

## V

For several years after taking up residence in New Mexico, I began my photographic activities each April with a search for desert horned larks. I spent many hours observing these birds, recording their activities in detail, <sup>As would be my</sup> ~~in addition to~~ photographing them. I had never met with any birds like them, and I found their behavior near their nests endlessly fascinating. All the horned larks of North America have the curious habit of collecting small pebbles and arranging them on one side of the nest as a kind of paved doorstep. The function of this habit is as obscure as that of the red-breasted nuthatch in smearing pitch around its nesting hole. In the grassland areas of New Mexico where I have studied horned larks, the adobe soil contains very little gravel, so that instead of gravel they use lumps of clay. They approach the nest by running along the ground, a manner less likely than any other to reveal the nest's location. Sometimes they make low reconnoitering flights before settling on the ground a dozen yards away, often to stand upright for minutes on end as they peer over a clump of weeds. Reassured at last, a lark will dart forward with lowered head from one tuft of grass to the next. To keep one always in view requires unwavering attention, since their pinkish color blends with the soil as they freeze into immobility, making the camouflage almost perfect. Then, if its position has not been carefully noted, the bird is not easily found again.

Equally interesting is the behavior of pinon jays in protecting their young from predators. I have never seen a pinon jay fly directly to its nest, to the tree in which it is situated, or even to one close by; nor have I ever seen one perch in the top of the nest tree.

The behavior of scrub jays is similarly secretive, although I have found their nests by watching them through glasses from a hillside, noting where they perched and then searching all the trees in the area.

For two years, scrub jays nested in the honeysuckle vines beside the kitchen door to my house in New Mexico, repairing the old nest the second year. They became so tame that the female could be stroked while she incubated her eggs, and later it was possible for one to put a hand on the nest while they fed their young. <sup>A pair of</sup> ~~These~~ jays also nested in a piñon pine near the house. On June 3, 1948, when the nest contained five young birds near fledging age, I set up my camera and flash equipment nearby. <sup>Since</sup> ~~These~~ birds were much more timid, and had not come to the nest while I was in sight, I had set up a blind from which to operate the camera. The adults were now feeding their young very infrequently—an indication that the time of fledging was imminent, and that the parents were trying to induce them to leave the nest by withholding food.

I had waited for an hour and a half, during which neither adult came to the nest, when a sharp-shinned hawk alighted on the nest tree. Immediately I became alert for a dramatic event, though I did not know quite what to expect. Would the jays defend their nest, or would I be a witness to an unopposed act of predation? The latter was what happened, but not in a manner to produce a once-in-a-lifetime photographic opportunity. The jays remained quiet until the hawk flew down to a lower branch, when one of them started crying out vociferously. When the hawk moved to a perch directly behind the nest, I expected its next move would be to hop onto the side of the nest. Instead, almost before I realized what was happening, the hawk swiftly and silently reached out one taloned foot, seized a young jay by the head, and



flew off with it. For a moment the parent jays had ceased their clamor, and the other young jays were as silent as the predator itself; its victim had probably been killed instantly. As soon as the sharpshin had taken wing, however, the adult jays began crying out in unmistakable agitation as they flew after it for several hundred yards.

When they returned from their hopeless pursuit, the adults did not go to the nest. The four remaining young birds now became increasingly restless; ~~then~~ <sup>then</sup> one by one, they hopped onto the edge of the nest, into the surrounding branches, and finally to the ground. The removal of one of their number, by reducing the accustomed pressure of close quarters, had perhaps hastened their departure from the nest.

Another time in New Mexico, likewise a photographic failure, I was attempting to photograph long-tailed chats in a willow thicket on the flood banks of the Rio Grande. Like the jays, these birds were so extremely timid that I had resorted to a blind; but even then they would not accept my equipment. I had removed most of it from near the nest and had begun to set it up again, piece by piece, when the chats set up the unmistakable, querulous complaint that always indicates the presence of a snake. I could see none, however, nor could I be sure whether it was approaching along the ground or over the tops of bushes, as some snakes are quite capable of doing. Even though I was very much on the alert, I was completely taken by surprise when I saw that this one had zeroed in over <sup>(the willow tree containing</sup> the chats' nest and was now poised there, looking down at the young birds. The thought came to me of what a dramatic picture I might have gotten, had my equipment been in operation, as I watched the sinuous, copper-colored length twined among the willow stems, arching over to reveal the pale yellow-pink of the belly scales, its head aimed like an arrow at the young birds below. Then I rushed from the blind and drove it off—a Rio Grande red racer at least five feet long. But I did not know how persistent snakes can be. In twenty minutes it was back; three times I chased it from the nest, and three times it slithered off over the

willow branches without going all the way to the ground, and with a speed that lived up to its name. The fourth time, my determination fed by anger, I caught and killed it. Then, somewhat ashamed of my own interference with the ways of nature, I packed up my camera and equipment and left.

This was not my only experience with snakes. At the Santa Anna Refuge in southern Texas I had found the nest of a hooded oriole beautifully situated among low-hanging festoons of Spanish moss. Having waited to begin photography until the young orioles were five days old, I arrived early in the morning to find a blue racer draped among the moss, its head inside the nest. Its bulging coils were proof that the last of the young orioles was even then in the process of being swallowed. As I shook the branch from which the moss hung, in a mixture of disgust and disappointment, the racer let itself down to the ground and sped away.

~~Another~~<sup>Once</sup> time, in Florida, I came upon two chicken snakes in the act of cleaning out a martin colony from several old woodpecker holes in a dead tree. The snakes, coiled together and hanging from the entrance to the lowest of the nests, were so engorged with their meal that they looked like a stocking stuffed with tennis balls. The smooth and barkless surface of the tree, in which they were too high to reach and from which they could not be dislodged by pounding on it, raised the question of how the snakes had managed to climb it.

During my sojourn in south Texas I found a coot's nest in a cattail swamp at the edge of a small pond. Since the water was too deep for a blind but not deep enough for a tripod, I decided on a procedure that had worked well in a similar situation, years before, <sup>at</sup> in a small Illinois prairie marsh inhabited by red-winged blackbirds. While I moved through the cattails, counting the redwings, I flushed a marsh bird from a nest containing eight sparsely speckled, buffy eggs. Since she went off quickly through the reeds, I could not identify her, <sup>from the eggs</sup>, which were smaller than a bittern's and not immaculate, I but/guessed her to be a Virginia rail. Because of the reputed timidity



of rails, I surmised that an attempt at photographing the owner of the nest would not succeed, and decided on another strategy. This was to place a triggering device, concealed in a split section of dried cattail stalk, in the nest in such a way that the rail would press against it and release the shutter as she settled over her eggs. The scheme would undoubtedly be a one-time affair if it worked at all, since following the trauma of the first exposure it was unlikely that the bird would return a second time so long as the camera and lamps remained in place. Nor was there any way to ensure that the bird would be in the most satisfactory position at the moment of exposure. Nevertheless, concluding that nothing risked meant nothing gained, the next day I set up my camera with the triggering device in the nest, and then walked to higher ground on the far side of the small marsh to watch what happened. I hadn't been there long when I saw the flash and knew that mechanically, at least, the device had worked. Later, the picture of a Virginia rail arranging her eggs proved that the effort was justified.

Such was the device I intended to try with the coot. Setting it up as I had before, I went away and waited several hours before returning to see whether a photograph had been taken in the meantime. No bird slipped away into the cattails as I waded out to the camera, and my first thought was that she had deserted. Then I saw that the nest was empty. Evidently a predator had come and eaten the eggs. Its identity was a mystery, since there were no broken eggs, fragments of shells, or signs of their contents to be seen: the nest was as tidy as though it had just been completed. In my bafflement, it did not immediately occur to me that I might have a record of what had happened. And indeed the processed film revealed the predator: ~~there~~ an indigo snake in the act of swallowing one of the eggs, all of which it had swallowed whole.

Hawks and snakes are not alone in their taste for the eggs and young of birds. Crows and jays both share it. My experience in having tame scrub jays at my doorstep has only somewhat tempered my own long-standing antipathy toward the bluejays of Great Spruce Head Island. Part of the antipathy, I confess, is a result of their having spoiled so many photographic opportunities for me by their depredations on the nests of smaller birds. With good cause, bluejays appear to be heartily disliked by their potential victims. Wherever a jay goes, it is likely to be followed by the protesting complaints of lesser forest species, which may go as far as to launch a swooping attack—as I have seen a pugnacious olive-sided flycatcher do. Through it all, the jays' attitude remains one of studied disdain or indifference.

I put the blame on bluejays for tearing away the loose bark behind which a pair of brown creepers had built their nest in the spring of 1969. The creepers had chosen a dead balsam standing in the open, its bark hanging in ragged sheets about a lean, bleaching trunk. The jays must have been on the watch while the nest was being built in order to have found that nest. What appears to have been the same fate overtook a family of tree swallows that had made the unfortunate decision to nest in a long-abandoned flicker hole in a dead white birch. Since the wood had rotted away behind the still intact bark, the jays had little difficulty in penetrating it and devouring the young swallows. Another pair of swallows I watched in the process of choosing a nest site had better luck. They had chosen a year-old downy woodpecker hole in a dead spruce, which was still solid. While they were <sup>probing and</sup> considering its merits, a downy



woodpecker happened to alight on the tree. Since for the swallows the tree was now their territory, one of them showed its intense displeasure by diving at the woodpecker in short, swift lunges. The woodpecker, evidently feeling that he had an equal claim to the tree, ducked around it at each lunge, thus frustrating the attacker. The swallow's mate now joined the combat, and their concerted tactic of diving at the newcomer from two sides succeeded in driving him away.

Evidence of predation by bluejays is not lacking. One episode in which I observed it at first hand occurred while I was in the midst of photographing a pair of nesting redstarts. While the pair went off to gather food for their young, there was little for me to do except observe what went on around me from my position in an alder thicket. It was during one of these periods that I heard the mewling notes of a pair of red-eyed vireos that indicate extreme distress-- a sound such as many species of birds utter when the situation is desperate, as <sup>the chicks I have described had done</sup> ~~for example~~ when a nest is invaded by a snake. I have heard flickers driven to the ground and cornered by a bird hawk give the same cry of terror. Attracted by the sound, I have several times driven off the hawk, whereupon the flicker's equanimity returned at once.

At the cries of the vireos, other birds soon joined in: a catbird mewed, whitethroats scolded, several warblers uttered noisy chipping notes, goldfinches whined and squeaked, and a pair of Acadian chickadees added their wheeze dee dee dee to the chorus. In the distance, a thrush began its puck puck. Compelled by the same morbid attraction that brings human spectators to the scene of an accident, birds gathered from all directions, and as the commotion grew louder, led by the vireos, <sup>the crowd</sup> ~~it~~ came flying in my direction. It was then that I saw the silhouette of a large bird moving deliberately from tree to tree

above the vireos. My first thought was that it must be a crow; but when the predator alighted in the top branches of a birch tree almost directly overhead, I recognized it as a bluejay. Held in its beak was a young bird, still wriggling and twitching. Having eluded the protesting parents, the jay now proceeded to transfer its prey to the grasp of one foot against the branch, where it hammered at it with its bill. When the wriggling ceased, the jay flew off again with its now dead victim.

Bluejays, starlings, bronzed grackles and cowbirds are all relative newcomers to the avifauna of Great Spruce Head Island. Since the species was misguidedly introduced into the United States in 1890, the aggressive starling has spread throughout the continent in ever growing numbers. I suspect, though without incontrovertible evidence, that starlings account for much of the nest-robbing against warblers, flycatchers, and tree swallows on the island. Certainly they are aggressive enough when it comes to pre-empting nesting sites from tree swallows and flickers, or appropriating them from already established residents. Flickers have the worst of it, since the cavities they chisel out are almost exactly the right size for a nesting starling. Three years ago I found five china-white eggs, two of them cracked and the other three apparently undamaged, lying on the ground below a flicker hole in a spruce stub which I had been observing. Presumably the eggs had been removed by starlings in search of a nesting site. How they had managed to do so without more damage is a mystery, although what I have seen gulls do with eider eggs--about which I shall have something to say presently--suggests the answer. That particular effort was unsuccessful, since the flickers returned, laid more eggs, and reared a family.

The increase of bronzed grackles, a species generally more at



home around farmland and developed areas than climax forest, is harder to account for than that of the starling. So far as its predatory habits are concerned, however, analyses of stomach contents and eyewitness accounts in ornithological literature have indicated ~~their~~ <sup>its</sup> role in pillaging the nests of smaller birds.

The cowbird's habits are, of course, not predatory but parasitical. The influx of this species on the island was apparent to me in the large number of parasitized nests I began to discover after years of seeing ~~now~~ <sup>no</sup> such evidence in the nest of potential hosts. The increase is so great that the chance of finding a young cowbird or a foreign egg in the nest of a warbler or an alder flycatcher on the island is approaching fifty per cent.

Over the period of nearly sixty years ~~since I first became acquainted~~ with Great Spruce Head Island, many changes have taken place. Forests have grown up where meadows once sloped down to white gravel beaches. Mature stands of coniferous forest have been flattened by winter gales, opening the ground to the light and making way for a new generation of seedlings that race upward, growing more than a foot in a single season. The changes in the forest cover have been accompanied by a corresponding gradual shift in the bird fauna. In the early 1920s, hermit and olive-backed thrushes were extremely common. To the liquid cadence of their voices at twilight would be added the crystalline, repeated syllables of the white-throated sparrow. Adding the final poignant effect, a woodcock rising from the edge of a wet pasture and then fluttering back to earth would give voice to its faint, warbled song, whose mystery is greater than any other.

In recent years the thrush population, except for robins, has declined greatly. Within the last decade, olive-backs have become the scarce and hermit thrush is no longer a summer resident. The veery,

which for a while during the 1960s seemed to be replacing the hermit thrush, has now also disappeared. With the replacement of yellow and white birches and other hardwood trees by coniferous forest, red-eyed vireos have gone the way of the thrushes. Meanwhile, those of their congeners that are more at home among evergreens appear to be moving in. Since 1968 I have seen blue-headed vireos--a new species for the island--during three seasons, and have twice found their nests. Among warblers now present as summer residents, although not in the past, are the blackburnian, bay-breasted, and Canada. They are replacing <sup>such as</sup> others, the magnolia and Nashville, and to a limited degree the black-throated green warbler. The greatest change, however--even greater <sup>cowbirds,</sup> than the influx of starlings and bronzed grackles--has been in the arrival during the last ten years of purple finches and red crossbills in prodigious numbers, accompanied by smaller numbers of white-winged crossbills and occasionally by pine grosbeaks.

Although changes in vegetation have had their effect on the bird life of Great Spruce Head Island, the factor of changes as a result of human agency can also be observed. And although disaster such as has overtaken the bird life of other areas has not occurred on the Maine coast, signs of its imminence already loom on the horizon. The once abundant osprey has shrunk in Penobscot Bay from hundreds to a mere handful: in 1913 seventeen pairs nested on the island, whereas there were two in 1971, and in 1969 there had been none at all. Prosperous gull and tern colonies that once covered innumerable small islands and mainland ledges have all but disappeared. The rookeries of great blue and black-crowned night herons that filled me with awe when I visited them half a century ago have ceased to exist.



So far as I know, the only seabirds to have increased significantly during that half century are the eider ducks. During my youth they were present in small numbers on the <sup>remote,</sup> barren outer islands; since then they have increased prodigiously, moving up the bay to nest in spring along the shores of all the islands. By the last week in May, the time I usually arrive in Penobscot Bay, most of the eiders have paired and many of the females are already sitting, on nests lined with gray down, on clutches numbering from three to five enormous, greenish eggs. Others are still being courted by the gaudy black-and-white drakes, whom they coyly ignore. At low tide, much of their time is spent swimming about in the floating seaweed; at high tide, they roost on the dry ledges. As pair formation is completed, fewer and fewer females are observed out on the water—only those whose first attempts at nesting have been interrupted by the predation of black-backed and herring gulls, pausing before a second attempt. By now the drakes have gathered into flocks as they prepare to depart for the outer islands, where they are resident the year round except for this short breeding interlude inshore.

The incubation period lasts twenty-five days—which means that allowing for late starters and second or third attempts at nesting, the breeding season covers almost two months. The numbers of eider ducks have increased even though their enemies take a heavy toll of eggs and young each year, probably because the life span of an eider that has reached adulthood may extend over many seasons. Crows and ravens prey on eiders, taking mainly their eggs; but throughout the breeding season the most persistent predators are gulls. When gull colonies still thrived in the bay, I spent much time in late spring photographing them from a blind set in the midst of a colony. Thus I had ample opportunity to observe what went on between the gulls

and those eiders so unforesighted as to attempt<sup>to raise</sup>/their ducklings here.

The great black-backed gulls, being considerably larger than the herring gulls<sup>1</sup>--on whom they also preyed with what seemed to me a cannibalistic disregard for kinship<sup>1</sup>--destroyed most of the eiders' eggs. Generally one of these gulls would hammer away at the unguarded eggs in a nest until the shell cracked, drinking up whatever fraction of its liquid contents wasn't immediately spilled out and lost.

During these solitary photographic expeditions, I began to learn the effects of human trespassers on such island colonies. By landing and setting up a blind, I had frightened several ducks off their nests along with scores of gulls. But the gulls, whose boldness was reinforced by their numbers as compared with the solitary timidity of the ducks, soon returned. The advantage of flight over swimming, a more cautious approach favored by the eiders, also served the gulls. As a result, the eiders' nests were unprotected for long periods after the gulls had settled down on their nests or were strutting about bugling in their usual fashion. Thus it was inevitable that not a few eider nests, including even some of those on which the female was actually sitting, would be discovered by gulls on the prow.

From my blind I watched an eider nest being raided simultaneously by a great black-backed and a herring gull. Despite the size of the eider's eggs, which are considerably larger than their own, a gull of either species is able to hold an egg crosswise in its bill and walk or fly off with it. What looks like an uncomfortable stretch is required, but in this manner the egg can be held just behind the slight hook of the upper mandible.

I have also watched from a blind while crows destroyed unguarded eider nests. Indeed, <sup>in early spring</sup> crows gather on these treeless islands, which otherwise offer them little, simply to prey on the ducks. Sloop



Island, where I set up a blind in 1939 to photograph the great black-backed gulls--and where I made most of these observations--is a chain of three grass-covered rocky islets or tombeles connected by gravel bars. I began my observations while the eiders and blackbacks were both incubating, and before many of the herring gulls had laid eggs. Between May 29 and June 2, during three days spent on the island, I saw two-thirds of the duck nests I had counted on the first day destroyed. A pair of crows had built a nest, possibly to take advantage of a readily available food supply, in a crevice of rock just above the high tide line. They laid four eggs, but the nest was washed away in a storm; so much for the foresight of that undertaking.

In bird colonies where dominant and minority species associate, some very strange things can happen. Occasionally, for example, eiders will be found making use of gulls' grass nests from the previous year as a foundation for their own. If their eggs are laid before the nest <sup>lining</sup> is laid down, a gull may usurp the site before the start of incubation and lay her eggs alongside the duck's. I have found gulls' nests containing both gull and eider eggs, and suspect that the gull could incubate them both. If the ducks have feathered their adopted nests, however, it is likely that the gulls will destroy the eggs and remove the lining. In view of the ability of gulls to carry off a duck's egg, it is also possible than eider eggs found in a gull's nest may have been placed there by the gull.

Besides eating their eggs, gulls also prey on young ducklings. The most vulnerable period for the latter is at the time of hatching, before they have ~~been~~ dried off and been led down to the water. Any disturbance of the female at this time may mean the loss of her whole brood. Even after they have reached the water, the ducklings are secure only if they stay close to their mother. A stray in the midst

of a gull colony is not long for this world, as a drama I once witnessed made all too clear. It involved a duckling that had become separated from its siblings soon after it entered the water. In a valiant but one-sided struggle for survival, it was doing its best to catch up with its mother when a black-backed gull spotted and swooped down on it. Seeing the threat, the duckling dived beneath the surface, whereupon the gull swerved off and circled for another look while the duckling bobbed up. Another swoop and another quick dive followed, but the downy little bird was too buoyant to stay under water for long and popped up too soon. On the third dive, the gull plunged after it head first, to appear seconds later holding in its bill a limp and bedraggled duckling, with which it flew toward shore to a chorus of excited trumpeting by other gulls.

As the hatchlings increase in numbers, the females and their broods join forces and in so doing find security in numbers. They form rafts containing as many as several dozen adults and anywhere from a third to half as many ducklings, which are escorted along the rocky shore at low tide to feed on <sup>the</sup> small crustaceans and annelids they find under the lank brown seaweed and on the barnacle-encrusted rocks. That the adult females so far outnumber the young in these nursery congregations is a measure of the loss by predation. The entire broods of some birds have been wiped out; others may have lost all but one or two. While the ducklings conducted by their mothers nibble at the barnacles, the old birds without offspring cruise along the shore, keeping ~~them~~ a constant alert against danger. <sup>With</sup> ~~at~~ the appearance of a human figure near at hand, the guard ducks set up a great quacking and rapidly swim farther out. The mothers gather their chicks about them and also swim away from shore <sup>but</sup> ~~but~~ no faster than the young ones are capable of following. Very young duckling huddle close to their



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mother's tail for safety the way children hold their parents' hands in a crowd, paddle along vigorously, bobbing in her wake. If the danger appears still greater, those females without ducklings abandon their responsibility to take off with a noisy clatter and splashing of wings, leaving behind a trail of foam while the deserted mothers fend alone for their young and themselves. The maternal instinct is so strong that those with young remain without regard for the risk to themselves, encouraging the ducklings and leading them out into deep water. Once in a while a duckling will become separated from the other members of the brood; then, on a clucking signal from its mother, it will scoot after her, using both feet and wings in a burst of energy that seems literally to lift it off the surface of the water. The kinship of ducklings to parents is sorted out in these times of emergency, as they leave the common group to join the adult to whom, by the process known among students of animal behavior as imprinting, they were conditioned to attach themselves at the time of hatching.

Social life within an assemblage of female eiders finds expression in continuous vocalization, which in anthropomorphic terms suggests the gossip chatter of a cocktail party. Low-pitched quackings and mutterings are interrupted every so often by a whoo whoo or, less frequently, by a hoarse, guttural arrrroo. These utterances are not aggressive, but appear to serve a communicative function, helping to cement the social ties within the flock. From time to time a duck, an immature yearling or a solitary drake that has remained behind with the female flock, will rise out of the water on its tail and vigorously flap its wings. The function of this behavior, which is usually performed by two or more birds in succession, is apparently to relieve latent aggression, or possibly it announces residual territorial claims as a substitute for actual physical confrontation.

On a windless day, when a gray blanket of fog over the bay obscures all but the nearest landmarks, softening all details of rocks and trees on the shore to faint silhouettes, the moist atmosphere carries the calling of gulls and the muted grumbling of ducks for long distances over the surface of the water. Arriving out of the fog, these sounds of nature, like those of auto horns or the throb of motors, reach the ears of the listener as though from no direction. But the curtailment of vision enhances what can be heard on such days; the hush produced by the fog among the forest birds, and its dampening effect on all background noises, seems to foster the transmission of the slightest sound. The effect for the ducks may not be the same, however, since they appear to be less alert to danger from the land on foggy days. At such times, where the shore is screened by trees, I have been able to take advantage of this barrier, creeping down behind it to where I could view ducklings feeding with their mothers at closer range than would be possible in clear weather. Under such conditions the peeping of the baby ducks, the faint scraping of their bills as they nibble at the barnacles, and the gentle murmuring of the mothers are audible. The close view also permits observation of their method of feeding. It is not all done at the surface. <sup>Since</sup> at halftide most of the barnacle rocks are submerged, in order to feed on the associated marine life the ducks may dive, as they do with seemingly little difficulty in spite of their buoyancy. Looking down on them from above, I have been able to observe this achievement. They submerge head first and paddle with their feet to barnacles not hidden by rockweed a foot or two below the surface. To stay in position under water, the little ducks are forced to paddle continuously. After grazing for less than a minute, they pop up like corks. As they break the surface, their



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downy backs are covered with silvery beads, which quickly roll off like droplets of mercury. The juvenile down is a nearly perfect insulation because of an oily property that makes it unwettable and thus able to hold air. But not all aquatic birds are characterized by plumage impervious to water. Some, notably the anhingas or snakebirds and the cormorants, which do their fishing under water and are not less at home there than ducks, must return to land periodically to dry off. Along the coast of Maine, the silhouette of a black cormorant perched atop a spar buoy with wings spread and held motionless in heraldic fashion, is a common sight.

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The first explorers of our continent's northeastern shores reported in amazement a sight that is now gone forever: the teeming hordes of the great auk, a flightless, penguinlike bird, that occupied every rocky niche and ledge along the coasts of Greenland and Labrador. By the entire species had been bludgeoned into extinction by ships' crews who packed the battered bodies into hogsheads to be rendered into cooking oil. The same fate overtook the less numerous Labrador duck, and the passenger pigeon, whose migrating flocks once darkened the Midwestern skies like storm clouds, and which was exterminated for use as pig food and fertilizer and as a mere target for the sport of killing.

Early in this century, American and snowy egrets were brought near to extinction by the depredations of plume hunters. They were saved from this fate in the nick of time by the action of the United States Congress, as a response to an aroused public feeling, in declaring the importation and interstate traffic in plumes illegal. Under the protection of this and other laws guarding against the disturbance of these and other birds, the egrets have regained much of their former abundance in the Everglades region of southern Florida. But many other species of birds are barely surviving, or are slowly losing their

fight for survival because of curtailment of a favorable territory in which to carry on their breeding functions, to rest during migratory flights, or to find food during the winter. The California condor, the whooping crane, and several 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. Until recently, however, most birds have not been directly threatened by the activities of man. Even though enormous tracts of land have been cleared in the Midwestern states, the total number of birds does not appear to have diminished. Certain forest species, including some varieties of woodpeckers, nuthatches, hawks, and owls, are undoubtedly rarer. On the other hand, birds that prefer semi-open country, bushy sproutland, and second-growth forest appear to have multiplied greatly. Among these are several kinds of warblers, many of the sparrows and their allies, the cuckoos, some of the thrushes, and the crows, all of which are much more plentiful than they were in pioneer days. The blue-winged, golden-winged, and chestnut-sided warblers, for example, favor sproutland and young second-growth forest as nesting habitats; song sparrows are bush- and ground-nesting birds; and robins and bluebirds are members of the thrush family which, as everyone who has lived in a suburb or on a farm knows, adapt readily to a human environment. Who is not familiar with the sight of a fat robin running in short spurts across a lawn, pausing as it cocks its head to one side--to listen, we were told as children, but much more probably to look--and all of a sudden probing deep into the soft soil to pull out, with legs braced and neck arched, a long rubbery worm?

The introduction since the end of World War II of chlorinated hydrocarbon insecticides has caused a decline in the populations of several species of birds. Some of the chemicals in this class are



also toxic to plants and are used as weed-killers and defoliants. The most familiar of the insecticides is DDT. First used to control mosquitoes, it was soon discovered to be active against many orders of insects, and then belatedly that it killed crustaceans, fish, and birds as well. DDT and its many close chemical relatives kill by interrupting the transmission of nerve impulses, and therefore can affect a broad spectrum of organisms. Because they are substances without counterparts in nature, and foreign to the environment, they are refractory to decomposition by the natural chemistry of living organism and cannot be excreted by the organs of elimination. As a result, the animal organism as a last resort stores them in the fatty tissue, the attics and cellars of its internal structure, where they may remain for years, until the fats are mobilized to meet emergency demands. When this occurs, and the foreign deposits enter the circulatory system, the animal is in trouble. This is true whether the fatty tissue in which they have been stored is in the liver, kidney, bone marrow, or--most disastrous of all--the lipid elements of the nerve tissue, where they can affect the mechanisms for conducting nerve impulses so as to cause paralysis. Moreover, some of these poisons which are not completely resistant to catabolic attack may be broken down into even more toxic and resistant products, which can cause injury in concentrations a thousand times lower than the original substance.

But ~~the~~ the worst effect of these hydrocarbons is in the way they are passed upward along the food chain, with often devastating effects on predatory higher animals. It is true that when an area is sprayed for mosquitoes or some other insect pest, it is unlikely that a human being, a dog, or even a bird will come in contact with enough of the poison to be injured immediately. Such may have been the reasoning first put forward as a reassurance about the harmlessness

of these chemicals. The storage of hydrocarbons in their fatty tissues by carnivorous fishes may represent an increase of a millionfold over the original concentration of these chemicals in the water, from which the lower forms of life at the bottom of the food chain absorb them as fast as they appear. In turn, fish-eating birds such as grebes, loons, and ospreys, may ingest massive doses of these poisons. The reproductive physiology of birds is particularly susceptible to DDT and similar chemicals, which lower fertility and eventually prevent eggshells from forming correctly.

Quite aside from these hazards, the use of organic insecticides as a way of permanently controlling insects is a futile undertaking in the end. Adaptation to changes in the environment comes about through mutations; and the rate at which mutations occur depends in turn on the rate of reproduction by the species concerned. In man, the periodicity of reproduction is about twenty years, so that centuries or even millenniums must pass before adaptation through natural selection--leaving out of consideration the possibility of future genetic engineering--becomes appreciable. For the common songbirds and other passerine species, reproductive periodicity is about one year, so that even with them evolution is too slow a process to permit the adaptation of a species to a potentially lethal change in the environment in time to save it from extinction. With insects, however, the situation is quite different. The reproductive cycle of the housefly is so short that if all the descendants of one pair lived and reproduced normally during one season from April to August, the total number would be  $10^{20}$ , or one hundred billion billion. For the cabbage aphid, assuming an average of forty-one young per female in sixteen generations between March and October, the figure would be  $10^{24}$ . Strains of insects resistant to many of the common insecticides have been observed. At Tampa Bay, Florida, where aerial



spraying was conducted for several years to control mosquitoes, it was found that increasingly high concentrations of DDT were needed to produce the same results as in the previous year. Eventually the program was discontinued; and in the meantime the destruction of fish and crustaceans in the shallow waters of the bay that the populations of herons and egrets ~~which depended on these animals as a source of food~~ were driven from the region—for which, incidentally, they had been a tourist attraction.

The greatest possible benefit from the exploration of space which human technology has made possible may be the perspective gained from the windows of the Apollo spacecraft on the small, lonely, vulnerable planet and the exceptional conditions on it that have made the phenomenon of life possible. If we can appreciate the fragility of the dynamic balance that has been preserved, we may also begin to appreciate the shortness of our tenure on earth and to use the powers we have recently acquired to perpetuate rather than destroy that balance. If we are to do so, we must begin with a humble recognition of the interdependence of all living things.