LIFE'S GREATEST EVIL

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Dr. Skutch took his doctorate in botany at Johns Hopkins in 1928 and spent the next two years in Panama and Honduras studying the anatomy of the banana leaf. At that time he became interested in the birds of Central America and resolved to make a study of them. This he did, combining his bird studies with plant collecting. Having, in the course of his travels, come to look upon Costa Rica's Valley of El General as his home, in 1941 he bought a farm of 50 hectares, newly carved from the forest. Here he has lived ever since, doing subsistence farming and devoting his spare time to the study of wild life and to writing.

DURING my senior year in college, I used to indulge in long philosophic discussions with a lower classman—now a distinguished professor, but then still in the overwise stage of early learning—who held that there is neither good nor evil in the world, but only survival and failure to survive. After long pondering, I believe that I can define good and evil in terms to which even a biologist of the mechanistic school can hardly take exception. At least, I fancy that I can do so for evil.

The great evil of life is parasitism. In the vegetable kingdom it is easy to recognize a parasite, a plant that does not manufacture its food directly from inorganic substances present in the soil, water, and air, but removes it from the tissues of other living plants, or even from animals. But when we turn from the vegetable to the animal kingdom, the definition of a parasite is not so simple. In the sense in which we apply the term to plants, all animals are parasites, for they must take their nourishment from other living things. For them we need another definition of parasitism, and it will be well if we can apply this definition also to parasitism among plants. For the purposes of this discussion, we may define a parasite as an organism that lives without making use of those faculties which are the peculiar characteristics of the class of organisms of which it is a member. The outstanding characteristic of plants as a whole—what sets them apart from other groups of living things—is their ability to build up organic compounds from inorganic substances, using for this purpose the energy of sunlight or, in rare instances, forms of chemical energy. Any plant lacking this faculty is by our definition parasitic, although I would exclude from this category the saprophytic fungi, which possess the peculiar faculty of breaking down dead organic substances and are, by virtue of this, most useful organisms, playing an indispensable part in the economy of nature. Mistletoes and other plants of similar habit are generally called half-parasites—a well-chosen term. They possess the faculty of photosynthesis, but lack another ability almost equally widespread in the vegetable kingdom, that of absorbing water and salts directly from the environment; rather, they take them from the tissues of some other living plant. Vines are another kind of partial parasite because they lack still another prime characteristic of vascular plants, that of holding their stems erect.

The peculiar faculties of animals are the directive senses and the power of locomotion. The host of flukes, tapeworms, cestodes, and other animals that live entirely within the bodies of bigger animals—unpigmented, sightless, deaf, practically devoid of the power of independent locomotion—are parasites in the highest degree. A tick that lives on the outside of its host is scarcely less a parasite; it merely sits down and sucks blood, has poorly developed sense organs, and only the weakest powers of locomotion. But a mosquito, which also gorges itself with our blood and is almost equally repugnant to us, is not a parasite. Its senses are acute, and it possesses a high degree of agility, as we soon learn when we try to swat one of our tormentors of this class—at least before it becomes bloated and heavy with blood. In its manner of life it is almost in the same class

with the bee, which sucks the juices of flowers rather than those of red-blooded animals. The shark, although a carnivore, is not a parasite; but the remora, which attaches itself to the shark and shares its food, is a parasite, because it has lost much of the faculty of swimming, a prime characteristic of fishes. Among birds, cowbirds, cuckoos, and other species that drop their eggs into the nests of other birds to be incubated by them are justly called parasites; although in their manner of flying, obtaining food, and the like they are normal birds, they have lost one of the primary avian faculties, that of building nests, with the subsequent hatching of eggs and attending the offspring.

Parasitism is an unmitigated evil—an evil that cuts two ways. It results in the degeneracy of the parasite; and in the host species it causes immense destruction while contributing little or nothing to the evolutionary development of that species—perhaps even causing retrogression if the parasitism is heavy. The degeneration of parasites, both structural and functional, is so obvious and has been so often discussed that here we need only to call attention to it. Compare any parasitic plant devoid of chlorophyll with any leafy green plant; a tick or other sessile bloodsucker with a spider or any flying insect; or, in the particular field in which it is parasitic, a cowbird or European cuckoo with any nest-building bird—the points of degeneration are obvious.

Turning now to the effects of the parasites on the species that serve as hosts, when we consider the countless numbers of individuals that through many generations have been attacked or killed by the parasites, I think it altogether marvelous that parasitism has had so little apparent evolutionary effect upon the hosts either in structure or in habits. Among plants, I am familiar with no important structural modifications that might with confidence be attributed to the selective influence of parasites. Perhaps some plants have developed heavier and denser bark, thicker and more impermeable cuticles, or increased lignification of internal tissues through the natural selection of individuals that, by these means, more successfully withstood the penetration of parasitic fungi. But these modifications of vegetable tissues appear to result from the influences of dryness, strong insolation, and other physical conditions of the environment rather than from the menace of parasites. At best, the modifications induced in plants by parasites are largely in the microscopic field rather than in gross structure.

Among animals, parasites appear to have had strangely little effect in modifying either structure or habits. When we reflect upon the countless millions of men who have succumbed to various widespread forms of disease caused by microscopic parasites—and some of larger size—it is unbelievable how little direct effect the incidence of these diseases has had on the dietary, sanitary, or other habits of mankind. I have heard it said that the widespread custom of tea-drinking in China arose out of the danger of drinking polluted water without boiling; and possibly religious injunctions against the consumption of pork were given as a preventive of tapeworm infection (although if this had been the real motive the danger could have been avoided by adequate cooking). But instances of this sort are uncommon, and at most they represent attempts to meet the menace of a pitifully small proportion of the parasites that from time immemorial have preyed upon mankind. It was only after scientific investigations—conducted largely within the past few generations—had shown us how by modifying our way of life we could avoid certain parasitic infections that the existence of these parasites caused any salutary change in our habits. In a restricted but fascinating field in which I am especially interested, I cannot discover that the parasitism of nests—extremely heavy in some species—by cuckoos, cowbirds, and their like has had any marked effect upon the nidification or other reproductive habits of their victims.

IT IS instructive to compare the evolutionary effects of the struggle between parasite and host with other forms of conflict in the living world: that between individuals of the same species or of species with similar habits,

and that between predator and prey. Quite in contrast with parasitism, these forms of competition have had immense effect upon the development of both plants and animals. The competition of green plant with green plant for a place in the sun has led to the progressive upward elongation and strengthening of stems; it is apparently to this struggle that we owe the loftiest trees and the most impressive forests. Yet the competition between self-supported green plants and even half-parasites like vines and creepers—a struggle keen enough throughout the humid tropics—has led to very little modification in the structure of the victims, save perhaps here and there a quickening of upward growth, a reduction of branching in early life, and greater smoothness of bark, which make it more difficult for vines to attach themselves to trees. The competition between vine and vine can lead only to a chaotic tangle of vegetation.

Among animals with kindred dietary habits, competition has led to a sharpening of sight, scent, and wits; an increase in swiftness, endurance, and radius of foraging; and, to take a single classic example of modification in structure, to the lengthening of the neck of the giraffe, which enables it to reach foliage beyond the grasp of other browsing animals. Even more important, perhaps, this competition has led to endless diversification and specialization, with correlated changes in structure and function. Thus the flycatcher, the wood warbler, the creeper, and the thrush are all insectivorous birds, but competition for this type of food has favored specialization, so that the first catches it in the air; the second, among the foliage; the third, on the bark of trees; and the last, largely on the ground—and each has peculiar structures and habits to fit it for the part it plays in the economy of nature.

Predation has also been of the greatest importance in shaping the course of the evolutionary development of living creatures. It seems likely that the predation—if we may use the term in this instance—of grazing animals upon herbage has led to the development, in grasses and plants associated with them, of basal or intercalary modes of growth, which enable these herbs to resist the effects of grazing far better than plants with the apical type of growth that is more common in the vegetable kingdom. Since grasses cover so large a proportion of the land areas of our planet, the importance of this modification in mode of growth in response to predation can hardly be exaggerated. Among animals, predation has led to greater keenness of senses and fleetness of movement in both the predators and the prey, and to many curious modifications in form and color which help the latter to elude the sharp eyes of their persecutors. Among mankind, a few real or quasi predators, such as tigers and venomous snakes, have far greater influence upon the manner of living and thinking of primitive people than the parasites that cause them infinitely more harm. Only as science helps us to evaluate the real magnitude of the dangers to be feared from the various classes of our enemies is this situation reversed. My rather primitive neighbors are far more afraid of the *tigre* than I; I fear a host of invisible organisms they never think about.

We may lament the tremendous loss of life, even up to the extermination of whole species, brought about by the competition between individual and individual in a crowded world, and by the habit of one living thing preying upon another. But at least this competition and this predation have been fruitful in the progressive development of organisms in myriad diverse ways. Parasitism has taken its tremendous toll of life with scarcely any return that we can see; it has led to retrogression rather than to progress. Hence, we may call it the greatest evil of life.

The opposite effects on living things of parasitism on the one hand and predation and competition on the other are not far to seek. Modifications brought about in a species through the selective actions of the latter are of general value and usually result in the greater fitness of the organism to meet the varied stresses of its environment. The length of trunk that enables the jacaranda tree to hold its crown above that of the ira also serves to hold it above that of the campana and most others of its competitors in the tropical forest. The thorns that protect a bush from browsing by a cow usually also serve to guard it against the horse, the ass, and the deer. The fleetness that enables the antelope to outrun the lion will serve it in good stead when pursued by the tiger, the panther, and the wolf. The intelligence of the crow helps it not only in its quest of food, but also in outwitting its archenemy, man.

But the heritable modifications brought about in organisms through the selective action of parasites are as a rule neither in structure nor in habits, but only in the form of slight modifications in chemical composition, and these modifications are rarely of general value. A man may become immune to typhoid fever without acquiring immunity to lockjaw, although the bacteria causing these two diseases are so similar in appearance that they are classified in the same genus. Indeed, an individual may be resistant to one strain of a pathogene and susceptible to another; and it seems that some of the fungi and bacteria that cause disease may be constantly changing, either by selection or through mutation, so that they repeatedly overcome any resistance their victims might have acquired to them in their earlier forms. Such insidious, protean adversaries can have little effect in developing the species they parasitize; they serve only to destroy.

Among men the greatest evil is the same as that in organic nature as a whole—parasitism. In order to apply to mankind our definition of a parasite as "an organism that lives without making use of those faculties which are the peculiar characteristics of the class of organisms of which it is a member," we must first decide what are the peculiar, distinguishing characteristics of the human species. Considering chiefly the means by which each group of organisms maintains life, the peculiar faculty of men is their ability to produce what they need by mental or physical effort or, more usually, by a well-balanced combination of the two. This ability distinguishes all but the lowest savages among men from all other mammals except, to a certain extent, the beaver, and from all animals of other classes except a few of the social insects, notable among which are the agricultural atta ants.

The parasites among men are those who exist through the efforts of other men, producing nothing themselves. They include the idle rich who live in sloth on inherited fortunes, the shiftless poor who live on charity or such windfalls as they can find, the thief, the swindler, the forger, the smuggler, and the panderer to the vices and follies of men. The highwayman, were he a member of the feline or the canine tribe, would not be classed as a parasite but as a predatory animal—although predatory animals do not as a rule prey upon others of their own species. He has often developed to a high degree the keenness of sense, the speed, the endurance, and the cunning of a predator; but he has not developed the peculiarly human faculty of productive physical or intellectual activity, and as a man we must class him as a parasite.

The losses to mankind by human parasites, their continued drain on human effort through the ages, have been incalculably great. In aggregate they have probably been responsible for a wastage of human effort of the same order of magnitude as that caused by wars. The total becomes far more stupendous if we include in the category of parasitism all those wars which were essentially parasitic in nature. From the raids of wild clans to carry off cattle, grain, or other coveted goods from their neighbors, through the strife of medieval barons and princelings who coveted their neighbors' estates, down to World War II—which began as a gigantic attempt by the mad, unprincipled leaders of a fanatical political party to enrich themselves at the expense of all the world—a large proportion of all wars have been for the purpose of plundering, and hence parasitic in character.

Despite this vast and continued wastage, it is amazing how little effect parasitism has had upon the essential structure of human society. This statement may at first glimpse appear extravagant. To test the effects parasites might have had upon the character of human institutions, let us imagine what would be the results of their complete removal. Could we somehow get rid of all thieves, swindlers, counterfeiters, forgers, and idlers, poor and rich, in what way would our customs and manner of life change? Surprisingly little, I believe. We should have fewer

locks on our doors; but only an infinitesimal portion of human ingenuity has been devoted to the devising of locks and safes. There would be fewer policemen in the streets and a slightly lower tax rate, because we would not be obliged to support a large force for law enforcement nor institutions for the confinement of thieves and their like. We would be less careful in examining the signatures on our checks and other documents. We should be less preoccupied over the safety of our property, but otherwise we should go on living much as we have lived. The constant drain on human wealth and effort through the activities of human parasites has influenced our way of life as amazingly little as the unending menace to human life and health by smaller parasites has altered our pattern of living.

Again, it is instructive to compare the effects of parasitism with those of competition within the species. Honest and legitimate competition in business or other fields of human endeavor has ruined the hopes and blighted the lives of the countless men who have lost out in it, and caused unmeasured misery and suffering to them and their dependents—possibly as much as the loss of possessions through dishonest activities. The latter has been an unmitigated evil, whereas the former has had many favorable consequences for society as a whole. A manufacturer who by fair means drives his competitors into bankruptcy or puts them out of business must either make a better product, or the same product by a more efficient process, so that he can sell it at a lower price. Driven by the pressure to improve their methods of manufacture or starve, other producers of the same article will perfect their operations, and eventually the whole community will benefit through having cheaper and better wares. Competition is cruel but productive; parasitism, cruel and nonproductive.

Among men, as among all other organisms, parasitism is the absolute and unmixed evil—the evil that cuts two ways. For the parasite it results in moral and often, too, in intellectual and physical degeneration; for the hosts—the rest of society—it causes tremendous losses with no compensating gains.