The problem of lead poisoning in Lebanon has not received the attention that it had in many other countries of the world. It may seem that the problem is even worse than it would appear because the largest amount of fishing is at the points of highest lead concentration. The point of highest lead concentration is the west end of Ras Beirut, point 13 in Figure 1, which is heavily fished. The dock area which is a centre of net fishing in Beirut, also has a high concentration of lead.

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Polychlorinated Biphenyls in North Atlantic Seabirds

Polychlorinated biphenyls are usually thought to be discharged in industrial effluents and therefore to be commonest in inshore waters close to centres of industry. It now appears that high concentrations are found in pelagic-feeding seabirds from the North Atlantic, far from possible industrial sources of these compounds.

Organochlorines have been known to be present in British seabird eggs for a decade (Moore & Tatton, 1965), and substantial amounts in a pelagic seabird frequenting one of the remotest North Atlantic breeding sites, the Bermuda petrel *Pterodroma cahow*, and traces in Antarctic species, for half that time (Wurster & Wingate, 1968; Sladen *et al.*, 1966). At first these were identified as pesticides and their metabolites, but more recently polychlorinated biphenyls (PCBs) used in industry have been detected as well, at first as a source of interference in other estimations and then as additional contaminants (Jensen, 1966; 1972) in a number of highly polluted areas in Europe and North America such as the Baltic (Jensen *et al.*, 1969), Dutch Waddenzee (Koeman *et al.*, 1969) and coast of California (Risebrough *et al.*, 1968).

Their presence was noticed in British seabirds such as the guillemot and kittiwake in the first report of their occurrence in British wildlife (Holmes *et al.*, 1967) but, while a few quantitative estimations are given in one review of their occurrence in British birds (Prestt *et al.*, 1970), and considerable concentrations were found in the livers of some of the large auks washed up starving around the Irish Sea in the autumn of 1969 (Holdgate, 1971), there is still comparatively little published information available on their occurrence in the more pelagic species in the North Atlantic. We are therefore placing on record the results of a preliminary examination of a number of birds collected in the course of other work in areas between Britain and the Arctic.

Methods

The specimens examined were selected to include a representative range of the more marine species and types of body available for analysis. All tissue samples were subjected to Soxhlet extraction overnight with hexane: acetone. After evaporation of the solvent, the residue was made up with hexane. Muscle and liver samples were cleaned up on florisil columns directly, while fat and oil samples were subjected to dimethylformamide liquid-liquid partition, (De Faubert Maunder *et al.*, 1964) before florisil. PCBs along with DDT compounds were separated from DDD and pp'DDT on silica columns (Holden & Marsden, 1969) or more commonly by saponification with alcoholic KOH. PCBs were identified by the peak pattern obtained on three gas chromatography columns, SE-30, QF1/XE-60 or SE30-QF1 compared with a peak pattern obtained using a standard mixture Aroclor 1254 (Monsanto). The identity of the peaks was confirmed by mass spectrometry. PCBs were quantified using a method similar to that of Risebrough *et al.* (1968). This method gave excellent results using Aroclor 1254, but the relative peak heights in the seabird samples are different from those with Aroclor 1254, introducing some inaccuracies. However, the relative peak heights in all the seabirds were similar and direct comparisons between them can be made with greater accuracy. While DDE, which was the commonest of the other organochlorines present, cannot be separated satisfactorily from a PCB with a similar retention time, in the majority of the samples where the PCB/DDE ratio is low the interference by PCBs in the determination of DDE is fairly small. Where the ratio is larger than ten, the interference is substantial. In the results given in Table 1 the DDE value is calculated from the total height of the peak with a retention time equal to that of DDE. Thus where the PCB/DDE ratio is large, it should probably be even greater than that recorded.

Results

The results are interesting in a number of respects. In the first place, the relation found between PCBs and

TABLE 1 Polychlorinated biphenyls in seabirds.

Species	Origin	Date	Weight	Liver	Muscle	Fat	Ratio		Notes
Fulmar *Fulmarus glacialis*	60°08'N 04°00'W	5.71	850g	3.2	3.1	57	7	ca	
	60°31'N 04°52'W	5.71	880g	5.0	9.4	103	10	ca	
	60°22'N 04°31'W	5.71	890g	1.2	1.7	32	6	ca	
	60°26'N 04°39'W	5.71	965g	1.5	2.3	42	5	ca	1
	59°54'N 03°45'W	5.71	630g	2.1	2.8	40	6	ca	
	60°21'N 00°29'W	7.71	850g	5.5	3.9	55	5	ca	
	57°00'N 00°31'W	7.71	750g	5.9	4.1	–	6	ca	
	Bear Island	7.72		1.6	2.6	12.9	5	ca	
	Davis Strait	8.72	700g	4.2	3.7	–	2	ca	
	Fife	11.71	–	17.8	5.2	–	4	ba	2
Great shearwater *Puffins gravis*	Trinidad	6.72	385g	0.7	0.1	–	0.6	b	
	Trinidad	6.72	447g	0.5	0.1	–	1	b	
Manx shearwater *Puffinus puffinus*	Rhum, Inverness	3.71	–	0.5	0.4	–	2	ca	
	Rhum, Inverness	3.71	–	0.2	0.2	–	2	ca	
British storm-petrel *Hydrobates pelagicus*	Shetland	6.72	–	[illegible]	3.6	74	8	ca	
	Shetland	6.72	–	3.2	3.3	–	5	ca	
	Shetland	6.72	–	7.0	6.4	–	8	ca	
	Aberdeenshire	9.71	20+g	2.2	18.7	–	5	ba	3
Gannet *Sula bassana*	Fife	3.72	3500g	2.2	2.1	[illegible]	7	ba	4
	Stornoway	5.72	2700g	3.0	3.2	[illegible]	[illegible]	ba	4
	Shetland	5.71	–	44.5	12.9	–	5	ca	
Shag *Phalacrocorax aristotelis*	Loch Riddon, Argyll	9.70	–	0.2	0.3	–	5	ci	
Great skua *Catharacta skua*	59°54'N 03°45'W	5.71	–	18.3	32.0	–	[illegible]	c	
	61°15'N 00°15'E	7.71	1400g	6.2	18.0	–	8	c	
	59°58'N 04°03'W	5.71	–	5.9	15.5	–	[illegible]	ca	5
	Foula, Shetland	7.72	–	4.1	11.0	–	4	ba	5
	Foula, Shetland	7.72	–	4.2	10.2	–	4	b	
	Foula, Shetland	7.72	–	0.05	–	–	3	bi	
Arctic skua *Stercorarius parasiticus*	58°48'N 00°16'E	7.71	350g	3.6	1.5	–	4	ca	
Glaucous gull *Larus hyperboreus*	Bear Island	7.72	1300g	311.0	88.0	–	3	ca	6
	Bear Island	7.72	1500g	13.0	36.0	535	[illegible]	[illegible]	
	Bear Island	7.72	1590g	40.0	11.0	–	3	ca	
	Bear Island	7.72	1550g	6.0	8.0	–	[illegible]	ca	
	Bear Island	7.72	1850g	34.0	20.0	–	3	ca	
	Bear Island	7.72	1900g	28.0	11.0	–	[illegible]	ca	
Great black-backed gull *Larus marinus*	North Rona	6.72	–	6.8	–	–	[illegible]	ba	
	North Rona	6.72	–	0.2	–	–	[illegible]	bi	
Lesser black-backed gull *Larus fuscus*	Faroes	7.71	–	9.4	3.9	–	5	[illegible]	
	Faroes	7.71	–	6.4	3.4	–	5	ca	
	Faroes	7.71	[illegible]00g	[illegible]	7.8	–	4	ca	
	62°00'N 06°12'W	5.71	[illegible]50g	12.7	10.2	[illegible]5.6	6	ca	
Herring gull *Larus argentatus*	Faroes	7.71	–	12.6	13.4	–	4	[illegible]	
	Aberdeenshire	5.71	1073g	0.2	0.2	–	[illegible]	ca	
	Isle of May, Fife	[illegible]	–	0.2	0.5	8.8	[illegible]	ca	
	Isle of May, Fife	5.72	–	1[illegible]	1.2	34.1	8	ca	
	Isle of May, Fife	5.72	–	0.6	1.0	8.6	7	ca	
Kittiwake *Rissa tridactyla*	60°20'N 04°25'W	5.71	420g	3.5	[illegible]	24	12	ca	
	60°31'N 04°52'W	5.71	380g	[illegible]	[illegible]	–	60	ca	
	60°08'N 04°00'W	5.71	445g	2.1	0.5	1[illegible]	15	ca	
	60°22'N 04°31'W	5.71	320g	20.6	5.6	–	40	ca	
	58°12'N 00°13'E	7.71	400g	4.5	3.8	–	[illegible]	ca	
	57°20'N 00°20'E	7.71	300g	3.4	4.2	–	[illegible]	ca	
	57°00'N 00°31'E	7.71	300g	4.6	4.5	–	[illegible]	ca	
	Bear Island	7.72	450g	1.6	3.7	18	[illegible]	ca	
	Davis Stait	8.72	325g	3.2	1.9	–	25	ca	
	58°03'N 02°20'W	2.71	–	0.3	0.4	[illegible].6	6	ci	
	60°22'N 04°31'W	5.71	395g	4.8	3.3	–	30	ci	
Arctic tern *Sterna paradisea*	Shetland	6.72	–	0.7	0.3	–	7	ca	
	Shetland	6.72	–	0.8	0.3	–	[illegible]	ca	
Black guillemot *Cepphus grylle*	Stornoway Hebrides	1.72	–	0.2	0.2	–	4	ca	
Common guillemot *Uria aalge*	Faroes	7.71	854g	0.6	0.4	–	4	ca	
	Faroes	7.71	840g	[illegible].1	0.7	–	4	ca	
	Faoes	7.71	86[illegible]g	0.8	0.4	–	4	[illegible]	
	Faroes	7.71	864g	0.6	0.7	–	4	[illegible]	
	Faroes	7.71	968g	0.6	0.4	–	3	ca	
	58°00'N 02°22'W	7.71	1000g	0.9	0.5	–	3	ca	
	58°00'N 02°22'W	7.71	–	7.6	4.6	–	24	ca	
	58°48'N 00°16'E	[illegible].71	500g	0.5	0.2	–	[illegible]	ca	
	Bear Island	7.72	950g	0.8	0.8	4.7	[illegible]	ca	
	57°33'N 01°43'E	7.71	1100g	0.5	0.3	–	4	ca	7
	57°33'N 01°43'E	7.71	700g	0.04	0.03	–	5	[illegible]	7
	Loch Riddon, Argyll	9.70	850g	–	0.1	–	5	c[illegible]	
	Abedeenshire	8.71	1100g	0.1	0.1	–	[illegible]	[illegible]ar	8
	Shetland	6.71	–	6.0	1.2	–	3	ca	9
	Aberdeenshire	3.72	–	0.6	0.3	11.8	6	bi	10
	Prestwick, Ayr	9.70	–	0.2	0.2	–	7	[illegible]i	11

Species	Origin	Date	Weight	Liver	Muscle	Fat	ratio	Notes
Brunnich's guillemot *Uria lomvia*	Bear Island	7.72	975g	0.3	0.2	3.1	2	ca
	Bear Island	7.72	1100g	0.1	0.1	3.1	2	ca
	Davis Strait	8.72	–	0.2	0.1	1.7	2	car
	Davis Strait	8.72	–	0.03	0.05	0.5	2	ci
Razorbill *Alca torda*	Faroes	7.71	660g	1.2	0.6	–	3	cs
	Faroes	7.71	670g	0.3	0.3	–	8	cs
	58°04'N 02°22'W	7.71	700g	0.4	0.3	–	5	cs
	Aberdeenshire	8.71	800g	2.7	2.0	–	15	car 8
	Stornoway	1.72	450g	2.7	1.6	–	6	ci
	Aberdeenshire	2.72	–	40.7	3.3	–	8	ca
Puffin *Fratercula arctica*	Faroes	7.71	424g	0.2	0.1	–	5	ca
	Faroes	7.71	320g	0.3	0.2	–	5	ca
	Faroes	7.71	418g	0.1	0.1	–	7	cs
	Faroes	7.71	391g	0.6	0.3	–	4	ca
	Faroes	7.71	383g	0.5	0.2	–	4	cs
	58°48'N 00°16'E	7.71	450g	0.7	0.4	–	6	ca
	58°48'N 00°16'E	7.71	450g	0.2	0.1	–	6	ca
	58°48'N 00°16'E	[illegible]	400g	0.3	[illegible]	–	6	cs
	Spitzbergen	7.72	–	0.5	0.2	5.2	5	ca
	Spitzbergen	7.72	–	0.2	0.1	2.4	3	ca
	Davis Strait	8.72	[illegible]	0.02	0.02	0.25	2	ca
	Davis Strait	8.72	550g	0.03	0.05	0.5	2	cs
Little auk *Alle alle*	Bear Island	7.72	–	0.7	0.2	–	3	ca
	Aberdeenshire	1.71	–	11.4	2.1	–	7	b
	Aberdeenshire	2.72	–	3.4	[illegible]	–	5	b
	Sutherland	2.72	–	6.0	1.2	–	4	os

Notes: c = caught or shot; b = found dead; o = oiled; i = immature (under one year); s = subadult (over one year, not yet breeding); a = fully adult; r = in wing moult.

1. Stomach oil contained 1.3 ppm PCBs.
2. An unusually small bird with advanced aspergillosis.
3. Ringed as an adult on Auskerry, Orkney, on 18.8.71.
4. Individuals from among some dozens of adult Gannets found dead without obvious cause along first the north-east and then west coast of Britain in the spring of 1972, possibly suffering from a virus disease?
5. Both ringed as chicks on Foula, the first on 14.7.66, the second at about that time (details not yet available), probably not yet breeding.
6. Bird captured in convulsions above seabird colony.
7. Adult and chick found in company together.
8. Collected together while flightless in wing moult.
9. Oiled bird from local breeding colony. Brain contained 2 ppm PCBs.
10. Representative examples of immatures found dead in numbers in winter, except that it had a localised feather defect of one wing of the sort discussed in *British Birds* 63: 34-36; 64: 229-230; 64: 236; 65: 85-8?; and *Marine Pollution Bulletin* 3 (10): 149-152.
11. From the site of maximum mortality of 1969 birdkill.

organochlorine pesticides in the North Pacific, where pesticides always occur in greater quantities than PCBs though the ratio varies locally (Risebrough *et al.*, 1968) is reversed in the north-east Atlantic, where PCBs are the dominant compounds detected. Secondly, although many of the larger auks were found to be carrying considerable loads of PCBs and other toxic chemicals during the birdkill in the Irish Sea during the autumn of 1969 (Holdgate, 1971), it was not they, nor other offshore-feeding fish-eaters such as the shag and shearwaters which were found to be carrying the largest loads of organochlorine at sea to the north, but a variety of more pelagic species which probably feed largely on plankton, including the fulmar, British stormpetrel and kittiwake, and especially the skuas and gulls frequenting isolated seabird breeding colonies. It was notable also that the gulls carried more organochlorine here than along the mainland coast, and indeed the highest value recorded was found in a glaucous gull caught in convulsions above the bird-cliffs of Bear Island in the Arctic, where judging by their pellets these birds were feeding entirely on seabirds' eggs (Bogan & Bourne, 1972).

A number of incidental findings are also of interest. The kittiwake rather consistently had higher PCB/DDE ratios than the other species examined. It is not clear why this should be, since many other birds share a rather similar distribution, diet and way of life, but it may be a reflection of obscure differences in these factors or their metabolism. Although their range is very similar to that of the fulmar, for example, they may prefer warmer surface waters, at least in the western North Atlantic (Brown, 1968). The lowest PCB/DDE ratio was found in a single adult greater black-backed gull from North Rona off the Hebrides, but it may have picked up an increased amount of the DDE in winter quarters inland, and it is notable that the ratio was higher in a chick bred locally. After this the next lowest ratio was found in the two species of shearwater in birds which had just returned from winter quarters in the South Atlantic, where PCBs may still be relatively scarce compounds. It is also notable that the total organochlorine load was low in both species, so that fat-levels running into hundreds of parts per million reported in great shearwaters and Wilson's storm-petrels *Oceanites oceanicus* off New England (Risebrough, 1971) must presumably be due to local pollution, and indeed intoxication may explain why these birds were so easy to catch (Gill *et al.*, 1970).

It is tempting to speculate that this area of high pollution off the east coast of North America may be one major source of contamination of water reaching Europe and the Arctic in the North Atlantic Drift, since the organochlorine levels were remarkably uniform in comparable birds that we examined from Scotland, the Faroes, the Barents Sea, and around 65°N 54°W in the Davis Strait, which suggests dissemination from some distant source away from Europe. The levels were a little lower in the Arctic auks, and they also had lower PCB/DDE ratios, but the difference was not marked except in puffins from the Davis Strait.

It seems fortunate that while the fulmars had 13 to 103 ppm PCBs in their fat and at least 1.2 ppm in other tissues, there was only 1.3 ppm in the sample of the stomach oil fed to the chick examined. This suggests that at least they are not poisoning their offspring by passing on the level found in the fat, as might be feared. A newly-fledged guillemot collected in the centre of the North Sea contained only a tenth as much organochlorine as its adult escort, and there was not much more in two immature guillemots, one oiled and one shot, collected in the autumn of 1970 in the region of maximum mortality for the species the year before (Holdgate, 1971) on either side of the Glasgow sludge-dump and a drain known to discharge PCBs (Holden, 1970; Waddington & Best, 1972). A young greater black-backed gull contained only a thirtieth the amount of organochlorine in an adult found dead with it, and a young great skua only a hundredth the amount in another adult of that species found dead nearby. It would appear that the birds must acquire their organochlorine loads late in life. Although Antarctic penguins showed raised organochlorine levels when they were starving during the annual moult (Sladen *et al.*, 1966) and they were often raised in the livers of emaciated moulting auks washed ashore on the north-east coast in spring (Parslow *et al.*, 1972) and around the Irish Sea in autumn (Holdgate, 1971) in 1969, a razorbill and common and Brunnich's guillemots collected in full wing-moult but exceptionally fat had normal organochlorine levels. The organochlorine levels in the livers of many of the beached birds were raised relative to muscle levels. Clearly the levels found in bird bodies depends on the past history of the bird, those in fat and muscle of healthy birds providing an indication of the initial level, and that in the liver compared with these an indication of the extent to which organochlorine may have been mobilized during a period of stress before death.

It seems clear from these results that not only seabirds frequenting enclosed waters but also the North Atlantic avifauna in general are now accumulating PCBs as well as other toxic chemicals. The most markedly affected pelagic species, the great skua, fulmar, and kittiwake, like the gulls which are also known to accumulate large amounts of organocholorine both along the coast and inland before it has much effect (Keith, 1966), have all been increasing for years as the result of a combination of protection at the breeding places combined with the provision of food by man in the form of fish offal at sea and garbage ashore. It seems possible however, that the organochlorine levels now accumulating in partially predatory species such as the glaucous gulls and great skua and its eggs (Prestt *et al.*, 1970) might soon begin to affect them adversely if they prove as susceptible to them as the Scottish coastal peregrines *Falco peregrinus* which also feed largely on seabirds and are showing a sustained decline despite measures to control the use of organochlorine pesticides inland (Ratcliffe, 1972). Since the total populations of these birds are not vast, the skua in particular nesting in force only in the northern hemisphere in a limited area between Scotland and Iceland, while its southern populations are also known to be contaminated (Tatton & Ruzicka, 1967) and we have now shown that gulls may be affected fatally at a very remote site, the consequences could be serious for them.

Since it has been estimated by a panel reporting to the US National Academy of Sciences that only a quarter of the organochlorines already present in natural reservoirs have yet reached the sea, and their half-lives may be of the order of decades (Goldberg *et al.*, 1971), and it seems difficult to dispute the general principle involved in this argument whatever the extent to which the details may be disputable, it remains to be seen how far this progressive accumulation of PCBs in marine wildlife may proceed before the recent ban by one of several manufacturers on their sale for open use takes effect, or what the ultimate consequences may be.

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CORRESPONDENCE

Dear Sir,

We read with interest the article by J. W. M. Logan and E. J. Perkins, concerning the toxicity of Essolvene (*Marine Pollution Bulletin* (1972) 3 (10) 155).

Table 1 gave the median tolerance levels for some freshwater invertebrates for Essolvene alone and in combination with either Kuwait crude oil or diesel oil. The last column of the table gave the toxicity of BP 1100 which is one of the more recently developed dispersants, although now superseded by BP 1100X.

The data for BP 1100 were provided to the authors by B. Gribbon in a private communication and consequently the extent to which the measurements on Essolvene and BP 1100 were directly comparable was not clear. Certainly measurements were not made at the same temperature, BP 1100 being examined at 17.5-19.5°C while Essolvene was tested at 11°C (*Asellus aquaticus*) or 9-11°C (*Sphaerium corneum*) In addition it is not known if the organisms were collected from the same area, at the same time of year, and so on.

Nevertheless, the concept of comparing modern low toxicity dispersants with older products such as Essolvene or BP 1002 is interesting and Table 1 gives such data for three marine species.

The attached determinations were conducted by the Ministry of Agriculture, Fisheries and Food Laboratories at Burnham-on-Crouch, using the method developed by Portmann and Connor (1968).

Logan and Perkins conclude by drawing attention to possible hazards associated with the use of toxic dispersants in fresh water, a view with which we certainly concur. Indeed, we do not even recommend the use of BP 1100X in fresh water situations since generally speaking:

(a) Physical containment and removal may be feasible;

(b) The volume of water available for dilution is much more limited than in a marine situation;

(c) There may be a risk of contaminating potable water.

Yours faithfully,
L. R. BEYNON
T. E. LESTER

BP Research Centre,
Sunbury-on-Thames.

TABLE 1

Toxicity tests, shown as the 48 H LC_{50} value—in ppm v/v

Organism	BP 1002	BP 1100	BP 1100X*	Essolvene
Brown Shrimp (*Crangon crangon*)	6	>3300	>10,000	10
Cockle (*Cardium edule*)	81	1000-3300	>10,000	33-100
Armed bullhead (*Agonus cataphractus*)	–	1000-3300	>10,000	–

Reference: Beynon (1971); Beynon (1971); Portmann and Wilson (1971); Portmann and Wilson (1971).
* 96 h LC_{50} value.

BOOK REVIEW

What goes on in Estuaries

The Estuarine Environment edited by R. S. K. Barnes and J. Green. London: Applied Science Publishers Ltd. (1972). xii+133 pp. £3.50.

This book of eight review papers comprises the proceedings of a symposium to mark the foundation of the Estuarine and Brackish Water Sciences Association. The papers cover physical, chemical and biological aspects of the subject and, although in no way integrated, they do provide an up to date introduction into recent scientific research on estuaries, with particular emphasis on those in Britain. Regretfully the papers are of mixed quality, but that of K. R. Dyer on sedimentation is comprehensive and particularly good. Other noteworthy contributions are those of L. C. Beadle on matters physiological, R. L. Jefferies on the inorganic nutrition of salt-marsh plants and P. R. Walne on estuarine fisheries.

The estuary, *par excellence*, is a physically controlled environment and those species that can tolerate its extremes can be considered to be opportunistic species—which elsewhere may not be able to compete against the biological stress imposed by established stenophysical species. Thus, it is perhaps significant that the list of species from the Ythan estuary, given on the paper by H. Milne and G. M. Dunnet, would not be greatly different from that of the estuary of one of Britain's sewers, the Tyne. That is not to say that the Ythan is completely unpolluted. It would be rewarding to compare the growth, longevity and reproductive potential of estuaries of markedly different degrees of pollution. The estuaries are rich in nutrients and it would also be rewarding, in more than one sense, if the commercial shellfish which form a large proportion, numerically, of these opportunists (for example *Mya, Mytilus*) could be used again for human consumption, as they were in the time of the monks of Tynemouth Priory.

The present interest in estuaries, of which this book and the newly formed Association are manifestations, is both timely in economic terms and in that it brings together an array of experts from different disciplines. The book illustrates all too clearly the need for a co-ordinated multi-disciplinary approach. But 133 pages at £3.50 will not bring many to drink at a fountain, even if it were unpolluted quintessentia.

J. A. ALLEN

Mr. R. S. Friar of Alcan (UK) Limited has asked us to point out that the title 'Guillemots killed by Fluoride?' and the abstract of the article in last month's *Marine Pollution Bulletin* 3 (10), 149-152 suggest that fluorine poisoning was responsible for the deaths of the birds, although this was not claimed in the body of the paper.

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