POLYCHLORINATED BIPHENYL TOXICITY TO TWO PHYTOPLANKTERS AS A FUNCTION OF ENVIRONMENTAL CONDITIONS

Robert Alan Michaels, Ph.D.
State University of New York
at Stony Brook, 1979

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Batch unialgal cultures of one resistant and one sensitive marine phytoplankter were exposed to polychlorinated biphenyls (PCB's) under a variety of culture conditions, and the effects on growth and photosynthesis were determined to detect interactions between environmental conditions and toxicity. The hypothesis was tested that varying culture regimes would alter the relative growth and PCB-resistance of the organisms studied. These were the resistant, naked green flagellate, Dunaliella tertiolecta, and two isolates of the sensitive diatom, Thalassiosira pseudonana, one of estuarine and one of oceanic (Sargasso Sea) origin.

Compared with growth in a fully nutrient-enriched culture medium, low nutrient concentration inhibited growth of the estuarine isolate T. pseudonana; sensitivity to PCB increased under this nutrient stress. In contrast, low nutrient concentration enhanced growth, but not PCB resistance, of the oceanic isolate, reducing the differential in PCB resistance between these isolates.

Low salinity inhibited growth of the estuarine isolate of T. pseudonana and increased resistance, enhancing growth of cells treated with PCB at low compared with normal salinity. Increased resistance with stress suggested that altered PCB distribution at low salinity reduced exposure of sensitive intracellular sites of action to the toxin. This hypothesis was refuted by adapting cells to low salinity, transferring them to normal salinity and finding resistance to PCB equal to that exhibited at low salinity. Genetic or physiological adaptation to low salinity, rather than altered PCB availability, produced the resistance.

Whereas T. pseudonana gained resistance, D. tertiolecta lost resistance to PCB upon sudden exposure to low salinity. Unlike walled T. pseudonana, naked D. tertiolecta responded to sudden reductions in salinity by expanding in volume. Very low salinity caused lysis. PCB did not affect this process. Induced sensitivity to PCB must have been caused physiologically by PCB gaining access to sensitive sites of action, rather than structurally by weakening the cell membrane and sensitizing the cell to osmotic damage at low salinity.

To identify the factor in salinity variation most important in modifying PCB susceptibility, altered ion concentrations and ratios were investigated. Variation in Na^+, H^+, and in total ionic concentration modified PCB toxicity, whereas variation in K^+ and Ca^{2+} did not. In T. pseudonana, when the nonelectrolyte glycerol was substituted for seawater salts to reduce total ion concentration while maintaining constant osmolarity, PCB-treated cells displayed reduced susceptibility as in the case of lowered salinity. Hence, the effect of ions exceeded any effect of osmolarity.

Photosynthetic ^{14}C-fixation per cell and cell density were measured simultaneously at low, normal, or high salinity. The relationship between salinity and susceptibility of T. pseudonana to PCB was identical whether the indicator of PCB effect was growth or photosynthesis per cell. At normal salinity photosynthesis per cell was inhibited up to 90% by 50 $\mu g/l$ of PCB, refuting claimed independence of PCB action and photosynthesis. PCB inhibition of photosynthesis per cell diminished at low salinity, but not at high salinity, paralleling the effect of PCB on growth.

Although growth of D. tertiolecta decreased at low salinity, photosynthesis per cell increased. The increase was not as great as that of controls, however, paralleling the sensitization of growth to PCB at low salinity. At normal or high salinity, photosynthesis per cell, like growth, was unaffected by PCB.

The resistance of D. tertiolecta to PCB did not vary with nutrient concentration, in contrast with T. pseudonana. D. tertiolecta resistance was not conferred by release of a PCB detoxifier into the medium, nor by possession of PCB-resistant ATPase. Thus, the differential in susceptibility to PCB, though somewhat variable, was pronounced under all culture conditions applied. In contrast, the differential between isolates of T. pseudonana depended upon culture conditions, and was not determined by habitat of origin.