trillion (ppt) in bottom feeding micro-organisms, may end up as a concentration of several parts per million (ppm) in fish. Typically, therefore, organisms high in the food chain show relatively high concentrations of PCBs. Baltic Sea mussels averaged 4.3 parts per million (ppm) in their fat, herring averaged 6.8 ppm, seals 34 ppm, and guillemot eggs 250 ppm.[5] Levels in fat are generally higher than in the rest of the body because PCBs concentrate in animal fats. Thus a peregrine falcon was found to contain 65 ppm overall but 1980 ppm in its fat.[6] An extreme case was that of a Swedish eagle owl whose fat contained 12 000 ppm of PCBs, or 12 g per kg.[4] Concentration generally increases with age, but stress, starvation and reproduction may cause the release of the fat-stored PCBs into the bird's system.

PCBs are hazardous to human health if consumed directly via food contamination. Two serious incidents have occurred in Japan (1968) and Taiwan (1980): rice oil contaminated by PCBs leaking from a factory pipe, caused the symptoms of 'Yusho disease' in over 3000 people. These symptoms — which include the serious skin condition chloracne, metabolic disturbances, and adverse effects on bones, joints, and teeth — were produced by ingestion of as little as 0.5 grams of PCB. There is also statistical evidence that occupational exposure may lead to lung cancer.

The effects of PCBs on animal life vary. Their acute toxicity to birds and mammals is relatively low, less than that of DDT. However continuous low-level exposure and the resultant build-up in tissue leads to a variety of effects including damage to vital organs, especially the liver. More importantly, PCBs share with DDT the ability to interfere drastically with reproduction in some animals. Quite small quantities of PCBs affect calcium metabolism in birds: the result, in species such as peregrines, pelicans, sea eagles, gannets and frigate-birds is a thinning of egg-shells. Such eggs are much more likely to break, and hatching success may also be affected by lower water retention.[6]

Many invertebrates are also killed by quite low concentrations of PCBs.

Recognizing the sensitivity of aquatic life, and the effects of accumulation, a number of authorities have proposed standards for water quality. Since the effects of chronic low level exposure to a given level of any chemical can never be known for certain, water quality standards are partly arbitrary; responsible authorities might be expected to err on the side of caution. Thus the United States Food and Drug Administration allows a maximum level of 1 ppt in drinking water; the United States National Academy of Sciences recommended a maximum of 2 ppt to protect aquatic life,[9] while the World Health Organization has suggested 5 ppt as a maximum for unpolluted water.[4]

PCBs in New Zealand

Our research shows that between 100 and 500 tonnes of PCBs have been used in closed systems in New Zealand. We have no idea of the amount of PCBs that have been used outside controlled systems in New Zealand, but at least 14 tonnes was imported for such uses in 1973. New Zealand was still importing PCBs for use as plasticisers in 1977, four years after the OECD had strongly recommended that they be used only in closed systems.

Research by Solly and Shanks shows that environmental contamination by PCBs is local, if not national. Of 621 mammal and bird specimens collected from the main and outlying islands, 57 specimens contained at least 0.1 ppm of PCBs. The highest levels, in the range of 4.98–7.61 ppm, were found in predators — kingfisher, gannets, giant petrel, harrier, sea-leopard and fur seal.[10] Two small scale analyses of human autopsy fat samples showed detectable levels in all the subjects: one 1974 survey of 51 samples showed an average concentration in fat of 0.82 ppm while a 1975 study of 35 samples averaged 0.35 ppm. The highest level was 4.67 ppm, and levels increased with age.[11]

New Zealand is unlikely to suffer disasters such as the 'Yusho' incident, and our waterways will not become contaminated to the extent of some American rivers such as the Hudson. Nonetheless, we have large quantities in use and in storage awaiting disposal, which could add to the existing contamination. PCBs present a hazard because:

- People who are unaware of their presence or possible effects are unable to take precautions when handling PCBs or equipment containing PCBs.
- Equipment may be accidentally damaged and PCBs spilled.
- Improper disposal of all or any existing units creates a long-term hazard.

PCB safety in New Zealand is hindered by widespread ignorance even among those whom we expected to be well informed. We contacted the appropriate departments of the Technical Institutes: of the 12 who replied, only one indicated that it gives its electrical students a good training in the hazards and safe handling of PCBs. Three others made some reference to PCBs, while eight make no mention at all; indeed, four of these did not know about the hazards of PCBs themselves. Several of these Institutes have asked us for material suitable for incorporation in their course.

Many electrical workers and others who *are* aware of the hazards of PCBs will find it difficult to know when to take precautions as many units containing PCBs are unlabelled. This includes many of the several thousand capacitors used by the electrical supply authorities for power factor correction. Indeed, our enquiries show that many manufacturers are themselves ignorant of the contents of capacitors they use in their own products.

An unfortunate result of this lack of awareness is that numbers of defective capacitors have been 'put out with the rubbish'. The Health Department takes the view that to dispose of what is calls 'small quantities' of PCBs — up to five litres — in rubbish tips is a safe practice. We disagree. Rubbish tips provide a long-term source of PCB contamination, through slow leakage and possibly plant uptake. Moreover, the organic material in a tip eventually decays, leaving the PCBs free to recirculate in the environment.[2]

The Health Department's public utterances, and replies to enquiries, suggest that they do not fully appreciate the potential hazards of PCBs.

However it is the long-term, chronic effects on health which are of significance.[2] This is the view shared by the industry: Landis and Gyr, a former manufacturer of capacitors containing PCB, takes the view that *no* PCBs regardless of quantity, must be placed in tips.[12] Monsanto itself states that high temperature incineration is the only safe method of disposal.[13]

Recent controversy over a trial burn of PCBs at the Golden Bay Cement Company's kiln, Tarakohe, shows that even within New Zealand officialdom there is much disagreement about the safety of PCBs. On the one hand, the Health Department believes that PCBs are not particularly dangerous. The Electricity Department, however, circularised all registered electricians in 1979, informing them that PCBs are 'quite toxic', and stating that they must not be dumped. The department recommends that 'Precautions should be taken by wearing protective clothing, plastic gloves, and face protection'.[14]

The question of the environmental effects of PCB incineration at Tarakohe has also provoked a variety of official responses. High temperature incineration is usually regarded as a safe means of PCB destruction, and a 1982 trial burn of PCBs in the rotary kiln at Tarakohe more than met the United States Environmental Protection Agency's standard of 99.9% destruction.[15] Local opposition has come from Federated Farmers, horticulturalists, fishermen, and others. They claim that the Health Department's supervision of the trial was 'sloppy', that the PCBs were handled in a lax manner, and that monitoring of stack gases was inadequate. They argue that a spill in Golden Bay could ruin the shellfish industry and have harmful effects on waders and other wildlife on Farewell Spit. In reply, J. Roxborough, the Nelson District Medical Officer of Health, claimed that the media had 'emotionalised and sensationalised' the danger and that if a drum of PCB were to fall into the Bay no more than an acre of seabed would be affected.[16] In turn, a Fisheries scientist stated that even a small spill could cause serious damage to the mussel and scallop and to Farewell Spit.[17]

This debate between supposed experts would border on the farcical were it not for the fact that there is certainly *a* risk of environmental damage from the improper disposal of PCBs. Even those who confidently assure us that it is perfectly safe must acknowledge that PCBs, like any other toxic, bioaccumulative, long-lasting chemical, needs to be handled properly. The argument is really about the degree of risk, and extremist comments on both sides are not likely to lead to the best solution. It is not true, as has been claimed, that a spilled cupful of PCBs could destroy Golden Bay. It is pointless to quote horrendous statistics for PCB concentration in salmon from Lake Michigan as if they represented the likely