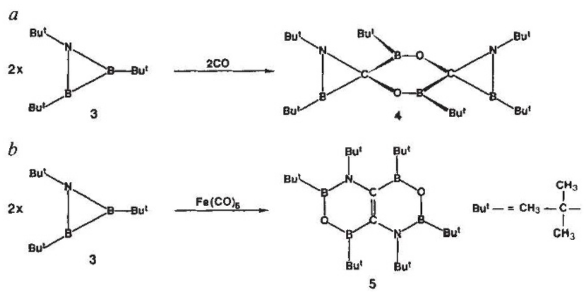

FIG. 2 Reactions of tri-*tert*-butylazadiboriridine (compound **3**) with carbon monoxide discovered by Paetzold *et al.*[4]. *a*, With CO gas, in solution in pentane at dry-ice temperature for 30 min, forming compound **4**. *b*, With CO produced from iron pentacarbonyl ($Fe(CO)_5$) by ultraviolet irradiation, at −30° C for 24 hours, yielding compound **5**.

an isomer of **4** (Fig. 2*b*). In this case the product has a bicyclic structure resembling naphthalene but the central group of ten atoms do not form a fully planar arrangement. Rather, the central six atoms are in a single plane with the outer pairs (B–O) being displaced above and below the plane of the central atoms. The structure was again confirmed by X-ray crystallography and spectral analysis.

The structures of these products — which bear little resemblance to the reagents, let alone one another — clearly took Paetzold and his colleagues by surprise. Indeed, the fact that carbon monoxide reacts at all with compound **3** contrasts strongly with its inert behaviour towards the non-cyclic analogue of **3**, $Bu^t(Me_2N)B–B(NMe_2)Bu^t$. How, then are the reactions to be understood?

First, three-coordinate boron compounds have only six electrons in the outer shell of the boron atom and are thus usually electrophilic. Direct attachment of two boron atoms to each other creates a situation in which both are in competition for any available electron density, and compounds containing such an arrangement of atoms could therefore be described as superelectrophilic. Such compounds are rarely stable unless the groups attached to the boron atoms are able to contribute some charge, as (for example) dimethylamino groups can. In the case of compound **3** there is only one nitrogen atom to donate a pair of electrons to two electron-seeking boron atoms and the structure is also strained owing to the three-membered ring. Thus, although the compound may be formally aromatic (having 2 π-electrons in a continuous ring), it is not too surprising that it is also highly reactive.

A clue to the reaction taking place (Fig. 2*a*) can be gained from reactions of carbon monoxide with simple trialkylboranes[5] (Fig. 3). In such reactions carbon monoxide 'coordinates' to the trialkylborane (compound **6**) to give a species (compound **7**) which can rearrange to an acylborane (compound **8**). This is unstable and dimerizes and rearranges further to give a dioxadiborinane (compound **9**). The production of compound **4** from compound **3** could take place by an entirely analogous sequence involving cleavage of the B–B bond during the first rearrangement step.

The formation of compound **5** (Fig. 2*b*) is more difficult to explain, involving as it does the complete separation of the carbon and oxygen atoms of the original carbon monoxide. The German researchers offer no suggestion as to how it may be formed. However, the long reaction time and the irradiation with ultraviolet light are likely to be significant. Future experiments should be designed to establish whether compound **4** rearranges into compound **5** on irradiation or whether an intermediate in the production of **4** can be diverted to **5** by irradiation.

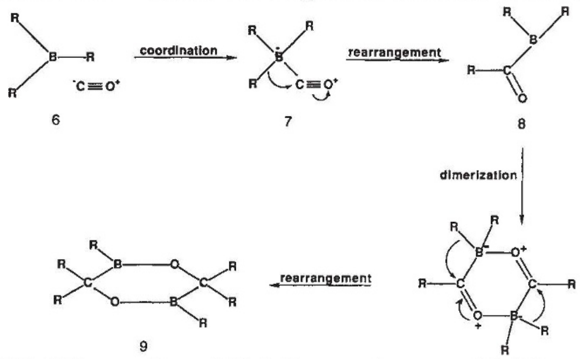

FIG. 3 The reactions of trialkylboranes (compound **6**; R is an alkyl group) with carbon monoxide involve several rearrangement steps (curly arrows correspond to movement of electrons): a clue to the mechanism in the reactions discovered by Paetzold *et al.*[4]?

Whatever the precise mechanisms of reactions such as these may be, the ability to create complicated molecular gymnastics in such apparently simple ways offers opportunities for the design of new methods which will reduce the number of synthetic steps needed to build up complicated structures. Even more exciting is the prospect of formation of new types of chemicals with properties as yet unimagined. □

Keith Smith is in the Department of Chemistry, University College of Swansea, Singleton Park, Swansea SA2 8PP, UK.

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DAEDALUS

Cloud straining

KITE flying is one of the most pleasant of pastimes. Only modest skill is needed to manipulate the control lines of the kite and keep it aloft despite the gusts and fluctuations of the wind. A DREADCO engineer, more or less for fun, has recently automated this skill. Sensors on his 'autokite', coupled via its control cables to a computerized manipulator on the ground, enable it to be flown aloft and stabilized at any altitude without human intervention. No matter how the wind fluctuates, the autokite reacts to maintain its height.

Daedalus is now wondering how to exploit this neat invention. A permanent and stable kite would, of course, make a useful radio antenna or a platform for aerial photography. A large array of them, flown on command, might carry aloft an extended wire fence as an instantly erected protection against cruise missiles. But the most intriguing use, he reckons, is in rain making. Several projects round the world are studying the use of 'fog nets' to extract liquid water from mountain-top clouds. As the fog blows through the fine nylon mesh, some of the suspended droplets strike the fibres; a steady stream of water trickles down the net and can be collected. A square metre of such a net can trap 3 litres of water a day. If the net could be deployed in the sky, it could extract water from those tantalizing clouds that so often blow by without depositing rain.

So Daedalus is designing a really big 'flying net' to intercept the clouds. A long array of autokites will suspend a huge extended fog net between them. With proper design, the wind blowing through the net will generate enough lift to keep it up, so the autokites will merely have to keep it properly extended and positioned. Ground commands will lift the massive web to the right altitude for the local clouds, which will blow through it and deposit much of their water. This could be allowed to spill out of the bottom of the net in intense sprays of local rain; but a better arrangement would channel it down pipes in the control-cables for collection on the ground.

Thus our infuriating dependence on the weather would almost be eliminated. Even in rainy Britain, droughts often occur; and very little of the rain that does fall is usefully collected. But arrays of cloud-straining autokites will capture water all the time — except on those rare and perfect days of cloudless blue. And all of it will be collected; for storage by a private owner, or distribution through the public water-system. Cloud-fresh natural rainwater, unhardened by chalk and unsullied by lead pipes, should be pure enough for all domestic needs. It might even steal the market from those pretentious natural mineral waters.

David Jones