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shaved rats in the cold and the course of return to normal temperature in the 23°C environment (the curves for 120 and 240 mg/kg, omitted for the sake of clarity, fall appropriately between their respective higher and lower dosages). The curve for rats given 30 mg of sodium salicylate per kilogram of body weight was significantly different from the curve for rats given saline. (The mean rectal temperature of the four rats after 15 minutes in the cold was 37.9°C. One-half hour after injection of sodium salicylate the mean rectal temperature was 36.0°C, and 1 hour after injection it was 35.3°C.) There was an orderly, progressive dose-dependent decrease in body temperature for all concentrations of salicylate tested. Within 30 minutes of drug administration there was no overlap in the standard errors of the means of each group except for the 30 and 60 mg/kg groups. The rectal temperatures of all the shaved rats were lower than those of the unshaved rats. Within 2 hours after removal from the cold, the body temperatures of all the rats except those given the two highest dosages of sodium salicylate had returned to those values that prevailed before the administration of the drug. The decline in the rectal temperatures of the unshaved rats was also dependent on the dosage of salicylate given. One hour after injection the rectal temperatures of the groups given saline or sodium salicylate (60, 180, or 300 mg/kg in saline) had declined, respectively, by 0.4°, 0.7°, 2.5°, and 3.6°C. Sodium salicylate in dosages of 180 and 300 mg/kg also lowered the body temperature of unshaved rats maintained at 23°C, although the decline was more gradual and not as great as for rats in the cold (Fig. 2). The body temperatures of all the animals returned to the values that prevailed before drug injection within 4 hours.

It is clear that the higher dosages of sodium salicylate lowered the normal body temperature of rats in a 23°C environment, and at all dosages tested sodium salicylate lowered the body temperature of rats in the cold. Salicylates have been thought to be effective in lowering only febrile temperatures. The data presented here demonstrate that they can lower normal, nonfebrile temperatures also.

Body temperature rises when either heat production is augmented or heat loss is lessened, or when both effects occur simultaneously. These changes are brought about when warm-sensitive neurons in the brain decrease or cold-sensitive neurons increase their respective firing rates (*2*). Bacterial pyrogen causes fever by affecting both types of thermoregulatory neurons (*2*, *3*). Salicylates increase the sensitivity of pyrogen-suppressed neurons, and the body temperature declines (*3*). However, salicylates may also act directly on thermoregulatory neurons whose firing rates have not been changed by previous administration of pyrogen (*4*). Cold stress, like pyrogens, may act through some biochemical intermediary, possibly prostaglandins, to alter the firing rate of thermosensitive neurons and cause increased heat production and decreased heat loss. In the cold, however, this action would lead not to fever but rather to the maintenance of a normal body temperature or at best to a slight degree of hyperthermia, because of the increased loss of heat to the environment. If prostaglandins are released during cold stress as well as during fever, and if, as has already been demonstrated (*5*), salicylates inhibit the release of prostaglandins, then one should expect a decrease in body temperature in the cold, which is what the data presented here demonstrate.

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Polychlorinated Biphenyls and DDT Alter Species Composition in Mixed Cultures of Algae

Abstract. *Either DDT or polychlorinated biphenyls were added to mixed cultures containing a marine diatom and a marine green alga that were sensitive and resistant, respectively, to these organochlorine compounds. The diatom grew faster and was therefore dominant in control cultures, but its dominance diminished in treated cultures, even at concentrations of chlorinated hydrocarbons that had no apparent effect in pure cultures. Such stable pollutants could disrupt the species composition of phytoplankton communities, thereby affecting whole ecosystems.*

The impact of certain persistent chlorinated hydrocarbons on various higher nontarget organisms has been well documented (*1*), but effects on photosynthetic algae, the base of aquatic food webs, have not been extensively studied. Marine phytoplankton vary in sensitivity to chlorinated hydrocarbons, including DDT [1,1,1-trichloro-2,2-bis (*p*-chlorophenyl)ethane] and polychlorinated biphenyls (PCBs). Some species show effects at concentrations as low as a few parts per billion (ppb), whereas others are resistant to much higher concentrations (*2*, *3*). Some of these chemicals, especially DDT and PCBs, are extremely widespread pollutants of the biosphere, and, because they are selectively toxic to certain sensitive algal species, it has been hypothesized that they could alter the species composition of phytoplankton communities (*2*, *3*). Evidence for this hypothesis is lacking; we therefore investigated the effects of DDT and PCBs in mixed algal cultures containing a sensitive and a resistant species.

Two marine organisms were selected on the basis of their sensitivity to organochlorine compounds: growth of the diatom *Thalassiosira pseudonana* was inhibited by PCBs and DDT, whereas *Dunaliella tertiolecta*, a green alga, was not affected by these chemicals (*3*). Methods of culture and procedures for treatment have been described (*3*). Cultures contained a total of 10^4 exponentially growing cells per milliliter at zero time; mixed cultures contained the two species in a 1:1 ratio. Mixed and pure cultures were treated simultaneously. Cells in pure

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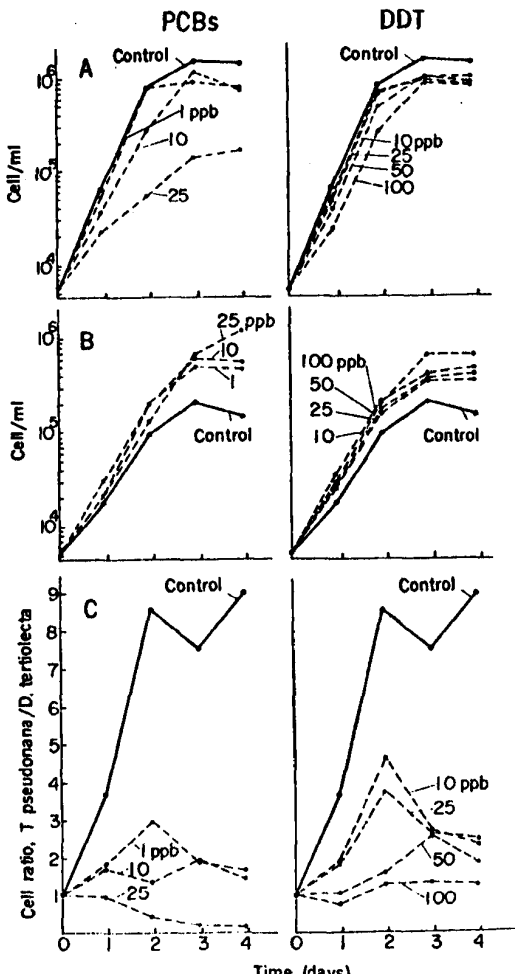

Fig. 1. Growth of (A) *T. pseudonana* and (B) *D. tertiolecta* in mixed cultures; (C) species ratios. Data points are the means of three replicates. Cell concentrations: single classification analyses of variance showed that, at day 4, *D. tertiolecta* controls differed from all treated cultures ($P < .005$); *T. pseudonana* controls differed from all treated cultures ($P < .025$), except at 25 ppb of DDT ($P < .10$). Species ratios: analyses of variance, performed by means of the Kruskal-Wallis and Wilcoxon two-sample tests (*13*) revealed that, on days 3 and 4, controls differed from all treated cultures ($P < .001$); ratios for 100 ppb of DDT differed from those for 50 ppb of DDT, and ratios for 25 ppb of PCBs differed from those for 10 ppb of PCBs ($P < .05$).

culture were counted with a Coulter counter, whereas those in mixed cultures were counted microscopically with a Neubauer-Lévy counting chamber because the two cell types could not be differentiated by the Coulter counter.

The results with pure cultures confirmed those described previously (*3*). Polychlorinated biphenyls inhibited the growth of *T. pseudonana* at 25 ppb, but not at 10 ppb or less. Growth was also significantly inhibited by DDT at 100 ppb; inhibition at 50 ppb was slight, and none occurred at 25 ppb or lower. By contrast, the growth of *D. tertiolecta* was not affected at any of the concentrations of PCBs or DDT tested.

In untreated mixed cultures, *T. pseudonana* reproduced more rapidly than *D. tertiolecta*, reaching an eight- to ninefold greater cell concentration after 4 days. Treatment with PCBs or DDT significantly diminished the competitive success of *T. pseudonana* and increased that of *D. tertiolecta* at all concentrations tested, even though the lowest concentrations (*1* and *10* ppb, respectively) had no detectable effect on the growth of *T. pseudonana* in pure cultures (Fig. 1, A and B). The graphs of species ratios (Fig. 1C) suggest that still lower concentrations would alter the final species composition of the cultures. Higher concentrations of the organochlorine compounds caused greater deviation in species ratios from those of the control cultures.

Although species ratios were substantially changed, the final total cell numbers did not differ significantly among control and treated mixed cultures. Since cells of the two species are approximately the same size, the final biomass was not markedly affected. This result suggests that the two organisms were competing for a limiting nutrient in the mixed cultures. Presumably *T. pseudonana* assimilated most of the nutrient in control cultures because it grew faster, but its ability to compete was impaired by PCBs and DDT; more nutrient then became available for *D. tertiolecta*. Since phytoplankters often compete for limiting resources in nature (*4*), tests evaluating pollutants in mixed cultures probably give a more ecologically meaningful indication of algal sensitivity than those in pure cultures. *Thalassiosira pseudonana* was substantially more sensitive to PCBs and DDT in mixed cultures than in pure cultures.

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stable pollutants (*5*) could alter natural algal communities by suppressing sensitive species and permitting pollutant-resistant forms to become dominant. Polychlorinated biphenyls and DDT can occur in natural waters at concentrations comparable to those that altered the species ratios in our experiments, although concentrations found in nature are generally lower (*6*). Exposure to organochlorine compounds is probably greater than the concentrations in natural waters would indicate, however, because these substances are rapidly absorbed from water by organisms, including phytoplankters (*1*). In eutrophic environments, alterations of algal communities could further reduce an already decreased species diversity (*7*), aggravating problems of algal blooms and contributing to the general degradation of the ecosystem (*8*).

Many zooplankters graze selectively, often choosing their food on the basis of size or shape (*9, 10*). The dietary requirements of herbivores are not satisfied by all algal species, as indicated by the growth rates of oyster and clam larvae (*11*), the viability of barnacle nauplii (*10*), and reproduction in copepods (*12*). Hence, altering the species composition of a phytoplankton community could profoundly affect the health, distribution, and abundance of many animal populations higher in the food web (*8, 10, 11*).

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Information-Processing by Pigeons

Abstract. Two pigeons matched to sample on the basis of color or line orientation when a sample consisted of a value for each stimulus dimension or a value for only one dimension. When the duration of the sample stimulus was varied to maintain constant performance, compound stimuli required more time than single elements.

Most studies of stimulus analysis in animals impose focused-attention tasks which require the subject to attend to a specific stimulus feature (*1*). An alternative approach, adopted by Blough (*2*) and common in the literature of human information-processing, is to require the subject to divide his attention among a number of stimulus features. Lindsay (*3*) has demonstrated that in a divided-attention task stimulus duration is a critical determinant of performance. Despite suggestions (*4*) that stimulus duration may be a powerful variable in stimulus selection by animals, it has not been systematically examined. Using a psychophysical technique to measure the minimum stimulus duration necessary to maintain a constant performance level, we found that stimulus duration was longer under conditions of divided attention than of nondivided attention.

Two white Carneaux pigeons were maintained at approximately 85 percent of their free-feeding weights. Both were trained to match to sample in an operant conditioning chamber. The chamber was equipped with three Lehigh Valley pigeon keys, horizontally aligned on the front panel. Each was backed by an Industrial Electronics Engineers in-line stimulus projector. The food hopper was located directly beneath the center key. The chamber was located in a room in which sound was attenuated, and further sound attenuation and ventilation were provided by an air blower system. A PDP-8/L computer (Digital Equipment Corporation) controlled stimulus presentations and reinforcements, conducted on-line analysis, and reported data on a teletypewriter.

A white light projected on the center key signaled the onset of a trial; a single peck to the center key resulted in the immediate replacement of the white light by the sample stimulus. The sample stimulus consisted of one of two colors (red or blue) or one of two orientations (0° or 90°) of three white lines superimposed on a black background. After 5 seconds the center key was darkened and the two side keys were illuminated by the comparison stimuli, which were red and blue or 0° and 90° line orientations. A "match,"

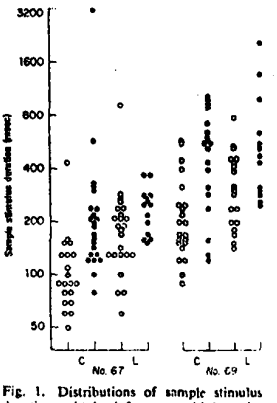

Fig. 1. Distributions of sample stimulus durations obtained from two birds under conditions of divided and nondivided attention. Each point is the result of a matching-to-sample session in which the duration of the sample stimulus was varied to maintain performance constant at 80 percent correct. The durations for matching color and line orientation are plotted separately for each bird (letters *C* and *L*, respectively). Closed circles represent divided-attention sessions, and open circles represent nondivided-attention sessions.

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