No animals have received so much attention, been so extremely admired, or so greatly persecuted, by man as have the birds. This dubious distinction has found its most impressive manifestation in North America during the past two centuries. Two species that populated the continent and its coastal waters in millions have been extirpated by the purposeful actions of men. The Passenger Pigeon whose migrating flocks like storm clouds darkened the mid-western skies was shot into oblivion for pig food, for fertilizer, and for the sport of killing. The Great Auk, the flightless, penguin-like bird of the northern hemisphere, whose teeming hoards, to the amazement of the first explorers of America's northeastern shores, occupied every nitch and ledge on the rocky coasts of Labrador and Greenland, were bludgeoned into extinction by ship crews. With the less well known Labrador Duck their battered bodies were packed into hogsheads for the honor of later rendering into cooking oil.

American and Snowy Egrets were brought near to extinction in the United States early in this century by plume hunters. From this fate they were saved in the nick of time by Congressional action, responding to aroused public feeling, that declared illegal the importation and interstate traffic in plumes. At the time this legislation was passed Egrets were maintaining a precarious existence in southern Florida. Plumage hunters sought out the last remnants of these embattled species where they had retreated to the remotest mangrove islands and saw grass marshes of the Everglade wilderness. So

valuable were the feathers on the milliner's market that these men risked any danger, any hardship, in the trackless mosquito infested swamp in their rapacious, remorseless pursuit of the Egrets. The plumes, which develop only during the breeding season, were plucked from birds shot off their nests; their bodies left to rot where they fell. The young, unshaded and unfed, soon perished from neglect in the steamy mangrove jungle, and whole rookeries became a carnage. The horror of these deeds, though they never aroused the slightest doubts or compassion among their perpetrators, eventually became known to people with ~~more~~ different refined sensibilities. The ensuing ~~disgusted~~ outcry at the cruelty, the waste, the pointless destruction committed for the gratification of greed and feminine vanity brought the slaughter to an end. Under the protection of laws which rendered the ~~unconscionable~~ exploitation unprofitable, and with broader protection against disturbance of these and many other birds afforded by sanctuaries and public parks, the Egrets have regained much of their former abundance. At last the aesthetic conscience of man prevailed over his acquisitive instincts permitting him to appreciate the greater beauty of the living bird than the plume in the lady's hat.

The fate of the Carolina Parakeet was the result of many causes not all understood, but which include shooting for its feathers in addition to destruction of the bird's habitat. As with the Ivory-billed Woodpecker, a bird also adapted to an environment of narrow ecological limits, the

Parakeet may neither have been able to survive in the dwindling habitat to which it had specialized, nor to adjust to a new environment.

Many of the species of birds that are barely surviving, or are slowly losing their fight for survival are in trouble because of curtailment of a favorable territory in which to carry on their breeding functions, in which to rest on migratory flights, or, in which, on winter grounds, to pursue a constant quest for food. The breeding and food gathering difficulties may be associated with the loss of critical spacial needs of individual pairs. The California Condor, the Whooping Crane, and several of the varieties of Prairie Chickens have been losing ground, not so much because of persecution by man as through the gradual attrition of their ancestral habitats. Though man is responsible for this whittling down, the cause of the decrease in wild life ~~is~~ has been indirect and unplanned, not a frontal, purposeful attack as it was on Passenger pigeons, Great Auks, and Buffalo.

Until recently most birds have not been directly threatened by the activities of man. This is because as a class they are remarkably adaptive. Even though enormous tracts of land have been cleared in the mid-western states the total number of birds has not apparently diminished. Certain forest species, of course, are less numerous, but many other kinds are more abundant than ever before. Some varieties of woodpeckers, nut-hatches, hawks, and owls are undoubtedly rarer. On the other hand, the birds which prefer semi-open country, bushy sprout land, and second growth forest have probably multiplied greatly.

Among these latter species are several kinds of warblers, many of the sparrows and their allies, cuckoos, some of the thrushes, and crows. It can hardly be doubted that Blue-winged and Golden-winged Warblers, Chestnut-sided Warblers, Song Sparrows, Robins, Bluebirds until very recently, and Crows are much more plentiful than they were in pioneer days. The three warblers favor sprout land and young second growth forest as nesting habitats; Song Sparrows are bush and ground nesting birds; Robins and Bluebirds, as everyone who has ever lived in a suburb or on a farm knows adapt readily to a human environment, nesting around buildings and in bird boxes put up to attract them. Robins are able to extract for themselves and their young an ample supply of worms from that favorite foraging place, the well ~~kept watered~~ tended lawn. How many of us are not familiar with the sight of a fat robin running in short spurts across a lawn, pausing, cocking its head to one side -- to listen we were told as children, but much more likely to look -- and of a sudden probing deep into the soft soil to pull out with braced legs and arching neck a long rubbery worm?

The introduction by the technological revolution which has taken place since the end of World War II, of chlorinated hydrocarbon insecticides for insect pest control, has caused a decline in the United States in the populations of several species of birds. Some of the chemicals in this class are toxic also to plants and are used as weed killers and defoliants. The most familiar of these insecticides is DDT. It was first used to control mosquitoes, but was soon dis-

covered to be active against many orders of insects, and belatedly to kill crustaceans, fish, and birds. DDT and its many close chemical relatives, because they kill by interrupting the transmission of nerve impulses, are non-specific nerve poisons and therefore active on a broad spectrum of organisms. They are substances foreign to the environment without counterparts in nature, refractory to decomposition by the natural chemistry of living organisms. And because they cannot be ~~gotten rid of either through~~ excreted by the normal eliminating organs, the animal as a last resort stores them where they will be out of direct contact with vital processes. Since they are all fat soluble and since fats themselves serve as a reservoir of surplus energy, which is not continuously utilized, these hydrocarbons can safely be deposited in the adipose tissues -- the attics and cellars -- of the animal body where they may remain for years until fats are mobilized to meet emergency demands. When this occurs they appear in the circulation, and then the animal is in for trouble. Unfortunately, the organism has little choice into which fatty tissues it deposits these foreign substances, whether in liver, kidney, bone marrow, or most disastrous of all in the lipid elements of nerve tissue where they are in close relationship with the mechanisms of nerve impulse conduction, and can produce paralysis. Moreover, some kinds of these poisons, not completely resistant to catabolic attack, are partly reduced to even more toxic and resistant products which cause injury in concentrations a thousand times lower than the parent substances.

But this is not the worst of it. These hydrocarbons are passed up the food chain from lower to higher animals. The toxicity to them is not uniform throughout the biota; some animals being more susceptible than others, which store the insecticides in high concentrations, a situation that has had a devastatingly deletarious effect on predator species. The extreme water insolubility of chlorinated hydrocarbons is a property responsible for misjudgment of the effect they produce on the biological environment. Measurements of contaminating concentrations of these chemicals in water yield such small figures that manufacturers belittle their significance in disregard of the mechanism by which they enter the food chain, and because financial interest predisposes them to do so. The very fact of the extreme difference in their solubility in water and fats leads to the absorption from water of even minute amounts by the lipids of aquatic organisms until a state of equilibrium is attained between the greatly divergent solubilities in the two media. As a result all lower forms of life from bacteria to protozoans through the aquatic worms and insect larvae continue to extract from their environment all such non-metabolizable substances as fast as they appear as contaminants. Subsequently, scavangers, bottom feeders, and fish that eat insects and other invertebrates concentrate the hydrocarbons further in their fatty tissues. The carnivorous fish carry this storage to still higher concentrations of thousands of parts per million, an increase of a million-fold over the starting concentration in water of

less than one part per billion. Fish eating birds -- grebes, loons, and ospreys to name a few -- consequently may over a period of time injest massive doses of chlorinated hydrocarbons. The reproductive physiology of birds is particularly susceptible to disruption by DDT and its allied chemicals which interfere with the enzyme system involved in calcium metabolism manifested first as lowered fertility and later by defective egg shell formation. Robins that have suffered extremely high death rates in communities where DDT was used for controlling Dutch Elm Disease obtain the poison from earthworms taken from the soil under sprayed trees. Earthworms like fish concentrate DDT, but unlike fish are highly resistant to its effects and so remain for life a reservoir of death to robins.

Because most insects are very small they can be killed by small amounts of poisons, whereas larger animals are only effected by proportionately larger doses. If the proportionality goes by weight, the amount of poison intake necessary to kill a man would be about one hundred million times that needed to kill a mosquito weighing a milligram. So when an area is sprayed for mosquitoes or some other insect pest it is unlikely that enough poison will come in contact with a person, a dog, or even a bird to injure it immediately. Such may have been the reasoning first put forward to reassure people as to the harmlessness of these chemicals. That many of them are deadly to man has been proved by the accidental spilling of concentrates on handlers who have died in spite of every effort to wash off the poison immediately. And the breathing of sprays during crop

application has also lead to fatalities.

A more insidious danger arises from residual poisons on vegetables and fruits that have been sprayed to kill pests. Although federal regulations govern allowable residues on market products, and prescribe the minimum time between the last spraying and harvesting, inadequate inspection and state laws less strict than federal often fail to prevent the marketing of dangerously contaminated farm produce. Since residues are not readily washed off, even with soap, those who eat these products accumulate poisons in their bodies faster than is considered safe by the usually permissive standards of government agencies, regardful with equal solicitude for the economic advantages to the chemical manufacturers as for the health of the consumer. And even when residues are kept to accepted safe limits they will in time accumulate to levels which though not immediately harmful to health can under morbid stress and chronic illness exacerbate a disease process and contribute to the cause of death.

Even if we are willing to accept these hazards to health and the cost in life, still the use of organic insecticides permanently to control various kinds of insects is a futile undertaking in the end, and so the losses are sustained without the advantages of the expected benefits. Adaptation to changes in the environment comes about through mutations; and the rate at which mutations occur in turn depends on the rate of reproduction of the species under consideration. In man the periodicity of reproduction is about twenty years which means

that many centuries or even millenniums must pass before adaptation through natural selection -- leaving out of consideration the possibility of future genetic engineering -- becomes appreciable. For passerine birds, the common song birds for example, reproductive periodicity is about one year so that even with them evolution is too slow a process to adapt a species to a potentially lethal environmental change, in time to save it from extinction. With insects, however, the situation is quite different. The reproductive cycle of the house fly is so short that if all the descendants of one pair lived and reproduced normally during one summer season from April to August the total number would be 10^{20}. One hundred billion billion. A comparable figure for the cabbage aphid assuming an average of 41 young per female in 16 generations between March and October is 10^{24}, ~~or 10,000 times more than the house fly.~~ Thus it is obvious that among insects the opportunity for mutations to take place bestowing resistance to organic poisons is enormously increased. Strains of insects resistant to many of the common insecticides have been observed. House flies insusceptible to DDT are becoming common. In many mosquito control programs it has been noted after several applications of chlorinated hydrocarbons that the insect is as abundant as it was at the starting of spraying. In Tampa Bay, Florida where mosquito control was conducted for several years by aerial spraying, increasingly high concentrations of DDT were found necessary to produce the same results as were obtained the previous year until ultimately the program

was discontinued. In the mean time the destruction of fish and crustacean life in the shallow waters of the bay had become so extensive that the population of herons and egrets, tourist attractions of the region, which depend on these animals as a major food resource were driven from the area.

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The defenders of DDT, who oppose any limitation on its manufacture and use, cite the undeniable benefit it has brought to people around the world, notably in the undeveloped, tropical countries, by controlling malaria and other insect vector diseases. Ceylon is named as the ~~arch~~ prime example of a country whose moribund society, saddled with endemic malaria, was rescued from a condition of chronic ill-health and lassitude and raised to a state of vigor and social progress by the wide-spread application of DDT to control the anopheles mosquito. Yet, recently the effectiveness of the insecticide has diminished, the anopheles have not been eradicated as forecast and are reappearing in strains resistant to DDT, and malaria more virulent than before has returned to deplete the Ceylanese. To forestall regression to the former state of social deterioration the use of DDT has had to be supplanted by other insecticides of the chlorinated hydrocarbon group, with only partial success, and at the same time old conventional public health measures have been reinstituted. The question must be asked whether chemical insecticides offer any hope for the elimination or lasting control of insect born diseases, or should a totally different approach be sought for the permanent eradication of these plagues on mankind of which biological controls promise the greatest success.