elsewhere at present. Only two U.S. companies have full-scale programs on drugs from the sea—Upjohn and Lederle. Dr. John S. Webb of Lederle notes that his firm's program is beyond the collecting phase and is now concentrating on pharmacological work. And Dr. Miller points out that Hoffmann-La Roche's parent Swiss company has begun an active drugs-from-the-sea program in Australia. Representatives of many other drug firms attended the conference, apparently to keep abreast of work in the field.

Dr. Miller notes that the real problem in slowing marine drug research is money. He says that it currently takes from seven to 10 years and about $7 million to bring a new drug to market. Drug firms, lacking knowledge and experience in drugs from the sea, are reluctant to undertake large long-term commitments and risks in the field with little assurance of coming up with commercial products.

Feeling acutely a lack of support by the Sea Grant program and other federal agencies for development of new biologically active substances from the sea, a number of participants in the Drugs from the Sea Conference have formed an informal *ad hoc* committee to determine how best to coordinate efforts of those in the field, to promote promising studies, and to attract additional support. Called the Committee on Objectives and Procedures (COOP), and headed by the University of Miami's Dr. Sigel, the group is interested in receiving the names, affiliations, disciplines, and a brief description of research activities of those working on biologically active substances of marine origin.

Prevalence, impact of PCB's probed

WATER, AIR, AND WASTE—Evidence of the ubiquitous distribution of polychlorinated biphenyls—in water, in soils, and in fish, birds, and mammals—keeps on piling up. What's more, there is now convincing evidence that low levels of PCB's in the environment have already caused significant damage to an important regional industry. A Food and Drug Administration official says, however, that recent restrictions on the use of PCB's have brought the situation under control, at least from the standpoint of human safety, and that environmental PCB levels should begin to decrease in the next few years.

These were some of the highlights of a symposium titled "PCB's—still prevalent, still persistent," held jointly with the Division of Pesticide Chemistry.

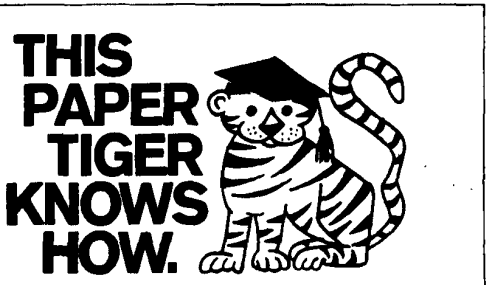
PCB's are present in the aquatic environment even in such "pristine settings" as national parks and forests, says Dr. Hans J. Crump-Weisner of the U.S. Geological Survey's water resources division. Water and bottom sediment samples were collected in 10 states in various parts of the U.S. PCB concentrations ranged from 0.1 to 4.0 micrograms per liter in unfiltered water samples. Dr. Crump-Weisner points out that because of the low solubility of PCB's in water, water samples alone are not a good measure. Of the sediments analyzed, 20% were positive for PCB's, with levels up to about 3.2 p.p.m.

Nor have the farthest reaches of Canada escaped PCB contamination, according to Dr. Gerald W. Bowes of the Canadian Wildlife Service, Ottawa, Ont. Chemist Bowes has been analyzing polar bears for PCB's. The bears were captured all over northern Canada—from the Yukon to Baffin Bay, from southern Hudson Bay to Ellesmere Island, far north of the Arctic Circle. Every bear tested so far has been "positive," Dr. Bowes says, noting that the bear with the highest PCB residues in its tissues was taken at latitude 85° north, less than 400 miles from the North Pole. He adds that tagging and recapture studies show that polar bear subpopulations don't roam all over Canada but instead tend to remain in the same general area; this fact reinforces the evidence that PCB's are very widely distributed in the biosphere.

Closer to home and perhaps even more to the point, PCB's have been found in more than 50% of 2189 samples of human adipose tissue analyzed for the Environmental Protection Agency's human monitoring survey. Dr. Anne R. Yobs, of EPA's division of community pesticide studies, Chamblee, Ga., explains that the fatty tissues were removed during surgery or in postmortem examinations. Samples came from 18 states and the District of Columbia.

Preliminary results show that 167 samples (7.6%) contained more than 2 p.p.m. PCB. The highest concentration was 16 p.p.m.; 18 samples showed levels in excess of 8 p.p.m. Between 1 and 2 p.p.m. were found in 651 samples (29.7%) and trace amounts were detected in an additional 370 (16.9%) of the samples. The other 1001 samples (35.7%) were negative. Positive samples came from every hospital, city, and state participating in this survey, Dr. Yobs notes.

Not only are PCB's "everywhere," they are also potentially dangerous, according to data presented by several panelists. For example, Dr. Foster L. Mayer, Jr., of the Interior Department's Fish-Pesticide Laboratory, Columbia, Mo., and Dr. D. R. Nimmo, of EPA's Gulf Breeze (Florida) Laboratory cite experiments showing that, although the acute toxicity of PCB's to fish is insignificant, many of the compounds are acutely toxic to invertebrate animals important in the fish food chain. Fur-



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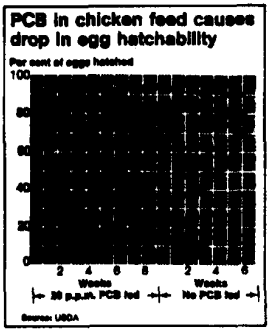
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thermore, because PCB's accumulate in tissues, chronic exposure to extremely low levels—less than 1 p.p.b. in some cases—causes injury or death to many fish, crustaceans, and other aquatic organisms.

Dr. Helene C. Cecil, of USDA's Agricultural Research Service, Beltsville, Md., described the results of experiments measuring the results of feeding PCB's to chickens. (There have been several instances of accidental contamination of poultry feed by PCB's, she notes.)

Adding various PCB's at a rate of 20 p.p.m. to hens' diets had no apparent effects on feed consumption, body weight, mortality, egg weight, or shell thickness, Dr. Cecil says. After nine weeks, however, egg production had dropped significantly. And, although egg fertility remained high, hatchability dropped dramatically—to a low of 2% in eggs from hens receiving a particular PCB, Monsanto's Aroclor 1248. Aroclors 1232 and 1254 also caused sharp declines in hatchability. However, both the relatively rapidly metabolized Aroclor 1221 and the highly chlorinated, almost completely unmetabolized Aroclor 1268 seemed to have little or no effect.



More than a third of the dead embryos showed teratogenic abnormalities: edema, small bodies, rotated ankles, and short or crossed beaks. The chicks that did hatch appeared normal but didn't grow as well as chicks from the control group.

Restrictions on use of PCB's make it unlikely that poultry feed contamination will be a problem in the future. Not much can be done about PCB's in Great Lakes fish, however, and that fact is causing financial woe for mink ranchers. They settled around the Great Lakes largely because of the availability and cheapness of fish, a mainstay of the mink's diet. But in the mid-1960's, the ranchers started noticing that mink reproduction was falling off. The problem reached a peak in 1967-68 when the coho salmon—introduced into the Great Lakes to control

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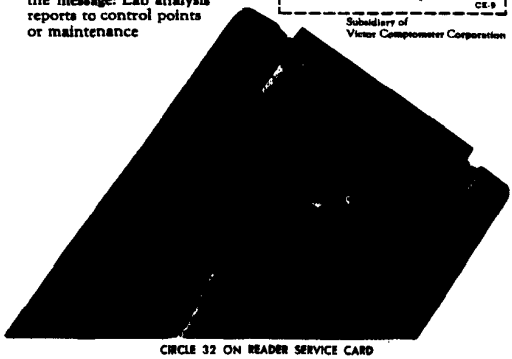
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trash fish—came on the scene. Mink litters dropped from an average of four kits to less than one half.

Was the coho itself somehow poisonous? No, says Dr. Robert K. Ringer of Michigan State University, East Lansing. Although mink fed 30% Great Lakes coho for three months whelped no kits at all, they thrived on coho brought in from Oregon. MSU scientists first suspected residues of insecticides, but found that feeding DDT and dieldrin didn't affect the mink the way that coho did. Then they looked at PCB's. Levels ran as high as 15 p.p.m. in the Great Lakes coho. And tests showed that not even one kit per litter survived when the mothers' diets contained as little as 5 p.p.m. PCB's.

So now the mink ranchers must feed ocean fish, poultry, or meat by-products —all more expensive than Great Lakes fish. Also, Dr. Ringer notes, the promising Great Lakes coho industry has been "struck down in its infancy." Although nothing much can be done about PCB's in fresh-water fish, restrictions on the use of PCB's should bring about a gradual decline in environmental levels, says Dr. Albert C. Kolbye, Jr., Deputy Director of FDA's Bureau of Foods. For example, PCB's are no longer used in "carbonless carbon paper" (main source of PCB's in recycled paper), or as a heat-exchange fluid in food processing applications.

Dr. Kolbye believes that present FDA working guidelines for PCB residues in foods provide an ample margin of protection as far as human safety is concerned. He adds, however, that the limits are based on specific occurrences of "accidental" contamination. If the frequency of PCB contamination of foodstuffs should increase, the guidelines would be substantially lowered.

Organoarsines have ladderlike structure

INORGANIC—Homoatomic organoarsine polymers—a new structural class of polymeric materials with an unusual ladderlike framework—exhibit semiconducting and photoconducting properties, say chemist Arnold L. Rheingold and physicist John E. Lewis, both of State University of New York, Plattsburgh.

Dr. Rheingold comments that arsenic apparently takes second place only to carbon in its ability to form stable, catenated polymers. One such "scalamer" (from the Latin word for ladder) can be synthesized by adding a trace of methyldichloroarsine to a solution of cyclic pentameric polymethylpolyarsine in benzene to initiate condensation reactions that ultimately yield macrocrystalline polymers with molecular weights as high as 10,000. Dr. Rheingold notes that the product is essentially halogen-free, implying that the dihaloarsine plays only a catalytic role in the reaction. However, the ratio of dihaloarsine to pentamer does seem to control the molecular weight of the polymer.

The scalamers' novel structure suggests that the ladders of metal atoms might have "interesting" electrical properties, Dr. Rheingold says. Indeed, studies of single-crystal conductivity have shown that the polymethylpolyarsine ladder is likely a semiconductor with an energy band gap of about 1.2 e.v. The logarithmic correlation between conductivity and reciprocal temperature is characteristic of intrinsic behavior. (In intrinsic semiconductors, the charge carriers arise from excitation of valence electrons rather than from impurity or defect structures, Dr. Rheingold explains.)

The polymers are also photoconductors. The SUNY scientists have found that conductivity under room light increases to about 100 times the dark conductivity. Photoconductive properties are receiving additional study, as are the effects of different alkyl substituents on conductivity and band gap. The range of available semiconductor properties could be quite extensive, Dr. Rheingold predicts.

Bacteria show both space, time sense

BIOLOGICAL—Bacteria possess a time sense, not just a spatial sense. They detect chemical gradients by comparing present and past, and in this sense exhibit "behavior" and "memory," according to Dr. Robert M. McNab, postdoctoral fellow at the University of California, Berkeley.

Dr. McNab and Dr. Daniel E. Koshland, Jr., professor of biochemistry at the university, have determined the basis for the phenomenon of chemotaxis. Known for almost 100 years, the phenomenon has received renewed attention only recently.

Many species of bacteria are able to swim and many of these can extract information from their environment and modify their swimming patterns to ensure migration to a more favored environment. In chemotaxis, bacteria respond to chemical compounds such as sugars and amino acids, foods important to the bacteria for their survival, and migrate up concentration gradients of these. However, Dr. McNab explains, it hasn't been known whether bacteria sensed such gradients in time or in space, the latter an unlikely explanation because of the small size of bacteria. Although a bacterium can swim extremely fast—it moves 10 times its body length in a second, Dr. McNab notes—it is only 1/10,000 inch long.

To determine if a time sense was involved, Dr. McNab and Dr. Koshland devised a means to transfer bacteria rapidly through a tiny mixing device from one uniform environment to a new

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