ON SOME INTERACTIONS OF ORGANISMS.*

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While the structural relations of living organisms, as expressed in a classification, can best be figured by a tree —the various groups, past and present, being related to each other either as twigs to twigs, as twigs to branches, or as branches to the main stem—yet this illustration does not at all express their *functional* relations. While the anatomical characters of the various groups may show that they are all branches of a common stock, from which they have arisen by repeated divisions and continued divergencies, the history of their lives will show that they are now much more intimately and variously bound together by mutual interactions than are twigs of the same branch—that with respect to their vital activities they occupy rather the relation of organs of the same animal body. If for a type of their classification we look to the vegetable world, for an illustration of their mutual actions and reactions we must look to the animal world. The serious modification of any group, either in numbers, habits, or distribution, must modify, considerably, various other groups; and each of these must transmit the change in turn, or initiate some other form of change, the disturbance thus propagating itself in a far-extending circle.

While the whole organic world, viewed as a living unit, thus differs from the single plant by the much greater in-

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* As details accumulated relating to the food of animals and similar subjects, it was found that a proper discussion of them would necessarily lead, step by step, to a full review of certain parts of the general subject of the reactions between groups of organisms and their surroundings, organic and inorganic. Without such a review, the facts can not be safely generalized, nor the conclusions clearly apprehended to which they point. It has therefore seemed best to prepare the way for the discussion of special subjects by this general discussion of the subject at large.

The practical importance of this larger view is illustrated by the fact that if the current ideas of the value of parasitic and predaceous insects are accepted, we must condemn the bluebird to extermination as a pest; while if the conclusions of this paper are essentially sound, this bird is a very useful species and should be carefully preserved.

terdependence of its parts, on the other hand, it differs from the single animal in the fact that, notwithstanding this intimate and instant sympathy of part with part, it has an immense vitality. To cut off the leg of an animal is often sufficient to destroy its life, but one might cut off the *head* of the animal world, so to speak, without seriously impairing its energy. Suddenly to annihilate every living vertebrate would doubtless set on foot some tremendous revolutions in the life of the earth, but it is certain that in time the wound would heal—that Nature would finish by readjusting her machinery and would then go on much as before. In fact, any subkingdom of animals or any class of plants might thus be struck out, without the slightest danger that terrestrial life would perish as a consequence. The functions of the missing member would be taken on in part by other members, and in part be rendered needless by new adjustments.

We see many present illustrations of this fact, as in Australia, where there is but one native carnivorous animal, and that probably not indigenous; in several Pacific islands where mammals are unknown; and in New Zealand and the Galapagos, where insects are extremely few and the flowers, therefore, chiefly colorless and odorless. We see, likewise, illustrations of the same truth in the conditions of vegetable and animal life in earlier geological periods. Plants and insects, for example, existed together through vast periods of time when there were neither mammals nor birds on earth to supervise or regulate their relations.

If this is true of such immense and revolutionary disturbances, it is all the more certain that this same spontaneous action of natural forces must in time reduce the smaller disturbances of the primitive order caused everywhere by civilized man, and must end by adjusting the whole scheme of organic relations to his interests as completely as to the interests of any other species. It is also plain that if man understands clearly the disorders which arise in the system of Nature as a result of the rapid progressive changes in his own condition and activities, and understands also the processes of Nature which tend to lessen and remove these disorders, he may, by his own intelligent interference, often avoid or greatly mitigate the evils of his situation, as well as hasten their remedy and removal.

Some general notion of the original order of Nature, which obtains where civilization has not penetrated, will be needful for an understanding of the most important consequences of the modifications of that order which man brings to pass—for an understanding of the relations of our own industrial operations and interests to the general laws and activities of the organic world under whose constant influence we must live and work.

There is a general consent that primeval nature, as in the uninhabited forest or the untilled plain, presents a settled harmony of interaction among organic groups which is in strong contrast with the many serious maladjustments of plants and animals found in countries occupied by man. This is so familiar a fact that I need not dwell upon it, but will cite the reader to the generally accessible "Introduction to Entomology," by Kirby & Spence, for a sufficient statement of it. It will be more to my purpose to discuss the subject from a different standpoint. To determine the primitive order of Nature by induction alone requires such a vast number of observations in all parts of the world, for so long a period of time, that more positive and satisfactory conclusions may perhaps be reached if we call in the aid of first principles, traveling to our end by the *a priori* road.

For the purposes of this inquiry I shall assume as established laws of life, the reality of the struggle for existence, the appearance of variations, and the frequent inheritance of such as conduce to the good of the individual and the species—in short, the evolution of species and higher groups under the influence of natural selection. I shall also postulate, as an accepted law of Nature, the generalization that the species is maintained at the cost of the individual—that, as a general rule, the rate of reproduction is in inverse ratio to the grade of individual development and activity; or, as Spencer tersely states this law, that "Individuation and Genesis are antagonistic." Evidently a species cannot long maintain itself in numbers greater than can find sufficient food, year after year. If it is a phytophagous insect, for example, it will soon dwindle if it seriously lessens the numbers of the plants upon which it feeds, either directly, by eating them up, or indirectly, by so weakening them that they labor under a marked disadvantage in the struggle with other plants for foothold, light, air and food. The interest of the insect is therefore identical with the interest of the plant it feeds upon. Whatever injuriously affects the latter, equally injures the former; and whatever favors the latter, equally favors the former. This must, therefore, be regarded as the extreme normal limit of the numbers of a phytophagous species—a limit such that its depredations shall do no especial harm to the plants upon which it depends for food, but shall remove only the excess of foliage or fruit, or else superfluous individuals which must either perish otherwise, if not eaten, or, surviving, must injure their species by overcrowding. If the plant-feeder multiply beyond the above limit, evidently the diminution of its food supply will soon react to diminish its own numbers; a counter reaction will then take place in favor of the plant, and so on through an oscillation of indefinite continuance.

On the other hand, the reduction of the phytophagous insect below the normal number will evidently injure the food plant by preventing a reduction of its excess of growth or numbers, and will also set up an oscillation like the preceding, except that the steps will be taken in reverse order.*

I next point out the fact that precisely the same reasoning applies to predaceous and parasitic insects. Their interests, also, are identical with the interests of the species they parasitize or prey upon. A diminution of their food reacts to decrease their own numbers. They are thus vitally interested in confining their depredations to the excess of individuals produced, or to redundant or otherwise unessential structures. It is only by a sort of un-

* See "Principles of Biology," by Herbert Spencer, Vol II, pp. 397-478.

lucky accident that a destructive species really injures the species preyed upon.

The discussion has thus far affected only such organisms as are confined to a single species. It remains to see how it applies to such as have several sources of support open to them—such, for instance, as feed indifferently upon several plants or upon a variety of animals, or both. Let us take, first, the case of a predaceous beetle feeding upon a variety of other insects—either indifferently, upon whatever species is most numerous or most accessible, or preferably upon certain species, resorting to others only in case of an insufficiency of its favorite food.

It is at once evident that, taking the group of its food-insects as a unit, the same reasoning applies as if it were restricted to a single species for food; that is, it is interested in the maintenance of these food-species at the highest number consistent with the general conditions of the environment—interested to confine its own depredations to that surplus of its food which would otherwise perish if not eaten—interested, therefore, in establishing a rate of reproduction for itself which will not unduly lessen its food supply. Its interest in the numbers of each species of the group it eats will evidently be the same as its interest in the group as a whole, since the group as a whole can be kept at the highest number possible only by keeping each species at the highest number possible.

If the predatory insect prefer some species of the group to others, we need only say that whatever interest it has in any species of the group, will be an interest in keeping up its numbers to the highest limit; and any failure in this respect will injure it in precisely the ratio of the value of that species as an element of its food. It would be most injured by anything injuriously affecting the species it most preferred—the *preferences* of animals being, according to the doctrine of evolution, like their instincts, inherited tendencies toward the things which have proved beneficial to their progenitors.

This argument holds for birds as well as for insects, for animals of all kinds, in fact, whether their food be simple or mixed, animal or vegetable, or both. It also applies to parasitic plants. The ideal adjustment is one in which the reproductive rate of each species should be so exactly adapted to its food supply and to the various drains upon it that the species preyed upon should normally produce an excess sufficient for the species it supports. And this statement evidently applies throughout the entire scale of being. Among all orders of plants and animals, the ideal balance of Nature is one promotive of the highest good of all the species. In this ideal state, towards which Nature seems continually striving, every food-producing species of plant or animal would grow and multiply at a rate sufficient to furnish the required amount of food, and every depredating species would reproduce at a rate no higher than just sufficient to appropriate the food thus furnished.

We must now point out how this common interest is naturally subserved—how the mutually beneficial balance between animals and their food is ordinarily maintained.

Exact adjustment is doubtless never reached anywhere even for a single year. It is usually closely approached in primitive nature, but the chances are practically infinite against its becoming really complete, and maladjustment in some degree is therefore the general rule. All species must oscillate more or less. Even the more stable features of the organic environment are too unstable to allow the establishment of any perfectly uniform habit of growth and increase in any species. The most unvarying species will at one time crowd its boundaries vigorously, and at another, sensibly recede from them. That such an oscillation is injurious to a species may be briefly shown. The most favorable condition of a species is that in which its numbers are maintained at the highest possible average limit; and this, as already demonstrated, requires that its food supplies should likewise be maintained at the highest possible limit—that the species should, in fact, confine its appropriations to the unessential surplus of its food. But when the numbers of an oscillating species are above this average limit, it will devour more than this surplus of its food—its food supplies will be directly lessened. On the other hand, when the oscillating species falls below this limit, its food supplies, reacting, of course cannot increase *beyond* the highest possible limit, but will reach it and there stop. The average amount of food will therefore be less than it might be if the species dependent upon it did not oscillate—and, the food being less, the average number of the species itself must be smaller. Our problem is, therefore, to determine how these innumerable small oscillations, due to imperfect adjustment, are usually kept within bounds—to discover the forces and laws which tend to prevent either inordinate increase or decrease of any species, and also those by which widely oscillating species are brought into subjection and reduced to a condition of prosperous uniformity. We may know in general that such laws and forces are constantly at work, and that the tendency of things is towards this healthful equilibrium, because we see substantially such an equilibrium widely established and steadily maintained through long periods of time, notwithstanding the great number and kaleidoscopic variability of the forces by which each species is impressed. But this idea will repay more detailed elucidation. We will notice, first, some of the checks upon injurious oscillations arising out of the laws of the individual organism, and afterwards those which are brought to bear upon it from without.

It will at once be seen that, in any case, the maladjustments possible are of only two kinds—the rate of reproduction in the species must be either relatively too small or relatively too great. If it be relatively too small, if the species bring forth fewer young than could mature, on the average, under existing circumstances, whatever may be the oscillations arising, they will tend to disappear with the disappearance of the species. The average numbers of such a species being, in the most favorable event, less than they might be, it will be at a certain disadvantage in the general struggle for existence—it will eventually yield to some more prolific species with which it comes in competition. If, for any reason, its rate of multiplication be or become too high, the law of the antagonism between individuation and genesis will constantly tend to bring it within the proper limit. Reproduction being more active than is necessary, the individual force and activity will be less than it might be—the species will be at a disadvantage in the search for food, and in all its other activities, as compared with other species more exactly adjusted, or, as compared with members of its own species which tend to a better adjustment. As soon as a better-adjusted competitor appears, the other must begin to suffer, and in the long course of evolution will almost certainly disappear. The fact of survival is therefore usually sufficient evidence of a fairly complete adjustment of the rate of production to the drains upon the species.

For the sake of illustration, let us take an instance—and the most difficult we can find for the application of these ideas—the case of a caterpillar and its hymenopterous parasite.

If the rate of increase of the parasite be relatively too great, that is, if more parasites are produced than can find places of deposit for their eggs in the bodies of the mere *excess* of caterpillars, some of them will deposit their eggs in caterpillars which would otherwise come to maturity—that is the number of caterpillars will be gradually diminished. With this diminution of their hosts the parasites will find it more and more difficult favorably to bestow all their eggs, and many of them will fail of development. The multiplication of the parasites will thus be checked, and their numbers will finally become so far reduced that less than the then excess of caterpillars will be infested by them, in which case the caterpillars will commence to increase in numbers, and so on indefinitely. Briefly, the excessive rate of increase of the parasite will keep up an oscillation of numbers in both parasite and host which will cross and recross a certain average line.

Let us now look at the method by which Nature may check this injurious fluctuation.

Let us suppose two groups of a parasitic species at work on the same species of caterpillar, of which one (*A*) is distinguished by a tendency to an excessive reproductive rate, while the other (*B*) multiplies no faster than is consistent with the best interest of its host. *A*, producing more eggs than *B*, must either parasitize more caterpillars than *B*, or must deposit a greater number of eggs in each. It cannot parasite more caterpillars than *B*, because this would require greater activity—a higher individuation—and this is contrary to the law that individuation and genesis are antagonistic. Instead of being more active than *B,* it will then be less active, and will, therefore, deposit more eggs in each caterpillar. *B*, however, cannot have acquired the habit of depositing too few eggs in each caterpillar, as that would compel it to search habitually for a greater number of larvæ than necessary—to have acquired, that is, a habit of wasting energy—which is, as already said, contrary to evolution. *A* will, therefore, sometimes deposit too many eggs in a caterpillar, and will then either lose the whole deposit, or bring forth a weakened offspring, which will, in the long run, give way to the more vigorous progeny of *B*. This regular production of a wasted excess will constitute an uncompensated drain upon variety *A,* which will end, like any other radical defect, in its yielding to its better-adjusted rival.

Or if, notwithstanding the foregoing, we suppose this excessive reproductive rate to have become fully established, then the parasite-ridden species will evidently labor under such a disadvantage in the struggle for existence that it will probably be crowded out, in time, by some more fortunate rival. If the pair are permanently ill-adjusted, so that permanent loss of numbers follows, they will be treated by the laws of natural selection as a single imperfect animal—they will be pushed to the wall by some better-adjusted caterpillar and parasite, or by some insect free from troublesome companions. We may be sure, therefore, that, as a general rule, in the course of evolution, only those species have been able to survive whose parasites, if any, were not prolific enough sensibly to limit the numbers of their hosts for any length of time.

We notice incidentally that it is thus made unlikely that an injurious species can be exterminated, can even be permanently lessened in numbers, by a parasite strictly dependent upon it—a conclusion which remarkably diminishes the economic rôle of parasitism. The same line of argument will, of course, apply, with slight modifications, to any animal or even to any plant dependent upon any other animal or any other plant for existence.

From the foregoing argument we conclude that, since the interest of a species of plant or animal and the interest of its "enemies" are identical, and since the operations of natural selection tend constantly to bring about an adjustment of the species and its enemies which shall best promote this common interest, therefore *the annihilation of all the established "enemies" of a species would, as a rule, have no effect to increase its final average numbers.* This being a general law, applying to all organisms, it is plain that the real and final limits of a species are the *inorganic* features of its environment—soil, climate, seasonal peculiarities, and the like.

In treating of the external forces brought to bear upon an oscillating species to restrain its disastrous fluctuations, I shall mention only a part of the organic checks to which it is subject.

It is a general truth, that those animals and plants are least likely to oscillate widely which are preyed upon by the greatest number of species, of the most varied habit. Then the occasional diminution of a single enemy will not greatly affect them, as any consequent excess of their own numbers will be largely cut down by their other enemies, and especially as, in most cases, the backward oscillations of one set of enemies will be neutralized by the forward oscillations of another set. But by the operations of natural selection, most animals are compelled to maintain a varied food habit—so that if one element fails others may be available. Thus each species preyed upon is likely to have a number of enemies, which will assist each other in keeping it properly in check.

Against the uprising of inordinate numbers of insects, commonly harmless but capable of becoming temporarily injurious, the most valuable and reliable protection is undoubtedly afforded by those predaceous birds and insects which eat a *mixed food,* so that in the absence or diminution of any one element of their food, their own numbers are not seriously affected. Resorting, then, to other food supplies, they are found ready, on occasion, for immediate and overwhelming attack against any threatening foe. Especially does the wonderful locomotive power of birds, enabling them to escape scarcity in one region, which might otherwise decimate them, by simply passing to another more favorable one, without the loss of a life, fit them, above all other animals and agencies, to arrest disorder at the start—to head off aspiring and destructive rebellion before it has had time fairly to make head. But we should not therefrom derive the general, but false and mischievous, notion that the indefinite multiplication of either birds or predaceous insects is good. Too many of either is nearly or quite as harmful as too few.

And this brings us to the application of these principles to the interests of civilized man. We must note how the new forces which he brings into the field expend themselves among those we have been studying, and to what reactions they are in turn subjected. We must first see how far the primitive natural order of life lends itself to the supply of man's needs, to the accomplishment of his purposes; and must determine, in a general way, where he may be content to leave it undisturbed, where he should address himself to its improvement, and where he is compelled to attempt wholly to set it aside, substituting artificial arrangements of his own, devised solely in his own interest.

Some of Nature's arrangements man finds himself unable to improve upon for his own benefit. No one thinks of cultivating the forest to hasten the growth of the wood, or of trimming the wild oak or the maple, or of planting artificially the nuts and acorns in the woods to increase the number of the trees.

We are content to leave things there to go on essentially in the old way, merely anticipating the processes of natural death and decay by removing the trees before they spontaneously perish, and glad if the revolutions of organic life which we set up in the country around do not penetrate to the forest, visiting the leaves and trunks of the trees with the scourge of excessive insect depredations.

Usually, however, we find the ready-made system of Nature less to our liking, and all our cultures are attempts to set it aside more or less completely. In the pasture and meadow, it answers our purpose to substitute other species for the grasses growing there spontaneously, and these adapt themselves easily to the circumstances which have proved favorable to their native predecessors. But in the grain-field and fruit-garden the case is different. Not only do we bring in species often very unlike any aboriginal vegetation and still further altered by long cultivation, but we propose an end quite different from that for whose accomplishment all the arrangements of Nature have been made.

According to the settled order, the whole economy of every fully-established plant and animal is directed to the production of one more plant or animal to take the place of the first one when it perishes. All the excess of growth and reproduction is a reward to friends or a tribute to powerful enemies, intended to make only this one end secure. But man is not content with this. He does not raise apple-trees for the sake of raising more apple-trees. He would cut off all excess not useful to himself, and all that is useful he would stimulate to the utmost, and appropriate to his own benefit. In carrying out this purpose he finds himself opposed and harassed at every step by rules and customs of the natural world established long ages before he was seen upon the earth—laws certainly too powerful for him wholly to defy, customs too deeply rooted for him to overturn without the most complicated consequences. And yet even here, we see that the primitive order is not an evil, it is simply insufficient. It is good as far as it goes, and must be carefully respected in its essence, however far it may be modified in detail. We find abundant reason for a belief in its usual beneficence and for a reluctance to disturb it without urgent necessity.

At the best the disturbances we must originate will be tremendous. Old combinations will necessarily be broken up and new ones entered into. As in a country undergoing a radical change in its form of government, disorders will almost certainly break out—some of them fearfully destructive and temporarily uncontrollable; but the general tendency towards a just equilibrium will make itself felt, and intelligent effort will mitigate some evils and avoid others. Without attempting to go into deatils—which would be quite unnecessary for my purpose—I will endeavor briefly to show the bearing of some of these ideas upon practical conduct.

To man, as to nature at large, the question of adjustment is of vast importance, since the eminently destructive species are the widely oscillating ones. Those insects which are well adjusted to their environments, organic and inorganic, are either harmless or inflict but moderate injury (our ordinary crickets and grasshoppers are examples); while those that are imperfectly adjusted, whose numbers are, therefore, subject to wide fluctuations, like the Colorado grasshopper, the chinch-bug and the army-worm, are the enemies which we have reason to dread. Man should then especially address his efforts, first, to prevent any unnecessary disturbance of the settled order of the life of his region which will convert relatively stationary species into widely oscillating ones; second, to destroy or render stationary all the oscillating species injurious to him; or, failing in this, to restrict their oscillations within the narrowest limits possible.

For example, remembering that every species oscillates to some extent, and is held to relatively constant numbers by the joint action of several restraining forces, we see that the removal or weakening of any check or barrier is sufficient to widen and intensify this dangerous oscillation; may even convert a perfectly harmless species into a frightful pest. Witness the maple bark-louse, which is so rare in natural forests as scarcely ever to be seen, limited there as it is by its feeble locomotive power and the scattered situation of the trees it infests. With the multiplication and concentration of its food in towns, it has increased enormously, and if it has not done the gravest injury it is because the trees attacked by it are of comparatively slight economic value, and because it has finally reached new limits which hem it in once more.

We are therefore sure that the destruction of any species of insectivorous bird or predaceous insect is a thing to be done, if at all, only after the fullest acquaintance with the facts. The natural presumptions are nearly all in their favor. It is also certain that the species best worth preserving are the mixed feeders and not those of narrowly restricted dietary (parasites, for instance)—that while the destruction of the latter would cause injurious oscillations in the species affected by them, they afford a very uncertain safeguard against the *rise* of such oscillations. In fact, their undue increase would be finally as dangerous as their diminution.

Notwithstanding the strong presumption in favor of the natural system, when we remember that the purposes of man and what, for convenience's sake, we may call the purposes of Nature do not fully harmonize, we find it incredible that, acting intelligently, we should not be able to modify existing arrangements to our advantage—especially since much of the progress of the race is due to such modifications made in the past.

We should observe, in passing, that the principal general problem of economic biology is that of the discovery of the laws of oscillation in plants and animals, and of the methods of Nature for its prevention and control.

For all this, evidently, the first, indispensable requisite is a *thorough knowledge of the natural order*—an *intelligently conducted natural history survey.* Without the general knowledge which such a survey would give us, all our measures must be empirical, temporary, uncertain, and often dangerous.

Next we must know the nature, extent, and most important consequences of the disturbances of this order necessarily resulting from human interference—we must study the methods by which Nature reduces these disturbances, and learn how to second her efforts to our own best advantage.

But far the most important general conclusion we have reached is a conviction of the general beneficence of Nature, a profound respect for the natural order, a belief that the part of wisdom is essentially that of practical conservatism in dealing with the system of things by which we are surrounded.

Summary.

The argument and conclusions of this paper may be thus briefly recapitulated:—

We find a mutual interdependence of organic groups and a modifiability of their habits, numbers, and distribution which brings them under the control of man. We also see that, after the most violent disturbances of their internal relations, a favorable readjustment eventually occurs. Starting with the general laws of multiplication and natural selection, it is first observed that every species of plant or animal dependent upon living organic food is interested to establish such a rate of reproduction as will, first, meet all the drains to which it is itself subjected, and still leave a sufficient progeny to maintain its own numbers, and, second, leave a sufficient supply of its own food-species to keep them undiminished, year after year. That is, we find that the interests of any destructive plant or animal are identical with the interests of its food supply.

This common interest of the organism and its organic food is continually promoted by natural selection, by which those that unduly weaken the sources of their own support are eventually crowded out by others with a better-adjusted rate of increase; but, because of the immense number, variability, and complexity of the forces involved, a complete adjustment is never reached. Whether the rate of multiplication of the food-producing species be relatively too great or relatively too small, the result is to cause an oscillation of numbers of both depredating species and its food. These oscillations of a species are both directly and indirectly injurious to it, and tend, in various ways, to diminish the average of its numbers, especially by lessening the general average amount of the food available for it. By the operations of natural selection, therefore, widely oscillating species, thus placed at a marked disadvantage as compared with more stable ones, are either eliminated, or else reduced to order more or less completely. They tend to become so adjusted to their food supplies as to appropriate only their surplus and excess.

Hence, as a general thing, the real limits of a species are not set by its organic environment, but by the inorganic; and the removal of the organic checks upon a species would not finally diminish its average numbers.

Among the external checks upon the oscillations of species of insects, the most important are those predaceous insects and insectivorous birds which eat a varied food, using most freely those elements of their dietary which are, for the time being, most abundant.

When we compare the results of the primitive natural order with the interests of man, we see that, with much coincidence, there is also considerable conflict. While the natural order is directed to the mere maintenance of the species, the necessities of a man usually require much more. They require that the plant or animal should be urged to excessive and superfluous growth and increase, and that all the surplus, variously and widely distributed in nature, should now be appropriated to the supply of human wants. From the consequent human interferences with the established system of things, numerous disturbance arise—many of them full of danger, others fruitful of positive evil. Oscillations of species appear, not less injurious to man than to the plants and animals more directly involved. Indeed, most of the serious insect injuries, for example, are due to species whose injurious oscillations have resulted from changes of the organic balance initiated by man.

To avoid or mitigate the evils likely to arise, and to adapt the life of his region more exactly to his purposes, man must study the natural order as a whole, and must understand the disturbances to which it has been subject. Especially he must know the forces which tend to the reduction of these disturbances and those which tend to perpetuate or aggravate them, in order that he may reinforce the first and weaken or divert the second.

The main lesson of conduct taught us by these facts and reasonings is that of conservative action and exhaustive inquiry. Reasoning unwarranted by facts, and facts not correctly and sufficiently reasoned out, are equally worthless and dangerous for practical use.