FORERUNNERS OF DARWIN: 1745–1859

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TWELVE

THE IDEA OF DESCENT IN POST-ROMANTIC GERMAN BIOLOGY: 1848–1858

OWSEI TEMKIN

I

So great was the effect of Darwin's book on German scientists, philosophers, and educated laymen, that, in retrospect, the very doctrine of evolution seemed to have come as something new. Towards the end of his life, the philosopher Eduard von Hartmann (1842-1906) wrote:

> The time from 1830 to 1860 was a period of pure observation in biology. The students of the '50s had no idea that French scientists and German philosophers had envisaged such a thing as the evolution of nature, because at that time, a professor would have thought it unscientific even to mention such fantasies.
>
> Darwin's work "On the Origin of Species" (1858 English, 1859 German) struck this dull narrow-mindedness like lightning from a blue sky and brought about a veritable mental revolution.[1]

This picture is certainly wrong. The mere fact that Chambers' *Vestiges of Creation*, as Lovejoy has shown,[2] influenced a man like Schopenhauer and was translated into German in 1851,[3] is sufficient evidence that even in Germany the silence cannot have been com-

[1] Eduard von Hartmann, *Das Problem des Lebens*; Biologische Studien. Bad Sachsa im Harz: Haacke, 1906, p. 1 f. The importance of this reference evinces from its being cited in *Ueberwegs Grundriss der Geschichte der Philosophie*, vierter Teil, p. 315 f. (12th ed. Berlin, 1923).

[2] A. O. Lovejoy, "Schopenhauer as an Evolutionist," *The Monist*, 1911, *21*: 195-222. See this volume, p. 415.

[3] See below.

plete. Darwin himself, in a later edition of the *Origin*, could cite a considerable number of those who had believed in descent before him. As early as 1862, A. Braun stated that the theory of descent did not reach an unprepared science.[4] By 1875 controversies were under way as to whether de Maillet, Robinet, and Buffon could be called "forerunners" of Darwin,[5] and Potonié, in 1890, cited about a dozen names of German evolutionists during the period with which we are concerned here.[6] Because many of the publications are hard to obtain even in Europe, I have not been able to analyze all of the works. On the other hand, I have taken the word German in the broad linguistic sense of German writing authors, thereby including the Austrian, Unger, and the Swiss, Nägeli. Though incomplete as far as coverage is concerned the following analysis may yet throw some light on the question: What was the relationship of German biologists towards the doctrine of evolution in the post-romantic decade before the appearance of the *Origin*?

The pertinency of this question is evident if we remember the role Darwinism was to play in German biology. It offered a solution to two problems: that of the origin of species and that of the cor-

[4] H. Potonié, "Aufzählung von Gelehrten, die in der Zeit von Lamarck bis Darwin sich im Sinne der Descendenz-Theorie geäussert haben," *Naturwissenschaftliche Wochenschrift*, November 9, 1890, *5*: 441-445; see p. 442. Braun's own attitude to transformism seems ambiguous; cf. Potonié, ibid., p. 444, and Walter Zimmermann, *Evolution*. Freiburg-München: Alber, 1953 (*Orbis Academicus* II/3), p. 380 ff.

[5] Georg Seidlitz, *Die Darwin'sche Theorie*. Zweite vermehrte Auflage, Leipzig: Engelmann, 1875, p. 31 ff.

[6] Potonié, op. cit. (ftn. 4). Of the subsequent books and articles listing German forerunners of Darwin I mention here E. Rádl, *Geschichte der biologischen Theorien*. II. Teil, Leipzig: Engelmann, 1909, *passim*; J. H. F. Kohlbrugge, "J. B. de Lamarck und der Einfluss seiner Descendenztheorie von 1809-1859," *Zeitschrift für Morphologie und Anthropologie*, 1914, *18*: 191-206; J. H. F. Kohlbrugge, "War Darwin ein originelles Genie?" *Biologisches Zentralblatt*, 1915, *35*: 93-111; J. F. Pompeckj, "J. C. M. Reinecke, ein deutscher Vorkämpfer der Deszendenzlehre aus dem Anfange des neunzehnten Jahrhunderts," *Palaeontologische Zeitschrift*, 1927, *8*: 39-42; Otto H. Schindewolf, "Einhundert Jahre Paläontologie (Paläozoologie). Ein Rückblick auf ihre Entwicklung in Deutschland." *Zeitschrift der Deutschen geologischen Gesellschaft*, 1948, *100*: 67-93 (Dr. Bentley Glass kindly drew my attention to this article); Schindewolf, "Einige vergessene deutsche Vertreter des Abstammungsgedankens aus dem Anfange des 19. Jahrhunderts, *Palaeontologische Zeitschrift*, 1941, *22*: 139-168. Eduard Uhlmann, "Entwicklungsgedanke und Artbegriff in ihrer geschichtlichen Entstehung und sachlichen Beziehung," *Jenaische Zeitschrift für Naturwissenschaft*, 1923, *59*: 1-116, is particularly important because it contains lengthy quotations from originals, including some not available to me.

relation between structure and function. It was no longer necessary to believe in the creation of species, and it became possible to explain the apparent finality of the organism and its parts by adaptation without recourse to plan or purpose. Both answers bolstered greatly the mechanistic and materialistic tendencies in German biology. Darwinism became the symbol of materialistic thought. Thus it seems worth while asking what role notions of biological descent played in the period before the appearance of the *Origin of Species* when materialistic tendencies were rising.

The materialistic tendencies of German biologists fell into two categories. The first aimed at a mechanistic explanation of life and denied the existence of a vital force. A decisive attack in this direction was made by Schwann in his *Microscopical Researches* of 1839. There followed Lotze's famous article on vital force of 1842. Shortly afterwards, three pupils of the great Johannes Müller (1801-1858) banded together in their fight against vitalism: Helmholtz, Brücke, du Bois-Reymond. They were joined by Carl Ludwig. The program of the school was formulated in 1848 by du Bois-Reymond in the preface to the first volume of his *Untersuchungen über thierische Elektricität.* Physiology was to be reduced to analytical mechanics. Ludwig's textbook of physiology was written in the spirit of this mechanistic philosophy which viewed even the cellular theory with some suspicion.[7]

The materialism of the second category was directed against the belief in the existence of an immaterial human soul or of any realities outside of "matter and force." The leaders of this faction were Carl Vogt, Moleschott, and Louis Büchner.[8] The biological mechanists, as we may characterize the former group, were not necessarily metaphysical materialists in the sense of the latter. Schwann held a Cartesian position and was a devout Catholic.[9] But materialism of a metaphysical shade was spreading among the German biologists of the fifties, and the controversy, which had a strong anti-clerical undertone, came to a head at the thirty-first meeting of the Society of German Scientists and Physicians at

[7] See Owsei Temkin, "Materialism in French and German physiology of the early nineteenth century," *Bull. Hist. Med.*, 1946, *20*: 322-327, and "Metaphors of human biology," in Robert C. Stauffer (ed.), *Science and Civilization.* Madison: University of Wisconsin Press, 1949, p. 173.

[8] On this and the following see Erik Nordenskiöld, *The History of Biology.* New York: Tudor, 1942, pp. 448-452.

[9] Temkin, "Materialism in French and German physiology," op. cit., (ftn. 7) p. 324.

Goettingen, in 1854, when Rudolph Wagner presented "an anthropological address" (as the subtitle called it) on "Human Creation and the Substance of the Soul."[10] The paper defended the belief in the descent of man from one pair (as against a multiple origin) and denied science the right to interfere in matters concerning religion. Although Wagner was not directly discussing animal descent, a passage in his published speech characterizes his attitude:

> As a matter of fact, only animals of one and the same species mix fruitfully. Animals of different, closely related species mix under special, mostly artificial, conditions. But the hybrids are sterile and die out. This fundamental law exists for the protection of the historical existence of species.[11]

The ensuing debate was stormy, with the materialists having the upper hand,[12] and the following years witnessed a literary feud between Carl Vogt (who was an old opponent of Rudolph Wagner) on the one hand,[13] and Rudolph Wagner and Andreas Wagner[14] on the other, in which both sides excelled in tactless invective. In the midst of this controversy appeared the popular book on "Force and Matter" by Louis Büchner, which became one of the basic works of German philosophical materialism and was reprinted again and again in subsequent years.[15]

The biological mechanists had one thing in common with the metaphysical materialists: both were opposed to the *Naturphiloso-*

[10] Rudolph Wagner, *Menschenschöpfung und Seelensubstanz.* Ein anthropologischer Vortrag, gehalten in der ersten öffentlichen Sitzung der 31. Versammlung deutscher Naturforscher und Aerzte in Goettingen am 18. September 1854. Goettingen: Wigand, 1854.

[11] Ibid., p. 13.

[12] For a description of the events see *Ueberweg's Grundriss*, (ftn. 1) p. 287 and Nordenskiöld, loc. cit. (ftn. 8).

[13] Carl Vogt, *Köhlerglaube und Wissenschaft.* Eine Streitschrift gegen Hofrath Rudolph Wagner in Göttingen. I have used the second printing of the fourth edition which appeared in Giessen: Ricker, 1856. In this pamphlet Vogt relates his earlier controversies with Wagner.

[14] Andreas Wagner, *Naturwissenschaft und Bibel* im Gegensatz zu dem Köhlerglauben des Herrn Carl Vogt, als des wiedererstandenen und aus dem Französischen ins Deutsche übersetzten Bory. Stuttgart: Liesching, 1855. The allusion is to Bory de St. Vincent (1780-1846), on whom see Henry Fairfield Osborn, *From the Greeks to Darwin*, second edition, New York: Scribner's, 1929, pp. 291-293.

[15] Louis Büchner, *Kraft und Stoff.* Empirisch-naturphilosophische Studien. In allgemein-verständlicher Darstellung. Frankfurt a. M.: Meidinger, 1855. He was a practicing physician who, for a short time, had taught at the University of Tübingen.

phie of the preceding era. Naturphilosophie in the spirit of Schelling was no longer a scientific power in the 1840's. But it was remembered as a destructive influence in German science. And it was still remembered that Naturphilosophie had encouraged the idea of descent. There is no doubt that evolutionary ideas had been rife among German romantics since the end of the eighteenth century. Yet in the individual case it is hard to ascertain whether the notion of evolution implied actual descent. Romantic thinkers were inclined to envisage all creation as an ever-ascending evolution of things from inanimate matter to man. But this concept of evolution did not imply that every higher species actually descended from lower ones. Many, if not the majority, believed that in creating higher species nature improved upon herself, but that, nevertheless, each species had to be created anew. They could, therefore, easily accept the doctrine of the destruction of prehistoric animals by catastrophes. Yet some among the German romantic biologists definitely believed that there was a transmutation of lower forms into higher ones.[16]

Both rightly and wrongly, Naturphilosophie, which had dominated German science during the romantic era, was tainted with the suspicion of upholding ideas of descent. The botanist, E. Meyer, in an article of 1854, wrote: "Among the deplorable [influences of Naturphilosophie] I reckon the deep shaking of the belief in the constancy of species. . . ."[17] Admittedly, a shaken belief in the constancy of species is not yet a positive belief in their historical transformation.[18] Isolated remarks which sound as if their authors affirmed descent must not be taken at their face value without careful investigation.

This holds equally true of the period under discussion. Thus the zoologist, Julius Victor Carus, is usually referred to as a forerunner

[16] See Jane Oppenheimer's contribution in this volume; also Owsei Temkin, "German concepts of ontogeny and history around 1800," *Bull. Hist. Med.*, 1950, *24*: 227-246, and the literature cited above, footnote 6.

[17] Quoted from Potonié, op. cit., (ftn. 4) p. 442 f. (E. Meyer's article is said to have appeared in the *Königsberger naturwissenschaftliche Unterhaltungen*, vol. 3, under the title: "Ueber die Beständigkeit der Arten, besonders im Pflanzenreich.")

[18] Walter Baron, "Die idealistische Morphologie Al. Brauns und A. P. de Candolles und ihr Verhältnis zur Deszendenzlehre," *Beihefte zum Botanischen Centralblatt*, 1931, *48*: 314-334; see p. 317. This article provides an excellent comparison beween the different points of view and aims of the "idealistic morphologists" and the followers of Darwin.

of Darwin, and this reference is based on a passage from his *System der thierischen Morphologie* of 1853. The passage in question reads:

> . . . on the other hand, I may hope not to be misunderstood if, with regard to the present form of our classificatory endeavors and the *relationship* [*Verwandtschaft*] of certain forms of organic beings, I call attention to the fact that the first created forms, which from the admittedly oldest geological strata confront us as witnesses for an earlier creation which was closer at least to the first,—that these forms, apart from their organic character show the general character only of the group in which we place them. Consequently, in a sense limited of course by the absolute lack of possible demonstration, we can consider them the ancestors from which through perpetual generation and accommodation to progressively very different conditions of life, there originated the wealth of forms of the present creation.[19]

Taken by itself, this passage seems, if not clear, to be at least a clear reference to descent of present forms from earlier ones. But as far as I see, the bulk of the book leaves it undecided whether Carus has in mind concrete, or ideal, "evolutionary series in the animal world."[20] Towards the end of the book he expresses himself in a manner which seems to contradict the idea of descent. Morphology, he says, "not only demonstrates to us the immutable equality of the laws [i. e. of "formation"] but also their perfection from the very beginning. Often as the formative activity of the Creator manifested itself in the production of new animal worlds, still no forms proceeded from his hand which did not follow the same uniform plan."[21]

[19] J. Victor Carus, *System der thierischen Morphologie*. Leipzig: Engelmann, 1853, p. 5: ". . . darf aber auf der andern Seite wol hoffen nicht misverstanden zu werden, wenn ich mit Rücksicht auf die gegenwärtige Form unserer classificatorischen Bemühungen und auf die *Verwandtschaft* gewisser Formen der organisierten Wesen daran erinnere, dass die erstgeschaffenen Formen, welche uns aus den anerkannt ältesten geologischen Lagern als Zeugen einer früheren, der ersten wenigstens näher stehenden Schöpfung entgegentreten, ausser ihrem organischen Charakter nur den allgemeinen der Gruppe zeigen, zu welcher wir sie stellen, dass wir sie also, natürlich nur in einem durch den absoluten Mangel eines möglichen Beweises beschränkten Sinne, als die Urahnen betrachten können, aus denen durch fortgesetzte Zeugung und Accomodation an progressiv sehr verschiedene Lebensverhältnisse der Formenreichthum der jetzigen Schöpfung entstand." Part of that passage is quoted by Uhlmann, op. cit., (ftn. 7) p. 69 and misquoted by Ernst Haeckel, *Natürliche Schöpfungsgeschichte*, Sechste verbesserte Auflage. Berlin: Reimer, 1875, p. 98.

[20] "Entwickelungsreihe in der Thierwelt," discussed by Carus, op. cit., on pp. 275-278.

[21] Ibid., p. 505 f.

Seidlitz, in 1875, introduced the quotation of Carus' statement by the following remark: "The reserve with which this investigator, now an unconditional follower of Darwin, vents his transformistic thought in one single passage of the introduction is very significant for the public opinion of science at that time." [22] Seidlitz may have been right, but it must not be overlooked that, as the example of Virchow will show, ideas held before 1859 were sometimes given a new interpretation afterwards. It is for this reason that I have omitted a discussion of authors whose publications were not accessible to me, even where excerpts from their writings were available.[23]

To be sure, scientific opinion was preponderantly against the idea of transmutation. But there was no unity in the camp as to the alternatives. In view of the geological record, the eternity of all species could no longer seriously be defended, as Virchow made clear in his attack upon Czolbe.[24] Those who upheld a belief in creation in accordance with the biblical account may well have found their leader in the Swiss zoologist Louis Agassiz (1807-1873), who, in 1846, had emigrated to the United States.[25] In matters of descent,

[22] Seidlitz, op. cit., (ftn. 5) p. 52.

[23] As far as I can see, this omission includes:

W. Hofmeister (1849-1851), see Potonié, op. cit., (ftn. 4) p. 444 who refers to Sachs, *Geschichte der Botanik*, pp. 214-217. But in the English translation of this work (second impression, Oxford: Clarendon, 1906) Hofmeister is not cited as holding transformist views, although it is emphasized that his results were incompatible with the idea of constant species.

H. P. D. Reichenbach, who, according to Seidlitz, op. cit., (ftn. 5) presented a paper at the twenty-eighth meeting (at Gotha) of German Scientists and Physicians, published in 1854 at his own expense in Altona (where he practiced medicine) under the title *Ein kleiner Beitrag zur Anthropologie und Philosophie.*

Oswald Heer, who in his *Tertiäre Flora der Schweiz* of 1855, according to Seidlitz, op. cit., (ftn. 5) p. 53, spoke of "'Umprägung der Arten' . . . wie er die in relativ kurzer Zeit erfolgende Umänderung der Arten nennt."

F. T. Kützing, from whose "Historisch-kritische Untersuchungen über den Artbegriff bei den Organismen und dessen wissenschaftlichen Wert," *Programm der Realschule zu Nordhausen*, 1856, Uhlmann, op. cit., (ftn. 7) p. 71 ff. gives several excerpts.

Gustav Jaeger, who is credited by Seidlitz, op. cit., p. 53 with having "developed the theory of descent to its last consequences" in 1857 before a select group of young scientists. Its late publication in 1864 in the *Zoologische Briefe* is attributed to the reluctance to flaunt the opinion of scholars before 1859.

Although Schopenhauer's evolutionary ideas fall within our period, I have not referred to them in view of Professor Lovejoy's article.

[24] Rudolf Virchow, "Alter und neuer Vitalismus," *Archiv für pathologische Anatomie* etc., 1856, *9*: 3-56; see below, p. 348.

[25] Louis Agassiz and A. A. Gould, *Outlines of Comparative Physiology*, Touching the Structure and Development of the Races of Animals, Living and

his views were uncompromising. Admitting that the fossil record showed "a manifest progress in the succession of beings," he insisted:

> But this connection is not the consequence of a direct lineage between the faunas of different ages. There is nothing like parental descent connecting them. The fishes of the Paleozoic age are in no respect the ancestors of the reptiles of the Secondary age, nor does Man descend from the mammals which preceded him in the Tertiary age. The link by which they are connected is of a higher and immaterial nature; and their connection is to be sought in the view of the Creator himself, whose aim, in forming the earth, in allowing it to undergo the successive changes which geology has pointed out, and in creating successively all the different types of animals which have passed away, was to introduce Man upon its surface.

Agassiz' thought was summed up as follows:

> To study, in this view, the succession of animals in time, and their distribution in space, is therefore to become acquainted with the ideas of God himself.[26]

The ease with which a fundamentally pious biologist like Schleiden who was opposed to materialistic tendencies of a philosophical kind could gloss over the Mosaic account of creation, demonstrates the tenuous hold of biblical orthodoxy on the minds of German scientists. It cannot be taken for granted that all those who neglected to express themselves on the origin of species, unquestioningly accepted their supernatural creation. Unless they dismissed the whole problem from their minds, another possibility was left to them, viz., a series of spontaneous generations. In their *Grundzüge der Botanik*, Endlicher and Unger, in 1843, wrote:

Extinct. For the Use of Schools and Colleges. Edited from the Revised Edition, and greatly enlarged, by Thomas Wright, M.D. London: Bohn, 1851. Agassiz' erstwhile student, Carl Vogt, in *Altes und Neues aus Thier-und Menschenleben.* 2 vols., Frankfort a. M.: Literarische Anstalt, 1859 (the preface is dated March 31), vol. 1, p. 353 quotes Agassiz's work on fossil fish, vol. 1, p. 171, for the belief in a personal creator who, twenty times or more, destroyed all life to replace it by better forms.

[26] Agassiz-Gould, ibid., pp. 417-418. There is a good deal of an older tradition in this whole line of thought. Walter Baron. "Zu Louis Agassiz's Beurteilung des Darwinismus," *Sudhoffs Archiv für Geschichte der Medizin und der Naturwissenschaften*, 1956, *40*: 259-277, has pointed out that Agassiz was motivated by ideas of natural theology rather than of Naturphilosophie or sentimental religiosity. But it has to be added that the concept of "ideas of creation" is to be found in Herder and von Baer as well; see Temkin, "German concepts of ontogeny," op. cit. (ftn. 16).

The genesis of the present vegetation, like that of all earlier vegetations, can, however, only be conceived as a spontaneous generation in accordance with the idea of the plant organism eternally progressing towards perfection. It probably emerged, if a conclusion based on present experiences is admissible, from a slimy carbonaceous substratum [*Matrix*], out of which cells developed into shoots, and these into complete plants.

In these acts of spontaneous generation of which the earth does not seem constantly capable, but only after longer or shorter intervals, and only after previous violent changes on its surface and in the medium surrounding it, plant species were created in large numbers and according to certain contrasts. . . .[27]

This quotation reflects the status of the cellular theory in the 'forties, when the principle of *omnis cellula a cellula* had not yet been developed by Remak (1852)[28] and formulated by Virchow (1855). In 1859, Carl Ernst von Baer tried to limit the need for such spontaneous generations to a minimum. Like many other scientists, he felt uneasy about them, admitting that spontaneous generation was merely another word for creation minus the stigma of supernatural intervention.[29] But it is well to remember that Pasteur's first publication on the subject appeared in 1860, after Darwin's *Origin*. And even then spontaneous generation was not eliminated as a postulate, least of all by speculating Darwinists like Haeckel and Huxley. The difference was that after 1859 spontaneous generation was banished to a semi-mythical time at the beginning of evolution. Before 1859, many nontransformists as well as transformists assumed that it might have initiated every new "creation." This, I think, explains why, to the mechanistically minded biologist, spontaneous generation was more important as a principle than was descent. "Lest we take refuge in miracles and the incomprehensible, we must admit the origin of the first organized creatures on the earth by the free creative power of matter itself . . ." wrote Her-

[27] Stephan Endlicher und Franz Unger, *Grundzüge der Botanik*. Wien: Gerold, 1843, p. 461.

[28] Bruno Kisch, *Forgotten Leaders in Modern Medicine*: Valentin, Gruby, Remak, Auerbach. Philadelphia: The American Philosophical Society, 1954 (*Transactions of the American Philosophical Society*, New Series, vol. 44, part 2, 1954), p. 258.

[29] See Seidlitz, op. cit., (ftn. 5) p. 55 f. Zimmermann, op. cit., (ftn. 4) p. 503: "Bis zur Mitte des vergangenen Jahrhunderts nahmen auch namhafte Biologen, wie H. G. Bronn (1800-1862), K. E. v. Baer, K. v. Nägeli (für Pilze) plötzliche, sich in unseren Tagen abspielende Urzeugungen als erwiesen an."

mann Burmeister (1807-1892),[30] who dismissed the notion of descent, although he was not unsympathetic to it. And Rudolf Virchow, in 1856, insisted on the need of admitting spontaneous generation. Though he is not clear as to details, his way of expressing himself does not point to the limitation of spontaneous generation to a single event at the dawn of organic life.[31] He needed a principle that avoided eternity of species and supernatural intervention, yet upheld the idea of progress.[32] Against this background the various arguments for transformism have now to be viewed.

II

The beginning might well be made with the geologist Bernhard Cotta's (1808-1879) "Letters on Alexander von Humboldt's Kosmos." The first volume appeared in 1848, and the dedication, dated April 2 of that year, shows the author under the perturbing influence of the revolution; the occupation with the book has helped to quiet his mind, and he hopes "that the result of this occupation may affect others similarly."[33] As is to be expected from his desire for equanimity, the tone of the book is not polemical, although Cotta declares his antagonism to the speculative philosophy in Germany. The true scientist, he says, does not believe the world to be the result of his thought, but rather he believes his thought to be the end-product of the world, of his observation of the world. A few lines later Cotta offers a hypothetical explanation: "Indeed, from our limited earthly point of view we might even be tempted to

[30] Hermann Burmeister, *Geschichte der Schöpfung.* Eine Darstellung des Entwicklungsganges der Erde und ihrer Bewohner. Für die Gebildeten aller Stände. Fünfte verbesserte Auflage, Leipzig: Wigand, 1854, p. 325.

[31] Virchow, op. cit., (ftn. 24) p. 25: "Aber selbst wenn wir die Erfolglosigkeit aller Versuche, einzelne Zellen zu erzeugen, in unserer Zeit zugestehen müssen, so können wir darin keinen Grund für ihre Ewigkeit finden. Das Gesetz, nach dem ihre Bildung erfolgte, muss nothwendig ein ewiges sein, so dass jedesmal, wenn im Laufe der natürlichen Vorgänge die Bedingungen für seine Offenbarung günstig werden, die organische Gestaltung sich verwirklicht." See also below, p. 348.

[32] Ibid. "Die Zeiträume, welche der Mensch überblickt, sind, selbst wenn wir den grössten Rahmen ausspannen, indem wir die Jahrtausende nach Millionen rechnen, immerhin sehr beschränkt, und doch gestatten sie uns, die befriedigende Ueberzeugung zu gewinnen, dass ein freilich sehr langsamer und häufig unterbrochener Fortschritt in der Welt ist."

[33] Bernhard Cotta, *Briefe über Alexander von Humboldt's Kosmos.* Erster Theil, Leipzig: Weigel, 1848, p. III.

assert that man with his intelligence is the final result of a long evolutionary series [*Entwicklungsreihe*] of organic beings, a series which, through all its generations, has absorbed an immeasurable sum of external impressions (unconscious observations of nature and of its laws) and has thereby worked its way up to a thinking, rational being." [34] A rash interpretation of the sentence as referring to descent will be checked by the realization that it is the "evolutionary series" that works its way up.

Cotta offers a good example of how important it is to distinguish between evolution and transmutation (or descent). "In the 24th letter I wrote to you something about the sequence in which the organic forms originated one after the other on the earth. In this we recognized a *gradual evolution* [*Entwicklung*] *from the lower to the higher.*" [35] Cotta's italicization enhances the impression that he has evolution in the modern sense in mind, i. e., transmutation. But the immediately following sentence shows that evolution is used in a broader sense: "Yet how the single organisms, i. e. the first individuals of each species originated is still veiled in deep obscurity." [36]

Nevertheless, in the 24th letter as well as later he discusses transmutation in unmistakable terms. He presents it as a hypothesis advanced by others, even though his own inclination towards it is obvious. "Here I must point out to you right away," he writes in the 24th letter, "that much esteemed scientists have made the assertion that the diversity and the change of organic forms on the earth are altogether not caused by the origin of entirely new species, but only by an ever more diverse and higher evolution [*Entwicklung*] of the originally formed. According to this opinion, in the course of immeasurable periods, and corresponding to the respective external conditions there arose from one organic form all others. Accordingly we must consider man too as the highest evolutionary step of a first organic seed [*Keim*]. This explanation of the diversity in organic nature has a good deal for it. . . ." [37]

Even in his main discussion of organic life on earth Cotta does not forget to emphasize the hypothetical character of an explanation by descent.

> The opinion *that the different organic forms developed gradually from one another* has already often been expressed, and

[34] Ibid., p. vi. This idea is taken up again at the end of the volume, p. 340, and given a rather clear materialistic sense.
[35] Ibid., p. 262. [36] Ibid., pp. 262-263. [37] Ibid., p. 140.

defended by argument, by true natural philosophers. Quite recently an anonymous Englishman sought ingeniously to prove this view in the book *Vestiges of the Natural History of Creation*, and indeed, there is much to be said for it even though it will, in the very nature of the matter, long remain a mere hypothesis. The law of the organization of matter is as yet completely undiscovered; its results have, as already stated, not yet been drawn into the sphere of the inevitable. If, however, for the moment we assume that such a law governing matter exists, that certain substances in certain circumstances unite and become organic forms, then the special diversity of these substances and circumstances will determine the diversity of the forms and be reflected in them. In the simplest external circumstances, the simplest, most suitable, organic forms will have arisen; and as the circumstances changed and became diversified, the organic forms gradually changed and became diversified also.[38]

From the above and a few other passages it is possible to form an impression as to why Cotta hesitated to associate himself frankly with transformism, why, nevertheless, he defended the idea, and along what line he looked for a possible explanation. Apart from our general ignorance of the laws of organization, he sees a main obstacle in the sharp separation of species. Never has an actual transition been observed between really different species. They differ, down to their minutest parts, "though *perhaps* we must assume that they developed historically from one another."[39] On what can he base the latter possibility? Cotta has great faith in the effect of long periods of time. While in the shortness of historical time we have not observed the formation of truly new species, yet table fruits and domestic animals can be considered as "almost" new formations of species.[40] Unbounded time could achieve what cannot be observed in relatively short periods. But this is at best a defense of transformism. What is Cotta's argument *for* it? In the first place, aversion to the acceptance of divine acts of creation: "If for every special form you refer to the creator of the world, that means cutting through the knot rather than untying it. You put an *assumption* instead of an *explanation* just because you lack the latter."[41] Apart from suggesting an explanation of the variety of species, the idea of transmutation also avoids a multiplicity of spontaneous generations and supports a progressive view

[38] Ibid., p. 263.
[39] Ibid., p. 262. Italics mine.
[40] Ibid., p. 264.
[41] Ibid., p. 263.

of man. As we shall see, Cotta, in these points, meets with the botanist Unger.

Since Cotta does not expressly make the idea of descent his own, it is not surprising to find relatively little thought given to its possible mechanism. Nevertheless, though he does not mention the name as far as I see, enough is said to characterize his attitude as Lamarckian. Greatly impressed by the harmony between structure and environment, Cotta cites as an especially impressive instance Charles Darwin's account of *Birgus latro*, a large crab living on the Keeling islands, that eats coconuts. "Had a species of crab previously living in the sea found pleasure in living on land and enjoying coconuts and had, therefore, through thousands of generations gradually changed its whole organization so as to become able to eat the nuts with relative ease? Or, was an animal, adapted for this special end, produced by a special act of creation?" Such questions cannot be answered directly; however, there are "the thousands of less conspicuous yet analogous cases in which the organization of animals manifestly changes gradually for a definite purpose through exercise, as the greyhound has taken on a form quite different from the dachshund or butcher's dog, and the race horse a form different from the draught-horse." [42]

In the same year, 1848, the botanist Schleiden too published a popular work, *The Plant*.[43] Schleiden argued for transformism but, in contrast to Cotta he did so unreservedly. Schleiden has no doubt that the world is God's creation, but to him that does not imply accepting the Mosaic story. He tries to fit the origin and development of plant life into the history of the earth, which makes him think that

> In some period of this gradual shaping of the earth, the first of organic existence originated, through forces, which may indeed still be in action, but under conditions and co-operation of those various forces such as now appear no longer possible upon our earth. The ocean was probably the birth-place of these organisms. . . .[44]

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[42] Ibid., p. 266.

[43] M. J. Schleiden, *The Plant*; a Biography. Translated by Arthur Henfrey. Second edition, with additions. London: Baillière, 1853. However, judging from the quotations given by Uhlmann, *op. cit.* (ftn. 6), ideas of descent were already expressed in the first German edition of 1848.

[44] *The Plant*, p. 277 f.

A little later, Schleiden adds: "In subsequent periods, organisms also originated upon the dry land . . ,"[45] which sounds as if he too believed in repeated spontaneous generations. But then he seems to deny such an interpretation because he ascribes the whole subsequent process to gradual descent from a single cell.

> This view, that the whole fulness of the vegetable world has been gradually developed out of a single cell and its descendants, by gradual formation of varieties, which became stereotyped into species, and then, in like manner, became the producers of new forms, is at least quite as possible as any other, and is perhaps more probable and correspondent than any other, since it carries back the Absolutely Inexplicable, namely, the production of an Organic Being, into the very narrowest limits which can be imagined.[46]

This summary shows Schleiden's reason for believing in transmutation. As to the "how," he first proposed a hypothesis for the formation of varieties by referring to tropical conditions:

> The principal causes producing a luxuriant and varied world of forms in the tropics, are moisture and warmth, the causes of their multiformity appear to lie in the richness of the soil in readily soluble inorganic matters, which in the first place give rise to a variation in the chemical processes of the plant, and thus to a greater or less deviation in the form. These two conditions *meet* in the tropics, because they are dependent one upon the other, since the more luxuriant vegetation called forth by the moist, warm atmosphere, prepares by its death and rapid decay, a soil richer in soluble inorganic matters, for the succeeding generation.[47]

Once formed, varieties "when they have continued to vegetate under the same conditions for several generations, pass into subspecies, that is into varieties which may be propagated with certainty by their seeds. . . ." Assuming now that the same influences continue to act for a very long period,

> will not, at last, as the variety thus becomes a sub-species, so also this become so permanent, that we shall and must describe it as a species [?] Then, if the first cell be given, the foregoing points out how the whole wealth of the vegetable kingdom may have been formed by a gradual passage from it through varieties, subspecies and species, and thus onward, beginning anew from each

[45] Ibid. [46] Ibid., p. 293. [47] Ibid., p. 289 f.

species—in a space of time, indeed, of which we have no conception, for which, however, since there is nothing *real* wanting, we may provide at pleasure in our dreams; for it may be mentioned here that all the recent distinguished Geologists come ever more and more to the opinion, that very much, in the formation of the crust of our earth, which was formerly ascribed to violent, convulsive and sudden revolutions, has rather been the product of forces acting slowly through the course of enormous periods of time.[48]

Schleiden presupposes a very long geological time (which would have easily been granted to him by German scientists of the period); he also presupposes the principle of "actuality" in geology as defended by von Hoff in Germany and Lyell in England, and a modifying influence of the environment upon plant form. It should be noted that the environmental factors which he cites do not necessarily require adaptational tendencies on the part of the plant. They work through chemical and physical forces. Schleiden was opposed to any "vital force," though he was equally opposed to metaphysical materialism. Indeed, in 1863 he published a severe attack upon the materialistic tendencies in modern science.[49]

Environmental changes, though of a very different nature, are also invoked by Karl Heinrich Baumgärtner (1798-1886), from 1824-1862 professor of clinical medicine in Freiburg i.B.[50] In his younger years he had worked on the segmentation of the ovum, and to this work he referred again in the "Textbook of Physiology" of 1853, where he enunciated his theory of transmutation through influences upon surviving ova of creatures destroyed in earlier phases of geological history.[51] Two years later, in 1855, he issued in short theses the ideas prepared in the "Textbook" and subsequently elaborated.[52] They may here be sketched in the presentation he gave them in his *Schöpfungsgedanken*, "Physiological Studies for the Educated," as Baumgärtner called the book he pub-

[48] Ibid.

[49] See Temkin, "Materialism," (ftn. 7) p. 324.

[50] E. Th. Nauck, "Die ersten Jahrzehnte des psychiatrischen und neurologischen Unterrichts in Freiburg i. Br.," *Ber. Naturf. Ges. Freiburg i. Br.*, 1956, *46*: 63-84; see p. 64 f.

[51] Karl Heinrich Baumgärtner, *Lehrbuch der Physiologie mit Nutzanwendungen auf die ärztliche Praxis.* Stuttgart: Rieger, 1853, pp. 71 ff. and 190.

[52] K. H. Baumgärtner, *Anfänge zu einer physiologischen Schöpfungsgeschichte der Pflanzen- und der Thierwelt, und Mittel zur weiteren Durchführung derselben.* Stuttgart: Rieger, 1855.

lished in 1859.[53] The first part, giving his evolutionary thought, had appeared before;[54] so that any suspicion of an early influence by Darwin's *Origin* may be dismissed.

Baumgärtner had discovered—or believed to have discovered—what he called "the law of the ascending germ-metamorphosis in the periods of creation."[55] He argues that the chicken must have existed before the egg and the cock before the semen. Neither they nor their seed can have originated by spontaneous generation. Nor can they have originated from free organic substances. Likewise, the transformation of a complete organism into a different animal is very unlikley. Therefore, animals must have developed from germs; i. e., the higher animals must have developed from the germs of lower organisms.[56]

In particular, evolution took the following course. "Through organizing influences," as Baumgärtner calls them, in the first creative process, the simplest organism originated from nitrogen, carbon, hydrogen, and oxygen.[57] The original cell formed through spontaneous generation and became differentiated in analogy to the differentiation of animal and vegetal poles in the egg. A separation into primitive animals and plants may have been the direct result. The succeeding creative period began with a destruction of all the existing adult creatures and a change in their surviving seed. General cosmic phenomena accompanied by electrical polarizing forces were responsible for the catastrophe as well as the evolutionary step.[58] The new polarizations in the surviving seed brought about cleavages in new directions and therewith possibilities for the development of new, higher species. Baumgärtner does not assume that all the animals of the new creation were immediately available. They might start out as particles of the dividing ovum, gradually changing into the final forms. In particular, Baumgärtner depicted the evolution of man during the last period of creation as a transformation of low embryonic forms into the adult form. Evolution proceeded in many series, the various races of men might well have been the results of different evolutionary series. Spontaneous generation was not limited to the very first creation, but occurred again in each new period.[59] All this assured to evolution a great variety

[53] K. H. Baumgärtner, *Schöpfungsgedanken.* Physiologische Studien für Gebildete. Freiburg: Wagner, 1859.
[54] Ibid., p. iii-iv.
[55] Ibid., p. 307.
[56] Ibid., pp. 310-316.
[57] Ibid., p. 318.
[58] Ibid., p. 326 ff.
[59] Ibid., p. 336 f.

of possibilities and to the author an opportunity of indulging in peculiar speculations. For instance, beasts of prey and their victims are thought to be adapted to one another because they originally formed from the same egg. Again, some men were still leading a larval existence in the water while others more perfect watched them as they walked along the shore.[60]

Baumgärtner's arguments for descent are not convincing. If, as he believes, spontaneous generation can take place at the beginnings of all creative periods and if new species of animals lead a long life in a larval state, why then is it necessary to assume a mutation of earlier germs at all? One cannot help suspecting that Baumgärtner's motives for favoring descent were in part metaphysical ones. In his *Schöpfungsgedanken*, at least, the metaphysical element is obvious. All the changing organizations lead to the idea of a cosmic organism which, in turn, presupposes a directive power. "Thus," he writes, "physiological research leads us to the idea of God, viz. to the conviction that there is a thinking power to which the natural laws themselves and the final reason of all things must be traced back."[61] Moreover, the "law of transformation of germs and of the progressive evolution of mental life shows us that at any rate the movement marches on and that, therefore, our hopes for a higher destination are no empty illusion."[62]

In contrast to the popular books of Cotta, Schleiden, and Baumgärtner, Unger's "Attempt at a History of the Vegetable Realm" of 1852 is a work of a vastly different character. Himself professor of botany at the University of Vienna, Unger presents a solid paleontological investigation. And while we could quote a passage of 1843 where he (and Endlicher) clearly asserted repeated spontaneous generations, Unger has now changed his mind.[63] The assumption of spontaneous generation contradicts contemporary experience and the idea of descent recommends itself just because it helps to avoid such an awkward hypothesis. Going back in time, Unger finds algae as the most primitive of all later forms. In theory, at least, he dares to go even further and assume the previous existence of an "Urpflanze" (we are immediately reminded of Goethe),

[60] Ibid., p. 346. [61] Ibid., p. 373. [62] Ibid., p. 370 f.

[63] Among the German followers of the theory of transmutation during the period under discussion, Unger and Schaaffhausen (with the exception of Schopenhauer) are probably best known. Both are mentioned in Darwin's "Historical Sketch," and their writings are discussed by Zimmermann, op. cit., (ftn. 4).

or even a primary cell, "which is at the bottom of all vegetal existence."[64] Comparing the flora of past ages with that of more recent ones, he finds that the number of new species increases with the periods. If, therefore, all species originated spontaneously, spontaneous generation should have occurred more and more often, and most frequently in our own period. This is contrary to all experience. Accordingly, descent is the alternative—descent, however, which is due to inner forces. External conditions may have played a minor role, but they could not have been decisive because of the regularity noted in the development of new plant forms. "Nothing has been added in this regulated evolutionary process of the vegetal world that had not been previously prepared and indicated, so to speak. Neither genus, nor family, nor class of plants has manifested itself without having become necessary in time."[65] This allows Unger to consider the totality of plants a "truly coherent organism."[66] But how does this agree with the alleged stability of species? Unger avoids a clear-cut answer. He says that uniformity does not exclude variations. Old species did not simply change into new ones. Rather, some individuals metamorphosed while the old type still remained existent for some time.

His idea of an "inner development" allows Unger to avoid the question as to the origin of the *Urpflanze* and, at the same time to place this development into a grandiose cosmic frame. The unity of plant life stands in contrast to inanimate nature. Though we do not know how the first cell originated, we can at least accept it as "the origin of all organic life and, therefore, the true bearer of all higher evolution."[67] There is no reason to believe that the productive activity will stop. Our present period is still young, our world is full of imperfections and thus man strives after accomplishment of the ideal he has in his mind. The same is true of animals and plants. The formation of new races is but the urge to perfection, the attempt to be ready for entry into the next cosmic period.[68]

In opposing transmutation to spontaneous generation Unger did not stand alone. Cotta had advanced the argument that the occurrence of spontaneous generation could not be decided by direct observation. Anyhow, Cotta thought, "if it is true that the single organic forms developed from one another through the influence

[64] F. Unger, *Versuch einer Geschichte der Pflanzenwelt*. Wien: Braumüller, 1852, p. 340.
[65] Ibid., p. 344.
[66] Ibid., p. 345.
[67] Ibid., p. 340.
[68] Ibid., p. 349.

of changed external circumstances of life, this is again a reason against the spontaneous generation of single individuals." [69] Likewise, in Cotta's opinion gradual development points to further progress. At present, man is the highest stage of organization, "but we cannot know what more gifted being will result from many thousands of years of further development." [70] Humanity as a whole advances in abilities, knowledge, and morality. Indeed the dependence of morality on development is the great justification for the scientist's endeavor "to replace the personal activity of a creator by evolution through scientific law." [71]

Here is the place to point out the role which the optimistic belief in progress played in biology before Darwin. Virchow, in the above mentioned essay of 1856, frankly stated his preference for a view that recognized progress in the history of living forms as against a view that considered species eternal and immutable.[72] I believe that at that time, Virchow, temporarily at least, acquiesced in the assumption of repeated occurrences of spontaneous generation. But the underlying sentiment was the same as Unger's, though Unger expressed it in terms of a theory of descent and an idealistic philosophy.

In the face of such views it is hard to decide whether even Unger was led to accept descent as a purely logical consequence of his paleontological and geographical research, or postulated it under the influence of metaphysical predilections. The form he gave to it indicates that his general views on man, the world, and their progress played a considerable part. It is, therefore, all the more interesting that Schaaffhausen's famous article "On the Constancy and Transformation of Species," which appeared but one year later, in 1853, is an acceptance as well as a rejection of Unger's evolutionary ideas. Schaaffhausen states that not only von Baer, but even Vogt and Burmeister recoiled from the idea that man originated from the orangutan.[73] Opinions vary, from Agassiz who believed in twenty renewals of creation, to Unger who propounded that "the evolution of the vegetal realm began with an *Urpflanze* and that

[69] Cotta, op. cit., (ftn. 33) p. 267.
[70] Ibid.
[71] Ibid., p. 268.
[72] Virchow, op. cit., (ftn. 24) p. 24 f. Erwin H. Ackerknecht, *Rudolf Virchow: Doctor, Statesman, Anthropologist*. Madison: University of Wisconsin Press, 1953, p. 200.
[73] Hermann Schaaffhausen, "Ueber Beständigkeit und Umwandlung der Arten," *Anthropologische Studien*, Bonn: Marcus, 1885, pp. 134-164; see p. 135.

the various types appeared gradually in ever-increasing number, having emanated due to an inner formative urge of the plant itself." [74] In the main, Schaaffhausen is concerned with the problem of the constancy of species. He combats this idea with all the material and arguments at his disposal. At the head of his summary there stands the sentence: "The immutability of species which most scientists regard as a natural law is not proved, for there are no definite and unchangeable characteristics of the species, and the borderline between species and subspecies [*Art* and *Abart*] is wavering and uncertain." [75] Schaaffhausen stresses the need for more and more exact observation, especially regarding variations. This is a very sober attitude, though more is involved than is at first apparent. Beside expecting an ever-increasing discovery of missing links, he also confronts the opponents of evolution with the alternative "that the oak or horse originated from the elements." [76] And in contrast to Unger's inner urge, he puts his belief in the influence of, and adaptation to, external influences.[77] But he does not explain the mechanism of such influences and adaptations. Moreover, his subsequent attitude shows that his work on species was not quite free from general ideas. In a paper of 1860, he opens a short polemic against Büchner and Virchow with the words: "In our days, when a new materialistic school even denies the order in the world at large because it leads to the assumption of the concept of God, when one admires the chaos rather than the cosmos, it is all the more necessary to call to mind the doctrine of the unity of life and to show how well founded it is." [78] And he closes the polemic by saying: "But if we see the organic forms emanating one from the other and life obtaining its vigor from the sources of telluric nature only, and the earth receiving air and warmth from another star whose course again follows a higher law, then with this insight we approach the eternal mind whose creative thought also was creative deed, by which he made and at every moment makes anew, the world and its wonders." [79]

At this point one may wonder why strictly scientific arguments were not allowed to stand by themselves. Unfortunately, scientific results were sometimes more confusing than enlightening. In 1851,

[74] Ibid., p. 136.
[75] Ibid., p. 163.
[76] Ibid., p. 161.
[77] Ibid., p. 138.
[78] "Ueber die Gesetze der organischen Bildung," op. cit., (ftn. 73) pp. 294-326; see p. 325.
[79] Ibid., p. 326.

Johannes Müller had observed snails developing within echinoderms. This alleged discovery threw him and many others into utter confusion.[80] Snails and echinoderms belong not only to different species, but to different phyla! If such a metamorphosis were possible, then anything was possible!

Among the effects of the puzzling phenomena of *Generationswechsel* and parasitism seems to have been a predilection to view descent as a series of mutations rather than continuous changes. Such a predilection was noticeable in Baumgärtner, we shall find it again in Büchner, and it looms large in the evolutionary thought of the botanist Carl Nägeli (1817-91), which we analyze on the basis of his paper on "Individuality in Nature" presented in 1856.[81]

The paper starts out with a reference to the dispute between materialists and spiritualists. It soon becomes clear that Nägeli, though a biological mechanist, occupies, philosophically, an idealistic position. Scientific empiricism, he insists, moves within the narrow bounderies marked by imperfections of our sensory perceptions, by the eternity of space and time, and by their infinite divisibility. It cannot transcend the threshold to the world of the spirit.[82] This agnostic criticism is balanced by an idealistic evaluation of progress. As he himself says, the main part of the paper attempts to show that "material nature, through individual formations which come into being and pass away, rises to the highest point of development in a continual evolutionary urge and necessary gradation."[83] All this is similar to the tendency of mankind towards perfection through a change of individuals. The organic species, as he writes at the end of the paper, "itself is an individual which develops through continuous change, which finds a limitation through this change, and in this limitation creates new species." Material forms perish, the idea remains, ". . . for the material phenomena are but the transitory points, empty of content, of a movement which ceaselessly strives towards a better goal."[84]

[80] Emil du Bois-Reymond, "Gedächtnisrede auf Johannes Müller," *Reden.* 2 vols., Leipzig: Veit, 1886-87; vol. 2, p. 262 ff.

[81] Carl Nägeli, "Die Individualität in der Natur mit vorzüglicher Berücksichtigung des Pflanzenreiches," *Monatsschrift des wissenschaftlichen Vereins in Zürich*, 1856, *1*: 171-212. I was led to this publication by Uhlmann, op. cit. (ftn. 6). The paper is a semi-popular presentation and it is possible that other works by Nägeli prior to 1859 deal with transformism from a different point of view.

[82] Nägeli, op. cit., (ftn. 81) p. 176.

[83] Ibid., p. 171.

[84] Ibid., pp. 211 and 212.

to be of great importance. As far as that is possible in the limited scope, namely, it brings the history of earlier creations into harmony with the prevailing general, physical, and organic laws and banishes completely the fiat of the rational personality, a creator, assumed by many other scientists. This theory of the transition of one species into another and of the gradual evolution of the organic form-type under the influence of external agents, would undoubtedly offer much greater inner credibility, if the hitherto known facts did not thwart and hinder. To these, however, we must defer until perhaps the faulty observations contained in them are discovered, and thereby the fact itself is rectified.[96]

To put it pointedly, Vogt regrets that he cannot accept the theory of descent. A scientist has to bow to facts, but he is allowed to hope that some day the facts will be corrected.

I do not know whether in the preceding years, too, Vogt had secretly hoped for a removal of the obstacles to the theory of descent. But it seems very probable that Rudolf Virchow had had this hope from at least 1856. At that time, as we have seen, Virchow emphasized the necessity for assuming spontaneous generation, and left open the possibility of a series of such events to explain the formation of progressively higher species. He did not declare himself a transformist, but he did not hide his sympathy either:

> As long as it is still not possible in the sense of the school of natural philosophers to show a continuous development of plants and animals from the simplest form to the most highly developed organisms in such a way that genus is transformed into genus. . . .[97]

As Ackerknecht has pointed out, Virchow was not an anti-Darwinist, although he warned against uncritical acceptance and generalization of Darwinistic ideas.[98] In an essay "On the Mechan-

[96] Karl Vogt, *Altes und Neues aus Thier- und Menschenleben.* 2 vols. Frankfurt a. M.: Literarische Anstalt, 1859; see vol. 1, p. 351.

[97] Virchow, op. cit., (ftn. 24) p. 24: "So lange es noch nicht möglich ist, im Sinne der naturphilosophischen Schule eine fortschreitende Entwickelung der Pflanzen und Thiere von der einfachsten Form zu den höchst entwickelten Organisationen in der Art zu zeigen, dass Gattung sich in Gattung umbildet; so lange man, wie Czolbe selbst anführt, mit Linné schliessen muss, dass alle Gattungen schon von (ihrem) Anfang an als solche existirten: so würde es nothwendig sein, um den Gedanken einer Epigenese der Gattungen, einer 'Schöpfung' zurückzuweisen, dass man die Ewigkeit aller organischen Gattungen aufstellte."

[98] Erwin H. Ackerknecht, op. cit., (ftn. 72) p. 199 ff.

istic Concept of Life" that appeared in 1862, he claimed to have insisted on transmutation as a necessary link in a mechanistic view of life, even before the appearance of Darwin's book. This essay purported to be the speech he had made at the 1858 meeting of German Scientists and Physicians.[99] In the published essay we read:

> But life must have had a beginning, for geology leads us into epochs of the earth's development in which no life was possible, where no trace, no remnant, of life is extant. But if there was a beginning to life, then it must also be possible for science to fathom the conditions for this beginning. As yet this is an unsolved problem. Indeed, our experiences do not even give us the right to consider the invariability of species which at the moment seems to be so assured, as a fixed rule for all time. For geology teaches us to recognize a certain series of steps by which the species succeeded one another, higher ones succeeding lower ones, and however much the experience of our own time conflicts with it, I am bound nevertheless to confess that rather it seems to me to be a necessity for science to return to the possibility of transition from species to species. Only then does the mechanical theory of life attain real security in this respect.[100]

Virchow apparently felt that his readers might suspect him of having written under the influence of the *Origin* which had appeared in the meantime. Thus he added the following footnote:

> Charles Darwin's book (*On the origin of species by means of natural selection*, London, 1859) which became famous so quickly, had not yet appeared when the foregoing was written.[101]

Since Virchow emphasized that the speech was not read from a manuscript, it is quite likely that no manuscript existed in 1858. However, there appeared a short official report which included the following passage:

> For it is already very difficult to decide whether there are rigid differences between plant and animal cells. For the sequence of organic development from the simpler to the higher forms, as taught by Naturphilosophie, no proofs have as yet been found,

[99] Rudolf Virchow "Ueber die mechanische Auffassung des Lebens. Nach einem frei gehaltenen Vortrag aus der dritten allgemeinen Sitzung der 34. Versammlung deutscher Naturforscher und Aerzte. (Carlsruhe, am 22. September 1858)," in *Vier Reden über Leben und Kranksein*. Berlin: Reimer, 1862, pp. 1-33. Note that the speech was not read from a manuscript!

[100] Ibid., p. 31.

[101] Ibid., p. 31, footnote.

and one is inclined to constancy of form. There seems to be a limited, preestablished route by which the principal characteristics of organisms are reproduced by inheritance and remain constant. Always the same form arises from earlier form without particular development. However ingratiatingly the indicated sequence of development may present itself to us, however desirable its proof may be to the individual investigator, the natural scientist who sacrifices himself and his pet inclinations to calm knowledge is obliged to designate this view as a fantasy. We are bound to assume the immutability of genera and species as a necessary consequence of organic laws. This compulsion is valid, however, only for the present, for the state of our knowledge today, and permits us to hope that more information will be found later.[102]

The two versions differ not only in letter, which is to be expected, but also in emphasis. According to the official report, transmutation is an unproved idea of Naturphilosophie; the true scientist views it with scepticism; he must admit the immutability of genera and species at the present time, though he reserves judgment as to what future research may reveal.[103]

These notions agree reasonably well with the article of 1856, and they also agree with a remark Virchow made in 1877 when, in the face of the great success of Darwin, he wrote in a reminiscent vein:

For those of us who were still acquainted with the old Naturephilosophy, it was certainly somewhat surprising to see how the genius of a single man restored to its rightful place, after its long and, alas, not entirely unjustified banishment, an idea already

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[102] The report is reprinted in Karl Sudhoff, *Rudolf Virchow und die Deutschen Naturforscherversammlungen*. Leipzig: Akademische Verlagsgesellschaft, 1922, pp. 5-7; see p. 6 f. The report continues: "Der Redner rechnete es sich als ein gewisses Verdienst an, dieses ihm widerstrebende Gesetz auch in Krankheiten nachgewiesen zu haben, indem er zeigte, der Körper tue nichts, wozu ihn nicht seine Bildung im voraus berechtigt; hieraus folgt, dass man die generatio aequivoca ablehnen muss. Der Naturforscher vermag auf die drängenden Fragen keine bestimmte Antwort zu erteilen."

Comparison with the printed version of 1862 indicates that Virchow thought above all of present conditions. In the version of 1862, he goes so far as to postulate the origin of life at some time in the geological past, allowing transmutation to take over from that event. The official excerpt is not clear as to Virchow's attitude to spontaneous generation in the past.

[103] In view of our uncertainty regarding the authorship of the official report and its denial of spontaneous generation, I hesitate to take it as manifest contradiction of the version of 1862. But it seems fair to say that the report throws doubt on Virchow's unequivocal support of transformism at the meeting.

given official status as an *a priori* necessity by the Nature-philosophers, not only reactivating it but making it the basis of a general conception of the history of the organic world.[104]

It thus seems likely that both Vogt and Virchow, before the appearance of the *Origin*, realized that a theory of transmutation would fit better than any other into a mechanistic biology. Both, however, believed that the true scientist must sacrifice "pet inclinations" to facts. It would, moreover, seem that, after 1859, Virchow persuaded himself that he had insisted on this theory with greater emphasis than may actually have been the case.[105]

Vogt and Virchow were professional scientists of repute and, therefore, supposed to put facts before theory whenever the two disagreed. Louis Büchner, on the other hand, was hardly more than a scientifically trained popularizer of materialistic metaphysics, and in his *Kraft und Stoff* of 1855 we find indeed an outright proclamation of the belief in descent as an almost scientific fact. To Büchner it appears "scarcely understandable how some scientists can object to the assumption of a law of gradual transmutation —for no other reason than that as a rule, under our present-day conditions, such a separation of the individual species of animals is observed, that like parents always create only like offspring."[106]

Admitting that recent research left little room for spontaneous generation, Büchner nevertheless deemed it "not unlikely that it is still possible for the smallest and most imperfect organisms."[107] Johannes Müller's alleged discovery of snails developing in echinoderms is proclaimed as incontrovertible proof "that conditions must once have been possible where such a process could take place in higher animals or in which a monkey, nay any other animal gave birth to a human being!"[108] We have no right to draw inferences from the short period of our experience and from prevailing conditions to the endlessly long prehistoric times and to those states of the earth "in which nature undoubtedly was younger and stronger and more powerful in producing organic forms."[109] There is a law

[104] Rudolf Virchow, "Standpoints in scientific medicine [1877]," translated by L. J. Rather, *Bull. Hist. Med.*, 1956, *30*: 537-543; see p. 540.

[105] In the following paragraph (ibid., p. 540), Virchow says that in the Karlsruhe lecture of 1858, he expressed "the variability of species as a necessary presupposition of the mechanical theory of life . . . in the most clear-cut manner."

[106] Louis Büchner, op. cit., (ftn. 15) p. 82.

[107] Ibid., p. 73. [108] Ibid., p. 87. [109] Ibid., p. 82 f.

of transmutation according to which the transmutation was not, as the old school of natural philosophy demanded, a very gradual one, but rather saltatory and vested in the embryonic development. Thus he summarizes:

> From the most improbable beginning, the simplest element of organic form produced by a union of inorganic materials in involuntary generation, from the sorriest plant or animal cell, it was possible, with the help of extraordinary natural forces and endless periods of time, for that whole, rich world to develop which, infinitely varied in its ramifications, we find surrounding us.[110]

III

The foregoing survey lacks completeness as to authors as well as works covered. However, none of the great biologists claimed as adherents of the idea of descent has been completely disregarded. It seems, therefore, permissible to attempt some general statements.

Our initial question related to the role of the idea of transmutation in German biology during a decade of rising materialism. The idea did not agree with the biblical account, but was otherwise philosophically neutral. If we use the terms "idealist" and "materialist" in the broad sense of the preceding pages, we find more numerous support among the idealists: [111] Schleiden, Baumgärtner, Unger, Schaaffhausen, and Nägeli. Among the materialists, only Büchner supported it outright. Cotta favored it without committing himself. Vogt, though sympathetic, opposed it, and however much it may have appealed to Virchow, his open acceptance is unproven.

This result serves first of all as a renewed reminder of the importance of distinguishing between the idea of transmutation and Darwinism as a particular mode of it. It is not our task to inquire into the reasons for the great success of Darwinism. But we shall try to find reasons for the weakness of the idea of transmutation before 1859. Whether the idea was intrinsically weak, i. e., whether it lacked logical compulsion and factual evidence, shall not occupy us here, since Professor Lovejoy has examined this question in a much broader framework. Rather, we shall see whether the argu-

[110] Ibid., p. 87 f.

[111] Rádl, op. cit. (ftn. 6), has indicated that evolutionary ideas were favored by a number of men who subsequently to 1859 became anti-Darwinists. In this connection the article by S. J. Holmes, "K. E. von Baer's perplexities over evolution," *Isis*, 1947, *37*: 7-14 is instructive.

ments offered were weak *qua* arguments and lacking in persuasive power.

Such weakness is demonstrated first of all in the failure of winning a large number of followers. I mention this obvious phenomenon only in order to emphasize my doubt that suppression by the prevailing scientific opinion is largely to blame. In the case of Vogt and Virchow this could scarcely be the case; their aggressive temperament would have induced them to fight for the principle of transmutation had they felt sufficiently sure of it. Conversely, their reserve towards a theory which had their sympathy indicates that, rightly or wrongly, German biologists before 1859 considered the evidence against transmutation to be too strong.

The weakness is further documented by the multiplicity of arguments and explanations among those upholding transformism. Remarkably enough, none of the authors, except Cotta, was satisfied with accepting the views of any contemporary or previous champion, and of Cotta it would not be strictly correct to speak in terms of acceptance. However much they were influenced by Lamarck, Naturphilosophie, the *Vestiges of Creation*, or any other of Darwin's forerunners, such influence was not considered decisive.[112] Instead, most of them elaborated explanations of their own, or, like Unger and Schaaffhausen, avoided entering into details. In particular, Cotta, Schleiden, Unger, and Schaaffhausen seem to have thought of gradual changes, whereas Baumgärtner, Nägeli, and Büchner thought rather of sudden mutations.

Moreover, of the explanations adduced, some were ingenious, some were vague, and others (like Baumgärtner's and Büchner's) were fantastic. None of them, however, carried Darwin's great gift to the physiologist, viz., freedom from the embarrassment of teleology. In view of the fact that some of the explanations offered, like those of Schleiden and Baumgärtner, might also be called "mechanistic," this seems significant. It suggests that a theory of descent that failed to explain the mutual adaptation between body structure and environment lacked a good deal of the appeal which Darwinism exerted for physiologists like Helmholtz and du Bois-Reymond, to whom the question of the origin of species was of secondary importance.[113]

[112] The only exception is Cotta who, however, went to the other extreme of not adopting openly the views which he reported.

[113] Helmholtz, in a paper of 1853 (*Popular Lectures on Scientific Subjects*, translated by E. Atkinson, New York: 1873, p. 48) mentions the view "that

There was agreement that supernatural influences had to be excluded. There was, moreover, a more or less strongly pronounced desire to exclude, or reduce to a minimum, the frequency of spontaneous generations. Nägeli stated the case most distinctly—but vitiated it by admitting spontaneous generation even in his own day. Unger was most consistent, but then carried over old concepts of *Urpflanze* and idealistic morphology. Most difficult is the evaluation of the relative weight of scientific and speculative arguments. With Baumgärtner and Büchner the impression prevails that they believed in descent and thus found arguments for it, while Schaaffhausen went perhaps furthest in postulating transmutation because the case for the constancy of species seemed very doubtful to him. Taking our authors in the aggregate, all we can say is that nowhere do we find a theory of descent defended in isolation from a *Weltanschauung*, even if exclusion of supernatural creative acts is classed as a premise of scientific reasoning.

On the other hand, it is manifest that the idea of descent was not shrouded in complete silence. Even if weak, it was alive and found outspoken supporters. Thus one cannot help wondering why it did not exert a larger appeal in a time and region which was so favorably inclined to historical thinking. The appeal of an idea does not, after all, necessarily rest on its logical strength and supporting facts. *Entwickelungsgeschichte* was fashionable among German historians and biologists. Why was there no stronger temptation to applying it to species, especially since the concept of progress spoke in favor of transformism? It cannot even be said that another idea of great psychological force, such as biblical orthodoxy, opposed it. Remarkably enough, the Mosaic account of creation plays a negligable role in the argumentation as compared with the constancy of species. The latter of course was the main argument opposed to transmutation. But, whatever its merits, its psychological power is open to doubt.

I think that a psychological explanation has to take account of the fact that, far from being forgotten, the idea of transmutation was

during the geological periods that have passed over the earth, one species has been developed from another, so that, for example, the breast-fin of the fish has gradually changed into an arm or a wing." Without committing himself he adds that probably the majority of observers do not incline to this view. For du Bois-Reymond see John Theodore Merz, *A History of European Thought in the Nineteenth Century*. Vol. II, 3rd ed. Edinburgh-London: Blackwood, 1928, p. 435.

only too well remembered from the days of Naturphilosophie and speculative science.[114] To the post-romantic generation of German biologists, transformism lacked the appeal of newness. This generation prided itself on its rigorously scientific attitude which implied resistance to mere speculation. A comparison with the parallel fate of the idea of a microorganismic etiology of infectious diseases may help our understanding of the situation. Both ideas, that of transmutation and that of the bacterial cause of disease, were widely accepted after 1859: the former suddenly and dramatically with the appearance of Darwin's book, the latter more slowly in the wake of the work of Pasteur. Both ideas were not only well known before 1859, but suffered the fate of being too well known.[115] Nothing essentially new had been added to them, and they might profitably be disregarded by progressive scientists, intent upon the discovery of concrete facts. Whether in either case supporting facts were so conspicuously lacking as to justify that attitude is a different question which cannot be answered within the narrow limits of the period under discussion.

[114] J. H. F. Kohlbrugge, "War Darwin ein originelles Genie?" op. cit. (ftn. 6), has emphasized the widespread interest in theories of transmutation before Darwin and has pointed out several of the factors that account for it. His arguments are, however, influenced by the desire to belittle Darwin's claims, which gives them a one-sided tendency.

[115] As Henry E. Sigerist, *The Great Doctors* (Translated by Eden and Cedar Paul, New York: Norton, 1933), p. 352, pointed out, Henle's *Pathologische Untersuchungen* of 1840, in which he cogently argued for the microorganismic etiology of infectious diseases, found little recognition because "people were willing to believe the evidence of their own eyes. But they were weary of speculation." Erwin H. Ackerknecht, "Anticontagionism between 1821 and 1867," *Bull. Hist. Med.*, 1938, *22*: 562-593, with reference to Henle, says "that what to us appears a vanguard action, impressed Henle's contemporaries rather as a rearguard action. . . ." Yet even before Pasteur, the arguments for the *contagium animatum* were supported not only by speculation but by observable facts as well!