), significant column ozone reductions of up to 14% are predicted (*a* in the figure). The inclusion of (1) has a dramatic effect on calculated ozone depletion. The predicted column changes are approximately halved (*b*).

There is a significant conversion of NO_x to HNO_3 via reaction (1) so that the efficiency of the NO_x catalytic cycle ($NO + O_3 \rightarrow NO_2 + O_2$ and $NO_2 + O \rightarrow NO + O_2$) is reduced compared to runs with only gas-phase chemistry. In the model lower stratosphere including reaction (1), the HO_x ($OH + O_3 \rightarrow HO_2 + O_2$ and $HO_2 + O_3 \rightarrow OH + 2O_2$) and ClO_x ($Cl + O_3 \rightarrow ClO + O_2$ and $ClO + O \rightarrow Cl + O_2$) cycles now dominate ozone loss, so that additions of NO_x have a much smaller effect on ozone abundances.

Because of volcanic eruptions, the aerosol surface area is often well above the background level. We have performed other runs with γ=0.14 (ref. 7) and doubling the background aerosol surface area. The results show further reductions in the impact of NO_x emissions (*c*). There is even a slight increase (less than 1%) in the column ozone at most latitudes. Injections of NO_2 reduce the efficiency of the HO_x and ClO_x catalytic cycle by the homogeneous formation of HNO_3 and $ClONO_2$. The regions of small ozone production are thus due to a decrease in the rate of the HO_x and ClO_x cycle which is not compensated by the increase in the rate of NO_x cycle.

We conclude that the direct impact of high-speed civil transport aircraft on ozone is likely to be much less than previously thought, and that the magnitude of any ozone reductions will critically depend on the sulphate aerosol layer. To improve the modelling of the lower stratosphere, a key area in atmospheric chemistry, more laboratory studies and field measurements are required.

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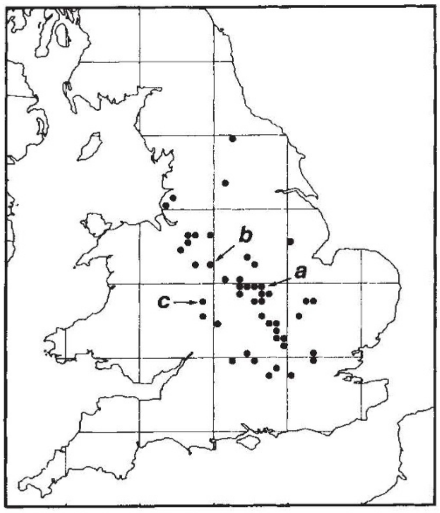
Amphipod also invades Britain

SIR — Following the report in Scientific Correspondence[1] of the invasion of the River Rhine by the immigrant amphipod *Corophium curvispinum* (var *devium*?), I would like to provide an update on the distribution of this species in Britain, where it has also become locally abundant in canals and rivers. First reported



Distribution of *C. curvispinum* var *devium* in the British Isles (with acknowledgements to the Biological Records Centre, Monks Wood) a, Grand Union canal; b, Trent–Mersey canal; c, river Severn.

in 1935 in the River Avon[2], and later (1970) in the Grand Union canal[3], this tubicolous crustacean has been turning up more frequently in nets whenever scrapings of canal revetments are made, particularly in the English midlands (see figure). It is now thought to be an important food for coarse fish and may have been spread in the ballast water or on the hulls of boat traffic[4].

Van den Brink *et al.*[1] suggested that the amphipod is successful in the Rhine partly because of its toleration of high salinities. Our studies[5,6] show that *C. curvispinum* is leakier to Na^+ and Cl^- and water than other freshwater amphipod species — for example Na^+ exchange is 18–30% of body content per hour compared to 4–10% in *Gammarus* species[7]. Cladocerans (such as *Daphnia*) have similar sodium turnover rates but, with lower internal Na^+ concentrations, probably expend less energy in replacing ions lost by outward diffusion. A feature of *C. curvispinum* is the physiological variability shown between different populations from different sites, notably in the ability to retain and replace Na^+ and Cl^-.

We believe that the species is becoming better adapted to low salinities (adults can maintain Na^+ balance in as low as 0.5 mM Na^+), and that these differences are indicative of differing degrees of adaptation to new freshwater habitats. Ion turnover and uptake rates are lowest in a River Severn population (mean annual environmental Na^+ = 1.2 ± 0.1 mM) and highest in the Grand Union and Trent–Mersey canals. Between 1980 and 1990, sodium permeabilities have decreased at some sites.

Many questions remain as to whether these changes are phenotypic or genotypic, and the picture may be further complicated by multiple introductions into Britain of stock at different times. Nevertheless, the direction of change is clear, towards lower permeability and, therefore, reduced ion turnover, features which *C. curvispinum* shares with other species[8] and which seem to be important in the evolution of freshwater faunas.

It would be interesting to see if the Rhine populations are as well-adapted to freshwater as British ones. It is probable that the Rhine observations represent the next stage in a westward colonization which started in the Ponto-caspian basin, aided by improvements in river and canal communications. The ancestors of some of the British populations may have been picked up by ships trading with north German ports following the amphipod's appearance in the river Elbe in 1918.

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Gas sample correction

SIR — P. Allard *et al.* (*Nature* **351**, 387–391; 1991) cited me as having performed an analysis of a gas sample from Paterno on the southern slope of Mount Etna. Not only did I not analyse this sample, the value given by Allard *et al.* is incorrect. Allard *et al.* claim that the CO_2-rich gas sample had a helium-isotope ratio (*R*/*RA*) of 6.6, but my analyses (to be published elsewhere) show that these ratios are 5.9–6.0.

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