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# BIOLOGY

BY

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but a preliminary scaffolding for the Natural system, already partly foreseen, even beginning, in his day. Plant classifications, in their larger groupings, are still far from perfect, and thus in progress and debate; and the re-arrangement of botanic gardens, to keep pace with these, is obviously even harder to effect than that of great libraries: but, thanks to their more manageable herbaria, the botanists are still leading the way. So where classified collections, botanical, zoological and mineral, furnish the only subjects of a special library, its cataloguers and librarians have no too great difficulty in keeping abreast of these three museums and curators, however active collectors these may be, even advancing classifiers as well.

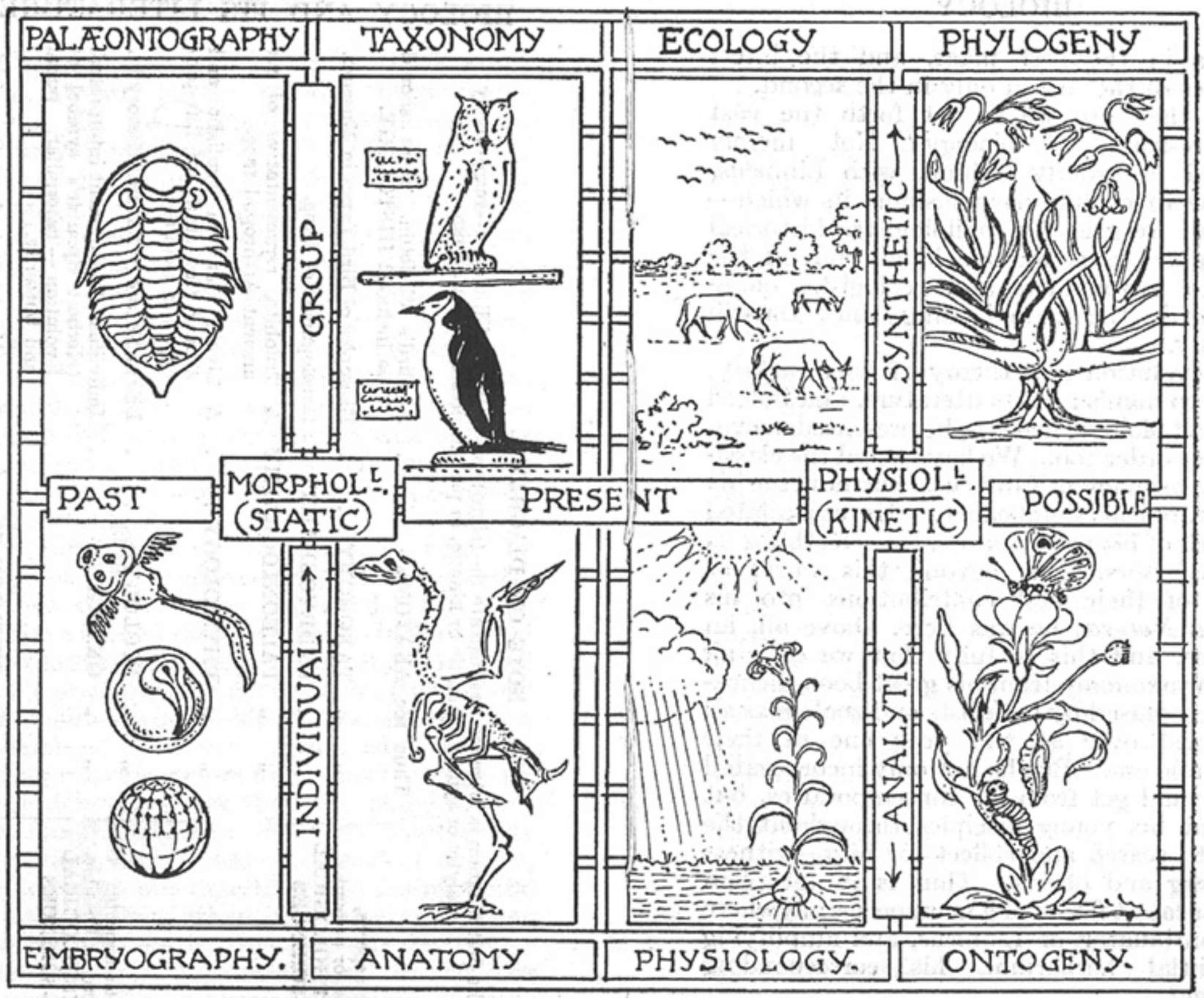
But our library difficulties, since next for biology in all its departments, are far greater, and thus still too much unsolved. But why not take a second step, and from the biological side—that is, primarily, for the most rational possible grasping of the whole literature of our various sub-sciences—since this will be best for readers, however secondarily for the working convenience of librarians? After all, speedy delivery is not the main thing for our intellectual feast-hall: what we want is the full dietary, and in due succession of courses, best suited to our digestion and desire. And the former first, when we have our young families with us—in this case our students—while even for an honoured guest—in this case the gentle reader—we have to consider standard



## NOTE ON DIAGRAM I.

I. The first diagram is intended to illustrate the (eight) sub-sciences of Biology:—respectively analytic or synthetic, static or kinetic, in past or present, or in change.

| | | | |
|---|---|---|---|
| Static aspects, in past or present. MORPHOLOGICAL SUB-SCIENCES | Thus for | ANATOMY . . | A Bird's Skeleton. Here should be included HISTOLOGY. |
| | „ „ | TAXONOMY . . | Examples of Bird Types in Museum. |
| | „ „ | EMBRYOGRAPHY . | Development of Frog. |
| | „ „ | PALEONTOGRAPHY | A Trilobite, representative of an ancient Arthropod race. |
| Kinetic aspects, Present or Possible. PHYSIOLOGICAL SUB-SCIENCES | „ „ | PHYSIOLOGY . . | A Living Plant in sunlight and shower (for study of Life-processes in detail). |
| | „ „ | ECOLOGY . . | Life in Nature ("Natural History"). |
| | „ „ | ONTOGENY . . | Individual development interpreted. (Herbert Spencer's symbol of Evolution — caterpillar, pupa, and butterfly.) |
| | „ „ | PHYLOGENY . . | Suggestion of part of a "Genealogical Tree"; with its branching and leafing. |


PALÆONTOGRAPHY
TAXONOMY
ECOLOGY
PHYLOGENY
GROUP
SYNTHETIC
PAST
MORPHOL^L.
(STATIC)
PRESENT
PHYSIOL^L.
(KINETIC)
POSSIBLE
INDIVIDUAL
ANALYTIC
EMBRYOGRAPHY.
ANATOMY
PHYSIOLOGY.
ONTOGENY.

## CHAPTER IX

### WHAT IS LIFE?

WHAT IS LIFE? The commonest answer to this question—which has perplexed the minds of men since we know not when—may well be—"I know, when you do not ask me!" But biologists and physicians have ever striven to get further than this; and hence have given various answers, until at length we have the Characteristics of the Living, as in Chapter I. Yet here, towards further questioning, let us start anew with something of historic retrospect.

Enough here to begin with that of Bichat—though obviously in principle as old as thought—"life is the sum of the functions which resist death." True, of course, so far as it goes; and only superficially contradictory to Claude Bernard's—"Life is Death"—since this was his epigrammatic summary of his deeper view of functions in terms of their physico-chemical changes, their metabolisms, and these necessarily with destructive changes (katabolisms), as well as constructive processes (anabolisms); so that it is even physiologically true that "in the midst of life, we are in death." Lewes—a serious

thinker of Stuart Mill's time, and way, but with more of science—defined life as "a series of definite and successive changes, both of structure and composition, which take place within an individual without destroying its identity"; while a somewhat later writer of theological and idealistic standpoint describes life as "the invisible, individual, co-ordinating cause directing the forces involved in the production and activity of any organism possessing individuality." These two latter descriptions are still of interest, since not only illustrating contrasted standpoints of the last century, but as substantially expressing for it the "mechanistic" (and physico-chemical), and thus "materialistic" viewpoint, and the contrasted "vitalistic" doctrine of life in this historic controversy, not yet ended.

Note, however, that both types so far agree, in concentrating on life as of the organism, in itself: since omitting any reference to surrounding circumstances. But from the days of Lamarck to those of Comte—indeed, for that matter from Hippocrates—these, with other writers of their times, had seen the essential importance of not omitting the *milieu* of life; and Mr. Spencer did the great service, for English language and thought alike, of translating milieu as "environment"—a word since and increasingly familiar. Hence both organism and environment are kept in view in his definition of life, as "the definite combination of heterogeneous changes, both



simultaneous and successive, in correspondence with external co-existences and sequences." So far well: for we must henceforth free ourselves from this frequent defect—even of the mechanistic tradition, let alone the vitalistic—of concentrating on their chosen aspect of the organism, thus too much thought of as standing by itself, and as if apart from the environment; though with complexities of this its whole functioning is concerned. In other words, we blame the vitalists for too habitually thinking and writing of "vital forces" yesterday and of "entelechy" or "*élan vital*" to-day, with inadequate grappling with the questions of how these may concretely deal with environmental conditions and events; yet as naturalists we cannot feel the prevalent insistence upon the essential physics and chemistry of protoplasm or cell, with all its undeniable interest, to be adequately satisfying either. It is encouraging to note recent books, like Dr. Haldane's—clearly re-expressing the conception of function in terms of organism and environment together; for though it would be indignantly denied, by vitalistic and mechanistic writers alike, that they could seriously think of respiration without both its organs and their atmosphere, and thus as functional interchange between these, we cannot but press them both towards a more consistent and thoroughgoing maintenance of this principle throughout their writings. The difficulty is that this interaction of life with its surroundings is so familiar in life and

habit that it has long lacked more careful consideration by either school: so upon this view of life in its functioning let us now concentrate.

A Notation for the Life-Process.—We may take it now as accepted by all that life, as process, as relation, is twofold—of Environment in action upon organism, and of Organism upon environment. See now if we cannot clearly express this simple conception of life-process in that clearest of languages which gets below verbal languages altogether, the notations in which the mathematician thinks and writes; and these often as his equations, here fortunately of the very simplest. Represent Life as $L$, how write its equation? $L = x$, as the unknown, is what we begin with; but now to "solve" this $x$, interpret it as definitely as may be? For environment let us write $E$ for its active aspect, and $e$ for its passive aspect, when reacted on. Organism may similarly be written $o$ when acted on, and $O$ when active or reactive. Take function as $f$, in both cases.

The determination of life by circumstance, the action of Environment on organism, ($E \rightarrow f \rightarrow o$) may be briefly set down as $Efo$; and its converse and complement, the reaction of life upon circumstance, that of Organism on environment ($O \rightarrow f \rightarrow e$), may be written $Ofe$. Both these represent but half-processes: each statement—$Ofe$ and $Efo$—is thus but a half-truth. In life they succeed each other; yet they keep together, and in mutual relation



—*ratio*. Thus our $x$ of Life, confronted with this life-process, notated in its twofold aspect, becomes

$$L = x = Efo : Ofe.$$

Or, with ratio otherwise stated,

$$L = x = \frac{Efo}{Ofe}.$$

But on the whole the former will generally be found most convenient.

We know, and only too well by experience, that many are impatient of the simplest notations: yet if the reader will but look into this simple life-formula with patience, he will see in it that we are not claiming too much for it, as it opens to his mind's eye, as lucid, even luminous; as suggestive, even evocatory. For when we have in mind the magnitude of this problem of understanding life, not only organic, but human, and thus its importance for all that man and his thought have most valued throughout the ages, it is much to see, in *Efo*, the domination of life by circumstances; and, in *Ofe*, the domination by life of circumstances. For the first half-formula not only sums up—but thence, spell-wise, evokes and brings into view—the spectacle of life, as bowed before inexorable Fate, submissive to impassive Gods: the other shows Life overthrowing Titans, accomplishing heroic labours. Similarly in great world-religions, with their oft-contrasted heresies and sects: so too

through the history of philosophies, with their many schools; ever the same ill-balanced claims, of Determinism on the one side, of Freedom on the other. And so even in our modern times, with their splintered contrasts; witness the confusion of their politics, the sterility of their economics—as for single example, yet in both of these increasingly potent—"the economic interpretation of history" so generally pushed to extremities of doctrine and action on one hand; and the converse over-insistence on purely idealistic and moral interpretation in university and church; hence powerless accordingly to react on minds of socialist and revolutionist, save indeed further to exasperate them, as seeming to them but "reactionary."

So in the world of leisure, with its "print-habit"; for here most seek the novel of circumstance, but some that of character. Many follow the games of chance, though some contest the championships of strength and skill: and the crowding spectators of the latter are thus mainly of the former type, whose life yet seeks vicariously for what it fails in.

In childhood, however, we read *Robinson Crusoe* and *Pilgrim's Progress* by turns: for though the hero of the first appears when sorely dominated by circumstances, he rises to the occasion, and thus soon dominates his isle: and though Christian sets out upon the ideal pilgrimage, he has no lack of amazing difficulties and glorious adventures on the way. But

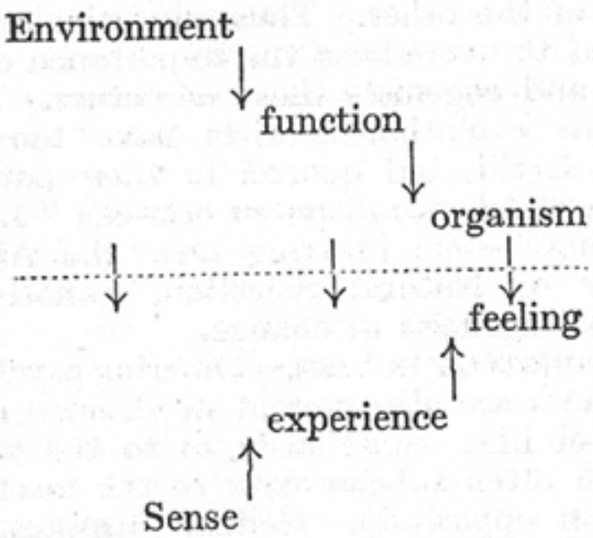


as we mature, we mostly settle down, even to fixity, with its insistence upon one habitual view, its under-valuation, even to forgetfulness, of the other. Thus educationists have tended to over-stress the importance of nurture, and eugenists those of nature. So too modern evolution-theorists have too much renewed this old quarrel in their particular terms, and hence disputed between "Luck or Cunning"—one insisting on "the All-sufficiency of Natural Selection," another on internal agencies of change.

PSYCHOLOGY IN LIFE.—Differing psychological views are also present in all such discussions of life; consciously so to the vitalist, though often subconscious to the mechanist, save in opposition. Neither disputes, however, the obvious and increasing senses of the animal world, nor, in higher types at least, their manifestations of feeling; while their learning by experience is increasingly carried into experimental marvels. But sense deals primarily with the environment; feeling fundamentally permeates the organism, and this in relation to its essential life, thus from hunger to sex, from offspring to herd or grouping. And the association of experience with functioning in environment is again obvious, intricate and perplexing though it becomes, as, for instance, with the evolution of "instinct" and its applications.

The Life-process, on its (determinist) *Efo* side, and now viewed as organic and as

psychological by turns, but best together, appears in summary thus—




Our " biology " and " psychology " are here seen linked together. But if so, their separation, in our customary way, does not really constitute them two separate sciences, properly so called; we see now that these are only our separate sides—convenient, and even necessary for analysis—of the simple old unitary way of studying and interpreting life as we see it, whether in watching the robins, or in choosing a horse. " Biologist " and " Psychologist," though alike starting from the old naturalists, by turns observant, and would-be interpretative, have arisen by their division of critical labours. So far well, but next not well; since becoming one-sided and thus often opponents, like the knights who quarrelled



over the silver and golden sides of the same shield. But with the later progress of life-science they have each had to take note of the other's phenomenal viewpoint. So now their studies are becoming viewed anew, a good deal as in the old natural history way, though this more advanced, more critically treated. Thus, in fact, our for a time mutually exclusive studies are coming together again, as "Bio-psychology," and advancing in collaboration.

Yet their meeting is not on equal terms: for the more biologic mind—which cannot but retain the naïve attitude of the sciences of observation, which have developed apart from the discussions of philosophy—must here at once claim that the psychologic functionings, as above notated, are but the " epi-phenomena " of the organismal life; as Huxley, in his direct and outspoken way, long ago called them. Our psychology, so far, at any rate, is thus frankly " materialistic "; so that the psychologists of the older schools, despite this naturalistic psychology, see in it but a scanty concession, and that to veil a real aggression; hence naturally enough they are more displeased with us than ever. Moreover, younger and later bio-Psychologists have arisen, substantially acceptant of this epiphenomenal view; and—equipping themselves with instruments of measurement yet more subtle than those of the physiological laboratories which first trained them—they have measured not only sensibilities, but functionings, and traced the experience of these even into measuring

fatigues and pains. So even for feeling: since what the most controlled human face may conceal, may be detected, as in the circulation by the plethysmograph. And next, beyond such experimental and physiological psychologists, we have to recognise a further group, increasingly working towards their forcibly-stated goal, of a comprehensive "Behaviour-psychology," and often with progress as little to be ignored as is that of the bio-chemists on their side, however the old vitalists in their day might oppose it with futile protest.

With Bio-psychology thus in the ascendant, the old psychology naturally seems to be sinking fast; and its disappearance, despite colours still flying, appears but a question of time, and that the life-expectancy of survivors. Undeniably, behaviourism demolishes more and more of the anthropomorphic interpretations of the old natural history: it is thus more than threatening even our good old dog-friend, with that renewal of Descartes' automaton view, which one of Huxley's "Lay Sermons" long ago so clearly recalled. Indeed, most seriously of all, this bio-psychologic automaton view is found increasingly applicable—and is thus vigorously applied—even to many of our human thinkings and doings; so the older psychology has again and again to give back, and surrender field after field of those it had so long held as secure.

At this rate, where is the traditional psychology, which holds by an inner life, to find any



position it can really hold? As to human life, it can and does fall back upon its highest developments, and recalls to their would-be besiegers such frank admissions as those of Wallace, that he could see no way of evolutionary development for these—say of the mathematical faculty or the musical, let alone the philosophical and the religious. But the attack answers—granted, of course, for yesterday, and even to-day—but that does not affect our extending trenches, our deepening mines, for new attack to-morrow.

And, as consistent evolutionists—whatever our sympathies—must we not admit they must thus proceed? For otherwise, would not both antagonists have to agree that life, and with it our world-view, must be in dualism; whereas unity is not only the postulate of each science, but the united goal of all. Without this Master-Guest indeed, there could be no researches to speak of, in any field of science; for each and all of these has been, is, and must be, undertaken and prosecuted in the faith that, however strange, variable and perplexingly intricate may be the phenomena of its particular field, these notwithstanding are somehow orderly; as indeed becomes manifest when the discovery is reached. Hence since order, law, unity, thus appear in every field yet investigated—be it of form, of process, of succession, or of all together—who, and above all what man of science, can reasonably lose faith in an all-prevailing unity, "unseen, yet in unbroken line, through man and beast,

through grain and grass"? In the full verse from which that line is taken, Emerson—our poet of Evolution before even Tennyson—broadly combines the contrasted perspectives of the two main schools of thought—which helps to explain why he has been too little read by either of them. But scientists shrink from poets, since they must creep far oftener than fly. So recall for a little our elder initiator of evolution doctrines, Lamarck. His view, of organic function making the organ by use-inheritance, was far too naïve, as Neo-Lamarckians freely admit: but they increasingly revive his next conception beyond this, one psychical in character, of inwardly felt need and urge, as "desire." Yet the child does not add to his stature by stretching his neck, however strong his wish; so why the giraffe either, with all his behaviour of hungry desire? The Darwinian explanation—that, given high-placed foliage, it will be the giraffes which happen to have varied towards longer necks, which can thereby best browse, survive and bear young, again thus variable, and again nature-selected—was thus far more obviously satisfying. Yet students of growth and development are bringing fresh points, of deeper view; and these—without, of course, excluding the scrutinies and tests of natural selection—bring into view an urge of life, in child's growth, and in giraffe's alike. Organic urge this is, of course: but the biologist, nowadays becoming bio-psychologist, is not entitled wholly to deny to the life-



processes and activities of either creature some bio-psychologic aspect, but must indeed claim this, epiphenomenal though for him it still seems. Indeed, since psychical characters are inherited, and thus through the fertilised ovum, what biologist can now be materialistic enough to shrink from Haeckel's thoroughgoing monism, thus granting the cell a psychic aspect as well as an organic? Moreover, are not all the preceding views facilitated, and not a little, by the modern "psychology of the Subconscious"? If then "*Élan Vital*" be thus psychically interpreted, and even "Entelechy" viewed as its most comprehensive aspect, these terms become less alarming to consistent evolutionists than they at first seemed.

It is, of course, still obvious that all this is far from satisfying, or even congenial, to our older school of psychologists, or to those of kindred associations; though they must admit it is something for biologists to be recognising psychology at all.

Look once more at our life-formula, not simply Efo, but Efo: Ofe. These obviously go on repeating, and with change also: since action on environment does so far change it, and it may be notably; as, for instance, when we stay too long in a closed room; or, for better instance, if we make plant-life purify its air for us. Thus our formula becomes Efo: Ofe $\longrightarrow$ E′fo: O′fe. Environment and Organism may thus change together, though the Organism more obviously. They may thus

even come to fit together closely, as in so many adaptations. Have we not here indeed, not only the beginning of a notation for modifications by environment, but one worth trying to extend and apply to adaptations?

But without pursuing side-applications we return to the main values of this life-formula, as two. First, that it comprehends and correlates the environment and the organism, too long and still too commonly torn asunder, too long divided between the physicist and the morphologist, each thus static, hence necrographic. Secondly, it enables us to keep clearly in view both the organic and the psychic aspects of their interaction—too much separated, as "body" and "mind"—say rather, since now accurately, as "corpse" and "ghost"; and these as the prey of necrologist and phantomologist respectively.

THE LIFE-PROCESS MORE CLEARLY STATED. —Leaving now these aside together, return to our biology proper, with its study of life's organic and psychic aspects associated, as what we may now call Bio-psychosis. In ordinary life we act, we do things, thus modifying our environment; indeed that is our main life-functioning, our day's work, our life-work in sum. Our at first subconscious, then dim, vague, confused, and slowly dawning, "*desire*" comes at length to clearness and decision as Will. In the measure that we have come to "work with a will," we escape from mere toil, mere slavery, to freedom; we have got



beyond mere external determinism, of however initially pressing, exacting, even threatening circumstance, be this of natural environment or of social bondage. This aspect of our life's urge, towards victory over circumstance, can no longer be called mere Bio-psychosis: it is the very converse; in a word, it is Psycho-biosis. Our modification of our environment, be it to great victory or but as stout endeavour, is now no longer merely epi-phenomenal. It is Psycho-epi-phenomenal, since such life-functioning is no longer merely imposed from without, but its emergent response from within.

But, it must fairly be asked, what of every reflex action? Is it not the stimulus from without (Efo), that evokes (Ofe), the response? That stimulus does stimulate, who will deny? Yet what better test of rank, and rise, both in individual development, and in the scale of being also, than the quality and measure of this response? Is not here the essential process of evolution?

Life is in these days so vividly condensed into games (whence their interest and popularity, primarily for childhood, for youth, but found well worth continuing into age as well) that we may well typify stimulus as bowling, response as batting, and note how both have evolved together. We see that while the great bowler (here known as Environment) may and does knock out (Natural Selection) the weaker batsmen (organisms), it is still the

guiding eye and ruling brain, served by trained and powerful muscle, of the best of these batting organisms that make their goodly score out of the difficult bowling, and thus establish the main glory of such players and their game.

Thus then we learn by living, complexer environment going with completer sense, complexer organismal development in association with intenser and more varied feeling, while the correspondingly complexer interaction of all these deepens experience, enriches memory, awakens intelligence. These subjective factors also react upon one another, sense flowing into experience, this into feeling, and, of course, reversely too: indeed all with further correlations too complex for present limits.

Our outline-beginnings of a notation for the further study of biology and psychology together may thus be carried a step further, indeed in indefinite series (and prolonged either way)—$\downarrow\frac{\text{Efo}}{Efo}\rightarrow\uparrow\frac{\text{Ofe}}{Ofe}\rightarrow\downarrow\frac{\text{E'fo}}{E'fo}\rightarrow\uparrow\frac{\text{O'fe'}}{O'fe'}$.

The italicised denominators of the "relations" indicate the psychical aspects; and our view is thus of no mere parallelism, but of interaction, and of an interaction that is developmental, even evolutionary.

The Notation of Social Life.—Environment, Function, Organism, albeit the three essentials of the chord of life, are still terms somewhat abstract: at any rate too general; as even the experienced biologist soon comes



to feel when he tries to work out their interactions, and still more to define these in notation. Whereas when we turn to the highest species, Man himself, and employ his old human terms for these three essentials —Place, Work, People—or (say) Family, Folk, etc.—there is an immediate gain in familiarity, concreteness and vividness, and consequently an easier comprehensibility of their interactions. Thus, too, with man himself, biology began, as we have seen above, and so indeed for each and all of its subsciences. In modern teaching of biology (though against this the human anatomist has long protested) it has become customary, and with advantages of simplicity, convenience, etc., to begin with simple forms, and proceed upwards; so that human studies appear at the culmination of our preliminary ones, and thus also as evolutionary climax. But here, with our present insistence upon the importance of a clear general conception of Life, the converse and original order reappears, justified in reason, in investigating and learning. We may thus for a little consider our human life and experience first, and this not simply in the interest of facilitating our understanding of human and social studies, but of our biology itself. Is it said, by any naturalist teacher devoted to the type-system, chosen in ascending order, and ending before coming to man—This method, though natural enough when naturalists were mostly doctors, is surely now out of date! But the reply

is as easy: Too much so, doubtless; but who last used it?—and this for the crowning interest and glory of our science, breaking new paths, even for other sciences, with their triumphant contribution to the doctrine of Evolution—who but Darwin and Wallace? And both alike were led to discern Natural Selection because they had found it lacking in Malthus on "Population"; as also to emphasise the struggle for existence, since this was suggested to them by its extreme manifestations in the practice and economic theory of our industrial and commercial age, and also in the wars which have preceded and accompanied its rise. So manifest is this essential account of these biological initiators, as based on economist precursors, that a notable American historian of economics (and one not in any ignorance of Darwin's biological significance; indeed himself originally a skilled stock-breeder) describes Darwin as "the last of the great British economists."

So if the human and even social approach was good enough for Darwin and Wallace, and so fruitful for biology, it may well be good for us and our science to try the same again. What indeed if the diminution of extensive grasp and comprehensive furtherance of our science which has been too often apparent since Darwin's day be not solely the consequence of the resulting (and needed) intensification of all its specialisms, but also in consequence of its specialists cloistering



themselves in their laboratories and museums, apart from their fellow-evolutionists in the human and social fields? May it not be time to say: Since Darwin took a horse from these, and found it Pegasus, may we not look over the hedge again?

We are thus seeking not only the logic of life, but something of its practical conduct (*i.e.* its ethic) also; and with rewards in widening consciousness, deepening sympathies also, with the whole world of life around us, human and simpler together. We may thus look anew over the fields of life and its evolution, and review their sub-sciences, but now in yet clearer grouping, fuller understanding also, than in our biological terms (Efo) alone. For with *Environment* as Place, we are entering on the full study of Geography, and this in widening concreteness of outlook, beyond our studies and homes. We see—*i.e.* observe, scrutinise, even "survey"—our own human hive, our city, town or village, and find this rich in even a biological suggestiveness, only in these times beginning to be appreciated; we survey too our immediate region, and thus begin to understand those beyond, even to their making up of the wide world, with its varied human and organic life. Our Environment has thus been extending: our own Place is seen to be more significant than before.

So next as "Function" humanises and realises into Work, such work as our place provides, even compels (Efo), or admits of

within our powers (Ofe). Moreover, here we are in the true laboratory of Economics; and we see how and why so many economists —of any and every school—fall short and fail, if they have not adequately come to grips with their would-be science by passing through work-experience; but have been content to listen to the bargainings of the market. So too when our chosen type-organisms are human Folk: since we here gain no less illumination from anthropology, with its folk-ways, folk-lore, and so on. We even see fresh light on all these three main sub-sciences—Geography (Place), Economics (Work), and Anthropology (Folk)—when we realise their correlation, and escape from their long-persisting detachment—their dis-specialism, as separate societies, institutes, museums, libraries, university departments, or miscellaneous reading—into the elements of a unifying chord of life, fundamental henceforth to a yet more unifying science—Sociology.

Our first outline of life's synthesis, helpful for all the four living sub-sciences of Biology, as Efo: Ofe, can now be thoroughly parallelised with the like for Sociology as Pwf: Fwp, as we have just seen that arise, from the unified sub-sciences of Place, Work and Folk. And though these have been long in coming to recognise their place within its larger fold, this cannot be much longer delayed. For this assures them an increased



vitality and productivity; and not only for their respective problems and tasks, but far more as they become collectively incorporated, and indeed clearly and solidly interwoven, as the fundamental and initial web of sociology.

ORGANISM AND SOCIETY.—There is, however, a yet more general question, which no student, whether of general biology or of social science, can long escape facing, since each must ask—What of the essential relation between the two? While "Organism" seems naturally given as the subject of biology, and "Society" as obviously given for sociology, the questions of comparing Organism with Society—and of course conversely, Society with Organism—cannot be escaped on either side, and indeed seem highly promising ones. Hence biology has no small literature of this kind, since it cannot but arise in principle as soon as our survey of the animal kingdom rises from the protozoon to the sponge, from hydra to hydroid, or from the solitary sea-anemone to the vast composite of the coral; or as we pass from the individualistic gall-fly to the socialistic bees, and thence also to the ants, with their yet more marvellous and varied towns. On this line of biological study, and towards social grade-comparison, the first monograph was indeed that of Espinas, afterwards an economist of note; but Perrier and later zoologists have continued it too. It is, however, on the side of sociology, for obvious reasons, that the comparison of

Society with Organism has been most laboured; as notably by Herbert Spencer, and also by later writers, up to to-day.

Yet all these comparisons have after all borne too little fruit for either science: and if we ask—Why?—What has gone wrong?—the notations $\begin{matrix}\text{Efo} : \text{Ofe} \\ \text{Pwf} : \text{Fwp}\end{matrix}$ answer plainly. For here the essential comparison is seen; no longer merely, or even mainly, of the Organism with the folk, the people, the Society, but as that of their respective life-processes. For organic life and social life agree in principle, in their necessary and constant interaction with environment; yet with innumerable differences as well as resemblances between the three essential factors of each; not only therefore between organism and society, but between organic functioning and economic, as also between the relatively simple biological environment, with the far more complex social one. How this notation not only serves to extricate us from inadequate (or often forced) comparisons, but next may be applied and developed—with substantial clearing up, for the social field especially, but for those of biology too; and thence even with better comparisons accordingly—is thus not only a long story, but manifold; and hence too elaborate for treatment within these limits.

SUMMARY.—Our answer to the question What is life? has been neither that of the mechanist nor of the vitalist, but has utilised,



even combined, the characteristic doctrine of each. For with $\downarrow\frac{\text{Efo}}{Efo}$ on the one side we associate $\uparrow\frac{\text{Ofe}}{Ofe}$ on the other; and similarly for human life as social, $\downarrow\frac{\text{Pwf}}{Pwf} : \uparrow\frac{\text{Fwp}}{Fwp}$. That is, we do justice to environmental impressions and experiences on one side of our notation, yet to organismal and social impulse and expression on the other. We see, then, in the process and progress of life, the alternation of stimulus and response, of passivities and activities, in unending yet varying rhythm; with the latter on the whole as increasingly potent and thus directive, even *telic*. In short, life's oscillations, between Bio-psychosis and Psycho-biosis, show coadjustment, and even of the former by and through the latter. Both external determinisms and internal selections thus have their influence throughout life, yet towards predominance of the latter—and this as the varying measure of evolutionary rise.

This conception of life, in process and in change, will also be seen to distinguish mere environmental modifications from the uprush and outcome of the mutations proper, with their changes of life's rhythm. First clearly, of course, in human life, and in their social fields, where they are each so plainly manifested—yet why only there?

Here then is a theory of life—one inviting,

even challenging, further discussion and fuller enquiry, and these in the world of nature, in the zoological and botanic garden, and in the experimental work; as well as in self and others, and in university and city.

At any rate—be this doctrine approved or not—how better can we conclude our preceding outlines of the progress of life-studies in their various fields, than by a theory of life which touches all of them, and raises questionings throughout their ever-increasing evolutionary range?

## ENVOI

THE APPLICATIONS OF BIOLOGY (BIOTECHNICS).—Into the vast fields of Applied Biology it is here beyond our limits to enter. Yet though pure science is here our problem, it is Life-science; and thus it is legitimate to point out that its clearer charting, and in relations as full as may be, is helpful, towards clearer applications as well. As a first outline towards this required clearness, our second diagram may readily be turned over, upon an opposite page. Thus we have a complete mirror-reversal of our schema of the sciences; and with like spaces; but now for charting the main arts of life in their orderly relations to each other, and, of course, to the sciences as well. Yet though we commonly speak of "applied" sciences as if they came second, the reverse is largely true—for none will deny how much the arts have been originative to the sciences, nor how suggestive still.

The associated principle of organised action must here be noted. On the whole, in science, we use the ascending order (mathematical, physical, biological, social); and thence we have come to consider the subjective sciences proper (logic, æsthetics, psychology, ethics) in their prime associations with the objective

ones. But upon the side of action, we may—and indeed do—best begin upon the highest level, the practically social. We thence descend; and, moreover, with each and all lines of concrete action organised; yet each and all now impelled and guided from their subjective side. Hence true Politics is Etho-Politics; and thus true Biotechnics has as far as may be—and thus above all in human life and education—to be also Psycho-technics. Industry (Technics) has to be "a good job"; and it thus becomes Eutechnics, as were the crafts as well as arts of old. And for Metrics, we must clearly know what we are measuring for:—hence Thematimetrics—for its logical, and indeed whole subjective, guidance—and power.

Thought and Action, Action and Thought, are thus capable of fertile and even lucid integration in the mind; and, hard though it must ever be to realise this in practice, such Orchestration of Life is clearly conceivable. It is even in detail defensible upon our charting, and is thus more plain before us.

As practical minds then, is it not time to have done with our after-War despairings and thus again look forward into the coming years—for which already, beyond the ageing forces of reaction and revolution, the Practical Idealists—thus Ideopraxists—are gathering, especially among youth? For these, all the past, with its great initiatives, should be at best but as of precursors, towards renewed initiatives. And these have now to be



increasingly co-ordinated, towards the guidance of Human and Organic Evolution. Evolution-lore is thus seen to be not merely a deciphering of origins, but also a discernment of paths.

The way is difficult and long: no chartings can ever fully suffice; yet life's insurgence is ever seeking and finding its way. *Vivendo discimus.*