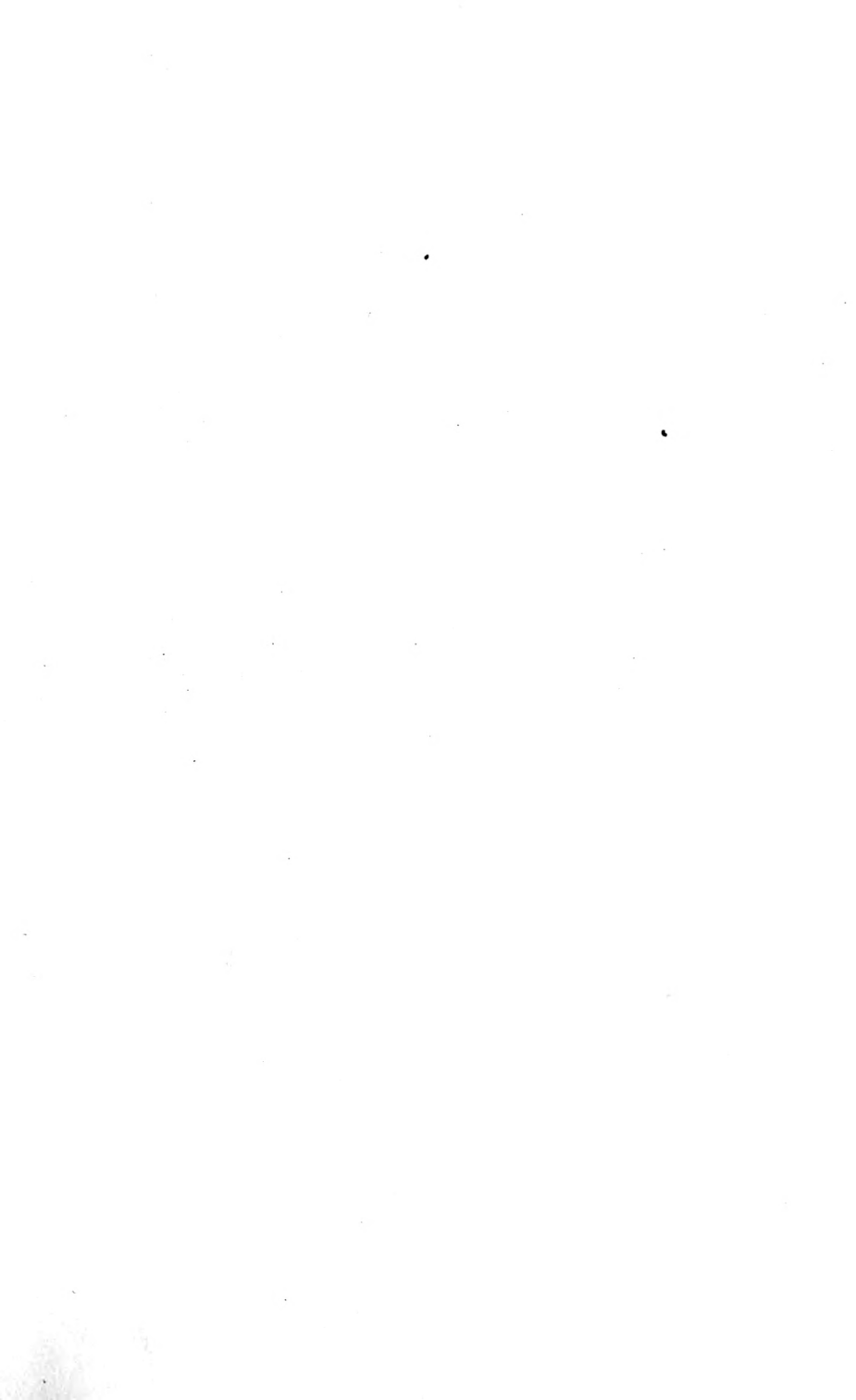


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EXPERIMENTAL STUDIES IN HIGHER EDUCATION.

BY PROFESSOR PATRICK GEDDES.



A SUMMER SCHOOL OF SCIENCE.

Vacation Science Courses, Edinburgh.



EDINBURGH:

JAMES THIN, 55 SOUTH BRIDGE.

1890.

PRICE THREEPENCE.

PREFATORY NOTE

DURING the past few years of active University discussion, and of continually varying proposals of reform, or of degrees of change, the writer has been increasingly impressed by the necessity of replacing speculation as far as may be by actual observation, and the guidance of either the established order or its assailants by that of repeated experiment. Hence the publication of the present paper, which will be followed at short intervals by others.

TO BE PUBLISHED SHORTLY

No. I.

UNIVERSITY RESIDENCE IN SCOTLAND—UNIVERSITY HALL

No. II.

THE STUDENT'S WANDERJOURS AND THE SCOT'S GOELIGS
IN PARIS.

VACATION
SCIENCE COURSES,
EDINBURGH.

FOURTH SESSION, 1890.

4th to 30th AUGUST.



“The shortness of life maketh it impossible for one man thoroughly to learn antimony, in which every day something of new is being discovered.”

BASIL VALENTINE, *Triumphant Chariot of Antimony.*

“The more a science advances, the more it becomes concentrated into little books.”

LEIBNITZ.

VACATION SCIENCE COURSES, EDINBURGH.

FOURTH SESSION, 1890.

THESE Courses were opened in August 1887 by Mr J. Arthur Thomson, Lecturer on Zoology in the School of Medicine, and Mr G. F. Scott-Elliot, Demonstrator of Botany in the University. The Zoological Course was held in the Granton Marine Station, kindly lent by Dr John Murray, of the "Challenger" Expedition; and the Botanical Course at the Royal Botanic Garden, through the kindness of the late Professor Dickson.

In 1888 both Courses were united at Granton, and shortened from six to four weeks. Mr Scott-Elliot having gone abroad, his place was taken by Mr Patrick Geddes.

Last summer considerable developments were made. The Courses of Zoology and Botany were doubled, so as to admit of fuller treatment, and of adaptation to beginners and more advanced students. A Course of Elementary Lectures, intended as an introduction to the social sciences, was also delivered by Prof. Geddes.

Nature of the Courses.

The courses correspond broadly to those of the "Teachers' Retreat," held annually in connection with the University Summer Gathering at Chautauqua (U.S.A.), and with the classes for special study which have similarly followed the Summer Gathering at Oxford for the past two years. They were, in fact, largely undertaken in the view of preparation for, and ultimate association with, similar University Gather-

ings at Edinburgh, such as that held last autumn. The classes are attended by persons of both sexes, of all ages, and various occupations, including not only teachers, and students of the Universities, and of University Extension Courses, but many others whose interest in science has been otherwise aroused.

While these Courses, as far as time allows, aim at fully maintaining an academic standard, the prevailing University methods are in certain respects departed from. They embody an attempt to deal with the widely felt difficulty of "Education *versus* Examination"—witness the recent well-known protest in the *Nineteenth Century*—and they essentially return to the older teaching system. The teaching is based upon personal observation and interpretation of actual facts, which the lectures systematise and extend; and, as far as possible, the lectures accompany or follow the practical work and excursions, instead of preceding them. Book-work, and the taking of detailed lecture notes, may be dispensed with, but the student is assisted to keep a record of laboratory work, and of other personal observations; and he is invited to take part in the preparation of the summaries and diagrams, which are distributed, as nearly as possible, daily. It is found that these conditions, together with the inquiry and discussion to which they give rise, furnish not only an incentive to work, but, if need be, a sufficient test of individual progress.

As regards the matter of study, the first object of these Courses has been to furnish an adequate introduction to the study of the natural sciences, and this in a way more consistently physiological and evolutionary than that of examination programmes, which are inevitably precluded from entering those fields of actual discussion and contemporary research upon which the living interest in a science so much depends. In brief, to awaken or increase an intelligent interest in natural science, and to help to vivify study and teaching alike in school or college,—these have hitherto been the primary objects.

Last year's addition of a Course introductory to the social

sciences will be readily understood on consideration of that parallelism and interdependence of the "humanities" and the natural sciences, which are being demonstrated on all sides by thinkers of the most widely separate schools. The satisfactory results of this additional study, and these even in their reaction upon the strictly zoological and botanical work, have, as a matter of fact, greatly encouraged and accelerated the further developments proposed for the present year.

Educational Problem of the Courses.

The work of previous years will be continued, but now in a fuller and more systematic way, and with more definite relation to pressing contemporary problems, educational and social. Of the latter illustrations are hardly necessary; but with respect to the former, it may be pointed out that not only are the prevalent systems of higher education at present under active discussion in all countries, but that in Scotland, as in France, the reorganisation of the national Universities has actually begun.

To determine the requirements of general education or liberal culture, on the one hand, and those of the preparation for the tasks of life upon the other, and duly to adjust each to each, is indeed an old problem, yet one for which, it is admitted on all hands, the old solutions or compromises no longer suffice. It is now a matter of common experience, that that well-intentioned compromise, which would fain admit the claims of the innumerable literary and scientific specialists, who have for the last generation disputed the field, has in practice led to little more than the increase of tasks too grievous to be borne. This overloading of programmes, alike in school and college, is now naturally tending towards a reaction in favour of their limitation. This, again, presents the other horn of the dilemma. In our Universities we are threatened with that separation of the old Faculty of Arts into a sharply distinguished Faculty of Letters and Faculty of Science, which has had the admitted result of

rendering all the Universities which have hitherto practised it so much less efficient and less productive than those of Germany. This disastrous cleavage is already too apparent in our schools,—witness the indefinite persistence of the so-called “classical” and “modern” sides, essentially characterised by the elements of Latin and Chemistry respectively, and these too often by mere verbal or mineral analysis.

It will at once be evident that the gradual solution of difficulties, which have so largely arisen along with the vast increase of our knowledge, can be looked for only as we become better able to arrange this. But educationists cannot be expected to remodel their programmes merely upon a classification of knowledge, however simplified; they justly require evidence as to its applicability in practice. In a word, the need of initiative, yet also the difficulty of this, are generally admitted. Hence, indeed, one of the main reasons for *vacation* courses.

The most urgent of educational questions at present is, What course, what curriculum are we to follow? The traditional curriculum of the Scottish Universities? This, indeed, uniquely preserves the features of the ancient synthesis, recast in the trivium and quadrivium of the Middle Ages, modified at the Renaissance but still more influenced by its decay, and now awaiting only a formal sanction for its abandonment.

Or the absolute freedom, the “*Lehrfreiheit und Lernfreiheit*” of the German Universities? But this freedom is in the choice of specialisms alone, and has long abandoned, save in philosophic dreams, the very thought of a realisable unity.

We have still a choice of ingenious schemes, such as those already adopted in Cambridge, or now proposed on all sides in Scotland, and which represent so many attempts at compromise between the material interests and educational methods of the old faculties, on the one hand, and the piecemeal introduction of German specialism on the other. But will these compromises, however character-

istically English, however apparently practical, satisfy the want of intellectual unity, or even avail for any length of time to disguise its loss?

What then remains? The only other scheme in actual operation is that of the University of France, with its sharply defined Faculties of Letters and of Science. These, too, as we have already noted, have been found wanting, and that in more than one respect. Their isolation of the Humanities from the underlying studies, the "preliminary sciences," has fatally produced its result in a majority of unscientific humanists and non-humanist men of science. And when we bear in mind the consistency with which the examination system has been applied during the past generation, it is little wonder that a mind thus trained, despite (nay almost because of) its naturally vigorous logic, its less fragmentary synthesis, should be less open to research than that of the German, less adaptable to new conclusions than that of the Englishman or Scot. Hence it is that this system, more perhaps than any other, is at present under anxious reconsideration.

Where then is a solution to be sought for? From the University let us turn for a moment to its simpler germ as well as product, the Elementary School. All educationists, it may safely be said, are in sympathy with that reform of geographical teaching which instead of loading the memory with mere lists of towns and rivers, aims at building up a vivid and intelligent picture of the world, with man in his place in it; which assures both precision and generality by constant use of map and chart, physical and historical, as well as political; and which secures the reality and usefulness of the whole by continual reference to the learner's own country, nay, even to his familiar neighbourhood.

Yet what are all our later and mature studies but a deepening in observation and in interpretation of the same study of the earth and man? Between the simple universe of the child-geographer and the encyclopædic survey of Aristotle there is no other difference.



We must, indeed, for practical purposes break up our study of the earth and man into the great groups of science, physical, biological, and social; these again into sub-sciences; and these once more into specialisms without number. Every investigator has thus constantly to be taking up the position of the microscopist, who, to intensify his scrutiny, must proportionally narrow his field, and even diminish his penetration through it, long after the view of the object as a whole has been given up. Yet, so necessary and vital is this dangerous process to the advancement of learning that that higher education is now justly reckoned incomplete which has included no such discipline in detailed research. The thorough application of this principle in all departments of study is in fact the great lesson we owe to the Universities of Germany.

Since the beginning of the division of intellectual labour the vast majority of students have naturally been devoted to the humanities, while of the few attracted by other studies, the keen pleasures of abstract thought naturally claimed the greater number. The few who remained to enjoy and arrange the actual phenomena of observation soon found that only those of the physical world seemed capable of exact treatment, and so handed over unresolved to the practical arts, like medicine or agriculture, all the problems of life, all the infinite variety of the organic world. With these separations, all others followed. The humanist, the mathematician, and the chemist, could not but each go his own way, leaving philosophic system-builders to work almost in the void; and thus the variously degenerative life-histories of the Universities above sketched, became inevitable.

The return towards unity, it is true, has happily also been in progress. Thus the modern unification of the physical sciences, at first mainly associated with the progress of industry, and later with the doctrine of energy, or the reform of linguistic studies through the rise of philology, are only among the more striking evidences of this.

But only in our own age has the ordering of the intermediate field, that of organic life, become possible ; and at first largely through the help of all the older studies. The physicist and chemist contribute their methods and appliances, and enforce upon the physiologist their points of view ; the abstract thinker lends his categories of genus and species, and so on. Even the changing theories of human society saturate and colour the incipient science ; witness as obvious examples the projection of the modern conception of social progress upon nature as "organic evolution," or of the doctrines of population and industrial competition as that of "progress through natural selection in the struggle for existence."

So far we have regarded the biologist as occupied mainly in learning from the elder sciences, and with the much needed internal progress of his own. But the reverse process is also going on ; the discipline of classification, the conception of evolution, return in developed form upon the studies which gave them birth, and unlock many of their most perplexing secrets. Mental science, history, philology, economics, all become profoundly influenced, and this in ways far too numerous to be even outlined here.* Hence it is that the biological sciences, whose educational value in their cruder states must be frankly admitted to have long ago fallen into a not undeserved discredit, are now everywhere claiming a reconsideration of their academic place and rank. At first recognised as an integral part of that general account of man and nature which is the intellectual basis of every education which claims to be general, and therefore as essential to the arts curriculum (as is still happily the case in at least one Scottish University), they have gradually been pushed back upon their traditional association with the medical schools, a connection now increasingly dispensed with. Their rehabilitation within the University itself is, however, a matter of no little difficulty, since here

* Cf. the writer's article on EVOLUTION, *Chambers's Encyclopædia*, New Edition, 1889.

the vast majority of their judges are either specialists who have been educated without the natural sciences at all, or even more dangerously, have suffered from the inefficient or archaic teaching of these. But outside the Universities, in that general world of thought for which these exist and prepare, the claim of biology is already fully conceded. Conceptions such as those of evolution, heredity, environment, and many others, are the common stock, alike of essayist and historian, of poet and romancer, nay, of ordinary conversation itself. In a word, the renewal of the antique connection between "natural and civil history," which is so fundamental a feature of the present scheme, can only surprise or perplex the mind limited within its own immediate field, or cramped within the traditional University curriculum in its recent and actual state of admitted decadence. No man of wider interests, from the simplest general reader to the professed philosopher, is any longer unwilling to avail himself of such light as the world of simplest life can shed upon that of the complexest, the microcosm upon the macrocosm, the organic upon the human. Hence, as such men set themselves to modernise our Universities, the existing studies of quantity and number, of matter and energy, on the one hand, of antiquity, language, and mind, upon the other, have themselves nothing to fear, although they may no longer exclude those of life and evolution from being set in their midst, nor those of modern life and duty as their head and crown.*

Such then is the explanation of the arrangement of the Courses now offered. Without claiming to propose any exclusive, much less complete or final, settlement of the problems which have been outlined, they embody a serious attempt towards their experimental solution, and this in forms applicable towards the improvement of both school

* In evidence of this it may be noted that the two chairs last added to the Sorbonne are those of the Theory of Evolution and of the History of the Revolution, while the two public courses lately founded in the Paris Hotel de Ville are of Sociology and Biology.

and University programmes. Only small, modest, and tentative beginnings can as yet be offered, limited alike by the material and intellectual resources of the very small number of teachers. These have themselves learned that the Actual University is so vast that neither study nor travel suffice to exhaust the possibilities of knowledge within its most restricted fields, yet they also believe that wheresoever men may gather in the love of truth and unity, the Ideal University is already opening one of its many gates.

PROGRAMME FOR 1890.

Sociology. (A.) General Course.—The course will this year be essentially devoted to descriptive economics and history, and will make frequent use of the concrete illustrations afforded by the city and district, and exceptionally this year by the International Exhibition. The handling of historical and economic details by the help of graphic methods (such as those of the Historical Seminar) will be fully entered upon, and the position of the leading schools, not only in Economics and History, but also in General Sociology will be outlined and discussed. The influence of physical and biological conditions upon social phenomena, and the converse action of man upon nature will also be touched on.

(B.) Special Course.—While in the General Course the city and district are viewed as merely illustrating the general social evolution of which they form a part, the Special Course will deal with these in their national and local aspect. In this more practical course the associated study of the Historical Seminar (founded in 1886, on the model of that of the University of

Ghent) will usually replace the formal lecture. Excursions will be frequently arranged, not only to the city with its monuments, museums, exhibition, &c., but to characteristic districts, such as the "Kingdom" of Fife, the Clyde, and the Border

Biology. General Course.—This course of lectures will be accompanied by direct observation and practical work (including the examination of types). It is intended, however, primarily to familiarise the student with the fundamental conceptions of animal and vegetable physiology, with the theory of evolution, and to introduce him to the study of the essential literature and history of Biology. An endeavour will be made to arrange this biological study in lines broadly parallel to that of the sociological course as also to those of botany and zoology. On the other hand, some time will be devoted to wider "physiographical" studies, or to an introduction to the physical and chemical conditions on which the biological phenomena depend.

Zoology.—The course will be chiefly devoted to a study of the fauna of the Forth, and will be illustrated by dissection of types, shore walks, visits to the museum, and by a dredging excursion.

Botany.—The course will this year be devoted to the study of the leading types of flowering plants, illustrated by laboratory work and excursions, and by experiments on vegetable physiology. Special attention will be given to the requirements of teachers of elementary botany in schools.

Physical Science.—No Special Course can this year be offered, but the relation of living beings to their physical and chemical environment will be discussed in the Biological Courses, especially in the demonstrations of vegetable physiology. See also above the outline of the Course of General Sociology.

As the detailed Syllabuses of these Courses will not be ready much before August, two or three are here reprinted from former years. These, however, were originally prepared for University Extension purposes, and without reference to the present attempt at parallelism and unity in teaching.

SYLLABUS OF LECTURES

ON

SOCIAL SCIENCE AND SOCIAL LIFE :

An Introduction to Practical Economics.

By PATRICK GEDDES.

The Science of Society: its Rise and Aims.—Its place among the Sciences. Graphic Classification of the Sciences; applications of this as a "thinking machine." Every man his own philosopher. Dependence of Sociology upon other sciences (Biology, &c.); its reaction upon these.

Ways thus Gained of Looking at Economics.—Statistics and how to grapple with them. Graphic Statistics; Classification of Statistics.

Analysis of the Principles of Economics by help of the Physical and Natural Sciences. Corresponding theories of Practical Economics from the physical, biological, and psychological point of view respectively.

The Individual in Society.—(a) Personal Life as a fraction of the Social Whole. Use ("Consumption") of Wealth: *i.e.* (1) products transitory and permanent; (2) services. Total Consumption equal to Real Wages.

(b) The social whole viewed as the sum of our personal activities. Results of Consumption, and practical bearings of this: nature and responsibilities of individual Consumption as determining (1) *function* of producer; (2) *environment* of consumer: hence duration and quality of life of both. Standards of Comfort, measured in *grades and degradations*.

Retrospect of Consumption, ancient, mediæval, and modern. Personal, domestic, civic, and national consumption. Need of theory of consumption by older and newer economic schools; outline of this.

Productive and Unproductive Labour. A Day's work and its consequences. Retrospect of views as to relation of economics and morals; attempt to define this. The ladder of moral and economic progress. Every man his own moralist.

Population.—(a) Quality, (b) Conditions of Multiplication, *i.e.* "Theory of Population," (c) Resultant Quantity. The Census and its uses—number, state; and movement of the community; state of physical and mental efficiency; nature and classification of occupations. Application of biology to economics. Quality of community as the aggregate result of individual environment and heredity, *i.e.* of present occupation and surroundings, plus inherited results of these in past. Depression and possible elevation of industrial communities. Economic problem of the sexes; biological and ethical factors of this.

Essential Material Wealth.—An Exhibition, a city, even a house, as a Museum of Industry. Transitory and Permanent Products. Progress estimated in *quantity* (statistics), (b) *quality* (food analysis, art criticism) of products. Necessary and super-necessary consumption; utilitarianism and æstheticism, with their respective claims. Political economy of Fine Art, historic and practical; powers and duties of the artist. The secret of beauty; every man his own art critic.

Wealth of Nations.—Its increase or decrease in quantity and quality. Crises; depressions in trade. Retrospect of national and civic wealth, ancient, mediæval, and modern. Ancient and mediæval cities; (a) Athens, Rome, and Constantinople; (b) Venice, Pisa, Ghent, Bruges; modern industrial ones. The incipient Civic Renaissance—modern capitals; Manchester, Birmingham; Edinburgh, Glasgow; minor towns.

Wealth of Individuals.—Personal wealth, real and nominal; analysis of these; public wealth as an algebraic (not arithmetical) sum. Nature of thrift: Various forms of accumulation; insurance; saving of money, with various modes of investment and various forms of interest, and respective result of these. Industrial remuneration—Nominal and real wages—What determines the rate of wages? Riches and poverty—Nature, origin, and consequences of these; enumeration of proposed remedies.

Facts of Social Evolution in the Past.—History, and how to acquire its essential facts; graphic notations, e.g. Decline and Fall of Roman Empire; Mediæval Europe; Modern Netherlands or Britain.

Generalisations of History and the sociological interpretation of them (Philosophy of History). Concrete applications of this: Edinburgh, the "Kingdom" of Fife. Every man his own historian.

Social Evolution in the Past.—(a) *Historical Sketch of European progress* (ancient, mediæval, and modern), with special reference to the history of labour. Slavery, serfdom, wage labour. Characteristics of Feudal period, of Middle-class period, and of current (Transitional or semi-democratic) period. Outline of corresponding states of economic theory. Corresponding graphic notations; the pendulum of progress.

(b) *Interpretations of Past Evolution.*—The battle of rival theories, means of criticising and classifying these; Philosophy of History of Political Economy; every man his own economist. (a) Optimistic view, systematised by orthodox economists, and reflected in current literature and journalism. (b) Pessimistic view, as diffused in literature (Sismondi, Carlyle, Ruskin, &c.), and as systematised by unorthodox economists (contemporary schools of socialism, communism, anarchism); interpretation and classification of the various economic schools by aid of their respective ideals.

Social Evolution in the Present.—Springs of present state of action and corresponding theory during the past century. Nature of contrast between the Greek and the conventional modern standpoint; origin and criticism of the latter. Its rectification in progress—stages of this.

Interpretation of current events and discussions in their social bearings; the week's news and how it is read at different levels.

Factors (streams and forces) of contemporary social evolution, for worse and for better.

Practical Economics.—Individual and public possibilities of exchanging unconscious for conscious action on social evolution.

The problem—How to make the best of life (a) for others, and (b) for self ("scientific meliorism")? Ideals, collective and personal—illusory and progressively realisable.

Social problems in detail:—(a) concerning quality and quantity of population; (b) concerning consumption, production, and distribution of wealth. Remedial and progressive measures—how related; e.g. organisation of beneficence, organisation of industry.

Means of analytical and synthetic treatment of these problems; corre-

sponding immediate practical possibilities (*a*) of individual men and women (in occupation, leisure, expenditure, and influence); (*b*) of united action.

APPENDIX.—THE PRODUCTION OF WEALTH.

Exploitation, Arts and Manufactures, Transport and Trade. Origin and development of these.

Exploitation.—Sources of matter and energy in nature. Agriculture, mining, fisheries; progress in these. The Physiocratic school, and the systematic application of physical science to economics. Theory of interest.

The earth as modified by human action. Law of diminishing return.

The instruments of production. Outline summary of practice and theory respecting the use, tenure, and nature of land and capital at different stages of progress (ancient, mediæval, modern).

Arts and Manufactures.—Historical review of the evolution of industry. Hunting, pastoral, agricultural, and early civic states; rise and progress of division of labour; origin and classification of modern occupations; economic functions of women. Concentration of labour.

Arts of (*a*) *ultimate*, (*b*) *mediate* utility. (*a*) Arts of alimentation, clothing construction, &c. (finer arts). (*b*) Metallurgy and applied chemistry, mechanism, transport (coarser arts). Economy of machines and manufactures.

Reaction of different kinds of occupation on worker (*i.e.* of *function on organism*). Consequent relation of state of arts to that of civilisation, and influence of industrial progress on contemporary society.

Transport and Trade.—Ships, roads, canals, railways, telegraphs. Modern engineering. Progress of transport; general relation to civilisation, and direct effects upon commerce.

Economics in transport—their application.

Development of modern commerce. Money, its nature and uses. Function of traders—retailer, wholesaler, agent, speculator, &c. Reaction of exchange upon production.

Retrospect of economic theories corresponding to leading phases of commercial development. Extrication of theories underlying modern business mind. The art of money—"making."

SYLLABUS OF LECTURES

ON THE

OUTLINES OF MODERN BOTANY:

An Introduction to the Study of the Life and Forms of Plants.

BY PATRICK GEDDES.

(INTRODUCTORY.) *Life and Movement in Plants.*—Carnivorous Plants—Pitcher plants, Venus' Fly-trap, Sun-dew. Modes of capture, digestion and movement, sensitiveness. Movement and digestion in living beings generally. Unity of nature. Sources of complete literature of the subject (as typical for guidance in reading).

Movement and Nervous Action in Plants.—Hook and thorn climbers—root climbers. Twining plants (hop, convolvulus, &c.). Plants with sensitive organs—leaf climbers and tendrils bearers. Examples and explanations of such movements. Earth-seeking—movements and sensitiveness of rootlets. Rooting and sprouting of the seedling—how effected. Light-seeking and light-avoiding movements. Growth movements. Sleep of plants—its mechanism and uses. Sensitive plants. Nervous action in plants. Darwin's generalisation from preceding facts—*circumnutation*. Difficulties urged against this view. Retrospect of various conceptions of the vegetable world—(1) Barbaric, (2) Hellenic, (3) Conventional (Linnæan and Utilitarian), (4) Modern Physiological (neo-Hellenic).

Relation of Plants to Moisture, Soil, and Atmosphere.—Absorption and transpiration—how effected. Chemical composition of plants; ash, organic constituents—how respectively obtained. The living plant-stuff (protoplasm), its chemistry: (a) colourless, (b) with green colouring matter (chlorophyll). Relation of colourless and green parts of plants to atmosphere (1) in darkness, (2) in light. History of discovery (Bonnet, Priestley, Ingenhousz, Senebier, T. de Saussure) as affording characteristics of progress of research. Function of vegetation in general economy of nature as to (1) atmosphere, (2) animal life. Balance of nature.

Adaptation of Plant Form to Life and Surrounding (Functions and Environment).—Roots, for earth-seeking, absorption, storage, extension of plant, parasitism. Stems—support, ascent of crude and descent of elaborated sap; protection and storage; floating and submerged, climbing, creeping, and burrowing stems. Leaves—their typical structure. Varieties of form—how interpreted, researches of Lubbock, &c. Modified leaves—floating and submerged, climbing and twining, storing, protective (from climate or enemies), insect catching or attracting. Reproductive leaves. Leaf arrangement and bud-packing (*Phyllotaxis*)—its uses and probable origin.

Flowers.—Buttercup and lily as essential types (*Dicotyledon* and *Monocotyledon*). Flower arrangement (inflorescence)—how modified; raceme, umbel or spike, head, &c. Modification of lily type for fertilisation by (a) wind, (b) insects; rushes and orchids. Forms and uses of separate parts of flower—(1) accessory (sepals, petals), and (2) essential (stamens, carpels). Adaptation of these to (a) collective and general function of (cross) fertilisation; (b) respective special functions—(1) protection from climate and enemies, attractive, mechanical; (2) reproductive. Utility of floral details, viz., position and shape of parts, colours, markings, perfume, &c.

Mature Ovary (Fruit).—Adaptations for (1) protecting seed from climate and enemies; (2) dispersion of seed—(a) passive, by aid of wind, water, animals; (b) active, by scattering or planting seed.

Mature Ovule (Seed).—Protection from climate and enemies; "albumen" as accumulated capital for start in struggle for existence; germination.

Physiological Recapitulation.—Functions and their changes. Complex relations of living beings; struggle for existence; interdependence, e.g. insects and flowers, cats and clover, cattle and birds, &c. Need of observation of complete flora.

Form and Structure of Plants considered apart from Use and Adaptation (MORPHOLOGY). Morphological study of the flora: observation (orderly and detailed); resulting description (exhaustive yet telegraphic); drawing. Necessity of naming; advantages of binomial nomenclature.

Species, genus. Arrangement of genera into larger groups, Specialisation and generalisation; illustration by means of brackets, maps, &c. History of progress of vegetable classification (*Taxonomy*)—(1) pre-Linnæan, (2) Linnæan and Artificial, (3) Natural system (Jessieu, De Candolle, Brown, and in progress).

Systematic Botany.—200,000 species of modern herbariums—botanic garden illustrating selection of these; needed key afforded by small type botanic garden—map of this.

- A. *Phanerogams*—(I.) *Dicotyledons*—(a) *Thalamiflorals* (buttercups, poppies, violets, corn-flowers, pinks, geraniums, &c.); (b) *Calyciflorals* (roses, peas, saxifrages, umbellifers, &c.); (c) *Corolliflorals* (primroses and heaths; figworts, labiates, and borages; bells and composites); (d) Forms reduced from preceding (nettles and figs, oaks and beeches, poplars and willows). (II.) *Monocotyledons* (lilies; bananas, ginger and orchids; palms and arums; rushes, sedges, and grasses). (III.) *Gymnosperms* (conifers and cycads).
- B. *Cryptogams*—(I.) *Archegoniates*—(a) ferns, horsetails, club-mosses; (b) mosses, chara. (II.) Lichens, algæ, fungi; complex, filamentous, and unicellular forms. The primitive plants and their relations to animals. The *Mycelozoa*.

Distribution of the vegetable kingdom in space (*botanical geography*), and in time (*palæontology*). Genealogical tree of the vegetable kingdom.

Morphology of Organs.—(*Comparative Anatomy*)—Comparison of stems, of roots, of leaves, and of parts of flower.

Erect, creeping, leaf-like, &c.,	<i>stems</i> = ascending	} <i>axis</i> .
Descending, &c.,	<i>roots</i> = descending	
Bulbscales, thorns, budscales, leaves, bracts, =	leaves	} <i>appendages</i> .
Sepals, petals, stamens, carpel,	= floral leaves	

Plant thus consists of axis and appendages. History of progress of morphological theory. Predecessors and successors of Goethe.

Morphology of Tissues.—(*Histology*)—Axis and appendages alike consist of (a) embryonic and (b) developed—(1) *epidermic*, (2) *fundamental*, (3) *fascicular tissues* variously arranged. (i) *Epidermic tissue*—epidermis, hairs, sporecases, prickles, &c. (2) *Fundamental*—parenchyma, sclerenchyma, &c. (3) *Fascicular*—(a) *bast* (vessels, or cell-fusions; fibres, or elongated and thickened cells; and ordinary cells); (b) *wood* (vessels, fibres, and cells).

Embryonic Tissues.—Growth and development of plant by multiplication and differentiation of primitive embryonic cells. The plant egg. The cell-theory of Schleiden, its development and re-statement. Protoplasm, its anabolism and katabolism. Returning physiological synthesis from living protoplasm through cell, tissue, organ, to organism; henceforth conceived as no longer either simply as a specimen or a subject for analysis, but as a *working thought-model*.

The Origin of Plants.—Recapitulation and summary of preceding lectures as bearing on the problem. Evidences of organic evolution; history of the idea. Darwin and his predecessors. Natural selection. Need of theory of variation. Outline and rationale of this. Evolution in progress around us; increasing power of control and acceleration (artificial selection). Summary and re-statement of the doctrine of evolution. Botany in education.

SYLLABUS OF LECTURES

ON

ANIMAL LIFE.

By J. ARTHUR THOMSON, M.A.,

Lecturer on Zoology in the School of Medicine, Edinburgh.

The Wealth of Life.—Haunts and habits of animals.—Life in the deep sea.—The fauna of different regions, *e.g.*, Australia.—The animal census.

Bird's-eye view of the animal world.—Debated ground between the animal and vegetable kingdoms.—(1) The simplest animals, single cells; (2) Simple colonies of these, sponges; (3) Stinging animals, *e.g.*, "zoophytes" and jelly-fish, sea-anemones and corals; (4) Unjointed and jointed worms; (5) Starfish and sea-urchin group; (6) Jointed-footed creatures: crustaceans, insects, myriapods, and spiders; (7) Molluscs: bivalve shell-fish, snails, and cuttlefish.

History of our knowledge of forms.—Mythical natural history.—The old naturalists and the new.—From Aristotle to Darwin.—The "Challenger" expedition.—Zoological stations.

Survey of Back-boned Animals.—(8) The simplest of these; (9) Fishes; (10) Amphibians: frogs, newts, blindworms; (11) Reptiles: tortoises, lizards, snakes, and crocodiles; (12) Birds; (13) Mammals.

The gradual progress of life.—Attempts to understand this.—The old classification and the new.—From Linnæus to Hæckel.—The genealogical tree.—Connecting links between the groups.

The Battle of Life.—Thrust and parry.—Animals with armour and weapons, Tooth and claw.—The pains of progress.—Shifts for a living.—Thievish association or parasitism.—Mimicry, *e.g.*, in leaf-like insects.

The web of life.—Cats and clover crop.—Balance of nature, *e.g.*, in the relation of plants and animals to the air.—Mutual perfecting, *e.g.*, of flowers and insects.—Partnerships between plants and animals.—Mutual helpfulness of hermit crab and sea-anemone.—Co-operative colonies of animals.—The secret of division of labour.

Laggards and scouts in the race.—The race not always to the swift nor the battle to the strong.—The fittest not always the best.—The standard of evolution.

The progress of science illustrated in the history of parasitism.

The Problems of Life.—The great forces of love and hunger.—The whirlpool of life.—How dead matter rolls into life and rolls out again.—Income and expenditure.—Internal and external work.

The physiology of the amœba compared with that of man.—The difference and the unity.—Different ways of solving the same problems, *e.g.*, various modes of moving and breathing.

The chief functions.—Special cases, *e.g.*, animals feeding like plants, coloured, phosphorescent, dried-up forms, &c. &c.

Reference to history of physiology.—Old theories of animal and vital spirits.—The animal as an engine.—Deeper analysis necessary.

Divisions of Labour within the Animal.—Various contrivances for special purposes.—Comparison of amoeba and frog.—The gradual growth of organs.—Function before organ.—Comparative survey of the principal organs.

Reference to the history of the anatomy of animals.—The progress from Linnæus to Cuvier.

Life in its Lowest Terms.—The microscope.—Its evolution.—Influence on zoology.—The new world of simple forms.—Deeper penetration into the structure of the higher.

Life's simplest children.—Their relation to higher forms.—The cell-theory.—How all animals start from the beginning again.—The life-history of the simplest compared with changes in the elements of the highest.—The cell-cycle.—The stones in the house of life.

How the chemist helped the naturalist.—Besieging the citadel of life.—The fountain of life.—Life reduced to its least common denominator.—Living matter or protoplasm.

Continued history of anatomy and physiology.—The work of Bichat.—The study of the cell.—Present endeavour to understand the protoplasm itself.—What is meant by scientific analysis.—Nature not only to be described, but to be made translucent.

The Conditions of Life and Death.—*The relation of outside and inside.*—Internal answers to outside influences.—The effect of work and change of work.—Results of sluggishness in sea-squirts.—Relation of function to form.—The giraffe's long neck.

The outside forces hammering animals into shape.—Influences of pressure, heat, light, food, &c.—Variation and disease.—Experiments on tadpoles and caterpillars.—Making one species into another.—The results of luxurious surroundings, *e.g.*, on parasitic worms and crustaceans.—Winter changes.

The direct effects of one animal on another.—The indirect effects.—Influence of man on animals.—Domestication.—The history of pigeons.

The distribution of animals.—Active and passive spreading.—Fauna of islands.—The work of Alfred Russell Wallace.—Migration.—Old notion of cataclysms.—The effect of the ice-age.

Factors in evolution.—How have animals come to be what they are?—Answers of Lamarck, Darwin, and Semper.

Life, Growth, Sex, and Reproduction.—Immortality of the simplest forms of life.—Length of life among animals.—The beginning of death.

The limit of growth.—Relation between growing and multiplying.—Regeneration of lost parts, *e.g.*, in starfish.—Asexual and sexual reproduction.

The origin of sex.—Differences between the sexes.—Factors determining sex.—Complementary males.—The story of the aphides.—Parthenogenesis.—The population question among animals.

History of the theory of reproduction.—The speculations of the ancient naturalists contrasted with general results of Spencer.

Development.—The life-history of a sponge compared with that of the simplest back-boned animal.—Growth of the embryo.—Larval forms like tadpoles and caterpillars.—History of a crab.—How explicable.

The buried branches of the genealogical tree help us.—History from the tombs.—The pedigree of horses.—Fossil-birds.—The resemblance between the history of the race and the childhood of the individual.—The key to the riddle.—The past living in the present.—The individual life recapitulating the history of the kind.

Facts in this light.—Metamorphosis of insects and frogs.—Alternation of generations.—Roundabout development.—Rudimentary organs.—Abnormalities.—Backward development.

The laws of development according to Von Baer, Hæckel, and Herbert Spencer.

How Like begets Like.—Mutual influence of organs.—The internal struggle for existence.—The germ-cells not isolated.—Facts of heredity.

History of the theory of heredity.—Old notions.—Bonnet and Haller.—Darwin's pangenesis.—Its revived forms.—The memory of the protoplasm.—Recent advances.—The continuity of living matter.

Animal Intelligence.—The perfecting of sense organs and nervous system.—The "force of habit."—"Instinct."—Lubbock's study of ants.

Development and expression of emotions among animals.—Love of beauty, *e.g.*, among birds.—Love among animals.—Sexual selection.—"Morality of animals."—Parental care.—Social life.

Animal and Human Life.—The work of corals and earthworms.—Domestication.—Influence of animals on man.—Material results, *e.g.*, fisheries and oyster culture.—Medical results, *e.g.*, researches on parasites and micro-organisms.—Hints for hygiene.

The place of biology in the general system of knowledge.—Its relation to the science of matter and energy.—Foundation of the science of society.—Biological ideals based on general results.—The philosopher's stone and the elixir vitæ.—The science and art of life.

TIME TABLE

—♦—
AUGUST 4-30.
 —♦—

9-10.	{ SOCIOLOGY, General Course . . . }	Prof. GEDDES.
10-12.30.	{ BIOLOGY— Lecture and Practical work . . . }	{ Prof. GEDDES and Mr THOMSON, with the assistance of Mr R. Turnbull, B.Sc., Lec- turer on Botany in the School of Medi- cine for Women; Miss Etta Johnston and Mr A. J. Her- bertson, Demonstra- tors of Botany, Uni- versity College, Dun- dee. }
12.30-1.30.	INTERVAL (Bathe, Lunch, &c.)	
1.30-4.	{ ZOOLOGY— Lecture and Labora- tory Work . . . }	{ Mr THOMSON, with the assistance of Mr W. E. FOTHERGILL, M.A., B.Sc. }
	{ BOTANY— Lecture and Labora- tory Work . . . }	{ Prof. GEDDES and Demonstrators. }
	{ SOCIOLOGY,* Special Course— }	{ Seminar, Excursions, &c. }

* The Special Course dealing with Scotland will only be held this year provided a sufficient number of Students enter before July 15.

The Classes will be held, as formerly, at Granton Marine Station, which is only a short distance from the town, and readily reached by rail or car.

The fee for one course, except the Sociological Lectures, is £2. 2s.; for any two, £3. 3s.; for the Sociological Lectures alone, £1. 1s. 6d., or with any other course, £1. 1s.

Gentlemen attending the course can find board at the University Hall, from £1. 1s. weekly. Ladies desiring to find residence may communicate with Miss JANE HAY, 6 Merchiston Terrace, Edinburgh, who will endeavour to give them every assistance. It is hoped that a University settlement may be placed at their disposal.

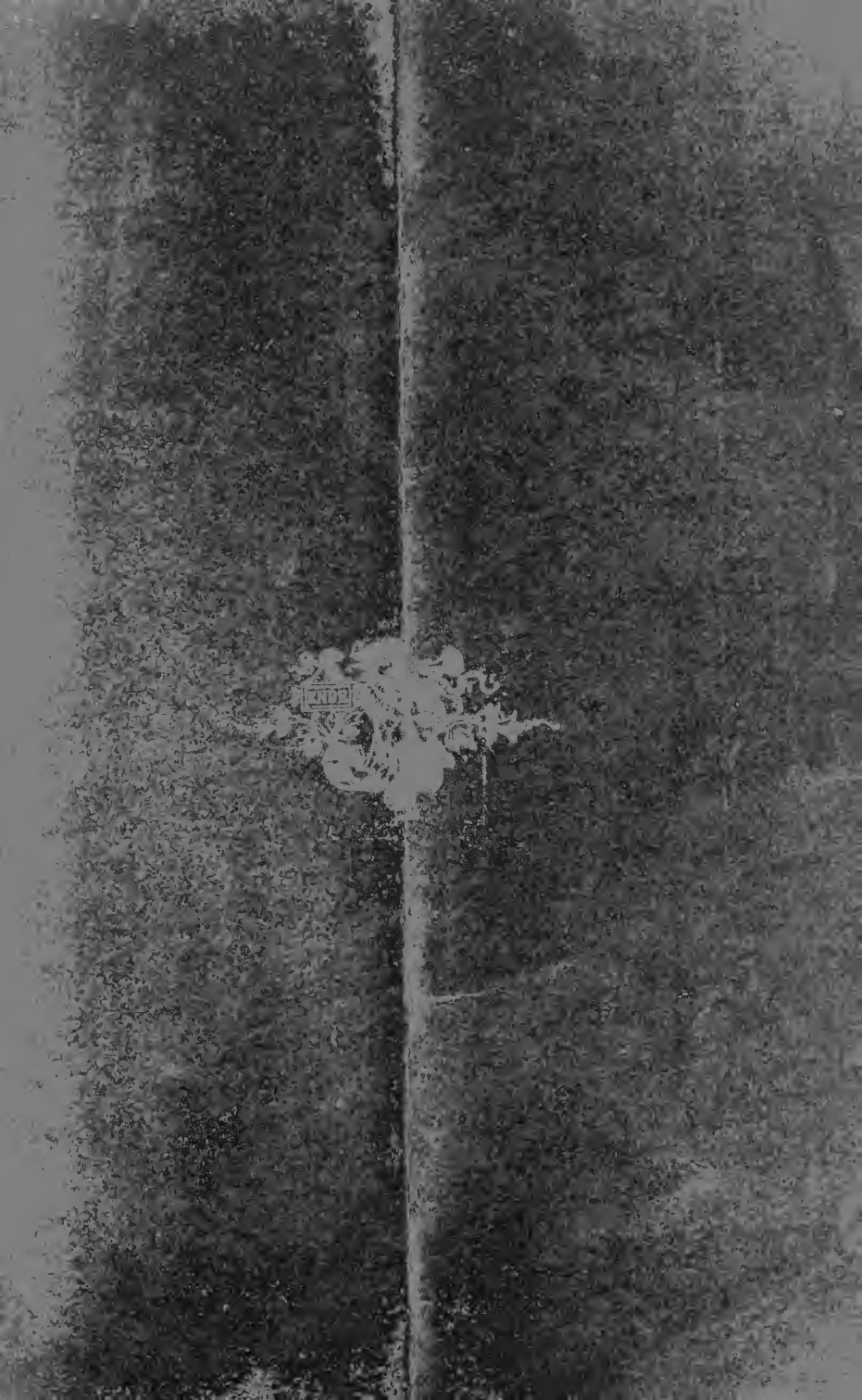
For entering for the classes, or for further information, apply to J. ARTHUR THOMSON, 30 Royal Circus, Edinburgh.

As the accommodation for all classes is limited, and as, moreover, some material preparation is necessary, intending students are requested to send in their names, if possible, by the middle of July.

N.B.—In response to inquiries from American students, it may be stated (*a*) that the Courses of Sociology may preferably be taken at the outset of a tour in Europe although also at its end; (*b*) that the cheapest mode of travel is from New York to Glasgow (*e.g.*, Saloon Return, State Line, 65 to 75 dols., Anchor Line, 75 dols.), whence sixty-five minutes' rail to Edinburgh.



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