

tions, which are stimulated to synthesize DNA by contact with antigen, enter a resting phase until stimulated to re-enter division by secondary exposure to the same antigen. By definition these would be memory cells. They apparently correspond to Mitchell and Miller's "educated T lymphocytes"¹², for they were only observed at a time when the mitotic response of thymus-derived lymphocytes is maximal³. We are currently seeking direct experimental proof of their identity. Previous attempts to establish this point¹¹ have failed, perhaps because of the use of *Salmonella* antigens, which are poor stimulators of thymus-derived cells¹². Our finding implies that cell replication may serve as a means of enlarging and/or altering the pool of thymus-derived cells capable of reacting with certain antigens. Replication may not, however, be essential to the helper function of these cells¹².

At the peak of the secondary response to SRC 30–40% of the cells in mitosis in the spleen are thymus-derived³. Thus we were initially surprised to find only 8–9% of the spleen cells responding mitotically to a second injection of antigen which showed evidence of having responded in the earlier primary response. It is important to remember that the work delineating the time and magnitude of the response of thymus-derived cells to antigen was carried out in irradiated, thymus-grafted mice. Thus it is possible that there may be some differences in normal mice. If there should be any significant differences, however, there would probably be an increase of thymus-derived cells responding in normal mice. Davies *et al.* have shown that increasing the number of reconstituting thymus grafts up to a point increases the number of peripheral thymus-derived cells³. This increase does not, however, alter the percentage of thymus-derived cells responding to antigen in lymph nodes nor does it change the timing of their response. It is possible that some thymus-derived memory cells lost their label through division after the period of labelling. We are investigating the possibility of recruitment of thymus-derived cells by other thymus-derived cells responding specifically. The small number (0–1%) of labelled cells found in control animals may be due, at least in part, to the emergence and subsequent response of a few thymus-derived cells which were undergoing division in the thymus at the time of thymidine administration.

The chief conclusion we should like to draw from this experiment is that one result of the DNA synthesis which follows primary antigenic stimulation is the generation of memory cells. The ability to identify these cells should be of value in characterizing them further.

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Note added in proof: Since we submitted this manuscript, another report in which memory cells were identified by autoradiography, has appeared. Bosmann, C., and Feldman, J. D., *Clin. Exp. Immunol.*, 7, 565; 1970.

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Polychlorinated Biphenyls: Photolysis of 2,4,6,2',4',6'- Hexachlorobiphenyl

MANY aromatic organochlorine compounds are readily utilized or otherwise decomposed by a number of specific microorganisms. In the environment, however, these compounds are relatively stable and resistant to general microbial breakdown. For many of these compounds photochemical degradation, induced by the ultraviolet content of the Sun's light, may be a major pathway of decomposition.

Because a large number of pesticides contain a chloroaromatic moiety as a primary structural feature, considerable attention has been paid to the photolysis of these compounds^{1–7}. Photochemical decomposition of chlorobiphenyls may be a significant process in the environment because they absorb in that region of the ultraviolet (ref. 8 and our unpublished demonstrations) which is available in natural conditions (compare ref. 1) from sunlight.

Commercially available polychlorinated biphenyls (PCB) for example 'Aroclor', consist of a complex mixture of chlorinated biphenyls which can be resolved into more than fifty peaks by gas chromatography on 'Scot columns' (private communication from D. J. Sissons and G. M. Telling). As it is difficult to correlate data from such a complex mixture we have synthesized a series of isomeric di, tri, tetra, penta, hexa, octa and decachlorobiphenyls to facilitate fundamental studies on analytical, biological and chemical aspects of PCB (manuscript in preparation). We have also shown that all these compounds give strong molecular ions on electron

Table 1 GLC and Mass Spectral Data for Hexachlorobiphenyl Photolysis Products

	Retention time* (min)	m/e of M ⁺	Chlorine† content
TLC band I			
Peak 1	5.6	—‡	0
Peak 2	8.2	—‡	0
Peak 3	9.9	222	2
Peak 4	13.5	256	3
Peak 5	14.1	290 (256)	4, (3")
Peak 6	19.0	324 (290)	5, (4")
Peak 7	29.7	358	6
Peak 8	56.9	304	2
TLC band II			
Peak 1	19.6	290	4
Peak 2	26.8	324	5
Peak 3	35.2‡	358	6

* Conditions: instrument, Hewlett-Packard 5730; column, 6% QF-1+4% SE30 on 'Chromosorb' (AW) 60–80 mesh 5', 1/4" outside diameter, glass; injection port temperature, 220° C; column temperature, 175° C; flame ionization detector temperature and collection port temperature, 240° C; helium flow rate, 40 ml./min.

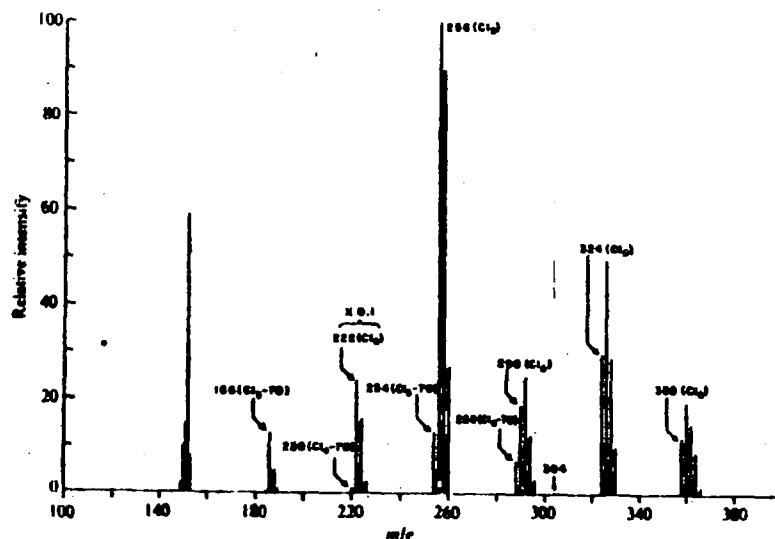
† From isotope peak distribution; tr, trace.

‡ Hydrocarbon peaks, M⁺ not identified.

§ Corresponding to starting material.

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Fig. 1 70 eV mass spectrum (DuPont/CEC 21-110B instrument). The temperature of the sample, controlled independently from the source temperature¹⁰, was 40° C. The intensity of ions corresponding to the components ($Cl_6=C_{12}H_4Cl_6$, $Cl_5=C_{12}H_5Cl_5$, and so on) in the mixture varies with sample temperature. Each isomer shows an M^+-70 ion as the most important fragment. These ions are indicated as Cl_6-70 , Cl_5-70 , and so on.



impact, followed by less intense ions resulting from successive loss of Cl and/or HCl (manuscript in preparation). As the general formula for PCB is $C_{12}H_{10-n}Cl_n$, the molecular ions of individual isomers are thus readily recognized in a mass spectrum of a mixture of these compounds (compare ref. 9).

We now wish to report the photochemical behaviour of 2,4,6,2',4',6'-hexachlorobiphenyl. A sample of 25 mg of this compound in 2.0 ml. of hexane was irradiated at λ_{max} 3100 Å for 100 min. Thin-layer chromatography, using 'Merck Silica Gel F-254' and hexane, revealed the presence of two major bands; band I (R_f 0.40) and band II (R_f 0.65, corresponding to starting material). The mass spectrum of band I (Fig. 1) indicated molecular ions corresponding to di, tri, tetra, penta and hexachlorobiphenyls. Gas liquid chromatography (GLC) of bands I and II revealed eight and three major peaks respectively. Retention times and mass spectra data for all peak components are reported in Table 1. When irradiation was carried out in methanol, similar results were obtained, but in addition a third and more polar band appeared, containing oxygenated polychlorinated compounds with structures which have not been investigated further.

Two conclusions can be drawn from the results of this study: (i) during photolysis, chlorine is removed rather readily from hexachlorobiphenyl yielding compounds of lower chlorine content; (ii) photochemical production of new compounds formed by loss of chlorine, rearrangement or condensation may lead to further complications in residue analysis with the possible appearance of chlorobiphenyls ("peaks") in environmental samples that are not present in commercial PCB mixtures.

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Selection for Resistance to Carbamate and Organophosphorus Insecticides in *Anopheles albimanus*

The development of resistance in anopheline mosquitoes to DDT, HCH, and cyclodienes, and the consequent set back in malaria eradication programmes has lent urgency to the search for alternative insecticides to replace the chlorinated hydrocarbons. During the past few years, more than 1,300 new insecticides, chiefly organophosphates and carbamates, have been tested under an international collaborative programme of the World Health Organization¹. Testing consists of seven sequential stages and only insecticides that satisfy the criteria in all stages are recommended for use on a large scale.

One of the insecticides that satisfied the criteria of stage VI (operational evaluation) and has been found suitable for stage VII (epidemiological evaluation) is the carbamate, propoxur². It is intrinsically more toxic to adults of many mosquito species than dieldrin, malathion, fenitrothion and fenitrothion, and as a residual spray has been found to be effective for 2 to 4 months against *Anopheles gambiae* and *A. funestus* in Africa, *A. stephensi* and *A. dirhali* in Iran, and *A. albimanus* in El Salvador³.

No case of resistance to carbamate or organophosphorus insecticides has yet been reported although tolerance to malathion has been suspected in *A. albimanus* in Guatemala and Nicaragua^{3,4} and subsequently demonstrated in El Salvador^{5,6}. In this communication we report the development of high degrees of carbamate and organophosphorus resistance in *A. albimanus* resulting from intensive selection pressure in the field, and subsequently in the laboratory.

Earlier attempts to induce carbamate resistance in *A. albimanus* by laboratory selection have been unsuccessful although in *Culex pipiens fatigans* a 30× level of resistance to propoxur developed in larvae within twenty-five generations of selection pressure^{7,8}. A strain of *A. albimanus* from Panama selected with *m*-isopropylphenyl methylcarbamate for fifty generations developed only a 2.8× increase in the LC_{50} level⁷. Another strain from Haiti, containing dieldrin-resistant individuals, when subjected to larval selection pressure by propoxur for nineteen generations and to adult pressure during the

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