DUKE
UNIVERSITY

LIBRARY

3/6 n

Digitized by the Internet Archive
in 2016 with funding from
Duke University Libraries

EVOLUTION BY CO-OPERATION

BY THE SAME AUTHOR.

NUTRITION AND EVOLUTION.

‘A volume of real, deep interest . . . must be recognised as worthy to rank in first-rate criticism.’

Daily Chronicle.

‘Contains many good ideas. Its tendency is in harmony with the most recent views of biological research.’—DR. BRUNO OETTINGER in the *Frankfurter Zeitung*.

SURVIVAL AND REPRODUCTION.

‘Toujours du plus haut intérêt.’—*La Nature*.

‘The author’s propositions are certainly interesting and worth further testing by research.’—DR. W. BREITENBACH in the *Neue Weltanschauung*.

EVOLUTION BY CO-OPERATION

A STUDY IN BIO-ECONOMICS

BY

HERMANN REINHEIMER

AUTHOR OF

'NUTRITION AND EVOLUTION' AND 'SURVIVAL AND REPRODUCTION'

LONDON

KEGAN PAUL, TRENCH, TRÜBNER & CO. LTD.
BROADWAY HOUSE, 68-74 CARTER LANE, E.C.

1913

TO
MY FATHER

PREFACE

SOME of my readers will have heard of the once famous 'Vestiges of Creation,' a book that appeared anonymously in 1844, created a great sensation, ran through twelve editions, and the authorship of which was at last acknowledged by Robert Chambers. The book dealt with evolution, or 'Progressive Development,' the principle which the author said that he was bringing forward 'on this momentous occasion.' We read in Chambers' 'Encyclopædia,' 1867, that 'by Darwin the chief arguments of the "Vestiges" are used with great scientific caution.'

Chambers, who declared that Lamarck rested too much on the well-known effect of use or exercise in strengthening and enlarging an organ and of disuse in atrophying it, regarded evolution as a process analogous to ordinary gestation. Given time, space, and geological and physiological factors, as well as a 'variative power connected with the will and dispositions,' and the impulse originally imparted to the forms of life has gradually advanced them by generation. 'Let it not be said,' he declares, 'that the phenomena concerned in the generation of bees may be very different from those

concerned in the reproduction of the higher animals. There is a unity throughout Nature which makes the one case an instructive reflection of the other.'

Here, then, we have a pregnant reference to physiological factors, the most important of which I claim to be nutrition, for it determines in a large measure the processes of fertilisation and of gestation, and thus the biological status, not only of the bee-tribe, but of all organisms. I have already devoted two volumes to this subject and I find it is yet far from being exhausted.

Darwinism, not to its credit, has so far shelved the inquiry into the factor of nutrition, and looks askance at any attempts to elucidate what it taboos as 'the slippery basis of metabolism.' The result is that the study of what I would call Biological Eugenics has hung fire ever since Darwin's day, though it is a subject that is of the utmost importance in our every-day life. Although Darwin was an expert breeder, and with wonderful ingenuity elucidated the important principle of plant-eugenics, viz. that 'Nature abhors perpetual self-fertilisation,' he seems not to have realised that the share which feeding has in the maturation of endowments and of values in evolution is of greater fundamental importance than a mere combination of gametes.

After all, the differences from the average type induced by 'selective' breeding are only such as

might be expected in the progeny of 'selected' animals as the result of new metabolic influences. Here the preliminary question arises, how is it that fertilisation and gestation may conduce to a gradual elevation of type and of the general level of biological existence? If an adequacy of force—which, I maintain, adequate feeding alone can provide—is indispensable to orthogenesis, a *super*-adequacy of force (as Robert Chambers says) is needed to achieve rise of type. To obtain this super-adequacy of force the genius of early organic life struck out the method of reciprocal differentiation—as a means of economising physiological labour (recognised by Darwin as of great importance) and of storing up increment forces and qualities, which by a variety of complementary processes are blended and thus bring about mutual enhancement. However this line of development originated, without reciprocal differentiation and mutuality there would have been no maturation, no fertilisation, and, hence, no gestation and, hence, no progressive evolution.

Nay, the very generation of nutritional force for the sustenance of these functions and, hence, of organic evolution, is a matter of reciprocal differentiation and, therefore, of reciprocal activities. Ability to rely upon the powers of mutuality thus primarily rendered evolution possible, i.e. division of labour implies and necessitates co-operation.

When Darwin had marshalled the evidence which confirmed our faith in evolution, he left the important eugenic threads (if I may epitomise them so) where Chambers had left them.

The economic threads concerning production, economic usefulness and efficiency, likewise, he left where another pioneer, Malthus, who is sometimes referred to as his master, had left them.

A continuation and combination of the 'eugenic' and economic threads no doubt would have led Darwin into the study of Bio-Economics proper, which I am now endeavouring to set forth for the first time.

Darwin is supposed to have admitted more than fifty years ago 'that it is extraordinarily difficult to say precisely why one species has been victorious over another in the great battle of life,' and, moreover, to have had another consideration in his mind, which 'has often been lost sight of since.' 'It is illustrated, for instance, by the researches of Bumpus and of Crampton on the survival of sparrows and pupæ respectively. The point was that the survivors seemed to survive, not because of single peculiarities, but because of *their general stability and efficiency*' [italics mine].¹

To the study of the physiological and combined economic factors productive of 'general stability and efficiency'—the study of biological eugenics—freed from the misleading side-issues of 'single peculiarities,' I have

¹ *Evolution*, by Professors Geddes and Thomson.

devoted myself for some years, and in so doing, I claim to be contributing to and furthering Darwin's work. I believe I have shown in previous volumes that just as purity is the indispensable condition of stability in the inorganic world, so in the organic world only those types excel by stability and efficiency which are free from the blemishes of (accumulated) surfeit and of illegitimate associations and appropriations.

The Malthusian generalisation on population is very commendably modified and circumscribed by Chambers thus: 'the fecundity of nature has ordained that her creatures shall ever be pressing upon the verge of the *local* [*italics mine*] means of subsistence.' This, though in my view still too highly generalised, at any rate refers only to a local congestion and adumbrates the remedy by fresh organismal efforts or by discovering new fields of activity.

Indeed, so far from inferring a deadly struggle for food, he goes on to say that 'a colonising principle accordingly comes into play,' and very pertinently he suggests that certain individuals are perhaps 'elected to the new life by some of those *varieties of appetency* which occur in all tribes; thus *exposing themselves* to new influences, and ceasing to experience those formerly operating' [*italics mine*].

From the point of view of Bio-Economics I should say that though local cases of over-population occur, new qualifications—progressive and retrogressive—also

constantly arise and present opportunities for new positions in the general economy of Nature. The retrogressive have to be content with those adaptations and opportunities compatible with their (relative) backwardness. 'Varieties in appetency'—changes of feeding habits, accumulated through many generations—in particular are responsible for physiological and biological isolation, i.e. for eventual divergences of species.

The case of biological over-population is thus seen to involve a less lethal struggle than was supposed by Darwin and his friends, who, viewing only the death-roll of Nature, allowed themselves rather too unreflectingly to be driven into the Malthusian theory of internecine struggle.

Unable on this view of Nature's book-keeping to see how a local surfeit could be cured by bio-economic adjustments, and to balance consumption by production, they were constrained to postulate a universal 'struggle for food,' a 'utilitarian selection' by which the unsuccessful candidates were necessarily destroyed. Natural Selection 'isolates beneficial variations by killing off the others.' 'In all cases it must be a struggle, with death as the penalty for being vanquished.'

Without competition there is no 'selection,' and 'it is natural selection, working with other forms of isolation, which has brought about the main progress of life.'¹ What co-operation there is (according to this view), consists

¹ F. W. Hutton, F.R.S., etc., in *Darwinism and Lamarckism*.

in the help which the lucky 'selected' individuals afford to nature in exterminating the 'non-elect.'

It is true that Darwin pointed out that diversification of habits has its advantages, but his principle of 'natural' or 'utilitarian' selection is not supposed to isolate different members of the same group, but, on the contrary, to entirely destroy all new variations 'when the external conditions remain the same for a long time.'¹ The new Darwinism, therefore, has recourse to 'isolation' as an additional help to 'selection.' How is it that some types have been isolated and preserved whilst others have not? The answer of Darwinism consists of little more than words: 'Isolation and Preservation.' The main cause of 'general stability and efficiency' is scarcely touched. The study of the effects of the biological environment, so meritoriously begun by Darwin and by Wallace, instead of becoming a fruitful foundation of Bio-Economics and Eugenics, thus resolved itself mainly into an account of 'warfare' and of 'famine'—and for the rest into a war of words. Darwin's principle of 'the struggle for existence' has admittedly only a metaphorical meaning, and has also glaring limitations and deficiencies, which even the help of 'isolation' as a 'principle' cannot cure. The question whether, on the whole, necessities and usefulness have received a true setting in Darwinism can therefore scarcely be answered in the affirmative.

In view of the surpassing importance of the bio-

¹ F. W. Hutton, F.R.S., etc., in *Darwinism and Lamarckism*.

economic interdependence of organisms, a more rational view of organismal necessities and duties and equally a more rational standard of usefulness—‘use’ in the widest sense—has to be adopted than is adopted in either case by Darwinism. We must leave behind the deadly region of crude utilitarianism.

Development must be explained in terms of Bio-Economics in the place of an explanatory method which forces everything into the procrustean bed of ‘Selection.’ Nor can we any longer afford to leave so vital a factor in evolutionary development as correlation—‘our ignorance of which is profound’—out of consideration. All development is correlated development. Unless this is fully recognised our study of evolution must be based on Pseudo-Biology and Pseudo-Economics. We must not be content to remain ‘profoundly ignorant of the conditions of existence of every animal’ as Darwin puts it in his ‘Journal of a Naturalist’; but we must make a special study of the systematic activities of organisms and learn to estimate the physiological and biological correlation-value of such organismal functions.

Biological transformations will thus become intelligible in the light of combined physiological and bio-economic development correlated with transmitted functions and habits. Controversies about transmission or non-transmission of ‘acquired’ characters appear quite trivial in comparison with considerations of this kind.

Nor need we lay great stress on ‘chance’ variations.

What is not required in evolution will not stay long, and is at any rate of little significance. Whatever exists must, with misuse (rather than disuse), tend toward an untimely end. It is values and qualifications that everywhere determine persistence. To be or not to be of any evolutionary importance does not so much depend, as previous writers, including even Chambers, held, on 'the accident of external conditions,' but is a matter of qualification. To advance or to retrograde, to gain a super-adequacy of force or to become deficient of force, is to be or not to be co-operative, efficient, and therefore stable. It is never a matter of 'chance.'

Those of my readers familiar with the literature of Darwinism will know that the 'general economy of Nature' is there, though rather casually, made responsible for a great deal. Wherein does it consist?

Messrs. Geddes and Thomson suggest that 'Darwin's characteristic fundamental idea of the intricacy of inter-relations in the web of life lies below the idea of the struggle for existence, and therefore below the idea of natural selection.' They speak of the need of appreciating the 'fundamental natural history fact' of the web of life. But what of the underlying fact of Natural (or Biological) Economy? On these questions, as well as on the first principles of feeding and of Eugenics, on usefulness and on efficiency—'magnalia naturae quoad usus humanos'—the following pages, I trust, will throw more light.

Surbiton : June 1913.

CONTENTS

CHAP.	PAGE
INTRODUCTION	1
I. BIOLOGICAL ECONOMY	31
II. SELECTION	95
III. DIGESTIVE TRANSFORMATION	126
IV. IS NATURE NON-MORAL ?	131
V. CORRELATIONS	134
VI. THE SOLIDARITY OF ORGANIC LIFE	147
VII. THE ETERNAL FEMININE IN NATURE	152
VIII. ADEQUACY OF FORCES	164
IX. EVOLUTION BY PARASITISM	172
INDEX	197

EVOLUTION BY CO-OPERATION

INTRODUCTION

‘Immer strebe zum Ganzen.’—(*Diesterweg.*)

‘The preservation of each species can rarely be determined by any one advantage, but by the union of all, great and small.’—(*Darwin.*)

‘After long intervals of time, the productions of the world appear to have changed simultaneously.’—(*Darwin.*)

THE central problem of Life, and, *a fortiori*, of Organic Evolution, is production—production of the necessities and utilities of life first, and the requirements of progress after. The method of solving the problem consists in systematic activity (work) and in physiological and biological division of labour, which in its turn entails on the structural side differentiation of a correlated and reciprocal character. Economically speaking, it follows that once this step of reciprocal differentiation was reached it became a necessity (or duty) for all participants to maintain adequate efforts, lest the level of organic existence should tend to return towards the pre-differentiated state instead of gradually rising to a level of which *homo sapiens* is the best expression.

It has been asserted that hunger and love have been the most powerful stimulants of progress; but

it is also necessary to recognise that nutrition and reproduction, through which they act, have throughout evolution shown a most remarkable tendency towards reciprocal arrangements. Hunger and love have thus at an early date led to 'other-regarding' functions, which 'other-regarding' functions also partake of the nature of 'all-regarding' functions in so far as they were most calculated to serve the interests of the organic world as a whole.

To take a striking and particularly appropriate example of this relation from Henry Drummond : ' Every plant in the world lives for others ; it sets aside something, something costly, cared for, the highest expression of its nature. The seed is the tithe of love, the tithe which nature renders to man.' Moreover, the system of elaborate service of one organism to another, which in Sir E. Ray Lankester's words is now ¹ ' found *on examination* [italics mine] to be practically universal, though of extraordinary variety and diverse degrees of intimacy,' invites comparison with the economic relations between social groups in the human family.

The abundance of facts of mutual labour in nature has long struck me as an important feature demanding fresh interpretations. Whether we incline on the whole to interpret these facts teleologically, or merely as the higher egoism of the total community subordinating to itself the activities of the mere unit, makes little difference.

¹ *Daily Telegraph*, March 4, 1913.

What in my view is extremely significant, however, and what makes the study of evolution along economic lines so fruitful, is the fact that all progressive or retrogressive developments in evolution have been attended and paralleled by definite and characteristic economic developments.

The economic phase of evolution presents itself mainly, I submit, as a process of biological co-operation, similar to—though on a wider scale than—the process of co-operation obtaining in human society. Thus as one nation from others so a species may borrow forces from the biological environment with impunity, so long as it continues to contribute adequately to the common organic funds. Broadly speaking, it may be said that both organisation and biological status have improved in the course of evolution, in proportion as the organism's economic activities tended to help rather than to hinder the collective welfare of the organic world. The mammalia, the type most qualified for 'other-regarding' and 'all-regarding' functions, thus have attained the highest rank in evolution.

In the biological world everything is interdependent, and continues to be by virtue of its relations to something else. Everything is complementary to something else. Just as an organism itself is a monument to the co-operative principle of differentiation of function and structure, so the existence of the total biological family rests securely on the same principle. Its very specialisation serves the

common purpose of raising a maximum of organic utilities with a minimum of organic cost.

The process of gradual specialisation in the biological world differs only in degree from that which rendered man in society or, say, some of the hymenoptera particularly striking types of co-operation. Is it not significant that far below man in the scale of life already we find such a wonderful degree of co-operation—both domestic and bio-economic—with momentous results upon the evolution of life? ‘A whole volume would scarcely suffice to enumerate the various talents and habits of the honey-seeking crowd,’ says Maeterlinck. Of the *Apiens* he says (what has been variously pointed out by other writers): to them ‘we probably owe most of our flowers and fruits (for it is actually estimated that more than a hundred thousand varieties of plants would disappear if the bees did not visit them), and possibly even our civilisation, for in these mysteries all things intertwine.’ The study of biological co-operation, however, is only in its infancy, and we must welcome, therefore, attempts that have already been made in one or two directions to found on those variations in domestic economy a system of classification that ‘may forerun considerable changes in many departments of zoology.’

My contention is that co-operative principles have, in similar ways to those obtaining between bee and flower, prevailed throughout the course of evolution. From the moment division of labour set in, co-operation must

have been essential to the organic world, for it afforded the only possibility of preservation and progress. Just as in human society an invisible but nevertheless actual and indispensable standard of useful morality has gradually arisen, so also the biological world is ruled by an invisible but actual standard of domestic and bio-economic usefulness or social morality. This being the case, we may expect the sway of a quasi bio-moral force to have left its mark upon the very instincts of organisms. We may expect organisms by the force of such circumstances—as well as by virtue of their very constitution—to be pre-eminently co-operatively inclined. This is demonstrably the case, however frequently the co-operative instincts are apt to become perverted and misdirected.

It is the bio-economic task of organisms to earn their sustenance and over and above this to provide for marginal and exchangeable bio-economic values to be used in the mutual accomplishment of evolution. The chief part of this task consists in the provision of raw material and in the transforming and storing (capitalising) of solar energies, in which process physical forces are being systematically raised to the position of physiological forces. The resulting values are bio-economically useful and exchangeable as between species and larger groups. The continuance of this systematic organismal effort (work) is necessary in order to maintain both the supplies of energy and the essential capacities for work, and here again the self-preservation of the organic world implies a

common interest which in course of time must make itself felt as economic and biological pressure against all elements impeding co-operative production. Hence we find that those organisms which manifestly fail in maintaining such co-operative effort are most precariously placed, are penalised physiologically (by various forms of retrogression, of infection and disease) and likewise biologically by various kinds of enmities and afflictions.

I submit that the negative reactions resulting from negative bio-economic activities (i.e. wastefulness and depredation) in course of time produce a diminution of transformative power, which becomes traceable upon organisation as loss of symmetry, frequently manifesting itself in extreme sexual dimorphism, together with a general tendency towards monstrosity. Before organisms could function efficiently in the external biological environment, they had to achieve internal (physiological) efficiency. Physiological and bio-economic development therefore moved along parallel and correlated paths.

Another result of negative activities is the tendency towards unchecked and unduly accelerated reproduction. All these developments, which the biological world presents so frequently and variously, are accompanied by various forms of diathesis incompatible with stability. The consequence is an eventual loss of biological status or may be extinction. The extreme cases of this non-co-operative or purely self-regarding course of life are in my view to be found in the various modifications of form and

of fate presented by organisms that have lapsed into parasitism.

The hymenoptera again provide us with a few typical—though by no means extreme—examples of comparatively negative or (according to my classification) pathological results. To quote again from Maeterlinck : ‘ First there come the nearest kindred of our domestic honey-fly, the thick-set, hairy humble-bee, *occasionally small in size, but as a rule enormous.*’ ‘ They are still half-barbarous ; they ravish the calyces, *destroying* them if they resist, and push through the satin veils of the corollas like a cave-bear that might have forced its way into the silken, pearl-bestrewn tent of a Byzantine princess.’ ‘ By their side, larger than the largest of them, there passes a *monster* clothed in darkness. It burns with a sombre fire, of green and violet : it is the *Xylocopa* wood-ranger, the giant of the melliferous world.’ ‘ Then follow pell-mell *Dasypodæ* and wasp-like *Halicti*, *Andrennae*, which often fall victims to a fantastic parasite, the *Stylops*, *whereby their appearance is completely changed*’ [italics mine].

And further, comparing the supposed ancestor of our bee—the *Prosopis*—possessed of an elegance which ‘ hides an inconceivable poverty ’ : ‘ She leads a life of starvation. She is almost naked, whereas her sisters are clad in a warm and sumptuous fleece. She has not, like the *Apidæ*, baskets to gather the pollen, nor, in their default, the tuft of the *Andrennae*, nor the ventral brush of the *Gastrilegidæ*. Her tiny claws must laboriously gather

the powder from the calyces, which powder she needs must swallow to take it back to her lair. She has no implements other than her tongue, her mouth, and her claws, but her tongue is too short, her claws are feeble, and her mandibles without strength. Unable to produce wax, bore holes through wood, or dig in the earth, she contrives clumsy galleries in the tender pith of dry berries ; erects a few awkward cells, stores these with a little food for the offspring she never will see, and then, having accomplished this poor task of hers, that tends she knows not whither and of whose aim we are no less ignorant, she goes off and dies in a corner, as solitarily as she had lived.'

In these instances we have depicted almost every form of negative bio-economic result. The comparative precariousness and poverty of the non-reciprocal savage life, and indeed its value-destroying propensities ; the development of monstrosity, the proneness of idlers to parasitic infection (disease), the change of form, the absence of organic implements by the aid of which to render exchangeable services and to achieve that biological reciprocity which purchases further evolution, the comparatively accelerated life-cycle which causes the mother to die long before she can be of educational and altruistic avail to her offspring—all these, I maintain, are tell-tale developments. They are, in my view, the injurious complements to comparatively wasteful bio-economic developments, which in course of time lead up

to various eliminations either through increase of morbidity and self-destructive propensity or through clashes with the more precious organisation of the strenuous types, who comply with the highest standards of good bio-economic conduct.

The bees also present us with good examples of the tacit recognition of bio-economic values in the world of organisms and of direct eliminations according to value. Thus the virgin workers are supposed to recognise the queen as a 'symbol of life more precious, more vast than their own.' They will sacrifice their lives for the sake of hers. On the other hand, the clumsy, useless, noisy drones, who are 'pretentious, gluttonous, dirty, coarse, totally and scandalously idle, insatiable,' and moreover of 'enormous' size (note here the dimorphism¹ in accordance with conduct!), are mercilessly massacred with the advent of economic stress, 'when flowers begin to close sooner and open later.'

It has been said that an organism dies because its processes go on no longer teleologically (*zweckmässig*), but only causally. J. v. Uxküll, to whom we owe this definition of dying, explains: 'When we look backward every phase in the process of development seems to us to have proceeded in a strictly causal manner from physio-chemical processes. But when we look forward it is certain that the physio-chemical processes, if left to

¹ Again I must refer the reader to previous volumes where these phenomena are treated of. They are by no means confined to the bees.

their own causality, must immediately bring about the destruction of the organism.'

This seems very true. I maintain that the biological analogue to this physiological 'Zweckmässigkeit' (purposiveness) is to be found in bio-economic usefulness (Zweckmässigkeit), although the alternative process which is the cause of biological dying is frequently slow and difficult to recognise.

We must bear in mind that organisms live not only by virtue of, but also in spite of what they are. They may resist death in spite of the presence of morbid forces. Lapse of physiological effort (sluggishness) or a local surfeit (impregnation with foreign matter) need not produce death as an immediate result, though they involve more or less persisting pathological developments, which are transmissible.

So long as the organism remains plastic enough, it may contrive a variety of expedients to bring its organisation by some retrogressive adjustment into line with the changed habits and the changed inheritance. Preservation alone, therefore, is by no means a sufficient guarantee of healthy survival. It may be that some positive components present are just vital enough to impress some kind of specific aspect upon the otherwise slowly degenerating species. Some characters may have remained tolerably constant, being dependent on a remaining useful organ.

These pathological points are so vital to the under-

standing of the bio-economic theory which I commend that I must insist on them at some length. It has been customary hitherto to refer to the 'endowment' of organisms in a vague and haphazard manner. In a valid analysis, it should be possible to account for the essential endowments as well as for the subjective hindrances of an organism or a species. We do not yet possess, however, a qualitative or quantitative biological analysis. Biologists remain satisfied that the mere achievement of reproduction is in general a sufficient criterion of biological success, irrespective of maturation-value and eugenics, and regardless of the obvious degeneration which frequently accompanies reproduction. The standard of highness is an 'obscure subject' according to Darwin. What is essential in endowment is that which has been accumulated by persistent and co-operative ancestral efforts. It is comparable to a fund which, though it may now be in course of dissipation, was yet originated by labour. In an analogous manner organisms may deflect parts of their funds retrogressively to non-co-operative uses until eventually rudiments only of their quondam bio-economic status may remain. The very perfection of offensiveness and of predacious propensity in a species, therefore, must not deceive us about its real state of instability¹ any more than about the true *fons et*

¹ The fact that domestication in the case of many carnivorous animals leads to sterility seems to indicate that their survival-capacity has become impaired.

origo of its remaining strength. If it is now tending in the very opposite direction to which ancestral virtue tended, it can only exercise this abuse of power by dint of exhausting that which its ancestors have built up. Mendelism has shown that not always does the plume proclaim the fowl, and similarly we must not allow ourselves to be deceived by the appearances of tooth and claw as regards the true composition and stability of an organism. If, frequently, the slow atrophy of 'other-regarding' organisation is an opportunity of the perfecting of aggressive organisation, this process only represents an inferior rearrangement of parts, a genuine retrogression—more particularly so in the light of correlations (about which more anon).

The fact that large classes of organisms—the aristocracy of life—have manifestly declined to avail themselves of retrogressive practices and of short cuts, have disdained all manner of tempting adaptations, have in particular shown a remarkable perseverance of feeding habits, is in my opinion more striking than the prevalence of more or less depraved types. The highest types of animals, the primates and man, have chosen not to organise for aggression at all, but to rely instead on the forces that mutuality was to bestow upon them. Man, it seems, has inherited an organisation 'from vegetarian ancestors even more remote than the apes.'¹

During the conduct of life negative elements are

¹ Sir E. Ray Lankester, *Daily Telegraph*, May 19, 1913.

mainly, though imperceptibly, brought together by bad habits. 'Magna est vis consuetudinis.' It is habit by which organisms either reach the substance of life or are drawn further and further away from it. It is habit which in course of time is productive of cumulative effects. Just as systematic activity, efficiently and co-operatively applied, is the main support of evolution, so systematic activity misapplied—bad physiological and economic habit—is the main impediment. If bad habits are apt eventually to produce pathological effects they must likewise in course of time involve negative biological effects, which are less easy to disentangle. In studying such effects we must make due allowance for the time element and for adventitious factors which are apt to hide the true normal factors, lest we should be obliged to apply the epithet 'chance' to an effect the cause of which lies far back in time when normal habits gave way to abnormal habits—to habits which we may also term dysteleological, because they fail to conform to a bio-economic standard of conduct, to comply with which forms a kind of end in respect of the healthy survival of the race and of the biological world generally.

To arrive at just conclusions on so vast a matter as organic evolution it is necessary to try to understand minor developments by the aid of broad developments, and, moreover, to look the broad facts of Nature squarely and fairly in the face, though the results obtained may not

seem at first glance to harmonise with preconceived notions. When we consider, for instance, that plant and animal are physiologically complementary, in accordance with a world-wide division of labour, that the actual position of a plant in the scale of evolution is according to its productiveness of values, and further that the habit of obtaining food by short cuts rather than by effort universally leads to degeneration, such broad facts are full of significance. Notwithstanding a vast concatenation of cause and effect during the long periods of evolution and the almost bewildering complexity of the 'web of life,' they tell us that in course of time bio-economically useful behaviour has been the normal road to evolution and has indeed determined survival and prevalence. They also show that the same factors upon which organic life relies for its very existence, viz. co-operative factors, are likewise the normal essentials to its subsequent evolution. The same may be said of a number of other facts connected with the phenomena of symbiosis,¹ of cross-fertilisation, of cultivation and distribution of seeds, which moreover justify the further conclusion that the fundamental principles of human society—give and take—had been complied with as the rule of progressive life long before man's advent. Virtue thus is older

¹ The botanist Kerner states that 'the reciprocity here implied is, however, at bottom but a copy of the complementary interaction of plants and animals which takes place on a grand scale in the organic world,' and yet Darwin declares that we are profoundly ignorant of the mutual relations of the inhabitants of the world !

than man and older than vice. On the other hand, laxity of physiological and economic effort, with the subsequent failure to provide exchangeable bio-economic margins, we have already recognised as a fundamental cause of negative developments. *A fortiori* is this true of the fatal evolution by a species of the habit of depredation.

The factor which we must now recognise, as lending itself most readily to the cumulative introduction of impediments (impurities) and to the evolution of the habit of depredation, is nutrition, which, I submit, is playing the most prominent part in effecting the transformations of the organic world.

‘*Ex quo vis ligno non fit Mercurius.*’ By providing the organismal building material, nutrition first of all largely determines organic form and architecture; by providing the soil and the force for all subsequent maturations and transformations, it largely conditions all future possibilities. As representing stored-up organic capital, moreover, nutrition may easily be seen to be the medium through which many important biological reactions and affinities must arise. Whether food is obtained co-operatively or predaceously, this is an issue which in the long run must involve numerous vital correlations.

The difference of pressure upon diverse species is by no means as arbitrary a matter as has hitherto been supposed. It has a history—a history of cause and effect. In making use of food material, a species draws in effect on

the great store of sustenance established by the combined efforts of all organisms. Food material, having been produced co-operatively, must also be distributed according to principles of co-operation. That this is indeed necessary, if wholesome economic activity is to be permanently maintained, is fairly obvious. That there are apparently flourishing exceptions to this great rule cannot deceive us as regards the underlying realities of the general economic scheme of nature. We must remember—although here, as in nature generally, a vast complexity of things sometimes would seem to render it problematical—that in human economics likewise no citizen or nation can more than temporarily suffer or rejoice by itself, or gain a lasting advantage through the misfortune of another.

That the nutritive need is the most fundamental problem of the so-called 'Struggle for Life' is variously and in a general way admitted by Darwinists. How far the solving of this problem involved regular and systematic bio-economic activity is, however, but scantily recognised by Darwin and his school. Darwinists to this day commit the error of neglecting the study of the evolution of habits, and of regarding feeding habits (amongst others) as fixed. Darwin gives exceedingly few examples of animals acquiring habits, although he assumes that certain habits have been acquired. 'Here, as on other occasions,' he says, 'I lie under a heavy disadvantage.' But feeding habits have undergone changes in the past, just as organs have

undergone changes; the former, indeed, have largely determined the latter, for the changes of feeding habits involved vital physiological and bio-economic changes. The result of these omissions is that Darwinism has failed to take account of the economics of production as they apply to the general economy of Nature. Failing a proper Biological Economy, it confined itself to the most sterile portion of Political Economy, represented by the Malthusian doctrine. A further result was the vagueness and inadequacy—recognised by many students—of the Darwinian Selection theory. The very word ‘struggle’ is little more than a metaphor. When it is said that an animal ‘struggles,’ all that is really meant is that it lives, with the assumption that it lives most prominently at the expense of others, that its very presence adds to the difficulties of organic existence. If, with writers like Henry Drummond and P. Kropotkin, we argue rather that ‘the struggle for the life of others is sunk as deep in the cosmic process as the struggle for Life,’ that there exists a vast amount of co-operation and mutual aid, that in any case a distinction must be made between behaviour that is wasteful and behaviour which is not, the Darwinian theory conjures up a plurality of other climatic and geological inclemencies with which to put the grimmest possible complexion upon the history of the evolution of life. The necessities entailed in the inclemencies of physical and atmospheric circumstances, however,

are by no means on a par with bio-economic necessities and contingencies, which pre-eminently determine whether organisms are to be or not to be.

The Malthusian doctrine asserts that 'there is a constant tendency in all animated life to increase beyond the nourishment prepared for it.'

This is far too sweeping a statement. It does not make adequate allowance for the share which the organism itself bears in the production of sustenance or of its equivalents. It does not allow for the variations in bio-economic conduct, which, as they determine changes of pressure, so also determine rates of multiplication. Redundancy produced by excess of nutrition, or, what frequently amounts to the same thing, sluggishness, cannot in justice be charged upon natural laws. The statement *rien ne se peuple comme les gueux* applies to the biological world generally. It is abnormal and pathological for the reproductive power of an organism to sink below a certain level of bio-economic restraint, i.e. to the level of physical forces that have passed out of control in the system. We are to believe, according to Malthusianism and Darwinism, that to be imbued with such improvident and self-destructive tendencies represents the normal rule of life. Moreover, according to Darwinism we are to believe that in this death-dealing tendency there lies the very germ of life. The more thorough this destruction of luckless numbers (specially of young) the better it is for the healthy progress of

the remainder, according to Darwinism. But, though healthy biological progress be less impeded by the removal of many that are superfluous, it cannot be said to be due to or to consist mainly of this lethal process. The rate of infant mortality may tell us a great deal about a people, yet it is not the death of these infants that builds up the nation's economic and political utilities. We have to look to its co-operative activities. We have to behold it at work. In the same way we must look to work and bio-economic co-operation if we wish to determine the positive factors of evolution.

I submit that biological infant-destruction comes under that vast evolutionary chapter of pathology.

The majority of people at the present day are inclined to place the devouring of young animals for food on an exact par with that of plant seeds. It is only a difference of appetites, they think. They see no fundamental physiological and bio-economic difference in so vast a change as that implied by the transition of a 'cross-feeding' to an 'in-feeding' habit. The popular view on these matters, however, is erroneous. Bio-economically speaking, it is the duty of the plant world to manufacture the food-stuffs for its complement, the animal world. In so doing it not only ensures its own self-preservation and that of the animal, but improves its own security and status together with those of the animal.

It is an incontestable fact that the majority of the foods of the world are products of reproduction, in

particular of plant-reproduction—‘love-foods’ in Henry Drummond’s phraseology. This rule constitutes, I maintain, the normal (reciprocal and valuable) relation of animal to plant, so far as animal nutrition is concerned, and, I submit, it has its physiological foundation in the fact that nutrition entails a kind of fertilisation, determined as to its results by the adequacy of the preceding (reciprocal) processes of maturation of the uniting material (quality.) The plant is neither physiologically nor biologically the poorer for what is legitimately taken away from it by its physiological complement, the animal. On the contrary, the normal relation which provides the true and permanent conditions for the creation of values between plant and animal is by no means one of depredation, but on the contrary one of co-operation. It is the outcome of a primordial division of labour, which in the course of the evolutionary process became increasingly perfected. It is a relation that cannot without impunity be violated for any length of time. Those animals which deviate from the legitimate reciprocal relations are apt to drift into redundancy, which may constitute a nuisance to the common interests of the biological world. Depredation—here as elsewhere—leads to manifold retaliation, involving in turn further aberrations, difficulties and impasses. Once an abnormality of metabolism has arisen, organisms—just like men—are prone to clamour for just those things they ought not to have, and to dislike just those things

which are for their real good. Such being the case, a serious and lasting infringement of the normal rule may, by a series of gradations, lead up to the fixing of the fatal habit of 'in-feeding,' which (as I have elsewhere shown more fully) is abhorred by nature, just as is, according to Darwin, perpetual self-fertilisation (inbreeding). It may lead up to what I have termed a 'parasitic diathesis'—that metabolic abnormality which is the source of much economic sterility and of consequent limitation and insecurity of life.

In the case of the food-supply by the plant, we see reproduction entering the service of bio-economic (reciprocal) usefulness with manifestly positive results. It is an arrangement of mutuality.

In the case of animal devouring animal, no new values are created, although the elimination and mutual destruction of wasteful and dysteleological types which take place may be viewed as advantageous by conducing, indirectly, to the greater security of the strenuous community. Biological infant destruction of this kind can scarcely be accounted a direct means of increasing organic wealth. It is a one-sided arrangement, depending upon illegitimate gains in the absence of work and of mutual service. Whatever its immediate 'advantage' may be, it is sterile as regards the maturation of permanent values.

To bring in economics as Darwinism does, only at a point where we behold an excessive number of young

fighting each other for an insufficient supply of food, is in my opinion to establish an arbitrary system of Bio-Economics. It is beginning at an abnormal point, at a point where wastefulness has led organisms into a *cul-de-sac*, successfully avoided by great classes of others whose economic conduct has won them a better destiny. A tendency to increase in a geometrical ratio, though it be a potential attribute of all types, is not exercised in the case of the aristocracy of life. They are too busily engaged in the production of organic utilities, in the maturing and rearing of higher values—the increasingly specialised reactions of their nervous system, in accordance with the laws of compensation implying checks on redundancy and acceleration of reproduction, self-control, prudence and restraint.

By representing it to be easier for things to be dead than living—which is postulating that the universe is at bottom inimical to life—Darwinism makes, in Shakespeare's words, 'guilty of our disasters (often the surfeit of our own behaviour) the sun, the moon, the stars; as if we were villains on necessity, fools by heavenly compulsion.'

As regards the physical universe, it is obvious that life, from the moment it functioned physiologically, had obtained an advantage *vis-à-vis* the physical forces—an advantage which it contrived constantly to augment by further co-operative developments. It was a great event in the evolution of life on our globe, which may

have involved the most stupendous efforts to accomplish, when organisms succeeded in contending with the physical difficulties by means of division of labour and by specialisation.

Once, therefore, this important economic step of life was accomplished and became fixed in the shape of capacities, the control of the physical environment became immensely increased by means of mutual aid and consequent improvement of automatic action. On the other hand, the advent of new bio-economic factors was apt to make for a certain amount of complexity, under which the solidarity of interest frequently seemed to vanish. Thenceforth the difficulties of organisms were of a biological rather than of a climatic nature. It is of great importance that these distinctions should be always made. Those organisms which failed in bio-economic effort eventually had to be content with less satisfactory surroundings. That many succumbed to the stress of physical circumstances, such as extreme cold, is true; but it is often a mere matter of pathology.

Failing a recognition of Bio-Economics, organisms had to be represented as being obliged to become 'rebels' against Nature—equally represented as niggardly and mainly red in tooth and claw. They had to form an *imperium in imperio*, in order to get on in the Hobbesian war of each against all.¹ They had to gain their advantages

¹ We can understand Darwin at his hour of day declaring: 'From the war of Nature, from famine and death, the most exalted object

by fair means or by foul. Some are indeed supposed to have gained successes by foul and otiose means. The parasites are the extreme examples. The denial of the pathology of parasitism is a necessary corollary of the Darwinian theory of the struggle for existence, but really clashes with the facts of Nature.

The same must be said of its denial of the well-authenticated facts of the zoological distribution of disease, to which it is committed by another corollary of the 'Natural Selection' theory, viz. that wild Nature, being 'naturally selected,' cannot harbour disease.

The Darwinian theory of Natural Selection, therefore, possesses no more than a general advantage in vaguely pointing to necessity as a factor in evolution. It has failed, however, to elucidate the nature of the various organismal necessities. Extreme Selectionists are satisfied with a distorted picture of the relation of organism to universe, with a pseudo-economic outlook on life and with a mass of metaphorical and semi-theological verbiage which ought to have no place in an exact science. It has thus happened, as Huxley apprehended, that : 'The new generation, educated under the influences of the present day, will be in danger of accepting the main doctrines of the "Origin of Species" with as little

which we are capable of conceiving, namely, the production of higher animals, directly follows.' If he were still among us, however, he could scarcely be credited to hold the same view.

reflection, and it may be with as little justification, as so many of our contemporaries rejected them.'

The pressure to which Darwin assigns chief importance as a factor in evolution is that arising from a remorseless and chaotic struggle of a multitude of selfish interests, where what remains of 'usefulness' is determined by personal and local considerations alone. The pressure to which I attach chief importance is that which constrains organisms in hundreds of ways to remain physiologically and biologically co-operative, under penalty of a variety of more or less painful and more or less chronic reactions—the usefulness of all developments being determined by a bio-economic standard of values. Darwin, according to an eminent German writer, 'has discovered death as a factor of evolution.' The factor that I would proclaim as more important is that of 'work.'

Darwin suggested that the effect of the interaction of organism and nature is analogous to that which man produces consciously in selecting certain types for his purposes preferably to others—a proposition which presents many difficulties. Huxley could give only very reluctant adhesion. Darwinism is supposed to have answered this question of analogy 'in the affirmative,' which—to say the least—is rather problematical, although in any case analogies are not proofs.

Although, generally speaking, the parallels between the evolution of life and of the works of man lend themselves to arguments of design rather than of Natural

Selection, we will concede a certain economic analogy between the quasi-conscious procedure on the part of Nature in allowing vital differentiations to arise in accordance with vital and correlated needs and the conscious (though frequently irrational) procedure to similar though more transient and local effects on the part of man. How far may we legitimately carry this analogy? Darwin states that 'the origin of most of our domestic animals will probably for ever remain vague.' But was it not at least by antecedent processes of nutrition, fertilisation and gestation, attended by a fair share of autonomy (reduced by domestication), that certain animals were eventually enabled to qualify for a close association with man? After all, the difference between wild and domestic animals of allied breeds lies more in their disposition and character than in their physique, and domestication happens but late in the evolution of an animal. 'Man can never act by selection,' says Darwin, 'excepting on variations which are first given to him in some slight degree by Nature.' Nature thus provides the all-important primordial conditions and the essential subsequent tendencies to variations. Nature endows and provides. Man appropriates and consumes. It may be said that man employs death to prevent too great a deterioration of his domestic breeds, and that this bears a resemblance to certain disciplinary and pathological processes in nature. But, though he thus preserves some fitness by death rather than by eugenics,

his success is due to endowments resulting from constructive processes of evolution, viz. those comprising 'natural gestation.' In reality man works by 'natural gestation' plus modification and elimination. And thus it appears that Darwin's attempt to formulate a higher order of facts in the terms of a relatively insignificant order of facts is scarcely warranted.

Darwin, of course, repudiated 'conscious choice' on the part of Nature—by which he asserted himself to mean only 'the aggregate action and product of many natural laws.'

If we are to reject 'conscious choice' and to rely upon 'aggregate action,' upon a great natural process as free as possible from teleological taints, we are justified in giving most emphasis to that necessity which most obviously possesses directive force and most obviously is concerned with respect of the totality of things organic, viz. the necessity of progressive bio-economic usefulness. On due consideration it will appear that I am scarcely giving the bio-economic principle too much to do, but that Darwinism, tacitly though vaguely implying such a principle, gives it too little to do.

If some will identify elimination with 'Natural Selection,' it should at least be made quite clear that elimination is never the source of endowment and qualification.

The standard of usefulness in a vast bio-economic process must needs be wide and sublime compared with the standard of individual usefulness.

Although Darwinists speak of a great natural process, they have no such reasoned standard of values. They are endeavouring instead to prove their process in local and trifling phenomena which have the slenderest connection with it, and frequently are due to pathological causes, while they ignore the wider implications. 'Natural Selection' is supposed to have the value of abetting organisms in obtaining that which the particular circumstances of the moment render desirable—regardless whether the adaptation has a wider positive value or not in respect of the self-preservation of the biological world. The assumption, which because of its narrowness forms the chief obstacle to the advance of Bio-Economics, is that 'Natural Selection' may 'tend to simplify or degrade the organisation; for a complicated mechanism for simple actions would be useless or even disadvantageous.' Surely 'Natural Selection' cannot have been the main agency responsible for the raising of the organismal world according to the dictates of an ever more efficient bio-economic co-operation, if what is somewhat grandiloquently styled 'the operation of natural selection' is thus (supposedly) purely a matter of expediency! Degeneration, in my view, frequently happens in spite of Nature (sufficient and progressive in her economic scheme). According to Darwinists, progress accidentally happens in spite of Nature (represented as niggardly in her economy.) Degeneration, so far from being directly produced by a vast process of

Nature involving economics, is, I submit, produced by the very opposite—by a prolonged organismal opposition to the general economy of Nature. The chief shortcoming of the Darwinian Selection theory is its failure to define the parts played in the great process of interaction between Nature and organism by

- (a) Autonomy, i.e. the constant power of the organism to make new combinations (response and control—Psycho-Biology),
- (b) Co-operation (Bio-Economics),
- (c) ‘ Natural gestation ’ (Morphogeny, Bio-Chemistry, and Eugenics).

In endeavouring to replace ‘ Natural Selection ’ by a theory of bio-economic co-operation, I am not denying the facts nor the use of competition and of warfare which Nature so variously and abundantly presents. I am not even denying the occasional usefulness of warfare. Drastic action may be rendered necessary—if everything else fails—to break up states of stagnancy, to protect and defend values of all kinds, and to overcome the withholding of rightful opportunities. ‘ Impunity lets loose the whole army of evildoers, and drives them upon the innocent,’ as Bacon says in his *Novum Organum*. I am only according them their true place in the general economic scheme of Nature, in which the co-operative factors, though ubiquitous, are generally less conspicuous than the martial. I am not seeking to range organisms by the side of angels. I recognise—which is quite a

different matter—that they are all ‘condemned to some nobility’; but that they are also—individually and collectively—under the doom of frailty. This recognition, which Robert Louis Stevenson has expressed in eloquent words, I may say, constitutes practically the only tenet of faith required by my theory.

Neither do I wish in the least to minimise Darwin’s great and meritorious work, which towers up unimpaired whether his Natural Selection theory be true or not. I cheerfully acknowledge his wonderful genius well perceived that the functional activity of organisms is frequently possessed of a more than local utility. As years went by, he became more and more impressed by fresh factors of interaction and mutual aid as well as of physiology, which he recognised as easily tending towards a modification of his theory. As Dr. J. A. Lindsay, who believes that ‘few men have had less reason than Darwin to retract any opinion once definitely formulated,’ states: ‘it is clear that Darwin wavered much and wavered often as regards the weight to be assigned to external conditions—climate, food, occupation—as factors of evolution. He was at one time inclined to attribute very little weight to such conditions in comparison with natural selection; later in life he was disposed to assign greater importance to them.’¹

¹ *British Medical Journal*, November 6, 1909.

CHAPTER I

BIOLOGICAL ECONOMY ¹

‘Yet if a little pollen were carried, at first occasionally and then habitually, by the pollen-devouring insects from flower to flower, and a cross thus effected, although nine-tenths of the pollen were destroyed it might still be a great gain to the plant to be thus robbed.’—(*Darwin.*)

THE founders of Political Economy based it upon the laws of Nature. This was a felt need, so much so that some of the definitions were rejected by critics as too broad and including other sciences, so that the best encyclopædias would really be the best treatise on Political Economy. It is as if the pioneers of Political Economy dimly realised its kinship with Biological (or Natural) Economy. We shall see hereafter that many of their propositions are possessed of a truly bio-economic foundation.

Similarly, Biology stood in need of Economics to account for the facts of interaction and competition in nature. It is the undying merit of the founders of

¹ This chapter represents a paper read (in part) before the British Association (Dundee, 1912). I have left it as far as possible intact, which accounts for some repetitions in other parts of the book.

Darwinism, apart from other immense contributions to natural history, to have done most valuable spade work towards a fuller appreciation of the economic significance of the biological environment. They considered, however, that their immediate task was to account for the vast amount of extermination incidental to the evolutionary process. The positive part of evolution, the production of values, the building up of lasting physiological and anatomic assets, the inconspicuous effects of ages of 'natural gestation,' for the time being was in effect shelved under the headings of 'preservation,' 'variation,' and 'heredity,' to which too little attention was subsequently paid. Thus it happened that the Malthusian doctrine on population almost alone of economic teachings appealed to Darwin and his school. 'Malthus once grasped and applied,' we are told, 'Darwin drew no more drafts upon political economy.' This omission, I believe, it is now necessary to correct, since I am convinced that there is in the biological world as real and necessary a balance of mutual services as Political Economy has shown to exist in human society, and it is the object of this chapter to establish that proposition. The work of Malthus rests, I believe, on a purely empirical and superficial biological basis, and I submit that his generalisation, as employed by Darwin, viz. that there is 'a constant tendency in all animated life to increase beyond the nourishment prepared for it,' is devoid of biological sanction.

The 'preparation' of food for the animal, for instance, is, I maintain, based on a necessary fundamental division of labour between the plant and animal kingdoms, rendering the one the physiological complement of the other. So long and in so far as the powers of production and reproduction on the part of the plant are ample, and so long and in so far as both plant and animal retain their proper economic status in the order resulting from this division of labour, there is in my view no danger of a dearth of food. It is well known that the fauna of a country primarily depends on its flora. It is not the absence of sufficient food-stuffs *per se* that is responsible for the failure of many species; but it is uneconomic habits of feeding, which, as I shall endeavour to show fully later, in so far as they produce metabolic abnormalities and insecurity of life—but not otherwise—spell starvation in the midst of plenty, and frequently cause a wasteful production of a maximum of individuals with a minimum of available food supply.

According to modern Political Economy, cannibalism, slavery, feudal systems and every kind of parasitic nurture are objectionable as bad economics, spelling physical and social disease—the surfeited and submerged classes alike being characterised by exaggerated reproductive tendencies. We know the redundancy of tubercular stocks, for instance, and we likewise know that

‘Rien ne se peuple comme les gueux.’

Now, what do we find in nature? The cases of surfeit

and what I consider extreme uneconomic feeding are universally attended by excessive, i.e. uneconomic reproductions, together with general degradation. Nothing, for instance, could be more uneconomic, more degrading and more suicidal from the point of view of modern economic teaching, than to find members of a human community actually feeding upon others without any return of services, as occurs in the animal world in parasitism and in hyper-parasitism.

Nothing, again, could be more uneconomical than the prodigious multiplication of these very same parasites, seeing that with a maximum of reproductive expenditure only a minimum of life can be sustained. To classify such cases as normal is a fatal error, and to assert that the one out of a million which survives represents a case of 'selection' is at best a fond belief.

In these instances it is strikingly marked that an abnormal metabolism distorts every organismal function, rendering even the food-supply for the embryo problematical. An organism which develops inordinate feeding habits, and subsequently produces no values, is handicapped in the matter of providing at least for its own offspring. It is in true prodigal fashion living on family capital, but presently its career of dissipation meets with an effective check in the shape of inability to meet its own excessive reproductive demands. This, as is well known, often involves the sacrifice of the mother owing to the absence of adequate margins of nutrition.

Thus the larvæ of the dipterous midge *Mlastor* literally feed upon the mother to the death—a process that may go on for several generations. The same cause produces pædogenesis, an untimely acceleration of reproduction.¹ The trematode worm *Gyrodactylus* exhibits three generations of embryos, one within the other, while the oldest is yet unborn. The daughter is ready, at the moment of her birth, to give birth to another daughter. ‘Quod observatum fere est, celerius occidere festinatam maturitatem’—early maturity followed by early decay, according to a Roman writer.

There can be little doubt that these cases represent an abuse of nutritional and reproductive functions. The same methods apply—only in a minor degree—to the intermediate stages of metabolic and economic abnormalities. A carnivorous *Drosera* has been richly provided with insects, and the production of seeds was thus artificially raised to five times what it was in the unsurfeited condition—an example of prolificness through inordinate feeding.

A stimulating nutrition, as also sluggishness, are acknowledged to favour the retention of double sexuality, and, moreover, to aggravate it by abrogating the restraint of natural periodicity and inducing self-fertilisation, just as seasonal parthenogenesis may be artificially aggravated

¹ ‘Retardation of the period of reproduction’ was recognised by Darwin as a mode of ‘transition’ [evolution], while he hints at the possibility of a loss of the adult stage of development through [undue ?] acceleration.

by keeping up the particular excitants and the 'nutritive optimum.' Redundancy thus produced by bad organismal choice and excess cannot in justice be charged upon natural laws.

On the other hand, there are in almost every group of the animal kingdom certain members producing a small number of young and sedulously guarding these during the perilous time of youth. These are the normal and most important types amongst whom gregariousness and sociability are specially marked. They have developed and retained a habit of moderation in matters of nutrition and of reproduction, and likewise an instinctive apprehension of the contingencies of their external circumstances. A tendency to increase in a geometrical ratio may be said to be one of their potential attributes, as indeed it is of all types, but it is not exercised except under abnormal conditions.

They are said to belong to the aristocracy of each division of the animal kingdom, and their relatively high position is indeed one of qualification. As the scale of life is ascended, not only are the numbers in the family reduced, but the period of youth becomes longer and the young have opportunities of developing those habits which are the foundation of the real wealth of the organic family. Security of life, the great essential of industry, is enhanced.

The constant tendency in normal life is thus towards restraint, favouring maintenance of vital external correlations *pari passu* with the internal correlations, in the

interest of specific excellence and of the production of higher economic values. As Dr. Chalmers Mitchell has well pointed out, the duration of the period of youth could not well be regarded as necessary only for the development of the adult structure, but must have some deeper-seated advantage, which in his view was that parental care in guarding and feeding the young was increasingly called into play.

Indeed it must have had a more far-reaching advantage than mere immediate usefulness to the individual. The explanation is, I believe, that these aristocratic adaptations, if I may call them so, are particularly marked as partaking of a general biological utility. And it is for this reason that I find myself in agreement with the declaration of Professors Thomson and Geddes, in their latest joint production, that 'all these survivals of the truly fittest, through love and sacrifice, sociability and co-operation, simple to complex, need far other prominence than they can possibly receive even by some mildewing attenuation of the classic economic hypothesis of the progress of the species essentially through the internecine struggle among its individuals at the margin of subsistence.'

These, then, are the types that have fought a battle royal for life, reaping from their heroic striving for an ampler life increased length of days for young and adult alike, and a consequent real enhancement of life all round, as against mere multiplication of lower forms. Theirs is the effort for life to which I attach importance, the effort

to obtain a higher and more valuable life. All the difficulties and dangers to which organisms are subjected are trifling in comparison with the importance of their fulfilment of these tasks. Many of these difficulties are positively helpful in favouring the exercise of due restraint; but others arise solely from faulty action of the organism itself. There is, I maintain, a principle in Nature which, complied with, spells preservation or better, and, disobeyed, spells deterioration or worse; but it is not a natural selection, in the narrow sense of competition for food: it is the fundamental economic necessity of contributing to general utility. Henry Drummond has aptly pointed out that 'the Struggle for Life, in the first instance, is simply living itself; at the best, it is living under a healthy normal maximum of pressure; at the worst, under an abnormal maximum.'

Quality rather than mere reproduction is the criterion of success and of a successful struggle for existence. The tendency to exist is not necessarily identical with the tendency to reproduce.¹ On the contrary, the latter may be the condition of death rather than of existence. Pliny the Elder, in his 'Natural History,' already pointed out '*Voluptas vivere cœpit, vita ipsa desiit*,' and Goette goes so far as to say: 'It is not death that makes

¹ According to E. Thompson Seton, the blue foxes in Alaska are so strictly monogamous that it is extremely hard to get a widowed fox to mate, and a hunter reported to the Senate: 'Until we can break down the high moral standard of the foxes our profits will be greatly curtailed.'

reproduction necessary, but reproduction has death as its inevitable consequence.'

Not to dissipate endowment by reproductive indulgence, but on the contrary to increase it by adequate services and productions prior to reproduction, to assist in 'the long-enduring gestation of Nature,' as Chambers has it: these are the great tasks of organisms, for which indeed we find them making the greatest sacrifices. I affirm that exercise of restraint is the normal rule of life; that reproduction is in the first place subordinate to the production of bio-economic values, and that, further, what competition and elimination take place in Nature are by way of adjustment and of mutual accommodation in respect of such values. Excellence in the long run alone can confer values; mere bulk and mere numbers are of no consequence. There are opportunities for all organisms to rise higher in the scale, according to an indefinite improvableness, by complying with Nature's claim for reciprocal service. Beyond the 'struggle' for existence is the 'struggle' for a better existence. In the 'struggle' for the life of others Drummond sees an opening appointed in the physical order for the introduction of the moral order.

The adoption of the narrower Malthusian generalisation by Darwinism has, however, retarded the investigations of the wider factors of nutrition and their relation to reproduction, as it has likewise retarded the investigation into the nature and extent of the 'rudimentary

ethical process,' which even Huxley admitted when he stated that 'even in these rudimentary forms of society love and fear come into play and enforce a greater or less renunciation of self-will.'

The word 'prepared' in the Malthusian formula obviously does not allow sufficiently for the possibilities of food production through useful bio-economic activity, of which more anon, and the whole Malthusian proposition is based on the common fallacy that no discrimination as regards quality and quantity of food is required on the part of organisms.

I submit that Malthus' formula should be modified thus: 'Among the various tendencies manifested by frail animate life, there is apt to arise a dangerous tendency to sluggishness and surfeit, which, if allowed to spread, results in the under-production of nourishment and simultaneous over-production of inferior individuals. This tendency produces friction which may assume serious aspects of disease—physical, social and economic—and is maintained until a healthier economic balance is restored by the reversion of organisms to their true and reciprocal bio-economic functions.' The tendency to increase is by no means always uniform. The law of population accords with, and is subordinate to, the law of qualitative development. I shall endeavour further to justify these views by a number of bio-economic and physiological considerations.

An organism has been defined as a greater or less

number of definite parts or elements, generally of diverse nature, but which possess intimate relations among themselves. These parts must have a meaning for each other ; they must have something to spare for and to exchange with each other. In short, organisation, i.e. specialisation of function, implies co-operation, i.e. social activity, and I therefore maintain that the relation of parts must approximate to the condition of trade in the human community, where no member can more than temporarily suffer or rejoice by itself, and where an apparent advantage to one gained through the misfortune of another is only superficial.

The pre-requisites of trade are the division of labour and the production of surpluses for exchange. The true co-operative spirit in commerce presupposes that both parties are benefited. The co-operative principle, however, is so complex and silent in its operations that we are largely unconscious of its ubiquity in nature as well as in human society.

The ends in human society are the same as in Nature : i.e. to secure with ever-increasing efficiency the production and storage of energies that go to sustain and to help to advance life, to produce a maximum of organic and social utilities with a minimum of organic cost ; and in fact it will be found that a not inconsiderable part of the labour of organisms is employed in the storage of energies which enable them to produce bio-economic values for the benefit of the organic world. It may be noted here

that the process above emphasised implies the systematic raising of physical to the rank of physiological forces.

This work is tacitly implied when we state, for instance, that the morphological position of a species in the system is physiologically founded, and, philosophically speaking, one might say that organic evolution represents the work done by a particular organic impulse called life against the inertia of physical forces.

One might say that life carries on a trade with energies, using the organismal world as reservoirs of the ensuing wealth by pressing their productive and reproductive potentialities into its service, part of the gain being that organisms are continuously being made into ever better instruments of life, more and more to function purposively, i.e. according to the dictates of life rather than the dictates of physical causality. In any case, and however this may be, in the study of organic life we can never get away from the actuality of economic aspects.

Organisms are thus constitutionally made for work entailing the production of exchangeable values, and maintenance of organisation itself implies adequate restraint in many directions. This is all that the statement that 'organisms are full of purposiveness, even when they have no brains for holding a purpose,' can well imply. An organism is itself a monument to the co-operative principle.

Just as there is a primordial necessity for every organism to arise through the primitive unicellular condition,

so there is a primordial necessity to maintain regularisation of function and symmetry of form as essentials of organisation by adequate economic habits of life. In both cases the economic factors are the most important ; indeed it is part of the function of the fertilisation process to correct as far as possible irregularities produced by uneconomic habits, and to restore the individual to the balance of Nature by means of maturation (or reduction) processes.

It is one of the essential and typical characteristics of an organism (when still in the unicellular state) to unite and coalesce with another organism for a common purpose, and in the most marvellous way, so far as nicety of proportions is concerned. The common purpose is largely an economic purpose, and such a wonderful sense of proportion is shown in this vital process that I consider it one of my justifications for looking upon all distorted proportions of form as negative or pathological developments—the outcome of uneconomic function. The so-called struggle of parts—where it does take place either on the embryonic or on the adult scale—must be viewed, I maintain, as an attempt at restoration of the normal economic and physiological balance, consequent upon wasteful habits.

In so far as organisms are reproductive as well as productive, they are not only themselves, but more than themselves: they are systems linking the past with the future. As they owe much to the past, so they owe much to those that are to come ; their constitution condemns

them to be debtors, trustees and traders ; nor can they get away from the discharge of their obligations. Part of the discharge of their social duties is made by way of 'preparing' the food supply for the embryo, another by way of care and education of offspring. 'Without gratis benefit to offspring and earned benefits to adults, life could not have continued,' says Herbert Spencer.

As social beings we find organisms linked together much in the same way as the parts of an organism, when they yield some kind of advantage to one another, when they stand in the relation of economic and sympathetic persons to each other. First we have simple multiplication of units, which function together economically and sympathetically, i.e. gaining something by mutuality and co-operation, and then by diversification of function. The social factor is the most important—leading to mutual advantage, to mutual forbearance and defence, to security, to production, to exchange, and, hence, to all-round gain. Darwin remarked : 'The advantage of diversification of structure in the inhabitants of the same region is, in fact, the same as that of the physiological division of labour in the organs of the same body. So, in the general economy of any land, the more widely and perfectly the animals and plants are diversified for different habits of life, so will a greater number of individuals be capable of there supporting themselves.' Diversification of function in the interest of general utility and of quality rather than of quantity—that is the great principle which is also

borne out in the matter of cross-breeding and cross-feeding, to which I shall have to recur later.

Organisms have from an early date become inextricably involved in interdependence, which interdependence has almost attained the force of a *contrat social*, so much so that, wherever the household of Nature is concerned, the words, 'task,' 'duty,' 'legitimacy' are applicable to all organisms. Facts of interdependence have often been pointed out, though perhaps not with the emphasis which they deserve. I should say that the significance of existing organisation consists in having contracted in the course of evolution a definite economic function rendering the particular organism an efficient economic instrument in the organic world. The ups and downs in the natural history of the organism have depended largely on the degree of loyalty to contract, and though a progressive transformation may have taken place, a similar quasi-contract is always implied. They have depended likewise to some extent on the behaviour of other links in the economic chain. Thus it has rightly been pointed out that the evolution of the horse is wrapped up with the evolution of the plains. The basis of right and wrong lies further back than what are ordinarily understood as social relations ; it begins with mutual economic relations. The common interests which have compelled economic relations involve a positive or negative value, i.e. social usefulness or the reverse of each individual or species in the degree that they aid or hinder the well-being of all.

Constitution, social and psychic factors, economic interaction, all taken into consideration, we may, therefore, consider organisms among other things as economic persons, as traders by nature, whose mutual activities constantly enhance their biological status. It is normal for an organism to produce values, moreover exchangeable values, to render mutual services, and to earn its food rather than to find it 'prepared' for it, and Seneca's saying that '*ubicumque homo est, ibi beneficii locus est,*' applies to all normally functioning organisms.

In Political Economy two things must concur in the production of value, namely the thing to be wrought or used, and a person to work or use it, and it is obvious that without the 'earth' men would not produce wealth. This holds equally good of all ranks of organisms, especially if in our conception of wealth we are not too materialistic, if we are prepared to concede that true wealth consists in heritable and traditional assets, in power of control, in capacity, in emotional and intellectual endowment, rather than in the possession of commodities.

We have seen how an organism by all its circumstances is, in Stevenson's words, 'condemned to some nobility,' in particular to that of loyalty to obligations once contracted by the species. We have likewise seen that to produce or not to produce—rather than merely consume and reproduce—that is the question. If the sum total of a nation's activity is summed up by the word 'trade'

and on the balance of trade depends the position of a nation in the greater community of nations, and consequently its own well-being, we may with equal justice say that the balance between living things and their surroundings is kept by an economic law according to which those who do not produce become debtor communities, falling back in varying degree as regards position and environment. They are of relatively little consequence, except that they may easily become a danger to the strenuous community through the disease they set up.

Now, the leading principles of international commerce have been stated thus: 'In the exchange of commodities between different nations, as between different individuals, the tendency of the exchange is always to an equilibrium; that is, that a given amount of labour, regulated by a given amount of skill, of one nation, should exchange for an equal amount of equally skilled labour of another . . . It is a matter of complete indifference in what sort of commodities any community pays a particular balance against it. The advantage of the exchange consists in the fact that each gets an article it wants in place of an article it does not want, an article of which its supply is deficient, or which it has not at all, in place of an article of which its supply is superabundant. The whole exports and imports of a community must, in general, be periodically balanced. There are communities, as well as individuals, which have a tendency to live upon credit, and sometimes imports may be gained in this way

for which no substantial return is ever made; but, generally speaking, balances of national trade cannot be permanently run up, so that the whole exports of a community during a considerable period, such as a consecutive series of years, may be taken as the measure of its importing power, and *vice versa*.'

Here we have most important considerations which, I believe, are strictly applicable also to Biology. Moreover, the trend of international and indeed of all commerce is to reduce waste and to increase mutual aid and efficiency. Competition serves but as an instrument in the co-operative process. In this sense it has long appeared that the laws of trade are also the laws of Nature, for in Nature also we find that it is only the economically useful types who are able to adapt themselves to the demands of time and to keep pace with the increasing demands for physiological and economic efficiency. If the plant world is, physiologically, the complement of the animal world, the relation of the two kingdoms is also a typical example of an exchange of values produced in superabundance on the one hand for values the supply of which is deficient. What was said about the measure of 'importing power' is equally important and illustrative of what happens in the household of Nature. What services and position a species may command depends entirely upon its productions; gaining imports by short cuts and living upon credit, all such one-sided arrangements ultimately lead to

physiological bankruptcy and to biological reactions or affinities of a negative order. In the biological community in the long run, species are measured by what they can 'export,' i.e. by what they can afford by way of values and of service, by what they can produce over and above mere sustenance. The actual position* of a plant in the scale of evolution, for instance, is according to its productiveness of values. The primitive groups of higher plants, such as mosses and ferns and gymnosperms, do not contain by far as many different substances as the phanerogams. All the numerous glycosides, most alkaloids, and the bitter principles occur in the phanerogamic groups. The lowest plants of the classes algae and fungi in general contain only the widespread organic compounds, such as fats, carbohydrates, or proteids. The lichens, a highly developed symbiotic group of fungi, alone contain a greater number of specific organic compounds belonging to the class of benzene-derivatives. The lowest algae and fungi, as well as the bacteria, have essentially the chemical composition of protoplasm. The plant thus produces values for others over and above its need for sustenance and self-preservation. Whether or not we assent to the idea of a universal desire of well-doing, the facts are that the enumeration of such values produced by the plant would fill volumes.¹ From time

¹ The wealth of the world at the present day consists of grains and vegetable products rather than of gold and silver. Be it also remembered that the introduction of the potato added millions to the population of Europe.

immemorial plant and animal have known how to produce exchangeable values, and have freely exchanged them to their mutual benefit. Most striking examples of animal service are those rendered in 'cross-fertilisation' and in the distribution of seeds. Thus when Grant Allen tells us that 'the insect has thus turned the whole surface of the earth into a boundless flower-garden, which supplies him from year to year with pollen or honey, and itself in turn gains perpetuation by the baits that it offers for his allurement,' he states in other words that both insect and flower have contrived to produce exchangeable values and to export and to exchange them, thereby not only increasing their own wealth but in addition being of surpassing service to the rest of life, rendering possible the advent of higher stages with whose well-being they are thus inextricably bound up. Nay, more, the study of the contrivances to achieve cross-fertilisation and of the 'meaning of fruits' entitles us to say that the plant places not only its general energies but its very reproductive powers—not as mere baits, but systematically, and with enormous consequences generally—at the service of the animal in order that it may in exchange obtain the boon of cross-fertilisation. And this also enhances the significance of reproduction as an economic factor. Reproduction derives its significance from the previous productions and from the status of the parents, and it is therefore a qualitative rather than a quantitative factor. Economic individuals—so long as

they function legitimately—are indeed important factors and assets in wealth production. But reproduction *per se*—apart from quality—has no terrors, because it cannot have an abiding place in the never-idle workshop of nature. Organisms normally reproduce precisely in so far as they have to maintain values produced by long-continued cumulative efforts of their species, which it is beyond the power of the individual adequately to maintain for any length of time; because they are carriers of values over and above the value of the individual, because they have to preserve the organic community from loss of values, and because their specific value is to be of avail in the interests of the common good. Higher production is the purport of the fertilisation process, and fertilisation itself is frequently as dearly purchased as is cross-fertilisation by the plant. Thus Maupas found that with infusoria the costliness of conjugation was immensely higher than that of fission, and that while one pair were indulging in a single conjugation, another had become, by asexual division, the ancestor of from forty to fifty thousand individuals, which I interpret as meaning that it is quality rather than quantity that is of consequence, and that this quality has to be referred to an inter-biological standard. Why else should fertilisation occur at all? A mere local consideration does not seem to indicate that the organism is better off with conjugation than with fission; on the contrary. But a wider consideration shows that the latter may

easily be the mode of stagnancy and indulgence, which not only provide no margin for 'export' but are causes of positive danger to the organic community. A due consideration of various facts associated with the fertilisation process is apt to emphasise the qualitative element in reproduction. As a German writer expresses it: 'It is not that germ-cells unite in order that a new individual may arise, but it is rather that the new individual takes its origin from the single cell resulting from conjugation in order that a mingling of qualities may take place.' The essence of fertilisation thus seems to be the raising of the level of being through amphimixis, which seems also to be borne out by such facts as prepotency of pollen among plants and of self-sterility, especially in those cases where the pollen from the same flowers acts on the stigma like a poison.

In Hatschek's opinion the function of fertilisation is that 'of checking variation and holding the species true to the specific type,' which in my view is tantamount to saying that it holds the species true to its bio-economic position.

To return to cross-fertilisation, I would say that it is responsible for a great part of the wealth of the flowering plant. Self-fertilisation, on the other hand, is inferior in organic wealth production, much in the same way as the exclusion of a nation from foreign trade injures it in its economic welfare and renders it poorer in aggregate wealth. I concur with Darwin's famous aphorism that

‘*Nature abhors perpetual self-fertilisation,*’ but, I add, the reason is its combined bio-economic and physiological sterility.

I therefore consider the superabundant (and apparently wasteful) production of pollen by some plants in order to achieve cross-fertilisation as work done by way of keeping up ‘exports.’ In the case of *Linaria vulgaris*, in Darwin’s classical experiments the crossed plants proved more vigorous than the self-fertilised, and Darwin tells us that ‘bees incessantly visit the flowers of this *Linaria* and carry pollen from one to another.’ Here we have a classical instance of a wholesome trade, attended by regular systematic activities, by a large measure of stability and security, and by wholesome results generally.

This biological trade, it seems, established itself very much in the same way as human trade. First, the allure-ment of the article which the animal itself could not produce, but was in need of. This led to mere appropriation. But a one-sided arrangement would not give lasting satisfaction. There had to be regularisation of affinities ; there had to be give and take. The arrangement would have been devoid of permanent elements and opposed to organic self-preservation had it been for any length of time merely detrimental to the plant which surrendered values and gained nothing in return. Thus, in course of long ages, mutually satisfactory contrivances were evolved, and the intrusion of unwelcome

insects was prevented. It is said that the one aim of all these respective modifications of structure is to economise the pollen and ensure its use for fertilisation, which indicates that, in this instance at any rate, there is not an inherent lavishness of reproduction, and that the aim is not merely numbers, but rather the provision of a purchase consideration for further desirable developments. With the advent of honey-bearing many plants, however, have contrived an economy of pollen-production. Thus, for instance, we may say that fruits, seeds, nectar, leaves, oils and other valuable vegetable substances indispensable in animal development are the currency in which the plant pays, and from its own status can well afford to pay, for counter services on the part of the animal. The plant is not the poorer but the richer and the healthier for what is legitimately taken from it. That perpetual depredation in these relations, however, is abhorred by nature, is clearly marked in a vast number of protective contrivances, representing cases of bio-economic reaction.

Thus, according to Kerner: 'The foliage of the Deadly Nightshade is a poison to the larger grazing animals, and by them is left undisturbed; but the leaves of this plant are not only non-poisonous to a small beetle (*Haltica Atropae*) but form this animal's most important food. The larvæ of this beetle often eat numerous holes in the leaves, which, however, by no means prevent the development of the Deadly Nightshade. Accordingly the leaves are

protected by the alkaloid contained in them only against wholesale extermination ; limited portions of them can be surrendered and sacrificed with impunity.'

This principle of mutual service is in my view an essential factor in the economy of nature, and it is in any case very widely spread. The plant, in accordance with its more limited status, we may also say, pays in kind, while the more highly specialised animal pays in services. They all receive by virtue of what they have earned, and thus the words of Euripides are profoundly true that 'Silver and gold are not the only coin ; virtue too passes current all over the world.' All circulating media, according to Political Economy, are the result of a long evolutionary process, and the most important requisite of currency is stability of value. It must have a redemptive basis, in that its value must consist in stored-up labour.

On all these points, the facts connected with the great division of plant and animal labour amply justify the proposition that we are dealing with a genuine economic relation. We must remember that when Darwin believed it to be one of the greatest oversights in his work not to have sufficiently considered the existence of structures apparently neither beneficial nor injurious, and expressed the view that one day we may, however, know more about the significance of structure, a new world of light seemed to be opening when he was able to show, in one particular at least, an enormous extension of the region of usefulness.

When he was able to show that plants gained both in vigour and in ultimate fertility by being crossed, and that this crossing was effected under mutual relations by insects; that just as flowers have been adapted to secure cross-fertilisation, fruits have been developed to assist in the dispersal of seeds; that their forms, sizes, juices, and colours can be shown to be specially adapted to secure such dispersal by the agency of birds and mammals, which stand in need of these products, almost every detail was found to have a purpose and use.

I submit that it is a further extension of the principle of usefulness along bio-economic lines which is needed to complete the work of Darwin.

In the case of insect fertilisation we have systematic activities, services and exchange of services with stable values, and the consequent gain testifies to the healthfulness of this round of activities.

‘It is now believed by some botanists,’ says Dr. Wallace, ‘that many inconspicuous and imperfect flowers, including those that are wind-fertilised, such as plantains, nettles, sedges and grasses, do not represent primitive or undeveloped forms, but are degradations from more perfect flowers which were once adapted to insect fertilisation. In almost every order we find some plants which have become thus reduced or degraded for wind- or self-fertilisation.’ The fact that we find the principle of bio-economic utility frequently deviated from must

not deceive us as to its fundamental importance in progressive evolution.

How different, too, where the bees obtain nectar in a felonious manner, without give and take, by biting holes through the corolla ! Fewer plants will now be reared ; the bees in turn will suffer and decrease in number, to the detriment of the common organic interests. There is not enough currency to go round, and in consequence the community finds itself crippled in many of its activities. Analogous to the results of rapacity and depredation in human societies, insecurity now prevails, production goes on under disadvantages and exchange is handicapped. How unjustified appears the Malthusian generalisation in the light of these facts ! How shallow the selective philosophy declaring that, the doctrine of Malthus being correct, *a fortiori* it must apply to Nature where there can be no artificial increase of food and no prudential restraint from marriage. Messrs. Thomson and Geddes repeat this fallacy, although, strangely, it is they who proffer at the same time the admirable advice to the true Darwinian no longer to swear by the word of the master, but to go forth anew into the field with a social philosophy advanced beyond that of Darwin's teacher Malthus.

In Dr. Wallace's appreciation of the biological environment 'it is usually the amount of destruction which an animal or plant is exposed to, not its rapid multiplication, that determines its numbers in any country.' 'The

abundance of a species bears little or no relation to its seed-producing power.' The latter statement is true, but according to my interpretation it is bio-economic usefulness which primarily determines abundance of a species, and absence of such usefulness which determines its destruction. That plants do qualify for abundance through economic usefulness is pointed out by no one more beautifully than by Dr. Wallace himself, who thus unwittingly contradicts his own destruction theory. He mentions the case of *Lantana mixta*, and says: 'The fruit of this plant is so acceptable to frugivorous birds of all kinds that, through their instrumentality, it is spreading rapidly, to the complete exclusion of the indigenous vegetation where it becomes established.' This I claim as a good illustration of the value of biological co-operation. It instances at the same time how the pressure of conditions against the reproductive power of a species is nowhere fixed and final, but depends on behaviour, and that animals, just like men, are capable of giving ample and legitimate scope to the reproductive power of plants, which supply them thus with legitimate food.¹

Can we, in the light of these considerations, be surprised that the flowering plant eventually became prominent and overspread almost the whole world, whereas other types of inferior bio-economic value

¹ Even the wide distribution of fresh-water plants, according to Darwin, depends in main part on the wide dispersal of their seeds by animals, more especially by fresh-water birds. 'Even fresh-water fish eat some kinds of seeds, though they reject many other kinds after having swallowed them.'

dwindled in numbers and became extinct? At present, it is said, we can only speculate as to the causes which have contributed to the changes in the fortunes of a family, and Darwin refers to the many complex contingencies on which the existence of each species depends. The proposition that these contingencies are mainly economic cannot be lightly disregarded. As soon as the co-operative radius diminishes, so does the whole circumference of life. It has been pointed out that 'if bears instead of men had been shipped from Europe to North America, there would now be no more bears than in the time of Columbus, and possibly fewer, for bear food would not have been increased nor the conditions of bear life extended by the bear immigration, but probably the reverse. But within the limits of the United States alone there are forty-five [now, of course, more] millions of men where then there were only a few hundred thousand, and yet there is now within that territory much more food *per capita* for the forty-five millions than there was then for the few hundred thousand. It is not the increase of food that has caused this increase of men, but the increase of men that has brought the increase of food.'¹ Thus again we see that whether increase of population tends to cause want or not depends on behaviour.

¹ Darwin hinted that a carnivorous quadruped may succeed in increasing by 'becoming less carnivorous.' That he did not, however, sufficiently appreciate the importance of nutritional factors is evident from his remark that 'we are ignorant with respect to the conditions which determine the numbers and range of each species.'

Such, then, are the large facts, and minor cases of specialisation, however contradictory they may at first glance appear, must be read in their light. There are other large facts of Nature which have startling parallels in Political Economy. Economists, referring to the 'productive faculties' and 'means' of a nation, mean the capacity and resources for producing things that have an exchangeable value. They generally agree in the definition of 'value' as being 'determined by the amount of marketable things for which an article can be exchanged.' One of their doctrines, from which consequences of some weight are deduced, asserts that 'labour is the only source of wealth.' The notion of some ancient nations, that plunder was the great source of national wealth, is now considered as exploded. The parallel universal facts of Nature as stated by Sir E. Ray Lankester are that :

(a) Any new set of conditions occurring to an animal, which render its food and safety very easily attained, seem to lead as a rule to degeneration ;

(b) That the same fate awaits the flowering plant which, abandoning the great task of the green plants by feeding on the material manufactured by other plants, becomes devoid of chlorophyll.

Biology is at present debarred from applying the method of Political Economy to these phenomena because of its belief in the efficiency of Natural Selection. It is therefore constrained to speak of degeneration as 'simplification,' which has become 'useful' and agreeable to the

organism. With this I cannot agree, for degeneration attended by a loss of the capacity and resources for producing things that have an exchangeable value, however agreeable the allurements of sluggishness may appear to an organism, is a step in the direction of physiological and biological bankruptcy, and not of genuine simplification. Cope's definition at least demands that the sum of the subtractions must be greater than the sum of the additions. You can simplify a life by stripping it of a number of wasteful or non-essential activities, but never by lowering its economic value and its whole status. You can reduce a crystal to the amorphous state, but this is not simplifying the crystal. It has been said that the best philosopher is he who can think most simply ; but surely this is the man least depending on others for his thinking, whilst the condition of the simplified degenerate in nature is that of one-sided dependence on the work of others.

Short cuts to obtain 'imports' are not calculated to produce abiding gains. This is borne out by human and by natural history alike. A nation that ceases to manufacture cannot escape impoverishment. The richest countries are not those where Nature is most prolific, but those where labour is most efficient.

I will admit 'usefulness' as a criterion as soon as it may be referred to a sufficiently wide and reliable standard. Without an implied standard of this kind the word 'useful' becomes useless, indeed worse than useless,

I am ready to admit 'usefulness' and 'simplification' in the case of the reduction of one kind of sexual apparatus, for instance, leading as it does to unisexuality and resulting as it does in a better division of labour, in wholesome diversification, production of higher values and of greater excellence generally. Here we have instances of progressive reduction and progressive atrophy which a proper diagnosis must distinguish from rank retrogression, and to which, I maintain, the term degeneration should not be applied.

Moreover, I firmly believe the supposed usefulness of degeneration to the organism is fictitious; for existence and independence are rendered more and more precarious, and the seeming advantage in one direction is purchased by too high a price in general capacity. However useful a so-called high specialisation attending degeneration may seem to be to the animal possessing it, it is recognised to be very often one cause of its decline and death.

From the above statements of Sir E. Ray Lankester, we may glean that food *per se* is not enough to produce abiding gains; a superadded productive condition of the organism is an essential for such a consummation. Moreover we see that organisms, as they cannot with impunity to themselves and without detriment to the balance of life afford to shirk certain economic duties, cannot with impunity habitually and indolently appropriate the food material manufactured by close relatives.

I have expressed this latter conclusion in analogous

terms to Darwin's aphorism regarding in-breeding thus :

‘ Nature abhors perpetual in-feeding,’

and I consider this conclusion to express a most profound evolutionary law, whilst at the same time providing the key to the study of the biological origin of disease. I hold that in-feeding habits render an organism progressively liable to the influence of bad elements in the environment.

A self-supporting organism requires a fairly all-round sense of proportions, a certain autonomy, in order to retain its status in the world of life. This autonomy is its true strength, affording far better protection than any conceivable weapons could do. If the important substances which the plant, as the result of a co-operative evolutionary process, is capable of offering in a wonderful degree of efficiency and efficacy, cease to appeal to an animal, the latter is gradually divorcing itself from its true complement; its senses, organs and structure will gradually change, and it will thus be led in different directions, fatal to its own self-supporting capacities and fatal to the preservation of the economic balance of life.

I have endeavoured to show that the wider significance of organic interdependence consists in the fact that every self-supporting organism, by accumulating and exchanging adequate surpluses, is enabled to command valuable supports for sustenance and enhancement of life from the biological community. The organism that relinquishes

its bio-economic tasks, however, loses its supports. Lack of self-supporting activity alone, as we may deduce from Sir E. Ray Lankester's statements, results in visible loss of vital parts. The statements indeed may be read to hint at the lack of the bio-economic factor, the absence of redemptive work, rather than absence of physiological factors, although, of course, it is the simultaneous loss of both that causes degeneration. If particular parts of an organism cease to do work, the physiological result is that they cease to be fed. Thus Goebel, the German botanist, states: 'The external form of the plant is conditioned by the vital activity of the plant and by the food supply to each part of it,' and he holds besides that the quality of the food supply explains the nature of the parts formed.

Physiology shows that a particular habit of feeding produces particular enzymes, a particular composition of body fluids, particular glands, particular vascular, bone and nerve developments, a particular soil for metabolic response and for organic memory and particular correlations. Abnormal development of any tissue or organ must alter the state of the body fluids just as the abnormal nutrition of any one organ must affect the others. In the cell already a large number of enzymes occur and function according to division of labour; their manifold actions being exactly regulated so as not to disturb but to benefit each other. That the inheritance of chemical properties which are of great importance for the production of form actually takes place is now as well known as that of

morphological properties. Heredity is to a large extent a physiological problem. It only remains to determine how far the chemical mechanism is in the long run affected by feeding habits and to what extent the latter are cumulatively effective. What I have said already on this matter points to a fundamental and combined physiological and biological necessity of discrimination as regards feeding.

I have indicated some of the organic currency in which mutual services are normally commuted, and it follows that to prevent any part of this currency from becoming debased is a matter of vital moment to plant and animal alike. Debasement of currency must set in wherever an important link in the metabolic chain of nature (such as the elaboration of food material) is suppressed, because such a mode, were it allowed to spread, would spell organic impoverishment; and likewise on physiological grounds, because an organism that has recourse to in-feeding habits replaces the particular, stable, regulated, corrective and matured material by the indiscriminate, unstable, unregulated and immature material, which acts as a slow poison. A promiscuous and waste-producing physiological activity must favour an abnormal morphology, monstrosity, or unstable developments generally.

With every intensification of in-feeding propensities valuable correlations are surrendered, and inferior relations are set up. New practices will set in,¹ new affinities will be set up, much in the same way as

¹ 'Habits easily become associated with other habits,' says Darwin.

is the case with degradation in human society. I submit that the gradual modification of the true whale till it all but lost its mammalian character, and thatⁿ of flightless and rather bulky birds, proceeded on such lines. Sir E. Ray Lankester states that it is very difficult to say why the Great Auk died out, for it had not been hunted down. He does not so much as hint at a bio-economic and combined pathological cause. The Dodo was too fat for its little wings to lift it from the ground. Obesity is, however, now recognised as a disease. If the descent of the inclined plane of in-feeding is persisted in, bad habits degenerate into rank criminality. The usual gradation is : depredation, insectivorism, pure carnivorism or parasitism, as the case may be. In all cases the in-feeders have cross-feeding relatives or are descended from such. Thus the Australian Kea, according to G. R. Marriner, 'like other parrots, is normally a vegetarian. But somehow it has also become strongly insectivorous.' When circumstances further changed in its disfavour, 'with man came sheep, and with sheep the great temptation, and soon also the fall that has for ever blackened the character of these interesting mountain parrots'; from being a harmless parrot (and, I would add, from being a seed disperser) it has become a bird of prey of no mean order. The whole character has changed for the worse. It has had to acquire a new art : the art of sheep-killing. Marriner points out : 'The change seems more or less natural, for there seems to be very

little difference between eating a large plump grub and a piece of fat.' We have here an instance of how insectivorism may merge into pure carnivorism.

Proper 'cross-feeding,' on the other hand, I contend, is the great principle of progress. It constitutes a vital check on excessive katabolism, and it is an essential to fitness, and explains the origin of fitness, which the mere phrase 'survival of the fittest' never does. It is calculated to ensure due exercise of powers, due physiological labour, due physiological and economic independence, due care of offspring, due fertilisation and due possibilities of response. It is the *sine quâ non* of 'aristocratic' adaptations, because it is a kind of amphimixis, ensuring proper discrimination in and maturation of the very important material that is everywhere to sustain the highest types without loss of vital correlations.

Reproduction, we have seen, implies the timely projection from those ready for such distintegration of vital physiological elements—now somewhat enriched and now somewhat debased, as the case may be, capable of forming a rejuvenated equilibrium. But its significance also consists in the fact that a more or less adequately corrected, matured and 'evolved' nutritive material is during the process restored to the species, and, hence, to the biological community at large.

An example from the embryonic stage of life, typifying the desirability of adequately matured and evolved food material, we have, I submit, in the case of the endosperm

of Indian corn, which has been shown to arise by a process very similar to that which gives rise to the embryo itself. The hereditary qualities, moreover, of endosperm and associated embryo are said to be exactly the same; hence such food material partakes of the vital characteristics of germ-cells. We must remember, as Drummond puts it, that nearly all the foods of the world are love-foods—the date, the raisin, the banana and the bread-fruit, the locust and the honey, the eggs, the grains, the seeds, the cereals and the legumes.’ ‘The first and universal food of the world is milk, a product of reproduction.’

Quantitatively speaking, the value of the fertilisation process is such that after mytosis the germ-cell contains of nuclear substance *only that*, but *all that*, which is necessary to produce a new typical aggregation of hereditary substances. Surfeit and waste material are got rid of. Qualitative, quantitative, and bio-economic considerations combined, therefore, go to show that a co-operative mode of nutrition, such as I submit cross-feeding to be, has superior advantages.

As regards animal nutrition we must remember that plant food offers proteins and carbo-hydrates far superior, as regards purity, stability and reliability, to those derived from flesh food. In currency aspects cross-feeding, therefore, is far superior to in-feeding. Hatschek asserts that ‘all nutrition is reproduction,’ but I go further by pointing out the underlying amphimixis. Nutrition

entails a kind of fertilisation, determined as to its results—analogue to the case of sex—by the preceding processes of maturation and by the bio-economic and physiological adequacy of the uniting material. The anabolic plant elaborates and matures the food material, which is thus comparable to the unfertilised ovum; the relatively katabolic animal elaborates—and keeps in fair constancy of composition and of maturation—the blood, which presently is to unite to itself the matured food elements much in a manner analogous to that in which the sperm unites with the ovum in fertilisation. Blood and ‘love’-foods may be viewed as the outcome of a joint and co-operative physiological evolution of animal and plant, during which process they have become endowed with their singular value and significance. The process of digestion, as we know, consists of reduction processes, and the food first of all has to be reduced to the soluble state before union can take place. The union of properly isomerised, matured and ‘evolved,’ anabolic and katabolic elements is conducive to permanent syntheses and stable equilibria. ‘Love’-foods are superior to other foods analogously as germ-cells are superior to somatic cells, viz. in containing the elements of continuity and of growth. Bio-chemical research is now isolating some of the vital substances contained in grains or their coats, which substances are generally missing in artificial food and destroyed by cooking. These results show that it is the adequacy—rather than the quantity or crude

combination—of component forces which is required in amphimixis (nutritional and sexual), and, moreover, that our reliance for the obtaining of a 'super-adequacy of force' from nutrition must be placed upon the 'long-enduring gestation of nature,' which alone can provide complemental material endowed with the subtle compounds and in the most favourable molecular structure that are essential to digestion. If, in course of time, these mutually complemental anabolic and katabolic elements become increasingly adapted for each other, the energies required for these maturation processes are capable of being economised, with the result that surpluses are created which are available for physiological or mental and social improvement. Permanence and stability of physiological conditions are indispensable to the building up of a proper soil for higher development, and we can see that they primarily depend upon cross-feeding. The flesh and juices of other animals at best must be considered as second-hand food. They import into a system, it is true, some of the residual energies originally derived from a plant, but together with certain unreliable, and often dangerous katabolic elements which disturb the primordial beneficence of the previous cross-feeding arrangements and render the union unstable and predominatingly katabolic. The result is pathological over-stimulation and consequent disproportion of parts, a removal of the previous wholesome bio-economic embargo on increase of size or of numbers. The demands

for purity and stability of values on an organic currency are never satisfied if depredation is relied upon for a supply of organic coinage. The animals preyed upon, moreover, very generally represent the offal of life—in wild nature generally those sick and weak, and in civilisation those rendered somewhat morbid by domestication.

Hosts are always injured and modified by parasitic nurture. They never yield a reliable, pure, and stable coinage. The ingestion of host food produces a manifest biological reaction in the shape of an intestinal pathogenic flora. There is an economic law of currency according to which bad money gradually drives out good money. Physiological and biological economy we thus find to provide the exact analogue to this (Gresham's) law. In the place of a nobler coinage, an in-feeding species is content with baser coinage, and whilst the latter is not prejudicial to numbers and bulk, good coinage becomes increasingly rare. The predominance of the baser kind of physiological values frequently means additional stimulation of a disaggregating kind. The cell which has lost its strict regularisation of enzymes suffers disease in a way analogous to that in which the presence of impurities or heterogeneous contact is responsible for atomic dissociation of the mineral and for the illness of metals.¹ The previous arrangement of restraint on the

¹ In his work, *La Biologie Synthétique*, Prof. Stéphane Leduc states that 'the faculties of nutrition, absorption, elaboration or chemical

part of enzymes gives way to a promiscuous stimulation derived largely from waste products, toxins, excitants and stimulants introduced by indiscriminate feeding. Rickets, for instance, which is an undue softness of bone in young animals, induced by unsuitable food, has an exceedingly wide zoological distribution, and some believe that the scalariform shells of some molluscs may be regarded as arising from the same cause as rickets in vertebrates. The more precise and universal cause of this disease is believed to be the deficiency of lime salts with the food. My interpretation is that inappropriate food has gradually driven out appropriate food, analogous to the action of bad on good currency. A bio-chemical antagonism between the soluble alkalies and the alkaline earths, calcium and magnesium, is known to exist in animal physiology. 'If the bicarbonates, or indeed any salt of sodium or potassium such as the citrate, tartrate, or acetate of sodium or potassium, be administered to a human being in fair quantity for any brief but appreciable period, the following

metamorphosis, assimilation, elimination, growth, development, functional differentiation, organisation, inanition and disease are shown by osmotic growths exactly as by living organisms.'

These views, if correct, do not detract from my bio-economic theory. A synthetic theory of Bio-Economics, were it only for its implications regarding the significance of nutrition, indeed has to embrace the inorganic world, just as Physiology has to include the study of the chemical mechanism of life. Moreover, Prof. Leduc's views testify to the universality of laws of definite proportions which obtain, in my opinion, in organic as well as in inorganic morphogenesis.

extraordinary phenomenon is manifest. Large quantities of calcium and magnesium salts immediately make their appearance in the urine, thus showing that sodium or potassium when administered to an animal in excess at once exhibits so strong a contrast in the economy of that animal that immediately a large output of calcium and magnesium occurs.'

Physiological arrangements, thus give way under predominance of physical forces, i.e. they become pathological. Such is the process of evolution of what I call the 'misère' of in-feeding.

In-feeding, like in-breeding, thus ultimately produces forms which are no longer competent to vary sufficiently to keep pace with the demands of the time. The cross-feeding, slow-breeding, and social types—the aristocracy of life—have in the meantime been establishing a higher economic organisation, which proves victorious in practice. Rise of type and of character anywhere on the globe is calculated to spread sympathetic, constraining and, incidentally, eliminative effects in many directions, favourably affecting the whole level of existence, just as the elevating effect of character is manifested through the medium of foreign trade, which is apparent in a forcing up towards a common level of honesty and efficiency the practices of government and business life. If in the Koran it is laid down that 'a ruler who appoints any man to an office, when there is in his dominions another man better qualified for it, sins against God and

against the State,' this is not only a sentimental encouragement, or a vague belief in the ultimate triumph of excellence; but it betrays a shrewd insight into the law of nature and a knowledge of the penalties inherent upon the neglect of quality. We may likewise assume that the progressive organisms have perfected their resistance to disease *pari passu* with their general improvement of organisation and of adaptive faculty, so that it is the relatively backward types that offer a congenial soil for the growth of pathogenic organisms.

It is said that the so-called highly specialised types must become extinct because they fail to produce varieties—the chances of survival of a type being in direct ratio to the number of favourable varieties it produces. This is a kind of mathematical explanation which leaves out of account the profounder explanation of economic and, hence, physiological sterility. Palæontology indeed shows that the number and extent of the variations diminish as fast as the specialisation increases. 'When a branch disappears by extinction,' says Depéret, 'it is, so to speak, replaced by another branch having an evolution until then slower.' Indeed 'slow transformation' presents itself 'as the most normal process of palæontological evolution.'

These statements point to the superiority of the relatively slow cross-feeding and cross-breeding modes to the relatively accelerated and unrestrained in-feeding and in-breeding methods. The latter modes in their

palæontological significance are described by Depéret as the 'intermittent tendency shown by branches of producing, at certain moments of their regular evolution, numerous variations round about the parental type.' He continues: 'These periods of crisis, or, if you will, of aberration, in the morphology of certain types generally alternate with calm periods of a slighter variation, during which the branch pursues with deliberation and regularity the normal course of its development.' Of course my explanation of these aberrations is not that of Professor Depéret.

The limitation produced by in-feeding is sometimes unwittingly referred to as the law of irreversibility, by which is meant that a branch, once started on the lines of a given specialisation, can in no case travel backwards on the track traversed. How, in extreme cases, this must lead to an absolute *cul-de-sac* we shall presently see in the case of parasitism. In the meantime it is interesting to find Professor Depéret uttering the hope of many palæontologists of finding an unknown force of a more internal order which limits the variations of the groups. Such a force, I believe, will be found in nutrition.

The 'misère' of in-feeding, however, is particularly marked in parasitism. The very word is taken from human life; a parasite being an idler, living on the values manufactured by another without any return of service, originally a sponger who for a good dinner was ready to submit to almost any humiliation. Be it from sheer

idleness or through the temptation of circumstances, from whatever predispositions there be, such cases gradually produce a social disease.

Parasitism in nature equally, in my view, constitutes a disease. In order to include its very important incubatory phase, and to indicate that in the long run a course of pathological developments can be seen to originate in habit which is wasteful and therefore opposed to the common biological interest, I have introduced the term 'parasitic diathesis.' An occasional lapse into parasitic errors does not constitute an organism a rank parasite, any more than a man occasionally transgressing the laws of health necessarily becomes a chronic dyspeptic. The diathesis differs in intensity in different cases, and it need not be chronic, although it frequently perpetuates itself.

At the recent 'Kongress für innere Medizin' at Wiesbaden, the concept 'diathesis' was defined as: 'Eine in ihrem Wesen noch unbekannte Stoffwechselerkrankung' (a metabolic abnormality not yet thoroughly understood). 'Der Hauptgedanke war der, dass der Körper nur in seiner Gesamtheit erkranken kann,' i.e. that disease is a constitutional matter. It was stated that 'zweckmässige Ernährung, unter die eine Eindämmung der Fleischnahrung zu rechnen ist,' constituted the best means of prevention. Now, in accordance with my thesis, the consensus of medical opinion at that Congress was to the effect that a reduction of an existing parasitic

diathesis (although of a comparatively mild form) would prevent the increase of a certain type of disease.

I have already pointed out that the predominance of physical forces in an organic system is marked in a very definite way in gradual loss of symmetry and of wholesome diversification, in increase of size on the lines of accretion rather than of bio-economic utility and of eugenics. A species so afflicted represents a partly dissociated synthesis. The condition of such types sometimes is referred to as that of 'over-specialisation,' and it is said of them that they are accustomed to live in luxurious indolence. Such were the giant Pterodactyles of the Cretaceous period, the colossal Dinosaurs of the Upper Jurassic and Cretaceous and the large mammals following them.

It was duly pointed out by A. S. Woodward, at the British Association Meeting at Winnipeg, that 'it is not, of course, all the members of a race that increase in size; some remain small until the end, and they generally survive long after the others are extinct.' The condition of the monstrous type is that of sterility and of premature old age—a pathological deterioration, a kind of giant's disease. Elephants, whales, and ostriches are thus at the present day supposed to be approaching their final stage of existence.

My interpretation of the palæontological law that many large groups of animals began with types small in size is that in the majority of cases such growth, just as

teratological development, is on the lines of accretion outwardly marking the predominance of physical over bio-economic forces. Although an organism may have abandoned the task of production and have thereby rendered negative many important components, it may still be possessed of positive components vital enough to impress some kind of specific aspect upon the otherwise disaggregating species. Some characters may remain tolerably constant, being dependent on some remaining useful organ. Nevertheless the antithesis between physical and physiological forces is strongly marked in sexual dimorphism, in female preponderance, or in the tendency to monstrosity, which are comparable to the tendency to amorphism upon the break-up of crystallisation. Antithetic developments are thus highly significant in diagnosis. They indicate that there is a tendency among the parts to develop disharmoniously and eventually antagonistically. That the resultant of the synthesis is turning downward is thus outwardly marked by an approach to accretion and amorphism.

I am led to these conclusions by personal observations of change of form resulting from changes in nutrition, and it is easily seen that the same cause and effect always have pervaded and still do pervade all groups, from the lowest to the highest. The small titmouse (*Parus ater*) has a more vegetarian diet than the great titmouse, which not only feeds on larger insects, but is said sometimes to kill small and weak birds. The smaller falcons, like the

hobby, live largely on insects, but the closer in-feeding of those falcons which prey upon other birds is indicated in larger size. Again, the young of the flat-fish are quite symmetrical, indicating that at one time the intensity of in-feeding was less pronounced. I interpret this case to mean that with increasing metabolic abnormality in the past there was an increasing depth of the body—the usual concomitant of in-feeding—causing loss of vertical position and of symmetry.

To cite one example of an inverse development: it has been pointed out that the duck *Dendrocygna autumnalis*, when compelled by circumstances to feed upon seeds and grain, instead of animal life, becomes so relatively light and active that 'it can alight on a stalk of growing corn with the ease of a blackbird, and it is quite at home among the lofty trees where it makes its nest.'

As soon as restraint in matters of feeding is removed, so likewise is the embargo on any increase of size or numbers. This is also seen in domestication, which frequently is the cause of an induced diathesis. The consequent increase of size goes *pari passu* with the degradation through gradual loss of vital factors. Professor Punnett refers to the idea that the 'various domestic forms of animals and plants have arisen by the omission from time to time of this factor or of that. It is frequently a process of continuous loss. Everything was there in the beginning, in the wild or independent state, before degradation set in. Mutations owe their origin

to a disturbance in the processes of cell division through which the gametes originate. At some stage or other the normal equal distribution of the various factors is upset, and some gametes receive a factor less than others.' What leads to the surmised unequal division of the gametes? Of this, says Professor Punnett, 'we know practically nothing.'

It is significant, in my opinion, that the horse shows remarkable survivals of behaviour, amongst which I would assign first place to the stability of feeding habits. It is even said that the young foals do not gorge themselves with milk as calves do. In the survival of legitimate economic behaviour alone do I see the explanation of Cope's second and complementary law, which is that of non-specialisation. It states that 'organic types which are not specialised alone are capable of an ulterior evolution.'

As regards parasitism, the view that it is a physiological habit which theoretically may be assumed by any organism, and which actually has been assumed by members of every living group, seems to me very seriously to underrate its significance in the biological world.

By that theory we are required to look mainly at the more or less accidental factor of attachment rather than the abuse of nutrition, which I consider to be its fundamental nature and fraught with great significance. This view is perhaps most concisely and ably stated in the article 'Parasitism' in the 'Encyclopædia Britannica'

last edition. There we are told that 'when parasitism is to be employed as a scientific term, it must connote something more than mere dependence on another living organism for nutrition.' This is quite true, though in a different sense from that here implied, viz. it is true in the sense only that it must connote illegitimate dependence. Dependence in itself need not lead to physical attachment any more than to degeneration; on the contrary, mutual dependence, as I have shown, is the condition of progress; and even attachment, so long as it entails mutual aid, need not necessarily produce degeneration. The writer indeed makes the concession that 'green plants build up their food from the inorganic elements of the air and the soil, and are *farthest removed from the suspicion of dependence*; but most, if not all, thrive only *by the aid* of living microbes either actually attached to their roots or swimming in the nutrient soil.' Could it thus be seen that a 'host' actually thrives by the aid of a 'guest' and that direct and economic benefits result from the union, surely the term parasitism would not apply, surely such a case would be far removed from the suspicion even of parasitism, so much so indeed that, as in the case of the green plant, it represents the very opposite pole to parasitism, viz. co-operation. Even among the lowest plants, the lichens—in so far as they are a highly developed symbiotic group—they distinguish themselves favourably from the rest of their class by containing a greater number of specific organic compounds.

Now what are the necessary additional conceptions to make parasitism a scientific term according to this view? 'The bodies of host and parasite must be,' says the article, 'in temporary or permanent physical contact other than the mere preying of the latter on the former, and the presence of the parasite must not be beneficial, and is usually detrimental to the host.'

The wording of the latter part, that 'the presence of the parasite *must* not be beneficial and *is usually* detrimental to the host,' leaves a very mischievous loophole, by means of which the most far-reaching and typical cases of mutual aid, as that of the flower above and the case of the young mammal, have been branded as parasitism on the sole theory of attachment, however temporary. This is in the face of the fact that the mammalian arrangement produces organic and social betterment, and that harmony and co-operative principles reign in the reproductive life of mammalia, all of which is contrary to the rule in parasitic life.

That the detrimental effect of the guest on the host is, however, greatly incidental upon the preying is later conceded, so that of the mysterious 'attachment' effects little remains but the withdrawal of nutrient material, the toxic effect of the excretions and the destruction of tissues—the wastefulness, and consequent pathology of it all. Indeed the case of the free microbes in the soil capable of gathering nitrogen without the assistance of any host plant so long as the appropriate stimulations

are present shows that 'attachments' are the least important item, and food stimulation the more important.

Coming to the consideration of the 'Effects of Parasitism on Parasites' the article states: 'All living creatures have a certain degree of correspondence with the conditions of their environment, and parasitism is only a special case of such adaptation. The widest generalisation that can be made regarding it is that parasitism tends towards a rigid adaptation to a relatively limited stable environment, whilst free life tends towards a looser correspondence with a more varying environment.'

This, from my point of view, of course seems far too vague and inadequate a statement to make. That the environment has effects I do not deny, but I affirm that organisms are to a large extent responsible for their environment, and that it corresponds mainly with their economic activity. So long as this is healthy they retain choice, with possibilities of determining their environment rather than being extremely determined by it. When economic activities become unhealthy, choice vanishes, and thereupon dire necessities of 'special' and 'rigid' and 'limited' adaptations set in which entail degeneration. Parasitism is the condition of a too precarious hold on environment; it is indeed a 'special' adaptation in the sense in which I have already circumscribed this indefinite term, and it is a rigid and limited adaptation primarily in the sense that it lacks the elements of progress.

I fail to see, however, how there can be the condition of a stable environment for a parasite in view of the 'extensive modifications' that are its direct result; the 'host-environment' quickly changes for the worse and may be succumb altogether; the miserable 'guest' likewise quickly loses what capacities for production it once possessed, and is moreover increasingly the prey of other parasites infesting it in turn, and further modifying it in the negative direction.

In endeavouring to delineate the course of parasitic evolution, the article has recourse to metaphors: 'The *summum bonum* of a parasite is to reach and maintain existence in the limited conditions afforded by its host. The goal of the free-living organism is a varying or experimental fitness for varying surrounding conditions. And, if the metaphor be continued, the danger of parasitism for the parasite is that when it becomes too nicely adjusted to the special conditions of its host, and fails to attain these, it will inevitably perish.'

My comment is that the moment we admit the necessity for bio-economic function, failing which organisms gradually degenerate, all these metaphorical attempts at explanation are obviated.

The acme of special pleading, however, is reached in the following statements: 'The degeneration of parasites is merely a more precise adaptation to the favourable environment. The degenerate or specialised parasite is best equipped for successful existence, but the smallest change of environment is fatal.'

This logic is necessitated by the corollary of the doctrine of Natural Selection, in so far as this doctrine asserts that it is only the fittest that survive, and posits mere reproduction as the criterion of genuine survival. Those that were not the fittest have been exterminated, and those at any time and anywhere succeeding in mere reproduction are the fittest, hence there would be nothing pathological unless the 'operation' of natural selection was sometimes and somehow mysteriously inhibited.

The adherent of this doctrine thinks he is constrained to deny the pathology of parasitism, just as he denies the well-authenticated facts regarding the existence of disease in wild nature. The following terms, apart from other allegorical explanations, therefore have to do duty in the place of the simple word 'unhealthy': peculiar adaptation, special adaptation, rigid, limited, stable, precise, nicely adjusted adaptation, extensive modification, dependence, habit, simplification, specialisation.

What is successful existence? What is the standard? Can it really be in the light of the hypothesis of evolution that mere existence, mere reproduction are criteria of success? Is it possible that an adaptation which is fatal on the slightest change can in any way be termed successful? Is it possible that from the transformation undergone by a parasite a rise of type is likely—unless indeed, a recovery from parasitism took place first? Can it well be that the most sluggish of all, those who, in economic language, only import and never export, and

thus levy tribute only, and who fail even to maintain their inheritance, and injure others in their failure and fall, are the most successful ?

In a bio-sociological sense Thomson and Geddes have quite recently told us 'it is essentially the free-living and self-supporting creatures that really get on, that evolve in the best sense.' I maintain that in every important sense this is quite ascertainably the case.

What are the 'peculiarities' of what the article calls our most successful biological relations ?

'Organs of prehension are notably developed.' 'The normal organs of locomotion tend to disappear, whether these be wings or walking legs. Organs of sense, the chief purpose of which is to make animals react quickly to changes of environment, become degenerate in proportion as the changes which the parasite has to encounter are diminished.' 'The parasitic higher plant tends to lose its divisions into stem and leaves and roots, and to acquire a compact and amorphous body, the animal has no longer to seek its food, and the lithe segmentation of a body adapted to locomotion is substituted by a squat or insinuating form.'

This is clearly an undoing of the work of evolution, for the losses are vital and devoid of redemptive compensations in other directions. Morphogeny would bear me out were it not for the doctrine that 'Natural Selection acts perpetually and on an enormous scale in weeding out the "unfit" at every stage of existence, and preserving

only those which are in all respects the very best.' By 'Natural Selection' a writer generally means one of many things. The formula is usually supposed to denote Nature's disciplinary school, where that which the protean parent 'variation' has mysteriously produced is looked after by the harshest of schoolmasters, whose destructive constructiveness is such as to kill all save those individuals most self-assertive with regard to food and reproduction. These are the fittest schoolboys, and presently they assist their schoolmaster in furthering the common good by the destruction of all who appear to be in their way. So long as everything is not destroyed, it logically follows that something is preserved. It is 'favoured.' There we have preservation by a kind of logical sequence. Preservation and evolution, one might think, result from destruction which is only partial. But, surely, we cannot remain satisfied with an explanation which is based on a mysterious advent of variations, on a mysterious 'favour' of preservation, which disregards, or under-estimates, the co-operative factors, and which is so largely composed of metaphorical and dialectic elements. We cannot remain satisfied with any theory which does not allow for evolution by quality. Of course I do not deny their proper value to competitive efforts, but I hold with Schiller :

Grosses wirket ihr Streit,
Grösseres wirket ihr Bund.

The case of parasitism shows that Natural Selection, in so far as it is supposed to act solely by the preservation

of variations beneficial to the organism under the conditions to which it is exposed, is a principle by which anything and everything may be explained, including the most flagrant abuses of function ; that it is utterly devoid of any standard to which to refer the relations between organism and its environment. Preservation in Natural Selection leaves out the most important factor of all, viz. that which preserves the organism from itself. Darwinism has shown how organisms may protect themselves against the inordinate appetites of others, but not how they are in need of protecting themselves from their own inordinate desires. Darwinism is thus in danger of becoming a doctrine of expediency.

We are further told in the ' *Encyclopædia Britannica* ' : ' The reproduction of parasites offers many peculiarities, all of which are readily correlated with our generalisation. A creature rigidly adapted to a special environment fails when it does not reach that environment, and hence species most successful in reproduction are able to afford the greatest number of misses to secure some hits, and so to maintain existence. High reproductive capacity is still more urgent when the parasites tend to bring an end to their own environment by killing their hosts. Reproduction in parasites, so far from being degenerate, displays an exuberance of activity and an extraordinary efficiency. In parasitic flowering plants, the flowers tend to be highly conspicuous, the seeds to be numerous and specially adapted to ready diffusion.'

There is, in this passage, in my opinion, bad economics, based on a superficial philosophy. Surely we must read this supposed success of reproduction in conjunction with the loss of vital parts and of vital correlations. The apparent success in one direction is too dearly purchased by the losses in other more vital directions. What was purchased under tremendous sacrifices by their ancestors is now squandered by profligate organisms, and allows only one amongst a thousand offspring to pursue the shadow of what was once a true biological career. All the other offspring are wasted, and we have a minimum of result at a maximum of cost.

As regards parasitic flowering plants, apart from the morphological deterioration already referred to, it is a notorious fact that in the absence of green leaves they can only maintain herbaceous, soft, and short-lived stems, with at best isolated strands of wood and phloem tissue. They are marked by accelerated and unregulated growth, and hence (and this is most important) by loss of position in the system. The absence of woody stems, moreover, spells absence of resistance to varying conditions of climate and weather.

Moreover, the abnormal stimulation produced by illegitimate feeding habit is certainly a more potent factor of the redundancy of reproduction than any supposed aim on the part of the parasite to secure a chance or a hit for one of its myriad seeds. Maupas has shown that in the case of infusorians the reproductive power depends on

the quality and quantity of the food. The reproductive capacity itself was equally high, or higher, before the parasite had started on its career of prodigality, but it was then under normal and seasonable restraint, and not made use of in such prodigal fashion. It was once correlated with other functions and those of other parts now lost. It once had valuable biological correlations—now lost.

We must further remember the usual association of parasitism with all recognised modes of degenerate reproduction, such as parthenogenesis with reproductive nemesis and its enormous liability to infection. Self-fertilisation was found by Darwin, as we have found parasitism, not to be prejudicial to numbers; but, its offspring being rather susceptible to disease, this was one of his reasons for stigmatising it as 'abhorred by Nature.' Since his day our eyes have been more opened to the fact that infection is largely synonymous with disease, and we can no longer hesitate to stigmatise the parasitic condition as a pathological one—nay, as the very essence of the morbid biological relation which sets one member against another.

The article tells us further that 'the general tendency is in the direction of absolute limitation of one parasite, and indeed one stage of one parasite, to one kind of host. The series of events seems to be a gradual progression of temporary or occasional parasitism to obligatory parasitism, and to a further

restriction of the obligatory parasite to a particular kind of host.'

This confirms my remarks concerning the intensification of the parasitic diathesis. It shows that life under these circumstances becomes more limited in its range and of less consequence at every stage. This absolute limitation must be read in conjunction with increasing liability to infection. Thus the 'clothes-moth is known to be subject to the attack of over sixty species of Hymenoptera, and, it is said, to such an extent has parasitism been developed in this group that the parasites themselves are attacked by other parasites—giving rise to the phenomenon known as hyper-parasitism. Surely this does not represent successful existence! No progressive evolution is conceivable from these conditions. Parasites may breed exuberantly and in explosive fashion for a time, but the inevitable retribution sooner or later supervenes. Nothing is more pathetic, no failure is greater in Nature, than that which results in starvation in the midst of plenty, for that is the true condition of the myriads of 'misses' in view of the fatal fastidiousness of the obligatory parasite.

It is when he comes to the effects of parasitism on the host, when he cannot help noticing the metabolic and economic disturbances produced, that the writer of the article hints at a more enlightened view to come concerning the nature of parasitism. 'The intensity of the effect of parasitism on the hosts of the parasites ranges

from the smallest local injury to complete destruction. Most animals and plants harbour a number of parasites and seem to be unaffected by them. On the other hand, as special knowledge increases, the range of the direct and indirect effect of parasites is seen to be greater.' (Follow a few instances of wounds and abrasions, affording entrance to destructive spores.) 'As knowledge advances the indirect effects of parasitism are seen to be of more and more importance.' (Follows a list of further indirect injuries.) 'Through the wounds caused by biting insects, the microbes of various skin diseases and inflammation may gain entrance subsequently, or the insects may themselves be the carriers of the dangerous endoparasites, as in the case of mosquitoes and malaria, fleas and plague, tsetse flies and sleeping sickness.' 'The irritation caused through movements or the secretions of parasites may set up a reaction in the tissues of the host leading to abnormal growths.' 'The abstraction of food substances from the tissues of the guest may be insignificant even when the parasites are dangerous; but it is notable that in many cases the effect is not only that of causing an extra drain on the food-supply of the host, which might be met by increased appetite. The reaction is frequently selective; particular substances, such as glycogen, are absorbed in quantities or particular organs are especially attacked, with the consequent overthrow of the metabolic balance. Serious anæmia, out of all proportion to the mass of parasites present, is frequently produced, and the

hosts become weak and fail to thrive. The most usual and serious effect of their hosts of parasites is, however, the result of toxins liberated by them.'

We thus see again that the effects of parasitism are mainly pathological and incidental on the overthrow of the metabolic balance. Whatever part of the host is particularly attacked, the former correlations of parts must be disturbed, which produces further disturbances, as regards extra-organismal relations. The production and change of form are due to increase or diminution of the activities of groups of cells, under due regularisation of functions, which regularisations, as we have seen, derive their legitimacy from due economic activity. We have likewise seen that labour is activity systematically applied, and capital nothing but stored-up energy. In the same way we may say that the production of form is the result of work. Now it is obvious that parasitism essentially violates all these conditions of work, and what little of systematic activity remains is non-productive, and quite regardless of, indeed detrimental to, external or general utility. The place of profitable enzymes calculated to produce generally useful substances is taken by toxins calculated to poison other and higher organisms. The parasite's currency consists of toxins and is utterly devoid of a redemptive basis. Nutritional and sexual amphi-mixis are distorted or inhibited, the uniting material not being adequately matured. The nutritional soil provided by a parasite's body is not attuned, as it were,

to a sufficient range of vibrations to maintain former organs, the outcomes of former correlations. The possibilities of metabolic response to progressive vibrations are being lost. The important conclusion which emerges, and which I wish to insist upon, is that parasitism is a morbid condition which results in degeneration and ultimate destruction of the organism concerned, and that this is due to its violation of what I conceive to be the fundamental law of co-operation in the biological world.

CHAPTER II

SELECTION

‘It is to be regretted that at the present time so many naturalists accept the theory of Natural Selection as an exclusive explanation of the evolution of existing species. They unconsciously blind themselves to the existence of any other agent in the work of evolution.’
(CHARLES DIXON, *Nature*, vol. xxxiii., p. 128.)

THE Darwinian outline of evolution, as Fechner has already pointed out, relies upon the play of purposeless and aimless forces of nature, which displays the character of purposiveness only in so far as its non-expedient results get the worst of it and therefore must make room for the expedient results. To such a view Fechner objects. In any case he avers that this Darwinian principle of the struggle for existence is subordinate to the principle of the mutual dependence of organic beings.

He rightly demurs to the method which attempts to represent the reciprocal principle as a mere secondary success of Natural Selection. It is an after-thought of a very inadequate and inconvenient premiss to argue, as Darwinists do, that only those organisms will survive together which have modified themselves so as to exist

best together, and that the others will become extinct. But where do Darwinists allude to the fundamental conditions under which this mutual suitability occurs ?

The chief actors being accident or automatic and unconscious selection, according to the particular conditions of an accidental environment, whence arises the altruistic factor ?

The fundamental condition of reciprocal suitability of organisms, however, depends on the forces of co-operation arising from within, and irrespective of accidents, environment, and expedients.

To be co-operative is a matter of purposive, organismal selection (using the term in its proper connotation). Thus we have 'selection' re-transferred to its proper place, viz. within the organism. The moment organisms elect to be reciprocal, they are no longer at the mercy of chance, but render themselves increasingly independent from all those factors which Darwin included in his 'Natural Selection.'

Accident can have played little part in the origination of the method of reciprocity, as Fechner points out. Says he : ' In vain do I look in the theory of Natural Selection for a principle according to which the forces there indicated could produce such universal reciprocal differentiation as is presented by the two (separated) sexes (though both subjected to the same influences in the same locality).'

He continues : ' It is futile to urge the advantage of division of labour from the point of view of the Darwinian

theory, although of course these advantages exist. But if the division of labour in any business is to be a one-sided and accidental matter, having to wait until accident fulfils the rôle of the other party, the advantages would soon be turned into disadvantages and the bi-sexual process would fail rather than supplant the unisexual process. I cannot see how, on the hypothesis of Natural Selection as it stands, the division of labour in the process of reproduction could have been arrived at other than with such result.'

The question has indeed been asked: 'Why should fertilisation occur at all, if parthenogenesis in some cases works so well?' It cannot be answered satisfactorily by Darwinism, where everything is a matter of expediency, any more than the question raised by Darwin himself: 'What should it benefit the intestinal worm to be highly organised?' Similar objections have, of course, been raised before by writers who, as regards variations, complained of the lack of a definite and persistent principle in Darwinism.

As pointed out by Samuel Butler, Professor Fleeming Jenkin, and by Herbert Spencer, it is vital that variations, as Butler says, 'should be supposed to have a definite and persistent principle underlying them which shall tend to engender similar and simultaneous modifications, however small, in the vast majority of individuals composing any species. The existence of such a principle, and its permanence, is the only thing that can be supposed

capable of acting as a rudder and compass to the accumulation of variations, and of making it keep steadily on one course for every species, until eventually many havens far remote from one another are safely reached.'

I believe that I have shown that reciprocity in nature—whatever be its origin—in order to be permanent, requires the organismal selection of appropriate food, and further that this autonomous factor simultaneously involves vital bio-economic factors—all combining to provide the definiteness and purposiveness that are required.

The conditions for a purposive (harmonious) and reciprocal common life of organisms thus are not created by the struggle for existence, but at best only complemented.

The efficiency of the co-operative system, when impaired at any time by excesses, is being gradually restored by a self-acting process analogous to self-acting pathological processes in the animal organism. In the human body also the principle of reciprocal differentiation presides over the formation of the various organs, except that no actual separation of parts takes place, and hence there is not the same need for corrections through a 'struggle for existence' of the separated parts, such as is required in the development of the organic world.

But in so far as we may (in a more restricted sense) view disease as an attempt at correction or as a struggle

between contending parts, we may also view biological competition and elimination as a corrective process, only on a vaster scale and operating through time. This slow and widespread disease-process has little to do with the building up of endowments except as a warning wherever it is attended by pain.

We are told that, as the result of objections, in 1867 Darwin 'recognised that natural selection acts, not by preserving a few highly favoured individuals, but by killing off all those which do not come up to a certain standard.'

Clearly this is an indication of a biological corrective process analogous to the physiological corrective process that many of us suppose disease to be. As a biological corrective process Natural Selection might tolerably pass, so long as we make due allowance for the elements of time, of organismal autonomy and plasticity. As regards the time-element, I hold with Fechner that 'in the history of the world disharmonies may exist through a millennium, their dissolution taking place only in a second one. . . .'

'The dissolution of the evil consists in the fact that from the general order of things to which it is opposed reactions must arise, which grow as the evil grows and finally overgrow it; whereby not only may the evil be relieved, but positively turned into a source of a future good.'

Hence, though I admit the presence of self-acting

corrective processes, I cannot share the Dr. Pangloss philosophy to which Darwinists adhere, in view of the supposed omnipotence of Natural Selection. The proposition that the maintenance of health requires manifold elimination, moreover, is something quite different from that one which—in view of a great deal of elimination—declares that, everywhere and normally, too many individuals are born. Health, however, is the antidote of waste, and generally the concomitant of wholesome economic activity. Of healthy and wholesomely active individuals there can scarcely be too many in the world. It is when we come to the morbid types, the wastrels, that we find true redundancy.

Their retrogression and eventual elimination thus truly form part of the great pathological process of Nature which attends and complements her physiological work. So long as we continue to look upon every appetite as normal and quasi-sacrosanct—in so far as it remains consonant with any kind of reproduction—we shall deny the pathology of parasites, for instance, and mix up the fate of their offspring with that of productive organisms; we shall continue to consider the relation of production to consumption in the organic world as necessarily chaotic, and the question of population will necessarily remain, in Huxley's words, 'the real riddle of the Sphinx.'

Being able duly to complement Darwin's account of warfare, of competition, and of starvation in Nature by that of work and services, of mutual production, of

reciprocal differentiation and of 'natural gestation,' we have now reached a more correct appreciation of Nature's processes and we have likewise gained a better perspective concerning the place of individuals and of groups in the world of life.

We may now proceed to indicate some of the modifications required by Darwin's theory in the light and in terms of a more complete Natural Economy.

When Darwin says that 'every plant and animal must maintain the struggle for life' we may now interpret it to mean that every organism is under the obligation of rendering some kind of bio-economic service. When he proceeds: 'and in order to its continued existence must be successful in maintaining it,' we may say that this depends entirely on bio-economic usefulness, short of which there can be no success in the sense of progressive evolution. Darwin goes on:

'Not only against those other creatures which seem to make it their food, but still more in a competition with those which seek the same nutriment with itself.' Darwin speaks of two 'canine animals' struggling with each other in a time of dearth; of mistletoe *versus* mistletoe on the same branch; of mistletoe *versus* other fruit-bearing plants, all of which again raises the question of depredation and of abnormal habits—evils against which the strenuous organisms have generally managed to defend themselves—evils which belong to the class of disharmonies referred to above. Darwin here hints

at what is called the struggle between brothers and cousins. It is well to remember, however, that competition for food between close relatives may have all the range between, say, the extreme case of the young cuckoo and his foster-brothers and sisters—the hapless legitimate occupants of the nest which are cleared out by the young parasite—and on the other hand the avoidance of such fratricidal struggles by the principle of colonisation—‘If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left.’ Whether there is to be a struggle in the true sense of the word, or a mere matter of non-sanguinary mutual accommodation, depends on the nutritional habits. The cuckoo is a rank in-feeder—its food consists almost exclusively of insects. It has contracted an in-feeding habit which is abhorred by Nature, and which involves it in a parasitic diathesis. A suggestion regarding its unsatisfactory physiological condition has been thrown out by various biologists, including Geddes and Thomson. According to the old school, as represented by Robert Chambers, ‘The parasitical reproduction of the cuckoo sinks into that character which alone we can reconcile with the rest of the providential scheme,—a trivial exceptive evil in the midst of much that appears, and undoubtedly is, very good.’

However that may be, what I wish to point out is that sweeping generalisations concerning the ‘struggle for food’ cannot be founded upon extreme cases. ‘In this

struggle,' continues Darwin, 'the stronger, or those which possess anything peculiarly favourable in their organisation, must overcome the weaker.'

That it is not mere physical strength that leads to survival has long been recognised. That something 'peculiarly favourable' leads to survival sounds more feasible, but may mean anything. The young cuckoo—described by naturalists as 'an evil-looking little beast with a large mouth, a picture of ugliness'—has something 'peculiarly favourable' in its organisation, by means of which it accounts for some young of other species or for a weaker young cuckoo, as the case may be. The weaker are overcome. But if we examine the various correlations of the cuckoo's habit, they are such as to convince us that its precarious existence is purchased at the expense of survival capacity, that in reality a slow (pathological) process of race-suicide is going on. An organisation can be said to be truly fitted for survival only if its various correlations are of a permanently satisfactory kind.¹

The case of the cuckoo—which is merely a typical instance of the hereditary transmission of abnormal feeding habits—together with the corresponding physiological and biological correlations—is supposed to be one of the great puzzles of Darwinism. We are gravely

¹ Writing in *Wild Life* for May 1913, Alfred Taylor comes to the conclusion that the cuckoo is 'practically an outcast amongst birds,' and that even if it does get out of the great task of nest-building, incubation, and the rearing of its young, it has to pay dearly for the privilege.

assured that 'how the habit of nesting came to be lost, or the parasitic instinct of occupying the nests of other species and destroying their young to be acquired, is merely matter for conjecture.'

I have treated of this case in my 'Survival and Reproduction,' and the line I have taken in indicting the feeding habits as primarily responsible for the cuckoo's criminal 'adaptations' has met with the liveliest opposition. As regards the general importance of habit, it seems that at one time at least Lamarck and Darwin were in accord. It was habit (use and disuse of organs plus an inherited tendency to vary), according to the former, that shaped the organism, and the latter, in his 'Voyage of the Beagle,' speaks of habit as omnipotent and hereditary in its effects. But it is the value of feeding habits in affecting physiological and biological correlations that escaped the observation of both naturalists. It is *misuse* which produces at one and the same time inferior physiological correlations and a plurality of those eliminative biological reactions which Darwin thought to be due to a self-acting lethal process, administered by an aggregate of natural forces always bent on destroying those which did not come up to a certain standard dictated by mere momentary expediency. As regards transmission, it is now widely admitted that long-continued functional modifications may, by somatic induction, exert specific effects on the germ-cells. Is it then so very improbable that improper nutritive stimuli, if continued

long enough, are apt to vitiate the character of the germs *pari passu* with that of the adult organisms? 'The possessors of any advantage in the means of procuring food, or in the powers of offence or defence, may entirely displace their less favoured congeners,' continues Darwin.

Those who obtain their food by depredation eventually find themselves at a disadvantage as compared with those who earn it legitimately, just as polygamist animals are under a disadvantage compared with monogamists when it comes to a clash. The true advantage, as I have constantly maintained, is not the local one that Darwin emphasises, but the less conspicuous though more vital advantage which consists in the beneficial effects of favourable correlated circumstances generally. Those so circumstanced, moreover, do not rely on offence, but on defence; and if they yet 'displace' any of their congeners it is rather because the latter fail to qualify for the same position, or possibly for any position, in the polity of Nature. Not being organised for aggression, not needing the bodies of their relatives for food, but being, on the contrary, engaged in maintaining or raising the level of existence and the security of life, the mutually useful organisms generally content themselves with defending their security rather than waging a war of extermination upon others. In order to preserve the fit, it is not necessary to destroy the less fit.

'Can it be thought unlikely,' continues Darwin, 'seeing that variations useful to man have undoubtedly

occurred, that other variations, useful in some way to each being in the great and complex battle of life, should sometimes occur in the course of thousands of generation ? '

Darwin; in this passage, touches the principle of other-regarding' usefulness. Had he consistently studied this principle, it would have resulted in showing the mysterious good effects of the 'complex battle of life' to resolve themselves into effects of bio-economic mutuality instead of sanguinary struggles.

As I have pointed out, evolution centres round the production of bio-economic usefulness generally. Variations must be useful not so much in battles as in the labour of maintaining and improving organic life, although what is useful in the workaday world generally turns out to be most useful in battles also, where battles prove unavoidable. Variations are 'useful' to each being in so far as they are at the same time of use to others. Must we trust to chance—in the course of thousands of generations—for an occurrence of true usefulness in evolution ?

Usefulness was there from the first, and it was only due to its gradual superabundant production that evolution could progress at all.

Expressed in terms of Bio-Economics, Darwin's proposition regarding the advent of useful variations might be stated thus : Can it be thought unlikely that organisms equipped with a fair share of autonomy, and constantly called upon to solve a plurality of domestic and bio-economic problems, frequently proved equal to

their tasks and responded in a manner so as to become gradually modified in accordance with their increasing powers of service ?

We are further told by Darwin: 'Any variations in the slightest degree injurious would be rigidly destroyed.'

This figment of imagination forms a part of the gospel of Darwinism. In the sophistical way in which it is generally used, it does, in my opinion, incalculable harm.

I have said so again and again, and I concur with Samuel Butler's almost identical words, which I have only lately come across, that 'it is a discouraging symptom of the age that such a system should have been so long belauded.'

What Darwinists wish to establish is a faith—faith in a self-acting, natural process, which by implication acts so well that there is no need to give any detailed explanations of facts, so long as you believe. It is so simple to believe that all that is really injurious is at once destroyed, and equally simple on this belief to build the further inference (so cherished by Darwinists) that what survives (what is) is best. Hence Natural Selection, the supposed (though mysterious) agency, being answerable for the best, has undoubtedly been the most potent factor in evolution ! It must be so ! says Prof. J. S. Macdonald, of Sheffield.¹ 'It is perhaps for the very reason that

¹ 'Have we any right to assume,' asks Darwin, 'that the Creator works by intellectual powers like those of man ?' Let us hope He does not !

Darwinism is so simple,' complains Dr. Wallace, 'that it is so persistently misunderstood.'

Now, as I have said before, I am willing to believe in some kind of self-acting process such as many of us believe disease to be, only on a vaster scale and involving many long drawn-out pathological processes. Such a belief, however, is not the same as, nor is it indeed compatible with, the story of a rigid and immediate destruction of all noxious variations. (Dr. Wallace goes so far as to say of Natural Selection : ' It prevents any possible deterioration in the organic world. ') Far from it. Nor do the facts of nature bear out such a creed. What is wanted is a detailed examination of those vast pathological processes which so frequently accompany physiological processes and determine extinction, instead of having their existence denied by sophisticated argument.

' This preservation of favourable variations and the rejection of unfavourable variations I call Natural Selection,' declares Darwin.

The fact that neither physiological nor pathological processes underlying survival on the one hand and elimination on the other are adequately described by Darwinists, confirms me in the view that ' Natural Selection ' acts mainly by making sophists of otherwise able and learned, though not always too amiable men. Once, however, we are able rationally to combine the economic and physiological (or pathological) factors—just as it now turns out that pathology and criminality are

closely related—the services of Natural Selection will be no longer needed, I affirm, in the whole range of biology.

As regards ‘favourable modifications,’ Samuel Butler argues that: ‘Plain people would prefer to say that the main cause of any accumulation of favourable modifications consists rather in that which brings about the initial variations, and in the fact that these can be inherited at all, than in the fact that the unmodified individuals were not successful.—People do not become rich because the poor in great numbers go away, but because they have been lucky, or provident, or more commonly both. If they would keep their wealth when they have made it they must exclude luck thenceforth to the utmost of their power, and their children must follow their example or they will soon lose their money.’

Darwin further says: ‘Natural Selection includes no necessary and universal law of advancement or development; it only takes advantage of such variations as arise and are beneficial to each creature under its complex relations of life.’

If Natural Selection ‘does not include a necessary and universal law of advancement or development,’ it can only be thought of as a principle of mere expediency, and on no account as a thorough-going economic principle. In view of the bio-economic account of evolution that I have so far attempted to outline, it follows that Darwin has in any case given his principle of mere expediency far too much to do. For mere expediency we have found

everywhere to conduce to a perversion of the normal order. The number of species which selfish expediency has perverted may be legion, but their perpetuation is, I believe, nevertheless abhorred by Nature. Again I say that it seems to me that Darwin—faced by the difficulty of accounting for degeneration without an adequate system of Bio-Economics—had to twist his theory of evolution in order to make it fit two absolutely opposite things—expediency and bio-economic usefulness, or progress and retrogression. Frequently, indeed, Darwinists invite us to believe that those opposites are really one and the same thing, and that only our foolish thinking makes them opposites! ('Darwin,' says an anonymous contemporary of his, 'cannot, as he himself acknowledges, account for cases of degeneracy which are nevertheless so very numerous. Thus is he driven by his system to deny every instance of the sort.')

The phraseology of the above passage from Darwin, indeed, suggests that it was the difficulty of accounting for degeneration that caused him trouble. What is it that takes advantage of arising variations? It is one of two things: (a) General strenuousness and bio-economic usefulness, which are in themselves the most fruitful sources of engendering truly useful variations, or (b) Sluggishness and the abuse of bio-economic usefulness, which precisely engender variations of an opposite character.

In the case of degeneracy, organisms must pay the penalty, and instead of controlling their environment

they must increasingly be controlled by it. But we must not allow the prevalence of such retrograde 'adaptations' to delude us into believing that in normal evolution outside agencies are permitted by strenuous organisms to control and 'take advantage of' variations to any great extent.

If mere selfish expediency has shaped degeneration (by perverting that which an original strenuousness of progenitors had produced), progressive evolution is based on the opposite process, and has, therefore, little to do with 'Natural Selection.'

The combined factors, autonomy and Bio-Economics, to which I have called attention have the full force of a universal law of advancement such as Darwin was unable to associate with his 'principle.' Mere momentary expediency, irrespective of bio-economic consequences, has no place in the theory of evolution which I am propounding, except as accounting for those abnormalities which Darwinists, in their confusion, are constrained to declare are not abnormalities in any sense.

The question may be asked: How is it that they hold of the Natural Selection theory upon many is such as to cause them to remain satisfied with their theory? I can explain it only by the supposition that, in spite of their protestations to the contrary, the idea of Providence as a compensatory law (of their principle of mere expediency) lurks in the minds of these thinkers.¹

¹ As an older writer (Flourens) said: 'Natural Selection is only

They may flatter themselves that they have surmounted the theological argument by the use of the word 'natural.' But this word also has a deeper meaning, for 'nature' may be regarded as divine. We have heard of Him without whom no sparrow falls to the ground.

There appears to me to be no difference between the conception of an omnipotent God who watches over every moment of the sparrow's life and that of 'Natural Selection,' the Grand Functionary of Darwin, whose sole aim is the 'advantage' of 'each creature under its complex relations of life.'

I am the last to deny its proper place to Theology. Science, however, persists in asking : What is it by which this is done ?

I would urge that, in the light of the modifications which we have now applied, some of the early criticism of Darwin's theory, in spite of certain errors, seems well aimed and deserves resuscitation. In an anonymous work, 'The Darwinian Theory of the Transmutation of Species examined, by a Graduate of the University of Cambridge,'¹ the following strictures occur : 'His (Darwin's) Nature is Natural Selection, originating in no law, and owning no law ; it is only a long-sustained

Nature under another name. Either it is nothing or it is Nature, but Nature endowed with the attribute of Selection—Nature personified.' —'Aristote disait que " si l'art de bâtir était dans le bois, cet art agirait comme la nature." A la place de l'art de bâtir M. Darwin met l'élection naturelle, et c'est tout un ; l'un n'est pas plus chimérique que l'autre.'

¹ London, James Nisbet & Co., 1868, 2nd edition.

experiment, an empirical condition of things, trying all correctives and testing all suggestions, to reach at last the *elixir vitae* of a future perfection.'

The writer of this anonymous book is in favour of design in Nature, which we must forgive him, seeing that without due recognition of the factor of nutrition only a very partial account of cause and effect in evolution can be given. Bearing this in mind, the criticism contained in the following quotations from the above work to me seems perfectly justified:—

'We must now endeavour to ascertain what may be the precise meaning of the term "Natural Selection," which in itself contains substantially the whole of Mr. Darwin's theory. An unknown power selects and makes choice; it adopts, repudiates, modifies, and changes certain qualities in animals and vegetables; it adds or diminishes attributes and endowments, and always with a beneficial tendency to the being on which it operates; in the great majority of instances it effects a change in the right direction, after numerous incomplete experiments indeed, but ultimately with success; for improvement in the universal struggle for life is the general result of its agency. Where does this power reside? Is it in the animals and vegetables themselves, or is it something exterior to them that superintends and directs this process of amelioration? Is it Nature that alters the structures and the organisation; and if so, what is Nature?

‘ In not a few instances Mr. Darwin speaks as if all this were accomplished by that metaphorical word, Nature. “ I see,” he says, “ no limit to the amount of change, to the beauty and infinite complexity of the co-adaptations between all organic beings, one with another and with their physical conditions of life, which may be effected in the long course of time by *Nature’s power of selection.*”

‘ Here Nature is an intelligent agent, elaborating organised beings with beautiful and skilful art, adapting them for the new circumstances of their improving condition. Nature has the power, the knowledge, the skill, and the good taste to advance organised beings towards perfection, in designs of admirable wisdom and beauty. Nature, then, has all the attributes of the Creator, with only a different name ; but is Nature an intelligent power, or is it a deity ? Is it a god or a goddess ? Mr. Darwin tells us, indeed, that he uses the term metaphorically ; but why, in the first place, all through this grave and profound disquisition, trifle with a metaphor instead of using a reality ; and why, in the next place, forget that it is a metaphor and continually attribute to it acts of intelligence and designs of incomparable skill and science ? That Mr. Darwin does this beyond any other writer we shall presently see ; indeed he comprehensively informs us that “ Natural Selection is a *power incessantly ready for action*, and is as immeasurably superior to man’s feeble efforts as the works of *Nature* are

to those of art." This, however, is not a very fortunate illustration; for as Mr. Darwin makes Nature, and Nature's power of selection, and Natural Selection all one, it only amounts to this, that Nature's works are as superior to man's works as Nature's works are.'

The next passages show the difficulties and absurdities in which Darwin's narrow idea of usefulness had landed him: 'Here we must for a moment resume the serious tone, to draw attention to the flagrant abuse of words by which the theory is argued. It has already been noticed that both Natural Selection and the Struggle for Existence are avowed metaphors, and now, when we have come to Nature's most striking attribute, her beauty, we find it explained to us as originating in Natural Selection in "a forced sense," as if it had been selected for its utility, when the author candidly confesses that it is of no direct use. "The effect of sexual selection, when *displayed in beauty to charm the females*, can only be called useful in rather a forced sense."

'Now mark this: unless it be for the direct use of the animal or plant, nothing can be done by Natural Selection. This is the fundamental proposition on which the whole theory rests, repeated over and over again in many passages; everything is based on this,—take this away and the theory vanishes. Is not then this an instance in which the author has confuted himself? Has he not checkmated himself, and is not this manifest? In this way we may understand the moral qualities

of birds by the appearance of the males. The dusky cocks, which differ little from the hens, have had quaker-eyed partners, fond of the drab colours and homely attire ; the pea-hens, the pheasants, the birds of Paradise, the humming-birds and many more of the splendid species, descend from vain mothers, allured by gauds and garish show. The argus-pheasant, perhaps the most magnificent of male birds, is a sad instance of the frivolous disposition of his maternal ancestors. The crows and rooks spring from a grave and clerical lineage. The cock-sparrow argues the sobriety of taste that prevailed in his respectable family.

‘ Mr. Darwin, indeed, seems to have misgivings “ lest it should appear childish to attribute any effect to such weak means ;” but after a little talking over the matter, concludes, as usual, that he “ sees no good ground to doubt,” and so inserts the article in his creed ; for a creed it is, and continually presented to us as such, by the established formulary : “ I believe.” ’

To finish this picture with the last touch, the author informs us that ‘ he would not attribute *all* such sexual differences to this agency, for some of the peculiarities of the males he cannot believe are attractive to the females, particularly the tuft of hair on the breast of the turkey-cock, which he considers neither as useful nor ornamental. But has the learned author consulted the turkey-hens on this subject ? *De gustibus non disputandum* : the fair ones may admire a strong tuft of

hair on their husband's breasts ; who knows ? Philosophers and turkey-hens cannot be supposed always to see matters from one and the same point of view.'

The Darwinian muddle which has arisen through transferring organismal choice into a phantastic outside agency (although Darwin reluctantly concedes that 'a little dose of judgment or reason often comes into play even with animals low in the scale of nature') is brought home forcibly in the following lines: 'However, in the passage before us we see it acknowledged that Natural Selection has "not been brought into play," an expression which, when closely examined, means really that those animals have not begun to change themselves. Their limbs have not been "plastic"—a favourite little word with the author, in which is slyly condensed the power of self-creation—and so they have not brought Natural Selection into play.'

The anonymous author finishes his remarks on this part of his subject with the following droll observation: 'The goose seems to have a singularly inflexible organisation. Natural Selection, then, does not seem to be able to change a goose. That wise animal (for so we must esteem it) thinks it better to adhere to a conservative policy, and to be satisfied with things as they are, having no desire to lapse into a giraffe, a crab, an elephant, or a philosopher.'

The eagerness of the anonymous author to do justice

where justice is due shows itself in his references to Lamarck and to Robert Chambers.

Of the 'Vestiges' he says : 'It met with great success, soon became a popular book, and is still enjoying a measure of popularity. This is to be attributed in part to the pleasant style of its composition, and to the lucid and intelligible tone of the statements it contains. It is an *easy* book to read, and the novelty of its subject made it an entertaining one. The scientific world is disposed to speak slightly of the work as deficient in information, but the author does not seem to put forth the pretensions of a man of science, and he offers his statements simply as the result of his reading—he gathers from other writers his materials, and proposes his deductions on them with simplicity and modesty. There may be mistakes in the statements, or a deficiency of knowledge may here and there betray itself, but on the whole the book may be considered *the least offensive* of any that have yet appeared to advocate the theory of Transmutation.'

'Mr. Darwin considers the author of "Vestiges" as his pioneer, and the husbandman who has prepared the soil for the Darwinian harvest. But it is open to suspicion, and by some persons asserted, that we owe "The Origin of Species" to the influence which the "Vestiges" exercised on Mr. Darwin's mind : and that in the general argument of that publication Mr. Darwin found suggestions for a more perfect system of Transmutation, which it has been his business to elaborate.'

As regards the place of habits in Darwin's system, our anonymous author's sarcastic remarks are again well worth reading. He refers to the following statement of Darwin's: 'When cases of diversified and changed habits occur, it would be easy for Natural Selection to fit the animal for its changed habits, or exclusively for one of its several different habits. But it is difficult to tell, and immaterial for us, whether habits generally change first, and structure afterwards; or whether slight modifications of structure lead to changed habits; both probably often change almost simultaneously.'

These are his strictures: 'We quite agree with the author in acknowledging the difficulty of this question, but that it is immaterial we cannot at all concede. If transformations are to take place in Nature, and animals are to become new creatures, it must be a very important point to determine whether the change first takes place in the structure of the animal or in its habits. If a land-animal is about to turn into a fish, or a fish into a land-animal, or if a wingless animal is about to assume wings (all cases considered quite possible in the Theory, if indeed they are not, more properly speaking, historical facts), it must be deeply interesting to know whether the inclination to change precedes the altered structure, or *vice versa*.

'Perhaps this interesting question has been already settled for us by Shakespeare, who, as he rarely missed any subject, seems not to have overlooked the possibilities

of Natural Selection. In the "Midsummer Night's Dream" he first gives the ass's head to Bottom, and then represents Bottom as manifesting asinine inclinations. "Methinks I have a great desire for a pottle of hay; good hay, sweet hay hath no fellow." The rule then, after all, seems to be that when a man is turned into an ass he then begins to have asinine thoughts. In other words, the structure precedes the habit.'

Bearing on the principle of reciprocal differentiation, the author rightly remarks: 'Why one cell should absorb; why another, that seems exactly to resemble it, should assimilate; why a third should secrete; why a fourth should prepare the reproductive germs; and why, of two germs that seem exactly similar, one should be developed into the meanest zoophyte, and another into the complex fabric of man,—are questions that physiology is not likely ever to answer.'

We are also told that 'Natural Selection' may be defined to be 'the result of destruction,' and further that as regards the presence of many special structures 'there must have been something more than inheritance at work, for inheritance can neither add nor leave out a part of the body.'

The discrepancy of Darwin's raising in the face of his own theory the question, 'How do we know that it would be any advantage for the lower forms to be more highly organised?' is well perceived by our author, who retorts that 'from him this question is most strange;

for the answer would be that *in this Theory* the benefit of an advancing change would be everything.' If a form is low in the scale of organisation, Mr. Darwin takes it for granted, in his scheme of Natural Selection, that it would be an advantage to promote it into one of superior grade : on this the whole theory of metamorphosis proceeds ; how then can he thus turn round upon us, and ask what advantage it would be for an earthworm to be highly organised ?

' We cannot do better than to finish these remarks with Mr. Darwin's own words, self-immolating as they are to the learned gentleman ; " Who can pretend that he knows the Natural History of any organic being sufficiently well to say whether any particular change would be to its advantage ? " Who can write so effectually against Mr. Darwin as Mr. Darwin himself ? And who, when facing Nature, in a candid spirit and free from the contagion of paradox, can so acutely observe and so ably apply the observations he has made ?

' Yet this is the very thing which Mr. Darwin has asserted again and again in every chapter, that it has been for the advantage of the lower animals that they should be changed, and, moreover, he predicts that this system of mutation will go on amongst them till it reaches perfection.

' Here, then, is the contradiction : Mr. Darwin meets the objection of the lower animals remaining as yet unchanged by telling us it would not be to their advantage that they should be changed ; and yet he predicts that "*each creature*

will tend to become more and more improved in relation to its condition of life." In short, he writes for and against the advance of the lower animals; and his own confutation of himself is unanswerable. In the meanwhile we may rest satisfied that the Theory is visibly confuted by the existence of innumerable lower forms remaining unchanged, and by the palpable fact that the lower forms have *not* been exterminated by the higher. This may be noticed anywhere; moreover, we see numbers of species closely allied to one another living together, that is, occupying the same regions, without the slightest tendency to this imaginary extermination. The horse, it will be said, is an improvement on the ass; these creatures are so nearly allied that a mixed progeny can be produced between them, and yet there is no tendency in the horse to exterminate the ass in a state of nature; and so in thousands of other instances. If indeed we could bring ourselves to doubt that which is so evident, Mr. Darwin's perplexity of reasoning and his contradictions on this topic would be amply sufficient to convince us of the real state of the case. And here, to dismiss this subject of Natural Selection by extermination, this need only be added to foregoing remarks—"that this operation imagined by Mr. Darwin is merely an expedient to account for the total want of intermediate links, necessary to connect the transformation of one animal into another."

My readers will realise how confusion in the theory of evolution as here portrayed was bound to arise,

failing a proper orientation on matters of nutrition and of economics.

The anonymous author continues his brilliant criticism of the Natural Selection theory thus :

‘ In bidding farewell, then, to this subject, we have examined Natural Selection with sufficient care to understand that it represents nothing, and is a mere play of words. The only real part of the Theory is Accidental Change and Extermination. There is no other agency. There is nothing that can select ; no power, intellect, or existence of any sort, that can make any choice, or discriminate between the useful and the inexpedient.

‘ The animal is represented as changing its organisation spontaneously, and by slow degrees ; the animal that does not change is exterminated. This is the whole machinery by which organised beings have been produced. The term “ Natural Selection ” therefore is superfluous, it is an illusion, an allegorical phantasy devoid of real meaning, and representing no fact. It ought to be entirely banished from the system, and from the title-page of Mr. Darwin’s book, where it is offered as an alternative : “ Origin of Species, *by means of Natural Selection* ; or the Preservation of Favoured Races in the Struggle for Life.” That is, we may take our choice between these two statements, which are proposed as equivalent. But the first is a misrepresentation, for species cannot derive their origin from that which has no real existence ; and the second contains two errors : 1. “ The favoured races ” ;

favoured by whom, or by what ? This expression implies selection and has a reference to the first part of the title. 2. "The Struggle for Life" is a metaphor, which Mr. Darwin cannot pretend is to be taken literally. Thus the title of the book has three metaphorical expressions, as an earnest of all that was to follow.

"The production of species by accident and extermination" would have expressed more correctly and truthfully the gist of the Treatise.

'Mr. Darwin has himself told us that Natural Selection is a metaphor, and yet on this basis has he argued all through his book, without even once availing himself of that definition which he assures us conveys the real meaning of the term. That there has been an object in this we can scarcely doubt ; it has been intended to induce the reader, by continual usage of the words, to suppose that there is really a power of selection and of choice in this dispensation of metamorphoses. Very numerous are the passages in which Natural Selection is personified, and represented as a vigilant inspector and improver of the forms of life, and as endowed with transcendent skill and wisdom in her multiplied operations. Several of these passages the reader has seen, and that this inexcusable language has produced its effect on the converts to the system is more than probable.'

Finally our anonymous critic alludes to another instance of 'the excellent foppery of the world,' which consists in the habit of denouncing the constitution of

the universe rather than pleading guilty to the charge of surfeit and of biological criminality. He says : ‘ When a leopard destroys an antelope, or a wolf worries an innocent lamb, or a tiger dines on a wise and virtuous man, this may be abhorrent to our feelings of fitness—*except when we perpetrate the like crimes ourselves*. When we sit down to a quarter of lamb, with mint sauce, we never disturb ourselves about the conscience of the grim butcher who is making a sanguinary fortune by our Cyclopean appetites. It is not at all abhorrent to our ideas of fitness to do that ourselves which we hear of with such horror when perpetrated by a wolf or a lion. If a dog eats a sheep we have him hanged forthwith ; but if a thousand sheep are cut up next morning and sold in the London market, we think it a most encouraging circumstance, and a blessed proof of the prosperity of the landed interest.’

The Roman jurists did not trouble to invent a casuistry, as did Aristotle, for the justification of their predaceous exploitation of other nations—‘*cum in servum omnia liceant*.’ They frankly admitted that it was founded upon force and that it was ‘contrary to Nature.’ The Romans were a ‘practical’ people. Modern Science, too, tends to become ‘practical,’ as practical as the Science of the days of Juvenal. It has no longer any ‘enemies,’ and there is ‘nourishment’ in abundance. Hence it has become hypertrophied in parts and atrophied in others. Like some top-heavy bird, it is in danger of becoming flightless.

CHAPTER III

DIGESTIVE TRANSFORMATION

‘Medical science is to-day overweighted by the accumulation of a vast array of more or less crude and isolated facts. What we need is the illuminating generalisation, the daring hypothesis to co-ordinate facts hitherto out of relation with each other, to give perchance to science a new *organon*, to light the way to fresh fields of inquiry and discovery.’—(DR. J. A. LINDSAY, M.A., M.D.)

‘But, after the manner of brutes looking always downwards, and bowed towards earth and their tables, they live feeding and coupling.’ . . .

‘And, even to this day, such as denominate themselves from the Pythagorean manner of life appear to be somehow eminent beyond others.’—(*Plato*.)

DIGESTIVE transformation is an expression used by medical Darwinists which now requires correction. In a suggestive little volume, ‘The Gospel according to Darwin,’ Dr. Woods Hutchinson tells us : ‘When we turn to the higher forms of being, the dependence of life upon precedent death is so self-evident as to have been formulated into a truism. That the grass must die that sheep may live, and that sheep must die that man may live, are facts as familiar as the multiplication-table. If the command, “Thou shalt not kill,” were to be interpreted to extend to our animal cousins and our

vegetable ancestors, it might as well read at once, "Thou shalt starve."

'Without this power of the lower life to forward the higher life by dying, progress of any sort would be absolutely impossible. Even when we reach the human stage, where no such direct digestive transformation into higher forms is possible, the same necessity is still apparent.'

Now, of course, death has its place in Nature; but if it is well that even in their death organisms should be bio-economically useful, how much more may we normally expect them to be useful during life! It is by work, and not by death, that organisms normally forward their own life interests and those of others. It is by production that they justify their existence (as against all depraved types), avoid undue competition, and purchase mutual evolution. Failing this production, various means of competition have to be resorted to. When they resort to depredation or begin to devour each other we may say that the ordinary resources of organic 'civilisation' have already been rejected, and that all manner of criminality may now be expected. The digestive transformation to which this gives rise is not of a progressive or desirable character, and, as I have shown, it has not the approval of Nature, any more than has perpetual in-breeding.

The alternative of waste and starvation in Nature as well as in human society is not depredation, but

service. When faced by the good effects of productive and cross-feeding habits, however, Darwinists are nonplussed. Without competition, they tell us, there is no natural selection. Yet we have stability and efficiency in the absence of Darwinian competition—given at least cross-feeding. Thus F. W. Hutton, F.R.S., &c., tells us that ‘In the Pleistocene the African elephant lived in South Europe with other species, some of which belonged to the Indian type; and at the close of the Pleistocene, the mammoth, which had the most specialised teeth of any, became extinct. As these two forms were competing for so long a time, without either of them gaining any advantage, we cannot suppose that the two living species of elephant owe their preservation to the superior pattern of their molar teeth. The fact is that one pattern is as useful as the other, neither more nor less; and, as no advantage is gained by having different patterns, they cannot have been developed by Natural Selection.’

It is true, of course, that carnivorism has its place in the economy of Nature. The destructive animals, as Chambers has it, ‘seem to bear a relation to those upon which they are destined to prey, and to be a necessary accompaniment to them.’ They are ‘developed contemporaneously with the weaker tribes, the fertility of which would otherwise produce complete anarchy.’ It is necessary to add, however, that those weaker tribes frequently are apt to obtain their plant-food feloniously

and to become 'Pflanzen-Raubtiere' (predaceous plant-feeders), and that the numerical anarchy they produce is thus preceded by a nutritive (physiological and bio-economic) anarchy. Once such anarchy has recruited itself from their ranks, it is not a far cry to the development of pure carnivorism from the same ranks.

Primarily, then, an outrage is committed on the plant-kingdom, that faithful though long-suffering complement of the animal. If this outrage is—providentially, as the older writers thought—checked by carnivorism, if the cross-feeders are thus protected from that anarchy to which their own inordinate appetite would tend, it is only meet that they should pay the penalty for their transgression.

But this is not the same as saying that the lending of their diseased and overfed bodies to the 'digestive transformation' of those scavengers of still more depraved appetites (who otherwise devour much of the offal of life and suffer the consequences of perpetual in-feeding) is an indispensable factor of progressive evolution.

The value of carnivorism does not consist in 'digestive transformation.' Digestive transformation such as understood by Dr. Woods Hutchinson is not the kind of transformation that I would advise my readers to rely upon. We may take it, however, from the learned Doctor that digestion has to play a great part in evolution. What part exactly it does play, however, is, as Mr. Kipling would say, 'another story.'

As regards digestive transformation we must take to heart Nietzsche's saying: 'Nicht fort sondern hinauf sollt ihr euch pflanzen.'

It is fair to add that there are those among medical men who preserve an open mind as regards digestive transformation. Thus Dr. James Alexander Lindsay, who considers the idea of vegetarianism as one 'worth thinking over,' says that 'the phenomena of digestion will appeal to our intellect and imagination very differently according as we regard them as ultimate and final facts, or as part of an evolutionary process.'¹

¹ Bradshaw Lecture on Darwinism and Medicine, *Brit. Med. Journal*, Nov. 6, 1909.

CHAPTER IV

IS NATURE NON-MORAL ?

‘The moral order is a continuous line from the beginning.’—
HENRY DRUMMOND.

‘We must interpret the less developed by the more developed.’—
PROF. W. R. SORLEY.

‘Lo ! by me [wisdom] shall thy days be multiplied and years of life be added unto thee.’—KING SOLOMON.

THE causal bond between economic transgression and pathological developments, upon which I have throughout insisted, will of course appear novel to many readers. They must consider, however, that there is action and reaction throughout the web of correlations. Organisms do not always act and react upon each other to their own or the general good. Nor are the reactions always rapid, immediate and direct. To live up to high bio-economic duties, no doubt, does not always seem to be following lines of least resistance. ‘Sweet are the waters of stealth.’ Bad habits, moreover, are only gradually assumed, and the natural checks following in their wake take time to mature. In this way evil may

flourish for a time, though the mills of God are slowly but surely grinding. A kind of scientific obscurantism is opposed to this view of 'morality in nature.' Older writers admitted the possibility of 'a kind of blemish' otherwise irreconcilable with 'that idea of perfection which a general view of Nature irresistibly attributes to its author' (Chambers). Recent writers deny biological evil altogether in deference to the supposed omnipotence of Natural Selection. *Credo quia impossibile est* still holds sway; '*credo*,' moreover, relieves one of the inconvenient necessity of thinking.

The goddess who 'selects,' knowing only selfish expediency, of course, can hardly be said to be 'moral,' and Nature therefore is said to be non-moral!¹

But why should Nature not be credited with a morality which is not the same as, though analogous to, human morality, if she is credited with the attribute of Selection—not the same as, though analogous to, human Selection? Evidence of the former is at any rate more tangible than evidence of the latter, and belief in it requires less straining of concepts than belief in Selection.

All we can say is that there are various degrees of morality, and that the lower types, though they can rarely (or not at all) live up to the standard of the higher—and

¹ Evolution on this view is supposed to be a teleological event following as a result of laws wholly mechanical—'a truth that ought to be patent since the discovery [?] of Natural Selection.'—Hugh S. Elliot in *Science Progress*, Jan. 1913.

in precisely so far as they cannot as yet live up to a higher standard of morality must be content to be the 'lower'—have to conform to a certain bio-economic standard of morality, failing which they suffer the penalty of degeneration and of general decline.

Many of the lower types indeed seem to possess an appreciable 'little dose' of morality in addition to the 'little dose' of judgment and of reason conceded to them by Darwin. What a fine apprehension of evolutionary law is frequently contained in scriptural and ancient classical writings! Thus King Solomon points to the example of the bee and says, 'She is advanced by honouring wisdom.'

According to Mr. C. B. Roylance Kent,¹ 'social evolution is at bottom an ethical process; its end is the survival of those who are ethically the best, its aim not so much the survival of the fittest as the fitting of as many as possible to survive.' This view, in my opinion, is applicable to organic as well as to human evolution.

¹ *Fortnightly Review*, June 1913.

CHAPTER V

CORRELATIONS

‘ The effects of lessened exercise together with abundant food on the whole organisation are probably still more important.’—DARWIN.

‘ CORRELATION of growth ’ and ‘ correlation of variation,’ according to Sir E. Ray Lankester, are important matters, though ‘ little has been added to our knowledge since Darwin wrote.’¹ ‘ We know little more about it than the bare facts which indicate its existence. It is, I admit, a dangerous weapon, if hastily applied, because its laws and limitations have not been ascertained, but it removes difficulties and opens up possibilities which are of the greatest importance.’

The following are instances of ‘ correlated variation ’ as cited by Sir E. Ray Lankester : ‘ White sheep and pigs are poisoned by certain plants in their food, whilst dark-coloured individuals escape injury. Black pigs in Virginia eat the plant called “ paint root ” with impunity, whilst all other varieties of pig, when they eat this

¹ *Daily Telegraph*, January 15, 1913.

plant, acquire a disease of the hoofs which causes them to drop off.'

Obviously we have here, amongst others, important correlations of the bio-economic order, and I can agree with Sir E. Ray Lankester that new conditions may ensue by correlation which cannot be explained by 'utility,' except in so far as depredation (of which pigs and sheep make themselves guilty—'Pflanzen-Raubtiere') in course of time gives rise to correlations of an injurious kind.

Sir Edwin, however, is not in the habit of taking indispensable bio-economic implications into account; hence he is entirely mystified by such phenomena, and avers that there are numerous 'utilities of an obscure kind,' among which, I presume, he would include the above.

An adequate consideration of this subject shows that Gresham's law of currency holds good physiologically and biologically. If physiological currency is allowed to deteriorate by improper feeding (resulting in an under-adequacy of force), if 'give and take' are replaced by depredation and carnivorism, a number of correlations incompatible with progressive evolution must arise.

On Sir Edwin's own showing, correlated with great canine teeth are vast fangs, requiring an excessive blood-supply, which in turn (in all probability) reduces that of the neighbouring organ, the brain.

The wider correlation is, that predaceous feeding and

carnivorism eventually produce 'incredibly and absurdly small brains' in absurdly overgrown bodies, an anomalous and pathological condition. Such under-adequacy of force, combined with a corresponding disqualification, in my opinion explains the supposedly puzzling cause of the extinction of 'highly-specialised' monsters of the past.

In an article on 'From Ape to Man'¹ Sir E. Ray Lankester tells us: 'Just as man's brain is enormously larger than that of the ordinary monkey's, although his general make and anatomy is closely similar to theirs, so we find that the rhinoceros has an enormous brain as compared with extinct rhinoceros-like animals, the predecessors and ancestors of those now living. The extinct titanotherium of the lower Miocene period managed to carry on its life in an efficient way and to hold its own for a considerable period with a brain which was only one-eighth the bulk of that of a modern rhinoceros, as did other animals in the past with even greater bodies and smaller brains.

'Descartes and other philosophers have held that there is a great difference in the mental processes of animals as compared with those of man in this, namely, that man is "conscious," that is to say, conscious of himself as "I," and, as it were, looks on at himself acting on and being acted on by surrounding existences, whilst (so it is assumed) animals have not this consciousness,

¹ *Daily Telegraph*, February 12, 1913.

but are "automata," going through all the processes of life, and even behaving more or less as man does in similar circumstances, yet without being "conscious." This difference between man and animals is certainly not so absolute as it is sometimes asserted to be.'

What I maintain is that on further examination it will be found that all normally feeding animals thus bear testimony to the gradual forcing up of the mental level in evolution, and we may say that one very important correlation of a proper physiological currency consists in a marked gain of mentality.

The same authority assures us about the value of this evolutionary increase of brain thus: 'In proportion as the brain increases in volume (especially that part of it which is called "the cortex of the hemispheres") the animal to which that brain belongs *loses, gets rid* of inherited mechanisms or instincts, and becomes "educable"; that is to say, forms for itself new individual brain-mechanisms based on memorised experience. "Educability" is the quality which distinguishes the brain of increased size' (*italics mine*).

In other words, given the basis of an appropriate physiological currency, progressive evolution takes place. Sir Edwin, without even attempting to draw a line between normal and abnormal development, continues: 'Thus we get an indication of "the reason why" the modern rhinoceros has a brain eight times as big as the titanotherium's. It is more "educable." The ancestors

of our modern armour-plated friend have been surviving and beating their less "educable" brothers and sisters and cousins through a vast geological lapse of time; and the brains of the survivors have always been bigger, and they have become more educable and more educated until the race has culminated in those models of "sweet reasonableness," the modern rhinoceroses! That is what we infer; we do not judge the survivor of a fine early Miocene family by the fury and annoyance he shows when shot at, nor by the stolid contempt with which he treats mankind at the Zoo. The same signification—"educability"—attaches to the large brain of the higher apes; and man's still larger brain means still greater educability and resulting reasonableness.'

Thus what I would explain on the lines of cause and effect as a correlation resulting from adequate habits—in the absence of which, moreover, such desirable developments demonstrably do not take place—Sir E. Ray Lankester explains on the lines of 'Natural Selection.' As instanced, however, by the case of the elephant in my chapter on 'Digestive Transformation,' the cross-feeding types can scarcely be said to be competing with one another in the Darwinian sense of the word. And as we are assured that without competition there is no 'Selection,' I fail to see how 'Natural Selection and the survival of the fittest' should have led to this increased size and accompanying educability of the brain.

Nor can I see how 'isolation' *per se* can have produced

such happy results. We have here instances of general stability and efficiency of a definite physiological and bio-economic causation.

As regards the circumstances which led to the reduction in size of man's canine teeth and of the projection of his jaws, Sir E. Ray Lankester tells us, 'it is impossible to say more than that this was favoured by the increased skill of his hand and by the use of weapons, and probably was directly *correlated* with an increased growth of the brain' (*italics mine*). Surely, however, Sir Edwin will admit, and, of course, has in general terms admitted, that every change of dentition was related to changes of feeding, which, hence, must have the most important correlations in the developments of the brain.

The same must be said if it is true that 'Man was, far back in his monkey-days, a social and companion-loving animal, and the fact that his laughing and his weeping are accompanied by noise is due to the desire for attention and sympathy from his friends.'

No doubt his feeding habits and those of his progenitors must have been of a character permitting a sufficiency of social sympathy, which indeed constitutes another undeniable correlation of cross-feeding habits.

The question of feeding thus becoming more and more important, Sir Edwin goes on: 'It is not easy to suggest how the reduction in size of the canines and front teeth and of the length of the jaw could be of such advantage

to incipient man as to lead to the survival of those individuals in which these parts were least developed, and so gradually to the crowding of the teeth, reduced in size, into a jaw of reduced length, which at a late stage, long after man was man, and no ape, produced a bony chin as an outgrowth. The *nutrition* of these parts placed in the head near the brain, the great *canine* having *so vast a fang* that it reaches up to the eye-socket, whence it is called the "eye-tooth," render it probable that there is a *relation depending on nutrition* and blood supply between them and that all-important organ contained in the neighbouring bony box—the brain. As the *great teeth and long jaw have dwindled, the brain has increased in volume, and, what is more important, in activity* ' (italics mine).

It is clear that the apparent difficulties of explanation cannot be met by Darwinian ideas of 'advantage,' 'fitness,' 'selection,' and *hoc genus omne*.

It was an adequate physiological choice, in particular of food, which has conduced to an ulterior fitness and usefulness, the identical correlations being universally demonstrable. Cuvier already has shown how 'every organised being forms a whole, an unique and perfect system, the parts of which mutually correspond, and concur in the same definitive action by a reciprocal reaction. . . Each part, separately considered, points out and marks all the others.' It remained to be shown how and to what extent the part played by a species in

the broad Economy of Nature eventually involved bio-economic reactions and produced those changes of 'natural gestation' which determined its evolution. It remained to be demonstrated that of all functions feeding was the most prominent as affecting correlations.

We also learn from Sir Ray Lankester that 'pigs have a smaller brain in proportion to their bulk than monkeys,' and further that many of the huge reptiles of the past, such as the iguanodon, the triceratops, and the diplodocus, 'have brains of an *incredibly small* size, much smaller *in proportion to their bulk* than those of living reptiles, such as lizards and crocodiles' (italics mine). 'The skulls and whole skeletons of great rhinoceros-like animals—some of them ancestrally related to our living rhinoceros—which are dug up in early tertiary sands and clays, have *absurdly small brains*.' (Italics mine.)

The subject of correlation is at some length and very ably considered in that once famous book, 'The Reign of Law,' by the Duke of Argyll. He says: 'It is not until we ask ourselves this question that we discover what a deep question it is—how endless are the avenues of thought and of inquiry which it opens up.'

The author perceives that one kind of correlation may rise above another. 'Two growths might be correlated as regards each other, and might yet be wanting in any corresponding correlation *of fitness and of function towards outward things*' (italics mine). 'But the first of these two kinds of correlation would be useless without the last;

and this last is obviously the higher and more complex correlation of the two. It is higher, not only in the sense of being more complex, but as involving an idea which lifts us at once from a lower to a higher region of thought.'

In the following passage we get almost an adumbration of bio-economic correlation. 'Mr. Darwin has not pointed out this distinction clearly. Indeed, he does not seem to have had it in his view. He groups under one name—the correlation of growth—two classes of phenomena, which are indeed always combined in fact, but which are entirely separate in idea. Correlation of growth, in one sense, is that law of vital force which secures that any change in the shape of one limb in an animal shall be accompanied by a corresponding change in all the other limbs. Correlation of growth in the other sense is that adjustment of vital forces to the contingencies of external circumstance which secures that all the changes which do take place shall be changes adapted to the discharge of new functions—to the fulfilment of new conditions of life—to command over new sources of enjoyment.'

I agree with the Duke of Argyll in the following, as regards mere physical correlation: 'The truth is that correlation in this sense is involved in the very word "growth." Each part of every structure which is the result of growth must be correlated to every other part. This is essential to the very idea of growth, and to the very idea of an organism due to growth. When,

therefore, Mr. Darwin says that one of the laws on which variation of form depends is correlation of growth, he simply says that variations of growth depend on growth—for all growths must be correlated.’

‘But,’ he goes on to say, ‘correlation in this sense helps but a little way indeed in conceiving the origin of a new species. There might be the most minute and perfect harmony between the changes effected in an animal newly born without those changes tending even in the most remote degree towards the establishment of a new form of life. In order to that establishment there must be another correlation, and a correlation of a higher kind. There must be a correlation between those changes and all the outward conditions amidst which the new form is to be placed and live. If this correlation fails the new form will die. Yet, so far as we can see, this kind of correlation is without any physical cause. It is not necessarily involved, as the other kind of correlation is, in the very idea of growth. On the contrary, it is not only entirely separable in thought, but, as we see in monstrosities, it is sometimes separated in fact. We have no conception of any force emanating from external things which shall mould the structure of an organism in harmony with themselves.’

Again we come to the indispensable conclusion that the mysterious ‘force’ here referred to, emanating from external things and moulding the structure of organisms—according to its source and according to

their use of it—is nutrition. Food is the required ‘external thing.’ It is generally supposed to supply force, and at the present day a few at any rate begin to reflect on the adequacy or otherwise of the various kinds of food-‘force’ obtainable.

Whilst being an ‘external thing,’ however, by dint of its ‘fertilising’ and hereditary effects, its ‘amphimixis’ value, food eventually has all the force of an interior predisposing and predetermining ‘force.’ Whether an organism can truly harmonise itself or otherwise with ‘external things,’ and with the surrounding world of life, depends on habitual use or misuse of ‘force.’ With misuse of force the ‘harmony’ (or ‘adaptation’) may become so excessive that the organism no longer controls the environment, but is entirely controlled by it—a case of so-called ‘extreme determination.’ We may take the ‘harmony’ of parasitic adaptation as an instance. We can also see how the matter of correlation may indeed become complex and frequently obscure, in cases where a loss of autonomous powers has caused an organism to be at the mercy of various circumstances which, normally, it might master quite well. The erstwhile survival-forces may now become compounded with a plurality of adventitious influences.

‘It is this higher and more complex correlation which is the most constant and the most obvious of all the facts of Nature,’ says the Duke. ‘Throughout the whole range of Nature the system of internal correlation is

entirely subordinate to the system of external correlation. Forms or growths which are inseparably joined with each other in one group of animals are wholly divorced from each other in another group; whereas forms which have correlations adapted to external conditions are repeated over and over again across the widest gaps in the scale of natural affinity.

‘If, then, it be true that new species are created out of small variations in the form of old species, and this by way of natural generation, there must be some bond of connection which determines those variations in a definite direction, and keeps up the external correlations *pari passu* with the internal correlations. Natural Selection can have no part in this. Natural Selection seizes on these external correlations when they have come to be. But Natural Selection cannot enter the secret chambers of the womb, and there shape the new form in harmony with modified conditions of external life. How, then, are these external correlations provided for beforehand? There can be but one reply. It is by Utility, not acting as a physical cause upon organs already in existence, but acting through motive as a mental purpose in contriving organs before they have begun to be.’

Causa latet. Whatever mental purpose or ‘creative will’ there may be, and may have co-operated towards the results, we have seen that there is a more tangible force moulding and predetermining organs and species at work in evolution. It is a force which fulfils all the

requirements of definiteness and of purpose. This force is nutrition, seen in its far-reaching physiological and correlated bio-economic importance. Let us first exhaust the study of nutrition before invoking either Providence or Natural Selection. As the Duke elsewhere says ; ' But Science will continue to ask, even if she never gets an answer, what is the community of physical cause which produces this community of resulting structure ? '

We may now conclude that external correlations can be satisfactorily kept up *pari passu* with internal correlations only by a proper discharge of systematic and ' other-regarding ' activities, the indispensable prerequisite being, in my view, proper feeding.

Finally, when the Duke suggests that we have ' no glimmering even of knowledge as to the physical causes which have " attuned " a material organ so as to catch certain ethereal pulsations in the external world,' I would point out that an adequate capacity of metabolic response, based on adequate feeding habits, is indispensable to the ' attuning ' of a material organ. One proof of the matter is that, as our consideration of parasitism will show, metabolic deterioration and metabolic abnormalities frequently are the true causes of the disappearance of finer organs.

CHAPTER VI

THE SOLIDARITY OF ORGANIC LIFE

‘And probably it is an absolutely essential condition to the continued life, in tolerable mutual amity, of the wild things of the earth that this spirit [respect of rights] should govern their conduct.—HORACE HUTCHINSON.

‘Moral conduct is nothing less than social conduct, just as immoral conduct is directly anti-social.’—C. B. ROYLANCE KENT.

‘IF we watch the wonderful and beautiful division of labour among the cells which takes place in even the simplest forms of plant life, must we not almost imagine that some sort of an understanding exists between them? That some sort of blind instinct of *devotion* or *loyalty* to the mass accompanies the action of one group of cells in burying themselves in the ground, away from the light, the warmth, the dew, of another in flattening themselves out into leaves, all lungs and stomach, and of another in shrinking down into the woody fibre of the stem or petrifying themselves into its siliceous coating? In one sense, the relation is on a purely *mercantile* basis; each group renounces a part of its birthright in order to render certain *services*

to the plant-republic, which *in return* supplies it with food, water, air, or protection, as the case may be. And yet it is hard to rid ourselves of the idea that there must be some sort of *esprit de corps*, some *dim sense of solidarity* amongst them; at all events, even if we are not permitted to credit them with kindly intentions or with affectionate sentiments, yet it cannot be denied that their actions possess these qualities in a high degree. In the which they are decidedly superior to many professed philanthropists and reformers among their descendants of the present day. (Italics mine.)

‘Nor is the service rendered by any means always consistent with the welfare of the individual cell; in many cases it is exactly the reverse, and it literally “lays down its life for its friends” and performs its chief function by dying.

‘We cannot deny them the martyr’s death, or what is more difficult, the martyr’s life, though we may the martyr’s crown. The same is true of the cells of the animal organism, including those of our own bodies. A beautiful illustration of apparent devotion is furnished by the white cells of our blood, the leucocytes, whose principal function appears to be a protection of the body against all noxious germs or substances which penetrate its tissues. This they do by hurling themselves upon the intruder, regardless of whether they destroy, or are destroyed by him, and either overwhelm him by their

numbers or, failing this, imbed him in their dead bodies, so that he may be swept out of the system without being able to attack the other tissues. No enemy can enter the fortress save over their lifeless corpses. And the singular thing about it is that they are in no way directly connected with the fixed cells of the body, or under the control of the central nervous system.

‘ They are a band of free-lances ranging up and down the blood channels, who receive from the body their bread and salt, and in return are ready to die in the last ditch in its defence.

‘ The complete individuals also of most forms of plant-life display a decided tendency to group themselves together in clumps, in patches, and in masses. Nor is this due entirely or even mainly to direct propagation, or peculiarly favourable soil or aspect, but they *actually flourish better under certain degrees of mutual pressure* [italics mine]. Our grasses and grains, for instance, cannot reach their highest development except in masses. The huge ear and priceless berry of the wheat would be impossible were it not for the support afforded to its slender stalk by its fellows in the golden billows of the wheat-fields.

‘ The towering stature and spire-like erectness of the lordly pine can be attained only shoulder to shoulder with its brethren in the serried ranks of the dense forest. Alone it dare not brave the winds of heaven to half that height.

‘ Nor is it solely between cells of the same plant or plants of the same species that relations of mutual advantage exist. It has been demonstrated of late that almost all the classes of higher plants depend for their very existence upon the existence of swarms of bacteria in the soil, which change the nitrogen of the soil, of the air, into ammonia and nitrates, in which form alone it can be absorbed by the roots of grasses and herbs. Simply destroy the bacteria and moulds in any given patch of soil by heating it, and plants will refuse to grow in it. In most cases, of course, this relation is a mere geographical one, an accidental co-existence in the same soil-bed, but in others it is so definite and intimate that a term has been coined to express it—“symbiosis” or “mutualism.”

‘ Common clover, for instance, is largely dependent for its nourishment upon the abundance of tiny, apparently parasitic organisms which attach themselves to its rootlets, known as “root knots,” which absorb nitrogen from the air and elaborate it for the use of the plant. Hence its peculiar power, so highly prized by the farmer, of not only *not impoverishing but actually enriching the soil* in which it grows [*italics mine*].

‘ A similar service is rendered by the moulds which form upon the roots of oaks and ashes in certain soils.

‘ In the plant-world, at least, there is *no antagonism* between “the higher life” and the lower; in fact, the former absolutely depends upon the latter. It would, of course, be absurd to claim that any feeling

of affection or conscious purpose was present in, or prompted by, these mutual relations among vegetable cells, but still it seems hard to imagine its occurring with *such tremendous frequency and constancy* without some blind instinct of combination, some dim sense of solidarity, on the part of one or both groups [*italics mine*].

‘My main object in dwelling upon it is simply to call attention to the fact that combination is as essential and important a law of Nature as antagonism, friendly co-operation as hostility.

“‘Live and let live” is as necessary a part of the struggle for existence as “war to the knife.”’

The above passages are taken from Dr. Woods Hutchinson’s ‘The Gospel according to Darwin.’ With the author’s conclusions on these matters, needless to say, I have little fault to find, except that I would emphasise the importance of ‘live and let live’ throughout as the true method of evolution, compared with which ‘war to the knife’ occupies only a very subordinate position. For further detailed information concerning mutual aid and altruism in Nature, I would refer the reader to Kropotkin’s ‘Mutual Aid’ and Henry Drummond’s ‘The Ascent of Man.’

CHAPTER VII

THE ETERNAL FEMININE IN NATURE

‘Analogy would lead me one step farther, namely, to the belief that all animals and plants are descended from some one prototype.’—DARWIN.

‘How can those seeds which contain essential oils, rendering them unpalatable to birds, have been made to secrete such essential oils by these actions of birds which they restrain?’—HERBERT SPENCER.

‘Indessen freut es immer, wenn man seine Wurzeln ausdehnt und seine Existenz in andere eingreifen sieht.’—SCHILLER.

‘Wo fass ich dich, unendliche Natur? Euch Brüste, wo?’—GOETHE.

THE importance of the ‘Eternal Feminine,’ as expressed by that phrase in social relations, I believe dominates the whole process of evolution, even to the relations which obtain between the plant and animal world.

The case of the defensive partnership formed between plants and ants illustrates the way in which complements arise in Nature, and how their normal relation is one of give and take. The ants constitute themselves into a body-guard for the defence of the tree, and receive from

it an equivalent for their services in the form of board and lodging. 'The preventive policy seems as if based upon a quite rational deed of agreement.'¹

Though we may deny conscious choice or deliberate action in these relations, we cannot deny that they constitute economic relations. The example shows:

(a) That, generally speaking, those organisms which are capable of maturing bio-economic values, like the tree in this instance, or able to offer valuable services like the ant, may in various ways command counter-services when opportunities arise of establishing mutually useful relations;

(b) That the preservation and survival of such types are better secured than those of predaceous types which have nothing to offer, whose existence must, on the contrary, place them in precarious antagonism with those whose increasing health and strength repose in systematic reciprocity and mutual aid;

(c) That it is the meek, anabolic, vegetative and female element in particular that is characterised by survival value;²

¹ Massart and Vandervelde.

² We have seen how Darwin attaches great importance to the possession of 'anything peculiarly favourable' in the organisation, and how *a fortiori* this is true of the possession of favourable bio-economic peculiarities (qualifications). The plant shares with the female of animal species one very important 'favourable' peculiarity: indispensability—particularly by virtue of (complemental) physiological labour, of gestation, and of eugenics. It is a 'peculiarity' that counts for a great deal in survival.

(d) The principle of mutuality is universal, and certainly more ancient than the race of man.

A further inference I draw from this by no means isolated case is that the general influence of the plant kingdom upon that of the animal during evolution has been decidedly educative, and is throughout comparable to that which the 'female of the species' has had upon man. The long-suffering plant kingdom has yet in numerous silent ways managed to contrive the success of the truly useful, and to bring about the ultimate decline of those organisms which misused the established relation of 'give and take' between the two kingdoms.

Darwin has shown the gain of strength within the vegetable kingdom by maintenance of adequate relations (cross-breeding) between the sexes. It was only after a great number of generations that what I consider to be a true super-adequacy of force, due to proper plant-eugenics, became apparent. The immediate results in Darwin's experiments frequently seemed to show that self-fertilisation was not prejudicial to size and numbers. It was the remoter and permanent result, however, that led Darwin to declare: 'Nature abhors perpetual self-fertilisation.'

I would emphasise the further implication that the cross-fertilisation mode is superior, not only as a superior method of plant-eugenics, but also because of its greater subservience to organic solidarity in general. A striking

example of the portentous value in racial and general utility of a combination of cross-feeding and cross-breeding modes in a plant is presented by the case of the clover. Says Professor James Long : ' There is nothing in romance or ancient story more thrilling than the fact that by the employment of certain *mineral* fertilisers [cross-feeding !] the clovers and superior grasses, almost unknown before, appear and grow with luxuriance ; while the inferior grasses and weeds disappear, unable to contend against those species of plants, which, fed by men [cross-fed !], obtain the mastery of the situation.

' Clover is a deep-rooted plant and a nitrogen-gatherer, while it *revels in particular minerals*, sometimes one alone, although sometimes two or three are required. Thus, when these foods are supplied, clover responds with its beautiful foliage, its roots simultaneously piercing the soil to great depths in search of water, and at the same time appropriating foods which they find down below, and which they bring near the surface *for the benefit* of [co-operation !] neighbouring shallow-rooted plants ' ¹ [*italics mine*]. Darwin rightly laid great stress on the greater health and powers of resistance, and the greater constitutional vigour, exhibited by the cross-fertilised plants in his experiments. What I urge is that in so far as this is the case they can thus afford better exchange values by way of nutritive amphotism with the animal, and thus conduce to a general advance of

¹ *Daily News*, May 16, 1913.

organic gestation. I have already referred to the case of *Linaria vulgaris*, which, being cross-fertilised, was incessantly visited by bees. Whilst this case bears out the ecological aspect, it remains to be pointed out that the protracted 'gestation' of the cross-fertilising mode in the vegetable world constitutes a vitally important complement of the protracted 'gestation' characterising cross-feeding and cross-breeding in the animal world. Nuts, for instance, which are so largely eaten by mammalia and birds, according to Dr. Wallace, are chiefly the products of trees or shrubs of considerable longevity, and, as we may say that in general a protracted gestation underlies longevity,¹ we can see that there exists a significant correlation between the processes of gestation and maturation in the plant kingdom on the one hand and in the animal kingdom on the other.

Just as woman is presumed during long ages to have been the selector and to have controlled all sexual relations, just as nothing can be evolved except through and by the female of each species, so also the plant constitutes, more generally speaking, an indispensable complement of the animal, and must have contributed its definite share to the evolution of higher types. We

¹ 'Mr. E. Ray Lankester has recently discussed this subject, and he concludes, as far as its extreme complexity allows him to form a judgment, that longevity is generally related to the standard of each species in the scale of organisation, as well as to the *amount of expenditure in reproduction and in general activity*' [*italics mine*].—Darwin. *The Origin of Species*.

know that in the present, as in the past, the distribution and migrations of plants and of animals over the earth are in many respects closely bound up with each other. In any case, no animal has the power to satisfy one single impulse of hunger without the co-operation of the vegetable world ; and if fertilisation has also been viewed as an anabolic restoration, renewal, and rejuvenescence of a katabolic cell, we may similarly regard the satisfaction of hunger by an animal as an attempt at restoration and maintenance of indispensable plant anabolic complements.

Fechner expresses views very similar to those here set forth. He is of opinion that ‘ jeder Organismus mit der Welt in gewissem Sinne verwachsen ist ’—every organism has in a certain sense evolved in correlation with the world—and that, as regards the interdependence of the inner life of all organisms, flower and insect typify for us ‘ gleichwiegende Faktoren eines lebendigen Wechselverhältnisses ’ (equivalent factors of a living reciprocity). Whilst arguing for the existence of a plant soul, he avers that in any case plant and animal are the two great factors in Nature’s household, somewhat in the same way as male and female are the two great factors of the human household.

According to Fechner, the significance of the masculine or animal lies more in the internal life, that of the plant and female more in the expression of beauty—the masculine representing the aspect of purpose, the female rounding it off and containing it in beauty.

In any case, however, both parties are essential ; and if we have at last learned to reverence more justly the wonderful institution of motherhood and womanhood, and to recognise, in Walt Whitman's words, that

Unfolded only out of the perfect body of woman
Can a man be form'd of perfect body

it remains for us similarly to do justice to the claims of plant life in this connection.

Beauty in the female and purposiveness in the male, or their co-existence in either, have their foundation in adequate relations between the two great parties in the household of Nature, plant and animal, and he who runs may read on every hand that an abuse of these relations produces ugliness and criminality,¹ which I interpret as the result of an imperfect nutritive amphotism.

The earth, according to Fechner, is the grand matrix of all organic life and reality.² We rise upon the earth, says Fechner, 'as wavelets rise upon the ocean. We

¹ 'The habitual murderers, the professional assassins and liars-in-wait, like the alligator, the rattlesnake, the puff-adder, and the shark, bear the brand of Cain on every inch of their surface—in their dull, muddy, blotchy colours, uncouth or hideous shapes, and general repulsiveness of appearance,' says Dr. Woods Hutchinson.

² 'Reality,' said the late Professor James, from whose work 'The Pluralistic Universe' the above translation of Fechner's idea is taken, 'may exist distributively, just as it sensibly seems to, after all.' What we do, however, according to Professor James, is 'to harness up reality in our conceptual system, in order to drive it the better'—'conceptual map-making.' What he would study is 'the world of causal and dynamic relations, of activity and history.'

grow out of her soil as leaves grow from a tree. The wavelets catch the sunbeams separately, the leaves stir when the branches do not move. They realise their own events apart, just as in our own consciousness, when anything becomes emphatic, the background fades from observation. Yet the event works back upon the background as the wavelet works inside the branch. The whole sea and the whole tree are registers of what has happened, and are different for the wave's and the leaf's action having occurred.'

If Fechner is right, it follows that it is very important we should consider that nutrition is a means of maintaining adequate relations with the earth, i.e. of replenishing our vitality from the great store of the earth. Whole-some plant food is thus a means of importing vital 'earth-force' or 'soil-reality' into the constitution of the animal. Where abuse is absent, the animal, which cannot draw directly on the soil as the plant can, obtains adequate force in just proportions. It obtains proper 'female' qualities needed in its constitution to balance the 'male' (or katabolic) qualities, and thus to maintain beauty and symmetry and its proper male-female character. In the alternative event, however—with depredation—the felony of the partner (the animal) turns the gift of the plant into a poison—'der Blumen Rache'—and the plant evolves in self-defence contrivances of an antagonistic order. Still less, as we have seen, can an animal afford in the long run to obtain

force second-hand by in-feeding, which means a shortage of indispensable complemental qualities, resulting in corresponding abnormalities (dimorphism).

The soil-theory of evolution, held by some of the older naturalists, indeed becomes somewhat intelligible in the light of the above considerations concerning nutrition and the complements involved in the processes of its maturation.

Thus a French writer, Trémaux, stated : ‘ *La perfection des êtres est ou devient proportionnelle au degré d’élaboration du sol sur lequel ils vivent ; et le sol est en général d’autant plus élaboré qu’il appartient à une formation géologique plus récente.*’ And a critical contemporary of Darwin states : ‘ It is amusing to find that Mr. Darwin occasionally invokes the assistance of the soil to eke out the deficiencies of Natural Selection.’

We may say that as soon as the fertility of the soil is able to meet the demands of more highly organised plants, theirs is the prior claim to soil sustenance, much in the same way as in the human body the brain, as the highest organ, has the prior claim on the blood supply. Thus the benefits of fertilisation are distributed according to value and qualification ; and thus it is that the advent of higher values and qualifications everywhere sets up a new order of things, a new dispensation, with a new level of life and a new distribution of organic assets.

If we consider, with Fechner, the earth as the grand complement of the organic family, we may see how in a

general way, and greatly through nutrition, there had to be this interaction between soil and organism, and we can see in this an additional reason for avoiding predaceous exploitation of the soil ('Raub-bau'). Truly it is said in the Scriptures that 'thou shalt be in league with the stones of the field.' We speak of 'mother' earth, and in Greek mythology Antæus, the giant of Libya, the son of Poseidon and Gæa, when thrown in combat, derived fresh strength from each successive contact with his mother earth, which is figurative of the way in which we still obtain 'Antæus'-force from mother earth by remaining in adequate contact with her. This task, I submit, is performed by proper nutrition—a system of reciprocal elaboration and maturation, enabling us to maintain the process at a high degree of efficiency whilst conducting by the very beneficence of its correlations to the maintenance of a maximum of organic endowments at a minimum of cost. It is in this way also that nutrition has a predetermining evolutionary value, and—although otherwise a mechanical cause—ultimately involves the teleological, and is pre-eminently calculated to subserve 'dem Wahren, Schönen, Guten.'

What Robert Chambers terms the 'long-enduring gestation of Nature' is thus, in my opinion, primarily constituted by the reciprocal maturation of qualities by plant and animal, which qualities, when fused by adequate cross-feeding, are calculated to produce a 'nutritive

amphimixis' analogous to the fusion of reciprocally differentiated germ-cells in sexual amphimixis. *Such 'nutritive' amphimixis—preceded, as it requires to be, by adequate reciprocal activities—by restoring Force, Qualities and Balance (metabolic and morphological), constitutes, in my view, the most potent factor of progressive evolution.*

Sexual union was only a repetition of the same reciprocal method on a higher plane, and rather more concerned with the husbanding of those 'higher' values and qualities which have arisen as a superstructure upon the nutritive life.

On the structural side one good result of this 'long-enduring gestation of Nature' was the perfection of the human pelvis, which gives the organic structure necessary for sustaining an erect position. The progressive evolution of pelvic elements, in my opinion, depends on the progress of complemental gestation processes—nutritive (bio-economic) as well as sexual. In any case the retrograde developments as regards the pelvis can be traced to abnormal feeding habits—habitual abuse of the anabolic complement by the animal—just as other anatomic deteriorations are traceable to the same source. The reptiles, once possessed of greater pelvic advantages, now crawl on their bellies.

In 'Nutrition and Evolution' I have shown that in the vegetable kingdom also the strength and rigidity of 'erect' plants—the presence of sclerenchyma—depend on their mode of nutrition. As examples of useful types

we may instance the cotton plant, its fibre being full of elongated cells, also the oak, ash, and elm, all hardy and useful plants. On the other hand, parasitic plants, at any rate those without green leaves, in-feeders like the broom-rape and the dodder, can only maintain herbaceous, soft and short-lived stems, with at best isolated strands of wood and phloëm tissue.

From all of which again it follows that it is a combined and co-operative nutritive and sexual gestation of appropriate qualities that has produced the highest results in evolution.

CHAPTER VIII

ADEQUACY OF FORCES

‘Nature always works with long roots.’—HENRY DRUMMOND.

‘The general character of the Gasteropoda as a class is harmless, like that of the herbivorous mammalia.’ . . . ‘The humble *Helicidae* (snails), a family of Gasteropoda, are the first animals which we encounter as adventuring upon the firm surface of the globe.’ . . . ‘The (peculiarly destructive) Cephalopoda do not advance like these to land forms, with apparatus for aerial respiration.’—ROBERT CHAMBERS.

As I have pointed out, in the absence of a systematic biological analysis and particularly through the neglect of the study of nutrition, the subjects of quality and adequacy have hitherto received too little attention at the hands of experimenters and thinkers alike.

Robert Chambers, of the old school of theorists, was a geologist rather than a physiologist. Although he otherwise emphasised the importance of prolonged gestation as a factor of evolution, he did not realise the importance of nutrition as a predetermining force in the protracted gestation processes of Nature. Very commendably he affirmed, however, that whatever it be that produces retrogression in Nature, it is but a reversal of

the order which originally produced progress. Thus, referring to such cases as prominence of jaws, recession and diminution of the cranium, and certain classes of monstrosities which, in his view, provide an illustration of a reversal of progressive evolution, he says :

‘It is no great boldness to surmise that a super-adequacy of force in the measure of this under-adequacy (and the one thing seems as natural an occurrence as the other) would suffice in a natatorial bird to give it as a progeny the ornithorhynchus, or might give the progeny of an ornithorhynchus the mouth and feet of a true mammalian, and thus complete at two stages a passage from one class to another.’

Very pertinently he goes on : ‘Perhaps, with the bulk of men, even those devoted to science, the great difficulty is, after all, in conceiving the particulars of such a process as would be required to advance a fish into a reptile. And yet no difficulty could well be less substantial, seeing that the metamorphosis of the tadpole into the frog—a phenomenon presented to our observation in countless instances every spring—is, in part at least, as thoroughly a transmutation of the fish organisation into that of the reptile as the supposable change of sauroid fishes into saurian reptiles could ever be. It is different, as being only a process in ordinary gestation ; but it realises, *as far as the necessary organic changes are concerned*, the hypothetical view of an advance of one grade of animal forms into another. There is another fact connected

with the reproduction of the batrachian order of reptiles, that, when the young are enclosed in a dark box sunk in a river, with holes through which the water may flow, the animals grow, but never undergo their destined change ; they become gigantic tadpoles, and the reptile characters are not developed. Here the progeny of a reptile literally becomes a fish, and transition of species is thoroughly realised, although in retrogression. And this is an instance in which the whole animal is concerned. Now surely no one will deny that that which we see Nature *undo* she is able to *do*, and might be seen *doing*, if the proper occasion were to occur, or were the requisite attendant conditions realised.'

Having already pointed out in some detail what constitutes the double gestation process of Nature, I have but to add that the case of the tadpole, here instanced, provides an example of the progressive evolution of a cross-feeder—the tadpole being one of those types that have remained faithful to primitive cross-feeding habits. The general adequacy of such habits, as I have already shown, is sufficient to provide the ' requisite attendant conditions ' of progress.

In those cases, however, where the force originally derived from cross-feeding is turned to abuse, just as in the above instance where it is artificially diverted, it is apt to produce arrested development or precocious maturity, or monstrosity, as the case may be.

The metamorphosis of the Batrachians is thus typical

of the way in which variations arise in Nature through influences upon, or modifications in, the various processes that are vital in 'natural gestation' and the case in point certainly presents a more pertinent and a more legitimate example of progressive evolution than the case of domestication, which is a comparative surface-change only.

It is remarkable in this connection that the Batrachians excel by various forms of protection of the young and of direct nursing by the parents.

It was recognised by Darwin that (apart from changes in the environment, such as climate, vegetation, competition, enemies), certain habits play a part in the 'transition of forms.'

In 'The Origin of Species' he tells us : 'As we sometimes see individuals following habits different from those *proper to their species* [*italics mine*] and to the other species of the same genus, we might expect that such individuals would occasionally give rise to new species, having anomalous habits, and with their structure either slightly or considerably modified from that of their type. And such instances occur in Nature. Can a more striking instance of adaptation be given than that of a woodpecker for climbing trees and seizing insects in the chinks of the bark? Yet in North America there are woodpeckers which feed largely on fruit, and others with elongated wings which chase insects on the wing.'

The emphasis with Darwin, however, is on the mechanical aspect of particular habits rather than on the

general morphological, bio-economic and eugenic effects universally associated with nutritional habits. He overlooks that it is the antecedent (positive) factors of 'nutritional gestation' which provide the clue to all later developments. Instead of recognising the fundamental importance of these factors, Darwin—rather superficially, though it is important genealogically—refers us back to some 'unknown prototype,' equipped (or 'furnished') with such wonderful endowments (we must suppose) as to render all future steps of evolution comparatively easy. Thus, in speaking of the swim-bladder as a good illustration of how an organ originally constructed for one purpose, namely flotation, may in course of evolution be converted into one for a widely different purpose, namely respiration, he says: 'According to this view it may be inferred that all vertebrate animals with true lungs are descended *by ordinary generation from an ancient and unknown prototype, which was furnished with a floating apparatus or swim-bladder*' [italics mine].

An ancient and unknown but accommodating prototype! Given a million of years of orthogenesis for the production of an appropriate prototype, and what future possibilities may we not expect? If this ideal prototype had been an in-feeder dwelling at the bottom of the sea, it would scarcely have attained to aerial respiration! It was, on the contrary, the sufficiency of a protracted 'nutritional gestation,' which produced the prototype, i.e. laid the auspicious foundation for later eugenic

transformations. According to Cope, the point of departure of progressive lines 'has not been from the terminal types of the lines of preceding ages, but from points further back in the series.'

Progress depends upon long roots, i.e. upon a sufficiency of nutritional (natural) gestation. We cannot expect 'terminal types,' insufficient in this respect, merely because they preceded in time, to have been the ancestors of our progressive lines. Just as the passing of every organism through the unicellular condition in sexual reproduction is indispensable to rejuvenescence and to the thorough blending of ancestral and evolved qualities, so the sufficiency of a genuine, co-operative 'nutritional' amphimixis alone can guarantee permanent progress. Just as, on the other hand, asexual modes of propagation are possible for temporary purposes, so less sufficient modes of 'nutritional' gestation are possible for a time, although neither provide the conditions for progressive evolution or for the arrival of useful prototypes. These vital considerations, however, have been consistently overlooked by previous writers.

The 'Vestiges of Creation' provides another interesting case of morbidity and tendency towards monstrosity resulting from surfeit. 'When the eggs of the wild goose,' says Professor Low, 'are taken, and the young are supplied with food in unlimited quantity, the result is remarkable. The intestines, and with them the abdomen, become so much enlarged that the animal nearly loses the power

of flight, and the powerful muscles which enabled him in a wild state to take such flights become feeble from disease, and his long wings are rendered unserviceable. The beautiful bird that outstripped the flight of the eagle is now a captive without a chain.'

As regards the atrophy of the wings and pectoral arch, which means a loss of the most marked characteristic of birds—their power of flight—it is hinted by Matthew Davenport Hill, M.A., F.Z.S.,¹ that absence of enemies, abundance of food, and the mysterious law of correlation (of structures) may all have had something to do with the phenomenon.

In view of his uncertainties on these matters, however, the writer has one 'certain' explanation ready at hand: Natural Selection.

His useful little article nevertheless shows us that the 'misère' of flightless birds is associated and correlated with their in-feeding habits. They are usually of large size—too heavy and surfeited for flight. 'Muscular tissue and general vertebrate anatomy being what they are, we may safely assume that no animal much larger than a man ever flew through the atmosphere of our planet.'

We are also told that 'there can be little doubt that the reptilian forerunners of birds generally were terrestrial, and probably arboreal, animals, not aquatic, as some writers have suggested,' which, in my opinion, points to the fact that these reptile forerunners of birds must have

¹ *Knowledge*, August 1911.

been largely cross-feeding animals, living in a more advanced degree of association with vegetation than is possible in the water. By breaking away, however, from their primitive cross-feeding habits and taking retrogressively to an aquatic habitat, they became 'gigantic' degenerates, whose 'misère' is of the same nature as, though more pronounced than, that of the wild goose mentioned above.

Mr. Davenport Hill introduces us to one of the most ancient known birds, *Hesperornis*, found in the Cretaceous shales of Kansas, which had lost the power of flight completely.

'The bird was a *gigantic diver*, allied to the grebes of to-day, so well adapted to an aquatic habitat that it probably rarely, if ever, walked on land. The set-back of the legs, and the large knee-cap and enemial crest, seem to have rendered *an erect position impossible*.'

I have italicised what is important in this passage as pointing to the broader correlations that we have now seen to exist between habits and organisation.

An instance from plant life, showing how monstrosity resulting from surfeit and abnormal metabolism is correlated with ecological deterioration, is presented by the case of gigantic mushrooms. In proportion to the increase in dimensions they become more and more unwholesome, if not actually poisonous—they lose in amphotism-value, and they cannot conduce to general eugenics (or progressive evolution) as adequately as in the unsurfeited condition,

CHAPTER IX

EVOLUTION BY PARASITISM

‘The extinction of species has been involved in the most gratuitous mystery.’ . . . ‘No one can have marvelled more than I have done at the extinction of species.’—DARWIN.

‘Woe to him that increaseth *that which* is not his! how long? and to him that ladeth himself with thick clay!’

‘Because thou hast spoiled many nations, all the remnant of the people shall spoil thee.’—HABAKKUK II.

‘Be not afraid, ye beasts of the field: for the pastures of the wilderness do spring, for the tree beareth her fruit, the fig tree and the vine do yield their strength.’—JOEL II, 22.

My general thesis as regards parasitism (as stated in a previous chapter), that it is an offence against the normal order of Nature, inasmuch as it disturbs the reciprocal relations between animal and plant and between complementary groups of each—and is consequently and inevitably punished by degeneration and decline in the long run—is borne out by the facts disclosed in a suggestive little work, prefaced by Professor Patrick Geddes, on ‘Parasitism, Organic and Social,’ by Jean Massart and Émile Vandervelde. This book attempts to show the relations between parasitism among plants and animals

and parasitism in human society, and furnishes much evidence of the truth of my contention.

Thus, we are told that one mode of getting nourishment is by obtaining it directly from inorganic material, as most green plants do. This mode of nutrition, which I would comprise under 'cross-feeding,' the authors term *holophytic* (*a*).

'The seed-bearing plants, or Phanerogams, are almost exclusively holophytic (cross-feeders). . . . The holophytic method is evidently the most primitive.'

An organism may 'utilise the débris, the excreta, the dead bodies of other organisms. It is then said to be *saprophytic*, *coprophagous*, or *necrophagous*' (*b*).

Or it may live on the very substance of another organism, either destroying its victim, as *predatory* organisms do (*c*); or exploiting it, after the manner of parasites (*d*); or getting nourishment from it in return for services rendered, as in mutualism (*e*).

Needless to say, modes *b*, *c*, and *d*, on my classification, would come under 'in-feeding,' whilst (*e*), the most important of all (in my opinion), comes under the head of 'cross-feeding.'

We learn: 'The primitive holophytic organisms must have been followed by those which were able to feed upon organic débris and to reduce that once more to inorganic material. The occurrence of saprophytes is essential to the conservation of life. If the saprophytic, coprophagous, and necrophagous organisms disappeared, dead bodies and

excreta would accumulate on the earth's surface, all the material utilisable by animals or by plants would be locked up in the remains, and if there were no power to restore the dead material to an inorganic state the earth would soon become nothing but a gigantic charnel-house.

'Thus it was only after the establishment of holophytic and saprophytic organisms that it was possible for predatory, mutualist, or parasitic forms of life to appear.

'The parasites may have been derived from forms which found their sustenance in any of the four ways already mentioned. The *Thinanthaceae*, such as the yellow-rattle, are derived from holophytic *Scrophulariaceae*; the fungi which live at the expense of other plants are often traceable to saprophytic ancestors; the barnacle-like *Cirripedia* which exploit crabs are descended from carnivorous crustaceans; and the humble-bees which steal the nectar of the toad-flax (*Linaria*) began with taking the honey as a reward for carrying the pollen from flower to flower.'

This I take to show in the main that in-feeders are descended from cross-feeders, whatever may have been the necessities and temptations that have led many types to deviate from their primitive feeding habits.

We also learn that elaboration of food by the organism, even when it is obtained without effort, is a matter of some consequence and prevents the extreme consequences of pure parasitism in the way of degeneration, for 'the

Isopod crustaceans, which live in the mouths of fishes and take their food just as it has been seized, before it has been subjected to any process of digestion, have retained all their digestive organs.' To this type of parasite Van Beneden has applied the term *commensal*.

'Worms and other animals which infest the alimentary canal illustrate a more advanced stage of parasitism ; they take food which has been more or less digested, and therefore they are able to dispense with, and are generally without, those organs whose function it is to render the food diffusible.

'Finally, those parasites which live in the blood and the tissues, and thus obtain completely assimilated material, are in most cases without any digestive system. They are fed by diffusion from the nutritive medium in which they are bathed.' And further that 'certain saprophytic, coprophagous, or necrophagous species may become completely transformed into parasites ; others, while preserving their original mode of nutrition, may exhibit characters which link them more or less closely to parasites.'

Further interesting items bearing on points that I have previously raised are :—

(a) '*Parasitism involving the Exploitation of Energy*.—Belonging to this category are those organisms which rob another creature of part of its physical energy. These are not usually regarded as parasites, although it is plain enough that one may live at another's expense by utilising

his energy as well as by robbing him of his substance. Of course it is a question of definition, but it seems to us useful to bring those forms which take advantage of the energy of their neighbours, or of external resemblance to them, under the same category as those which borrow nutriment. For there are very close affinities between these phenomena,—a fact often unrecognised, since the facts are studied separately.'

(b) *A Return from Parasitism*.—'Many plants which ordinarily perch themselves on the trunks of trees are found from time to time growing on rocks, or sending roots into the ground, thus returning to an inorganic support.'

We next come across an economic argument: 'It is quite inconceivable that an animal or plant should draw its nutriment continuously from another of its own kind without destroying it; or even that it should exploit the energies of its fellow for any length of time without exhausting the latter's vitality.'

What seems equally inconceivable to me is that parasites can carry on such a process for any length of time without injuring themselves, and without seriously disturbing the balance of the organic world generally.

In the place of the elegant observation made by the authors that 'Natural selection has raised the parasitic habit to the dignity of a specific character,' I would say that at best only the undignified rôle of scavengers remains open to those organisms which are slowly travelling along

the lines of mere (selfish) expediency, and hence in the pathological direction. Though finally diverging far enough from their normal kin to make different classification convenient, such divergence, in my opinion, does not confer dignity upon an organism any more than does the mere fact of (redundant) reproduction. The only measure of dignity in Nature, in my opinion, is loyalty to bio-economic service.

The fact that, in the authors' own words, 'Degenerate parents do, it is true, rear degenerate offspring,' conveys to my mind little idea of dignity in parasitism. The authors also are agreed that in the social world, the social body is injured in its substance, i.e. its resources, by parasitism: 'In the social, as in the organic sphere, the smaller the amount of effort required in exploiting its victim, the more accentuated and typical becomes the parasitic character of the exploiting agent.'

Another chapter bears on the evolution of Parasitism: 'It would be exceedingly interesting to know accurately what are its beginnings and predisposing causes . . . Among plants, and among the Protists, or simplest forms of life—such as the Bacteria, which seem to incline to the vegetable type—parasitism is always derived from a holophytic or saprophytic mode of life. We shall illustrate this by examples taken at various stages of plant-life, from the Bacteria to the Phanerogams.

'The tubercle bacillus may serve as the example of this final stage in the evolution of a habit which takes its

origin from a holophytic mode of existence. Parasitism more complete it is impossible to conceive. For this organism is in the first case incapable of developing at all unless within its proper host. It draws its food-supply from the lymph and cellular substance of its victim, and is indebted to the blood not only for oxygen but also for the warmth that is a necessary condition to its continued existence, its adaptation to the temperature of the body it inhabits being so complete that it can hardly survive a transference. Nay, so thorough is its dependence that, powerless to move itself, it is indebted to the heart-beat of its host for the force which, carrying it along the blood-current, enables it to spread through the whole system.'

'The transition from holophytism to parasitism is still more obvious in the teratological phenomenon known as variegation. Upon the leaves of many plants, especially Japanese ones, there are areas entirely devoid of chlorophyll. The cells of these colourless parts are therefore incapable of effecting the *organic synthesis characteristic of plants* [italics mine], i.e. they are incapable of absorbing carbonic acid from the air, splitting it up by the aid of the radiant energy which passes through the green colouring matter, liberating the oxygen, and retaining the carbon as the basis of new organic compounds. They are therefore compelled to exist as parasites upon the green parts of the plant. This chlorosis may even extend to a whole branch, in which

case the helplessness of this part is shown readily by the fact that a cutting made from it cannot live. Be it observed, however, that in such cases of variegation we have to deal, not with one individual living at the expense of another, but merely with a group of cells which makes the rest of the colony minister to its necessities.'

This last case, in my humble opinion, presents an analogue to that of the pathological and antagonistic cell-development in cancer. In any case such an instance of pronounced pathology and precariousness as presented by these examples of the tubercle bacillus and of chlorosis among plants must preclude every idea of the 'dignity' of parasitism, however frequently it may give rise to fresh classifications in text-books.

Another lesson is that : 'Certain species of *Botrytis* live at the expense of living plants, but are incapable of successfully attacking one which is completely healthy. They always begin by installing themselves in a cell which has perished for some reason or other ; and taking this as their base of operations they extend themselves and carry death to the cells around.'

We may thus conclude that it is the ill-health—in particular, I would urge, the excess of nutrition and the resulting surfeit and morbidity—of otherwise or previously strenuous organisms which we must hold largely responsible for an intensification of the in-feeding diathesis among saprophytes. A congenial soil (surfeit)

in one organism frequently is an invitation to parasitic indulgences on the part of another. The in-feeding habit in particular seems to produce a fertile soil for an intestinal flora. Individual balance stands thus in correlation with organic balance generally.

As regards the evolution of Parasitism among animals we learn: 'The critical methods of embryology and of morphology alone are in most cases sufficient to establish the fact that among animals proper—which are characteristically predatory organisms—the parasitic mode of life is nearly always derived from a previous predatory one. This appears to be true also of those Protists (or simplest living forms) which incline rather to the animal than the plant type.'

'Anatomy and physiology corroborate the indications thus given by embryology, and all agree in supporting the theory that the parasitic form of life in these cases has been evolved from the predatory one.'

Apart from the insinuation that animals proper are 'characteristically predatory organisms,' which, in the light of Bio-Economics, we may now dismiss as an absurdity, we have here the important recognition that in the case of the animals parasitism is very frequently, if not generally, preceded by depredation, i.e. that the in-feeding habit may become intensified, and thus lead to the parasitic diathesis proper.

We are told by way of illustration that 'the gasteropod molluses are for the most part *herbivorous* or *carnivorous* ;

but a few species live as parasites upon Echinoderms' (*italics mine*).

Surely, then, at least in the case of the herbivorous species, it remains to be seen whether they are all alike and necessarily predaceous, whether they are 'Pflanzen-Raubtiere' or otherwise. In any case we cannot argue from abuse as to use. Again I protest that, although the 'critical methods of embryology and of morphology' are useful genealogically, unless they include the study of 'natural gestation,' they really beg the question of Orthogenesis, just as much as do Darwin's frequent references to prototypes and 'dominant races.'

This is almost conceded by Darwin, who often refers to 'our ignorance of the past history of each species,' speaking of the advent of the mammary glands, common to the whole class of mammals and indispensable for their existence. They must have been developed at an extremely early period, 'and we can know nothing positively about their manner of development.' Even the suggestion of marsupial origin remains purely genealogical, though containing an adumbration of prolonged parental care and of cross-feeding in the 'natural gestation' of the mammal.

On the other hand, referring to certain parasitic peculiarities distinguishing certain groups of insects from others, Darwin perceives that they represent a kind of pseudo-inheritance *quoad* common progenitor

(retrograde metamorphosis—perfectly distinct from the primordial condition of their adult progenitors).

The hair-claspers of parasitic mites (*Acaridæ*) ‘could not have been inherited from a common progenitor.’ ‘These organs must have been independently developed.’ Again, in the curious case of the *Sitaris*—a parasitic beetle which passes through certain unusual stages of development—he says: ‘Now, if an insect, undergoing transformations like those of the *Sitaris*, were to become the progenitor of a whole new class of insects, the course of development of the new class would be widely different from that of our existing insects; and the first larval stage certainly would not represent the former condition of any adult and ancient form.’

In other words, this hypothetical case would show that a parasitic progenitor could not determine a whole class of insects according to any reliable degree of Orthogenesis, such as we are happily accustomed to, by normal progenitors. To become such a progenitor is to be compounded of forces opposed to those prevailing under parasitism. Such expressions, therefore, as prototype, progenitor, and ‘dominant race’ conceal important ancestral dynamics, the potency of which depends greatly, in my opinion, on the virtue of proper cross-feeding.

I have already shown that I need not confine myself to rank parasitism in order to prove my proposition.

Some of Darwin’s remarks may well be read as a

concession to the view that carnivorism, with its general ill-effects on size and weight, with its harmful bio-economic reactions (its negative correlations, past and present), eventually becomes a bar to progressive evolution.

Speaking of objections to his theory, in 'The Origin of Species,' he tells us :

'Oceanic islands are inhabited by bats and seals, but by no terrestrial mammals; yet, as some of these bats are peculiar species, they must have long inhabited their present homes. Therefore Sir C. Lyell asks, and assigns certain reasons in answer, why have not seals and bats given birth on such islands to forms fitted to live on the land? But seals would necessarily be first converted into terrestrial *carnivorous* animals of *considerable size*, and bats into terrestrial insectivorous animals; for the former there would be no prey; for the bats ground-insects would serve as food, but these would already be largely preyed on by the reptiles or birds, which first colonise and abound on most oceanic islands' (*italics mine*).

Reconversions as here mooted by Darwin, of course, are entirely hypothetical, but their consideration shows the 'misère' of in-feeding from the point of view of evolution. It does not seem to have struck Darwin that the difficulty of reconversion consisted primarily in that loss of metabolic response and under-adequacy of physiological force which everywhere result from in-feeding and everywhere render a progressive

gestation impossible—though with an abundance of ‘prey.’

In a general way, however, he admits this much, that ‘gradations of structure, with each stage beneficial to a changing species, will be favoured only under certain *peculiar* conditions.’ Thus once again we come across that mysterious word ‘peculiar,’ which is to explain so much, but which in reality leaves the most vital explanations to our imagination.¹ This accommodating word truly is the ‘catalytic agent,’ the philosopher’s stone, which turns all things into the desired shape in Darwinism. Instead of telling us there and then—or for that matter anywhere else—what the ‘peculiar’ auspicious circumstances are which favour an advance of type, Darwin in a trice, as if by a magic wand, transfers our attention to those ‘peculiar’ *inauspicious* circumstances which we have already seen everywhere to determine retrograde metamorphoses.

‘A strictly terrestrial animal, by occasionally hunting for food in shallow water, then in streams or lakes, might at last be converted into an animal so thoroughly aquatic as to brave the open ocean. But seals would not find on oceanic islands the conditions favourable to their gradual reconversion into a terrestrial form.’

And thus Darwin, instead of giving us some information about the ‘peculiar’ conditions auspicious to seal eugenics, leaves the seals to their own terrible

¹ ‘What that something is we can hardly ever tell,’ says Darwin.

fate. As the terrestrial organisms, because of the more complex relations to their organic and inorganic conditions of life, according to Darwin, enjoy a quicker rate of change than the aquatic, we can understand that the seal is a loser from the point of view of evolution by his carnivorous habits barring the access to the land.

Evidently it is difficult, even for the ingenuity of the greatest naturalist—though but hypothetically—to construct a progressive race without a due bio-economic foundation, without the basis of an adequate previous ‘natural gestation.’

Evidently also it is easier for organisms, by indulgence in retrograde metamorphoses, in prodigal fashion to waste the capital begotten by the labour of their progenitors than to become avatars or patriarchs of an enduring and progressive race. Broad is the road that leadeth to destruction. The huge monsters of the past have left no progeny, and Darwin tells us :

‘It may be asked, in ridicule, whether I suppose that the megatherium and other allied huge monsters, which formerly lived in South America, have left behind them the sloth, armadillo, and ant-eater as their degenerate descendants. This cannot for an instant be admitted. These huge animals have become wholly extinct, and have left no progeny.’

He also tells us, without ever adducing the ‘peculiar’ reason of these failures, that in ‘failing orders’ like the Edentata of South America—with the genera and species

decreasing in numbers—very few of these will leave modified blood-descendants.

The almost universal extinction of monstrous organisms, indeed, forms the great puzzle of Darwinists, but in reality is an extreme object lesson replete with eugenic meaning, whilst showing the utter futility of 'Natural Selection.'

These monsters (supposedly) became what they were by the 'favour' or 'operation' of Natural Selection (expediency), which 'principle' has (supposedly) for ages been looking after their welfare, and, in so doing, after that of the organic world as a whole. But suddenly, without any warning to these protégés and without apparently any provocation on their part, the 'principle' has left them in the lurch.

Why could not the 'principle,' when it suddenly shifted its favour to smaller forms (faithful on the whole to cross-feeding habits), have helped at least a few of the monsters gradually to beget more diminutive progeny? ¹

Evidently Darwinists have not considered this question, and being moreover somewhat in the dark about the inconsistent behaviour of Natural Selection, they leave us to the only supposition possible, i.e. that

¹ Darwin indeed hints elsewhere (on the Geological Succession of Organic Beings) that lack of improvement according to the principle of 'the all-important relations of organism to organism in the struggle for life' means liability to extinction. But, as he fails to show what constitutes wholesome biological relations and what constitutes genuine improvement, he leaves the problem of extinction open to a more exact explanation such as I have endeavoured to set forth.

those previously 'favoured' monsters have perhaps had too big a dose of this same Natural Selection (expedient-adaptation)—which we may well understand they must have had.

However, we can leave it to those Selectionists still possessed of some sense of humour to draw the moral from it all. But now to return to 'Parasitism, Organic and Social.'

We are told that: 'Like all ento-parasites, *Entoconcha* is an extremely degenerate organism, so that the anatomy of the adult gives absolutely no clue to its systematic position. It is only by tracing the early life-history that we are able to discover that here we have a "prosobranch" gasteropod mollusc which has been metamorphosed by a parasitic career.'

Surely such a parasitic 'career' must now be considered as a rather undignified affair, seeing it ends by obliterating even our systematic classification! Even 'Natural Selection' should be ashamed of such an unrecognisable product! Nor is it invoked so much now, when the voluntary element in the development of the disease and degeneracy is coming ever more conspicuously to the fore.

As regards the authors' contention, however, that 'the mutualist relation is rarely met with except in social groups,' I am bound to say that my view is the exact opposite, since I regard this principle of mutuality between groups of organisms as fundamental and universal,

though it has hitherto sadly lacked recognition by naturalists.

Nothing, in fact, at the present day wants emphasising more than that the whole organic world is primarily and normally based on mutualist relations, and that every step that transgresses these relations leads towards degeneration and decline.

As regards the Evolution of Parasitism in Social Groups (of men) we are told: 'In lowly-organised communities the majority must necessarily gain their livelihood either by hunting, by fishing, or by gathering such food and other supplies as are to be had for the picking up; and the number of parasitic and predatory persons must be limited by the number of individuals of whom it is possible to make a prey.'

We also learn that: 'The transformation of a race of predatory exploiters into a race of parasites—that is the whole history of the Arab tribes of the Mogreb.'

Now, however, those tribes have been broken up and their remnants constitute those 'unfortunates whom the cultivators call *Ben ramassés*, and who have no means of livelihood save begging, prostitution, and every variety of crime. In this instance, then, the parasite is a predatory exploiter whose strength has been broken, who cannot maintain his former character in the presence of a changed environment.'

Concerning the atrophy of organs which is so marked a characteristic of parasitism, we are asked to believe that

it 'is to be sought in the operation of the law of Natural Selection, favouring the survival of the fittest, that is to say, the best adapted to their environment. We may say that a disused organ becomes a parasite upon the organism as a whole, just as we say that those parts of a "variegated" plant which are destitute of chlorophyll are parasitic in relation to the green parts. Now, as soon as an organ becomes a surcharge upon the resources of the organism, that organism is handicapped in the struggle for existence. Consequently, the atrophy of the organ in question is a distinct gain, which Natural Selection tends to make permanent.'

This is confusion worse confounded. Misuse is here confounded with disuse. The true handicap, of course, is misuse in the bio-economic sense, and not disuse in the physiological sense. Whether a disused organ becomes a parasite upon the organism as a whole or not depends entirely on the nutritional state and the general condition of health of the organism.

The cancer cell is by some writers supposed to be a parasite upon other tissues of the body, but a healthy body does not allow the cells of a disused organ to prey in similar fashion upon other cells.

Massart and Vandervelde themselves provide a number of instances of the development of means of defence against parasitic attack, such as (a) Destruction of Parasites, (b) Expulsion, (c) Incarceration, (d) Localisation. The following is an example of (c): 'In the case of

certain animals—for instance, the gerbil (*Gerbillus*) and the pouched marmot (*Spermatophilus*), small rodents inhabiting respectively Algeria and Southern Russia—it has been proved that tubercle bacilli are quickly engulfed by the cells. The latter give forth a secretion which forms a hard case around the bacillus, and in this prison it finally decomposes or returns to its elements. The incarcerating process is more completely affected by the gerbil than by the pouched marmot, and this more effectual imprisonment is associated with a more complete immunity. We cannot doubt, therefore, that it is with a view to self-defence that the organism imprisons the parasite in this chamber of doom—a veritable *oubliette*.’

Disuse of an organ, therefore, need not have the effect of rendering the state of the organism pathological. Disuse may stand in healthy correlation with predominant wholesome use in other parts of the organism and with increased bio-economic usefulness generally, in which case the whole constitution tends to become more efficient and more stable, in spite of a local (progressive) atrophy. In the case of the variegated plant, however, we saw that its general condition was one of helplessness and diminished vitality.

The condition of a parasite generally being one of surfeit—‘parasitism means not only abundant, but rich and stimulating nutrition,’ according to Geddes and Thomson—there ought, therefore, so far as quantity of

nutrition and a promiscuous pabulum for 'digestive transformation' are concerned, to be a sufficiency of resources for more organs rather than a deficiency for existing organs. A loss of vital organs and what it implies in correlated changes, however, cannot be accounted a gain except in mere expediency. From every other point of view it is a horrid waste, a shocking loss all round. It is the loss of vital correlations and the resulting limitation which are tantamount to a diminution of life and of those true evolutionary resources without which an organism cannot maintain either status or structure.

Nutritive fluids there are in parasitism in plenty; but they lack quality and they are directed by other stimulations than those which result from work and reciprocity, and hence they no longer go to support the media (or organs) which used to serve the purposes of bio-economic reciprocity. There is an under-adequacy of nutritional force, which now flows in abnormal channels. The 'nutrition-currents,' as Professor Weismann terms them, with their exciting qualities, reach and affect the germ-cells, stimulating them to precocious maturation, which accelerates the atrophy from disuse. The shaping of what organisation remains is now a matter of abnormal stimulation combined with environmental expediency. Hypertrophy of the digestive and sexual organs is thus usually the ally of expediency. If Natural Selection is the agency favouring such degeneracy, again I say it cannot have played a positive part in evolution.

At a late stage in this interesting book we are introduced to the 'law of compensation,' which law goes a long way to support my theory as regards correlations in general and as regards the pathology of parasitism in particular: 'In accordance with the law of compensation,' says Schoeffle, 'parasites, since they do not expend much energy in muscular or nervous activities, should be found to be addicted to excesses of drinking, eating, and sexuality.'

We are told: 'Ought we not, then, to infer, from this tendency to abuse of the sexual function, that parasitic organisms and classes will be more prolific than their victims, will multiply more rapidly than they, and cause a steady augmentation in the number of the degenerate?'

Messrs. Massart and Vandervelde themselves answer the question, but the only consolation that they can offer is that luckily numerous factors operate against the too rapid increase of parasites, social and other. The chief of these factors are eventual reproductive incapacity and a high rate of mortality, and, in human society, Malthusian practices, all pointing to the fact that parasitism results in rank pathology and in the end provides its own punishment.

We thus reach the subject of human degeneracy, which is strictly parallel to that in the lower worlds of life, and all that I have written applies with equal force to human relations.

If we are now, in the light of our bio-economic theory,

justified in viewing the atrophy produced by renunciation of function in parasitism as a reversal of the normal order of progress, we arrive again at the indispensable conclusion that adequate activity—work in the widest sense—is the only true measure of organic values. It is work that ultimately determines both forms and values. All the diverse forms of tissues, organs and entire animals, according to Professor G. C. Bourne,¹ ‘are but the expression of an infinite number of variations of a single theme, that theme being cell-division, multiplication, and differentiation.’ ‘We shall agree,’ says Professor Bourne, ‘at the bottom production and change of form are due to increase or diminution of the activities of groups of cells, and we are aware that in the higher animals change of structure is not altogether a local affair, but carries with it certain consequences in the nature of correlated changes in other parts of the body. If we are to make any progress in the study of morphogeny, we ought to have as exact ideas as possible as to what we mean when we speak of the activities of cells and of correlation.’ Professor Bourne thus refers us to physiology, which I affirm, however, is incomplete without a knowledge of the significance of nutritional amphimixis and of feeding habits (with their correlations in the bio-economic field).

Having shown the value of these factors, I assert that a bio-economic theme, viz. work, in turn underlies the single physiological theme. It is work that converts

¹ British Association at Sheffield, 1910.

energy into biological utilities. (In Professor A. B. Macallum's view 'the living cell is but a machine, an engine for transforming potential into kinetic and other forms of energy through or by changes in its surface energy.') It is work that produces not only form but also the transmutation of form. It is work that produces relations and correlations. It is work that produces evolution and keeps it going. When all is said concerning surface tension, and regarding enzymes and hormones as ultimate agents in the production of form ; when all is said respecting the frequent destruction—and even necessary destruction—of forms, let us remember that every day, from sunrise until sunset, myriads of (plant) laboratories, factories, workshops and industries all the world over, on land and in the sea, in the earth and on the surface soil, are incessantly occupied, adding each its little contribution to the general fund of organic wealth, organic goodwill, and organic solidarity. They are busy in the production of organic utilities, not only for present use in the world of life, but also for use by future generations. The vast majority of these toilers know not why they work, and, in the spirit of the true gentleman, they do not clamour for undue rewards or for relief from their burdens. Humbly and self-denyingly they toil on, as if their greatest happiness and privilege consisted in the production of a superabundance of material, and their aim were the avoidance and removal of all want in the organic world.

In the majority of cases the altruism is carried so far as to amount to an invitation to those who need it to relieve them from the burden of the superabundantly produced food-material ('Love-Foods')—the Natural thus appearing, in Chambers' words, 'to sink into and merge in a higher Artificial.' For thousands of years the earthworm has been ploughing the land for us, nor have we yet heard of a strike on the part of this humble but indispensable fellow-creature for a higher wage. If the 'gentlemanly' instincts had not in the long course of ages far outweighed the selfish propensities—if the evolutionary process had not thus been dominated by co-operation and mutuality rather than by the 'Struggle for Existence,'—the organic world could never have attained its present position.

INDEX

- ADEQUACY of food, 19, 65, 68
et seq., 89, 159 *et seq.*, 166 *et seq.*,
 189
 Amphimixis, 52, 67, 68, 93, 155
et seq., 162, 169, 171, 193
 Analysis, biological, 11
 Ancestral dynamics, 182
 Antæus, 161
 Antithetic developments, 6, 8, 70,
 78
 Ants, 152
 Argyll, Duke of, 141 *et seq.*
 Autonomy, 29, 63, 106, 111

 BACON on impunity, 29
 Bacteria, 49, 150, 177
 Bear-food, 59
 Behaviour, 43, 58, 59
 Ben ramassés, 188
 Bio-chemical antagonism, 72
Botrytis, 179
 Bourne, Prof. G. C., on form-
 production, 193
 Breeding, selective, 26
 in-, 63
 Butler, Samuel, 97, 106, 109

 CHAMBERS, Robert, on gestation,
 39, 161
 on the cuckoo, 102
 carnivorism, 128
 blemishes in nature, 132
 Gasteropoda, 164
 Cephalopoda, 164
 retrogression, 164
 on super-adequacy, 165
 batrachians, 166
 Chlorosis, 178
 Commensals, 175
 Compensation, law of, 22, 192
 Cope, on degeneration, 61
 on non-specialisation, 80
 descent, 169
 Correlations, 90, 104, 131, 134 *et*
seq., 180
 Cross-feeding, 19, 67, 128, 166, 173
 Cross-fertilisation, 50, 51, 52, 56,
 154
 Cuckoo, 130 *et seq.*
 Currency, 54, 65, 71

 DARWIN, Charles, on cause of
 survival, 1
 on population, 1
 standard of highness, 11
 conditions of existence, 14
 mutual relations, 14, 31
 importance of habit, 16, 65
 in-breeding, 21
 famine and death, 23
 usefulness, 25
 selective analogies, 26
 retardation of reproduc-
 tion, 35
 advantage of diversifica-
 tion, 44
 self-fertilisation, 53
Linaria vulgaris, 53, 156
 significance of structure, 55
 distribution of fresh-water
 plants, 58

- Darwin, Charles—*continued*.
 on complex contingencies, 59
 carnivorous quadrupeds, 59
 struggle for existence, 95
et seq.
 effects of abundant food, 134
 common descent of plant and animal, 152
 plant-eugenics, 154
 extinction, 172
 prototypes and dominance, 168, 181
 mammary glands, 181
 parasitic mites, 182
 sitaris, 182
 failing orders, 185
- Darwinism, on economics, 16
 on factors of production, 17
 destruction, 18
 universe, 22
 a doctrine of expediency, 88, 97
 lack of persistent principle, 97
 on variations, 107
 a creed, 107, 116
- Davenport Hill, M., on flightless birds, 170
- Degeneration, 11, 14, 28, 60, 62, 64, 71, 94, 110, 172 *et seq.*, 177
- Dendrocygna autumnalis*, 79
- Depéret, Charles, on slow transformations, 74 *et seq.*
 on aberrations, 75
- Diathesis, 6, 21, 76, 179, 180
 parasitic, 76
- Dimorphism, 6, 9, 78
- Dissociation, 71
- Dixon, Charles, on Natural Selection, 95
- Drosera, 35
- Drummond, Henry, on altruism, 2, 17
 on love-foods, 20
 struggle for life, 38
 moral order, 131
- ELABORATION of food, 174
- Elephants, 77, 128
- Endosperm of Indian corn, 67, 68
- Eugenics, 11, 26, 154
- Euripides, 55
- Extinction, 6, 77, 108, 172
- Extreme determination, 144
- FECHNER on reciprocal differentiation, 96
 on disharmonies, 99
 reciprocal relations, 157
et seq.
 reality, 159
- Fertilisation, 43, 51, 68, 157, 169
- Flourens, 111
- Food, co-operative production, 14, 33, 40, 44, 50, 157
- GEDDES and Thomson on fitness, 37
 on the cuckoo, 102
 parasitism, 190
- Gerbil, 190
- Goebel on quality of food, 64
- Goette on reproduction and death, 38
- Grant Allen on cross-fertilisation, 50
- Gresham's law of currency, 71, 135
- Gyrodactylus*, 35
- HABIT, 13, 16, 43, 63 *et seq.*, 103, 119, 131, 167
- Hatschek on function of fertilisation, 52
- Hesperornis*, 171
- Horse, 45, 80
- Hutchinson, Horace, on amity in nature, 147
- Hutton, F. W., 128
- Huxley on danger of dogmatism, 24

- Huxley on Darwin's selective analogy, 25
on ethics, 40
population, 100
Hymenoptera, 4, 7, 91
- IN-FEEDING, 19 *et seq.*, 63, 65, 73, 77, 168, 173
Infant-destruction, 18, 19, 21
Instability, 11
Interdependence, 45
Irreversibility, 75
- JAMES, Prof., on reality, 158
- KENT, C. B. Roylance, 133, 147
Kerner, on reciprocity in nature, 14
on poisonous plants, 54
Koran, 73
Kropotkin, P., on altruism, 17
- LANKESTER, Sir E. Ray, on mutual service, 2
on man's vegetarian ancestors, 12
degeneration, 60
extinction, 66
correlations, 134 *et seq.*
longevity, 156
Leduc, S., on Synthetic Biology, 71
Lichens, 49, 81
Lindsay, Dr. A., on Darwinism, 30
on medical science, 126
digestion, 130
Long, Prof. James, on mineral fertilisers, 155
- MACALLUM, Prof. A. B., on cell mechanics, 194
Maeterlinck on apiens, 4
on evolution of the bee, 7
- Malthus, 17, 18, 32, 40
Mammalia, 3, 82, 181
Marriner, S. R., on Australian Kea, 66
Massart, J., and Vandervelde, on parasitism, 172 *et seq.*
Maupas on conjugation, 51
on reproduction and food, 89
Mendelism, 12
Metabolic response, 95, 146, 183
Metabolism, abnormal, 20, 33, 79, 160, 179
Miastor, 35
Mitchell, Dr. Charles., on infancy of animals, 37
Mushrooms, gigantic, 171
Mutualism, 12, 21, 47, 95, 150, 154, 187
Mutual pressure, 15, 149
- NATURAL gestation, 26, 29, 32, 38, 167, 185
Natural Selection, 24, 26, 85, 87, 114, 128, 132, 145, 176, 186, 189
Nietzsche, 130
Nutrition, 2, 15 *et seq.*, 20, 65, 78, 140, 144, 168, 173
Nutrition and Evolution, 162
- ORGANISATION, 41-42
Orthogenesis, 168, 181, 182
Over-specialisation, 77
- PARASITIC plants, 86, 89, 163
Parasitism, 7, 24, 34, 75, 172
Parthenogenesis, 35, 90, 97
Pathogenic organisms, 71, 74
Pelvis, 162
Pflanzen-Raubtiere, 128, 135
Plato on Eugenics, 126
Pliny on reproduction, 38
Political Economy, 17, 31, 33, 46, 55, 60

- Production, the measure of status, 1, 5, 48-50
 Punnett, Prof., on effects of domestication, 79-80
- RECIPROCAL differentiation, 1, 96, 98, 120
 Redundancy, 6, 18, 33, 36, 100
 Reproduction, significance of, 38, 39, 50, 68, 89
 Retrogression, 6, 12, 100, 166
 Rickets, 72
- SAPROPHYTES, 173 *et seq.*
 Self-fertilisation, 52, 56, 90
 Seneca on man's place in the universe, 46
 Seton, E. Thompson, 38
 Solomon, King, on animal wisdom, 131, 133
 Sorley, Prof. W. R., on methods of interpretation, 131
 Spencer, H., on gratis benefits, 44
 on variations, 97
 plant contrivances, 152
 Status, 3, 49, 52
 Stevenson, R. L., on kinship of life, 30
 Survival and Reproduction, 104
 Symbiosis, 14, 150
- TADPOLE, 49, 165 *et seq.*
 Taylor, A., on the cuckoo, 103
 Trade, 41, 47, 48, 53
 Trémaux on soil, 160
 Tubercle bacillus, 177
- USEFULNESS, 5, 10, 27, 37, 38
 53, 55, 61, 105 *et seq.*
 Uxküll, J. von, 9
- VARIATIONS, 97, 105
 Variegation, 178
 'Vestiges of Creation,' 118, 169
- WALLACE, Dr. A. Russel, on wind-fertilisation, 56
 on destruction, 57
 Lantana mixta, 58
 simplicity of Darwinism, 108
 natural selection, 108
 longevity of nut trees, 156
 Weismann, Prof., 191
 Woods Hutchinson, Dr., 126, 129, 147-151, 158
 Woodpecker, 167
 Woodward, A. S., on extinction and size, 77
 Work, 1, 5, 19, 40, 44, 46, 56, 64, 193, 194

D005328001

575 R371E

420462

Reinheimer

Evolution by Co-Operation

DATE	ISSUED TO
MAR 1 7 1978	E. V. Walter

575 R371E

420462