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January 24, 1969

Professor Joshua Lederberg
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Dear Josh:

Out of the mass of complexities surrounding the pesticide problem, I shall try to select the topics that are pertinent to your recent newspaper column.

1. Effect of DDT on reproduction in peregrine falcons and, by implication, on the survival of this species.

- (a) Reproduction: obviously no controlled experiments have been done with peregrine falcons. However, certain game birds have been tested. In quail, little or no effect on fertility and hatchability at the very high level of 200 ppm of diet (Note - tolerance in crops is currently 7 ppm). The 200 ppm level is toxic to young birds but did not arrest hatchability. This is very interesting in itself, (see enclosure).
- (b) Egg Shell formation: no effect noted by H. R. Bird (Professor of Poultry Husbandry, University of Wisconsin) on laying hens. DDT lowered egg production but not hatchability at 310 ppm of diet; hatchability was lowered by 620 ppm but no effect on egg shells was noted (Bird, personal communication, 1968) (Note - During the incubation of the embryonated egg, calcium is withdrawn from the eggshell to provide for the skeleton of the chick. As a result, the thickness of the eggshell decreases, and it becomes fragile at hatching time. Measurements of the thickness of eggshells of wild birds have no comparative significance unless this fact is taken into account).

My conclusion is that finding DDT and DDE (if, indeed, the test was actually measuring these) may have interfered with reproduction, but the only controlled experiments show that birds are extraordinarily resistant to DDT as a substance affecting reproduction. Levels that are toxic to young birds apparently do not reduce reproduction. The effect of PCB on reproduction is unknown. The possibility that it may be deleterious should be examined before blaming everything on DDT.

- (c) Survival of the species: the peregrine falcon is not extinct in the eastern U.S.A., as the Hawk Mountain Survey shows. Starker Leopold informs me, that it used to nest on ledges of skyscrapers in eastern cities, and feed on pigeons, but it has disappeared from these habitats "as a result of DDT."

I cannot help wondering, however, in view of the fact that the peregrine made such a remarkable adaptation, may it not have fallen victim to some unidentified condition of urban life? In other words, it may have been a fatal move, unrelated to DDT, to leave the cliffs in the wilderness and move to the cornices of office buildings.

January 24, 1969

What factors affect the peregrine population? Undoubtedly gunfire is very prominent. Most hunters and farmers like to kill hawks. Their excuse is that hawks kill game-birds and poultry. Hunters are on the increase. According to Spencer, the peregrine is "fair game" (inadequately protected against hunting) in over half the area of U.S.A. and Canada. Incidentally, the British killed off peregrines in World War II for air defense reasons. The article that you sent me from NATURE stated that "breeding peregrines persist in apparently normal numbers in British Columbia and in the Arctic." I note that in Table I, three of the birds were listed as Arctic migrants, and one of these was reported to have the highest content of DDT, which seems very strange. Since peregrines are breeding in Canada and the Arctic, and since the Arctic peregrines seem to contain DDT, there is a deficiency in the thesis of the authors.

I cannot verify your statement: "In some wild species of birds, DDT has accumulated in body tissues to the point of causing serious disturbances in the metabolism of sex hormones. These are manifested by a serious thinning of the calcium carbonate shells of the birds' eggs and interference in breeding." I know of no evidence that would support the non sequitur in these two sentences. I recognize, of course, that species differences among birds may result in different responses to DDT, but so far, the experimental results with DDT and reproduction in birds show the existence of considerable resistance to DDT.

Incidentally, despite Riseborough et al, vitamin D is not a steroid, and its metabolism is not known to be mediated by hydroxylases. For causes of soft-shelled eggs, I refer you to textbooks of poultry husbandry. The most common cause in domestic poultry is psychological disturbances, which cause expulsion of the egg from the uterus of the hen before completion of the calcification process - ask any poultry farmer what effect he expects from sonic booms and he will probably tell you "soft-shelled eggs." I joined the Poultry Science Association in 1930, so I have had some contact with questions of avian biochemistry.

2. The effect of DDT as an inducer of steroid hydroxylase.

This has been reported to occur in rats when DDT is fed at 1 ppm of the diet (Science, 161:397, 1968). However, reproduction in rats is unaffected by far higher levels of DDT. Fitzhugh, of the FDA Labs, reported as follows:

"Rats fed diets containing 50, 100, and 600 ppm of DDT showed a progressive decline in the percentage of young successfully weaned, as compared with rats fed diets containing 0 or 10 ppm of DDT. However, the mortality of infant rats of mothers fed 50 and 100 ppm, although greater than the mortality of groups exposed to less DDT, was not greater than the mortality of infant rats in many laboratories. No effect on the number of rats born alive was evident in the first generation, but in the second generation rats fed 600 ppm produced very few living young, of which none survived the nursing period."

I therefore conclude that the effect on steroid hydroxylase is not necessarily correlated with reproduction. The body has all sorts of control mechanisms for regulating enzymes and their effects.

3. Your column does not ask, but provokes, the question: What are the effects of DDT on human beings, especially on reproduction?

I shall not attempt to deal with the extensive literature on human volunteers who have consumed enormous quantities of DDT. According to J. M. Barnes (W. H. O.):

"..Unless epidemiological studies on the health of people who have been heavily exposed to DDT for 20 years or more reveal an unsuspected long-term toxic effect, this insecticide will go down in history as one that has killed more insects and saved more people than any other substance."

January 24, 1969

Extensive reviews of this topic have been written by Hayes (see, for example, Ann. Rev. Entomology, 1962). Rather I draw attention to the effect of DDT on the Indian population as summarized by Pal (World Review of Pest Control, 1962, vol. 1, p. 6).

"Since 1953, about 147,593,270 lb. of DDT have been used, with small amounts of BHC and dieldrin. As a result, malaria morbidity has been significantly reduced in the country. The proportional case rate of malaria (per cent of malaria cases to total diseases as clinically diagnosed) in each year of this programme has shown a decline and the figures are presented in Chart 1. Estimates of actual morbidity and mortality are difficult but it would appear, from the available data, that malaria in India has been reduced from 75 million cases to less than 5 million. A new era in economic development and social progress has been initiated with its beneficial transformation of the life of the people. The average span of life in India is now 47 years, whereas before the eradication campaign it was 32 years. This improvement has resulted in better agriculture and industrial production. In the Terai region (Uttar Pradesh), land under cultivation and food grain production has increased and this region, once abandoned by its inhabitants because of the high incidence of malaria, has become a beautiful and prosperous area."

If there have been any effects on the birth-rate in India, they have been negligible.

4. Why am I arguing with you about DDT?

Certainly I have no financial interest in DDT. Perhaps it is the difference in our backgrounds. Roe (The Making of a Scientist) and more recently Klaw (The New Brahmins) have drawn attention to the change in the origins of scientists. Klaw said that some years ago, young men often went into science because they literally had to choose between the test tube and the plow. At the age of 18, I was hoeing Canada thistles in a field of oats. In subsequent years, more and more scientists, including yourself, have come from the world of asphalt and concrete, where food grows in supermarkets.

But my interest in DDT goes beyond my knowledge that without pesticides we would all starve to death.

On January 16, I received the following letter.

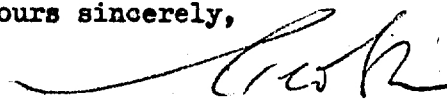
Dear Dr. Jukes,

Professor Garnham has asked me to lend you a slide of a patient with onchocerciasis. I enclose one showing a patient in his early forties with characteristic presbydermia looking prematurely old and with onchocercal blindness. One out of the 30 to 40 million people infected with the disease in Africa.

Please let me have the slide back when you have finished with it.

Best Wishes,

Yours sincerely,



George S. Nelson, M.D. D.Sc.,
Professor of Helminthology.

The background for this is in the following quotation (Proc. Roy. Soc. B, 167, 134, 1967).

136 P. C. C. Garnham, F.R.S. (Discussion Meeting)

If our experiment in malaria eradication in Kenya was a failure, it led, by a coincidence, to a spectacular success in another direction. During the course of the work in Kericho, donkeys laden with cans of *DDT* had to go up hill and down dale; on one occasion, a donkey slipped in crossing a river and the *DDT* fell into the water. We had previously noticed that this river was heavily infested with the larvae and pupae of various species of *Simulium*, the vector of onchocerciasis, a filarial condition which causes blindness in tropical Africa and in Central America.

After this incident, we were surprised to find that the *Simulium* had completely disappeared from the river. The opportunity was too good to be lost, and we set about plans for the eradication of *S. neavei*, the single vector of the disease in Kenya. Nearly all species of *Simulium* breed on rocks and grasses in rushing water, but the actual breeding place of *S. neavei* had never been found, and when I told Buxton that I wanted to start an experiment to observe the effect of *DDT* on rivers infested with this fly he was horrified: he felt that the actual breeding place must first be pinpointed and that it was most unscientific to use *DDT* in this blunderbuss way. I was not convinced, and my colleague MacMahon and I went ahead with the plans, and within 5 months had completely eradicated the fly from the worse onchocerciasis area in Kenya (Garnham & MacMahon 1954). It has never returned, and in the intervening years MacMahon extended the method to all infested rivers in Kenya, eradicating *S. neavei* from the whole country, and incidentally finding the breeding place of the insect, to his amazement, on the carapace of freshwater crabs.

Adults with onchocerciasis are blind, and are led around by their children, who later will turn blind.

McLean (Bioscience, September, 1967) made the following statement:

"I submit that the campaign of false fear against the use of modern pesticides has, is, and will cause deaths and sufferings greater than those of World War II. It has been over 12 years since a major new insecticide has been brought to market and this is due to unnecessary controversy. During this interim, daily deaths due to starvation and malnutrition have risen from 6,000-7,000 per day to over 12,000 per day, not to mention the millions who have died from vector-borne diseases. These lives could have been saved had the efforts devoted to controversy been used to encourage the discovery and wider use of insect controls."

I recognize the terrifying nature of the population explosion, but I do not wish to be one of those who withheld the means to live from the emerging peoples of the "Third World." And I think you should re-read your column, and ask yourself if the statements in it are well-supported, and what effect it will have on the fight against hunger and disease. Granted that we cannot get "something for nothing", how do the scales tip for *DDT*?

With best regards,

Tom

Thomas H. Jukes