DARWIN'S IMPACT ON GEOGRAPHY[1]

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ABSTRACT. Four themes in Darwin's writings are significant in the development of geographical thought. 1) The idea of development through time strongly influenced the progress of geomorphology, pedology, ecology, and to some extent the social sciences; 2) Darwin's stress on the intimate relationships between organic life and habitat gave impetus to organismic interpretations of regions and states, which persisted in geography long after the decline of biological Vitalism; 3) the themes of selection and struggle were deterministically applied in both human and political geography; 4) a fourth theme in Darwin's writings, the random nature of original variations, was ignored by geographers until recently, partly because of Darwin's own equivocal position on this issue. Finally, Darwin's work so changed the nineteenth century world view that the development of geography as a science itself became possible.

AT a time when many sciences are re-examining the impact of biological thinking, and particularly of Charles Darwin's writings, on their methods and theoretical foundations,[2] geographers have been strangely silent, and the Darwin centenary in geographical circles passed almost unremarked.[3] It is, in fact, strange that Darwin's name is not prominent in either of Hartshorne's volumes on geographic methodology, where only passing reference is made to the impact of the life sciences on geography.[4] Whereas the centenaries of the deaths of Humboldt and Ritter on May 6 and September 28, 1859, were commemorated by geographers, the first publication of *On the Origin of Species* on November 24 in the same year remained unnoticed.

Much of the geographical work of the past hundred years, however, has either explicitly or implicitly taken its inspiration from biology, and in particular from Darwin. Many of the original Darwinians, such as Hooker, Wallace, Huxley, Bates, and Darwin himself, had been actively concerned with geographical exploration, and it was largely facts of geographical distribution in a spatial setting which provided Darwin with the germ of his theory. This paper seeks to trace the broad lines of the biological impact on geography since 1859, to assess in what respects this impact was Darwinian and, equally important, what essential features of Darwin's thought were ignored by geographers.

It is important to recall that Darwin's theory was not simply one of 'evolution,' a word which did not appear in *The Origin* until the fifth edition in 1869, but concerned a mechanism whereby random variations in plants and animals could be selectively preserved, and by inheritance lead to changes at the species level. In geography, however, Darwinism was interpreted primarily as evolution, in the sense of a "continuous process of change in a temporal perspective long enough to produce a series of transforma-

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[1] I thank R. J. Chorley and P. Haggett, Cambridge University, for their comments on this paper.

[2] B. J. Loewenberg, "Darwin, Darwinism and History," *General Systems*, Vol. 3 (Ann Arbor: Society for General Systems Research, 1958), pp. 7–17. For an excellent recent review, see B. J. Loewenberg, "Darwin and Darwin Studies, 1959–63," in A. C. Crombie and M. A. Hoskin (Eds.), *History of Science*, Vol. 4 (Cambridge: Heffer, 1965), pp. 15–54.

[3] A meeting at the Royal Geographical Society for the Darwin Centenary did not consider Darwin's contribution to scientific thought: Sir C. G. Darwin, "Darwin as a Traveller," *Geographical Journal*, Vol. 126 (1960), pp. 129–36. See also footnote 87. A paper entitled "Ch. Darwin's Influence on the Progress of Science in Geography," by A. Malicki, was announced for presentation at the XI International Congress of the History of Science, Warsaw, 1965, but no abstract of this paper was published (*Sommaires*, XIe Congrès International d'Histoire des Sciences, Cracow, August 24–29, 1965. 2 volumes, 594 pp.).

[4] R. Hartshorne, *The Nature of Geography, a Critical Survey of Current Thought in the Light of the Past* (Lancaster, Pa.: Association of American Geographers, 1939) and R. Hartshorne, *Perspective on the Nature of Geography* (Chicago: Rand McNally and Co., for Association of American Geographers, 1959).

tions."[5] It was in this sense that many natural and social scientists welcomed evolution from about 1860 onwards. Darwin, however, was primarily concerned with the mechanism of the change or, as *The Origin* was subtitled, "the preservation of favoured races in the struggle for life." This element of struggle was applied in a deterministic way, particularly in human geography, at about the same period of time. The crux of Darwin's theory, the randomness of the initial variations,[6] passed almost unnoticed. In both physical and human geography, supposedly Darwinian ideas were applied in an eighteenth rather than a nineteenth century fashion, and geographers were still applying essentially Newtonian views of causation well into the twentieth century. Why the central theme of Darwin's work was thus neglected is, therefore, a fundamental problem in the history of ideas. Finally, the Darwinian revolution gave fresh impetus to concepts of biological origin which date back to Ritter and before, and the subsequent development of ecology led to new insights in some branches of geographical thinking.

In this paper four themes are taken to be especially significant contributions to geographical thought from biology and, particularly, from Darwin.[7] They are:

1) the idea of change through time;
2) the idea of organization;
3) the idea of struggle and selection;
4) the randomness or chance character of variations in nature.

Each of these four themes is examined in turn from the geographical point of view, to determine in what sense such views were biological or Darwinian in origin, how geography reacted to them, and what geographical insights they stimulated.

TIME AND EVOLUTION

The first part of the nineteenth century, culminating in Lyell's *Principles of Geology*,[8] saw the breakdown of the medieval view of the age of the earth, just as the Copernican revolution had revised ideas on its position in the universe four centuries earlier. The expansion of physical geography towards the end of the century drew on a double inspiration: that of the early geologists from Hutton to Lyell, and that of evolutionary biology, which was itself dependent on the earlier breakdown of restrictive cosmological ideas.

The strongest and most explicit impact of evolution was in the study of landforms, a field in which Darwin had worked during the *Beagle* years, when he formed his theory of the transformation of fringing reefs into barrier reefs and then into atolls by the slow operation of subsidence of their foundation through time.[9] The initial deduction and subsequent development of this theory, as Gruber[10] observed, closely resembles the later development of Darwin's biological ideas, and it could serve as the archetype for the "cyclic" ideas later developed in geomorphology. Huxley[11] himself published on the new subject of "physiography" in the 1870's, but it was Davis who took evolution as his inspiration in the idea cycle. Earlier workers wildering complexity of to reduce them to orde cation, much as had L but the failure to supp ciple to such study redu In his first paper on the forms, however, Davis life," and used such t adolescence, maturity, hood, infantile features phasize the analogy of going a sequence of ch time.[13] The power of to bring diverse facts relationships fascinated cycle in 1900, he state

> in a word it lengthens our in imagination, picture t area as clearly as we n quick growing plant, and and as little confuse the the many parts of a lan slopes, and water course the cotyledons, stems, b fruit of a rapidly maturi all these forms in appropr the brief course of a sin ripe for the introduction of evolution has been br the generation now matu ing years, and its applica is demanded.

[5] R. Scoon, "The Rise and Impact of Evolutionary Ideas," in S. Persons (Ed.), *Evolutionary Thought in America* (New Haven: Yale University Press, 1950), pp. 4–42; reference on p. 5.

[6] Samuel Butler neatly phrased the issue: "To me it seems that the 'Origin of Variation,' whatever it is, is the only true 'Origin of Species,'" in *Life and Habit* (London: Trübner and Co., 1878), reference on p. 263.

[7] No attempt is made to cover more general issues, such as the influence of Darwin's work on classification and taxonomy, with the resulting emphasis in geography on "genetic classification," or such fundamentally biological fields as zoogeography, on which both Darwin and Wallace worked. For commentary on these, see particularly D. B. Grigg, "The Logic of Regional Systems," *Annals*, Association of American Geographers, Vol. 55 (1965), pp. 465–91, and P. J. Darlington, Jr., "Darwin and Zoogeography," *Proceedings*, American Philosophical Society, Vol. 103 (1959), pp. 307–19.

[8] Sir Charles Lyell, *Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes now in Operation* (London: John Murray, 3 volumes, 1830–1833). See also C. C. Gillispie, *Genesis and Geology: a Study in the Relations of Scientific Thought, Natural Theology, and Social Opinion in Great Britain, 1790–1850* (Cambridge: Harvard University Press, 1951).

[9] C. R. Darwin, "Coral Islands," Introduction, map, and remarks by D. R. Stoddart, *Atoll Research Bulletin*, No. 88 (1962), pp. 1–20, and C. R. Darwin, *The Structure and Distribution of Coral Reefs* (London: Smith, Elder and Co., 1842).

[10] H. E. Gruber and V. Gruber, "The Eye of Reason: Darwin's Development during the *Beagle* Voyage," *Isis*, Vol. 53 (1962), pp. 186–200.

[11] T. H. Huxley, *Physiography, an Introduction to the Study of Nature* (London: Macmillan and Co., 1877).

[12] See, for example, the *The Earth: a Descriptive H of the Life of the Globe*, edi don: J. S. Virtue and Co.,

[13] W. M. Davis, "Geogra trated by a Study of Plains, tives," *Proceedings*, America vancement of Science (188

[14] W. M. Davis, "The Pl Lands," *Popular Science M* pp. 157–70; reprinted in W *Essays*, D. W. Johnson (1 Company, 1909) (hereafter 86; reference on pp. 85–86 "The Relations of the Ea their Progress in the Ninete *Geology*, Vol. 12 (1904), 675; "The Physical Factor *The Educational Bi-monthly* 22; "The Geographical Cyc Vol. 14 (1899), pp. 481–50 especially pp. 249 and 2 Geographical Cycle," *Bulle* America, Vol. 23 (1922), 594–95.

inspiration in the idea of the geographical cycle. Earlier workers, faced with the bewildering complexity of landforms, had sought to reduce them to order by nominal classification, much as had Linnaeus in taxonomy, but the failure to supply any unifying principle to such study reduced it to cataloguing.[12] In his first paper on the development of landforms, however, Davis referred to a "cycle of life," and used such terms as birth, youth, adolescence, maturity, old age, second childhood, infantile features, and struggle to emphasize the analogy of an organism undergoing a sequence of changes in form through time.[13] The power of evolutionary thinking to bring diverse facts into new meaningful relationships fascinated Davis: writing of the cycle in 1900, he stated that[14]

> in a word it lengthens our own life, so that we may, in imagination, picture the life of a geographical area as clearly as we now witness the life of a quick growing plant, and thus as readily conceive and as little confuse the orderly development of the many parts of a landform, its divides, cliffs, slopes, and water courses, as we now distinguish the cotyledons, stems, buds, leaves, flowers, and fruit of a rapidly maturing annual that produces all these forms in appropriate order and position in the brief course of a single summer. The time is ripe for the introduction of these ideas. The spirit of evolution has been breathed by the students of the generation now mature all through their growing years, and its application in all lines of study is demanded.

Throughout his working life, Davis emphasized this theme of orderliness and development through time, which he termed evolution, but it is perhaps significant that he took his illustrations not from the species or the population, but from the individual. So successful was Davis in promoting this view that in his hands geomorphology became more the study of the origin of landforms than of landforms themselves,[15] and was thus readily channeled into the restricted field of denudation chronology.

Darwin was, of course, deeply influenced by Lyell's *Principles*,[16] and the two distinct components of Lyell's uniformitarianism, gradualism, and actualism, are implicit in *The Origin*. It has been argued that a strict uniformitarianism had no place for progression or transmutation of species,[17] and Lyell himself emphatically rejected their mutability in the early editions of the *Principles*.[18] But in the sense of excluding catastrophic explanations, Huxley was certainly correct in his view that[19]

> consistent uniformitarianism postulates evolution as much in the organic as in the inorganic world,

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[12] See, for example, the writings of Elisée Reclus, *The Earth: a Descriptive History of the Phenomena of the Life of the Globe*, edited by A. H. Keane (London: J. S. Virtue and Co., Ltd., 1886).

[13] W. M. Davis, "Geographic Classification, Illustrated by a Study of Plains, Plateaus and their Derivatives," *Proceedings*, American Association for the Advancement of Science (1884), pp. 428–32.

[14] W. M. Davis, "The Physical Geography of the Lands," *Popular Science Monthly*, Vol. 57 (1900), pp. 157–70; reprinted in W. M. Davis, *Geographical Essays*, D. W. Johnson (Ed.) (Boston: Ginn and Company, 1909) (hereafter cited as *Essays*), pp. 70–86; reference on pp. 85–86. See also W. M. Davis, "The Relations of the Earth Sciences in view of their Progress in the Nineteenth Century," *Journal of Geology*, Vol. 12 (1904), pp. 669–87, especially p. 675; "The Physical Factor in General Geography," *The Educational Bi-monthly*, Vol. 1 (1906), pp. 112–22; "The Geographical Cycle," *Geographical Journal*, Vol. 14 (1899), pp. 481–504, and *Essays*, pp. 249–78, especially pp. 249 and 254; "Peneplains and the Geographical Cycle," *Bulletin*, Geological Society of America, Vol. 23 (1922), pp. 589–98, especially pp. 594–95.

[15] C. O. Sauer, "The Morphology of Landscape," *University of California Publications in Geography*, Vol. 2 (1925), pp. 19–54; see p. 32.

[16] As early as 1835 Darwin wrote to W. D. Fox that "I am become a zealous disciple of Mr. Lyell's views. . . . I am tempted to carry parts to a greater extent even than he does." C. R. Darwin to W. D. Fox, Lima, July 1835, in Francis Darwin (Ed.), *Life and Letters of Charles Darwin, including an Autobiographical Chapter* (London: John Murray, 3 volumes, 1887) (hereafter cited as *LLD*), reference in Vol. 1, p. 263.

[17] W. F. Cannon, "The Uniformitarian-Catastrophist Debate," *Isis*, Vol. 51 (1960), pp. 38–55; R. Hooykaas, *Natural Law and Divine Miracle: The Principle of Uniformity in Geology, Biology and Theology* (Leiden: E. J. Brill, 1963), pp. 93–101.

[18] See Gavin de Beer's comment: "Lyell used the principle of uniformitarianism to prove that evolution was impossible because evolution involved progressionism and progressionism involved catastrophism and catastrophism must be rejected. Darwin used uniformitarianism to show that simple, existing causes produced and directed evolution, and that there was no link between catastrophism and progressionism. . . . The supreme paradox was, therefore, that Darwin used Lyell's methods to show that Lyell's views on biology were wrong." G. de Beer, *Charles Darwin: Evolution by Natural Selection* (London: Thomas Nelson and Sons Limited, 1963), reference on p. 104.

[19] T. H. Huxley, "On the Reception of the 'Origin of Species,'" *LLD*, Vol. 2 (1887), footnote 16, pp. 179–204; reference on p. 190.

and that[20]

> the *Origin of Species* is the logical sequence of the *Principles of Geology*.

Uniformitarianism in geology, and subsequently in biology, involved, as Hutton clearly saw, the need for time in excess of that allowed by theology. In a famous passage on the Alps, Hutton described the continuous mantle of waste from the mountaintops to the sea:[21]

> throughout the whole of this long course, we may see some part of the mountain moving some part of the way. What more can we require? Nothing but time.

Once the reality of small but cumulative variations was established in biology, a similar conclusion followed. Time became one of Darwin's chief requirements, to the extent that he refused to accept Lord Kelvin's apparent demonstration of the youth of the earth based on estimated rates of cooling and the second law of thermodynamics.[22] And it was Kelvin, not Darwin, who was later shown to be wrong. When Davis in 1899, therefore, wrote his paper on the cycle of erosion, with the trinity of factors, structure, process, and time, it was time which he singled out as[23]

> the one of the most frequent application and of a most practical value

in landform study. The key to the cyclic view in geomorphology lies in fact in systematic, irreversible change of form through time, and from this derives the biological analogy of aging used by Davis, Johnson, and their school. Davisian geomorphology was deductive, time-oriented, and imbued with mechanistic notions of causation, deriving its uniformitarianism from Lyell and its theme of change through time at least partly from a simplified view of evolution.

Closely similar views were being proposed at about the same time in plant geography and particularly in ecology. Hooker, among the founders of the subject, was an explorer in his own right; later workers such as Shelford, Cowles, and Tansley were members of professional geographic bodies; and one man, Clements, occupied in plant ecology a position similar to that of Davis in geomorphology. In soil science also, similar naive views of evolution as change through time were emphasized by Marbut and his school, in introducing the ideas of Dokuchaiev and Sibirtsev into the English literature.[24] Both conceptually, and in the imagery employed, plant ecologists and pedologists followed Davis's biological analogy for change through time. Clements emphasized succession as the[25]

> universal process of formation development . . . the life-history of the climax formation.[26]

The conceptual similarity to geomorphology was seized on by Cowles, a botanist trained in physiography by S
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[20] T. H. Huxley, "The Coming of Age of 'The Origin of Species,'" in T. H. Huxley, *Science and Culture, and other Essays* (London: Macmillan and Co., 1882), pp. 310–24; reference on p. 315.

[21] J. Hutton, *Theory of the Earth, with Proofs and Illustrations* (London and Edinburgh: printed for Messrs. Cadell, Junior, and Davies, London, and William Creech, Edinburgh, 2 volumes, 1795), reference in Vol. 2, p. 329.

[22] W. Thomson, Baron Kelvin of Largs, "On the Secular Cooling of the Earth," in W. Thomson and P. G. Tait (Eds.), *Treatise on Natural Philosophy* (Oxford: At the Clarendon Press, 1867), Vol. 1 (all published), pp. 711–27; and W. Thomson, Baron Kelvin of Largs, "The 'Doctrine of Uniformity' in Geology briefly Refuted," *Popular Lectures and Addresses*, Vol. 2, *Geology and General Physics* (London: Macmillan and Co., 1894), pp. 6–9. Darwin admitted to being "greatly troubled at the short duration of the world according to Sir W. Thomson." C. R. Darwin to James Croll, 31 January 1869, in F. Darwin and A. C. Seward, editors, *More Letters of Charles Darwin: a Record of his Work in a Series of Hitherto Unpublished Letters* (London: John Murray, 2 volumes, 1903), reference in Vol. 2, p. 163. For an historical treatment of the problem of time, see F. C. Haber, *The Age of the World: Moses to Darwin* (Baltimore: Johns Hopkins Press, 1959), especially pp. 265–90.

[23] W. M. Davis, "The Geographical Cycle," *Geographical Journal*, Vol. 14 (1899), pp. 481–504, and *Essays*, footnote 14, pp. 249–78, reference on p. 249.

[24] For Dokuchaiev's views, see K. D. Glinka, *Treatise on Soil Science*, fourth edition (Jerusalem: Israel Program for Scientific Translations, for the National Science Foundation, Washington, D.C., 1963), p. 188; and, on the American school, C. F. Marbut, "Soils of the Great Plains," *Annals*, Association of American Geographers, Vol. 13 (1923), pp. 41–46.

[25] F. E. Clements, *Plant succession, an Analysis of the Development of Vegetation* (Washington: Carnegie Institution, 1916), reprinted in F. E. Clements, *Plant Succession and Indicators: a Definitive Edition of Plant Succesion and Plant Indicators* (New York: Hafner Publishing Company, 1963), reference on p. 3.

[26] F. E. Clements, *op. cit.*, footnote 25, pp. 6, 168, and 239.

[27] H. C. Cowles, "Th
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[29] R. H. Whittaker,

in physiography by Salisbury and Chamberlin, who brought Davisian geomorphology and Clementsian ecology together in "physiographical ecology," following field work in the Chicago area on the coincidence of plant formations and physiographic units.[27] Plant ecologists and geomorphologists both adopted terms such as infancy, youth, maturity, and old age to describe development through time.

As in geomorphology, the time-framework has proved too restrictive for later investigations.[28] Whittaker, in his thorough review of the climax concept, perceptively summarizes Clements's contribution to plant ecology, but he could well have been speaking of Davis's role in the development of geomorphology or Marbut's in pedology:[29]

> It was the great contribution of Clements to have formulated a system, a philosophy of vegetation, which has been a dominating influence on American ecology as a framework for ecological thought and investigation. . . . Some negative aspects of Clements' system are . . . the superficial verbalism, the tendency to fit evidence by one means or another into the philosophical structure, the thread of non-empiricism which runs through his thought and work. . . . The Clementsian system had a certain symmetry about it, it was a fine design if its premises were granted; and for its erection Clements may rank as one of the truly creative minds of the field.

In the social sciences the development of a time-perspective awaited that of a historical tradition, especially the emergence of a concept of prehistory in the 1830's. That evolutionary ideas were in the air in 1859 is shown by the appearance of Sir Henry Maine's *Ancient Law* as early as 1861. E. B. Tylor's *Early History of Mankind* (1865) and *Origin of Civilization* (1870), and the Duke of Argyll's *Primeval Civilization* (1869) set a fashion in the developmental interpretation of prehistory and ethnology which dominated the subject until Malinowski's functional reinterpretation in the 1920's. In social anthropology also, MacLennan's *Primitive Marriage* (1865), Frazer's *Golden Bough* (1890), Westermarck on religion, and Lewis Morgan, Durkheim, and Lévy-Bruhl on social structures, established an evolutionary position over a period of decades which dominated thinking in these subjects until the reaction in the twentieth century.[30] A few workers, some of them influential in geography, maintained a developmental framework, ranging from the "unilinear" school of White to the "multilinear" evolution of Steward.[31] Childe[32] influenced historical interpretation of technological development, particularly among English geographers; the botanist Geddes's work on cities influenced early ideas on urban geography;[33] Taylor applied developmental

[27] H. C. Cowles, "The Causes of Vegetative Cycles," *Botanical Gazette*, Vol. 51 (1911), p. 161; "The Causes of Vegetative Cycles," *Annals*, Association of American Geographers, Vol. 1 (1911), pp. 3–20, reference on p. 3. For Cowles's substantive work, see H. C. Cowles, "The Physiographic Ecology of Chicago and Vicinity: a Study of the Origin, Development and Classification of Plant Societies," *Botanical Gazette*, Vol. 31 (1901), p. 73. Cowles's teacher, Salisbury, was not himself an advocate of the cycle of erosion concept, but he used it as a teaching device.

[28] R. H. Whittaker, "A Consideration of Climax Theory: the Climax as a Population and Pattern," *Ecological Monographs*, Vol. 23 (1953), pp. 41–78; C. C. Nikiforoff, "Reappraisal of the Soil," *Science*, Vol. 129 (1959), pp. 186–96.

[29] R. H. Whittaker, *op. cit.*, footnote 28, p. 26.

[30] I. Goldman, "Evolution and Anthropology," *Victorian Studies*, Vol. 3 (1959), pp. 55–75; D. G. MacRae, "Darwinism and the Social Sciences," in S. A. Barnett (Ed.), *A Century of Darwin* (London: William Heinemann Limited, 1958), pp. 296–312; E. R. Leach, "Biology and Social Anthropology: the Current Status of the Biological Analogy," *Cambridge Review*, Vol. 85 (1964), pp. 248–51; F. S. C. Northrop, "Evolution in its Relation to the Philosophy of Nature and the Philosophy of Culture," in S. Persons (Ed.), *op. cit.*, footnote 5, pp. 44–83; R. W. Gerard, C. Kluckholn and A. Rapoport, "Biological and Cultural Evolution: some Analogies and Explorations," *Behavioral Science*, Vol. 1 (1956), pp. 6–34. For popular views, see H. R. Hays, *From Ape to Angel: An Informal History of Social Anthropology* (New York: Alfred A. Knopf, 1958), and G. E. Daniel, *The Idea of Prehistory* (London: Watts and Co., 1962).

[31] L. White, "Evolutionary Stages, Progress and the Evolution of Cultures," *Southwestern Journal of Anthropology*, Vol. 3 (1947), pp. 165–92; J. H. Steward, *Theory of Culture Change: the Methodology of Multilinear Evolution* (Urbana: University of Illinois Press, 1955).

[32] V. G. Childe, *Man Makes Himself* (London: Watts and Co., 1936); V. G. Childe, *Social Evolution* (London: Watts and Co., 1951).

[33] P. Geddes, *Cities in Evolution: An Introduction to the Town Planning Movement and to the Study of Civics* (London: Williams and Norgate, 1915); T. G. Taylor, *Urban Geography: A Study of Site, Evolution, Pattern and Classification in Villages, Towns and Cities* (London: Methuen and Co., first edition 1949, second edition 1951), see pp. 7–9, 421–23.

principles to the study of race and culture history;[34] and Beaver and others attempted to introduce cyclic ideas into the interpretation of economic landscapes[35] though with little success.

Change through time has been a dominant theme in much human geography, particularly in the work of the Berkeley School on the settlement of the American southwest and other areas. Here Sauer's influence has been dominant, and it is interesting that he himself studied at Chicago under the physiographer Salisbury and the plant ecologist Cowles.[36] Another pupil of Cowles, who also studied under Davis and published in both geomorphology and vegetation geography, was the historical geographer Ogilvie, who carried their emphasis on time into regional studies.[37]

[34] T. G. Taylor, *Environment and Race: A Study of the Evolution, Migration, Settlement and Status of the Races of Man* (London: Humphrey Milford, Oxford University Press, 1927); T. G. Taylor, *Environment and Nation: Geographical Factors in the Cultural and Political History of Europe* (Toronto: University of Toronto Press, 1936); T. G. Taylor, *Environment, Race and Migration. Fundamentals of Human Distribution: with Special Sections on Racial Classification; and Settlement in Canada and Australia* (Toronto: University of Toronto Press, 1937).

[35] S. H. Beaver, "Technology and Geography," *Advancement of Science*, Vol. 18 (1961), pp. 315–27; H. Bobek, "Die Hauptstufen der Gesellschafts- und Wirtschaftsentfaltung in geographischer Sicht," *Die Erde*, Vol. 90 (1959), pp. 259–98; H. Carol, "Stages of Technology and their Impact upon the Physical Environment: A Basic Problem in Cultural Geography," *Canadian Geographer*, Vol. 8 (1964), pp. 1–9. The time dimension is also emphasized in a different way by the Swedish school of human geography, for example by T. Hägerstrand, "The Propagation of Innovation Waves," *Lund Studies in Geography, Series B, Human Geography*, Vol. 4 (1952), pp. 3–19, and R. L. Morrill, "Simulation of Central Place Patterns over Time," *Lund Studies in Geography, Series B, Human Geography*, Vol. 24 (1962), pp. 109–20.

[36] J. Leighly, "Introduction," in J. Leighly (Ed.), *Land and Life: A Selection from the Writings of Carl Ortwin Sauer* (Berkeley and Los Angeles: University of California Press, 1963), pp. 1–8.

[37] A. G. Ogilvie. "The Time-Element in Geography," *Transactions and Papers*, Institute of British Geographers, No. 18 (1952), pp. 1–16; see p. 6. Similar views were expressed by H. C. Darby, "On the Relations of Geography and History," *Transactions and Papers*, Institute of British Geographers, No. 19 (1953), pp. 1–11, but E. W. Gilbert resisted the introduction of "scientific" or "evolutionary" ideas into historical geography, in "What is Historical Geography?" *Scottish Geographical Magazine*, Vol. 148 (1932), pp. 129–36.

The influence of plant ecology and the historical viewpoint was also clear, both in concept and language, in Whittlesey's idea of sequent occupance in the development of landscapes.[38]

The history of these narrowly evolutionary views in geography, however, resembled that in social anthropology: the early and enthusiastic application of time-frameworks to the data, and then a retreat from a developmental to a functional approach, or to a much modified and refined evolutionary interpretation. Primarily, however, geographers interpreted the biological revolution in terms of change through time: what for Darwin was a process became for Davis and others a history. This was powerfully reinforced not only when geology burst through theological restrictions on time, but also when man himself was found to have a history going back into antiquity. For a time "evolution" implied little more than the idea of change, development, and "progress," and Darwin was in spite of himself seen as its author.

ORGANIZATION AND ECOLOGY

Darwin's second major contribution to geography was the idea of the interrelationships and connections between all living things and their environment, developed in Haeckel's new science of *ecology*.[39] In the third chapter of *The Origin*, Darwin had been impressed by the "beautiful" and "exquisite" adaptation and interrelationships of organic forms in nature, and the theme of ecology is implicit if unstated in many of his writings:[40]

> how infinitely complex and close-fitting

he wrote in *The Origin*[41]

> are the mutual relations of all organic beings to each other and to the physical conditions of life.

[38] D. Whittlesey, "Sequent Occupance," *Annals*, Association of American Geographers, Vol. 19 (1929), pp. 162–65.

[39] E. Haeckel, "Entwicklunsgang und Aufgaben der Zoologie," *Jenaische Zeitschrift*, Vol. 5 (1869), p. 353.

[40] R. C. Stauffer, "Ecology in the Long Manuscript Version of Darwin's *Origin of Species* and Linnaeus' *Economy of Nature*," *Proceedings*, American Philosophical Society, Vol. 104 (1960), pp. 235–41, and P. Vorzimer, "Darwin's Ecology and Its Influence upon his Theory," *Isis*, Vol. 56 (1965), pp. 148–55.

[41] C. R. Darwin, *On the Origin of Species by Means of Natural Selection; or, The Preservation of favoured Races in the Struggle for Life* (London: John Murray,

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[45] T. H. Huxley,
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This was the theme of ecology and, while Clements in America was forcing vegetation into a time-framework, European workers in general were more concerned with community structures and functions, culminating in Tansley's idea of the ecosystem. Perhaps Darwin's most significant contribution to ecological thinking, however, was to include man in the living world of nature. This had been becoming inevitable, with Boucher de Perthes' work on the Somme gravels after 1837, but it was in 1859 that the importance of finds of ancient man was formally recognized, in Prestwich's paper to the Royal Society.[42] Darwin deliberately left the implications of *The Origin* for the history of man unspoken in his first edition, but he was disappointed by Lyell's reluctance to draw the obvious conclusions in *The Antiquity of Man* four years later.[43] The theological difficulties were considerable for, although it was possible to reinterpret the biblical account of time, fundamental Christian beliefs such as the fall of man and original sin hinged on specific details of special creation: if the creation proved a myth, what of the theology? In spite of Darwin's own reticence, his theory soon took the popular title of "the ape theory," and controversy in the 1860's centered around the problem of man's ancestry rather than of variation and selection.[44] Huxley's *Man's Place in Nature* in 1863, for example, dealt not with man's ecological status, but with his relationship with the apes;[46] man had emphatically become a subject for scientific speculation. Darwin himself, in the *Expression of the Emotions in Man and Animals* (1868) and in *The Descent of Man* (1871), went further by treating modern man on the same level as other living things.

Haeckel used the term "ecology" in 1869, and from about 1910 "human ecology" was used for the study of man and environment, not in a deterministic sense, but for man's place in the "web of life" or the "economy of nature." Park's statement of the scope of human ecology[46] deals with the web of life, the balance of nature, concepts of competition, dominance and succession, biological economics and symbiosis: all concepts taken from plant and animal ecology. For Park, human ecology investigated the processes involved in biotic balance, in which man interacts with nature through culture and technology. McKenzie[47] expressed similar ideas with a more economic bias. The simplicity of human ecology as a methodological framework when stated in purely biological terms was echoed by Barrows in his presidential address to the Association of American Geographers in 1923:[48]

> . . . geography is the science of human ecology. . . . Geography will aim to make clear the relationships existing between natural environments and the distribution and activities of man. Geographers will, I think, be wise to view this problem in general from the standpoint of man's adjustment to environment, rather than from that of environmental influence. . . . The center of geography is the study of human ecology in specific areas. This notion holds out to regional geography a distinctive field, an organizing concept throughout, and the opportunity to develop a unique group of underlying principles.

Barrows' address, perhaps hastening the expulsion of geomorphology from geography in the United States, aroused considerable animosity and little positive support among geographers, and the sociologists themselves gradually moved away from Park's position.

1859). Page references are given here to the reprint of the sixth edition (London: Geoffrey Cumberlege, Oxford University Press, 1951); reference on p. 81.

[42] J. Prestwich, "On the Occurrence of Flint-Implements, Associated with the Remains of Extinct Mammalia, in Undisturbed Beds of a late Geological Period," *Proceedings of the Royal Society*, Vol. 10 (1860), pp. 50–59, read 26 May 1859. Published in full with amended title in *Philosophical Transactions of the Royal Society*, Vol. 150 (1861), pp. 277–317.

[43] C. Lyell, *The Geological Evidences of the Antiquity of Man, with Remarks on Theories of the Origin of Species by Variation* (London: John Murray, 1863). See C. R. Darwin to J. D. Hooker, 24 February 1863, in *LLD*, Vol. 3 (1887), footnote 16, p. 9.

[44] A. Ellegård, "Darwin and the General Reader: The Reception of Darwin's Theory of Evolution in the British Periodical Press, 1859–1872," *Acta Universitatis Gothoburgensis: Göteborgs Universitets Arsskrift*, Vol. 64 (1958), pp. 1–394.

[45] T. H. Huxley, *Evidence as to Man's Place in Nature* (London: Williams and Norgate, 1863).

[46] R. E. Park, "Human Ecology," *American Journal of Sociology*, Vol. 42 (1936), pp. 1–15.

[47] R. D. McKenzie, "The Ecological Approach to the Study of the Human Community," *American Journal of Sociology*, Vol. 30 (1924), pp. 287–301; R. D. McKenzie, "The Scope of Human Ecology," *Publications*, American Sociological Society, Vol. 20 (1926), pp. 141–54.

[48] H. H. Barrows, "Geography as Human Ecology," *Annals*, Association of American Geographers, Vol. 13 (1923), pp. 1–14.

Bews, himself a botanist, followed Park closely,[49] but beginning with Alihan, sociologists turned to community as their field of study.[50] With some exceptions, such as White and Renner's textbooks,[51] the field delimited by Barrows and Park was abandoned by both geographers and sociologists,[52] though in America the Berkeley school adopted an ecological approach in the study of settlement in the American southwest.

Ecology has become, however, increasingly empirical in method, and in doing so it has run counter to, and ultimately has superseded, the synthetic geographical tradition of explanation by analogy, which attempted to understand the complexity and interrelationships of phenomena by reference to the even greater complexity of living organisms.[53] This is a theme which may be traced to classical writings and medieval scholasticism, and is in no sense Darwinian in origin, but after Darwin such treatment lost its more extreme metaphysical implications and became more directly biological in expression. The organism analogy is explicit in both classical plant ecology and pedology, particularly in Clements's writings. For him, the plant community is

> a complex organism, or superorganism, with characteristic development and structure[54]. . . . As an organism the formation arises, grows, matures, and dies. . . . Each climax formation is able to reproduce itself.[55]

Clements believed that[56]

> this concept is the 'open sesame' to a whole new vista of scientific throught, a veritable *magna carta* for future progress.

Similarly, Shaler, Whitney, and others interpreted the functional interrelationships in soils as a phase in the "higher estate of organic existence."[57] Later workers, however, failed to demonstrate the discrete existence of organic unity in either soil or vegetation formations,[58] and the organic analogy in physical geography never carried the influence which it did in other branches of the subject.[59]

In geography as a whole the organism analogy operated on three distinct levels: those of the earth, its regions, and its states; and on each level its use long predates Darwinian evolutionary theory. Organic theories of the state were revived by such philosophers as Hobbes, and were thoroughly worked out by Ahrens in 1850.[60] Much of this earlier work was teleological, as in Ritter's conception of terrestrial unity and in the preface to Hobbes' *Leviathan*, but in the nineteenth century the details of the analogy were being pursued more closely. Bluntschli[61] attributed to states the properties of human organisms, even the details of sex and personality, and a fundamental precept of Comte's positivism

[49] J. W. Bews, *Human Ecology* (London: Humphrey Milford, Oxford University Press, 1935).

[50] M. Alihan, *Social Ecology: A Critical Analysis* (Morningside Heights, New York: Columbia University Press, 1938); A. H. Hawley, *Human Ecology: A Theory of Community Structure* (New York: The Ronald Press Company, 1950).

[51] C. L. White and G. T. Renner, *Geography, an Introduction to Human Ecology* (New York: D. Appleton-Century Company, Inc., 1936), and *Human geography, an Ecological Study of Society* (New York: Appleton-Century-Crofts, Inc., 1948).

[52] L. F. Schnore, "Geography and Human Ecology," *Economic Geography*, Vol. 37 (1961), pp. 207–17.

[53] For commentary on the geographic relevance of the concepts of community and ecosystem, see W. B. Morgan and R. P. Moss, "Geography and Ecology: The Concept of the Community and its Relationship to Environment," *Annals*, Association of American Geographers, Vol. 55 (1965), pp. 339–50, and D. R. Stoddart, "Geography and the Ecological Approach: The Ecosystem as a Geographic Principle and Method," *Geography*, Vol. 50 (1965), pp. 242–51.

[54] F. E. Clements and V. E. Shelford, *Bio-ecology* (New York: John Wiley and Sons, Inc., 1939), p. 24.

[55] F. E. Clements, *op. cit.*, footnote 25, p. 3.

[56] F. E. Clements and V. E. Shelford, *op. cit.*, footnote 54, p. 24.

[57] N. S. Shaler, "The Origin and Nature of Soils," *12th Annual Report*, U.S. Geological Survey (1890–91), Part 1, pp. 213–345.

[58] See, for example, C. C. Nikiforoff, "Reappraisal of the Soil," *Science*, Vol. 129 (1959), pp. 186–96, and T. Kira, H. Ogawa, and K. Yoda, "Some Unsolved Problems in Tropical Forest Ecology," *Proceedings*, Ninth Pacific Science Congress, Vol. 4 (1962), pp. 124–34.

[59] But see the more extreme writings of, for example, C. Strickland, *Deltaic Formation, with Special Reference to the Hydrographic Processes of the Ganges and Brahmaputra* (Calcutta and London: Longmans, Green and Co., Ltd., 1940), especially Chapter 2, "The Sea in Pregnancy."

[60] H. Ahrens, *Die Organische Staatslehre, auf philosophisch-anthropologischer Grundlage* (Wien: G. Gerold & Sohn, 1850).

[61] J. Bluntschli, *Allgemeine Statslehre: Fünfte umgearbeitete Auflage des ersten Bandes des Allgemeinen Statsrechts (Lehre vom Modernen Stat, Erster Theil)* (Stuttgart: Verlag der J. G. Cotta'schen Buchhandlung, 1875).

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[62] A. Comte, *Cours de*
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[63] C. Ritter, *Comparati*
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[64] C. Ritter, *The Com*
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[65] P. Vidal de la Blach
raphie Générale," *Anna*
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Géographie," *Annales de*
pp. 289–99.

was that sociology could only be understood in biological terms.[62] The impact of Darwinian thinking, and the writings of Spencer in England and of Worms in France, helped popularize these narrower organic analogies in the social sciences, and they retained vitality in geography long after they had been abandoned in other branches of human studies.

The idea of the organic unity of the earth can best be traced to Ritter.[63]

> The earth is one; . . . all its parts are in ceaseless action and reaction on each other. . . . The earth is therefore . . . a unit, an organism of itself: it has its own law of development, its own cosmical life; it can be studied in no one of its parts.

To him the earth was a[64]

> living work from the hand of a living God, (with) a close and vital connection, like that between body and soul, between nature and history.

For both Humboldt and Ritter, unity, harmony, and interdependence of parts constituted the organic analogy. Half a century later Vidal de la Blache reached similar conclusions and acknowledged his debt to Ritter, both at the earth and at the regional level.[65]

In regional geography the idea of organic unity served as a unifying theme in an increasingly particularistic discipline. Herbertson in 1905 used the term "macro-organism" for the "complex entity" of physical and organic elements of the earth's surface:[66]

> the soil itself the flesh, the vegetation its epidermal covering with its animal parasites, and the water the circulating life-blood automatically stirred daily and seasonally by the great solar heat. . . . If we regard the Earth as an individual, and these geographical regions, districts, localities, as representing organs, tissues, and cells, we perhaps get nearest to a useful comparison.

Subsequently Herbertson wrote that natural regions are[67]

> definite associations of inorganic and living matter with definite structures and functions, with as real a form and possessing as regular and orderly changes as those of a plant or an animal.

Like plants and animals, regions can be hierarchically ranked into species, genera, orders, and classes.[68] Similar thinking pervaded English regional methodology in the first half of the century. Unstead spoke of the evolution of regions, in the sense of increasing complexity, and of their pathology, in the sense of conditions harmful to man. He admitted that regions, unlike organisms, cannot be said to die, but he compared continuity of existence in a region with that of the "germ-plasm of organisms through the successive generations,"[69] thus endowing regions at one time with the properties of individuals and at other times of populations. Similar organismic views were expressed by Bluntschli, Stevens, and most extremely by Swinnerton.[70]

In political geography the use of the organic analogy usually is associated with Ratzel, whose whole work is colored by Dar-

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[62] A. Comte, *Cours de Philosophie positive* (Paris: Bachelier, Librairie pour les Mathématiques, Vol. 1, and Bachelier, Imprimeur-Libraire pour les Sciences, Vols. 2–6, 6 volumes, 1830–1842), and commentary by F. W. Coker, "Organismic Theories of the State: Nineteenth Century Interpretations of the State as Organism, or as Person," *Columbia University Studies in History and Economics*, Vol. 38 (1910). Also H. Spencer, *The Principles of Sociology* (London: Williams and Norgate, 3 volumes, 1876–1896), especially Vol. 2, and R. Worms, *Organisme et Société* (Paris: V. Giard et E. Brière, Bibliothèque sociologique internationale, 1896; also published as a Thèse, Faculté des Lettres, Paris, 1895).

[63] C. Ritter, *Comparative Geography*, translated by W. L. Gage (Edinburgh and London: William Blackwood and Sons, 1865), pp. 64, 65.

[64] C. Ritter, *The Comparative Geography of Palestine and the Sinaitic Peninsula, translated and adapted to the use of Biblical Students* by W. L. Gage (Edinburgh: T. and T. Clark, 4 volumes, 1866), reference in Vol. 2, p. 4.

[65] P. Vidal de la Blache, "Le Principe de la Géographie Générale," *Annales de Géographie*, Vol. 5 (1896), pp. 129–42; "Des Caractères distinctifs de la Géographie," *Annales de Géographie* Vol. 22 (1913), pp. 289–99.

[66] A. J. Herbertson, "The Higher Units: a Geographical Essay," *Scientia*, Vol. 14 (1913), pp. 203–12, reference on p. 205. This paper is reprinted in *Geography*, Vol. 50 (1965), pp. 332–42.

[67] A. J. Herbertson, "Natural Regions," *Geographical Teacher*, Vol. 7 (1913–1914), pp. 158–63, reference on pp. 158–59.

[68] A. J. Herbertson, *op. cit.*, footnote 67, p. 161.

[69] J. F. Unstead, "Geographical Regions illustrated by reference to the Iberian Peninsula," *Scottish Geographical Magazine*, Vol. 42 (1926), pp. 159–70, reference on p. 168.

[70] H. Bluntschli, "Die Amazonasniederung als harmonischer Organismus," *Geographische Zeitschrift*, Vol. 27 (1921), pp. 49–67; A. Stevens, "The Natural Geographical Region," *Scottish Geographical Magazine*, Vol. 55 (1939), pp. 305–17, see pp. 308–10; H. H. Swinnerton, "The Biological Approach to the Study of the Cultural Landscape," *Geography*, Vol. 23 (1938), pp. 83–89.

winian evolutionary thinking.[71] The first chapter of his *Politische Geographie* is entitled "Der Staat als bodenständiger Organismus," and the mystical conception of the indivisibility of people and land when organized into a state goes far beyond the formalistic comparison of lines of communication and arteries, seats of government and the brain, and so on, which Spencer outlined.[72] The organic quality of states depends on organization and interdependence of parts; it then assumes properties of growth and competition, and in so doing goes beyond the organic analogies of the earth and the geographical region.

The fundamental criterion used by geographers for applying the organic analogy at all levels has been the possession of properties of organization of constituent components into a functionally related, mutually interdependent complex which in spite of continuous flow of matter and energy is in apparent equilibrium, and which possesses properties as a whole which are more than the sum of the parts.[73] In this one may distinguish the influence of Vitalism in biology and the holistic philosophy of Smuts and Whitehead.[74] The Vitalist approach has the appearance of profound insight, but in essence it calls up undemonstrable, and hence unprovable causes such as the *entelechy* of Driesch or the *élan vital* of Bergson, to explain phenomena which are otherwise too complex to understand. Such procedures in biology preclude the rational formulation and testing of hypotheses, for they lie outside hypothesis; they pose no questions, and hence obtain no answers.[75] This was perceived by Vallaux in geography many years ago, and with recent advances in the study of molecular biology Vitalism now has no place in science.[76] The major objection to the organic approach in geography, however, is methodological, for it is a synthetic notion which gives no assistance in actual investigation, and it is, furthermore, an essentially idiographic concept in an increasingly nomothetic science.[77] The concept is thus reduced to a metaphor of dubious value, hinging on gross formal and functional comparisons between living matter and complexly interrelated facts in areas, and as such has dropped out of geographic work since 1939, except in occasional mention of Herbertson and Vidal de la Blache.[78]

SELECTION AND STRUGGLE

Although the limitations of organic analogies require little demonstration, the problem of the effect of environment on man leads into the difficult fields of environmental influence,

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[71] On the nineteenth century background to Ratzel's thought, see particularly J. Steinmetzler, "Die Anthropogeographie Friedrich Ratzels und ihre ideengeschichtlichen Wurzeln," *Bonner Geographischer Abhandlungen*, Bd. 19 (1956), pp. 1–151.

[72] F. Ratzel, *Politische Geographie* (Munich: R. Oldenbourg, 1897), and H. Spencer, *op. cit.*, footnote 62.

[73] H. J. Fleure, *An Introduction to Geography* (London: Benn, 1929), p. 13.

[74] H. Driesch, *The Science and Philosophy of the Organism: the Gifford Lectures delivered before the University of Aberdeen in the year 1907* (Vol. 1) . . . *and in the year 1908* (Vol. 2) (London: Adam and Charles Black, 1908); J. C. Smuts, *Holism and Evolution* (London: Macmillan and Co., Ltd., 1926); A. N. Whitehead, *Science and the Modern World: Lowell Lectures 1925* (Cambridge: at the University Press, 1926).

[75] W. S. Beck, *Modern Science and the Nature of Life* (London: Macmillan and Co., 1958; page references to the 1961 edition, Harmondsworth: Penguin Books). There is some similarity between Vitalist beliefs and Vidal's idea of the "personnalité géographique" of regions. See P. Vidal de la Blache, *Tableau de la Géographie de la France*, Tome 1, première partie, of E. Lavisse, *Histoire de France illustrée depuis les Origines jusqu'à la Revolution* (Paris: Hachette et Cie., 1911), especially Première partie, "Personnalité géographique de la France," pp. 5–54.

[76] C. Vallaux, "La Surface Terrestre assimilée à un Organisme," Chapter 2, pp. 28–57, in *Les Sciences Géographiques* (Paris: Librairie Felix Alcan, nouvelle edition, 1929); see p. 49; Ernst Caspari, "On the Conceptual Basis of the Biological Sciences," in R. G. Colodny, (Ed.), *Frontiers of Science and Philosophy* (London: George Allen and Unwin Ltd., 1964), pp. 131–45; and Beck, *op. cit.*, footnote 75.

[77] W. R. Siddall, *Idiographic and Nomothetic Geography: The Application of Some Ideas in the Philosophy of History and Science to Geographic Methodology* (University of Washington, Ph.D. Thesis, 1959).

[78] Crowe attacked the organism analogy in 1938: P. R. Crowe, "On Progress in Geography," *Scottish Geographical Magazine*, Vol. 54 (1938), pp. 1–19, see pp. 10–11. See also the discussions by R. Hartshorne, "Is the Geographic Area an Organism?" in *The Nature of Geography*, *op. cit.*, footnote 4, pp. 256–60, and by D. R. Stoddart, "Organism and Ecosystem as Geographical Models," in R. J. Chorley and P. Haggett (Eds.), *Models in Geography* (London: Methuen and Co., 1967).

[79] G. Tatham, "Enviro
in T. G. Taylor (Ed.),
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[80] W. M. Davis, "An
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[81] C. O. Sauer, *op. cit.*,

[82] A. P. Brigham, "Pr
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Vol. 5 (1915), pp. 3–25;
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selection, and adaptation.[79] Most pre-Darwinian writers on the effects of environment were content to look for cause–effect relationships, without enquiring too closely into process, and this theme was taken up by Ratzel in the first volume of *Anthropogeographie*, and later by his students Miss Semple and Demolins. To the French school, imbued with Vidal's notions of harmony and interrelationship, this was too rigid a framework for analysis, but in America Davis attempted to carry simplistic ideas of causality into the definition of geography itself.[80]

> Any statement is of geographical quality if it contains a reasonable relation between some inorganic element of the earth on which we live, acting as a control, and some element of the existence, or growth, or behavior or distribution of the earth's organic inhabitants, serving as a response.

This suggestion gained little support among geographers, who realized that no science can take as its field of study a specific relationship rather than a body of data, for if it did the statement of its aims would presuppose the existence of the relationship itself.[81]

If causal relationship provided an unsound methodological principle, however, the problem of environmental influence remained.[82] Fleure, who came deeply under the influence of Darwinism in 1892–1895, stressed the need for the physiological study of environmental effects on man, and in his typology of human regions (regions of difficulty, of effort, of increment) came close to applying Darwinian ideas of natural selection through environmental influence to human groups.[83] The study of physiological effects, however, has become a specialized branch of biology outside geographical competence, and geographers have generally restricted themselves to the inference of causation from covariance on a coarser scale. Huntington particularly took up the problem of natural selection, environmental influences, and human population on a world scale, and Taylor explored the same theme in a series of studies of race, peoples, states, and towns, emphasizing their development through time under the influence of environmental factors.[84] The questions which these determinists raised, however, were posed in so gross a manner that they could only invite the grossest answers; most geographers realized this, and neither Taylor nor Huntington gained full academic acceptance. The questions which they asked could not be meaningfully answered in geographical terms, and the whole determinist–possibilist controversy, "unreal and futile" as Hartshorne termed it, moved on to a philosophical rather than an empirical level.[85]

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[79] G. Tatham, "Environmentalism and Possibilism," in T. G. Taylor (Ed.), *Geography in the Twentieth Century: A Study of Growth, Fields, Techniques, Aims and Trends* (London: Methuen, 1951), pp. 128–62; L. Febvre with L. Bataillon, *A Geographical Introduction to History* (London: Kegan Paul, Trench, Trubner and Co. Ltd., 1925), being the translation of *La Terre et l'Évolution Humaine: Introduction géographique à l'Histoire* (Paris: La Renaissance du Livre, 1922); F. Ratzel, *Anthropo-geographie oder Grundzüge der Anwendung der Erdkunde auf die Geschichte* (Stuttgart: J. Engelhorn, 1882).

[80] W. M. Davis, "An Inductive Study of the Content of Geography," *Bulletin*, American Geographical Society, Vol. 38 (1906), pp. 67–84, and *Essays*, footnote 14, pp. 3–22, reference on p. 8. Also W. M. Davis, "Systematic Geography," *Proceedings*, American Philosophical Society, Vol. 41 (1902), pp. 235–59.

[81] C. O. Sauer, *op. cit.*, footnote 15, pp. 51–52.

[82] A. P. Brigham, "Problems of Geographic Influence," *Annals*, Association of American Geographers, Vol. 5 (1915), pp. 3–25; C. R. Dryer, "Genetic Geography: The Development of the Geographic Sense and Concept," *Annals*, Association of American Geographers, Vol. 10 (1920), pp. 3–16.

[83] H. J. Fleure, "Geography and the Scientific Movement," *Geography*, Vol. 22 (1937), pp. 178–88; H. J. Fleure, "The Later Development in Herbertson's Thought: A Study in the Application of Darwin's Ideas," *Geography*, Vol. 37 (1952), pp. 97–103; H. J. Fleure, "Human regions," *Scottish Geographical Magazine*, Vol. 35 (1919), pp. 94–105; revised from "Régions humaines," *Annales de Géographie*, Vol. 26 (1917), pp. 161–74.

[84] E. Huntington, *Mainsprings of Civilisation* (New York: John Wiley and Sons, 1945); E. Huntington, "Geography and Natural Selection," *Annals*, Association of American Geographers, Vol. 14 (1924), pp. 1–16; T. G. Taylor, *Environment and Race: A study of the Evolution, Migration, Settlement and Status of the Races of Man* (London: Humphrey Milford, Oxford University Press, 1927); T. G. Taylor, *Environment and Nation: Geographical Factors in the Cultural and Political History of Europe* (Toronto: University of Toronto Press, 1936); T. G. Taylor, *Urban Geography: A Study of Site, Evolution, Pattern and Classification in Villages, Towns and Cities* (London: Methuen and Co. Ltd., 1949).

[85] R. Hartshorne, *Perspective on the Nature of Geography*, op. cit., footnote 4, p. 57; A. F. Martin, "The Necessity for Determinism, a Metaphysical Problem Confronting Geographers," *Transactions and Papers*, Institute of British Geographers, No. 17 (1951), pp. 1–11; for a review of the whole group of issues around environmental influence and deter-

Darwin's theory was, of course, one of natural selection rather than of evolution, and basic to his thesis was the idea, taken from Malthus, that populations tended to expand at a geometric rate and thus outstrip resources.[86]

> Thus, from the war of nature, from famine and death, the most exalted object of which we are capable of conceiving, namely, the production of the higher animals, directly follows, (wrote Darwin in the last paragraph of *The Origin*): There is grandeur in this view of life.

Such views in turn influenced social thinking, particularly in America, where Spencer's idea of the survival of the fittest and Darwin's of the struggle for life were used to justify laissez faire in politics and economics, particularly in the "Social Darwinism" of Sumner.[87] Hofstadter has shown how the geologists Ward and Shaler denied the value of unrestricted competition in social life, and how they and the Russian geographer Kropotkin stressed cooperation and mutual aid in social development.[88] The idea of social selection was often somewhat crudely phrased, especially in geographical writing. Thus Turner's frontier hypothesis[89] and especially Roosevelt's book on *The Winning of the West* both took the naive view that frontier conditions selected all that was pioneering and democratic in a society, which then itself took on the pioneer spirit. It is interesting that, except in the idea of competition, and its implications, Darwinism had little effect in classical equilibrium economics, and both the implications of random variation and of development through time are relatively recent innovations.[90]

It was in political geography, however, that ideas of struggle and selection on a national level were most significant. In 1896 Ratzel developed his seven laws of the growth of states, from which derived the powerful concept of *Lebensraum*:[91]

> Just as the struggle for existence in the plant and animal world always centrés about a matter of space, so the conflicts of nations are in great part only struggles for territory.

Although there is undoubtedly a danger that selective quotation of this sort may do violence to Ratzel's essentially scholarly position, as both Broek and Wanklyn argued,[92] it is clear that the organic analogy for Ratzel not only provided a simple and powerful model in analytical political geography, but also an apparently scientific justification, in Darwinian selection, for political behavior. It is interesting that Semple, in her exposition of Ratzel's own views, decided to omit the cruder Spencerian analogies as already outdated even in sociology,[93] but in spite of her disclaimers her writings are permeated by such thinking.

minism, see G. R. Lewthwaite, "Environmentalism and Determinism: A Search for Clarification," *Annals*, Association of American Geographers, Vol. 56 (1966), pp. 1–23.

[86] C. R. Darwin, *op. cit.*, footnote 41, p. 560.

[87] Herbst has attempted to trace the dichotomy in American geography between physical and human studies to the early influence of Social Darwinism on, for example, Davis's definition of the nature of the subject. See J. Herbst, "Social Darwinism and the History of American Geography," *Proceedings*, American Philosophical Society, Vol. 105 (1961), pp. 538–44.

[88] R. Hofstadter, *Social Darwinism in American Thought* (Philadelphia: University of Pennsylvania Press, 1944; revised edition, Boston: The Beacon Press, 1955); the decline of the more extreme Social Darwinism in America closely paralleled the eclipse of Spencer's evolutionary philosophy by the pragmatism of William James and John Dewey in the later years of the nineteenth century. See especially P. S. Wiener, *Evolution and the Founders of Pragmatism* (Cambridge: Harvard University Press, 1949).

[89] F. J. Turner, *The Frontier in American History* (New York: Henry Holt and Company, 1920).

[90] T. Veblen, "Why is Economics not an Evolutionary Science?" *Quarterly Journal of Economics*, Vol. 13 (1898), pp. 373–97; J. J. Spengler, "Evolutionism in American Economics, 1800–1946," in S. Persons, *op. cit.*, footnote 5, pp. 202–66; A. Alchian, "Uncertainty, Evolution, and Economic Theory," *Journal of Political Economy* (1950), pp. 211–21; and, on development economics, W. W. Rostow, *The Stages of Economic Growth: a non-communist Manifesto* (Cambridge: at the University Press, 1960).

[91] The laws are set forth in F. Ratzel, "Die Gesetze des räumlichen Wachstums der Staaten: ein Beitrag zur wissenschaftlichen politischen Geographie," *Petermanns Mitteilungen*, Vol. 42 (1896), pp. 97–107, and also "The Territorial Growth of States," *Scottish Geographical Magazine*, Vol. 12 (1896), pp. 351–61; the concept of *Lebensraum* is enunciated in F. Ratzel, *op. cit.*, footnote 79, p. 458.

[92] J. O. M. Broek, "Friedrich Ratzel in Retrospect," mimeographed, abstract in *Annals*, Association of of American Geographers, Vol. 44 (1954), p. 207, H. Wanklyn, *Friedrich Ratzel: a Biographical Memoir and Bibliography* (Cambridge: at the University Press, 1961).

[93] E. C. Semple, *Influences of Geographic Environment: on the Basis of Ratzel's System of Anthropogeography* (New York: Henry Holt and Company, 1911), p. v.

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Ratzel's views served as a source for the *Geopolitik* developed in Europe between the wars. States for Kjellen were biological manifestations,[94] endowed not only with morality but also with "organic lusts." Herbert Spencer's writings are directly echoed in Kjellen's *Staten som Lifsform.*[95] The political usage made of the organic view of the state, and the ideas of struggle and *Lebensraum*, brought the subject into intellectual disgrace in the 1930's, as Troll[96] has outlined, and modern political geography is at pains to dissociate itself from any kind of organic analogy.

RANDOMNESS AND CHANCE

This review of biological ideas in geography has demonstrated that "Darwinism" or "evolution" was almost always interpreted by geographers either in the sense of change through time or of social struggle and selection. In both cases the application has been largely deterministic: it has in fact been said that simple geographical determinism, in its picture of causality, was one of the last fields of operation of the Newtonian world-view in the twentieth century. Any discussion of the biological impact on geographical thinking must hinge on this central question: why was Darwinism, a theory for the selection of randomly occurring variants, interpreted in a deterministic and not a probabilistic sense?[97] Why was chance omitted in geography? The question is of more than historical interest, for a century after *The Origin*, geographers are beginning to recognize the importance of stochastic processes in geographic change.[98]

The problem is more remarkable because the study of random processes in the nineteenth century was by no means limited to Darwinian biology: indeed, Merz has written that[99]

> the study of this blind chance in theory and practice is one of the greatest scientific performances of the nineteenth century.

In the natural sciences Laplace laid the foundations of probability theory at the beginning of the century, and the theme was subsequently taken up by Adolphe Quetelet in the social sciences and used by Buckle in a work with which Darwin was certainly familiar.[100] The new kinetic theory of gases

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[94] R. Kjellen, *Staten som Lifsform*, Vol. 3, No. 3 of *Politiska Handböcker* (Stockholm: H. Geber, 1916), and the German editions, *Der Staat als Lebensform*, uebersetzt von Margarethe Landfeldt (Leipzig: S. Herzel, 1917) and *Der Staat als Lebensform*, uebertragung von J. Sandmeier (Berlin-Grunewald: K. Vowinckel, 1924, 4 Auflage). Also H. W. Weigert, *Generals and Geographers: The Twilight of Geopolitics* (New York: Oxford University Press, 1942), pp. 106–07.

[95] Rudolph Kjellen, *op. cit.*, footnote 94, quoted by R. H. Fifield and G. E. Pearcy, *Geopolitics in Principle and Practice* (Boston: Ginn and Company, 1944), p. 11.

[96] C. Troll, "Geographic Science in Germany during the Period 1933–1945: a Critique and Justification," *Annals*, Association of American Geographers, Vol. 39 (1949), pp. 99–137.

[97] R. A. Fisher goes so far as to state that "Darwin's chief contribution, not only to Biology but to the whole of natural science, was to have brought to light a process by which contingencies *a priori* improbable, are given, in the process of time, an increasing probability, until it is their non-occurrence rather than their occurrence which becomes highly improbable." See "Retrospect of the Criticisms of the Theory of Natural Selection," in J. Huxley, A. C. Hardy, and E. B. Ford (Eds.), *Evolution as a Process* (London: George Allen and Unwin Ltd., 1954), pp. 84–98, reference on p. 91.

[98] For an early statement on probability in geography, see J. Brunhes, "Du Caractère propre et du caractère complexe des Faits de Géographie Humaine," *Annals de Géographie*, Vol. 33 (1913), pp. 1–40, and translation in "The Specific Characteristics and Complex Character of the Subject-matter of Human Geography," *Scottish Geographical Magazine*, Vol. 29 (1913), pp. 304–22, 358–74: "Every truth concerning the relations between natural surroundings and human activities can never be anything but approximate; to represent it as something more exact than that is to falsify it" (pp. 362–63). "All biological relations, all oecological truths, are, and can be, nothing more than statistical truths" (p. 364). For recent substantive work, see, for example, T. Hägerstrand, *op. cit.*, and R. L. Morrill, *op. cit.*, footnote 35.

[99] J. T. Merz, *A History of European Thought in the Nineteenth Century*, Volume 2 (Edinburgh: William Blackwood and Sons Ltd., 1928), p. 624. For a historical review, see E. Nagel, "Principles of the Theory of Probability," *International Encyclopedia of Unified Science*, Vol. 1, No. 6 (Chicago: University of Chicago Press, 1939).

[100] P. S. de Laplace, *Théorie analytique des Probabilités* (Paris: Mme. Ve. Courcier, Imprimeur-Librairie pour les Mathématiques, 1812); P. S. de Laplace, *Essai philosophique sur les Probabilités* (Paris: Bachelier, Successeur de Mme. Ve. Courcier, Librairie pour les Mathématiques, 1814); L. A. J. Quetelet, *Sur l'Homme et le Développement de ses Facultés: ou essai de Physique sociale* (Bruxelles: L. Hauman et Compe., 2 volumes, 1836); J. Herschel, "Quetelet on Probabilities," *Edinburgh Review*, Vol. 42 (1850), pp. 1–57; H. T. Buckle, *History of Civilisation in England*, Volume 1 (London: J. W. Parker

developed by Herapath, Clausius, and Clerk Maxwell was appearing at the same time as *The Origin*.[101] Boltzmann extended statistical conceptions in mechanics; and in biology itself Darwin's work stimulated a long series of statistical studies, from Galton and Pearson to Fisher and Haldane. Why, then, in such an intellectual atmosphere, was the geographical interpretation so deterministic?[102]

Part of the answer lies in Darwin himself. Darwin's theory made a clear distinction between the way in which evolution was effected, and the course of evolution itself: geography seized on the latter and ignored the former. Darwin began with the idea of the selection of "chance" variations, which are "no doubt" governed by laws.[103] These laws Darwin failed to discover, and in time he came to emphasize chance less and less, and by the last edition of *The Origin* he was thinking of directional variation in a Lamarckian sense. Nowhere does he use the word "random," and in the fourth chapter of *The Origin* he states that the use of the word "chance" is "wholly incorrect."[104] Although he undoubtedly believed that unfavorable variations could be as numerous as favorable ones, this became less clear with each successive edition. Darwin's difficulty was this: whereas his theory explained adaptation in nature by variation and natural selection, he could not, before the discovery of Mendel's work on genetics, offer any explanation of the basic variation, but the very facts of adaptation, which provided his strongest evidence, and which natural selection explained, had long been accounted for by the Church in terms of Design.[105] Early nineteenth century theology in England was a curious mixture of revelation and natural theology, exemplified in the Bridgewater Treatises and in William Paley. Paley wrote, for example, in 1802, that[106]

> There cannot be a design without a designer; contrivance without a contriver; order without choice; arrangement, without any thing capable of arranging; subserviency and relation to a purpose, without that which could intend a purpose; means suitable to an end, and executing their office in accomplishing that end, without the end ever having been contemplated, or the means accomodated to it. Arrangement, disposition of parts, subserviency of means to an end, relation of instruments to an use, imply the presence of intelligence and mind.

Lacking a mechanism for variation, and shaken by the theoretical objections in Jenkin's *North British Review* article in 1867,[107] Darwin changed his ground. Although maintaining privately that[108]

> the old argument of design . . . fails (and that) there is no more design . . . than in the course which the wind blows,

he still had doubts: the thought of the eye made him cold all over, the sight of feathers in a peacock's tail made him sick.[109] To Asa Gray he wrote in distr
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> I am inclined to look from designed laws, wit or bad, left to the wor chance.

But the effort to reco was a failure:[111]

> A dog might as well Newton. . . . The more I become.

Darwin therefore mental issue of rand both the natural the nents of revealed religi centrated on descent descent could be dem ment from design w plausible than that fr selection could be de in pigeons, on a pure win thus outflanked flected them from his but at the same time the charge of plagiari ity. After all, *evolut* Darwin's mechanism Darwin could only de latter.[113] Darwinism ment or evolution t on in geography as subsume vast quantit and apparently unrel order which this int a remarkable effect sciences. But called omitted Darwin's c

and Son, 1857), and Darwin's comments in *LLD*, Vol. 2 (1888), footnote 16, pp. 110 and 386. One may of course argue that these earlier workers used statistical analysis as a tool to overcome error and incompleteness in our perception of the world, rather than recognizing that the real world is itself subject to chance. See the comments by M. B. Hesse on C. C. Gillispie, "Intellectual factors in the Background of Analysis by Probabilities," in A. C. Crombie (Ed.), *Scientific Change, Symposium on the History of Science, University of Oxford, 9–15 July 1961* (London: Heinemann, 1963), pp. 430–453 and comments pp. 471–76.

[101] J. Clerk Maxwell, "Illustrations of the Dynamical Theory of Cases, Part I," *London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Series 4, Vol. 19 (1860), pp. 19–32, read 21 September, 1859.

[102] F. Lukermann, in an interesting recent discussion, has drawn attention to the dependence of the French school of human geography on the work of French statisticians and natural scientists in the nineteenth century, from Laplace to Cournot and later Henri Poincaré, and the intellectual milieu in which they worked. The French possibilists thus form an exception to the generalizations in this paragraph. See F. Lukermann, "The 'Calcul des Probabilités' and the École Française de Géographie," *Canadian Geographer*, Vol. 9 (1965), pp. 128–37.

[103] C. R. Darwin to J. D. Hooker, 23 December 1856, *LLD*, Vol. 2 (1888), footnote 16, p. 87.

[104] Darwin, *op. cit.*, footnote 41, p. 138. Huxley, of course, interpreted even "chance" variations deterministically, *op. cit.*, 1887, footnote 19, pp. 199–201.

[105] See on this theme A. Ellergård, *op. cit.*, footnote 44.

[106] W. Paley, *Natural Theology, or, Evidences of the Existence and Attributes of the Deity collected from the Appearances of Nature* (London: printed for R. Faulder, 1802), p. 12.

[107] See the anonymous article by Fleeming Jenkin, "The Origin of Species," *North British Review*, Vol. 92 (1867), pp. 277–318, and discussion by P. Vorzimer, "Charles Darwin and Blending Inheritance," *Isis*, Vol. 54 (1963), pp. 371–90.

[108] C. R. Darwin, *The Autobiography of Charles Darwin 1809–1882*, edited by Nora Barlow (London: Collins, 1958), p. 87

[109] C. R. Darwin to Asa Gray, April 1860, *LLD*, Vol. 2 (1888), footnote 16, p. 296. Perhaps he re-

called Sturmius's remark examination of the eye W. Paley, *op. cit.*, footn

[110] Darwin to Asa Gra note 16, p. 312. 22 Ma

[111] *Ibid.*

[112] A. Ellergård, *op. c*

[113] D. Fleming, "The *Species*," *Journal of th* (1959), pp. 437–46; O win's theological diffic "Darwin's Religious Vi *of Ideas*, Vol. 20 (1958) "Charles Darwin, the *Studies*, Vol. 4 (1961), tive interpretation, deriv natural theology, see W Darwin's Achievement: *Studies*, Vol. 5 (1961),

Gray he wrote in distress in 1860 on the problem of evil and the question of design:[110]

> I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working of what we may call chance.

But the effort to reconcile the unreconcilable was a failure:[111]

> A dog might as well speculate on the mind of Newton. . . . The more I think the more bewildered I become.

Darwin therefore abandoned the fundamental issue of random variation, on which both the natural theologians and the exponents of revealed religion could unite, and concentrated on descent and on selection. If descent could be demonstrated, then the argument from design would appear much less plausible than that from evolution,[112] whereas selection could be demonstrated, for example in pigeons, on a purely empirical level. Darwin thus outflanked his opponents and deflected them from his most serious weakness, but at the same time he laid himself open to the charge of plagiarism and lack of originality. After all, *evolution* was not new, only Darwin's mechanism was, yet before Mendel Darwin could only defend the former, not the latter.[113] Darwinism in the sense of development or evolution through time was seized on in geography as a unifying principle to subsume vast quantities of otherwise discrete and apparently unrelated data: the clarity and order which this interpretation revealed had a remarkable effect on the progress of the sciences. But called Darwinism or not, it omitted Darwin's central theme. Mendel's work, and particularly the statistical treatment of heredity by Sir Ronald Fisher in *The Genetical Theory of Natural Selection* gave Darwinists the weapons they needed; but Fisher's book appeared seventy years after Darwin's, and by that time the "evolutionary" impact in geography and other sciences had been made.

CONCLUSION

Biological influences in geography during the past century, therefore, although often claiming descent from evolution or from Darwin, have been interpreted in ways which at times subtly and at times blatantly diverge from Darwin's actual philosophy. The major themes of change through time, of selection and struggle, and of the interrelatedness of things (the organic analogy, and later ecology), are all present in Darwin's writings, specifically in the eleventh, fourth, and third chapters of *The Origin of Species,* but the unique contribution of Darwin's theory, that of random variation, was, for religious and scientific reasons, neglected in geographical circles. It is interesting that methods which incorporate randomness are now being increasingly used by geographers.

The discussion of these four themes demonstrates that geographical thinking in the past hundred years has cut across biological thinking, incorporating some ideas into the corpus of thought derived by Hartshorne and Hettner from Kant and Humboldt, but neglecting others. Even in their most extreme statement, however, these themes never came to dominate geographical thinking, which, by concentrating on the interdependence of phenomena on the earth's surface, evolved a rationale of its own. In this, however, Darwin's influence can still be distinguished, in the impact which he made on the nineteenth century world view. Darwin established a sphere of scientific enquiry free from *a priori* theological ideas, and freed natural science from the arguments of natural theology. With the publication of *Essays and Reviews* in 1860,[114] theology itself began to turn away from science, and to acknowledge that in this field the Bible was no authority. Darwin, by empirical argument and inductive method, thus dismissed

called Sturmius's remark, quoted by Paley, "that the examination of the eye was a cure for atheism," in W. Paley, *op. cit.*, footnote 106, p. 35.

[110] Darwin to Asa Gray, *LLD*, Vol. 2 (1888), footnote 16, p. 312. 22 May 1860.

[111] *Ibid.*

[112] A. Ellergård, *op. cit.*, footnote 44.

[113] D. Fleming, "The Centenary of the *Origin of Species*," *Journal of the History of Ideas*, Vol. 20 (1959), pp. 437–46; On the general theme of Darwin's theological difficulties, see M. Mandelbaum, "Darwin's Religious Views," *Journal of the History of Ideas*, Vol. 20 (1958), p. 363–78, and D. Fleming, "Charles Darwin, the Anaesthetic Man," *Victorian Studies*, Vol. 4 (1961), pp. 219–36. For an alternative interpretation, deriving ideas of randomness from natural theology, see W. F. Cannon, "The Bases of Darwin's Achievement: a Revaluation," *Victorian Studies*, Vol. 5 (1961), pp. 109–34.

[114] F. Temple and others, *Essays and Reviews* (London: John W. Parker and Son, 1860).

teleology as a live issue in scientific explanation,[115] and though similar arguments persisted in Vitalist biology they were gradually reduced by the expansion of knowledge. Darwin, furthermore, sealed the acceptance of uniformitarianism and law in science, and completed the dismissal of Providential interference and catastrophism in scientific writing. And finally, and in this he was alone, Darwin established man's place in nature, both in Huxley's sense, and in Haeckel's, and in so doing made man a fit object for scientific study. Modern geography is inconceivable without these general advances, but their elaboration belong to the study of intellectual history, not to that of geographical thought.[116]

[115] The role of teleology in Darwin's thought is notoriously difficult to assess, especially in the later editions of *The Origin* as Darwin shifted his ground over mechanism. These, together with the much-quoted last paragraph, have led to the argument that Darwinian evolution was in fact of a teleological nature. The situation is complicated by the curious reaction in some theological circles, which saw in this interpretation a way out of the crisis which the publication of *The Origin* had caused. A reviewer has drawn my attention to G. Himmelfarb's account of this in *Darwin and the Darwinian Revolution* (London: Chatto and Windus, 1959), pp. 325–29. Asa Gray, among others, was acutely aware of the teleology issue, and his attempt to interpret *The Origin* teleologically led to growing estrangement from Darwin himself. Gray saw natural selection as purposive, "and to most minds Purpose will imply Intelligence"; A. Gray, "Relation of Insects to Flowers," *Contemporary Review*, Vol. 41 (1882), p. 609. This quotation is taken from the elegant treatment of Gray's position in "A theist in the Age of Darwin," Chapter 18, pp. 355–83, in A. H. Dupree, *Asa Gray 1810–1888* (Cambridge: Belknap Press of Harvard University Press, 1959).

[116] In preparing this paper the following discussions have been valuable: C. C. Gillispie, *Genesis and Geology: A Study in the Relations of Scientific Thought, Natural Theology, and Social Opinion in Great Britain, 1790–1850* (Cambridge: Harvard University Press, 1951); A. Ellergård, *Darwin and the General Reader* (footnote 44); L. Eiseley, *Darwin's Century: Evolution and the Men who discovered it* (London: Victor Gollancz, 1959); Gertrude Himmelfarb, *Darwin and the Darwinian Revolution* (London: Chatto and Windus, 1959); J. C. Greene, *Darwin and the Modern World View: the Rockwell Lectures, Rice University* (Baton Rouge: Louisiana State University Press, 1961); Jacob Bronowski, "Introduction," in M. Banton (Ed.), *Darwinism and the Study of Society* (London: Tavistock Publications, 1961); and the writings of Darwin himself, particularly *The Origin of Species* (1859), the *Life and Letters* (1888), and the *Autobiography* (1958).

Since this paper initially went to press, I have seen an early treatment of the geographical content of Darwin's own writings by Giovanni Marinelli, "Carlo Roberto Darwin e la Geografia," *Atti dell' Istituto Veneto de Scienze, Lettere ed Arti*, Serie 5, Vol. 8 (1882), pp. 1279–1321. Marinelli treats Darwin's coral reef work at length, and in analyzing the geographical nature of Darwin's other writings, he concludes that their principle was essentially chorological. The paper is reprinted in *Rivista de Filosofia scientifica*, Vol. 2 (1882–1883), pp. 385–410, and in *Scritti minori di Giovanni Marinelli*, Vol. 1, *Metodo e Storia della Geografia* (Firenze: Tipografia de M. Ricci, 1908), pp. 99–141. See also Willi Ule, "Darwin's Bedeutung in der Geographie," *Deutsche Rundschau für Geographie und Statistik*, Vol. 31 (1909), pp. 433–43.

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