The PCB story: seagulls aren't funny any more

Monsanto, sole UK and US manufacturers of PCBs, have accepted their ecological hazards before many biologists, and voluntarily slashed sales. The PCBs are toxic, highly persistent industrial chemicals which, like DDT, now contaminate much of our environment and leave huge residues in seabirds. But this is a global problem. Will Monsanto's competitors act too?

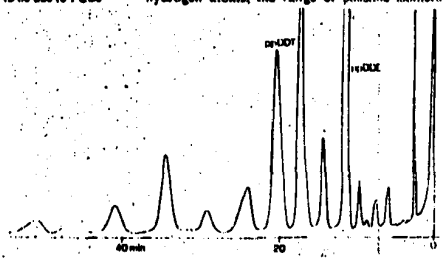
Jon Tinker

Monsanto Chemicals Ltd, sole north American and British manufacturers of the toxic and highly persistent group of industrial organochlorine chemicals called PCBs, has voluntarily and drastically curtailed its sales of these substances so as to minimise the risk of further environmental contamination. The ban in Britain came quietly into effect on 1 March, 1971, and the last few "uncontrollable" PCB orders will leave Monsanto's plant at Newport, Monmouthshire, during the next few weeks.

Such action, taken without any overt government pressure, is almost certainly unique. In one sense Monsanto's move may be seen as a desperate throw to retain at least part of a lucrative market which might otherwise be entirely lost. Indeed, the company makes no effort to deny that it believes the partial PCB ban to be in its own long term interests. But this cannot be allowed to obscure the unprecedented nature of a major industrial polluter accepting charges against a product long before guilt has been scientifically established.

For at least 18 months, Monsanto has been working towards the conscious abandonment of a product which has become too hot to handle. "Two years ago", I was told recently in Monsanto's European head office in Brussels, "the seagull problem was a joke in this building. Gradually we stopped laughing". How did this come about?

PCB stands for polychlorinated biphenyl. Carbolic acid or phenol C_6H_5OH gives the monovalent phenyl radical C_6H_5, and a biphenyl allows plenty of scope for the substitution of chlorine for one or more hydrogen atoms. A PCB molecule contains from one to six chlorine atoms, and since each chlorine can replace any one of 10 hydrogen atoms, the range of possible isomers is enormous. Thus Monsanto's Aroclor 1254 (12 carbon atoms and a 54 per cent chlorine content) consists mainly of pentachlorbiphenyl, yet it contains about 50 different PCB isomers and homologues.



Gaschromatogram of a purified extract from a sea eagle. The unlabelled peaks were at first thought to represent further metabolites or breakdown products of DDT, but later turned out to be due to PCBs

The PCBs were discovered in the late 19th century, but it was not until about 1930 that industrial applications were found: PCBs were excellent plasticisers for paints and adhesives, and provided fire-resistant electrical and hydraulic fluids. By the early 1960s Monsanto held a monopoly in both Britain and north America. Thus when the first suggestions came that the PCBs were toxic and extremely persistent Monsanto felt especially vulnerable.

The PCB hazard came to light by accident. In the early 1960s laboratories on both sides of the Atlantic were undertaking monitoring by gas liquid chromatography of organochlorine insecticide residues in wildlife. In addition to the peaks which were known to correspond to pesticides such as DDT and dieldrin, another series of unidentified peaks often appeared on the chromatograms. At first these were put down to unknown metabolites or breakdown products of insecticides, but in 1966 S. Jensen (see New Scientist, vol 32, p 612) showed that the peaks belonged to PCBs.

Since then it has been usual to measure PCB as well as insecticide residues in wildlife, but precise quantification is still not possible. Too many PCBs exist. Although it is the higher chlorinated homologues which seem to be most persistent, a chromatogram from a single specimen may well contain a dozen identifiable PCB peaks, and even one peak may later be resolved into two isomers. Thus estimates of the quantities of PCB present are normally only given to the nearest 10 per cent.

A recent review (I. Presst et al: Environmental Pollution, vol 1, p 3) showed that PCB residues in British freshwater fish feeding birds were up to 900 parts per million, in bird eating predatory birds up to 70 ppm, and in seabirds up to 8 ppm. PCBs may well be more poisonous than DDT at low doses, but the acute avian toxicity is about a tenth of DDT's. Symptoms of birds given fatal doses of PCB in the laboratory included enlarged kidneys, leg paralysis and body and wing trembling. PCBs share with DDT a very low water solubility, relatively high solubility in fats and the ability to become absorbed onto mud and other small suspended particles: with non-biodegradability a recipe for environmental danger.

Although the first Monsanto heard of the apparent persistence of PCBs was when they read Jensen's paper in 1966, these chemicals must have been contaminating wildlife for a quarter of a century before that. PCBs have recently been detected in the feathers of birds collected as long ago as 1940. During 1967 Monsanto pressed ahead with the analytical techniques necessary to confirm Jensen's work, and, as Alf Vodden, head of the company's fluids R & D in Europe, told me last week: "We soon became aware that PCBs could well pose an ecological hazard".

This is where the PCB story becomes unusual. Instead of directing its research and propaganda towards proving to its own (if to nobody else's)

MONS 087127



Norbert Dahlström

satisfaction that PCBs could not possibly do any damage. Monsanto accepted the ecologists' case long before it had got much beyond a shrewd suspicion.

It is instructive to compare this attitude with that of the insecticide manufacturers towards dieldrin and DDT at the same period. Although the charge that these insecticides had caused population crashes in hawks and eagles throughout Europe and north America was sufficient to convince any jury, some of the companies concerned (notably Shell, the main UK manufacturer of dieldrin) refused for years to admit the obvious.

Dr Norman Moore wrote recently (Biologist, vol 16, p 157): "It is particularly difficult for the chemist to realise that in unravelling complex ecological problems, logic and circumstantial evidence have to be invoked as well as experiments". Shell and some sectors of the insecticide industry failed to see this in respect to the organochlorines until the last possible moment; with PCBs, Monsanto grasped it before many ecologists.

Norbert Dahlström, Monsanto's 34-year old organic chemicals manager for Europe, last week explained to me the risks his company sees in the PCBs: paradoxically, using arguments which even some ecologists might find alarmist. "As soon as we realised the very persistent nature of this product, we recognised it to be a major problem. It is not highly toxic to mammals, but the LC/50 for brown shrimps is about 0.03 ppm —not all that much less than DDT, which is 0.001. Residues of up to 1000 ppm have been found in seabirds in America, and like DDT it disrupts the calcium metabolism and thus hormone balance. You get thin shelled eggs and behavioural changes. You just don't know *what* the long term effects will be".

Monsanto work has confirmed the conclusions of independent ecologists that it is primarily the aquatic and marine environments which are at risk from PCBs. This corresponds to the ways in which the products get loose: primarily down the drains, with some being burned and then falling in rain. Unlike the insecticides, which are deliberately sprayed onto crops, there is no soil contamination problem. "Once you've established that PCBs have similar toxic effects to DDT", argues Dahlström, "that they are persistent and that they accumulate, I don't see any other conclusion than that environmental harm is being done".

To suggest that this judgment of Monsanto's caused them to withdraw the product immediately would be too good to be true. Monsanto admits that the objective fact that PCBs are harmful is not the sole reason for action. "We don't want to pretend to be holier than thou. We're in business to profit and to prosper", said Dahlström, and promptly gave me four additional reasons why a partial ban on PCB makes sense to Monsanto.

First, as a US company it can see better than its European competitors which way the pollution wind is blowing. "I don't think it's a scare which will go away," Dahlström says, and Monsanto feels certain that pressure to restrict PCBs will come sooner or later. "We want to be master of our own fate, rather than to be swept overboard on a wave of political emotion". This is probably a stronger argument in the US than in Britain. Although both countries would need to legislate to ban PCBs, and such legislation could not be enacted very quickly, the US political system embodies such inordinate respect for authority that the President could probably bludgeon Monsanto into a "voluntary" ban. Monsanto scientists are under no illusion about the strength of the environmental lobby: they were manufacturers of cyclamates, which were banned last year as a result of what industry would call unscientific hysteria.

Additionally, although Monsanto naturally will not discuss it, I suspect that there is in the United States a serious risk of legal action against PCBs. US common law allows a suit by any citizen who claims he has been injured, even as notionally as by PCBs fouling his environment. As sole manufacturer, Monsanto would appear to be vulnerable.

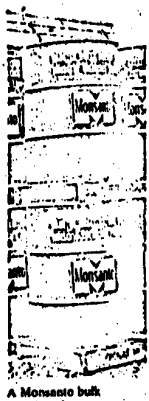
Secondly, Monsanto feels that PCBs in the electrical industry are controllable and need cause no environmental contamination. Once governments started arm-twisting, these applications might well disappear, together with those which do cause pollution.

Thirdly, Monsanto is anxious to market the anti-pollution technology which it has been forced to develop. To do this successfully, a clean environmental slate will certainly help.

Fourthly —and this has perhaps been the deciding factor— Monsanto's monopoly position in the two largest PCB markets means that it can act altruistically without too much risk of competitors taking its place.

So what exactly did Monsanto decide to do? First, it concluded that PCB applications fell naturally into two distinct categories: controllable and non-controllable. The controllable uses are in the electrical field, where PCBs replace mineral oils as the dielectric fluid in capacitors, as the coolant in transformers, and as a fire-resistant ingredient in heat transfer media. These uses are in enclosed, sealed systems. There are only a few, large customers. PCBs have indisputable value here on safety grounds and there are no alternatives.

All the other uses are non-controllable. PCBs are used as plasticisers in a wide range of paints, sealants, adhesives, and other surface coatings. They have some miscellaneous applications in thermostats, food, and pharmaceuticals, and as a component in industrial hydraulic fluids. Here there are hundreds of small customers, mainly supplied through agents. Some of the end products —marine paints for example— are in direct contact with the environment. Others involve aqueous waste going



A Monsanto bulk container for transporting polychlorinated biphenyls

down the drain, or incineration releasing the molecules undamaged into the atmosphere. In most cases there are alternative chemicals.

Quite fortuitously, where PCBs are essential, pollution is unlikely and control of a few large users is possible; where PCBs are bound to cause pollution, they are replaceable. The chemical and commercial gods could hardly have planned it better.

So letters went out to all Monsanto's PCB customers, advising them that from 1 September, 1970, in Canada and the US, and from 1 March, 1971, in Britain, what were considered non-controllable uses would no longer be supplied. Can this ban be evaded? Norbert Dahlström thinks not. "There aren't many capacitor manufacturers, and we know them all. If someone new suddenly came along and said he wanted PCB for capacitors we'd be very suspicious".

As for the controllable applications, Monsanto has effected a five point safety programme. For the past 18 months there has been an education campaign to get customers pollution-conscious. In the UK, five capacitor manufacturers have 80 per cent of the market, so a well-briefed Monsanto representative visited each of them for a week. Secondly, bulk discounts have been increased and bulk deliveries encouraged. For those who have to buy in small drums, there is a free collection service for unwashed empties. Thirdly, Monsanto has extended its acceptance of spent PCB fluids for reclamation. Fourthly, any unreclaimable material—contaminated electrical goods, drainage sludges, filter kegs etc—is to be collected free by Purle Bros and incinerated at a high enough temperature to oxidise the PCBs. Purle will send the bill to Monsanto, not to the customers. Fifthly, users are being encouraged to switch to less chlorinated PCB homologues; although these are more toxic, they are more easily biodegradable and thus less persistent.

"Aroclor isn't going to get any cheaper by all this", Dahlström stresses, and the electrical industry has been told this too. "We were quite apprehensive when the letters went out last November", he recalls, but on the whole the big UK customers have accepted the Monsanto arguments that tighter control is the only long term way of avoiding a total ban. How far the electrical industry will be able to convince *their* customers remains to be seen.

But the main sufferer will inevitably be Monsanto itself. While the company refuses to divulge any exact figures, well over 50 per cent of its UK Aroclor business will certainly disappear. Over 25 per cent of current sales may be lost altogether, since Monsanto does itself not sell the replacements; in north America, the proportional loss will be higher still. The permanent drop in annual turnover may well be in the region of $25 million.

To this improving tale of capitalistic self-sacrifice and environmental virtue, there is one snag and a possible bonus. The bonus could be the most powerful reason of all why Monsanto has voluntarily introduced its PCB restrictions: it is already believed to be moving along the road towards a biodegradable series of PCBs. Should these products one day prove marketable, no temporary sacrifice would be too great to avoid the market being compulsorily closed for ever.

The snag is less conjectural: PCBs are not subject to any patents: anyone who can afford the plant can make and sell them. Monsanto and another firm manufacture PCBs in Japan. Bayer makes them in Germany, Prodelec in France and the small firm Flix in Spain; I understand that there are also PCB plants in Russia, Poland and Czechoslovakia. Outside Canada, the USA and Britain, the market is open, and although Monsanto would like to make its partial ban worldwide. Dahlström insists that his company has gone as far as it can in isolation. My own investigations suggest that informal deals have already been made with competitors not to take up Monsanto's abandoned British and American business, but because of monopoly and anti-trust legislation these arrangements can be neither public nor legally binding. Additionally, I have good reason to believe Monsanto has received private assurances that the British government would do its best to thwart any foreign sales drive here.

But there will be little point in protecting North Sea birds and fisheries from British PCBs if they are still being contaminated from the continent. Monsanto agrees that it has discussed the problem with its European and Japanese competitors, but naturally is unable to indicate what their reactions are.

My information is that there are probably two key factors: Sweden and Bayer. Swedish government scientists are already considering an enforced ban, and Sweden's large heavy electrical industry is desperately anxious to forestall it. Monsanto makes PCBs only in Britain and the US, so (owing to EFTA) it has sizeable sales in Sweden, Bayer's PCBs also sell strongly there, and a deal between the two giants in Sweden would almost certainly be followed further south. The smaller firms, which are themselves customers of the big companies for other chemicals would then swing into line. My guess is that by the end of 1971, Monsanto's PCB policy will have spread to the rest of Europe. The urgent need then will be for international action, perhaps via the UN environment conference in Stockholm next year, to enforce a global ban. Without it, PCB factories will inevitably be set up in Brazil and other third world industrial centres.

Whether Monsanto's responsible initiative on PCBs springs from abstract moral principles or from enlightened self interest is a question which would have fascinated J. S. Mill and the English utilitarian philosophers. Ecologically, ethical motivation is irrelevant and action is all that matters. By any objective yardstick, Monsanto has lodged a substantial credit in the environmental bank. Hopefully, the PCB story has also educated at least one segment of the chemical industry. "Ten years ago we mainly did acute toxic work on a new product", say Dahlström. "Now we start with a close look at its biodegradability".

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