Chemistry

Janet Raloff reports from Miami at the 189th national meeting of the American Chemical Society

Highlighting a new PAHlution hazard

While acid rain's effect on wildlife is a growing public concern, the phototoxicity of other pollutants accompanying those acidic combustion byproducts has not been seriously evaluated, according to Jacques Kagan at the University of Illinois in Chicago. Research by Kagan and his co-workers suggests this has been a serious omission. In studies they conducted using tadpoles, mosquito larvae, brine shrimp, water fleas and flat-head minnows, concentrations of polycyclic aromatic hydrocarbons (PAHs) that had previously been considered nontoxic turned out to be quite lethal when the aquatic animals were exposed to them in the presence of light.

This calls into question the role of acid rain in the death of lakes in the northeastern United States and elsewhere. Kagan believes that PAHs might prove to be as much to blame as their more infamous acidic companions. What's more, though PAHs have hardly been ignored, most research on them has focused on their potential as carcinogens. Kagan says that in doing this, science has overlooked a large measure of their toxicology. In fact, he points out, several PAHs registering the most acute phototoxicity in his studies are noncarcinogenic.

Kagan's work grew out of a discovery reported last year that anthracene, a simple PAH, was toxic to tadpoles only in the presence of sunlight or ultraviolet light. Tadpoles kept in the dark were unaffected by an anthracene solution — even an anthracene solution that had previously been irradiated with light. Kagan's follow-up studies have examined seven more of the simplest PAHs, including two of the most common — fluoranthene and pyrene. Test concentrations of PAHs in water usually ranged from 0.001 to 6.67 parts per million, and light exposures typically lasted a total of 30 minutes.

Ultraviolet light made some PAHs lethal to water fleas at mere parts-per-billion levels, with fluoranthene and pyrene the most toxic. Similar effects were observed in other test species. For mosquito larvae, the most phototoxic PAH was pyrene. Though mildly toxic in the dark, it became 1,500 times more so when the larvae were also irradiated with ultraviolet light.

Kagan notes that the most phototoxic PAHs he studied were very strong absorbers of light in the precise spectral bands emitted by their ultraviolet lamps, a finding that hints at a possible factor for screening out other phototoxic PAHs.

EDB's long-lasting legacy

Ethylene dibromide (EDB), the toxic chemical banned last year from most agricultural uses (SN: 3/10/84, p. 151), has been turning up in groundwater throughout Florida's citrus regions, where it was widely employed for four decades to kill nematodes in soil. In hopes of gauging how long the carcinogen will continue to contaminate water and soil, Randy Weintraub at the University of Florida's pesticide research lab in Gainesville has been working to characterize EDB's chemical and microbial half-life — how long it takes for half of the chemical to degrade.

So far, he says, temperature seems to have the biggest effect on fostering chemical degradation — the higher the temperature, the faster the breakdown. However, even at the 72° F typical of Florida's groundwater, Weintraub's research suggests the chemical half-life is very long — between 300 and 500 days. Additionally, he says, there is some concern that ethylene glycol, one breakdown product, might further degrade to formaldehyde.

Preliminary tests also indicate there might be some microbes capable of degrading contaminated water. However, Weintraub cautions that the brominated degradation products apparently generated by the microbes might themselves prove to be toxic. The tests mixed EDB-polluted water with sewage sludge — home to many chemical-degrading microbes. The Florida researcher has not yet identified which of the sludge's many indigenous microbes were active in degrading the pesticide.

Earth Sciences

Recipe for new life: Stones over easy

One of the surest ways to provide an equal opportunity for all species to compete for a place in the sun is to wipe the slate clean. A fire, for example, can ravage a forest that is dominated by one or two types of trees, allowing all species with a pioneering spirit to conquer the new frontier. This maintenance of species diversity through disturbances like fires, storms and disease has been observed in living ecosystems many times. But until recently, evidence of the ecological theory had never been found in fossils.

Now Mark Wilson, a paleontologist at the College of Wooster in Wooster, Ohio, reports in the May 3 SCIENCE on fossil evidence from cobbles (small, flat stones) encrusted with marine invertebrates that lived 450 million years ago. Wilson's first observation was that the cobbles were encrusted on both sides, indicating to him that they had been periodically overturned, perhaps by a strong current over the mud in which the cobbles were probably embedded. By identifying the animals that built their homes on top of each other, as some species began to dominate the surface, Wilson could unravel a story of succession: At the beginning, when the cobbles were barren, a great diversity of bryozoan species and other animals settled on the surface. With time one particular bryozoan, the *Amplexopora*, began to crowd out the other animals until the stones overturned and the process began anew.

If there had not been periodic overturning of the cobbles, killing the animals that were living on the top, all the cobbles would have been completely covered with *Amplexopora* fossils. Instead, only 7 percent of the 84 cobbles examined were entirely encrusted. Wilson suspects that the few cobbles that were completely conquered by *Amplexopora* may not have been overturned because these animals built up a massive colony in a shape that stabilized the cobble. "In a sense," says Wilson, "they evolved in a way to counteract the disturbance that was limiting their distribution before."

Oil and the health of the oceans

Petroleum has seeped naturally into the world's oceans for centuries, if not for millions of years. But when modern industry came on the scene, the amount, distribution and type of petroleum entering the oceans changed dramatically. Today, the total input of petroleum from all sources is between 1.7 million and 8.8 million metric tons per year (mta), according to the National Research Council. Nonetheless, the authors of a newly released Council report called "Oil in the Sea" have found "no evident irrevocable damage to marine resources on a broad oceanic scale, by either chronic inputs or occasional major oil spills."

Ten years ago when the Council published a similar report, scientists were most concerned about tanker accidents and offshore oil production, which are now said to contribute 0.4 and 0.05 mta, respectively, to marine oil production. In the new report, the focus has shifted instead to chronic inputs such as routine tanker operations (0.7 mta), municipal wastes (0.7 mta), other runoff and wastes (0.5 mta), bilge and fuel oils (0.3 mta) and petroleum transported through rainwater or the atmosphere (0.3 mta).

Since the 1975 report, the state of knowledge about the fate and effect of oil pollution has improved considerably. For example, researchers now know that one-third to two-thirds of oil spilled on the sea surface evaporates. But there still remain enough gaps in understanding for the report to conclude that an "unequivocal assessment of the impact of oil on the environment does not yet exist." Major research needs include studies on the effects of chronic, low levels of petroleum on fish stocks, especially larval and juvenile fish, and on other marine life, as well as the impact of oil on tropical and polar environments, where much oil development is planned or under way.

Science Service, Inc. is collaborating with JSTOR to digitize, preserve, and extend access to *Science News*. www.jstor.org