LETTERS

Kepone Chronology

In a recent issue of *Science* (News and Comment, 7 May, p. 529), Nicholas Wade reports that Umberto Saffiotti resigned as director of the National Cancer Institute's (NCI's) chemical carcinogenesis bioassay program. According to Wade's article, part of the reason for Saffiotti's resignation from this position relates to the lack of staff assigned to the program and the attendant inability to promptly assess and disseminate experimental results. Without assigning responsibility for the bottleneck, the following chronology may serve to illustrate the consequences of such a failure to make information available.

The chemical Kepone (chlordecone) was tested in the NCI bioassay program, and the results were released on 8 April 1976 (*1*). (Preliminary results were available in January 1976.) The studies, conducted under contract to the NCI, were begun in November 1971 and May 1972 (of mice and rats, respectively). According to the NCI, the mice were killed in August 1973 (after 90 weeks), and the rats were killed in July 1974 (after 112 weeks). Both groups were dosed for 80 weeks. All pathology was held, and it is not yet clear when the slides were actually evaluated.

Life Science Products Company of Hopewell, Virginia, the firm that made Kepone, was formed in the fall of 1973 but did not begin manufacturing operations until March 1974. At that time, the NCI mouse bioassay had been completed but had not been evaluated. The rat study was completed 4 months later. If both studies had been evaluated within 6 months of the termination of the longest bioassay (that of rats), the results would have been available in January 1975. The Life Science plant was ordered closed by the state of Virginia on 25 July 1975.

Information on the toxicology of Kepone was minimal in the period between 1949 and 1958. In 1958, the Allied Chemical Corporation contracted with the Medical College of Virginia to conduct studies on the acute, subchronic, and chronic toxicity of Kepone in several species. These reports were used in connection with petitions to register Kepone as a pesticide; the data in the petitions were kept confidential. A memorandum dated 1958 was referred to in *Clinical Toxicology of Commercial Products* (*2*). This information, supplied by Allied Chemical, showed the rabbit to be the most sensitive species; the single lethal dose that killed 50 percent of the animals (LD_{50}) was 65 mg/kg; the rat was less sensitive (the single LD_{50} was 95 mg/kg). The minimum single lethal dose in the dog was 250 mg/kg. No information on the chronic toxicity of Kepone was released by Allied Chemical.

In the 1960's, two investigations of the subchronic toxicity of Kepone in mice were reported (*3*, *4*). They showed that Kepone produced tremors and ataxia. The report by Good *et al.* (*3*) suggested that effects on reproduction are detectable when the diet contains Kepone concentrations of 5 ppm. Both reports alluded to the cumulative nature of the toxin.

As a result of the disease that Kepone produced in exposed workers and the attendant court actions, the studies sponsored by Allied Chemical have become available (*5*). In these reports, the single LD_{50} in rats of Kepone dissolved in corn oil was 132 mg/kg. The estimated LD_{50} from a 3-month feeding study was 3.2 mg/kg per day. The 6-month LD_{50} was lower, 1.5 mg/kg per day. This indicates that Kepone is a cumulative poison and that at least 6 months are required for toxic concentrations to be reached with low doses. A chronicity factor, calculated from these data, is the ratio of the single LD_{50} value in repeatedly dosed animals. The values are 41 and 88 for 3- and 6-month periods, respectively. Only Mirex, an analog of Kepone with a 3-month chronicity factor of 60.8, appears to be a more cumulative toxin (*6*). Mirex has a comparable 3-month LD_{50} value, 6 mg/kg, but a larger single LD_{50} value, 365 mg/kg.

From the observations on the acute and chronic toxicity of Kepone, it can be said that a reduction in the exposure time would have benefited the employees at the Life Science Products plant. From the chronology, the NCI could have been instrumental in this reduction. Using the airborne Kepone concentration in the plant of 3 mg/cm^3 measured by state of Virginia officials in July 1975, it can be estimated that the workers could have received daily doses of Kepone that were within a factor of 12.5 of the dose calculated as a 6-month LD_{50} for the rat. The NCI carcinogenesis bioassay data and the data found in the toxicity studies sponsored by Allied Chemical indicate that Kepone concentrations of 10 ppm in the diet cause cancer in mice and rats. This dose is within a factor of 5 of the daily amount that estimates suggest could have been absorbed by the exposed workers. It remains to be seen whether the 15-month exposure period in humans will be enough to produce cancer.

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References

1. *Fed. Reg.* **41**, 14914 (1976).
2. M. N. Gleason, R. E. Gosselin, H. C. Hodge, Eds., *Clinical Toxicology of Commercial Products* (Williams & Wilkins, Baltimore, 1963), p. 39.
3. E. E. Good, G. W. Ware, D. F. Miller, *J. Econ. Entomol.* **58**, 754 (1965).
4. J. J. Huber, *Toxicol. Appl. Pharmacol.* **7**, 516 (1965).
5. *Toxicological Studies on Decachlorooctahydro-1,3,4-metheno-2H-cyclobuta [cd] pentalen-2-one (Compound 1189) (Kepone)* (available from Allied Chemical Corp., Morristown, N.J.).
6. T. B. Gaines and R. D. Kimbrough, *Arch. Environ. Health* **21**, 7 (1970).

Brown Pelican Reproduction

D. W. Anderson *et al.* (Reports, 21 Nov. 1975, p. 806) attribute the improvement since 1970 of brown pelican reproduction in Southern California to lower DDT residues in "the discharge at a sewage outfall associated with a Los Angeles plant that manufactured technical DDT."

The following observations are pertinent. Before 1970, the effluent from the factory mentioned by Anderson *et al.* (the Montrose plant) had drained into Southern California coastal waters by way of the Los Angeles County sewage treatment plant for more than 20 years without any reported effect on brown pelicans. During this period, the DDT in the effluent from the plant's settling pond averaged 10 to 15 pounds per day.

One month after the 1969 Santa Barbara oil spill, Risebrough reported that the pelicans were not reproducing because of high DDT residues (*1*). At the Wisconsin DDT hearings, which were characterized even by an Environmental Protection Agency (EPA) attorney as "a circus" (*2*), he had testified (*3*) that the brown pelican on Anacapa Island, off the Santa Barbara coast, was "extinct," "gone." Under cross-examination at the 1971–72 Washington DDT hearings, however, he retracted this statement (*4*). The pelican was not extinct after all.

In 1974, L. R. Axelrod of the EPA testified (*5*) before the House Appropriations Committee's subcommittee on agriculture that mercury was the principal suspect in eggshell thinning. The concentration of mercury in crude petroleum has been reported to be as high as 18 parts per million (*6*).

Noise, fright, and intrusion also cause birds to produce eggs with thin shells. Frequent visits to the brown pelican colonies by investigators, sometimes in helicopters, were stopped by the Department of the Interior as a result of protests. The pelicans have since made a quick recovery.

If DDT persists for decades, how could the pelicans have recovered so quickly? Either DDT is not as persistent as its detractors maintain, or it was not the cause of the pelicans' decline.

I believe the final judgment of the scientific community will be that DDT is not responsible for the depletion or extinction of living organisms except for insect pests.

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References

1. R. Jehl, Jr., *Pac. Discovery* **23**, 18 (January-February 1970).
2. B. Fielding, transcript of the Environmental Protection Agency, Public Hearing on DDT, Arlington, Va., 10 November 1971, pp. 4587–4588.
3. R. Risebrough, *ibid.*, 7 January 1972, pp. 6972–6974.
4. ———, *ibid.*, 15 February 1972, pp. 8490–8492.
5. L. R. Axelrod, in testimony before the U.S. House of Representatives, Committee on Appropriations, Subcommittee on Agriculture, *Environmental and Consumer Protection Appropriations for 1975;* part 5, *Environmental Programs* (93rd Congr., 2nd sess., 1974), p. 555.
6. F. M. D'Itri and P. B. Trost, paper presented at the International Conference on Environmental Mercury Contamination, Ann Arbor, Mich., 1970.

The excessive DDT contamination of the Southern California Bight in the late 1960's and early 1970's was associated with a number of wildlife problems that have been examined in a series of other reports (*1–3*).

Of the points raised by Sobelman, only three refer to the data and conclusions of our *Science* report. Observations before 1969 include a report of thin-shelled eggs from Anacapa Island in 1962 (*4*), a decline of Southern California brown pelican populations beginning in the mid- to late 1950's (*2*), and suggestions of reproductive problems on Los Coronados as early as 1963 (*5*). Investigations specifically directed toward this problem were begun in 1969 (*5, 6*).

We believe it important to stress our conclusion that this contamination resulted principally from an industrial discharge rather than agricultural or urban runoff. Sobelman maintains that the high DDT residues in the sewer pipe below the Montrose plant (*7*) and the more than 200 metric tons of DDT in the sediment offshore from the sewer outfall (*8*) did not originate at the Montrose plant. DDT residues entering the waste treatment plant of the Los Angeles County sanitation districts dropped sharply in 1970, after the changeover by Montrose from a settling pond disposal to a sanitary landfill disposal (*9*). Sobelman has so far not published any data supporting his conclusion that the effluent from the settling pond contributed only 10 to 15 pounds of DDT per day to the sewage system. Nor has he published any description of the analytical methodologies employed. The wide interest generated by this prob-