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THE BIOLOGICAL BASIS OF GENETIC PSYCHOLOGY

by

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Preface

American psychology was founded during the latter two decades of the nineteenth century. The fact that biology influenced its subsequent development is generally accepted, particularly the role played by Darwinian ideas. Despite this acknowledgement, the biological theories actually used by psychology have not been subjected to close scrutiny. The goal, then, was to determine the specific theories used in the formulation of genetic psychology.

As a most active founding father of both genetic psychology and the American discipline, G. Stanley Hall is an appropriate model. On examination, his major work Adolescence proved to be puzzling, largely because the theories of biological development he used did not accord with any of the well known theories that had been imported to the United States.

The plan then, was to carefully analyze American biology in order to determine the source of Hall's unique theories. This proved to be a complex problem, involving not only the development of American biological theories, but the development of American science itself.

The early decades of the nineteenth century were a period of growing maturity and increasing independence from European scientific dominance. Geology, itself maturing as a science during this period, proved to be the one science most influencing the development of the others. By mid century, geologists had proven themselves capable of independent theory formation, and had spurred the development of professional science in the United States. Biology, maturing in the latter half of the century, was profoundly influenced by American geological theories and the tremendous interest established in paleontology.

A potent factor influencing both the growth and direction of American biology was the arrival of Louis Agassiz in 1846. Prior to his arrival the major activity of zoologists was classification, which was necessary with so much of the country in the process of settlement. Agassiz was a talented but complex and opinionated man. His well developed scientific theories and strong beliefs as to nature and the world became an integral part of an American theory of biological evolution. They also brought him into serious conflict with members of the professional scientific community. Asa Gray, the leading botanist, was particularly concerned that Agassiz' views would be detrimental both to the direction of American science and to the reception of Darwin's theory of evolution. The clash between Agassiz' idealism and Gray's empericism was important in the acceptance of Darwin's theory and the subsequent direction of American biological sciences.

Although a scientist of international stature, Agassiz' main activity in the United States was his teaching. The results of his emphasis on basic research and independence of thought became evident as his students, now scientists in their own right, independently evaluated the theories of both Agassiz and Darwin. Accepting the idea of evolution, they proceeded to develop their own evolutionary theories. These theories were, however, significantly different from Darwin's. Darwin's theory was based on field observation. Following a tradition established by the geologists early in the century, the American naturalists based their theories on paleontology. But Agassiz' theories of the relationship of phylogeny and ontogeny as well as his views of geological catastrophism and metamorphic development were also integral components of these theories. Realizing the distinctive nature of their proposal, the American naturalists designated themselves the American School of evolution. Recognizing their emphasis on environmental influence, one of their members later coined the term 'Neo-Lamarckism'. It must be stressed, however, that these were complex, sophisticated theories, not a simple belief in the influence of the environment and the inheritance of acquired characteristics.

The latter decades of the century were a period of considerable debate over the theory of evolution, including a controversy between the Darwinians and the Neo-Lamarckians. During the latter two decades, the formative period for psychology, Neo-Lamarckism was in the ascendency. A careful analysis of these theories and Hall's psychology revealed that the American theories, in all their complexity, were accepted by Hall and used as the basis of his genetic psychology.

CHAPTER I

THE SCIENTIFIC MILIEUX IN AMERICA TO 1850

The nineteenth century opened with the Americans ready to enter a new era.[1] They had achieved their political independence convinced that America, the land of the future, was "reserved to be the last and greatest theatre for the improvement of mankind."[2] The glorious American destiny that they envisioned was to be achieved through the use of reason and science. The science held up as a model was the highly successful natural philosophy of Newton. By discovering and using the laws of nature they expected to be able to create the Heavenly City on earth and the ideal man to inhabit it. But the laws of nature they wanted to discover were in the realm of natural history. In order to be seen as useful, natural history had to develop to a new level of maturity.

The maturing of natural history as a science did not occur until the nineteenth century. As the most advanced branch of natural history, geology became the science most influencing the progress of the other sciences. Encouraging

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[1]Stow Persons, American Minds: a History of Ideas (New York: Holt, Rhinehart and Winston, 1958), p.128.

[2]Brook Hindle, The Pursuit of Science in Revolutionary America, 1735-1789 (Chapel Hill: The University of North Carolina Press, 1956), p.33.

this progress was the ever growing public interest and support for science.[3] With the geologists in the forefront, science was increasingly seen as a professional rather than an amateur pursuit. Also through geology, there was the beginning of a more fundamental change to an evolutionary world view, a change accelerated by the introduction of Charles Darwin's Origin of the Species in 1859.[4]

It is desirable to have some understanding of this development of American science during the first part of the century in order to understand the later developments in both biology and psychology. It was during this period that a body of competent professional scientists was formed. They were able critically to appraise and to respond to the theories of the eminent Louis Agassiz following his arrival in 1846, as well as to those of Darwin in 1859. This response can be seen as based on the particular developments of American science, and on the view of the naturalists that they had finally achieved their independence from Europe.

The Early Years of the Century

While the revolutionary war had undeniably interrupted scientific activity, the patriotism it aroused gave science a new direction.

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[3] Dirk J. Struik, Yankee Science in the Making revised ed. (New York: Collier Books, 1962), p.370.

[4] Charles Darwin, The Origin of the Species (Rand McNally and Company, undated).

> Americans felt themselves to be a chosen people, a nation dedicated to republican principles in a world ruled by monarchs. It was their duty to show that republican institutions were as favorable to letters and science as monarchical ones, nay, more so. To do less would be to betray the goddess of liberty in whose name they had fought.[5]

Despite this rhetoric, a period of transition and dependence on European science was continued into the nineteenth century.[6] One of the notable steps towards self-sufficiency proved to be the appointment of Benjamin Silliman as professor of chemistry and geology at Yale in 1802.

Silliman was a dedicated and capable worker. Most important, he founded the American Journal of Science and Arts in 1818. It not only encouraged "original American contributions" on a national level, but had as its "leading object to illustrate natural history, and especially our minerology and geology."[7] It served as a most important vehicle of communication among American scientists and as a record of their progress. Indeed, the continued viability of this journal serves as evidence for the argument that American science had come of age by 1820.[8]

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[5]John C. Greene, "American Science Comes of Age, 1780-1820," The Journal of American History, LV (June, 1968), 33-34.

[6]George Daniels, Science in American History: a Social History (New York: Alfred A. Knopf, 1971), pp.132-133.

[7]Edward S. Dana et al., A Century of Science in America (New Haven: Yale University Press, 1918), p.28.

[8]Greene, "Comes of Age," p.41, Daniels, Social History, p.151.

Silliman had spent the years from 1802-1806 in study at home and overseas, preparing for his position at Yale. His experience abroad indicates a problem inherent in the desire for independence of the American naturalists - the immature state of the life sciences themselves. The period from 1790-1820 was regarded as "the heroic age of geology",[9] with zoology and botany maturing later in the century. The development of these various branches of natural history in a sense paralleled the growing maturity of American science.

Silliman's teaching duties could hardly have been an easy task, for the science itself was in a state of conflict. While in Edinburgh, Silliman had witnessed the strife between the Wernerians and the Huttonians, the two leading geological schools.[10] The sciences of botany and zoology were equally without mature, comprehensive theories. In Germany the speculative approach of Naturphilosophie was prominent. In Britain the main activity was description and classification, while in France the emphasis was on comparative anatomy.

Despite this confusion, science in America boomed during the decade of the twenties. As early as 1821 Silliman suggested that the time should be called "the intellectual

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[9] Charles Coulston Gillespie, Genesis and Geology: a Study in the Relations of Scientific Thought, Natural Theology and Social Opinion in Great Britain, 1790-1850 (New York: Harper and Row, Harper Torchbooks, 1951), p.41.

[10] Dana et al., Century, pp.25,70.

age of the world" as he saw so many men pursuing

> ...so many and so useful researches... vigorously engaged in pushing its [knowledge] interests and extending its boundaries, while the press is prolific, beyond all former example, in production upon every art and every science.[11]

This growth and activity was reflected in the increased teaching of science, the development of professional attitudes by the scientists, and the geological surveys. A degree of conflict was also generated by these activities, as public expectations regarding the utility and accessibility of science were not necessarily met.

Teaching of Science

The number of colleges in which science was being taught was expanding at a great rate, as were the number of American text books being used. The thirty-seven new colleges founded during the twenty-five year period following Silliman's appointment at Yale all offered some instruction in natural history. By the middle of the century zoology specifically was taught in all the larger colleges.[12] Not only did the classical colleges have science as part of their curriculum, but

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[11]Benjamin Silliman, "Remarks on Some Points of Modern Chemical Theory, with a Notice of Professor Gorham Elements of Chemistry", American Journal of Science and Arts, 11, quoted in Daniels, Social History, p.13.

[12]Dana et al., Century, p.395.

> ...there was a dramatic upsurge in this teaching during the decade of the 1820's. Colleges did, however, insist on maintaining a balance between arts and science, but science was considered as central to the design of the curriculum as the classical languages themselves.[13]

Colleges such as Harvard and Yale were particularly influential in promoting science. But those colleges formed within the framework of evangelical America had also secularized their teaching programs so that "religion cannot be said to have hindered the progress of science within early 19th century collegiate institutes."[14]

The teaching and dissemination of science was not confined solely to the schools. These early decades also saw the proliferation of scientific societies, journals and 'Lyceums of Natural History'. New York State developed a policy of 'dollar-for-dollar' funding for those agricultural societies supporting the general promotion of science. This not only placed New York in the front of a nation wide trend, but also gives an indication of the government support for

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[13] Stanley M. Guralnick, "Sources of Misconceptions on the Role of Science in the Nineteenth Century American College," Science in America Since 1820, ed. by Nathan Reingold (New York: Science History Publications, 1976), pp.48-49.

[14] Ibid., p.53. See also Bernard I. Cohen, Some Early Tools of American Science, (New York: Russell and Russell, 1950), p.19. The cultivation and teaching of science had a long history at Harvard, reaching back to the seventeenth century when the first telescope was presented by John Winthrop.

science that did exist.[15] This support, however, often had to be cloaked under the guise of utility.

Several reasons have been suggested for this emphasis on 'justification by utility'. Governments needed to justify the expenditure of public funds. This was often difficult if science was seen only as an amateur pursuit. Both scientists and legislators found the Baconian view of 'science as useful knowledge' a convincing way to gain approval for government funding of the proliferating geological surveys in the early part of the century. By this means they were satisfying the ideal of a democratic culture that all citizens should earn their own way through some useful enterprise.[16] The utility of science for the citizens of the state was, however, not clearly defined. It could refer to such diverse things as the availability of information leading to the individual laissez-faire exploitation of natural resources or to the educational value for the public at large as "part of the learning of an educated man."[17]

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[15] A. Hunter Dupree, Science in the Federal Government (Cambridge: The Belknap Press of Harvard University Press, 1957), pp.1-3. Dupree presents a convincing case for the government as an early (1787) and significant source of strength and support for science. He argues that "Science has been a formative factor in making both the federal government and the American mind what they are today" and that American democracy's very essence has been influenced by the presence of science, p.2.

[16] Daniels, Social History, pp.155-57.

[17] Walter B. Hendrickson, "Nineteenth Century State Geological Surveys: Early Government Support of Science," Science in America Since 1820, p.137. Also George Daniels, "The Pure Science Ideal and Democratic Culture," Science, CLVI (30 June 1967), 1699-1705.

Reflecting the leading role of geology, Silliman was involved in many phases of scientific development during this period. As previously mentioned, he founded the influential American Journal of Science and Arts. He was also responsible for the founding of the American Geological Society in 1819, the first society for a single discipline. Further, he was the "first to take up actively the teaching of minerology based on the collections of specimens."[18] While there were no formal graduate schools for advanced training and basic research, A. Hunter Dupree has argued that in fact the geological surveys served this purpose.[19] Silliman's students went on to assume professional positions, teaching at various universities and becoming involved in the state and federal geological surveys.

Professionalization

As part of the belief in democracy, it was felt that all men were equally qualified to participate in and to judge the achievements of science. But the increasing complexity of the natural sciences quickly grew beyond the intelligent layman. This increasing complexity was first felt by the professionals themselves as they found that they could no

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[18] Dana et al., Century, p.67.

[19] Dupree, Federal Government, p.94.

longer deal with the general field of natural history. Specialization into the separate areas of geology, botany or zoology had become necessary. Geology, as the most advanced science, made the earliest advances in specialization. It was not until the middle of the century that zoology regarded itself as a profession.[20] Accordingly, the American Geological Society was the first society founded for a single discipline as early as 1819. Other sciences followed the example of the geologists, notably the American Astronomical Society of 1849. It was the first to have as its stated goal "the advancement, not the diffusion of knowledge."[21]

'Advancement, not diffusion' was the crux of the problem. The advances in science were such that only those possessing special qualifications could understand. By 1840 the result was the creation of "a body of esoteric knowledge called 'science'." The science was thus effectively removed from the public domain.

Its practitioners were an

> ...extraordinarily well educated group. Almost half of the scientific writers at the time had medical degrees, which were conferred as the result of actual attendance at a medical school, while twenty others were trained at colleges where

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[20]Dana _et al._, _Century_, p.395.

[21]Daniels, _Social History_, p.229.

> scientific instruction was offered. Only the remaining nine could, by any stretch of the imagination, be called self-educated. Among the twenty-nine who had been educated in Europe, Paris and Edinburgh seem to have shared top popularity.[22]

They still required public support and consequently had to justify their activities. Although clearly interested in basic research, the scientist accordingly based his argument for support in terms of utility, progress and the public good. This led to serious misconceptions, not only on the part of the public at the time, but later by historians as they tended to accept these justifications without closely examining the actual work of the scientists in question.[23]

The goal of the scientists was not only to justify their activities, but to be recognized as pursuing a legitimate, professional career. That the scientific community was successful in its endeavour to legitimize its activities and to establish a relatively secure place for itself can be seen in the remarks of James Dwight Dana, who suggested that this security was based on "an appreciation of the value of science, not only for its baser purpose of turning everything into gold, but for its nobler end of opening the earl-

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[22] George Daniels, American Science in the Age of Jackson (New York: Columbia University Press, 1968), p.31.

[23] Daniels, "Professionalization," pp.1699-1705.

ier revelation."[24]

Geological Surveys and Some Results

While the geological surveys had a publicly stated utilitarian motivation, they were also opportunities for the geologists to conduct basic research. During a period of rapid expansion and exploration in the country, the kind of research seen as necessary was a thorough examination of the empirical evidence in order to provide the base for inductive theory construction. Indeed, the plethora of new specimens obtained as a result of settlement, railroad building and the surveys, forced extensive revision of existing systems of classification.

While there had been earlier surveys under private sponsorship, the first state geological survey was undertaken in North Carolina in 1823. Predictably, the motivation was utilitarian. Denison Olmstead, a former student of Silliman's, suggested a geological survey to determine if there was sufficient economic advantage to justify the cost of an improved transportation system the legislature was considering. Olmstead's own interest was clearly in "the acquisition of knowledge".[25] He saw the survey as an aid in fulfilling

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[24]James Dwight Dana, "Address," American Association for the Advancement of Science Proceedings (IX No.3 1855), quoted in Daniels, "Professionalization," p.42.

[25]Hendrickson, "Geological Surveys," p.132.

his professorial duties at the University of North Carolina and an opportunity to make a contribution to basic scientific knowledge. The idea was thus taking form that the state should support research because of economic advantage, enabling the scientist to carry on his basic research at state expense.

While apparently of mutual benefit to both the state and the scientist, this concept laid the ground for conflicting expectations. Funding of future surveys depended in large part on the attitudes of both the individual scientists and the legislators. The ability of the scientist to maintain a balance between basic research and utility greatly enhanced the likelihood of government funding. Two examples will illustrate this point.

Edward Hitchcock, appointed to the Massachussetts state survey of 1830, could be considered the ideal state geologist. Gaining the confidence of the legislature by initially emphasizing utility, Hitchcock was able to have the survey continued and enlarged to include botany and zoology. Over half of the final report was devoted to paleontology and 'scientific' geology.[26]

The fate of the later (1860) and more ambitious California survey was somewhat different. A devoted geologist,

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[26]Hendrickson, "Geological Surveys," p.140.

Josiah Whitney considered the pursuit of pure science to be of prime importance. Farmers, miners and legislators expected it to be of direct value. They were understandably disappointed when, after five years work, the first volume dealt with four kinds of fossils. Whitney's insistent adherence to pure research combined with his outspoken manner led to the abolition of the enterprise.[27]

Anomalies abounded in this view of utilitarian science. While some value related to land use and mining could be seen for geology, the surveys often included comprehensive zoological and botanical studies, seemingly of peripheral usefulness. Surveys for such purposes as transcontinental train routes often included a full complement of geologists, zoologists and botanists.[28] But perhaps most puzzling was the interest in paleontology. This interest is most clearly illustrated in the work of James Hall, the founder of American paleontology.

Hall was appointed to the epochal New York survey at its inception in 1836 and became the State Paleontologist in 1840. He is referred to as "the classic example of the man

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[27] Gerald D. Nash, "The Conflict Between Pure and Applied Science in Nineteenth Century Public Policy: the California State Geological Survey, 1860-1874," Science in America Since 1820, pp.174-185. Whitney was able to have several additional volumes of his scientific reports published under scientific sponsorship.

[28] Dana et al., Century, p.199.

who subordinated practical geology to scientific geology." Despite the esoteric nature of his study (fossil invertebrates) and his penchant for publishing "expensive volumes with many steel-engraved plates",[29] Hall continued to receive state support for his entire life. While it is difficult to explain this support in terms of utility, the continuing interest in paleontology had important consequences. Later in the century American naturalists proposed an evolutionary theory based on paleontology which became influential as an alternative to Darwin.

Because of the extensive geological and paleontological evidence they observed, the geologists were the first of the natural historians to be confronted by the problem of evolution. Acceptance of the relationship of fossil remains to the strata in which they were found motivated a search for adequate explanations. Prominent among these were the theories of Abraham Werner and James Hutton.

Present in both Werner's and Hutton's theories were the contrasting ideas of uniformitarianism and catastrophism. These terms became used to contrast two differing views of geological processes. Charles Lyell, in his Principles of Geology,[30] stressed the uniformitarian position of using

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[29] Hendrickson, "Geological Surveys," p.142.

[30] Charles Lyell, Principles of Geology (1st ed., 3 vols., London), 1830-33.

only actual processes observed in the present day to explain the past. While constant change was assumed, it was not necessarily progressive.

On the other hand, catastrophists emphasized discontinuity, arguing that present causes cannot explain the past. Noting the sharp breaks in the geological and fossil record, they felt that there must have been periods marked by greater violence and more rapid change than observed today. Catastrophists generally became 'directionalist' in their views. They saw a beginning and an end to this process that was marked by a real change from one state to another through a series of changes. Catastrophism clearly viewed a world of change which was a discontinuous, rather than a continuous process.[31]

American geologists, accustomed to broad sweeps of regular strata, were predisposed to accept much of Lyell's theory. But the sharp breaks between strata and the lack of transitional forms in the fossil record equally suggested a catastrophic theory. This produces a combination of theories to describe long periods of tranquil conditions broken by catastrophies. As a result, by the 1830's geological processes were seen as dynamic and evolutionary.[32]

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[31] For clarification regarding the contrast of uniformitarianism and catastrophism, I am indebted to Dr. Peter Bowler, University of Winnipeg. See also his book, Fossils and Progress: Paleontology and the Idea of Progressive Evolution in the Nineteenth Century (New York: Science History Publications, 1976), passim.

[32] Daniels, Social History, p.229.

It was thus through the study of geology and paleontology that the idea of a world in a state of change and process was introduced. The paleontological record clearly revealed a progressive change of life forms through the strata, "the first enormously powerful argument for evolution".[33] The general public were aware of this progression, and most were intrigued with the idea that other forms of life had previously existed.[34]

Paleontology was, in fact, the basis of Richard Chambers Vestiges of the Natural History of Creation.[35] Chambers extended this evidence to propose a theory of biological evolution. Although his biological theories were not considered scientifically sound, his book was widely circulated and discussed. Indeed, as early as 1846 an American reviewer of Vestiges noted that the idea of evolution was "a very common tendency of thought".[36] Somewhat prophetically, a review in the American Journal of Science and the Arts noted that "the Vestiges, not withstanding some errors, has been and will continue to be of incalculable value to science and knowledge... should the theory of the writer of the Vestiges be finally

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[33]Milton Millhauser, Just Before Darwin: Robert Chambers and Vestiges (Middletown, Connecticut: Wesleyan University Press, 1959), p.89.

[34]Daniels, Social History, pp.220-21.

[35]Millhauser, Just Before Darwin, p.89.

[36]Daniels, Social History, p.230.

established, faith and religion would stand immovable, supported by reason and the inspired word."[37] There were also, of course, the earlier evolutionary theories of Erasmus Darwin and Jean-Baptiste Lamarck.

Through a combination of geological theory and these earlier evolutionary ideas, the climate was being prepared for the reception of Darwin's theory. It is perhaps significant that it was the geologist William Rogers who successfully defended Darwin's theory in public debate against the great Louis Agassiz. Indeed, through their work in the geological surveys and other professional endeavours, the geologists demonstrated an increasingly independent attitude towards both religion and European science. This growing independence prepared them to cope with the momentous events of the coming era.

In this respect, two approaches were taken to religion. In one view, nature and scientific evidence came first. For example, the geological and fossil evidence suggested a series of catastrophes. A series of creations was then postulated in order to bring the Biblical account of Genesis into accord with scientific evidence. Scientific evidence was not only given primacy, but also seen as a base for Biblical interpretation. An alternative was the separation of science and

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[37] Millhauser, Just Before Darwin, p.139-40, quoting a review in the American Journal of Science and Arts.

religion. In this view, science was for the purpose of explaining the phenomena of nature, while religion was concerned with morals. The two subjects were then seen as having quite distinct aims.[38]

A similiar independent attitude was taken towards scientific theory. It was realized by 1820 that there were facts about American geology that were irreconcilable with European theory. At times various combinations of European theory were used, but there was an increasing tendency to propose original theory to explain these phenomena. Thus the Americans argued that

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[38] Some authors such as George Daniels argue that catastrophism was seen as a means of reconciliation between geological processes and the Bible. Yet in posing this argument, Daniels describes the reinterpretation of the Biblical account of creation that was seen necessary due to geological evidence. See pp.214-216, Daniels, Social History. Reijer Hooykaas commented on this generally held belief that Catastrophists were motivated by religious orthodoxy and suggested that "Allegiance to Catastrophism may sometimes be a consequence of the desire to propound explanations conformable to the facts," quoted in Stanley M. Guralnick, "Geology and Religion Before Darwin: The Case of Edward Hitchcock, Theologian and Geologist (1793-1864)" Science in America Since 1820. Certainly geological evidence in America clearly supported a theory of catastrophism. Guralnick discusses the problem of religion faced by the geologists, and argues for the increasing independence of science from religion. See especially pp.125, 130.

> ...progress since 1840 as measured by the contributions of new ideas shows on the whole America at least equal to its intellectual rivals, at certain times actually the leader.[39]

While geology had its period of major scientific achievement during the first half of the nineteenth century, the major period of advancement for zoology and botany occurred in the second half. For zoology, the development from a descriptive natural history towards maturity as a science was greatly influenced by the dominating figure of Louis Agassiz. During this third quarter of the century, botany was personified by the quiet, knowledgeable Asa Gray. The climax of development of zoology and botany was, of course, the introduction of Darwin's theory of evolution. While the ensuing conflict clearly revealed the opposing views of science held by Agassiz and Gray, geologists and paleontologists also exerted a decided influence on the reception of Darwinism.

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[39]Dana _et al._, _Century_, p.191. As early as 1820 Amos Eaton proposed a theory of cyclic sedimention to explain a geological succession which did not fit European categories. See Daniels, _Social History_, p.207. In 1842 Henry Rogers formulated a dynamic theory of mountain formation that was hotly debated in Europe. Patsy A. Gerstner, "A Dynamic Theory of Mountain Building," _Science in America Since 1820_, p.113. These and other theories were not always accepted, but this was equally true of the many theories being proposed in Europe.

CHAPTER II

AGASSIZ AND GRAY: THE DIRECTION OF AMERICAN SCIENCE

The period of 1820-1850 saw the establishment of a sound, securely based scientific community with the necessary institutional supports.[1] The attempt by politicians and laymen to form a scientific organization of nation-wide scope, The National Institute of Science, had been quietly but determinedly opposed by scientists. By continuing their support of the American Association of Geology, the scientists were able to develop a nation-wide organization which they controlled, as the Geological Association expanded in 1847 to become the American Association for the Advancement of Science.[2] The scientists themselves were firmly established in their professional occupations, generally as professors or in government employ.

Despite the increasing complexity of natural history, public interest in science grew by leaps and bounds in the

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[1] George Daniels, American Science in the Age of Jackson (New York: Columbia University Press, 1968), pp.32-33. Merle Curti, The Growth of American Thought 3rd ed. (New York: Harper and Row, 1964), pp.316-24.

[2] Sally Kohlstadt, "A Step Towards Scientific Self-Identity in the United States: the Failure of the National Institute, 1844." Science in America Since 1820, ed. by Nathan Rheingold (New York: Science History Publications, 1976), pp.79-103.

"flood tide of democracy during the 1830's and 1840's.[3] A brand of popular science was widely disseminated in the press. During a time of specialization, this popular science led to the paradoxical belief that science "had left her retreat, and with familiar tone begun the work of instructing the race."[4] It was into this milieux of professional competence and wide public acclaim of science that Louis Agassiz would arrive in 1846, with Darwin's theory bursting upon the scene only thirteen years later.

Despite the growing independence and maturity of the American scientific community, European science was still accorded great respect. Consequently the arrival of the renowned Swiss naturalist, Louis Agassiz, was hailed by both the scientific community and the public alike. Through his teaching and his ideas, Agassiz' presence had a great impact on American thought.

It was in the last half of the century that the biological sciences matured. In zoology, credit for this development was given to Louis Agassiz.[5] Indeed, shortly after his arrival he had become "the fount of authority for all the zoologists of the country." In the eyes of the American pub-

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[3]Donald Zochert, "Science and the Common Man in Ante-Bellum America," Science in America Since 1820, p.7.

[4]*Ibid*., p.7.

[5]Edward S. Dana *et al*., *A Century of Science in America* (New Haven: Yale University Press, 1918), p.401.

lic, he was "the very model of a scientific man."[6]

Agassiz had definite ideas as to the nature of both science and the world. These were related to his European education and to his early exposure to Naturphilosophie. This led him to stress the importance of empirical observations, which he then insisted on interpreting in terms of an a priori transcendent world view. Oddly enough, this resulted in his making important contributions to evolutionary theory - yet remaining totally unable to accept the idea of the evolution of species.

Asa Gray, the leading botanist of the era, recognized the dominant position Agassiz so quickly assumed. For Gray, empirical observation was all important, regardless of where it led. Gray was a prominent opponent of Chamber's Vestiges in 1845. But illustrative of both his flexibility and his adherence to the principle of empiricism, his own research was leading him to question the fixity of species before he learned of Darwin's theory. He subsequently played a leading role in introducing Darwinism to America.

Gray became extremely concerned that American science, to its detriment, would become fixed in Agassiz' rigid mould. This would have influenced the direction of American science, as well as the acceptance of Darwin's theory of evolution.

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[6] A. Hunter Dupree, Asa Gray (Cambridge: The Belknap Press of Harvard University Press, 1959), p.224.

Gray's fear of Agassiz' power was justified, for Agassiz strongly influenced a vital sector of American evolutionary thought through his role as a teacher as well as through important aspects of his theory.

Louis Agassiz

Louis Agassiz had an international reputation as one of the most eminent naturalists in Europe. The original intent of his visit was for a stay of approximately two years. His visit was financed partly by the king of Prussia for research and partly by John Amory Lowell of Boston for a series of lectures. It was expected that this would give him sufficient time to explore the natural history of the United States.

The stage had been well prepared. The professional scientists were eager to learn at first hand the latest European theories, while a populace convinced of the merit of science flocked to hear the lectures of this dignified scholar with the charming European accent. Agassiz was an authority on paleontology and zoology. His reputation was richly deserved due to his intensive and original study of European fossil fishes as well as his revolutionary glacier theory. Accordingly, he complemented the established American science of paleontology and geology, yet brought in addition a new sophisticated approach to zoology.

A natural teacher, Agassiz was most willing to leave the cloistered research laboratories of science and begin instructing this race so eager to receive his teaching. His erudition, combined with his magnetic personality and the force and clarity of his presentation, led to a fantastically successful lecture series. Up to 5000 people crowded into Tremont Temple in Boston to hear his series on the "Plan of Creation in the Animal Kingdom". Offers for further lecture series poured in. "Americans cried for instruction, and Agassiz could not resist their pleas."[7] Further, both private and government sources were proving willing to support his scientific desires.

Agassiz became increasingly unwilling to leave this pleasant new home. Fortunately, John Amory Lowell and a host of powerful Bostonian friends became equally unwilling to lose this brilliant European. As a result, a position of professor of zoology and geology was created for him in the newly established Lawrence Scientific School at Harvard.[8]

With the acceptance of this appointment, however, a shift in Agassiz' perception of himself and his goals had occurred. No longer was he the dedicated research scientist,

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[7]Edward Lurie, Louis Agassiz: a Life in Science (Chicago: The University of Chicago Press, 1960), p.128.

[8]Ibid., pp.132-134.

but rather the embodiment of Continental learning and culture,[9] whose goal it was to lead the promising American science to the heights of which it was capable - in the European model. Here lies a paradox, for Agassiz was enamoured of social democracy. He too saw Europe as old, and agreed that America was the land of the future, a future he could help to shape. Yet at heart, he never lost his belief in the elitism of the European universities, nor his early training in German Naturphilosophie. It was these beliefs that created such problems in the later stages of his career.

But for now only success and promise beckoned this teacher of all America, this bringer of dreams, this "steam engine" in pursuit of the fulfillment of those dreams. All of America joined Agassiz in the pursuit of science: fishermen freely collected specimens, amateurs patiently waited for turtles to hatch so they could be brought to Agassiz within the critical three hours of birth - even Thoreau, the hermit of Walden Pond, sent specimens and entered into deep discussions of nature with Agassiz. Here lies one facet of Agassiz' genius: the ability to impart his enthusiasm for nature study to people from all walks of life, from fishmonger to teacher to Boston Brahmin, and most important, to those industrialists who could afford to sup-

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[9]Lurie, Agassiz, p.141.

port his schemes.

This truly remarkable man was supremely gifted in another area. He had the notable ability of convincing others of his dreams, persuading them with all the force of his personality to support his grandiose schemes. This support was extended far beyond the wildest imagination of the native American scientists. At the same time that Asa Gray encountered difficulty raising a paltry $3,885.00 to refurbish Harvard's Botanical Garden, the legislature of Massachussetts voted to give $100,000.00 to Agassiz for his Museum of Comparative Zoology - and there was a further $133,000.00 in donations from other sources.

While Agassiz' entire life was undeniably devoted to science, this total commitment led him enthusiastically to embrace impressive but often impractical schemes. These schemes, however, were quickly abandoned when a new interest caught his fancy. Thus many of those specimens he requested from all walks of life were neither catalogued nor used. Too much of Agassiz' time was devoted to the popularizing and control of science, to allow time to produce the major scientific work of which he was capable.

Indeed, Agassiz felt that he had to assume control of everything he was connected with. This included the Lawrence Scientific School, which became "more a laboratory and museum on the German model inhabited by the master and his apprentices than an American school in any sense;"[10] the summer school at Penikese, started by his students but quickly taken over by Agassiz; the direction of science in America itself through the scientific Lazaronni, a small group of eminent and well placed American scientists who founded the National Academy of Science. This control further extended to the work of his graduate students and assistants, whom he expected to work with little or no pay, turning the results of their labour over to him.

It is a credit to Agassiz' teaching ability that so many highly gifted students returned to work in his Museum of Natural History. His teaching method was indeed memorable. Arguing that one should read nature, not books, Agassiz' students wère supplied with specimens and taught painstaking observation. With certain variations, Agassiz started the process with single specimens, adding to the number in order to show relationships. By constantly expanding this process, the students came to learn directly from nature, to think independently and to draw their own conclusions.[11]

These talented students were subsequently disillu-

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[10] Dupree, Asa Gray, p.199.

[11] See Cooper Lane, Louis Agassiz as a Teacher (Ithica, New York: Comstock Publishing Co., Inc., 1945) for accounts of Agassiz teaching by his students. Also James David Teller, Louis Agassiz: Scientist and Teacher (Columbus: The Ohio State University Press, 1947), pp.71-87.

sioned as Agassiz failed to recognize their merit as the independent qualified scientists he had so thoroughly trained. Following a bitter quarrel, they left the museum and founded the <u>American Naturalist</u> as a journal to publish their own work independantly. Agassiz, resentful of the very independence he had fostered, replaced them with Europeans who would recognize the need for authority.[12]

In the meantime, there was growing disillusionment on the part of many scientists as they waited for the major original contributions to American science which Agassiz did not produce, and as they watched his continued appeals to a public tribunal rather than to his professional peers. The one person who felt not only disillusionment but real dismay was Agassiz' colleague at Harvard, Asa Gray.

Gray gradually came to realize that the resemblance of the Lawrence School to a German model was no accident. The German influence, including <u>Naturphilosophie</u>, had remained with Agassiz. This had resulted in the development of a theory of the universe on a strictly <u>a priori</u> basis. All the empirical evidence Agassiz had so painstakingly gathered was then interpreted in the light of this theory.

Gray particularly eschewed "mysticism and anything smacking of German idealism",[13] regarding this approach as

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[12] Lurie, <u>Agassiz</u>, pp.310-323.

[13] Dupree, <u>Asa Gray</u>, p.221.

highly dangerous for the future of American science. That science, Gray believed, should develop theory from the impartial generalization of an empirical base of operation, not distort the facts to fit a preconceived theory. The difference between the two can be stated succinctly: "When Gray looked at nature he saw questions. Agassiz saw only answers."[14]

Because of his unique knowledge of flora, by 1858 Gray was beginning to see the way to refute Agassiz' dangerous theories. He believed that Darwin's theory would be the most effective possible refutation of Agassiz. As a part of Darwin's circle, Gray knew that this theory was soon to be revealed.

A number of factors helped to create a favourable climate for the reception of the idea of evolution. Ironically, Agassiz was the source of several of these factors. His students had received Agassiz' excellent training in comparative zoology, anatomy and paleontology, and so were in a particularly good position to receive and critically evaluate Darwin's ideas. This was especially true since Agassiz' work in paleontology and embryology was used by Darwin in the formulation of his theory. Further, these young scientists had the necessary independence of thought, thanks to Agassiz, to formulate theories of their own.

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[14] Dupree, Asa Gray, p.232.

Along with Agassiz' many contributions to the scientific climate there remains the paradox of his adamant opposition to evolutionary theory. In order to begin to understand this, it is necessary to separate his metaphysical beliefs from the more truly scientific ones, which together helped to produce his total world view.

Agassiz' Metaphysical Beliefs

Fundamental to Agassiz' ideas was his committment to a Supreme Intelligence who had devised an ideal world plan in all its details. This rational, orderly plan of creation was one of pure thought, of Platonic ideal types arranged in an ascending order of excellence. These thoughts were then made manifest in the material world through the power of the Creator's intelligence. This was accomplished in a single act of creative will, producing all the species in their present numbers and geographic location. The result was an essentially static world picture, necessary for Agassiz' vision of the completeness and unchangeability of a Platonic ideal creation.

Within this framework, Agassiz conceived of the idea of evolution solely in terms of an Aristotelian unfolding of the egg to a preordained end. He viewed geological processes as the revelation of God's plan for the world by a similiar unfolding, a series of miraculous creations leading to the present final picture. Agassiz' concept of completeness and unchangeability, then, could only apply to each of these creations individually. This world picture involves elements of both the static and the developmental. Agassiz clearly viewed each creation in terms of a static world picture. There was a distinct element of development present, however, as he described a preordained, teleological process directed to and ending with the final arrival of man.

As the Creator had devised this plan through the use of pure reason, so also man could discern the essential structure through the use of pure reason. Man was able to do this because of the affinity of human intelligence with that of the Supreme Intelligence. Proof of this affinity was evident in man's ability to discern this plan of Creation.

In the breadth and unity of this vision, Agassiz reveals the early influence of his studies with Oken and Schelling. He had become enamoured of their grand and inspiring generalizations, accepting that nature could be viewed in a cosmic sense.[15] But Agassiz also studied with Cuvier, where he witnessed the debates between Cuvier and Geoffrey St.Hilaire.

Geoffrey St.Hilaire's speculations regarding the nature of species and the plan of creation were similiar in spirit to Naturphilosophie. They were readily demolished by Cuvier's insistence on the primary importance of precise knowledge as opposed to the "weak and inconclusive nature of St.Hilaire's

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[15]Lurie, Agassiz, p.28.

data."[16] Agassiz thus became convinced that any views of creation had to be based on a precise and intimate knowledge of the facts revealed in the natural world.

The paleontological evidence with which Cuvier was working revealed sharp breaks in the strata, with different life forms found in the various levels. This indicated that there had been a series of separate creations, that species were immutable, and that ancient forms were not related to the present species: "that species do not pass insensibly into one another, but that they appear and disappear unexpectedly without direct relation to their pre-cursors..."[17] Under Cuvier's influence Agassiz became adamantly opposed to the evolutionary ideas he saw inherent in Naturphilosophie. This opposition was based on the objection that it "was by no means the result of investigation, was not the expression of facts, but was an *a priori* construction, in which they made their view of the animal kingdom the foundation for a particular classification."[18]

Agassiz then turned to the careful and precise methods of Dollinger and Cuvier. The detailed factual knowledge that

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[16] Lurie, *Agassiz*, p.59.

[17] Louis Agassiz, *Recherches sur les poissons fossils...* (1833-43) I [1842], 171, quoted in Lurie, *Agassiz*, p.83.

[18] Louis Agassiz, *Twelve Lectures in Comparative Embryology* (Boston, 1849), p.27, quoted in Lurie, *Agassiz*, p.84.

he gained of nature enabled him to build a firm foundation on which to base his plan of creation. Ironically, he could not see that all his factual data would be subjectively interpreted in view of his own a priori conceptions. Accordingly, the development Agassiz observed in his embryological and paleontological studies was all directed to the fulfillment of the preordained ideal form he saw indicated in God's plan. The breaks in the geological strata that he observed could only be interpreted as evidence that there had indeed been a series of miraculous creations towards the final goal of man's perfected form. His glacier theory of a world wide ice age provided the mechanical proof of the catastrophe which had effectively eliminated all previous life forms, clearing the way for a new creation.

The individual parts of Agassiz' total picture, while contradictory, helped to produce his wide appeal among the American public. His extensive knowledge of factual data initially impressed the scientists and confirmed the Baconian belief of the public that science was fact. His romantic view of nature spoke to the "most vigorous intellectual movement in the country",[19] the Transcendentalism that was so strong in New England. His essentially static view of miraculous creation could appeal to the religious fundamentalists, yet there was an element of progress in his successively

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[19]Dupree, Asa Gray, p.221.

higher creations, culminating in the preordained appearance of man.

Asa Gray was aware of this wide public acclaim and of Agassiz' intent to publish a natural history of the United States. He grew increasingly alarmed that Agassiz' misconceived views would prevail to the detriment of science.[20]

Asa Gray

Asa Gray's competence as a botanist was without question. He was one of the few American scientists to have an international reputation. He had spent a year in England and had come to be accepted as a colleague of international science.[21] Indeed, in his view of science, Gray was close to the British botanists,[22] arguing for a thoroughgoing empirical base from which to generalize. He explicitly gave priority to experience and observation over religion and scientific generalizations, as well as over theories based on idealistic constructions. While Gray had objected to Richard Chambers Vestiges[23] in part due to religious grounds, he had also made it very clear that it is scientific truth that "we must receive...if proven, and build up our religious

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[20] Dupree, Asa Gray, pp.229-31.

[21] Ibid., p.92.

[22] Ibid., p.221.

[23] Richard Chambers, Vestiges of the Natural History of Creation (London, 1845).

belief by its side as well as we may."[24] And although not solely, it was largely due to the poor scientific evidence and the unprofessional appeal to the public that he wrote a scathing review of Chambers Explanations: a Sequel to "Vestiges of the Natural History of Creation". This review was a "comprehensive demonstration of the shortcomings of the Vestiges" on scientific, methodological and religious grounds.[25]

It is interesting to note that at this time Gray felt that any theory of evolution would necessitate a complete revolution in the view "generally taken of the relation to the Father of our being."[26] In contrast, James Dwight Dana felt that the important need met by religion was the "principle we as Christians believe, and this view will not be modified by any view of our creation." Dana had been close to the junction of plant and animal life while on his exploring expeditions of corals. Perhaps for this reason he had "never been afraid of the Vestiges."[27]

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[24] Asa Gray, "Review of Explanations: a Sequel to the Vestiges of the Natural History of Creation," North American Review, LXII (1846), quoted in Dupree, Asa Gray, p.146.

[25] Dupree, Asa Gray, p.147.

[26] Gray, "Review of Explanations," quoted in Dupree, Asa Gray, p.148.

[27] American Journal of Science, I (1846), 250-254, James D. Dana, New Haven, to Asa Gray, April 27, 1846, quoted in Dupree, Asa Gray, p.148.

Inspired by both Lamarck's theory and Chamber's Vestiges, there was considerable debate on evolution during the 1840's and 1850's. Both Agassiz and Gray opposed evolution at this time. Their subsequent views reveal an important contrast between Agassiz' rigidity and Gray's flexibility. Although his own theories were being used to support evolutionary ideas, including Darwin's, Agassiz remained an adamant opponent to the end. Gray's subsequent work on plant geography led him to ask some serious questions about the similiarity and differences between various species of plants from different parts of the world. Because he had a mind that was flexible and open to the implications of new evidence, by the late 1840's he was able to generalize that there must be a genetic connection between species.

As a practicing naturalist, he felt that he must assume

> ...regardless of theories of original creation, that the characteristics of a plant lying on his table were determined, within rather broad limits, by the characteristics of some organic ancestor.[28]

The question, then, was whether one species could undergo transmutation into another between one generation and the next. If so, how could species be classified? In order for taxonomy, indeed for natural history itself to make any sense, permanency of at least present species was needed. These

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[28] Dupree, Asa Gray, p.218.

questions were all prominent in Asa Gray's mind when he received his first letter from Charles Darwin, in April 1855.

Darwin, impressed with a letter from Gray to Joseph Hooker, was writing to request information regarding the range of Alpine plants in the United States. It would be the first of many requests for essentially statistical studies of the distribution of flora, information that Gray was eminently qualified to give. He responded that Darwin's investigations

> ...relate to matters in which I take much interest, but can do no more than furnish some few data when asked for, that others, who happily have leisure for such enquiries, may work up.[29]

There were crushing demands on Gray's time resulting from the belief of both government and public that in a democracy a man of science was public property. These demands would not permit Gray to fulfil his ambition to study "the geographical and climate relations" of North American plants, and to then compare them with the flora of northern Europe and northern Asia.[30]

The letter from Darwin to Gray was the beginning of an extensive and mutually stimulating correspondence that further showed Gray's greatness in his ability to rise to Darwin's

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[29] Asa Gray to Charles Darwin, partly reprinted in F. Darwin, <u>Life and Letters I</u>, 420, quoted in Dupree, <u>Asa Gray</u>, p.240.

[30] Dupree, <u>Asa Gray</u>, p.240.

level.[31] By 1857 Gray was admitted to Darwin' inner circle as, swearing him to secrecy, Darwin revealed to Gray the full extent of his revolutionary theory. While Gray had reservations about some problem areas such as the role assigned to natural selection, he was most impressed with the theory. Indeed, his integrity as a scientist would have lead him to seriously examine any theory based on such valid evidence and such close reasoning, for a further bond between Darwin and Gray was their mutual belief in empiricism. Accordingly, Darwin gave Gray every opportunity to object on methodological grounds, as the theory "is grieviously hypothetical and large parts are by no means worthy of being called inductive"[32] Gray, however, had at hand material of his own for which Darwin's theory could be used as a hypothesis, material and ideas with which he had been working since 1854.

Gray was in a unique position as the only botanist with an extensive collection of specimens of the flora of North America, Europe, eastern Asia and Japan. He was intrigued by the problem of their wide and disjunct geographical distribution. Firmly convinced that species were genetically related as parent to child, he could not accept the idea

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[31] Dupree, Asa Gray, p.240.

[32] Charles Darwin, Down, to Asa Gray, Nov. 29, 1857, F. Darwin, More Letters, I, 126, but quoted from the original in Dupree, Asa Gray, p.247.

of disjunct separate creations.[33] Yet how could he explain the unusual number of plants of eastern North America that were also found in eastern Asia, particularly in Japan, and no where else. His belief in genetic connection led him to the idea that each species must have originated in a single locality. Here his exchange of ideas with the European botanists proved most fruitful. In 1854 he was delighted to receive the lengthy introduction to Joseph Hooker's Flora of New Zealand, expressing Hooker's views essentially as follows:

> (1) that all individuals of a species have proceeded from one pair, and that they retain their distinctive characters; (2) that species vary more than is generally supposed; (3) that they are more widely distributed; and (4) that their distribution has been affected by natural causes, although not necessarily the same ones to which they are exposed now.[34]

Close to agreement with most of Hooker's ideas, Gray was stimulated to further thought centred around "the general and fundamental law of genetic resemblance".[35] Contributing to Gray's thoughts were those of his friend, Alphonse de Candolle. De Candolle's Geographie botanique raisonee comprised an extensive summation of the study of species from a geographical point of view. It particularly noted the problems of migration in earlier geological periods and such tricky problems

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[33] Dupree, Asa Gray, p.249.

[34] Ibid., pp.233-34.

[35] Ibid., p.234.

as the relation between the flora of North America and Asia. De Candolle, however, offered few solutions. In 1858, after extensive work classifying his Japanese specimens, Gray felt he was ready to offer a solution to this problem of disjunct distribution of plants in eastern Asia and eastern North America, one that would effectively refute Agassiz.

Gray now felt that this distribution must be related to Agassiz' ice age. He turned to his friend James Dwight Dana for the geological knowledge that he needed. Dana confirmed Gray's idea that there had been a warmer period immediately preceding the last ice age. This was followed, according to Dana, by another period warmer than the present. Gray then argued for common ancestry and a single centre of creation, the temperate plants becoming widely distributed in an unbroken range over the Bering Strait to both North America and Asia during the Tertiary period. The advancing glaciers then drove these plants southward, separating them into the branches now found in North America and Asia.

There was a further interesting question, however, in that not all the disjunct species were identical. Thus Gray concluded that representative species may "in many cases be lineal descendents from a pristine stock, just as domesticated races are". He further argued that "variation in species is wider than is generally supposed, and that derivation forms when segregated may be as constantly reproduced as their original."[36] Not only was this powerful support for Darwin's theory, it was the first time a large number of taxonomic data had been tied to the great sweep of geologic history.

Also important to Gray was the realization that this solution could be used to refute Agassiz' theory of creation, as that theory effectively removed any species problem from the domain of science to the miraculous. For this purpose Gray had to make use of Dana's idea that there was a second warm period following glaciation when, Gray argued, the temperate flora were again coterminous. This was necessary in order to anticipate Agassiz' argument that no flora had survived from the Tertiary period when the glacier had wiped the earth clean, ready for a new creation.

Gray's theory was presented to a meeting of the Cambridge Scientific Club on Dec. 10, 1858, and to the American Academy Jan. 11, 1859. This was followed by a series of meetings in February, March and April at Agassiz' request. The record of these meetings was subsequently printed in the Academy's Proceedings. The Cambridge Scientific Club, greatly enjoying the debate, gave both its members another turn in the spring of 1859.

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[36] Asa Gray, quoted by Dupree, Asa Gray, p.250. The source of this quotation is not given.

It was here Gray "expanded Darwin's views -- to see how it would strike a dozen people of varied minds and habits of thought, and partly, I confess, maliciously to vex the soul of Agassiz with views so diametrically opposed to all his pet notions."[37] The idea of evolution was recognized. Indeed, Benjamin Pierce was able to give an outline of the mechanism of natural selection in a letter to his wife. Despite this, few present seemed to realize the full import of Gray's presentation. Agassiz, however, was disturbed. As they walked home together, Gray was delighted to hear Agassiz comment "Gray, we must stop this."[38] But this, of course, was not possible.

Indeed, ideas of evolution had been present in American thought since early in the century. By the 1830's geology had become an essentially evolutionary science. This was due to its emphasis on both catastrophism and the process and change inherent in Lyell's uniformitarian theories, the latter so important to Darwin. Both Lamarck's theories and Chamber's _Vestiges_ were known. Ironically, through his opposition to the theories of Lamarck and Chambers, Agassiz had helped to make them familiar to both the public and his students. It was this latter highly trained group who subsequently became

[37] Asa Gray, "Differences in Science in 21 years," MSD dated Oct. 24, 1878, quoted in Dupree, _Asa Gray_, p.260.

[38] Dupree, _Asa Gray_, p.260.

so influential in the controversy regarding evolution later in the century. They were able critically to examine Darwin's theory, evaluate the debates between Agassiz and the geologist William Barton Rogers, and eventually propose alternate evolutionary theories to Darwin's.

Rogers was one of the eminent and highly competent American scientists, a group which also included Jeffries Wyman in anatomy, Joseph Leidy in paleontology and James Dwight Dana in geology and zoology. It was Gray's concern that these men give Darwin's theory a fair trial. Gray had done his part by ensuring the publication of Hooker's New Zealand paper, his own Japan paper, and his publications regarding the statistics of the flora of the United States, as well as through his introduction of Darwin to Cambridge. The stage was set for the scientific community, at least, to receive Darwin's Origin of the Species.

CHAPTER III

THE RECEPTION OF DARWIN

Asa Gray was active in the introduction of Darwin's theory of evolution to the United States. His main concern was to ensure that the theory receive a fair hearing from the scientific community. The initial response was a series of lively debates in which Agassiz' adamant and, at times, arrogant opposition to evolution became clear. By 1865 a steady stream of articles began to appear, indicating that the scientific community had indeed given Darwin's hypothesis a fair hearing. Although the idea of evolution was generally accepted, many weaknesses were perceived in Darwin's specific theory. Rather than reject the idea of evolution, however, the American naturalists started exploring alternatives by which these weaknesses could be overcome.

The Arrival of the Origin

A copy of the Origin of Species was on its way to Asa Gray by November 11, 1859. On sale to the general public in Britain November 28, it sold out the entire 1250 copies the first day. Gray's copy arrived shortly before Christmas. He read it during the week between Christmas and New Year, noting with approval Darwin's contention that inheritance of every character should be considered the rule, with non-inheritance the anomaly. He also noted the problem of the origin of variation, and the question of whether nature ever produces variation by large jumps. There was also, of course, the problem of design: how could such an intricate mechanism as the eye arise through chance variation and selection? Jeffries Wyman, James Russell Lowell, Henry W. Torrey, and Charles Eliot Norton discussing the book the day after Christmas, quickly realized that "if Darwin is right, Agassiz is wrong."[1] Agassiz' reaction could be expected, "it is poor - very poor!"[2]

With Agassiz' opening shot fired at the meeting of the American Academy of science in January, the evolutionary debate was underway. This debate was continued from February through April at the Boston Society of Natural History, with Agassiz pitted against a formidable opponent, the geologist William Barton Rogers. Rogers not only had an up-to-date and extensive knowledge of his field, he was an alert and impressive debater. Not even the famous confrontation between Huxley and Samuel Wilberforce at Oxford was as carefully arranged or as extensive as this. Neither there nor

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[1] C. E. Norton, Shady Hill, to Elizabeth C. Gaskell (Dec. 27,1859), Jane Whitehill, ed., Letters of Mrs. Gaskell and Charles Eliot Norton 1855-1865 (London, 1932), pp.42-43, quoted in A. Hunter Dupree, Asa Gray (Cambridge: The Belknap Press of Harvard University Press, 1959), p.267.

[2] Louis Agassiz, quoted in Dupree, Asa Gray, p.269.

anywhere else were two scientists of the calibre and reputation of Agassiz and Rogers involved in such a debate. This was not a debate of evolution versus theology but, as became apparent, of two diametrically opposed views of science itself. The first argument revolved around the question of whether the fossil record revealed a progressive differentiation of species through the strata of different periods. Agassiz was renowned for his work in paleontology and the fossil record was one of Darwin's biggest problems.

Agassiz argued that evolutionary development from lower to higher forms could not have occurred as certain life forms had remained unchanged from one period to the next. Further pointing out that fossils from earliest geological times showed diversity, Agassiz defended his theory of a series of miraculous creations. In refuting Agassiz' claim, Rogers used Agassiz' own theory of embryological recapitulation against him, supported with fossil evidence from Roger's own experience. He clearly indicated that like Darwin, he recognized the progressive differentiation that was seen in the fossil record.

The next debate centred around the continuity of species through successive geological periods. This was directly related to Agassiz' belief in catastrophism and successive miraculous creations. Again, Rogers was able to refute Agassiz with concrete evidence, also citing Agassiz' 'prophetic types' as proof that certain forms had been inferior to those which succeeded them. But Rogers also drew from Agassiz the revealing admission that Agassiz' views were not generally accepted. At the same time, Agassiz asserted his dogmatic conviction that time would prove him right.

During this series of four debates, Rogers forced Agassiz to defend a theory favourable to Darwin, offered at least as strong an argument as Agassiz, and through Agassiz' contradictory statements, caught him in a "flat-footed admission of the principal issue".[3] But even more damaging was the revelation of Agassiz' adamant, unreasonable attitude, his conviction of his own righteousness in the face of his own contradictions and worse, his evident feeling that the only competent zoologist was one who agreed with him. Agassiz' students witnessed these debates, and were alternately dismayed and delighted at Agassiz' obstinate defence of his ideals.[4] His scientific peers were simply dismayed. Realizing that Agassiz had come off second best, they could only wait for his promised review of The Origin. When it finally appeared in July of 1860 the disillusionment with Agassiz by the scientific community was complete.

The major problem with Agassiz' review was the clarity with which it exposed the two conflicting world views, Gray

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[3]Edward J. Pfeiffer, "United States," The Comparative Reception of Darwinism, ed. by Thomas F. Glick (Austin and London: University of Texas Press, 1972), p.180.

[4]Lurie, Louis Agassiz, p.297.

and Darwin's empiricism as contrasted with Agassiz' idealism. Rather than offering a reasoned exposition of Darwin, Agassiz simply dismissed the theory of evolution as "not having made the slightest impression on my mind."[5]

Darwin's closely reasoned argument was wrong, because the concept of species that Darwin used differed from that which Agassiz had been urging for many years, that species are 'categories of thought' in the mind of the Creator. Adamantly adhering to his idea of catastrophic breaks between geological strata, he argued that no fossil could possibly be the parent of any living animal. Further, as living animals exhibited the same form now as they did in the time of the ancients, there could have been no transmutation of species. The amount of time that Darwin claimed he required was a real problem for Agassiz, familiar as he was with the tremendous changes that take place within a short period of time in the development of the embryo.

But this is the crux of the problem: evolution for Agassiz was the development of the egg to a predetermined ideal form, the material manifestation of a thought in the mind of a Creator. As transmutation of these ideal forms was inconceivable, so also was transmutation of species in the material world - at least, for Agassiz.

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[5]Louis Agassiz, "Professor Agassiz on the Origin of Species," American Journal of Science, 2nd series, 1860, p.143.

In this clash of world views, no amount of evidence or argument could convince him otherwise. Agassiz was incapable of interpreting valid scientific data in any way other than his own Platonic idealism. Thus he concluded: "I shall therefore consider the transmutation theory as a scientific mistake, untrue in its facts, unscientific in its method, and mischievious in its tendencies."[6] The combined result of the debates and this review in which Agassiz proclaimed that Darwin's Origin had not "modified in any way the views that I have already propounded..."[7] was a serious loss of intellectual stature and respect for Agassiz. This particularly occurred within the scientific community from which he was ever more isolated. In the future, his energy would be directed to public addresses rather than to the professional forum, to his teaching and to building his museum. Yet Agassiz did point out some serious problems in Darwin's presentation, particularly as related to paleontology and to Darwin's insistence on infinitely gradual variation. But the alternative view of science that Agassiz offered was sufficiently outdated that the American naturalists became "even more anxious than before to discuss, evaluate and test the evolution idea."[8]

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[6] Agassiz, "Agassiz on the Origin," p.154.

[7] Ibid., p.143.

[8] Lurie, Louis Agassiz, p.300.

This fair appraisal of Darwin's theory was just the goal Gray had been working for. His first task was to arrange publication of an American edition of the Origin, which sold 1750 copies by May 1, 1860. He then wrote an exceptionally clear and impartial review for the American Journal of Science. This review was highly praised by Darwin himself, who further suggested that it be used as a preface to the American edition.[9]

Gray began the review by comparing the approach of Darwin and Agassiz. He noted that Agassiz' theory regarding as supernatural the origin, present number and distribution of species effectively removed this problem from the domain of inductive science. He then pointed out that Darwin regarded this as a natural process. Gray quoted extensively from Agassiz and Darwin, showing the similiarity of their work and demonstrating that "apparently every capital fact in one view is a capital fact in the other, the difference is in the interpretation." Agassiz' students would shortly recognize the validity of Gray's insight:

> In a word, the whole relations of animals, etc., to surrounding Nature and to each other are regarded under the one view as ultimate facts or in the ultimate aspect, and interpreted theologically; under the other as complex facts, to be analyzed and interpreted scientifically.[10]

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[9]Dupree, Asa Gray, p.278.

[10]Asa Gray, Darwiniana, ed. by A. Hunter Dupree (Cambridge: Harvard University Press, 1963), p.16.

In effect, Gray saw Agassiz as assuming too much to be inexplicable, that is as yet scientifically unexplained. On the other hand, Gray suspected that Darwin might be expecting too much to be explained scientifically. For while he saw sufficient merit in Darwin's theory to warrant trying it as a hypothesis, he also noted both its strengths and its weaknesses.

Thus Gray observed that Agassiz' theory that embryology recapitulates phylogeny "accords well with the theory of natural selection".[11] He repeated his initial approval of the idea of inheritance as the rule, divergence the anomaly. He accepted the hypothesis that varieties gradually diverge into species through natural selection, and that natural selection was the result of a Malthusian struggle for existence. Gray clearly saw that Darwin had not, however, explained the origin of variation.

Indeed there were a number of related problems that remained to be solved. These included the problem of heredity, the imperfection of the geological record (needed to show the operation of natural selection) and finally, the problem of the sterility of hybrids. The most problematic argument that Gray saw, however, was in the weakness of Darwin's explanation of the production and specialization of organs. While Darwin attempted to give a natural explanation, Gray

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[11]Asa Gray, Darwiniana, p.16.

noted the strong resemblance to Lamarck's unsatisfactory theory. Here Gray seemed to suggest that Darwin was overstepping the bounds of scientific endeavour into the realms of the unknown.

At this point Gray directly confronted the issue of science and religion. He acknowledged that this theory could be regarded as "compatible with an atheistic view of the universe",[12] but this could also be said of any physical theory, including Newton's. In effect, Gray was arguing for the neutrality of scientific theory, although he continued to suggest that a theological interpretation could and should be given to the derivative theory. Much of his argument seemed to rest on the great difficulty of trying to find an adequate natural explanation for something that is best explained theologically: the origin of variation, the production and the specialization of organs.

Gray then argued that evolution could be seen as the process whereby God is creating his design. He suggested that there were two possible theological interpretations, equally valid: "done from all time" or else "doing through all time". In his articles in the Atlantic Monthly he frankly advised Darwin to adopt this view, to "save himself much needless trouble."[13]

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[12] Gray, Darwiniana, p.44.

[13] Ibid., pp.47,120.

A constant theme throughout Gray's articles was his insistence that his readers not accept Darwin's theory as true. It was a scientific hypothesis that must be tested, and stand or fall on the basis of its scientific merit. To this end he pointed to its wide explanatory power, and to the fact that no species, once it has died out, has ever re-appeared. To Gray, this indicated that there must be a genetic connection of species through time, not separate miraculous creations. Gray's reasonable approach to Darwin's theory was further revealed in three debates of March 27, April 10 and May 1 at the American Academy of Arts and Science. Agassiz spoke briefly, supporting his allies Francis Bowen and John Amory Lowell. Gray made clear his independent judgment that "variation and natural selection would have to be admitted as operative in nature, but were probably inadequate to do the work which they had been put to."[14] As a result of Gray's reasonable attitude and Agassiz' intransigence, by the end of 1861 Agassiz had emerged as the sole opponent among the professional naturalists publicly committed to oppose the new doctrine.[15]

The Appraisal

Little was heard of Darwin's theory from the scientific community to indicate acceptance or rejection during the years

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[14] Dupree, Asa Gray, p.287.

[15] Lurie, Agassiz, p.300.

of the Civil War. With the papers and articles that gradually began to appear after 1865, it became apparent that the American naturalists had followed Gray's suggestion and had shown an open minded willingness to test the theory for themselves. During the ensuing years there was increasing evidence of acceptance of the idea of evolution, both in the work of the naturalists and in the teaching of evolution in the colleges. This may have been in part due to the return of the young naturalists, including Agassiz' students, from the war. The American Association for the Advancement of Science also resumed its annual meetings, thus providing a forum for these views to be heard.[16]

Accordingly, it was at the first large scale meeting of the American Association since the war (1867) that President J. S. Newberry summarized opinions on Darwinism. Although he made it clear that he was far from being a Darwinian, he felt that such a report was desirable as acceptance of Darwin's theory by scientists was possible. Indeed, this could already be detected in 1866 when Jeffries Wyman delivered a paper to the American Academy innocently entitled "Some Notes on the Cells of the Bee".

Following a meticulous and ingenious procedure, Wyman had been able to make a wood cut which clearly showed the ir-

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[16] Edward J. Pfeiffer, "The Reception of Darwinism in the United States, 1859-1880," (Unpublished Ph.D. dissertation, Brown University, 1957), p.59.

regularity of the angles of bees cells. By studying these cells comparatively, "as Darwin himself had done", Wyman effectively showed that the instinct which produced such cells was not uniform in its action and hence quite adaptive with the possibility also existing that bees use their intelligence in this construction. Either possibility was consistent with Darwin's theory and effectively refuted Bowen's argument against Gray. Postulating that the unvarying instinct of bees precluded any variation whatsoever, Bowen had argued that the variation described by Darwin as the base of evolution was impossible.

In the same year Alpheus Hyatt, Agassiz' most brilliant pupil, gave an address at the Boston Society of Natural History in which he gave an evolutionary interpretation of some fossil shell fish which he had been studying. As proved to be the case with many of the younger naturalists, however, it was not a Darwinian interpretation.[17]

Many of these young naturalists, both students of Agassiz and those such as Othniel Marsh who had been educated elsewhere, were now finding positions in the new colleges and science programs that were blossoming in this period. Those colleges founded under the impetus of the Morrill Land Grants programs generally included the natural sciences as an integral part of their agricultural base. There were also

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[17] Pfeiffer, "Reception of Darwinism," pp.60-63.

the new and progressive schools such as Cornell and Johns Hopkins, while older colleges such as Harvard were revamping their approach and expanding their science programs.[18] At Johns Hopkins, president Daniel Coit Gilman in 1876 had requested the advice of Thomas Huxley regarding the establishment of Huxley's newly developed biology course, based on Darwin's theory. While Huxley's associate, E. Newell Martin was hired to establish the program,[19] at least two of Agassiz' students, William L. Brooks and Philip R. Uhler were also hired.[20] Other of Agassiz' students were extending Agassiz'

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[18] Clifford Harold Peterson, "The Incorporation of the Basic Evolutionary Concepts of Charles Darwin in Selected American College Biology Programs in the Nineteenth Century," (Unpublished Ph.D. Dissertation, Columbia University, 1970), pp.78-83.

[19] _Ibid_., pp.110-115.

[20] _Ibid_., p.120. Also see Lawrence Vaisey, _The Emergence of the American University_ (Chicago: The University of Chicago Press, 1965). Vaisey argues for a German influence regarding the developments of science programs in the universities. Vaisey states that "The Hopkins immediately symbolized German research," (p.129). He did not mention the influence of Huxley at Johns Hopkins, and further overlooked the influence of Louis Agassiz and his students regarding the teaching of science during this period. He admits, however, that "in the early seventies knowledge of the German universities was still astonishingly vague," (pp.128-29). Given the progress in science that had already occurred, it seems likely that the pattern he sees developing may have come in large part from the growing needs of American science itself, as well as from the influence of Louis Agassiz and his students.

In Vaisey's discussion of Harvard, he overlooks Agassiz and the basic research he was teaching at the Lawrence Scientific School and the Museum of Comparative Zoology. While Vaisey mentions Addison E. Verril as a 'pioneer zoologist' (p.125), he fails to note that Verril was only one of Agassiz' many students. Indeed, he mentions Agassiz only once, to note that teaching method throughout the country: Alpheus Hyatt at Brown University, Alpheus Packard at Yale, Burt Wilder at Cornell, Joseph LeConte at University of California and Nathaniel Shaler at Harvard.[21]

The experience of Shaler is indicative of the progressive acceptance of evolutionary theory. In 1861, he strongly opposed Darwin, by 1865 he was willing to explain it to his classes, and by 1868 he had fully accepted and was using Darwin's theory. Brooks at Johns Hopkins had also become a convert to Darwinism while doing advanced work with Agassiz. Indeed, many of Agassiz' students had become converts to evolutionary theory, but not necessarily to Darwinism. They had been taught to think independently, and were simply too well trained to accept the many flaws that were inherent in Darwin's

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his "unorthodox theism" proved a hinderance to D.S.Jordan obtaining a position at Princeton (p.48). Vaisey concedes that it was not until mid-century that Germany emphasized research, subsequently influencing American universities in the late 1870's. Agassiz, however, arrived in 1846, with his students subsequently obtaining positions and influencing the teaching of science in many colleges and universities. The widespread impact of this teaching has been acknowledged by Lane Cooper, James Teller and Edward Lurie, among others. George Daniels also argues that "too much attention has been made of the German experience and too little attention has been paid to changing conditions within this country that could probably have accounted for the same results." See "The Pure-Science Ideal and Democratic Culture," Science, CLVI (30 June 1967), p.1700.

[21] Ibid., p.40.

proposal at this time. With their training in paleontology, the geological weakness was particularly troublesome. Thus the reviews and articles of the last quarter of the 19th century reveal both an acute awareness of these difficulties and a decided controversy between the Darwinist and the American School. The latter had formulated alternate evolutionary theories which were designed to overcome the weaknesses they perceived in Darwinism.

While the decade of the 1870's can be seen as generally affirming the main tenets of evolution, even the book reviews reveal a dissatisfaction with Darwin's hypothesis. Thus the unnamed reviewer of Contributions to the Theory of Natural Selection by Alfred Wallace (1870) commented that he

> ...cannot see that natural selection is by any means the primary cause of variation...it seems to become more and more evident that physical changes, or some other unknown causes, give the initiatory impetus to change.[22]

Both Darwin and Wallace stated that a variation must occur which in some way better equips the animal to its surroundings before natural selection can act. Wallace noted the great change in the climate that can occur, with corresponding change in the flora and fauna of the region. The reviewer then suggested that variation is influenced by these physi-

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[22] "Review of Contributions to the Theory of Natural Selection," American Naturalist, XV (1870), p.420.

cal causes, with "natural selection being only the secondary means by which these variations are perpetuated." He further noted with approval the last chapter, which treats of the limitations of natural selection, arguing that once "the intelligent faculties [of man] began to appear...all necessity for further physical change would be at an end."[23]

A review in 1877 of Lessons from Nature, as Manifested in Mind and Matter by St. George Mivart, echoed the above sentiments. While the reviewer did not necessarily agree with Mivart's philosophical approach, he did feel that

> We are not so sure that natural selection will not in the future hold a subordinate place and form but a single phase of a many sided theory, of which the corner stone has possibly not yet been discovered.[24]

A further objection was raised to Darwin's insistence on a slow, continuous change. Thus in Popular Science of 1876, Thomas Meehan observed that "in plants there is an evolution of form by slow and gradual modification through a long series of years, but also that evolution is often accompanied by suden leaps..." He further said that "if there has been through the ages change by sudden introduction as well as by slow modification, there is no use hunting in all cases for 'missing

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[23] "Review of Contributions," p.420.

[24] "Mivart's Lessons from Nature," American Naturalist, XI (1877), p.301.

links' that never existed."[25] Questioned as to his position as a Darwinian, Meehan defended his views as an evolutionist, but insisted on maintaining his autonomy as an independent observer, letting the facts fall where they might.

He did note, however, that he had "found a plank on which Agassiz and his friends might have stood with Darwin, and I could render no better service to evolutionary views." He also raised the problem of heredity and watered stock in relation to new varieties, suggesting self pollination. He argued that some of the observations he had placed on record "aid evolutionary views in some of their weakest points...I am really trying to save the doctrines of survival of the fittest and natural selection from the injuries dealt out to them in the house of their friends."[26]

Similarily, in the American Naturalist XI, 1877, W. H. Dall offered a "Provisional Hypothesis of Saltatory Evolution". He noted that the chief weapon that had been brought against the doctrine of evolution was missing links "which could not fairly be charged to the account of deficiencies in the paleontological record."[27] He suggested that

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[25] Thomas Meehan, "Getting Right on the Record," The Popular Science Monthly, X (1876), p.102.

[26] Ibid., pp.102-103.

[27] W. H. Dall, "On a Provisional Hypothesis of Saltatory Evolution," American Naturalist, XI (1877), p.135.

some species may have a very strong tendency to stay in a state of equilibrium, thus able to

> ...resist for a considerable period the changes which a gradual change in the environment may tend to bring about. When the latter has reached a pitch which renders the resistance no longer effectual, it is conceivable that a sudden change may take place in the constitution of the organism, rapidly adapting once more to its surroundings...[28]

The new form, better adapted, would then survive due to the law of natural selection, and the tendency to equilibrium and conservation of form would reassert itself. Far from rejecting the idea of evolution, Dall suggested that "the preceding reasoning might serve as a key to many puzzling facts in nature, and perhaps deprive the catastrophists of their most serviceable weapon."[29] Effectively, Dall and others were seeking proofs and explanations that would encompass the weak points of Darwin's hypothesis within a more comprehensive theory, rather than attempting to explain away the difficulties.

Addressing the American Association for the Advancement of Science in 1876, E. S. Morse gave a review of the contributions of zoology to the doctrine of descent. He credited Agassiz with raising the standard of zoological studies in the United States. He defended Agassiz' opposi-

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[28] Dall, "Saltatory Evolution," p.136.

[29] *Ibid.*, p.137.

tion to Darwin's views as beneficial as "they have prompted the seeking of proofs in this country, and now our students are prepared to show the results of their work in evidence of the laws of progressive development." After a brief summary of some early work, Morse particularly pointed to "the thoroughly original views"[30] of E. D. Cope and Alpheus Hyatt. They had developed a theory of accelerated and retarded rates at which animals acquired new characters, and thus formed new species. Morse did not attempt an exposition of these theories, but rather urged the publication of an illustrated and simple outline for the public. Not only Cope and Hyatt, but also Joseph LeConte and Clarence King had raised various objections to Darwin's specific theory, although they had accepted and developed the idea of evolution.

Hyatt regarded Darwin's natural selection as a secondary law which could explain certain phenomena of survival and perpetuation of characteristics. This, however, could only occur after the characteristic had originated through the action of the law of the dynamic evolution of acquired characteristics through the influence of the environment. Accordingly, natural selection could not "seriously affect characteristics until after it originates."[31] Cope equally argued that

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[30]Edward S. Morse, "Address of Vice President Morse," Proceedings of the American Association for the Advancement of Science, XXV (1876), p.159.

[31]Alpheus Hyatt, "Phylogeny of an Acquired Character," Proceedings of the American Philosophical Society, XXXII (1894), p.381.

"natural selection is to the plainest understanding incomplete as to an explanation of their [variations] origin, as its author freely allows."[32] Cope agreed with Huxley that what the hypothesis of evolution needed was a good theory of variation, but Cope argued that particularly needed was the origin of variations.[33]

LeConte agreed in essence with Cope and Hyatt, seeing secondary roles for both natural and sexual selection. He noted the problem of the "swamping" of a newly acquired characteristic by cross-breeding with the parental form. Of particular concern was the idea of random chance variation and the struggle for life applying to man, for "then alas for all our hopes of race improvement - physical, mental, and moral!"[34] He clearly saw that random chance variation and natural selection did not support a belief in progress, and noted that Spencer accorded the greatest power to the Lamarckian factors of environment and use and disuse, both of which

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[32] Edward Drinker Cope, The Origin of the Fittest (New York: MacMilan and Co., 1887), p.2.

[33] Ibid., pp.14-15.

[34] Joseph LeConte, Evolution: Its Nature, its Evidences, and its Relation to Religious Thought, 2nd ed. revised, (New York: D. Appleton and Company, 1899), p.97. LeConte was concerned with Weismann's contention that natural selection and the struggle for life were the only factors by which organic evolution was carried on. He recognized this as a means for the improvement of the species, but argued "natural selection will never be applied by man to himself as it is by Nature to organisms. His spiritual nature forbids." LeConte made a clear distinction between organic animal evolution and "civilized human evolution" of spiritual and mental qualities. He did not foresee the eugenics movement.

could lend themselves to a degree of control.[35]

In his article "Catastrophism and Evolution", Clarence King argued that contrary to Lyell's uniformitarian geology which may have related to England, American geological evidence indicates that there must have been periods of at least local, although fairly widespread catastrophes. During these periods, natural selection in terms of a Malthusian struggle could not have been operative. Instead, the most successful species would be those with the greatest degree of plasticity and consequently able to undergo rapid change in order to accommodate to a rapidly changing environment. He felt that Uniformitarianism had been "built in as one of the corner stones of an imposing structure of evolution"[36] from the time of Lamarck, Goethe and St. Hilaire to Darwin. He continued to argue, however, that it was the "error of universal and extreme catastrophes" that rightly was not accepted. But he also contended that the evolution of the environment would be found neither in the "uniformitarianism of Lyell and Hutton, Darwin and Haeckel, nor the universal catastrophism of Cuvier and the majority of the teleologists",[37] but rather in a modified catastrophism.

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[35]LeConte, Evolution, pp.73-75.

[36]Clarence King, "Catastrophism and Evolution," The American Naturalist, XI (August, 1877), p.463.

[37]Ibid., pp.463-464.

He noted that biology as a whole rejected catastrophism in order to save evolution, but that evolution was

> Preoccupied with the strictly biological environment...the complicated relationships with contemporaneous life...the intricate relationship of dependence of any species on some of its surrounding species.

Biologists had "signally failed to study the power and influence of the inorganic or geologic environment." Thus the doctrine of the aimless sporting and the survival of the fittest varieties was developed, and the inference made that in this way all forms from the first to the last were derived - "the gospel of chance".[38]

Against this, King contrasted his theory that the evolution of the environment had been the major cause of the evolution of life. He suggested that He who is the source of all energy also bestowed a power of development by change:

> ...arranging that the interaction of energy and matter which make up environment should, from time to time, burst in upon the current of life and sweep it onward and upward to ever higher and better manifestations. Moments of great catastrophe, thus translated into the language of life, become moments of creation, when out of plastic organisms something newer and nobler is called into being.[39]

King was thus reflecting the belief in progress so prevalent during this era, and also the felt necessity to develop a new and comprehensive theory of evolution. But with his wealth of references, he was also giving an indication of

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[38] King, "Catastrophism and Evolution," pp.467,469.

[39] *Ibid.*, p.470.

the background of developmental theories which had preceded the American naturalists' attempted reformulation and upon which they could draw.

The Background Theories

Of particular importance in examining the various theories of development is the change that is seen from a static view of life created in accordance to God's design, to Darwin's dynamic concept of life subject to the random working of an irrational natural force by means of natural selection. In biology this process started when the 17th century European thinkers began to question the nature and the significance of fossils. By the 18th century it was accepted that these were the remains of once living plants and animals.

The tremendous increase of geological and paleontological knowledge from this time led to the realization that there had been a sequence of populations in the course of earth's history. This led to the replacement of the Biblical story of creation by various theories related to God's design - but the outline of a process of development began to emerge. Important in this development was the change from the concept of a linear Chain of Being, which lent itself readily to a view of a linear progression, to the revelation in the fossil record of a multi-linear development of forms.[40]

[40]Peter J. Bowler, Fossils and Progress: Paleontology and the Idea of Progressive Evolution in the Nineteenth Century (New York: Science History Publications, 1976), p.1.

In the early 18th century Buffon suggested his cooling earth theory, namely that there had been a collision of a comet with the sun and that lumps of molten matter were thrown out thereby creating the planets and earth. As earth cooled, it went through six stages, with the formation and variation of life dependent on the varying conditions of the world, the latest condition being suitable for man. This was not a progressive system, however, as Buffon was still influenced by the notion that change was a decline from an original ideal form. Accordingly, all that could be anticipated was the slow decline and gradual extinction of all living forms.[41]

Lamarck also argued for the relationship of life to geologic change. Rather than stages, however, his geologic studies had convinced him that the surface of the earth had undergone slow, uniform change, a process that he extended to the heavenly bodies as well, arguing that no physical body has absolute stability.[42] It followed, then, that living bodies, as closely adapted as they are to the environment in which they live, must also have undergone slow, gradual change. Then, through his well known process of the use

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[41] Bowler, Fossils, pp.1,5; also Erik Nordenshiold, The History of Biology, trans. by Leonard Bucknall Eyre (New York: Tudor Publishing Co., 1928), pp.223-224; John C. Greene, The Death of Adam (New York: The New American Library, 1961), pp.81-83.

[42] Greene, Death of Adam, p.161.

and disuse of parts combined with the inheritance of these acquired characteristics extended through an infinity of time, complex beings could progressively develop from simple life forms. New, primitive life forms were constantly coming into being at the lowest end of this ever perfecting Scale of Being. While at times Lamarck seemed to view this as a purely mechanical process, at others he indicated that it was directed toward the realization of a preordained plan.[43]

At this point there is a contradiction in Lamarck's thinking. He argued for a preordained plan which would result in a linear gradation of life forms from simple to complex. He recognized, however, that interfering with the realization of this Scale of Being plan were life forms that seemed to diverge from it and even to terminate in blind alleys. He suggested that those leading to the fulfillment of the plan were due to "the direct operation of nature" while those diverging were produced by accidental circumstances of habitation and habit. The difficulty lay in distinguishing between the two.

The catastrophists, whether the Vulcanists arguing catastrophic volcanic activity, or the Neptunists arguing world engulfing floods, were both, in essence, suggesting ways in which new world conditions suitable for life could

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[43] Nordenskiold, <u>History of Biology</u>, pp.321-330; Greene, <u>Death of Adam</u>, pp.160-169.

be created in a short period of time. These theories were generally compatible with the Bible, the Noachian deluge often being incorporated. They were invariably directionalists who "saw the whole purpose of creation as the gradual preparation of the earth for the appearance of man."[44]

Both William "Strata" Smith and George Cuvier established that the age of fossils was related to the strata in which they were found. On the basis of his studies in the Paris Basin, Cuvier then developed his well known catastrophe theory. He observed the sharp line of demarcation between the strata and the numerous and different fossil life forms found in each level. From this he concluded that violent catastrophes must have occurred and entirely eradicated the existing species. This would explain why different fossil forms were found in each strata. Extending this, Cuvier concluded that fossil species could not possibly be related to living species. Thus to Cuvier, immutability of species was an absolute fact. Further, he made no suggestion that the differing life forms he uncovered in the sequence of strata showed any progress towards higher levels of organization,[45] although his discovery of the sudden appearance of mammals in the Tertiary period came to be regarded as evidence for

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[44]Bowler, Fossils, p.29; Greene, Death of Adam, pp.61-80.

[45]Bowler, Fossils, pp.16-17.

a progressive development of life.[46] With the often noted French disregard for theology, Cuvier himself did not argue for the miraculous creations to which his catastrophism lends itself. He suggested rather that some life would be preserved and subsequently migration would take place.

He did make a major contribution in attacking the Scale of Being concept, one of the weakest parts of Lamarck's theory. On the basis of his work in comparative anatomy he suggested that there were four basic "ground plans" on which the various life forms were constructed: Radiata, Articulata, Mollusca and Vertebrata. This became the basis for all subsequent animal classification, and provided a much firmer foundation for a theory of descent than had previously been available.

By 1830 an alternative to the idea of continuous miracles had been suggested through natural theology. Divine Providence could now be seen manifest in the original design of the system itself. Thus at each stage the earth could be seen as inhabited by a population especially designed to suit the conditions, with the appearance of man the fulfillment of the whole process. The idea of progress was secondary to the fulfillment of God's design. Indeed, the discontinuity and irregularity of the fossil record did not indicate progressive development but did support theories of catastrophism

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[46] Bowler, Fossils, p.27.

and successive miraculous creations.[47] The great advances made in geological and paleontological knowledge during the 19th century, however, lent increasing credibility to the idea of a progressive development.

A major advance was made in geology with the classification by Adam Sedgwick and Roderick J. Murchison of the highly confused Transition series of rocks. They were able to establish a complete sequence, from the Cambrian through the Silurian and Devonian to the base of the Carboniferous and the Secondary Series: the Paleozoic, Mesozoic and Cenozoic Eras. A progressive sequence of fossils could now be established from the Paleozoic (invertebrates through fishes) to the Mesozoic (Reptiles) through to the Cenozoic (Mammals).[48]

At this point the steps still seemed quite discontinuous, supporting the idea of God's Creation. There was a further problem with the continuing belief in a linear progression in which the Age of Fish gave way to the Age of Reptiles, for example, with the highest form of fish being one step lower on the Scale of Being than that of the lowest order of reptile. Through the work of Richard Owen and Heinrich Bronn, it was now being shown that there was not even a progressive development within classes, let alone between them. Thus

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[47] Greene, Death of Adam, p.130.

[48] Bowler, Fossils, p.34.

Owen was able to show that a great deal of divergence and specialization had occurred within the fish since the reptiles had developed. Whereas a linear progression would be in terms of development from the simplest fish to the most reptilian, it was now realized that fish had undergone extensive modification and specialization since the appearance of the first reptile. Heinrich Bronn's work in the late 1840's and '50's confirmed that other fossil forms followed this trend to specialization. As Peter Bowler points out:

> Progress could no longer be seen as the gradual advance through a linear hierarchy. On the contrary, it was a much more general trend that could affect all of the various lines of development in a manner totally unrelated to the advance toward man.[49]

Darwin was ready to accept the concept of specialization as not necessarily related to an idea of progress. Indeed, he was suspicious of progress,[50] arguing instead increasing complexity from the original generalized prototype. This specialization, however, could include degradation, as was evident in parasites. Also, if an organism was well suited to a stable environment, it would persist unchanged. Indeed, the random nature of natural selection and the concept of struggle would raise serious questions for the idea

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[49] Bowler, Fossils, p.110.

[50] Ibid., p.118. See pp.117-127 for a comprehensive discussion of Darwin and progress.

of progress - unless seen on the more flexible basis of divergence and multilinear development of forms within their own kind of structure. But while Darwin was content to give up the idea of progress, others were not. Further, there had been several progressive theories popularized during the 19th century, which could now be developed as part of an evolutionary picture.

Both Louis Agassiz and Robert Chambers had seen man as the last step of a plan of creation; Agassiz, of course, through a progressive series of miraculous creations. But Chambers had integrated man into a plan built into the universe and proceeding according to its own laws, with man as the last step the highest animal and the one whose mind had evolved along with his body. Chambers viewed this as a continuous progressive development, and even went so far as to hint that this process might continue with man superceded in the future by a higher and more intelligent form.[51]

Herbert Spencer accepted the idea of diversification and specialization, but he insisted that this process of diversification was followed by an ever increasing integration and mutual interdependence of a progressing whole. His works popularized Darwin and linked the idea of evolution with that of progress.[52] Indeed, for Spencer, biological

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[51]Bowler, Fossils, pp.54-61.

[52]Ibid., pp.128-29.

evolution became just one more manifestation of a universal law of progress. His works and his philosophy became very popular in the United States, with his Principles of Biology referred to by American naturalists.[53] They did not, however, accept his idea of a slow inexorable change with which man could not interfere.

With their emphasis on empirical study, American naturalists were not inclined to use any philosophy, even one as congenial as that of Spencer's, as the base for their own theories. They insisted on good, hard, factual evidence - and as the reviews of the period indicate, they were not all satisfied with either Darwin's evidence or his interpretation. The dissatisfaction was aimed at most of the main features of Darwin's theory. Firstly, they did not see natural selection as sufficient for the major role Darwin had assigned to it. Further, Darwin insisted on gradual change when there seemed to be considerable evidence for sudden discontinuous change. Finally, there were the problems of heredity and particularly the problem of the origins of variations, for, as they rightly pointed out, some variations had to exist before natural selection could act. While they accepted the idea of evolution, they felt that Darwin's theory was, at best, incomplete.

Bowler has argued that paleontology never developed

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[53] Cope, Origin of the Fittest, pp.viii-15, 413-448, passim; LeConte, Religious Thought, p.97.

into a leading argument against Darwin.[54] But while historically neglected, in the main, it was from paleontology that the Americans developed their arguments against Darwin, and their alternate theory of evolution.

There are, in fact, two directions to take in order to develop a theory of evolution. One of these is field observation: the observation of animals living today, their life-styles, habits and interdependence. This was, of course, Darwin's approach. The other is paleontology, where the development of life through the ages is recorded. It was to this latter study that the American naturalists turned in their attempt to develop a comprehensive theory of evolution that took into account those problems that Darwin had tried to explain away. As the paleontological record to this day still does not wholly support Darwin's theory, and still lends itself to alternate explanations,[55] it is not surprising that these theories differed considerably from Darwin's. Paleontology not only suggests an alternate evolutionary theory, but equally significant, an alternate view of the idea of development itself.

Darwin had relied on Lyell's uniformitarian geology,

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[54] Bowler, Fossils, p.118. In this work Bowler is referring to Europe. He has since turned his attention to the United States and the rival neo Lamarckian theory based on paleontology. See his article "Edward Drinker Cope and the Changing Structure of Evolutionary Theory," Isis 68 (June 1977), pp.249-265.

[55] J. Challinor, "Paleontology and Evolution," P.R.Bell (ed.) Darwin's Biological Work: Some Aspects Reconsidered (Cambridge: Cambridge University Press, 1959), pp.50-54.

resulting in a concept of development characterized by slow, barely perceptible change. As Clarence King argued, American geologists and paleontologists favored a theory of modified catastrophism due to the sharp breaks they observed in the geological record.[56] This resulted in a concept of discontinuous development marked by periods of rapid change and clearly defined stages of quite different natures, a concept of development quite different from that of Darwin. This can be seen as a further outcome of the alternate evolutionary theory proposed by the American naturalists.

Noting that the breaks in the geological record indicated that a drastic change of climate had resulted in a different life form, they suggested that the environment had been influential as a cause of the change. Although not initially aware of the similarity to Lamarck, they came to be called the Neo-Lamarckian or the American School. Amongst the most rigorously trained, independent thinking naturalists who included a thorough grounding in paleontology in their studies, were, of course, Agassiz' students. And a close examination of their work reveals that the greatest influence in the development of the alternate American theories of evolution was, ironically, Darwin's most adamant opponent, Louis Agassiz.

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[56] King, "Catastrophism," p.463. Dana *et al.*, *Century*, p.113.

CHAPTER IV

THE EVOLUTIONARY THEORIES OF THE AMERICAN NATURALISTS

Louis Agassiz had been a towering but controversial figure associated with the development of American science during the 19th century. Due to his inability to accept the idea of transmutation of species, he became regarded as outmoded and ineffectual by the scientific community during his own lifetime. This view of Agassiz was accepted by his biographer Edward Lurie, who dismissed the claims of Agassiz' students regarding his contribution to evolutionary theory as "a vast mistake".[1] This seems in part due to the use of the terms "Darwinism" and evolution as synonyms. Thus anyone accepting the idea of evolution tends to be regarded as a convert to Darwin's specific theory. Lurie underscores this as he argues that "the evolution idea did not require the recapitulation idea for its general validity"[2] and that Agassiz had "confused two different kinds of evolution."[3]

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[1]Edward Lurie, Louis Agassiz: a Life in Science (Chicago: The University of Chicago Press, 1960), pp.288-289.

[2]*Ibid.*, p.289.

[3]*Ibid.*, p.286.

While it may indeed be true that Darwin's theory, based on field observation, did not require the recapitulation theory, an alternate theory of evolution was possible that did. It is only recently through publications such as those of Edward J. Pfeiffer[4] that an awareness has developed of the contrast between Darwin's theory and those of the American school based on paleontology, embryology and zoology. This contrast appears to be related to the continuing influence of Agassiz on members of the American school, such as Joseph LeConte, Edward Drinker Cope and Alpheus Hyatt.

While Pfeiffer does mention Agassiz as an influence, his main concern centres around Neo-Lamarckism as a response to Darwinism and as an accommodation to religion. He sees this movement coming to a dead halt with the advent of Mendelian genetics. I suggest, rather, that the diverse interpretations of evolution developed by these American naturalists all represented extensions of Agassiz' thought, which subsequently became an integral part of the intellectual heritage of the United States as both the naturalists and others saw the concepts so developed as applicable to a science of man.

One has to be aware of certain pitfalls in attempting

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[4] Edward J. Pfeiffer, "United States," The Comparative Reception of Darwinism (Austin: The University of Texas Press, 1974), pp.188,199-203.

to determine Agassiz' influence on the American naturalists. One of these is the tendency to lump them together as Neo-Lamarckians when their ideas and their approach could and did differ significantly. The metaphysical aspects of these theories should neither be ignored nor confused with narrow theological creed. Both Ernst Mayr and Edward Lurie[5] have argued that it was not religion, but his background in German Romanticism that influenced Agassiz' approach to evolution. It can similarily be argued that it was the American background and the belief in progress that influenced the attitudes of his students.

As noted previously, Agassiz was known in America primarily as a teacher. He stressed above all the importance of direct observation as opposed to reliance on books, a primary need for independence of thought and research. To his dismay, his pupils accepted this teaching more completely than they did his theories. By the addition of a dynamic element to Agassiz' static world, they developed the main features of Agassiz' views to serve the purposes of their own individual evolutionary theories. A comparison of the main features of their equally complete world picture with that of Agassiz reveals the full impact of his influence and provides a revealing contrast with Darwin.

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[5]Ernst Mayr, "Agassiz, Darwin and Evolution," Harvard Library Bulletin XIII (1959), pp.165-194. Also Edward Lurie, "Louis Agassiz and the Idea of Evolution," Victorian Studies, III, Darwin Anniversary Issue No. 1 (1959).

Louis Agassiz

Agassiz believed in a rational universe of Platonic ideal types arranged in an ascending order of excellence, which were manifested in the material world by the powers of the Creator's intelligence. Man's affinity with the Supreme Intelligence was evident in his ability to discover the *a priori* principles of the Creator's plan as well as in the breeding of domestic plants and animals, which Agassiz saw as the product of the "limited influence and control the human mind has over organized beings."[6]

It is important to understand that Agassiz saw intelligence as an actual force able to directly influence the material world. It was through this physical force of intelligence that the world had been created and it was through man's lesser degree of intellectual power that he could produce the varieties of domestic plants and animals. Agassiz emphatically denied that these could possibly be the free products of the immediate action of mere physical causes.[7] He argued instead that while man could bring about these changes, nature cannot, as when left to her own devices she reverts to established permanent types.[8] It should be

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[6] Louis Agassiz, "Essay on Classification: Sections I-XVIII," *The Intelligence of Louis Agassiz*, ed. by Guy Davenport, (Boston: Beacon Press, 1963), p.86.

[7] *Ibid*.

[8] Louis Agassiz, *Methods of Study in Natural History*, reprint ed. (New York: Arno Press, 1970), pp.143-147.

noted that this concept of intelligent control is in sharp contrast to Darwin's idea of random chance variation.

This was a teleological picture, for while Agassiz recognized a multilinear development of the four great branches, his tree of life had a main trunk development leading straight to man. Man's appearance thus marked the completion of organic development. Accordingly, "the only improvement we may look to upon this earth, for the future, must consist in the development of man's moral and intellectual faculties."[9]

Agassiz constantly adhered to the ideas of completeness and discontinuity, into which fitted his well known theory of geologic catastrophe and successive miraculous creations. But there was a concept of progress inherent in this scheme, as each successive era represented a higher stage of creation, a progressive development which could be followed in the fossil record. To Agassiz, however, development was simply the unfolding of God's plan, as the development of the egg to maturity represented the unfolding of pre-existing characters of the individual.

Distinct from the transmutation of species, this ontogenetic development represented "the type" or model of evolution for Agassiz. True to his belief in discontinuity, this evolution occurred through a series of metamorphic transformations rather than a slow continuous growth. This

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[9] Agassiz, "Essay," p.53.

process of metamorphosis applied to all animals without exception, and included all those transformations which occurred in the animal from the egg through the mature state to old age. Thus embryonic transformations, the dramatic metamorphosis of insects, the transformation from down to feathers of a chick, the acquisition of horns or a lion's mane, were all considered to be part of the same process. Agassiz recognized the differing stages of development which various organisms had reached at birth, but he argued that even those animals born in a more mature state had to "complete the process begun in embryo".[10]

These transformations then form the basis by which to classify the animal: the greater the number of transformations, the higher the classification. To illustrate, Agassiz pointed to the similarity between the young sturgeon and the young whitefish, a similarity that is only transient, since the sturgeon with its retention of the cartiliginous backbone is "in some sense arrested in its development while the whitefish undergoes subsequent transformations" to reach a higher stage of development.[11] While Agassiz saw in this arrested development the unfolding of God's plan, Cope and Hyatt saw acceleration and retardation, which became the basis for

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[10] Louis Agassiz, and A. A. Gould, Principles of Zoology, Touching the Structure, Development, Distribution and Natural Arrangement of the Races of Animals, Living and Extinct (New York: Sheldon and Company, 1880), p.183.

[11] Ibid., p.181.

their theories of evolution.

Agassiz viewed the development of the animal as occurring in a cycle, from an apparently inferior early stage to the peak of its mature form "before it enters those stages of existence which constitute old age",[12] and drew a parallel between old age and the retrograde metamorphosis observed among certain parasites. He suggested that this concept of development applied not only to the individual but also to the species, an idea that was further developed by Hyatt.

But the one aspect of his work that Agassiz himself considered the most important was the relationship between phylogeny and ontogeny. In his own words:

> I have devoted my whole life to the study of Nature, and yet a single sentence may express all that I have done. I have shown that there is a correspondence between the succession of fishes in geological times and the different stages of their growth in the egg, - and this is all. It chanced to be a result that was found to apply to other groups, and has led to conclusions of a like nature.[13]

Agassiz then argued that the various stages of metamorphosis which an animal underwent reflected the history of its development through a lower to a higher order. He was careful to point out that these changes were never the passing of one

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[12] Agassiz, "Essay," p.105.

[13] Agassiz, Methods, p.23.

kind of animal into another kind of animal, but he did see the higher animal passing through transient periods in which it recalled the permanent adult forms of the lower species.[14] In this he differed from von Baer, who saw a resemblance only between the early stages of embryonic development. It was this concept of ontogeny recapitulating the adult form of the lower species that was used by the American naturalists.

But Agassiz went one step further, and compared both phylogeny and ontogeny with taxonomy. For Agassiz, embryology was the key showing the unity of the three series, from which could be seen the essential identity of the embryonic and the geologic succession, and the basic resemblance of the ontogenetic and phylogenetic series.[15] From this basic unity the plan of Creation could be seen. Others, such as LeConte, saw in this same unity laws of succession, evolution and development.

Despite the concepts of development inherent in Agassiz' work, he remained unable to accept Darwin's evolution due to his conceptual background in German Romanticism. As species in the natural world existed only in terms of their conformity to a pre-ordained Platonic ideal, transmutation of species was patently impossible as it would imply transmutation of

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[14] Agassiz, Methods, pp.75,96.

[15] James David Teller, Louis Agassiz, Scientist and Teacher (Columbus, Ohio: The Ohio State University Press, 1947), p.29.

this master mold.

The conceptual background of Agassiz' students was not only very different from Agassiz', however, but also most receptive to the idea of a progressive evolution. Included in their conceptual framework was a Baconian belief in the power of science as well as an Enlightenment faith in the power of reason, both to be used for the progress of man. Cope's internalizing of Agassiz' Supreme Intellect within each animal so that the individual could direct its own evolution through the use of its own intelligence, indicated an adherence to this faith in the power of reason to contribute to the advance of the species. While undeniably the theories of these American naturalists were based on careful studies in embryology, paleontology and zoology, they were likely predisposed towards a theory of evolution by the belief in progress and Manifest Destiny inherent in the social, cultural and intellectual mores of the United States during this period. Certainly one of LeConte's major objections to Darwin's theory of natural selection was that it was contrary to man's spiritual belief in progress.

Joseph LeConte

Joseph LeConte could be regarded as one of Agassiz' most committed disciples, despite his conversion to evolutionary theory - or perhaps more accurately, his conversion of Agassiz' theories to an evolutionary mode. Indeed, LeConte paid tribute to Agassiz as the founder of evolution, drawing a parallel between Kepler's position as law giver in astronomy and Agassiz' position as law giver in biology.[16] The three laws of organic succession which LeConte attributed to Agassiz were, in fact, LeConte's own dynamic extension of Agassiz' views on embryology, paleontology, and geology, which LeConte formulated as early as 1860, prior to his knowledge of either Darwin's or Spencer's evolution.

These were the laws of: differentiation, progress of the whole, and cyclical movement.[17] Along with Agassiz, LeConte viewed the development of the egg as the model of evolution.[18] In contrast to Agassiz' static world picture, however, LeConte saw the process of evolution pervading the entire universe, including "every department of human thought".[19] He drew a parallel between his laws and embryological development in order to verify their true evolutionary nature. He defined evolution as "(1) continuous progressive change, (2) according to certain laws, (3) by means of resident forces."[20]

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[16] Joseph LeConte, Evolution: Its Evidences, Its Nature and Its Relation to Religious Thought, 2nd edition revised. (New York: D. Appleton and Company, 1899), p.47.

[17] Ibid., pp.11-27.

[18] Ibid., pp.3,8.

[19] Ibid., p.31.

[20] Ibid., p.8.

He argued that this process could be seen in the three related series of Agassiz: the embryonic or ontogenetic series; the taxonomic series; and finally the "grandest and most fundamental", the geological or phylogenetic series.[21]

As the first point in the definition of evolution is that progressive change seen in the organic forms is similar to that observed in embryonic development, it needs to be shown that the laws of change are similar to both. Thus the law of differentiation can be verified in geology by the differentiation from generalized types to the specialized types, as seen in the fossil forms through diversification of the whole. Along with this diversification can be seen the law of the progress of the whole. LeConte accepts the idea of multilinear development, and has a clear understanding that the idea of specialization includes degradation, but he still adheres to Agassiz' idea of a tree of evolution with but "one straight and narrow way to the highest in evolution", man.[22] Others have diverged from the way, and once a branch has separated, it goes its own way. Thus a monkey can never become a man, this "golden opportunity" occurs but once.[23] In evolution progress is to higher and

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[21] LeConte, Evolution, p.10.

[22] Ibid., p.15.

[23] Ibid.

higher planes, but not along every line.

The law of cyclical movement is, of course, related to Agassiz' geological ages. While LeConte did not agree with Agassiz' total catastrophism followed by a new creation, he did argue for a kind of modified catastrophism, of periods of geological stability and consolidation of species separated by periods of geological unrest and upheaval, sweeping physical change and consequent rapid, sweeping change in organic forms.[24]

Thus while the law of cyclical movement decrees that there is a movement upward, it is not at a uniform rate. Instead, a wave-like pattern can be followed through the introduction, rise, culmination and decline of a direct succession of subsequent dominant classes through Agassiz' Ages of Mollusks, Fishes, Reptiles and Mammals to the Dominant Age of Man, "The Psychozoic Era".[25]

But LeConte's three laws must also correlate with ontogeny. Thus LeConte argues that the law of differentiation can be seen in the growth and specialized function of cells in the developing embryo. The law of the progress of the whole is evidenced in the advance of some cells to the higher function of brain cells, and the descent of others to

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[24]LeConte, Evolution, p.259.

[25]Joseph LeConte, Elements of Geology (New York: D. Appleton and Company, 1891), p.603.

lower functions such as kidney cells. But there is progress of the whole, as the "highest cells are progressively higher, and the whole aggregate is successively nobler and more complex."[26]

The ontogenetic parallel LeConte sees is in the later development of man after birth, as he passes through the "successive culmination and decline of higher and higher functions" through the stages of childhood, youth, maturity and old age.[27]

LeConte sees this occurring in the bodily development of "first the nutritive functions, then the reproductive and muscular, and last the cerebral." This same cyclical movement can be seen in mental development, for in the child there is the culmination of the receptive and the retentive faculties, next, the imaginative and aesthetic faculties in youth and young manhood followed by mature manhood, where the faculties of productive work can be seen as the elaborative and reflective faculties reach their peak, while old age reflects the period of moral and religious sentiments. The first two stages recede to subordinate positions with the culmination of the third stage of constructive work "building the temple of science and philosophy; and the

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[26]LeConte, Evolution, p.22.

[27]Ibid., p.23.

fourth dedicates that temple only to the noblest purposes."[28]

But in this development not only is the law of cyclical movement seen as each stage culminates, declines and becomes subordinate to the next, but the necessity of continued evolution becomes evident. For "childhood, glorious childhood, can not remain - it must quickly pass" as must "glorious youth",[29] for the next higher wave of faculties must in due course take over or deterioration will set in. The golden opportunity once lost, is lost forever, whether in the evolution of the species, or the development of the individual.

A similar process can be traced in social evolution, as specialization and interdependence of labour occurs, again some progressing to higher levels, while others advance downward to menial positions, but there is still progress of the whole. The law of cyclical movement can further be seen in the successive developments of ever higher civilizations, which, however, incorporate social forces of the preceding civilizations. LeConte saw a similiar cyclic movement regarding evolutionary forces, arguing that those evolutionary factors appearing later dominated the preceding ones.

LeConte was concerned that the origin of variation

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[28] LeConte, Evolution, p.23. G. Stanley Hall, the psychologist, uses these concepts when he writes his major work Adolescence in 1905.

[29] Ibid., pp.23-24.

had not been explained. Contrary to Darwin's point of view, he argued that since organic change occurred in the same cycles as geologic change, then it must be the physical environment which initially produced variation. According to his cyclic succession of evolutionary factors, when the changes resulting from this environmental influence had accumulated sufficiently, the secondary factors of natural and sexual selection could become not only operative but dominant. In the last cycle, however, the highest function of man's dominating intelligence had appeared, heralding both the Age of Man and a new stage of evolution, that of man's cooperation and control through the final evolutionary factor of reason.[30]

With the appearance of man's intelligence, LeConte, with Agassiz, marked the completion of organic evolution. LeConte then extended Agassiz' idea of the limited control of man's intelligence over domestic breeding to an unlimited ability to direct not only the evolution of all flora and fauna, but also his own moral and intellectual improvement. This would be accomplished by the dominance of man's intelligence over both the Darwinian and Lamarckian evolutionary modes. While LeConte recognized the utility of the controlled selection that is relevant to animal breeding, he argued that

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[30] LeConte, Evolution, pp.86-88.

man's "spiritual nature forbids"[31] him the use of natural selection in the improvement of the race. Hence the Lamarckian factors of environmental influence again assumed primacy, as it was through these factors that progress could be directed by man. LeConte clearly made a sharp distinction between organic evolution, which must obey natural laws, and the social evolution of man, which he saw as a voluntary process, the moral and intellectual progress of which Agassiz had spoken.

Since Agassiz himself had acknowledged the claims that he "had furnished the strongest evidence of the transmutation theory"[32] it is hardly surprising to see his work used as the basis for an evolutionary theory. What is surprising, however, is to see LeConte - as a member of the American School - make so little reference to Cope's theory of acceleration and retardation. Rather than a law of evolution, LeConte simply saw it as a further reason why the steps of ontogeny repeat phylogeny. Reflecting his commitment to the ideals of progress, he further argued that:

> The law of acceleration and retardation is a sort of young Americanism in the Animal Kingdom. If our boys acquire knowledge and character similar to the adults of a few generations back, they will have time while still young and plastic to press forward to still higher planes.[33]

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[31] LeConte, Evolution, p.97.

[32] Louis Agassiz, "Evolution and Premanence of Type," Davenport, Intelligence of Louis Agassiz, p.231.

[33] LeConte, Evolution, p.179.

Thus LeConte's theories reflected not only the continued influence of Agassiz, but again the belief in progress.

Edward Drinker Cope

The initial influence of Agassiz can most clearly be seen in Edward Drinker Cope's article "On the Origin of Genera", written in 1868,[34] while, in subsequent articles Cope's development from a creationist to a Neo-Lamarckian position can be followed. It should be noted Lamarck was not chosen as a patron saint in preference to Darwin; these American naturalists became aware of their Lamarckian similarities only after developing their own principles. While they were very conscious of their dissent from Darwin by 1876, it was not until 1885 that Alpheus Packard applied the term Neo-Lamarckian to them, proclaiming them a distinctively American School of evolution.[35] This distinctiveness is evident not only in their dissent from Darwin, but also in significant differences from Lamarck's theory. Prominent among these differences were Lamarck's belief in slow, continuous change and the American belief in discontinuous metamorphic change. These differences are attributable to the origin of the American theory in a quite different view of

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[34] Edward Drinker Cope, The Origin of the Fittest (New York: MacMillan and Company, 1887). This is a collection of articles that Cope had published from 1869-1885, selected and with a preface by Cope.

[35] Pfeiffer, United States, p.198.

evolution based on their law of acceleration and retardation of embryological growth,[36] rather than on the environmental influence which they later came to consider. Further this environmental influence was based on a theory of modified geological catastrophes rather than the slow, uniform change envisioned by Lamarck.

Although Agassiz appears to be the dominant influence, in 1868 Cope can be seen arguing vigorously against Agassiz' ideal form of species, which, as a metaphysical concept, could not be transformed. But Cope equally regarded Darwin's theory of natural selection as unacceptable in that while it presupposed the existence of variations, it did not explain their origin,[37] nor did it seem likely to direct their lines of progress.[38] His own evolutionary theory of acceleration and retardation, however, can be seen as evolving from Agassiz' theories of embryology and of geological eras.

Cope himself contrasted the basis of Darwin's theories in field observation and those of the Americans based on paleontology and embryology.[39] Darwin, in fact, complained

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[36] Peter Bowler, "Edward Drinker Cope and the changing Structure of Evolutionary Theory," _Isis_ LXVIII (June 1977), p.249.

[37] Cope, _Origin of Fittest_, p.14.

[38] _Ibid_., p.18.

[39] _Ibid_., p.15.

that he could not understand these evolutionary theories that were so different from his own,[40] while Cope frequently gave credit to Agassiz, to whom "natural science is under great obligations."[41]

To Cope, as to Agassiz and LeConte, the development of the egg represented the model of evolution. Accepting Agassiz' belief in discontinuity, Cope also saw the development of the individual as proceeding by a series of metamorphic transformations from the egg through old age rather than by a slow continuous growth. Agassiz' observations that some animals undergo more of these transformations to reach a higher stage of development would seem to be the basis for Cope's theory of acceleration and retardation. According to this theory, some animals will be arrested or retarded in their development, thus remaining at a lower level, while others will have their development accelerated, enabling them to add a further stage of metamorphic development within the same time period. Cope saw evidence for this in what he termed 'exact' and 'inexact' parallelism.

Cope argued that adult metamorphoses could occur, resulting in the addition of a new specialized character.

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[40] Frances Darwin, ed. The Life and Letters of Charles Darwin, Vol. III. (London: 1887), p.233.

[41] Edward Drinker Cope, "On the Systematic Arrangement of the Reptilia," The American Association for the Advancement of Science (1870), p.229.

Then through acceleration, this latest adult character would become progressively integrated into the embryological development so as to appear before the period of reproduction, thus "conferring upon its offspring features in advance of those possessed by its predecessors."[42] This not only resulted in the formation of a new genus, but also indicated that the development of higher species, in embryo, recapitulated the adult characters of lower species. Cope saw this as an exact parallel between the development of higher species and lower. Acceleration occurred as some of the embryonic features were displaced or crowded backward, making way for the incorporation of the new adult character and further opening the possibility for a future metamorphic transformation to a yet higher state of development.[43] Inexact parallelism was seen when sufficient embryonic stages had been displaced so that the exact parallelism could no longer be followed.

While Cope could describe this process through the study of the paleontological record, at this time he could offer no explanation for the occurrence other than suggesting that the "appearance of succession of genera was ordained by Creative Power",[44] that the overall course of evo-

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[42] Cope, Origin of Fittest, p.78.

[43] Ibid., p.91.

[44] Ibid., p.92.

lution was "conceived by the Creator according to a plan of His own, according to His pleasure."[45] He explicitly denied that there was any connection between transmutation of species and geological change, as some species remained unchanged through the strata. He noted that change appeared to be quite sudden, involved many species, and was separated by long periods during which no change would occur.[46] He did, however, see a role for natural selection in determining which metamorphic transformations would survive.[47]

By 1871 there is a significant difference. By now Cope had started to argue against the idea that evidence from design proved the interference of a personal God. He proposed instead that the effect of use and disuse exerted by the living being on its own body would result in the design so displayed, in effect arguing a conscious adaptation to the environment. Agassiz' idea that genera form series by the addition and subtraction of characters was extended by Cope's argument that it was through the development of single characters that structural change creating new species was accomplished. He postulated the idea of a growth force and combined it with the conservation of energy. Differen-

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[45] Cope, Origin of Fittest, p.269.

[46] Ibid., p.287.

[47] Ibid., pp.78, 106.

tiation and specialization from original generalized forms was then explained by the accelerated growth due to a concentration of growth force, with, however, subsequent retardation of growth in other areas. This was not a gradual process, but occurred through metamorphic transformations when growth influence reached the expression point. Indeed, Cope now argued for the evolution of intelligence itself from its origins in primitive consciousness.

Consciousness, Cope suggested, developed from that first evidence of sensibility in the protoplasm and its interaction with the environment through the seeking of food and the avoidance of enemies, the complementary acts of pleasure/pain. This ever growing consciousness led to the evolution of intelligence itself, an intelligence which through the use of will could direct the growth force to where it was most needed. Agassiz' Supreme Intellect had now become internalized and the animal could direct its own evolution, designing its own body in response to the environment.

Similiarly, Cope had initially noted the coincidence that change in species had seemed to correlatewith geological eras, but denied any adaptive significance. Cope now saw these geological changes as a direct influence on evolution, both destroying many highly specialized species through the sudden changes that occurred and providing the impetus for the development of new species due to the pressure of these changed environmental conditions.

Thus change of structure occurred as the result of the interaction of three factors: environment, motion and consciousness. By motion, Cope is referring to the friction, pressure or strain that can occur as a result of environmental pressures. Consciousness or intelligence responds by directing growth force or nutrition to those areas. Change of structure then occurs by the process of acceleration or retardation. But the prime essential to the acquisition of new movements and hence new structure is consciousness. Cope further argues that the ascending evolution of bodily structure is accompanied and directed by a concommittant evolution of intelligence.

Cope saw the evolution of intelligence as fundamental, as it was this intelligence which directed the shaping of the body to suit the environment. Cope further suggested that the equivalent to human intelligence could have developed elsewhere in the universe. If the environmental conditions in those locations differed from earth, then the bodily form would also differ. Thus Cope, like Agassiz, laid great stress on the power of intelligence itself. Similiar to both LeConte and Agassiz, Cope also saw no further need for organic evolution once man's highly developed intelligence had been attained.

There was a significant departure from Agassiz' plan of creation as Cope attempted to give a natural explanation for the development of the intelligent design of animal structure. Nevertheless, several aspects of Cope's work indicate that Agassiz was indeed influential as a basis from which Cope could develop his ideas. These included the concept of the power of intelligence to design animal structure, as well as Agassiz' idea of the arrested or continued development of species that formed the basis for Cope's theory of acceleration and retardation.[48] Perhaps most significant was Cope's acceptance of the idea of discontinuous development, not only of embryological development continuing through adult metamorphosis as the model of evolution, but also through the relation of evolution to geological eras.

While the concept of intelligence as a force able to create and change organic forms was equally important to Agassiz, LeConte and Cope, each developed and used this concept in somewhat different ways. With Alpheus Hyatt, a further significant change occurred. In seeking for a natural explanation for the variation and evolution of species, he ignored both the idea of God and intelligence.

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[48]While G. Stanley Hall used several of Cope's concepts, he particularly mentions Cope's law of acceleration and retardation.

Alpheus Hyatt

Hyatt's goal was to complete Agassiz' great discovery of the correlation of phylogeny and ontogeny by showing a similar correlation between the life cycle of the individual and the life cycle of the group.[49] Hyatt then viewed the developmental period of a type as parallel to the child and youth of an individual. The mature period of a type saw an increase in complexity of design and sheer numbers, followed in old age by a decline in both these factors, sometimes leading to extinction. The increasing complexity of design seen in a type was accomplished by the step by step addition of new characters through the process of acceleration and retardation.

Hyatt himself pointed out that "it is a common mistake to designate his work as embryological", stressing that he was concerned with the developmental process of the entire life cycle: embryo, child, adolescence, adult and old age.[50]

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[49] Alpheus Hyatt, "On the Parallelism between the different stages of Life in the Individual and those in the entire Group of the Molluscous Order Tetrabranchiata," Boston Society of Natural History: Memoirs I, Part I, (1866-1867), p.193.

[50] Alpheus Hyatt, Genesis of the Arietdae (Washington: Smithsonian Institution Contributions to Knowledge, 673, 1889), pp.vii-viii.

For this purpose he accepted Agassiz' concept of the egg as the model of evolution. He particularly emphasized the continuing metamorphic development after birth by extending his study to clearly include the entire ontogenetic cycle, including the decline to old age and death of an individual and a similiar decline and perhaps extinction of species. As it is basic to understanding of the complete evolutionary development of a type, Hyatt argued that this ontogenetic cycle should be studied first.

Aside from Alcide D'Orbigny, no one before Hyatt had attempted to describe systematically all the metamorphosis of an individual from its ovarian origin to its death. But even D'Orbigny did not attempt the task Hyatt had set himself, to complete the work begun by Von Baer and Agassiz in showing the correlation between the development of the young and the evolution of the phylum by showing a similar correlation exists between the development and subsequent decline of the individual.

Hyatt wanted to be very clear that his study referred to the way in which life had been molded or formed. He saw this related to Agassiz' discovery of the correlation of the stages of development of the individual and those of the phylum. He noted that this could only be done through the extended development that paleontology allowed for.

> The limitations of time cannot be overcome by the observer of existing life, and the study of natural succession of forms in any genetic line from the beginning to the end of evolution can only be pursued successfully by workers in phylogeny.[51]

Hyatt was clearly rejecting field observation, the basis of Darwin's theory. He further revealed his debt to Agassiz by pointing out that this relationship of ontogeny and phylogeny was originally discovered by Agassiz, therefore "it is Agassiz' law, not Haeckel's."[52]

The essence of Hyatt's theory is:

> In the young, hereditary similarities derived from more or less remote ancestors are repeated, but these are more and more overgrown and replaced by more recently acquired characteristics as the adult period is approached. In old age these more recently acquired characteristics disappear, and in consequence of their disappearance, certain parts of the body and finally the whole body assumes aspects which can more or less closely compare with those of the same parts and of the entire body in the young before the differential characteristics of the adolescent and the adult period arose.[53]

Hyatt saw the young stages of development as being nearly identical, divergence occurring with the maturity and increas-

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[51] Alpheus Hyatt, "Bioplastology and the Related Branches of Biologic Research," Proceedings, Boston Society of Natural History, XXVI (August, 1893), p.88.

[52] Alpheus Hyatt, "Phylogeny of an Acquired Characteristic," Proceedings of the American Philosophical Society, 32, (1894), p.390.

[53] *Ibid.*, p.89.

ing complexity of the individual or the type, pronounced similarities appearing with old age, and culminating in the death of the individual. As this same process can be followed through the birth, maturity and decline of a species, it can result in the extinction of the species, due to the loss of genetic force. He used his theory of acceleration to explain how the more recently acquired characteristics 'overgrow' or replace the more remote characteristics. Similarily, the law of retardation can explain how characteristics are lost. More recently acquired characteristics are particularly vulnerable, until they have stabilized in the organism. Hyatt saw a real utility in this study, "as it is possible to prophecy what is to happen in the future history of the type from the study of the corresponding... [changing] phenomena in the development of the individual."[54]

With his usual specificity, Hyatt objected to the term heredity, as it had come to be regarded as able to produce variations and consequently effects, a clear reference to Darwin's random variation. In contrast, Hyatt saw variation and subsequent change of form occurring solely through the influence of the environment on the individual, and through the work and effort put forth by the individual in

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[54] Hyatt, "Phylogeny," p.391.

response to this (environmental) influence.

These changed characters, which could be developed at any time during the life cycle of the individual, could then be passed on to the following generation through the specific law of inheritance that like tends to produce like. As he had fully accepted the idea of the continued metamorphosis of the individual from conception to old age, he added a corollory to the usual belief that hereditary characteristics have to be evident before the reproductive period by noting that similar characteristics which appear with old age can also be inherited.

Hyatt's emphasis on environmental factors led to a concommittant acceptance of the importance of geological eras, reflecting a further parallel with Agassiz' thought. The young, immature and adolescent stages of the development of a genus occurred when the geological environment was relatively empty. There was ample opportunity for migration to occur with subsequent adolescent change from the original generalized form due to the new environment. Maturity was described as that time when the greatest complexity of morphic form had been reached, but also the environment for a group had become crowded with a complexity of life forms, thus lessening the opportunity for change. This corresponded with a period of geologic and organic stability. This could, however, be followed by a decline and simplification both in the life form of the individual and the numbers of the group.

Hyatt cautioned against any kind of psychic influence that could be associated with the powers of Agassiz' Supreme Intelligence. He placed far more emphasis on the impersonal or mechanical influence of the environment than did Cope, and less on any kind of intelligent force directing variations. Indeed, he suggested that the use of the term 'effort' in describing the response of the animal to the environment "has mental connections with conscious endeavour",[55] and that the attempt must be made to eliminate old habits of associating this effort with psychic phenomena, rather than purely mechanical reactions.

Nevertheless, the influence of Agassiz remains evident. Hyatt's concept of acceleration and retardation was in general agreement with Cope's, and appears to have been developed from the same basis, i.e., Agassiz' observations of the arrested development in some species and the serial ordering of genera by the addition and subtraction of characters, step by step. Not only was it Hyatt's goal to extend and complete Agassiz' work, but he accepted Agassiz' concepts as the basis for a theory of evolution and defended the claim of Agassiz to Haeckel's law of biogenesis.

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[55] Hyatt, "Bioplastology," p.84.

While these three figures, LeConte, Cope and Hyatt all developed their theories of evolution based on Agassiz' work in embryology and paleontology, there were some interesting differences in the results. LeConte retained the concept of God's creation, now accomplished by his evolutionary laws based of Agassiz' embryology and paleontology, but argued that man directed evolution to suit his own progressive needs once his organic evolution was completed. Cope, equally basing his theory of acceleration and retardation on Agassiz, ended up seeking a natural (evolutionary) explanation not only for the source of the Supreme Intellect's power of Intelligence, but for all metaphysical phenomena of will and morals, for it was by these means that intelligent animals could direct their own evolution. Man, however, had no further need to evolve, as he could change the environment to suit his needs.

Where Agassiz had proposed a total but static world picture, LeConte and Cope had proposed total but evolving world pictures. Hyatt, while remaining close to Agassiz in his research goal to complete Agassiz' correlations, moved perhaps the furthest in his impersonal and mechanical theory of evolution.

Yet all three suggested a certain utility for man in their theories. Hyatt suggested that from the study of biology it could be possible to prophecy the future history of a type, raising the question as to whether this could also apply to the future of man. Cope had indicated that the evolution of consciousness and will, functions of the mind, could be determined through a study of biology, while LeConte openly advocated such a base for the science of man.

As Gray had hoped these naturalists had given Darwin's ideas a fair hearing. But while the idea of evolution was acceptable, the American School, in fact, developed its own version of evolutionary theory based on paleontology and Agassiz' concepts, rather than the field observation and concepts of Darwin. The result, however, was a progressive evolution that could be controlled by man through his intelligence and his utilization of environmental factors. Development was no longer the slow, gradual process postulated by Darwin and Spencer, but could be seen occurring in discontinuous, abrupt steps as conditions reached an expression point. The result was a concept of development characterized by clearly defined stages of quite different natures. Gray's suggestion that science be separated from religion had been accepted but so had his idea that evolution could be interpreted theologically as 'God creating through time'. The creation envisioned, however, was Agassiz' ideal world.

Pfeiffer notes that "by the end of the century there were probably more Neo-Lamarckians than Darwinians in American science". He suggests that this was in part due to the accord between Neo-Lamarckism and ideas and attitudes that had long been prevalent among Americans; ideas such as progress, seeing America in the youthful early stages of development to a glorious future with Europe entering the decaying stages of senescence and further, the "glorification of the American environment".[56]

Not only was the American environment seen as able to produce superior forms of life, but the American west also provided superior geological conditions for the "purposes of generalization".[57] Thus Clarence King's modified catastrophism clearly proved Lyell and Darwin wrong in the light of western geology, and incidentally confirmed America as the better environment for science.

Neo-Lamarckism also suited American political and social development. As there was division among the naturalists regarding the validity of Darwinian and Neo-Lamarckian theories of evolution, so also there was a split among the political thinkers regarding the implications of evolution. While the principles of Herbert Spencer and William Sumner were used by the advocates of laissez-faire, others such as Henry George pressed Neo-Lamarckian principles into the service of reform.[58]

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[56] Pfeiffer, <u>United States</u>, p.199.

[57] <u>Ibid</u>., p.200.

[58] <u>Ibid</u>., p.201.

The acceptance of evolution can thus be seen to have spread far beyond the confines of biology. Not only were the Darwinian and Neo-Lamarckian theories used as scientific verification of social and political theories, but they were also seen as providing a firm ground for the development of the social sciences. The impact of Darwin on psychology has long been recognized. Less well known, however, is the fact that a significant sector of the newly emerging American psychology turned to the Neo-Lamarckian evolutionary theory in its attempt to secure a sound scientific base. Indeed, members of the American school had earlier seen the significance of their theories for a science of man.

CHAPTER V

BIOLOGY AND PSYCHOLOGY: G. STANLEY HALL

Psychology has been characterized as having "a long past, but only a short history."[1] This refers, of course, to the age long philosophical concern about mind, as contrasted with the brief history of 'scientific' psychology. Historians of psychology generally agree that the philosophical tradition contributed to the development of psychology, but the eighteenth and nineteenth centuries were more impressed by the success of Newtonian physics. Regarding this success as an indication of the power of man's reason, the Enlightenment Philosophes argued that the rational approach applied to the study of man should yield equal success. This attempt to find the universal laws governing man's behaviour remained within the realm of mentalistic philosophy, however, as it was not until the nineteenth century that a science of man was initiated using the hypothetical deductive method of physics along with its tools of experiment and mathematics.

While physics provided the model, it was physiology,

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[1] Edwin G. Boring, A History of Experimental Psychology (2nd ed., (New York: Appleton-Crofts-Century, Inc., 1957) quoting Ebbinghaus, p.ix.

the experimental branch of medical science that yielded the first psychological facts.[2] These facts were due to the efforts of the phenomonologists, who were concerned with such problems as nerve conduction, sensation, and localization of function in the brain.[3] Thus 'scientific psychology' had its origins in Germany, the leading centre of physiology in the early nineteenth century. The formal beginning of experimental psychology is generally attributed to the efforts of the German physicist, Gustav Theodor Fechner. He "performed with scientific rigor those first experiments which laid the foundation for the new psychology and still lie at the base of its methodology."[4] Thus physics provided both the model and the method for the new psychology, while physiology was seen as the source of fact.

A third influence in the attempt to formulate a scientific psychology arose from natural history, the study of the development and the relationship of life. Established as the science of biology early in the nineteenth century, the outstanding success of its endeavours culminated by mid-century with Darwin's theory of evolution. The idea of evolution was particularly well received in the

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[2] Boring, Experimental Psychology, p.21.

[3] Ibid., p.134.

[4] Ibid., p.275.

United States, although as has been shown, not necessarily Darwin's specific theory. Nevertheless, the usefulness of evolutionary biology to a science of man was quickly seen by both the American naturalists and the pioneer American psychologists.

American psychology was founded in the latter two decades of the nineteenth century. It was during this period that the controversy between Darwinian and Neo-Lamarckian theories was at its height, with the American school in the ascendency. During the 1880's there were three pioneering figures in American psychology, George Trumball Ladd, William James and G. Stanley Hall.[5] Of these three founding fathers, James and Hall were both influenced by theories of biological evolution. Ladd's important contribution was the compilation of physiological psychology text books.[6]

James not only accepted Darwinism, but clearly rejected any Lamarckian principles. He argued that "spontaneous variation" had produced "the original elements of consciousness, sensation, space, resemblance, difference and other relations."[7] Natural selection had decreed the survival of those variations that proved useful and corres-

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[5] Boring, Experimental Psychology, p.524.

[6] *Ibid.*, pp.629-30.

[7] *Ibid.*, pp.631-640.

ponded with reality. His influence and that of Darwin on American functional psychology is well known. While Boring refers to James as the foremost American psychologist, his main interest was philosophy. Completing his classic, The Principles of Psychology, in 1890, he had become a full time philosopher by 1904.[8] Both the Neo-Lamarckian theory and Hall's adoption of it, while less well known, is significant in view of Hall's active role as a founder of American psychology.

In contrast to the continuing philosophical interest of James, it was Hall's ambition to found a science of psychology. Obtaining the first American Ph.D. in psychology from James, he subsequently studied physiological psychology in Germany.[9] Originally hired for the philosophy department at Johns Hopkins, Hall was subsequently appointed professor of psychology and pedagogy when the Hopkins established the first department in the United States devoted solely to psychology. When Hall moved to Clark University in 1888, he took psychology with him, including laboratory equipment and assistants. Psychology was not re-established at the Hopkins until 1903.[10]

[8] George A. Miller and Robert Buckhout, Psychology: The Science of Mental Life (New York: Harper and Row, Publishers, Inc., 1973), p.89.

[9] Dorothy Ross, G. Stanley Hall: The Psychologist as Prophet (Chicago: the University of Chicago Press, 1972), pp.63-86.

[10] Ibid., pp.179-180.

Hall was a true pioneer, as his restless approach constantly led him to explore new interests, while establishing a journal, professorship or some institutional support to perpetuate the old.[11] He founded the American Journal of Psychology in 1887. Convinced of the necessity for a scientific approach, he reserved this first American journal devoted to psychology for "psychological work of a scientific as distinct from a speculative character." Specifying as acceptable such categories as experimental investigation, inductive studies and psychogenesis in children, Hall concluded that "controversy so far as possible will be excluded."[12] This definition of psychology created considerable dissent, as it effectively barred a variety of approaches to psychology, including that of James. Further recognizing the need for institutional supports for the fledgling science, Hall founded the American Association of Psychology, the Pedagogical Seminary (now the Journal of Genetic Psychology), the Journal of Religious Psychology and the Journal of Applied Psychology. He was also a founder of educational psychology, child psychology and, of course, his main interest, genetic psychology.[13]

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[11] Boring, Experimental Psychology, p.517.

[12] G. Stanley Hall, "Editorial Note," American Journal of Psychology I, No.1 (1887), pp.3-4, quoted in Ross, Hall, p.171.

[13] Ross, Hall, p.182; Boring, Experimental Psychology, pp.521,568; G. Stanley Hall, Adolescence, 2 vols. (New York: D. Appleton and Company, 1904), p.v.

Boring noted that "at one time it seemed as if the majority of American psychologists had been associated with Hall either at Hopkins or Clark."[14] These included John Dewey, James McKeen Cattell, E. C. Sanford and Joseph Jastrow, among others.[15] In these early years his influence was such that he was regarded as "the embodiment of psychology's rising scientific star."[16]

In light of his widespread pioneering activity, it is indeed significant that Hall adopted Neo-Lamarckism as the basis for his psychology. Given the emphasis on development present in Neo-Lamarckism, it is not surprising that his greatest influence was in the field of child development and educational psychology.[17]

This acceptance of Neo-Lamarckism could well be related to other factors long present in American society. Among these were the continuance of the Enlightenment belief in man's ability to use his intelligence to create the Heavenly City on earth and the ideal man to inhabit it. This

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[14] Boring, Experimental Psychology, p.524.

[15] Ross, Hall, pp.154,167.

[16] Ibid., p.147.

[17] Boring, Experimental Psychology, p.523; Gardener, Murphy and Joseph Kovack, Historical Introduction to Modern Psychology (New York: Harcourt Brace Jovanovich, Inc., 1972), p.406.

required the ability to control and direct progress. Neo-Lamarckism provided both the means and the scientific verification that progress was possible. With varying emphasis, the American naturalists and Hall felt that understanding the stages of development of the human individual accompanied by the provision of appropriate environment and/or education would ensure the progress of man.

The Neo-Lamarckian emphasis on periods of rapid change also suited the "inherent spirit of America" which Huizinga characterized as "This, Here, and Soon."[18] Living through the upheavals of industrialization, it is understandable that such an eminent geologist as LeConte could argue that evolution was "...now going on under our eyes, and by the agency of man, resulting in a change of flora and fauna as sweeping, and far more rapid, than any which has ever taken place in the history of the earth."[19] Further, "The Contemporary Evolution of Man"[20] was also postulated by Hyatt and Henry Fairfield Osborne, a leading American biologist.

Believing that man now controlled evolution, great emphasis was placed on man's responsibility to ensure the

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[18] Johan Huizinga, America: a Dutch Historian's Vision: From Afar and Near, trans. by Herbert H. Rowen (New York: Harper and Row, 1972), p.271.

[19] Joseph LeConte, Elements of Geology (New York: D. Appleton and Company, 1891), p.604.

[20] Henry Fairfield Osborne, "The Contemporary Evolution of Man," The American Naturalist XXVI (June, 1892), p.455.

direction of that evolution. As Hyatt pointed out, that responsibility was indeed great, as "the tendency of evolution is quite as often towards retrogression and extinction as in the direction of progression."[21] But through understanding of the stages of man's development and the emphasis of environmental influence, Neo-Lamarckism was seen to provide the means to ensure and direct progress.

It is interesting to note that while the Naturalists had started writing earlier, their publications extended into that period Hofstadter characterized as the "Age of Reform".[22] Indeed, Hall's Adolescence was published during the Progressive era.

The American Naturalists and Genetic Psychology

While Hyatt, Cope and LeConte had all contributed to the alternate Neo-Lamarckian theories that were developed by the American School, it was Cope and LeConte who particularly saw a further meaning to these theories in their application to man. Indeed, Cope felt that "it is only want of familiarity with the subject which can induce a biologist to exclude the science of man from the field."[23] Most import-

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[21] Alpheus Hyatt, "The Influence of Woman in the Evolution of the Human Race," Natural Science XI (August, 1897), p.89.

[22] Richard Hofstadter, The Age of Reform (New York: Vintage Books, A Division of Random House, 1955), p.3.

[23] Edward Drinker Cope, The Origin of the Fittest, Essays on Evolution (New York: MacMillan and Company, 1887), p.424.

ant, they argued for a progressive evolution of psychic as well as physical life and development towards the higher mental and moral characteristics displayed by man. While there was still an element of design it was not necessarily ordained by God, but an ever evolving picture which could be influenced by man acting from his knowledge of the developmental laws of nature and the Lamarckian factors of environment and use-and-disuse.

Cope

Cope saw the origin of consciousness as the unique combination of elements that constitute protoplasm. Unable to separate consciousness from matter, he deemed the two co-eternal.[24] While he acknowledged the argument that consciousness is the product of evolution, he argued the converse, that evolution is the product of consciousness. The first evidence of consciousness is then the sensation felt by protozoa in response to their surroundings, with pleasure developing from the satisfaction of hunger, and pain from awareness of the need to escape from satisfying the hunger of their enemies. From this simple origin the higher attributes of emotion, reason and morals, or will, have developed.

Cope then traces psychological development in both

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[24] Cope, Origin of Fittest, pp.403,441.

paleontology and embryology as follows:

Paleontological	Embryological
Hunger	Hunger
Reproduction	Fear
Fear	Anger
Anger	Beauty
Parental instinct	Wonder
Sex	Power
Power	Admiration
Beauty	Pity
Wonder	Sex
	Parental Instinct[25]

He explains that the order in the first column is from the simple to the complex. This order is disturbed in the embryological development by the appearance of the higher characteristics and their changed order of appearance earlier and earlier in life due to the law of acceleration.

Cope places great importance on the function of memory. It was through memory that protazoa recognized sensation and that actions originating in the conscious have become automatic, contributing to the vast reservoir of the unconscious that he saw so largely influencing conscious actions. In describing the order of psychological characteristics, then, Cope stressed the importance of the faculty of memory, a faculty he believed strongest in early childhood. It is then that the brain tissues are most plastic and receptive to the structural changes resulting from both perception and thinking, "there is a ready [easy] metamorphosis of

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[25] Cope, Origin of Fittest, p.383.

tissue."[26] As the tissues become more rigid with age, resistance to memory strengthens.

While emotions are next in order of appearance, they are not fully developed until after the appearance of many of the intellectual faculties. Cope separates intelligence into two aspects, imagination and reason, thus suggesting the following order of appearance:

Species (Ancestral)	Individual (Embryological)
Indifference	Indifference
Emotions	Emotions
Intellect	Intellect
(a) Imagination	(a) Imagination
(b) Reason	(b) Reason [27]

Indeed, Cope argued that the development of man's morals and intelligence can be traced in the progress from primitive to civilized man. The developing intelligence of the race can also be followed in the history of the intelligence of the child through youth to maturity.[28] Cope also noted the differing development within the race. For example, impressionability is "most developed in the young, and better developed in women than men",[29] as is the affectional and emotional; while man is more rational and tenacious.[30]

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[26] Cope, Origin of Fittest, p.381. This concept was later used by the psychologist, G.Stanley Hall in developing his educational program.

[27] Ibid., p.386.

[28] Ibid., pp.154-155.

[29] Ibid., p.389.

[30] Ibid., pp.387-389.

Cope, however, stressed the need for the use of mental faculties in order to develop, emphasizing that brain and nerves are the most plastic of all the tissues. He further noted the changes "as we descend the scale of humanity, the energy and amount of the rational element grows less and less",[31] as do the higher emotions such as benevolence, while the power of fear increases.[32]

Cope openly discusses the question of design, seeing evidence of it in the adaptation of the organisms to their surroundings. He rejected Darwin's natural selection as an explanation, suggesting instead that it was the result of conscious effort. A true definition of life, then, is "energy under the direction of sensibility, or by a mechanism that has originated under the direction of sensibility."[33] Accordingly, design is the result of the animal consciously seeking pleasure and thus directing the growth force. The higher forms of life are then the result of the super addition of one result of growth force on another. This applies not only to the physical but also to the psychological realm. With the development of the higher order of intelligence, there is no longer only the simple consciousness of animals

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[31] Cope, Origin of Fittest, pp.387-389.

[32] These basic concepts were developed by Hall as he formulated his genetic psychology.

[33] Cope, Origin of Fittest, p.425.

to their needs and to their environment, but for the first time self-consciousness and the higher order of will and morals is possible.

Cope had previously suggested that all evolution takes place as a result of motion or action. He now divided these actions into two classes, the 'appetant', related to the pleasure and to the survival of the individual; and the altruistic, related to the pleasure and to the good of others, as "distinct from, and therefore opposed to, that of the subject."[34] Cope now clearly saw the dilemma of civilized man caught between the ancient primitive drive for the survival of the individual and the more recent psychological desire for moral and intellectual improvement of the race. But this results in the dilemna of man who has "come into possession of an intellect which is the product of ages of development, finds before him a new field of his own making, where his inherited powers fail."[35] It is now that man, through the use of memory, imagination and intellect is confronted with choice in "the field where the most momentous decisions possible in human life are made",[36] questions of ethics, right and wrong, and the 'good', defined as "the

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[34] Cope, Origin of Fittest, p.440.

[35] Ibid., p.451.

[36] Ibid., pp.452-453.

greatest happiness of the greatest number."[37] Cope argued against the inheritance of altruism, however, as it "cannot and should not overcome the inherent instinct for self preservation in man",[38] although he did believe in the inheritance of moral character. He placed his faith, rather, in intelligence, as it was through intelligence that moral truth was perceived as well as the consequences of acts and their relations to the "pleasures and pains of men."[39] It is in intelligence that hope for future progress lies, although this is by no means certain.

There is, however, a further problem. Cope had concluded that a dual nature existed in the human mind, the intellect, and social affections which are the products, in the mind, of the function of reproduction. He saw that these social instincts must survive and become more refined and specialized. But he further noted that "man, standing at the head of the series by his developed brain, possesses also the most specialized reproductive system."[40] Now referring to reproduction in its physiological sense, Cope pointed out that "functionally the two systems [physiologi-

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[37] Cope, Origin of Fittest, p.454.

[38] Ibid., p.454.

[39] Ibid., p.455.

[40] Ibid., p.448.

cal and intellectual] oppose each other, and that the exercise of one is at the expense of the other is a physiological law."[41] Not only did the "health of the individual, and the persistence of the species, depend on the maintenance of an equilibrium between them,"[42] but this concept also became a matter of concern regarding the progress of the race.

LeConte

LeConte believed that the spirit of man had developed out of the anima or consciousness,[43] a concept related to the "immaterial principle" that Agassiz had postulated as "the source of all the varied exhibitions of instinct and intelligence we see displayed" in animals.[44] Unlike Agassiz, however, LeConte saw man wholly identified with nature, as the increasing knowledge due to comparative anatonomy had conclusively shown man's relation to animals. But LeConte continued, pointing out that anatomy and physiology became

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[41] Cope, Origin of Fittest, p.449.

[42] Ibid., p.449. This is a problem that proved to be of serious concern to Hall. He had a great fear that interest in the new sexual feelings experienced by adolescents could be detrimental to the higher values of intelligence, idealism and altruism by which the race would progress.

[43] Joseph LeConte, Evolution: Its Nature, Its Evidences, and its Relation to Religious Thought (New York: D. Appleton and Company, 1899), p.313.

[44] Louis Agassiz and A. A. Gould, Principles of Zoology touching on the structure, development, distribution and natural arrangement of animals, living and extinct, new revised ed. (New York: Sheldon and Company, 1880), p.33.

truly scientific only through the comparative method. Similarily,

> Will not psychology become truly scientific only through comparative psychology, i.e., by the study of the spirit of man in relation to what corresponds to it in lower animals?[45]

LeConte had examined the taxonomic, embryonic and "evolution series from protazoan to man"[46] and had been unable to determine that point at which the immortal spirit of man came into being. He concluded that it must have developed "out of the lower forms of the life force, and this in turn out of the chemical and physical forces of nature."[47] He saw this occurring through a series of transitions to different planes, through the plane of elements to chemical compounds through vegetable and animal life, finally reaching the rational and moral plane. But in this series material for psychology became available only when, in the germ cell, "distinctive animal psychic life appears".[48] The comparative method utilized by psychology should then embrace the taxonomic, embryological and evolutionary series.

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[45] LeConte, Evolution, pp.305-306.

[46] Ibid., p.313.

[47] Ibid.

[48] Ibid., p.317.

With the appearance of man, the final goal of these "upward metamorphoses of energy", a new type of evolution begins. Impelled by a force from below, the organic evolution to man's physical form is now complete, and human progress will be achieved by "the attractive force of ideals. In a word, organic evolution is by the law of force, human evolution is by the law of love." Feeble when it first appeared in primitive man, this higher spiritual and rational factor of evolution has now assumed control of "the methods and factors of nature", resulting in man's "conscious, voluntary cooperation in the work of his own evolution - a conscious voluntary striving to attain an ideal."[49] LeConte suggested that Jesus Christ is the embodiment of that ideal. He argued that Christ was human. As man is the ideal in terms of being the goal and completion of animal life, so Christ, the ideal man, "may be only the goal and completion of human evolution."[50] He seems superhuman only because He represents the new plane of existence towards which man is striving. It was necessary that He appear when He did, prior to the evolution of a perfect form of man, since evolution was voluntary and drawn upward by the attractive force of such an ideal. LeConte did not see Christ as representing

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[49] LeConte, Evolution, p.86.

[50] Ibid., p.361.

that which was unattainably divine, but argued rather for the pragmatic realization of this ideal on earth.[51]

LeConte foresaw danger to the human race in this new voluntary and idealistic mode of evolution. The weak and unfit both are and ought to be sustained to strengthen the desired spiritual values of human evolution, but there existed the risk of weakening the blood of the race by inheritance and the spirit of the race by removal of the necessity of self help. He believed that this problem could be solved by "a rational education, physical, mental and moral."[52] Although LeConte did not elaborate on the question of education, finding it too wide a field to follow up, he did suggest how the factors Nature had used for organic evolution could be used by man, "in a new way to carry forward human evolution or progress."[53]

> Thus, for example, one organic factor - the environment - is modified or even totally changed so as to effect suitably the human organism. This is hygiene. Again, use and disuse - another factor - is similarly transformed. The various organs of the body and faculties of the mind are deliberately used in such wise and degree (determined by reason) as to produce the highest efficiency of each part and the greatest strength and beauty of the whole.

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[51] LeConte, <u>Evolution</u>, pp.360-364. By a strange coincidence, Hall also argued that Christ represented the culmination of the evolutionary series, the ideal example which youth, that transitional stage of man, needed in order to realize the advancing human ideal and the higher destiny of man. See Hall, <u>Adolescence</u>, 2, pp.327-329.

[52] <u>Ibid</u>., p.89.

[53] <u>Ibid</u>., p.91.

> This is education - physical, mental and moral. So also the selective factors become transformed, and natural selection becomes rational selection... applied to domestic animal...Why? Should it not be applied also to the improvement of our race in the selection of our mates in marriage, or in the selection of our teachers, our lawmakers, our rulers?[54]

While Cope and LeConte developed their ideas regarding a science of man somewhat differently, there was a wide general agreement. Both saw consciousness evolving from early protazoa. Both argued that with man a new plane of evolution had been reached, that organic evolution had ceased and man through the use of reason, controls and transforms the factors of nature for his own purposes. Both suggested that future development would occur at the psychic level of intellectual and spiritual progress. But most significant, both were clearly convinced that evolutionary biology would form a sound scientific base for the psychological study of man.

Hyatt, however, clearly pointed out the perils that lay in store for man if he did not take his responsibility for this new evolution seriously. He stressed that man's actions in every day affairs could influence "the future evolution of civilized races." He called attention to the fact

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[54] LeConte, Evolution, pp.91-92.

that "the tendency of evolution is quite as often towards retrogression and extinction as in the direction of progression," Hyatt's immediate concern was the woman's suffrage movement. He expressed this concern in his article "The Influence of Woman in the Evolution of the Race."[55]

For Hyatt, evolutionary progress was characterized by increasing differentiation and specialization. The increasing divergence of male and female sexes from a unisexual origin "is a marked characteristic of progression among highly civilized races." But "co-education, of the sexes, occupations of certain kinds and woman's suffrage" encouraged convergence with the lives of men "in these same highly civilized races."[56] Increasing likeness, to Hyatt, was a sign of regression. The message for psychology was clear. Male and female should be educated separately and raised with their divergent qualities of masculinity and femininity stressed, for the sake of progress.

While specifically arguing against co-education and woman's suffrage, Hyatt was also emphasizing that man must be constantly aware that his thoughtless actions of the day

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[55] Alpheus Hyatt, "The Influence of Woman in the Evolution of the Human Race," Natural Science XI (August, 1897), p.89.

[56] Ibid., p.90.

could have the dire consequence of certain retrogression and extinction. All was not dark, however, for these "same laws hold out hope for the maintenance of progress through an indefinite time" as man "is capable of controlling his own destiny through...[his] wonderful control over nature."[57]

The scientific base thus provided contained many of the beliefs long present in American thought. Prominent among these was the conviction that through the use of reason it should be possible to discover and to use the laws of nature for the progress of man. Although no longer believing in a static world picture designed by God, the idea of design was still present in the evolving world picture culminating in man. Design of the future ideal world, of future ideal man, would now be determined by man himself. Much of this idea of design can be attributed to the continued influence of Louis Agassiz, to his conception of a series of miraculous world creations teleologically directed towards the appearance of man, at which point future progress would be in terms of moral and intellectual improvement. It was the functional, utilitarian biology developed by his students, however, that provided the means whereby Agassiz' ideal type could be realized on this earth.

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[57]Hyatt, Natural Science, p.93.

A Genetic American Psychology

As Edwin Boring has noted, the pattern consciously followed by the founders of American psychology was the physiological psychology of Germany, or so they believed.[58] But he further noted that Darwin's theory of evolution had made a big impact on them, and argued that these two imported theories were shortly transformed into a uniquely American discipline, "functional and practical and pragmatic [which] used evolutionary principles to make itself work."[59] John Dewey summed it up:

> Knowledge of the process and conditions of physical and social change through experimental science and genetic history has one result with a double name: increase of control, and increase of responsibility; increase of power to direct natural change, and increase in responsibility for its equitable direction toward a fuller good.[60]

Indeed, control and progress were two of the main benefits that were expected from a genetic psychology.

As had been realized by a significant number of American naturalists, however, Darwin's theory, involving such concepts as random chance variation, natural selection

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[58] Edwin G. Boring, "The Influence of Evolutionary Thought upon American Psychological Thought," Evolutionary Thought in America, edited by Stow Persons (New York: George Braziller, Inc., 1956, p.268.

[59] Ibid., p.275.

[60] John Dewey, The Influence of Darwin on Philosophy and other Essays (Bloomington: Indiana University Press, 1965), p.73.

and multi-linear non-progressive specialization, did not lend itself either to the control or to the progress of man. But the alternate theories of the American School did. Further, by the latter decades of the 19th century, when American psychology was establishing itself as a separate scientific discipline, Neo-Lamarckism was prevalent in American science.

G. Stanley Hall

Among the founders of American psychology, G. Stanley Hall was the most enamoured with the idea of evolution.[61] As Boring has noted, Hall simply assumed and used evolution rather than explaining or defending it.[62] Hall had an encyclopedic, eclectic approach. He read voraciously, absorbed all and abandoned nothing. In producing his own unique synthesis, however, he did not always credit the source of his ideas. Indeed, it seems doubtful that Hall recognized the difference between the Darwinian and Neo-Lamarckian theories. To his undiscriminating view they were all evolutionary ideas, equally useful to produce his pioneering genetic psychology. The continuing, pervasive problem of the use of Darwinism and evolutionism as synonyms is once

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[61] G. Stanley Hall, Life and Confessions of a Psychologist (New York: D. Appleton and Company, 1923), pp.357-367.

[62] Boring, Evolutionary Thought, p.279.

again evident, for in pursuing his ambition to become the "Darwin of the mind"[63] Hall was clearly using the "new genetic theories"[64] of the American School.

It was Hall's contention that the traditional Platonic and Christian views regarding the origin of the mind were analogous to Agassiz' theory of miraculous creation. Although he expected his idea of psychic evolution to be even more disturbing than Darwin's biological evolution,[65] Hall argued that mind and life are inseparable and co-extensive, having evolved together in response to the environment.[66]

Thus sensation is

> ...also the first and oldest of all psychic processes...not only primordial... but...has, from the first, shaped not only all vital functions but structures into conformity with and adaptation to the external world...the senses are... the creators of automatisms and habits.[67]

Hall went on to argue that much of this remote past is now lost in the subconscious. He continued by saying that many of our actions are automatic, based on our ancestral origin.

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[63] Hall, Life and Confessions, p.260.

[64] Hall, Adolescence, p.1.

[65] Ibid., p.5.

[66] Ibid., p.63.

[67] G. Stanley Hall, "The Genetic View of Berkeley's Religious Motivation," (Clark University, Archives, MSS. G.Stanley Hall Papers, Series IV), pp.8-9.

But because man is plastic and adaptive, the remote past and the present constantly interact and influence each other.[68] Thus present life is "pervaded with reverberations of an immeasurable past."[69] While Hall assumed credit for this "new idea",[70] the basis for it had been laid in Cope's concept of the unconscious. Further, LeConte had previously used the same Platonic and Christian examples as contrast when defending his own theory regarding the evolution of the mind. Hall expressed admiration for LeConte as one of the few who showed the social significance of their work,[71] and he seemed to follow LeConte's suggestion that it was through the use of the comparative method that a truly scientific psychology would be developed.[72]

As with Agassiz and the American School, the model of evolution that Hall used is the egg. He accepted the idea that the process of metamorphic development continued through the time of birth to maturity, including Hyatt's

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[68] Hall, "Genetic View," p.65.

[69] Ibid., p.64.

[70] Ibid., p.40.

[71] Ibid., p.54.

[72] Hall, Adolescence, p.6.

extension of this process through senescence.[73] He used both the physical and psychic evolutionary ideas of the American School, attempting a correlation between the two. By establishing the physical state of development he expected to find a corresponding psychic state.

But while Hall was basing his theory on the embryological and paleontological base of the American School, Darwin was still his hero. Thus he concluded that

> We must turn to the larger and more laborious method of observation, description and induction...[noting] things neglected, trivial and incidental, such as Darwin says are often most vital.[74]

Hall then proceeded to emulate Darwin by scouring the world for data and statistics related to physical growth and mental states in order to determine the relative rates of acceleration and retardation of single characters, and hence to prophesy the future progress of the race, as Hyatt had suggested. Further, by employing the Lamarckian factors of the environment, use, and disuse as established by his edu-

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[73] Charles Everett Strickland, The Child and the Race: The Doctrines of Recapitulation and Culture Epochs in the Rise of the Child-Centered Ideal in American Educational Thought, 1875-1900 (unpublished Ph.D. Dissertation. The University of Wisconsin, 1963), p.214. Strickland notes Hall's use of a continuing 'recapitulation' after birth, and its extension to the psychic processes. Unaware of the American theories, he attributes this idea to assumption on the part of Hall: "If one were prepared to assume that the process of recapitulation continued after birth and if this process gave rise to psychic expressions...", p.214.

[74] Hall, Adolescence, p.viii.

cational policies, Hall expected to be able to direct future evolution, seeing himself in the role of the former of a future race, rather than a reformer.

Without preliminary, Hall's introductory sentence of his major work Adolescence is "The beginning of individual life...for all sexed animals is when the male cell penetrates the ovum."[75] He apparently accepted Hyatt's contention that the first step in the study of a species must be the establishment of the ontogenetic cycle, for he proceeded to give a detailed statistical report of ontogenetic development. He particularly noted the relative rates of growth during the different ages, not only of the whole child but also of the single characters of the various bones, muscles and organs to the extent of initially describing the diameter of the ovum and its percentage increase in size, and including, of course, a comparison with the different races.

The reason for this obsession with measurement was quite possibly related to Cope's statement that "what the scales are to the chemist...the rule and measure are to the biologist."[76] It is by this means that variations can be measured and compared, thus ascertaining if some form is

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[75] Hall, Adolescence, p.l.

[76] Cope, Origin of Fittest, p.296.

acquiring something which the parents did not possess, consequently advancing up the evolutionary ladder, or conversely, suffering some loss and subsequent regression - (Cope's and Hyatt's theory of acceleration and retardation).

Hall explains this "law of tachygenesis"[77] to describe how man has developed through the metazoan, "ameboid, heminthoid, piscan, amphibian, anthropoid and ethnoid stages", with the embryo passing through a "thousand years in a day",[78] due to the accelerated rate at which the higher species pass through the lower stages. But Hall's main interest in the law of acceleration and retardation was in terms of his belief that "man is not a permanent type but an organism in a very active stage of evolution."[79] While man's physical evolution is comparatively complete, the final perfected form has not yet been reached. As Hall saw this occurring through increase in size, beauty and proportion, increase in height indicated a progressive evolution, while shortness

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[77] Hall, Adolescence, p.3. Hall also uses Cope and Hyatt's term 'bathmism' to describe growth-force, as well as their term 'tachygenesis'.

[78] Ibid., p.3.

[79] Ibid., p.vii. This idea of the current evolution of man was specifically detailed by one of the leading biologists of the day, Henry Fairfield Osborne. His article, "The Contemporary Evolution of Man," was published in The American Naturalist, XXVI (June 1892), pp.455-481. Published prior to Hall's Adolescence, Osborne is also comparing physical measurements for evidence of present evolutionary trends.

indicated regression.

But Hall was convinced that it is the soul that is in a transition state of "more and more rapid progress."[80] He argued that an inventory was needed of the present states of man's accelerated and retarded areas of growth, since through a proper physical, intellectual and moral education, that is, through directed use and disuse, the desired physical and moral traits could be developed. In essence, Hall intended to work out the details of the educational program that LeConte suggested. This educational program would be framed in accordance with the psychic state of evolution of the child or adolescent. For as Hyatt's ambition was to extend Agassiz' correlation of phylogeny and ontogeny to encompass the life cycle of the individual and of the group to which it belonged, so Hall's ambition was to extend this latter correlation to the psychic evolution of the individual and the species, "holding that the child and the race are the keys to each other."[81] In fact, however, Hall was referring to the entire life cycle, as was Hyatt.

Hall then devoted the greater part of his study to adolescence, which for him was the most critical period for both the development of the individual and the race. His

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[80] Hall, Adolescence, p.vii.

[81] Ibid., p.viii.

description of the psychic stages of the evolution of the individual paralleling the description of the physical stages of evolution of Cope and Hyatt, moved through childhood, adolescence, maturity and senescence. Hall also followed the other two in relating this process to a modified theory of geologic catastrophism and recapitulation through the adult stages of the lower species.

Accordingly, Hall viewed the young child of 8 - 12 or 14 years of age as having completed the growth and development equivalent to the adult stage of man's primitive, savage forebears. This period of childhood is a time of great stability, as it represents the adjustment to "some long stationary period", when today's boy of 10 or 11 could well survive and function "indefinitely and with stability and security in some not too cold Lemuria, New Atlantis, Eden."[82] It was also possible that this stable period of childhood suggested "the age of senescence in some postsimian stage of ancestry,"[83] in which the prehuman forebears died at or before the pubescent growth increment occurred. A new and higher stage of manhood is now reached because the modern adolescent passed through and beyond this transitional stage of adolescence. Regardless of which alternative explanation

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[82]Hall, Adolescence, p.45.

[83]Ibid.

is chosen, the child has not yet reached the stage of the development of the intellect and reason, but rather, as Cope argued, his response to sensation and his faculty of memory is at its height. Consequently these qualities should be emphasized in the educational program, and the child subjected to a regime of drill and rote memorization. Despite the fact that the child does not understand the material he is blindly memorizing, the opportunity to so easily accumulate a store of facts will never again arise. Such assimilation could only be made at much greater effort later.

Hall rejected Darwin's doctrine of the gradual origin of the species, noting that Cope, DeVries and others had shown that the variations producing new species were sudden and discontinuous.[84] Continuing his explanation of the biological theories of these naturalists, Hall described long periods or epochs of stability (analogous to geologic epochs) broken by transitional periods of great variation, when many individuals of a new kind were produced in a short time so they could perpetuate themselves. While the parent species will settle to its old lines, it is liable to suffer competition or extermination due to its transpeciated des-

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[84] Hall, Adolescence, p.46.

cendents.[85] Hall regarded this period

> ...as something like the adolescence of the species in which they occur, and are analogous to the changes that take place in both the body and the soul of youth at this age of all-sided and saltatory development; when new traits, powers, faculties and dimensions, which have no other nascent period, arise.[86]

Hall argued not only for the sudden discontinuous change postulated by the American naturalists, but also for a modified geological catastrophism. He regarded the later stage in the phylogeny of modern man as marked off from previous stages.

> A little as the successive geologic strata are differentiated. Man is now in a recent epoch...in which a new story has been added to his nature, so that he is now a superman to his ancient forebears. A new being is born out of and superposed on the old, and in a new sense the boy is father to the man, and far older.[87]

But this period of adolescence (12-18 yrs.) is a time of great instability, of old moorings broken, of adjustments to the environment less complete, and consequently of great danger of reversion to the more stable period of savagery.

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[85] Hall, Adolescence, pp.46-47. For similar argument, see Cope, Origin, pp.78-79; LeConte, Evolution, pp.267-271; Hyatt, Phylogeny, pp.367-371.

[86] Ibid., p.47.

[87] Ibid., p.47.

> The young pubescent, achieving his growth in the realm of the fundamental qualities, dimensions and functions, comes up to adult size at eighteen relatively limp and inept, like an insect that has just accomplished its last molt, and is therefore far more in need of protection, physical care, moral and intellectual guidance; and in general as will be considered later in detail, this last great wave of growth throws the child up on to the shore of manhood or womanhood relatively helpless as from a second birth, ...in the individual arrests and accelerations...we detect the ripplemarks on successive old shore lines that represent once final stages of maturity, but which are now successfully transcended.[88]

There is, then, the need for the most "consummate practical wisdom, in providing the most favourable environment and eliminating every possible cause of arrest or reversion", thus ensuring that the promises and potencies of ever higher development both proceed and become stabilized in the race. "This is indeed the practical problem of the book."[89]

Hall referred with approval to Cope's contention that it was this period when "the influence of the environment in producing acquired characters transmitted by heredity is greatest."[90] For those "prophetic souls interested in the future of our race"[91] it is by greater development of the

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[88] Hall, Adolescence, p.48.

[89] Ibid., p.49.

[90] Ibid., p.50.

[91] Ibid.

adolescent that a higher stage will be added to the race, rather than through development in adult life.

Hall used masses of data regarding physical and mental states to verify that this adolescent period was indeed one of great instability and transition, just as this higher stage would be one of moral and intellectual development. Adolescence had been returned to an unspecialized, transitional state, but at a time when the power of the intellect was newly developed and imagination at its height. At that point, a new and higher stage could evolve through the power of the ideal. The provision of such an ideal was the greatest need in education for the adolescent.

While Hall suggested and explored many of the altruistic and higher aspirations of youth, pedagogically he suggested the need for Jesus Christ as representing

> ...the culmination of the entire series of organic forms of existence, the species in one typical individual, as the revealer of a new and higher cosmic consciousness, advancing the human ideal and opening the way to the higher destiny of man.[92]

Hall deplored the separation of science and religion, for

> ...we have as it were made God a hypocrite, saying one thing in his works and another in his words...the chief need of piety today

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[92] Hall, Adolescence, p.328.

> is the acceptance and utilization of the best results of scientific method and work.[93]

For Hall, of course, this referred to evolution. Thus it becomes clear that Hall saw Jesus as being the first to complete the metamorphic transformation to the higher, perfected ideal form that man could "factualize...on this earth."[94]

Thus to both LeConte and to Hall, Jesus was the embodiment of those ideals which would by the power of love, pull man upward in the new evolution that began with the appearance of man, a conscious, voluntary cooperation. This particular ideal was, however, attainable only by the male of the white race. The education of the female and of the lower races should be directed to the realization of their differing and less rational potential, or great harm is

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[93] Hall, "Archives," see also John Herman Randall, Jr. "The Changing Impact of Darwin on Philosophy," Journal of the History of Ideas, 22 (1961). He argues that "the men of the nineteenth century were desperately looking for a new religious faith...an up-to-date 'scientific' God" existing in or behind the scientific universe. Evolution was seen as at least helpful, or even as the answers to "the religious problem of harmonizing faith with reason and science." He suggests that it was this religious problem that was profoundly disruptive, rather than the "social Darwinism of Richard Hofstadter", and further, that this problem had originated with Newton's impersonal, mechanical universe, pp.439-441.

[94] G. Stanley Hall, Jesus the Christ, in the Light of Psychology (New York: D. Appleton and Company, 1923), p.xxi and 35-38; Adolescence, 2, pp.327-328.

is possible.[95]

Indeed, Hall saw the entire process fraught with danger. With Cope, he recognized the high degree of specialization of the functions of intellect and reproduction. He not only realized that these two powers opposed one another, but that adolescence is a time of rapid sexual development and the birth of powerful sexual drives. Exercise of this physiological drive, however, could lead to a regression to the savage state as it would be at the expense of the higher intellectual power wherein lay the hope of the race. Further, with Hyatt he saw that the most recently evolved characters raising the organism to a higher plane of existence were also those first to be lost, leading to devolution and the senescence of the race. This had to be constantly guarded against.

Hall, however, remained optimistic to the end. Writing Senescence in his retirement, he was convinced that the evidence exists that man was adding a new metamorphic stage to his life. Savage man had a short life. Hall interpreted the increasing life span of contemporary man as proof of this latest stage of evolution.[96] He still regarded ado-

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[95] Hall is clearly influenced by Hyatt in this view. Devoting a chapter to the special educational needs of females, he refers extensively to Hyatt's article.

[96] G. Stanley Hall, Senescence: the Last Half of Life (New York: D. Appleton and Company, 1922), pp.410-411.

lescence as the golden period of imagination and creativity, while maturity exhibited the qualities of reasoned vitality that accomplished the work of the world.[97] At age 40, he saw a new metamorphic birth to the higher plane of senescence, when, freed from the dominance of sense and the environment, and with the sublimation of sex, this final stage concentrated on pure intellect and the ideal,[98] resulting in vision and wisdom. This represents the superman that Hall believed was in the making.[99]

In formulating his genetic psychology based on the Neo-Lamarckian theory of evolution, Hall grappled with the same basic problems that Asa Gray and others had perceived, the question of design, teleology and the relation of religion to evolution. Design, while an integral part of Hall's psychology, was not God's design, but under the control and the responsibility of man. Like Agassiz, Hall had seen a teleological development, describing man as "the tips of the twigs of a vast buried tree." Hall saw this as the result of organic evolution, arguing "there is no external God but only human and physical nature." Having reached

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[97] Hall, Senescence, p.3.

[98] Ibid., pp.405-407. It is interesting to note that Hall, with Hyatt, sees an increasing physical resemblance of the old to the very young.

[99] Ibid., pp.265, 410-411.

the new stage of conscious, voluntary and progressive evolution, the role of religion was to keep the ideal perfected type before man as the goal for which to strive. But having completely accepted the idea of continuing evolution, Hall argued further that "these twigs [present man] may become the roots of a yet greater one and even a true superman may yet be born in the line of any of us."[100]

Thus Hall completed his study of the ontogenetic cycle, from birth to senescence. The basic structural framework had been the genetic theories originating with Louis Agassiz and developed by the American School, whose members included LeConte, Cope and Hyatt. Several concepts developed from these theories, two of which are of particular interest. The importance of the unconscious past on present mind processes is well known. Also significant was the concept of discontinuous development. In contrast to Darwin's slow, imperceptible change, this view of development is characterized by periods of rapid change and great plasticity alternating with periods of stability. As Hall argued, the change from a creationist, static view of mind to the discontinuous development of the Neo-Lamarckians was of particular importance to genetic psychology. It was in the structuring of this unique type of neo-Lamarckian base in biology that the American naturalists played their important role.

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[100] Hall, Senescence, p.486.

EPILOGUE

While there was widespread acceptance of the idea of evolution following the introduction of Darwin's theory to the United States, there were also serious objections to the mechanism he proposed, both on scientific and philosophical grounds. The alternate theory developed by the American School has been largely neglected,[1] yet it was a major influence on G. Stanley Hall as he formulated his genetic psychology. As this Neo-Lamarckian evolutionary theory was prevalent during the latter portion of the 19th century and extended into the early years of the 20th century, the question remains of its further influence, not only on psychology but on American intellectual thought.

James Baldwin and John Dewey also developed a form of genetic psychology, although they differed from Hall. There are indications that both Baldwin's and Dewey's theories differed considerably from Darwin's, that they also may have been influenced by the theories of the American School.

Further, Edward Pfeiffer has suggested that Joseph LeConte may have been the mentor of Henry George,[2] and

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[1] Michele L. Aldrich, "United States: Bibliographic Essay," The Comparative Reception of Darwinism, edited by Thomas F. Glick. (Austin and London: The University of Texas Press, 1972), p.212.

[2] Pfeiffer, United States, p.201.

points to the "Neo-Lamarckian rhetoric"[3] of Frederick Jackson Turner. Similarily, George W. Stocking, Jr. has pointed out that "the precise dilineation of the historical interrelationship of biological and social theory is a somewhat neglected problem in the history of scientific ideas"[4] as he indicates briefly the influence of Lamarckianism in American social science. It seems quite possible that the conservative Darwinists and reform Darwinists described by Richard Hofstadter in his classic Social Darwinism in American Thought represent the opposing Darwinian and Neo-Lamarckian theories. This suspicion is increased as Hofstadter points to Lester Ward, the reformer, and the separation he made of physical animal evolution and human mental evolution, a distinction so characteristic of the American School. Further, Ward was a paleontologist at a time when most of the paleontologists were Neo-Lamarckians.[5]

While the relation of Neo-Lamarckism to American psychology and to other areas of American thought seems open for further fruitful investigation, a word of caution is

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[3] Pfeiffer, United States, p.202.

[4] George W. Stocking, Jr., "Lamarckianism in American Social Science: 1890-1915," Journal of the History of Ideas, XXIII (1962), p.239.

[5] Dana, et al., Century, p.113.

needed. Agassiz was no longer considered influential when his theory of miraculous creation was discredited. As has been shown, however, other aspects of his theories continued long after to influence American thought. Similarily, the unfortunate title of Neo-Lamarckism could lead to the hasty dismissal of the theories of the American School, since the theory of inheritance of acquired characteristics was discredited. As with Agassiz, it may be other aspects of their complex theories that continued to influence various aspects of American thought.

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