

On the origin of 'species'

Ideological roots of the species concept

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Summary: In a letter from Charles LYELL to the Swedish professor Sven LOVÉN dated 15 December 1867 the English geologist expressed his thankfulness at having been informed about the species concept of LINNAEUS. The great Swedish botanist had later in life changed his view of the fixity of species and integrated further experience within his basic concept of creation to accommodate his opinion about the created original kinds. Incidentally, LYELL also mentioned in his letter that his friend Charles DARWIN was quite surprised, when he, in turn, was told that LINNAEUS had changed his mind.

To that very date DARWIN had believed that it was fair to generalize that according to LINNAEUS the species were simply immutable, fixed and distinct entities. This kind of misrepresentation has followed the image of LINNAEUS and of many of his contemporaries for more than two hundred years. LINNAEUS himself expressed clearly his doubts on the immutability of the species. It can be read in all the editions of his *Philosophia botanica*.

One of the purposes in this chapter is to investigate this misrepresentation of LINNAEUS and the astonishment of DARWIN. Obviously DARWIN had previously been unaware of LINNAEUS' revised thinking, in spite of the fact that he had Linnaei *Philosophia botanica* at hand in his own library. The chief objective in this chapter, however, is to draw attention to the ideological roots of the species concept and to some fundamental ideas of LINNAEUS for the benefit of modern taxonomy.

Later in their lives LINNAEUS as well as DARWIN believed in common descent of certain species. In the context of a theistically oriented Weltanschauung LINNAEUS changed taxonomical level for the created kinds in the Genesis account. By this move he stressed even more the importance of genera. Speciation occurred and it was always caused by hybridization. DARWIN, for his part, rejected the concept of theistic creation, and entertaining a materialistic Weltanschauung he insisted that all modification in the evolution of life occurred by natural forces, i. e. in a non-Linnaean sense of the word "natural" and in sharp contrast to supernatural. The young DARWIN's creationist view of species was in his own time old-fashioned and heavily influenced by Greek thought.

Not very surprisingly, DARWIN himself quite early in his life turned from his extreme form of idealistic creationism; which the greatest among the taxonomists, Carolus LINNAEUS, had abandoned as early as 1742 when it seemingly clashed with empirical data. The views of the mature LINNAEUS took DARWIN by surprise in 1867. Probably DARWIN had always looked upon the Swedish botanist as a stalwart upholder of the fixity of species and never thought of the possibility of a new reasonable synthesis within the framework of theistic creation.

I. Introduction

LINNAEUS and DARWIN

In a letter from Charles LYELL to the Swedish professor of paleontology Sven LOVÉN, the English geologist expressed his thankfulness at having been informed about the species con-

cept of LINNAEUS.¹ During a visit to the LYELLS in London 1867, LOVÉN had been asked about LINNAEUS' view on the nature and origin of species. LOVÉN had said something about the early opinions of his great countryman but also that LINNAEUS later "speculated" and even called

¹ The letter, dated 15 December 1867, is available at the Library of the Academy of Science in

Stockholm.

some species of plants "temporis filia".² Back home in Stockholm, however, LOVÉN prepared a more detailed answer. He consulted the Uppsala botanist Elias FRIES, who, according to LOVÉN, was more familiar with the botanical works and the spirit of LINNAEUS than any man then living.

In his answer LOVÉN outlined three different Linnaean views on species. The immutability stance of the early LINNAEUS was represented by the famous quotation from *Fundamenta botanica* 157: "We count as many species as there were created forms in the beginning."³ LOVÉN added the short comment that it was a "petitio principii, purely theoretical, and an accommodation to the mosaic narrative, not unusual at the time of LINNAEUS." In perceiving a second view LOVÉN stressed the Latin word "hodiernum", i. e. "today", in the same paragraph from *Philosophia botanica*, where it says in a quotation from *Classes plantarum* that: "There are as many species as there are different forms or structures today."⁴ This "today" made the dogma practical for LINNAEUS in his systematic works, LOVÉN explained. That was, according to LOVÉN, the slight difference from the first view.⁵ The third position was, however, quite different. As stated by LOVÉN, LINNAEUS began quite early to "speculate widely on the biology of species" and "more than once expressed the view that a great number of species has originated" since creation.⁶ To prove his point LOVÉN cited and commented on a florilegium of corro-

borating passages from LINNAEUS' works.

LYELL was happy to receive the letter just in time for the printing of his second volume of the 10th edition of his *Principles of Geology*. He could use several references, write some new passages and give LOVÉN and FRIES due acknowledgement in a note.⁷ In passing LYELL mentioned in his reply to LOVÉN that his "friend Charles DARWIN was a good deal surprised", when he, in turn, was told that LINNAEUS had changed his mind.

Accordingly, late in 1867 Charles DARWIN was told that LINNAEUS had changed his mind on the species question. To that very date DARWIN had believed that it was fair to generalize that according to LINNAEUS the species were simply immutable, fixed and distinct entities. This kind of misrepresentation has followed the image of LINNAEUS and of many of his contemporaries for more than two hundred years. In textbooks as well as in learned treatises the views of LINNAEUS have traditionally been represented as fixedly and rigidly as the very species concept itself. The truth of this issue, however, has not been hidden among dusty manuscripts. LINNAEUS himself expressed clearly his doubts on the immutability of the species. It can be read in all the editions of his *Philosophia botanica*. He even elaborated his overall picture of the creation and launched a new hypothesis, which harmonized better with available data and his own experience. Nevertheless, LINNAEUS has been stereotyped and mis-

² i. e. "daughter of time". See Ms. LOVÉN S. 17. A draft to a letter to Charles LYELL. My attention to the letter from LYELL and to the draft of the letter from LOVÉN was drawn by Ulf DANIELSSON *Darwinismens inträngande i Sverige* (The Penetration of Darwinism into Sweden) Part I *Lychnos* 1963-64, (Stockholm, 1965) p. 187. So far the original letter has not been traced. The letters of LYELL are unfortunately scattered among several international repositories.

³ C. LINNAEUS *Fundamenta botanica* (Amstelodami 1736) VI Characteres. § 157 "Species tot numeramus, quot diversae formae in principio sunt creatae."

⁴ C. LINNAEUS *Philosophia botanica* (Stockholmiae 1751) § 157 "Ergo species tot sunt quot diversae formae sive structurae hodiernum occurrunt."

⁵ Perhaps it is worth commenting that what LOVÉN

perceived to be a second view of LINNAEUS was rather a conclusion drawn by his reasoning, which started from the original thesis in *Fundamenta botanica*.

⁶ LOVÉN hesitated in choosing the words "view", "belief", "opinion" or "conviction" and quoted from *Amoenitates academicae* where in the dissertation *De Peloria* on pp. 70-71 LINNAEUS as praeses, obviously for the first time in print, elaborated his new thoughts.

⁷ In the "eleventh and entirely revised edition" (London, 1872) the credit is given on page 325 in vol. 2, where it says; "Two eminent Swedish naturalists, Professors FRIES and LOVÉN, have kindly pointed out to me these and many other passages in which LINNAEUS shows that he had freely speculated on the variability and transmutation of species."

represented, and too often – outside the sphere of serious Linnaean research⁸ – he, *mirabile dictu*, still is.

Objectives

One of the purposes in this chapter is to investigate this misrepresentation of LINNAEUS and the

astonishment of DARWIN. Obviously DARWIN had previously been unaware of LINNAEUS' revised thinking, in spite of the fact that he had Linnaei *Philosophia botanica* at hand in his own library.⁹ The chief objective, however, is to draw attention to the ideological roots of the species concept and to some fundamental ideas of LINNAEUS for the benefit of modern taxonomy.

II. Methodology in history of science research

Basic principles

Much has already been written on the species concept, but surprisingly little which explains DARWIN's curious astonishment.¹⁰ All too often in contemporary literature the species concept, before the time of DARWIN, is associated with two general characteristics; where the first is considered to cause the second: firstly, literal interpretation of the biblical account of creation and secondly, immutability.¹¹ This description, however, shows clearly that the interest of the DARWIN industry has not yet been sufficiently focused on understanding in what specific ideological context DARWIN wrote down his views on the species question, nor what opinion DARWIN was reacting against. Furthermore, the questions why and how he wanted to accomplish his demarcation against his adversaries

have not been given sufficient attention.

Of course, as Mary P. WINSOR says in a book review, the pre-*Origin* days require "an imaginative power greater than most of us can muster." And to mobilize that, as WINSOR maintains, "means to surrender not only our knowledge, but our materialist world-view."¹² With these few words, WINSOR has touched on some basic problems in the methodology of intellectual history. Historians of ideas were for a long time occupied with tracing "forerunners" or "precursors" to the "right" view.¹³ These "right" views seemed, curiously often, to be the dominating ones in their own time. Consequently, the task to understand the background and context was neglected and the opinions of the more or less "uninteresting" opponents were too easily dismissed. The heroes were men like GALILEO, NEWTON, LYELL, DARWIN and others. They were strip-

⁸ By scholars like C. E. B. BREMEKAMP, G. BROBERG, G. ERIKSSON, T. FRIES, J. L. LARSON.

⁹ "The Darwin Library – Down has both the *Systema naturae*, Ed. 13a, Cura J. F. GMELIN (bound in 10 vols.) (LINNAEUS 1789–96) and the *Systema vegetabilium*, Ed. 15a . . . (LINNAEUS 1797) . . . The Darwin Library – CUL [Cambridge University Library] has LINNAEUS's *Philosophia botanica* (LINNAEUS 1783b), lightly annotated." *The Correspondence of Charles Darwin* vol. 1. 1821–1836 (Cambridge 1985), p. 260 n. 6.

¹⁰ See e. g. Marc ERESHEFSKY *The Units of Evolution. Essays on the Nature of Species* (Cambridge Ma. 1992) David KOHN ed. *The Darwinian Heritage* (Princeton, 1985), Michael T. GHISELIN *The Triumph of the Darwinian Method* (Chicago, 1969), Neal C. GILLESPIE *Charles Darwin and the Problem of Creation* (Chicago, 1979), David L. HULL *Darwin and His Critics The Reception of Darwin's Theory of Evolution by the Scientific Community* (Chicago, 1973), *Science as Pro-*

cess (Chicago, 1988), M. J. KOTTLER *Charles Darwin's biological species concept and theory of geographic speciation: the transmutation notebooks. Annals of Science* 35, 275–297, Ernst MAYR (in his works *passim*) et al.

¹¹ See e.g. Ernst MAYR *The Growth of Biological Thought* (Cambridge, Mass. 1982) p. 255, *Toward a New Philosophy of Biology. Observations of an Evolutionist.* (Cambridge Mass., 1988) p. 313, Peter BOWLER *Evolution. The History of an Idea* (Berkeley, 1983, 1989, 5, 359), Neal C. GILLESPIE op. cit. pp. 20–21. This view is often connected with the assumption that the biblical world picture is static. Cf. Ernst MAYR *The Idea of Teleology Journal of the History of Ideas* (1992) vol. 51, No.1 p. 117ff. Franz M. WUKETITS *Evolutionstheorien. Historische Voraussetzungen, Positionen, Kritik* (Darmstadt, 1988), p. 18ff.

¹² Mary P. WINSOR *Isis* 76, 1985 p. 252.

¹³ See e. g. Bentley GLASS, Owsei TEMKIN, William L. STRAUSS *Forerunners of Darwin* (Baltimore, 1959).

ped of their world-view and time after time honoured and crowned as the saints of science without a stain on their scientific records. These interpretations now belong to history and are looked upon as ideologically motivated.¹⁴ With the demise of the positivist consensus in the form of logical empiricism, our images of the heroes have developed more human proportions.

The previous view of the Enlightenment and of the role of science as the sole torch of Truth is simply not sustainable any longer. The late positivist school of the philosophy of science was not really interested in the history of science,¹⁵ while historians of science have played an important role in the dethronement of this school and in tracing the interactions between science and society at large. When we deal with science in any culture and any time we have – at least to some extent – simultaneously to deal with the larger context: world-views, ideologies, religion, politics, economics etc. How else could we get a firm grip on understanding the speculative nature of GALILEO's ideas, the alchemy of NEWTON, the dogmatism of LYELL, the "Lamarckism" of DARWIN or all the other apparent inconsistencies in the past and even in our own time?

Rationality

A primary methodological principle is that an historian of science ought to presuppose that there was a rationale for a view once held.

¹⁴ The literature which has contributed and still contributes in this copernican revolution in the Philosophy of Science has been quite extensive since the publishing of Thomas S. KUHN's *The Structure of Scientific Revolutions* in 1962. Even though the issue on the arena of philosophy of science is not yet fully settled – and perhaps never will be – a post-positivist consensus among the defenders of scientific realism and the social constructivists has, according to Richard BOYD, emerged. See the anthology *The Philosophy of Science*, eds. R. BOYD, P. GASPER and J. D. TROUT (Cambridge, Mass. 1991), p. xi.

¹⁵ This assertion has been commented upon by many including M. J. S. HODGE and G. N. CANTOR, *The Development of Philosophy of Science Since 1900*, pp. 838–852 in *Companion to the History of Modern Science*, ed. R. C. COLBY et al. (London, 1990).

¹⁶ R. HOOYKAAS *Wissenschaftsgeschichte – eine Brük-*

Often the evidence available at the time led to a perfectly reasonable position, which, however, can be hard to assess if it does not square with the historian's own views. According to the Dutch historian of science, Reijer HOOYKAAS, an historian ought to look at the science of the past with a "phenomenological method" as if he were "its contemporary critical observer."¹⁶ He must, consequently, at least try to liberate himself from the burden of the common ideas of his own time. In his research he has to look for the contextual rationality of once accepted views, even if they no longer seem rational according to his own frame of reference.¹⁷

Different world-views

A second principle is to stress the crucial importance of distinguishing the different world-views represented by the object of interpretation and by the interpreter himself.¹⁸ The "materialist world-view" of WINSOR and others has not been the dominating one in Western culture very long, but it has already caused too many scholars to misunderstand and even neglect the historian's task of understanding and transmitting the historical background, the rationale and the coherence of ideas held at a different time and age. This chapter proposes that this is the case with the pre-*Origin* views on species.¹⁹ Therefore, it is vital to trace the history of the word "species" and its conceptual background, in order to uncover ideological roots of the species concept at the time of Char-

ke zwischen Natur- und Geisteswissenschaften. Berichte zur Wissenschaftsgeschichte 5, 1982, p 153.

¹⁷ Concerning the term and concept "Darwinism" James MOORE even finds that questions like "After all, who got it right? Who correctly interpreted what DARWIN said? Who understood what DARWIN really meant? Who has fair claim to represent authentic Darwinism?" are "unhistorical, and thus uninteresting." *Deconstructing Darwinism: The Politics of Evolution. Journal of the History of Biology (JHB)* 24 1991 p. 358.

¹⁸ Neal C. GILLESPIE op. cit. argues in the same way, when he uses FOUCAULT's "episteme", which is almost another word for epistemology, contrasting what he call "positivism" against "creationism".

¹⁹ In the history of geology, there has been a comparatively recent reevaluation of geological science before LYELL. R. HOOYKAAS triggered the reinterpret-

les DARWIN. This implies trying to grasp not only different historical and intellectual contexts but also different world-views.²⁰

History of "idea"

Concepts like "species" can not sufficiently be treated as solitary ideas in human history. Like all human artifacts, concepts have been formed by the minds of men. And as the minds of men differ, so do concepts. Nevertheless, historians, having been instructed by the intense dialogue on epistemology, on theory of science and on methodology of history of science, need to write the history of ideas all over again. Not in the old "forerunner-fashion", even though we still have much to learn from earlier generations of scholars.

III. Historical background

DARWIN and the fixity of species

Traditionally it has been said that the young Charles DARWIN (1809–1882) during his studies in Edinburgh and Cambridge was taught that species were eternal and immutable and that they did not interbreed. God's immutability, it was thought, secured the fixity of the species. Nevertheless, in the previous century there had been an interest among scientists in hybridization. Gunnar BROBERG calls attention to the fact that even the old textbooks in natural philosophy talked about "animalia spuria", which were explained by unnatural and forbidden contacts.²¹ But these bastards were the exceptions that confirmed God's original order of creation.

Although the immutability position was the officially received and accepted view in Great

This chapter, hopefully, will help us come a little bit closer to answering the question why LINNAEUS and DARWIN in their different social, ideological and scientific contexts reacted so differently to nature. Both were men of science, wanting to contribute to the project of enlightening mankind. They still have immensely prestigious positions in our society. Already in their own time they had become symbols of widely different interpretations of nature. To write on the question of species is, therefore, a challenge to write history and the history of ideas at the same time. But, the history of "species" must, to a considerable extent, be the history of an "idea". The simple reason for that, is that the Latin word "species" is an often used translation of the Greek word "idea (ἰδέα)". Therefore, this chapter could have been called: The history of "idea".

Britain there were of course different views on the scope and limit of species. The majority of the naturalists believed that species always produced offspring according to its own kind, but assessing the border between species on the one hand and subspecies and varieties on the other was a tricky business and always open to criticism. The problem was to define the limits between the systematic categories.

There were also centers of free-thinking. Some universities like London and Edinburgh were known for their intellectual freedom, and some free-thinkers were well known for their unorthodox views. Quite early DARWIN himself seems to have harboured heretical notions on the subject. There was the influence from his famous grandfather Erasmus DARWIN and his *Zoonomia*, which Charles had read as a young boy. In his autobiography, however, he asser-

tation by his seminal work *Natural law and Divine Miracle. A Historical-critical Study of the Principle of Uniformity in Geology, Biology and Theology* in 1959. After HOOYKAAS scholars like Susan F. CANNON with various male pseudonyms, M. J. S. RUDWICK, Nicolaas A. RUPKE et al. have followed up this project.

²⁰ The concept "world-view" could, perhaps, in certain contexts, be replaced by e. g. KUHN's "paradigm" or Foucault's "episteme".

²¹ Gunnar BROBERG *Homo sapiens L. Studier i Carl von Linnés naturuppfattning och människolära* (Stockholm, 1975), pp. 44–47

ted that he had read the work but that it did not produce any effect on him.²² More important were his two years (1826–1828) of medical studies in Edinburgh,²³ “a haven for wealthy Dissenters”,²⁴ where he got to know the “passionate Francophile”²⁵ and Lamarckian evolutionist Robert GRANT.²⁶ Adrian DESMOND and James MOORE assert that what he learned from GRANT “was to shape his own initial approach to evolution ten years later.”²⁷ This view seemed plausible even to DARWIN later in his autobiography.²⁸

LINNAEUS in England

The botanists John RAY (1628–1705) and Carolus LINNAEUS (1707–1778) had dominated the field of taxonomy and their influential works on systematics had impressed the view of the permanence of the created species on almost all

English natural scientists.²⁹ The young LINNAEUS was keen to organize the three kingdoms of nature according to the same principles.³⁰ Among his admiring contemporaries one often said: *Deus creavit, Linnaeus disposuit*.³¹

Soon LINNAEUS had got a firm footing in England. Contributing to this was his own visit to England 1736 and his early contacts with botanists such as DILLENIUS in Oxford. English friends even asked LINNAEUS to send Swedish disciples to England. The choice fell upon Daniel SOLANDER and Jonas DRYANDER, who worked as botanists, Museum Curators and librarians to the mighty and wealthy president of the Royal Society, Sir Joseph BANKS. Above all, as an indication of the success of the Linnaean taxonomy in England we have to take into account the final abode of the Linnaean Collections and the foundation of the prestigious Linnaean Society.

²² “without producing any effect on me.” op. cit. 13.

²³ Adrian DESMOND has with his *The Politics of Evolution* (Chicago, 1989) shown something of the complicated background of DARWIN by tapping medical journals and analyzing the social and medical context of especially London. DARWIN's friend and personal tutor Dr. GRANT moved from Edinburgh to England for the London University chair of comparative anatomy, which he held from 1827 to 1874.

²⁴ A. DESMOND & J. MOORE *Darwin* (London, 1991), p. 22.

²⁵ *ibid.* p. 34.

²⁶ In the article Edinburgh Lamarckians: Robert Jameson and Robert E. Grant. *JHB* vol. 24 (spring 1991), pp. 1–18 James A. SECORD convincingly argues that DARWIN's old professor of Natural History at Edinburgh Robert JAMESON was a Lamarckian and, with the words of DESMOND & MOORE op. cit. p. 42, “one wonders what Charles made of his closing lectures on the ‘Origin of the Species of Animals.’ ” An often overlooked circumstance is that DARWIN as most of his contemporaries believed in the inheritance of acquired characters. This can clearly be seen e. g. in his *Origin* and in his various drafts to the same work. In the end of the second volume of *The Variation of Plants and Animals under Domestication* (New York, 1868) Charles also launched his all embracing hypothesis about heredity, called Pangenesis. This hypothesis was very important for DARWIN, because it provided with a desperately needed cause to variations among plants and animals. The mechanism propo-

sed in the hypothesis with germs reproducing characters in each part of the body and shaping the following generation according to the present status at the reproduction, was definitely Lamarckian; not, however, in the sense that it was true to LAMARCK, but in the modern sense that it was in accordance with the common belief in the heredity of acquired characters.

²⁷ *ibid.* p. 36.

²⁸ *The Autobiography of Charles Darwin and Selected Letters*. ed. Francis DARWIN (New York, 1958, 1892) p. 13.

²⁹ Frans A. STAFLEU *Linnaeus and the Linnaeans. The Spreading of their ideas in systematic botany, 1735–1789* (Utrecht, 1971). See esp. chapter 7 Great Britain: Solid victory, pp. 199–240, see also e. g. *A History of the Linnaean Society of London* (London, 1938) and J. R. GREEN *History of botany in the United kingdom* (1914).

³⁰ Concerning the taxonomy of minerals see Reijer HOOYKAAS The species concept in eighteenth-century mineralogy. *Archives International d'Histoire des Sciences* vol. 1, 1952, pp. 45–55, Wissenschaftsgeschichte – eine Brücke zwischen Natur- und Geisteswissenschaften. *Berichte zur Wissenschaftsgeschichte* 5, pp. 155, Rachel LAUDAN Individuals, Species and the Development of Mineralogy and Geology, in Michael RUSE *What the Philosophy of Biology is. Essays dedicated to David Hull*. (Dordrecht, 1989), pp. 221–233, and by the same author *From Mineralogy to Geology: The Foundation of a Science 1650–1830* (Chicago 1987).

³¹ i. e. God created, LINNAEUS arranged.

Natural Theology moulded the minds of the intelligencia at Oxbridge. In *Historia plantarum* (1686) RAY had asserted the constancy of species, and in *Systema naturae* (1735) LINNAEUS had declared that "if we behold the works of God, it is more than sufficiently obvious to all, that every animate being comes into existence out of a parent's egg, and that all eggs produce offspring like its parents, wherefore no new species can arise."³² Furthermore he asserted in his *Fundamenta botanica* (1736) that we count as many species as there were different forms created at the beginning.³³ In addition to the various editions of *Fundamenta botanica* this famous dictum was also restated and commented in all the editions of *Philosophia botanica*. LINNAEUS meant that the essence of a plant or an animal enabled it to be classified according to species and higher orders. However, species and genera were clearly a result of God's creation. Variation was a product of culture; classes and orders were products of God's creation and art. These rules of LINNAEUS were supported by empirical observation. Species, according to LINNAEUS, are "constantissimae", because their generation is "vera continuatio". In *Classes plantarum* (1738) he argued that the created species were forms, which according to the inherent laws of generation, produced more, but always like themselves.³⁴ But also the genera were a product of creation. In *Philosophia botanica* and in his other writings he asserted that genera are "naturalia" i. e. an order of creation.³⁵ Most of the plants prove it, he wrote

simply. Gardening, LINNAEUS argued, proves that varieties are caused by cultivation and the natural orders even teach that most of the orders and classes are natural.³⁶

Natural classification

During his whole life LINNAEUS searched for a natural classification. He strived for a "methodus naturalis", but confessed that a key for the plant kingdom, for instance, could not be given before all plants were related to their orders.³⁷ In this context it is important to bear in mind that in using the Latin word "naturalis" or its various derivations LINNAEUS normally intends the meaning "created as such" or "specially created".³⁸ During his whole life LINNAEUS wanted to identify the kinds of plants and animals God created in the beginning. Belief in God was fundamental to him and divine intervention did not contradict his efforts to implement a system of nature.

The concept of genus was more fundamental for LINNAEUS than the concept of species. Both were natural and, therefore, created by God's direct intervention. But in establishing order the genera were prior in significance. In his introduction to *Genera plantarum* from 1737 LINNAEUS quoted Andreas CAESALPINUS, the father of Systematic Botany, who, following LINNAEUS, first "cum publico" presented a system of genera according to what he believed were their natural affinities. CAESALPINUS stated that if the genera are in disorder, everything will be in

³² C. LINNAEUS *Systema naturae* 1735 "Observationes in Regna III naturae. 1." "Si opera Dei intueamur, omnibus satis superque patet, viventia singula ex ovo propagari, omneque ovum producere sobolem parenti simillimam. Hinc nullae species novae hodiernum producuntur."

³³ See note 3.

³⁴ *Classes plantarum* (Lugduni BATAVORUM 1738) 5 ". . . quae formae, secundum generationis inditas leges, produxere plures, at sibi semper similes."

³⁵ Referring to other writings of LINNAEUS one example will due here. In the dissertation *Vires plantarum* from 1747 with the respondent F. HASSELQUIST the text says in the beginning of § VIII: "Videmus igitur dari, fere in universum, genera naturalia, ab ipso Creatore ordinata;" The text is quoted from *Amoenitates academicae* (Holmiae et Lipsiae MDCCXLIX).

³⁶ LINNAEUS *Philosophia botanica*, VI Characteres 162 "NATURAE opus semper est species (157) & Genus (159), CULTURAE saepius varietas (158), NATURAE & ARTIS Classis (160) ac Ordo (161). Species constantissimae sunt, cum earum generatio est vera continuatio. Genera esse naturalia evincunt plurimae plantae: *Aconita, Nigellae, Bignoniae, Ranunculi, Mesembryanthema, Zygophylla, Gerania, Oxalides*. Varietates culturae opus esse, docet Horticultura, quae easdem saepius & producit, & reducit. Classes & Ordines plerasque naturales esse, docent ordines naturales § 77."

³⁷ See *Fragmenta methodi naturalis*, in *Classes plantarum*, op. cit. p. 127.

³⁸ See e. g. *Philosophia botanica* § 159, where it says quoting from *Systema naturae* on genera that "Genus omne est naturale, in primordio tale creatum . . ." Cf. Frans A. STAFLEU op. cit. p. 67 and 125.

disorder.³⁹ The true demarcation of genera was, according to LINNAEUS, the very foundation, the *punctum fixum* and even the *canon fundamentalis* for all taxonomy. And if the botanists do not observe it, the splendid edifice will in the first tempest immediately collapse, LINNAEUS feared.⁴⁰

This combination of both species and genera as specially created made it easier for LINNAEUS later in life to modify his views on species. In *Philosophia botanica* LINNAEUS seemingly without any hesitation called his own aphorism on fixity of species into question in the very paragraph where he developed the dogma. That was never the case with genera.⁴¹ Accordingly for LINNAEUS botany rests on fixed genera.

For DARWIN natural classification was to ascertain actual relationships. These consisted in descent from a common stock. For him the word "nature" and its derivations had nothing to do with creation in the original sense of the word. In his *Origin of Species* he contended that phrases like "plan of the Creator" added "nothing . . . to our knowledge."⁴² In private letters he could be even more outspoken. To a Mr. WATERHOUSE he wrote simply that it was "empty high-sounding sentences"⁴³ and to his close friend, the botanist Joseph Dalton HOOKER, he wrote in March 1863: "I have long regretted that I truckled to public opinion, and used the Pentateuchal term of creation, by which I really meant 'appeared' by some wholly unknown process."⁴⁴

Yet DARWIN himself had once been happy to include the Creator in his theories and he had believed in the immutability of species. That

was, according to himself, the "common view", which he supplanted with his theory. In his autobiography DARWIN nevertheless claimed that he "never happened to come across a single one [i. e. naturalist] who seemed to doubt about the permanence of species."⁴⁵ And in his *Origin* he asserted: "Why, it may be asked, have all the most eminent living naturalists and geologists rejected this view of the mutability of species?"⁴⁶ In his introduction to the same work on page 6 he wrote that "the view which most naturalists entertain, and which I formerly entertained – namely, that each species has been independently created – is erroneous."

The immutability concept, according to DARWIN himself, would have led him to extreme conclusions. When he worked with his voluminous classification of Barnacles his "most frequent source of doubt was whether others would not think this or that was a God-created Barnacle & surely deserved a name."⁴⁷ By then he had become convinced that the species were mutable, but he should have known that he was far from alone in that respect.⁴⁸

PLATO and ARISTOTLE

Tracing back the formation of the Linnaean species concept, we have to turn to the classical Greek and Roman world. LINNAEUS worked as a natural scientist in the Aristotelian tradition. When ARISTOTLE classified animals or when Theophrastus, the great disciple of ARISTOTLE, classified plants they both used the concepts genus (Gk. "genos", γένος) and species (Gk. "eidos", εἶδος).⁴⁹ The use of the two concepts

³⁹ "Confusis generibus omnia confundi necesse est." *Genera plantarum* (Lugduni BATAVORUM 1737) § 6 in *Ratio operis*.

⁴⁰ *ibid.* § 8 ". . . quem si non observant aediles, illico ruit prima oborta tempestate splendissimum quamvis aedificium."

⁴¹ "NOVAS SPECIES dari in vegetabilibus negat generatio continuata, propagatio, observationes quotidianae, Cotyledones. Dubium movere *Marchant. act. paris.* 1719; Ego in *Peloria* 1744; *Gmelinus* in *orat. inaug.* 1749. vide *Amoenit. acad.* 71."

⁴² Charles DARWIN *On the Origin of Species* (London 1859) p. 413.

⁴³ *The Correspondence of Charles Darwin* vol. 2, 1837–1843 p. 375 f.

⁴⁴ Francis DARWIN *The Life and Letters of Charles Darwin* (London, 1887) vol. 2, pp. 202–203.

⁴⁵ *The Autobiography of Charles Darwin and Selected Letters.* op. cit. p. 45.

⁴⁶ Charles DARWIN *On the Origin of Species* (London 1859), p. 480.

⁴⁷ *The Correspondence of Charles Darwin* vol. 6. 1856–1857, p. 194.

⁴⁸ See below the paragraph "Lost credibility", p. 57.

⁴⁹ J. J. HALL *The classification of birds, in ARISTOTLE and early modern naturalists (I)*, *History of Science (Hist. Sci.)*, xxix (1991) p. 111 ff., James G. LENNOX *Aristotle on Genera, Species, and "the More and the Less"*, *JHB* vol. 13 pp. 321–346. Cf. A. GOTTHELF & J. G. LENNOX *Philosophical issues in Aristotle's*

had a clear technical distinction in the field of logic and later there developed a similar hierarchic distinction in biology.⁵⁰ Behind the Aristotelian concept of "eidos" was hidden the metaphysics of his master, PLATO.⁵¹ In PLATO's world-view the concept of "idea" (Gk. e. g. ἰδέα or εἶδος) had an essential importance.⁵² There was a world of ideas separated from the world of senses. This world of ideas was for PLATO the real world, and it consisted of perfect ideas of everything from qualities like "beauty" to living beings such as "man" and "cat".

The question is, what kind of relation these ideas had to the world people normally refer to as "reality". Traditionally, PLATO has been interpreted as having claimed that one gained knowledge of true reality by a philosophical contemplation of the eternal ideas, while ARISTOTLE thought that one acquired this knowledge by sense experience of the palpable instan-

ces of the different ideas in this world. This well-known difference between PLATO and his disciple ARISTOTLE can easily be seen in the subsequent history of the natural sciences, in which there have often been controversies between scientists of the two traditions. The Platonists have stressed and preferred philosophical contemplation to empirical studies and looked with condescending disdain at the foolishness and naïveté of those Aristotelian colleagues who have worked with hands and eyes. The conception of "idea" or "form" (i. e. Gk. μορφή) was therefore common to the two great philosophers, although they stressed different ways of arriving at knowledge of the ideas.

The purpose here is not to go into the sophisticated debate on the meaning of these terms in the writings of the great Greek philosophers.⁵³ Rather, the interest is focused on the understanding and use of these terms in the

biology (Cambridge, 1987) and P. PELLEGRIN ON ARISTOTLE'S Classification of animals. In a preliminary Ibycus-scanning through the corpus of ARISTOTLE, it was noticed that the nominative of the words ἰδέα, εἶδος, μορφή, γένος and σχῆμα occurred respectively 226, 561, 192, 869 and 618 times.

⁵⁰ Commenting the technical discussion on the classification of ARISTOTLE, HALL concludes: "However, despite the lack of special vocabulary there are passages in ARISTOTLE which suggests the construction of a hierarchy of progressively narrower genera, roughly similar to that used by modern zoologists." *ibid.* p. 112. Anne BAÜMER *Geschichte der Biologie Band 1: Biologie von der Antike bis zur Renaissance* (Frankfurt am Main, 1991) says that it was Caspar BAUHIN (1519–1603), who first made the completely accomplished hierarchic classification of species and genera. ("Hier gelangen Caspar BAUHIN erste Fortschritte, da er durch die Einführung einer binären Nomenklatur, die auf einer erstmals konsequent durchgeführten Unterscheidung zwischen Genus und Spezies beruhte, erste Anfänge einer natürlichen Systematik vorlegte, die von Andreas Cesalpin ausgearbeitet wurden." p. 228.)

⁵¹ See e. g. Anne BAÜMER *op. cit.* p. 42 "ARISTOTELES übertrug nämlich den Platonischen Ideenbegriff auf die biologische Art und bezeichnete mit ihm das Gleichbleibende im biologischen Naturgeschehen. Die Arten sind für Aristoteles ewig und unveränderlich, Ziel eines jeden Organismus ist es, wie bereits angedeutet, sich selbst zu reproduzieren, um auf diese Weise durch den Weiterbestand

seiner Art an der Ewigkeit teilzuhaben." Cf. D. M. Balme, LENNOX, GOTTHELF and also E. L. GREENE *Landmarks of Botanical History I–II* (STANFORD, 1983)

⁵² The original Greek meaning of the words ἰδέα and εἶδος is nearly the same. The words stem from the same root and both mean "that which is seen". The basic English rendering is "form", and as stated by LIDDELL & SCOTT, *Greek-English Lexicon* (Oxford, 1977) the words are also in the writings of PLATO and ARISTOTLE translated according to the different contexts, e. g. in logic – "class" or "kind" and in philosophy – "ideal form" and "archetype" (ἰδέα) or formal cause and essence (εἶδος).

⁵³ For example, Scott ATRAN denies in his *Origin of the Species and Genus Concepts: An Anthropological Perspective*. *JHB* Vol. 20, No. 2 (Summer 1987), p. 224ff, that the traditionally referred ingredient to Aristotelian essentialism of the eternal fixity of the forms "appropriately appl[ies] to Aristotle." On the other hand David HULL states in *Science as a Process. An Evolutionary Account of the Social and Conceptual Development of Science* (Chicago, 1988), p. 82 that "according to Aristotle and generations of Aristotelians, all species are as eternal and immutable as are the physical elements. No one today expects lead to evolve into gold; Aristotle had no higher expectations of fish evolving into frogs. To be sure, an organism might change its species, just as a sample of lead might be transmuted into a sample of gold, but the species themselves remain unchanged in the process. Species are at least potentially eternal."

generations which were to follow. Three strands of understanding in the history of the Latin West will be mentioned here.

Roman philosophy

Although there is some originality in the philosophical writings of the Romans, their greatest contribution was to hand down the Greek philosophical thought to the Latin-speaking world well into the Renaissance and even beyond. One very important figure in this respect was CICERO, the Roman politician and author. Approximately three hundred years after Greek philosophy reached its apex, CICERO made a tremendous contribution through his philosophical writings. Without any regard for modern copyright laws, he wrote influential treatises that depended heavily upon the Greek

heritage. In choosing Latin words for the Greek "eidos", "idea" or "morphe" he used "species"⁵⁴ and sometimes "forma".⁵⁵ The very terms and the ideas behind them became a cornerstone in the foundation of the species concept of CAESALPINUS, RAY, LINNAEUS and other early botanists.

The Vulgate

The Vulgate, JEROME's Latin translation of the Bible, has had an immense impact on the language and thought of Western culture. The Vulgate is influenced by CICERO's terms and uses the translation "species" or "genus" of the Hebrew "min",⁵⁶ which roughly can be translated with "sort", "kind" or "type".⁵⁷ The Vulgate's account of Genesis reiterates phrases like 'secundum speciem suam',⁵⁸ and in the

⁵⁴ See e. g. *Tusculanae disputationes* I. XXIV. 58 and *Academica* I. IX.

⁵⁵ See e. g. *Orator* 10, *De natura deorum* II 145.

⁵⁶ The technical expression that is used in the OT is, in transcribed form, *lēmīnō*, "according to its kind". It consists of the preposition *lē*, "according to", the noun *mīn*, "kind", and some form of the suffixed possessive pronoun in the third person, as e. g. here *-ō*, "its". The noun *mīn* is always in singular, but it is among OT-scholars understood as a collective singular. The translation is not controversial. The expression occurs 31 times in the OT. Genesis 1:11, 12(2), 21(2), 24(2), 25(3), 6:20(3), 7:14(4), Leviticus 11:14, 15, 16, 19, 22(4), 29, Deuteronomium 14:13, 14, 15, 18 and Hesekiel 47:10. For the Hebrew technical data in this note I'm thankful to the OT-scholar Åke VIBERG, Lund.

⁵⁷ The most common English and American Bible translations use "kind", e. g. King James Version, Revised Version, American Standard Version, New English Bible, New American Standard Bible. The Revised English Bible has "kind of seed" and The Jerusalem Bible "species". The New International Version and the English OT-scholar Gordon J. WENHAM uses "type". See *1 Word Biblical Commentary. Genesis 1-15* (Dallas, 1987). Martin LUTHER used "nach seiner Art". Carl Friedrich KEIL writes about "Art" in his *Genesis und Exodus* (Gießen, 1878) and so does also Franz DELITZSCH in *Neuer Commentar über die Genesis* (Leipzig, 1887). In explaining the Hebrew word *mīn* DELITZSCH says that it is "genau dem griech. εἶδος, dem lat. species entsprechend" (p. 58). Claus WESTERMANN writes in his *Genesis* (Neukirchen, 1974): "Zusammen mit den Definitionen kann das Wort nichts anderes bedeuten als

der moderne Begriff, wie er u. a. auch in der Naturwissenschaft verwendet wird: Art oder Gattung" (p. 174-175). On the other hand Walter KAISER writes in *Theological Wordbook of the Old Testament*, eds. R. Laird HARRIS, Gleason L. ARCHER, Jr., and Bruce K. WALTKE (Chicago, 1980), pp. 503-504: "Some have argued that when God created *mīn*, he thereby fixed the "species". This is a gratuitous assumption because a link between the word *mīn* with the biologists descriptive term species cannot be substantiated. . ." KAISER concludes the article on *mīn* in the following way: "God created the basic forms of life called *mīn* which can be classified according to modern biologists and zoologists as sometimes species, sometimes genus, sometimes family or order. This gives no support to the classical evolutionist view which requires developments across kingdom, phyla, and classes."

⁵⁸ i. e. "according to its species". In Genesis 1 of the Vulgate we find, as correspondingly with the Greek words in ARISTOTLE's biological writings, the terms "species" and "genus" used interchangeably: "secundum speciem suam" (v. 12), "secundum species suas" (v. 24) "iuxta species suas" (v. 25), "in species suas" (v. 21), "iuxta genus suum" (v. 12), "secundum genus suum" (v. 21) and "in genere suo" (v. 25). In the Septuagint (LXX) all these phrases are translated from the Hebrew with κατὰ γένος.

⁵⁹ In *De Genesi ad litteram* Augustine with his neoplatonist cast of theology used the word "genus" throughout and explains the concept in the following quote: "Hoc est ergo secundum genus, ubi et seminum vis et similitudo intellegitur succedentium decedentibus, quia nihil eorum ita creatum est, ut semel existeret, vel permansurum vel nullo succe-

history of theology and biblical interpretation the word "species" came to mean the unchanging form or idea of a created being.⁵⁹ My conclusion after studying the subject so far is that the Platonic and Aristotelian view of the immutability of species imposed itself upon the understanding of Genesis. This conflation of the Hebrew Scriptures and Greek philosophy had far-reaching consequences for the development of science and theology.

Scala naturae

Another classical notion of vast influence, essentially suggested by ARISTOTLE, was the Great Chain of Being, the *scala naturae*.⁶⁰ This concept had two closely related components, the idea of constancy and the idea of plenitude. Later in the Christian world these ideas contained at least two distinct beliefs: first, that God had created all things that possibly could have been created and, second, that God had created these perfect and immutable forms or species in a hierarchic order from the simplest physical organism to the most complex spiritual being. The chain was so complete that all things from angels to formless matter composed a ladder of increasing complexity and minute differences. And furthermore, it had all existed simultaneously since creation. *Natura non facit saltus*, i. e. nature makes no leaps, was the famous dictum for the perfection of the Creator's chain. The structure of the whole universe had the highest degree of perfection. Even Charles DARWIN, as most of the biologists before him, took this dictum to heart, but later with an important twist. Using it for slow accumulative change he reiterated the phrase to his friends and followers including the comparative ana-

tomist Thomas Henry HUXLEY, who among others from time to time leaned towards saltationism. With DARWIN, however, triumphed the temporalization of the Great Chain of Being. According to him, the chain had not been created all at once, but had successively evolved in time without any supernatural intervention. Together with the ideas of immutability, constancy and plenitude the Great Chain of Being had formed a view of nature that had made classification possible. With DARWIN and his followers the chain became a tree with no borders between the forms to transgress and in fact no species to transmute.⁶¹

Lost credibility

The pre-*Origin* stage of the species question was in a fluctuating state. The old Aristotelian position, which can duly be called a scientific hypothesis, was in its extreme form a dead end for research. Zoology and botany were no longer sciences characterized by collecting, describing and naming. More and more scholars, including dominating men such as LINNAEUS, BUFFON, Georges CUVIER and even contemporaries like Richard OWEN, worked with the same problem as DARWIN. Some of them wanted to be free to speculate not only on historical questions but on questions of origin. A growing number of scientists also found that their experiences of reality could not be harmonized with a rigid immutability stance. In 1915 J. H. F KOHLBRUGGE published an animated article, in which he asserted that 87 of DARWIN's contemporary scientists believed in the variability of species to such an extent that the author accused DARWIN of being unaware of the positions of his colleagues and incapable of mastering

dente decessurum." Lib. III.12. Thomas AQUINAS e. g. integrated the Aristotelian essentialism in his massive and elaborated systematic theology. AQUINAS wrote in his *Summa Theologiae* I.98.1: "Quia igitur in rebus corruptibilibus nihil est perpetuum et semper manens nisi species, bonum speciei est de principali intentione naturae, ad cuius conservationem naturalis generatio ordinatur."

⁶⁰ Arthur O. LOVEJOY *The Great Chain of Being* (Cambridge, Mass. 1936).

⁶¹ That was the critique of DARWIN by Louis AGASSIZ in

his *Contributions to the Natural History of the United States of America* vol. 3 (Boston, 1860), p. 89–90 n. 1. and by William HOPKINS in *Physical Theories of the Phenomena of Life*, in *Fraser's Magazine* 1861, 739–752 and 1862, 74–90. The first reference is from John Beatty *Speaking of Species: Darwin's Strategy*, in *The Darwinian Heritage*, ed. David KOHN (Princeton, 1985). HOPKINS essays are reprinted in *Darwin and His Critics The Reception of Darwin's Theory of Evolution by the Scientific Community*, ed. David L. HULL (Chicago, 1973), pp. 229–275.

foreign languages.⁶² Others, seemingly, did partake in a gentlemen's agreement not to discuss the issue in public.⁶³ After all, since NEWTON it was felt to be more a question of philosophy than of science.

The standard application of the old scientific Aristotelian view, which the young LINNAEUS as well as the young DARWIN had endorsed, and which had been married to the biblical interpretation of the creation account long before did, little by little, lose its intellectual and scientific credibility.⁶⁴ Of course there were many able defenders of a more sophisticated application of the old immutability stance like the Cambridge educated entomologist Thomas Vernon WOLLASTON, who three years before the *Origin* was published had written the work *On the Variation of Species*.⁶⁵ DARWIN had seen WOLLASTON as a potential convert, but was badly mistaken. In a review of the *Origin* in 1860 in *Annals and Magazine of Natural History* WOLLASTON thought that DARWIN had "pressed his theory too far". Varieties were "at times mistaken by naturalists for true species . . ." and that was "surely no argument against the genuineness of the latter: it merely shows", WOLLASTON continued, "the imperfection of our limited judgment, and that the best observers are liable to err, and either not to catch the true characters of a species intuitively (which, in point of fact, they could scarcely be expected to do), or else to assign at times undue importance to differences which they may afterwards detect not to be in reality specific."⁶⁶ For WOLLASTON and many others there were "fixed specific bounds"⁶⁷ and a legitimate variation within them.

To the Cambridge mathematician William HOPKINS there was an important difference between natural and artificial species, which DAR-

WIN had not grasped. In *Frazer's Magazine* HOPKINS reviewed DARWIN's opus. A natural species was, HOPKINS maintained, a "group of organic beings which can only have been derived by descent from beings similar to themselves" and artificial species were "equally distinguished by particular characters, but . . . such that . . . they may not have been derived from each other or from some original stock."⁶⁸ DARWIN had, according to HOPKINS, mixed these different groups of species in systematic literature, when he tried to "break down the line of demarcation between *varieties* and *species*, founded on the perfect fertility of the former when crossed with each other, and the sterility or very imperfect fertility of the latter when similarly crossed."⁶⁹ This was DARWIN's serious mistake, according to HOPKINS. In doing "this he [DARWIN] confounds artificial with natural species".⁷⁰

DARWIN and his sympathizers perceived the bad smell of theology from views like HOPKINS' and WOLLASTON's. For the latter category of scientists as for the early LINNAEUS a natural species had by definition an independent and separate origin and the idea of one origin for all classes of animals or plants was tantamount to a flat denial of natural species altogether. DARWIN and others, on the contrary, could not accept special creation as a natural explanation. That was plainly to give up what natural science was all about. DARWIN's antagonists were accused of using theological presuppositions. Natural science should only reckon with the world of phenomena. A natural scientist should never invoke anything but known forces, processes and materials. The rejection of the supernatural on questions of origins, however, required, as Ernst MAYR cogently has observed, "an erosion of the world-view prevail-

⁶² J. H. F. KOHLBRUGGE, *War Darwin ein originelles Genie?* in *Biologisches Zentralblatt* 35 (1915), 93–111. The accusation about DARWIN's incapability to master any foreign language was supported with a quotation from DARWIN himself. See Francis DARWIN *Life and Letters* vol. 1. p. 29, where DARWIN says: "During my whole life I have been singularly incapable of mastering any language."

⁶³ See David HULL *Darwin and His Critics*, p. 215.

⁶⁴ See GILLESPIE op. cit. chapter 2 *Special Creation among British and American Naturalists*, 1830–59,

pp. 19–40.

⁶⁵ Thomas Vernon WOLLASTON *On the Variation of Species: with Special Reference to the Insecta, followed by an Inquiry into the Nature of Genera* (London 1856).

⁶⁶ David L. HULL *Darwin and His Critics*, op. cit. 131–132.

⁶⁷ Quoted from DESMOND and MOORE, op. cit. p. 434.

⁶⁸ David L. HULL *Darwin and His Critics*, op. cit. 241.

⁶⁹ David L. HULL *Darwin and His Critics*, op. cit. 255.

⁷⁰ *ibid.*

ling in the western world prior to the adaption of evolutionary thinking."⁷¹ That slow erosion undermined imperceptibly the credibility of the belief in creation by divine fiat.

After the voyage

When DARWIN and the British ornithologist JOHN GOULD in March 1837 studied the finches that had been collected at the Galapagos islands, DARWIN was taught by GOULD that what he had thought were uninteresting varieties were actually different species.⁷² DARWIN thought that, according to the view of the fixity of species, God should have created the different species of finches at each island of the archipelago. It was the logical implausibility of such a conclusion that led DARWIN in the direction of the French and English free thinkers.⁷³

In this situation DARWIN did not doubt GOULD's classification. After all, GOULD was his tutor on birds. Nor did DARWIN try to adjust the Linnaean concept of species. Instead he started more seriously to write down his thoughts and speculations on transmutation in a series of notebooks.⁷⁴ Reading these notebooks today it is obvious that transmutation was a starting point for his speculations. What DARWIN did was to try old and new ideas. According to DESMOND and MOORE, "fossil monkeys", who were looked upon as immensely old, had, "to everyone's surprise", been discovered and publicly announced in spring 1837.⁷⁵ These news gained credibility to Lamarck's view and incited DARWIN in the same year to unhesitatingly speculate on the most delicate subject of man's common ancestry with apes.⁷⁷

DARWIN and criticism

In his autobiography DARWIN once refers to his first notebook on transmutation, which he started in July 1837: "I worked on true Baconian principles, and without any theory collected facts on a wholesale scale".⁷⁷ That was the image of science of the Enlightenment in a nutshell. After the publication of *the Origin of species*, friends like Prof. SEDGWICK criticized him severely for just the opposite. "You have deserted . . . the true method of induction . . . Many of your wide conclusions are based upon assumptions which can neither be proved nor disproved, why then express them in the language and arrangement of philosophical induction?" asked SEDGWICK in a letter of November 1859.⁷⁸ According to George GRINNELL, the "extent to which he was willing to push one model, and after its collapse, to entertain new models suggests that he was philosophically inclined to transmutation theories for reasons that transcended the empirical data with which he originally worked."⁷⁹

The old positivistic picture of DARWIN's scientific method and work with the evolutionary theory does not seem to fit the historical data now available. On the contrary the data reveal an early shift of world-view and epistemology, obviously partly triggered by a rigid application of the immutability position. DARWIN's later followers and biographers have all too often tried to uphold an artificial distinction between his theory on the one hand and his observations on the other. But there was no such distinction. His observations were dependent on theory, and his theory was dependent on his *Weltanschauung*.

⁷¹ ERNST MAYR *The Growth of Biological Thought. Diversity, Evolution and Inheritance* (Cambridge Ma. 1982), p. 310.

⁷² FRANK J. SULLOWAY *Darwin and His Finches: The Evolution of a Legend. JHB* vol. 15, pp. 21-22, and *Darwin's Conversion: The Beagle Voyage and Its Aftermath. JHB* vol. 15, pp. 359-362.

⁷³ We have good reasons to believe that DARWIN was well acquainted with the views of e. g. his grandfather ERASMUS DARWIN, JEAN BAPTISTE LAMARCK, ROBERT E. GRANT and ROBERT CHAMBERS. See ADRIAN DESMOND *The Politics of Evolution*, and JOEL S. SCHWARTZ *Darwin, Wallace and Huxley, and Vesti-*

ges of the natural History of Creation. JHB vol. 23, 1990, pp. 127-153.

⁷⁴ *Charles Darwin's Notebooks, 1836-1844* Eds. BARRET et al. (Cambridge, 1987).

⁷⁵ DESMOND & MOORE, op. cit. p. 222.

⁷⁶ *Charles Darwin's Notebooks, 1836-1844*, op. cit. B169 etc.

⁷⁷ *The Autobiography of Charles Darwin and Selected Letters*, op. cit. p. 42.

⁷⁸ op. cit. p. 229.

⁷⁹ G. GRINNELL *The Rise and Fall of Darwin's First Theory of Transmutation. JHB* 7, 1974, p. 273.

Fixity and fluidity

In describing Charles DARWIN's intellectual development concerning the species concept one must conclude that at least officially he started with fixity and ended up with fluidity. From an Aristotelian and early Linnaean static view he advanced a plastic one with ingredients like natural selection and pangenesis. This was serious business in Victorian England. In a letter to HOOKER in January 11, 1844, DARWIN revealed his views on the mutability of species and confided that it was "like confessing a murder".⁸⁰

In DARWIN's own understanding of his former view, the static species concept was bibli-

cal. What he did not know was that the roots of his former view were Aristotelian and in that respect a part of the Greek heritage of science. He was also unable or perhaps even unwilling to see that the immutability position did not have to be applied as strictly as some taxonomists did. One could say, without entering the debate on when modern science had its beginning, that DARWIN switched from one scientific paradigm to another, none of which had anything to do with the mosaic creation account. The roots were not biblical for the simple reason that it is not hermeneutically defensible to force the early Linnaean concept of "species" on the old Hebrew word "min".

IV. LINNAEUS and his new synthesis

LINNAEUS' change

This was roughly the historical *Sitz im Leben* when Charles LYELL expressed his thankfulness to the Swedish professor Sven LOVÉN for having been informed about the species concept of LINNAEUS: the Swedish botanist had changed his view on species and not until 1867 was Charles DARWIN informed about this change of mind of LINNAEUS.

During a botanical excursion in 1742 a student from Uppsala had discovered a strange flower, later called *Peloria*, which looked like a hybrid stemming from *Linaria*. When LINNAEUS later got the report he could not fit it into his natural system. His belief in the fixity of species was challenged and LINNAEUS soon felt forced to abandon his earlier belief. In the dissertation *De Peloria* (1744) LINNAEUS and his disciple Daniel RUDBERG made the discovery public and discussed the species problem. In the later edition of his dissertations, *Amoenitates academicae* (1749), LINNAEUS even added an extensive passage on hybridization in *De Peloria* which did not occur in the original work. There he wrote that even if it at first sight looked like a paradox for him, new species, and even genera, seem to

arise from crossing by different species in the vegetable kingdom.⁸¹ LINNAEUS obviously meant that by interspecific hybridization new species could come into existence, and by intergeneric hybridization even new genera could originate.

New proposals

LINNAEUS abandoned the fixity of species. He could have cast the net more widely and made the definition of "species" more flexible, but that would have caused great confusion in terminology and classification. After all he had only a decade before laid the very foundation for taxonomy through his great systematic works. The genus level in his system was, however, as stated above, also seen as natural, i. e. original at the time of creation. That, obviously, made it natural for LINNAEUS to launch a new proposal. In his *Fundamentum fructificationis* from 1762 and in his sixth edition of *Genera plantarum* (1764) he proposed a hypothesis which was more adapted to nature and to his own and others' experience.

In the preface to the sixth edition of *Genera plantarum*, the *Ratio operis*, LINNAEUS made some

⁸⁰ *The Correspondence of Charles Darwin* vol. 3, 1844–1846, p. 2,

⁸¹ *Amoenitates academicae, De Peloria* on pp. 70–71,

"Novas species immo et genera ex copula diversarum specierum in Regno vegetabili oriri primum intuitu paradoxon videtur."

important changes. In the introductory note on "Species" he omitted the word *semper* (i. e. always), where it says that these forms produce more like themselves.⁸² In the note on "Genera" he passed over the word 'species', where it said in earlier editions that all genera and species are natural. And where this phrase *Genera & species esse naturalia omnia* from *Classes plantarum* occurs a second time on page 5, LINNAEUS inserted a new passage which states: "Let us suppose that the thrice exalted God only created one species from a genus. Let us also suppose that these first species (in the beginning or in time) were fertilized by species from other genera; then it would follow that many species originate, and that the structure of the flower would be like the mother and structure of the straw like the father."⁸³ This was a remarkable but wholly understandable turn.

In his *Fundamentum fructificationis* LINNAEUS was even more explicit. There and in a supplement to his sixth edition of *Genera plantarum* he stated that God created as many individuals as there were orders, and that God later mixed these to form genera. Nature in its turn mixed these genera to form species and fate mixed these species to beget varieties.⁸⁴ For BREMEKAMP, a Dutch botanist, it seemed reasonable to interpret the new Linnaean system as if God in

the beginning created 50 to 60 plants and around 7000 animals.⁸⁵

BROBERG suggests that LINNAEUS' shift of position was due to his daily difficulties of separating species from varieties.⁸⁶ Soon after the discovery of the Peloria, LINNAEUS rather freely proposed cross-breedings between different species. In 1751 he published *Plantae hybridae* in which he suggested several hybrids. He also proposed that dog, wolf and fox belonged to the same created genus and that they were products of hybridization. The contemporary French biologist BUFFON objected and argued for a wider definition of the concept, in which their interbreeding argued their inclusion in the same species.⁸⁷

The different views here by LINNAEUS and BUFFON show plainly that sometimes the problem was more semantic than empirical. The early LINNAEUS had a strict view on the permanence of species. Many of his followers, however, were even more strict in their application, pushing the species concept further down in the hierarchy into the group of varieties or subspecies. Ever since LINNAEUS there have been innumerable quarrels between taxonomists where to draw the line between a variety and a species. And the more tightly the boundaries of species were set the more absurd the species concept became. When LINNAEUS later kept the

⁸² C. LINNAEUS *Genera plantarum* ed. sexta (Holmiae 1764), p. 2. LINNAEUS changed ". . . produxere plures, at sibi semper similes, ut Species nunc nobis non sint plures, quam quae fuere ab initio." from the first edition to the less dogmatic ". . . producunt plures, sibi similes, quam quae fuere."

⁸³ *ibid.* p. 5. "Supponamus D. T. O. ab initio creasse unicam tantum speciem e quovis genere. Supponamus etjam has primas Species dein (vel in primordio, vel in tempore) ab aliorum generum speciebus foecundatas; sequeretur inde quod plures orientur Species, dum hae Floris structura evaderent quodammodo Matri similes, at Herbae structura Patri. confer. *Amoen. acad.* 6. p. 279."

⁸⁴ *Fundamentum fructificationis* (Upsaliae, MDCCLXII) § XIII p. 20ff. and C. E. B. BREMEKAMP *op. cit.* Unfortunately I have not yet been able to find and read this supplement. See C. E. B. BREMEKAMP *Linnaeus' views on the hierarchy of the taxonomic groups*. *Acta botanica Nederlandica* 2 1953, p. 242-253. James L. LARSON *Reason and Experience* (Berkeley 1971), pp. 107, and G. BROBERG, *op. cit.* p. 85. On page 243

BREMEKAMP quotes LINNAEUS: "1. Creator T. O. in primordio vestitit Vegetabile *Medullare* principii constitutivis diversi *Corticalis*, unde tot difformia individua, quot Ordines Naturales prognata." "2. *Classicas* has (1) plantas Omnipotens miscuit inter se, unde tot *Genera* ordinum, quot inde plantae." "3. *Genericas* has (2) miscuit Natura, unde tot *Species* congeneres, quot hodie existunt." "4. *Species* has (3) miscuit Casus, unde totidem, quot passim occurrunt *Varietates*."

⁸⁵ C. E. B. BREMEKAMP, *op. cit.* p. 245ff. In his *The Growth of Biological Thought* (Cambridge, Mass. 1982), p. 259 Ernst MAYR did not understand the ideological and contextual rationale in this view and called it only "a curious belief".

⁸⁶ BROBERG, *op. cit.* p. 84.

⁸⁷ BUFFON *Histoire naturelle* 5 (1755), p. 210. This information about BUFFON comes from G. BROBERG *Homo Sapiens L* (Stockholm, 1975), p. 47. Cf. Arthur O. LOVEJOY *Buffon and the Problem of Species*, in *Forerunners of Darwin*, *op. cit.*, pp. 84-113.

terminology but switched level concerning the original created order of species, men like BUFFON used the word species as LINNAEUS later used "genus" and "ordo".

Speciation by hybridization

The Linnaean view that new species could be generated by hybridization were later supported by several great scientists.⁸⁸ The difficulty at the time of distinguishing between observations and imaginary bastards gave further support to LINNAEUS' new position. It did not, however, reach a broad popular audience, and it did not really alter his formal taxonomic publications. When LINNAEUS was confronted by empirical observation he changed his view of the fixity of species and integrated further experience within his concept of creation to accommodate his opinion about the created original kinds. DARWIN, on the other hand, changed his view rapidly and totally from a belief in fixed species to one in "fluctuating forms".⁸⁹ It is quite evident from his *Origin* that he wrote against the position that God had created every individual species.⁹⁰ In DARWIN's own words, that was "the ordinary view". This statement of DARWIN, however, did not reflect the thought of his more advanced contemporary colleagues, nor did it reflect the thoughts of the mature LINNAEUS about speciation after God's original creation by means of interspecific and intergeneric hybridization. It is quite certain, however, that DARWIN wrote against what he himself claimed to be his own former opinion. In that case one could even say that the *Origin* and, in fact, most of his writings was a long argument against himself as a young scientist.

With regard to the species concept itself, DARWIN perhaps used it in the *Origin* for strategic reasons in spite of his disbelief in species. From his viewpoint it could be an eye-opener for at least some of his colleagues.⁹¹

Conclusion

On Christmas Eve in 1856 DARWIN wrote to HOOKER, telling him how much he missed him in the midst of his work. DARWIN had "just been comparing definitions of species" and he felt that it was "really laughable" to read about all the different meanings of species among the naturalists. Even to try to define species was for himself to try to define the "undefinable".⁹² For DARWIN it was no longer meaningful to define species. In the Introduction to his *Origin* DARWIN wrote: "I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species."⁹³

According to LYELL, DARWIN was, as pointed out above, "a good deal surprised" when he was told of the "hypothetical and theoretical notions of LINNAEUS". "This", continued LYELL, "prove how little his [LINNAEUS'] mind was really fettered and how freely – if he had lived to our time – he would have welcomed the new ideas, which are gradually becoming general."⁹⁴ In the eleventh edition of his *Principles* LYELL expressed a similar astonishment and quoting from *Amoenitates academicae* he wrote that LINNAEUS "even throws out the idea that the day may come when botanists may hold that all the

⁸⁸ Including LINNAEUS KOHLBRUGGE mentions in op. cit. p. 98 GMELIN, KOELREUTER, ADANSON, ACKERMANN, HENSCHEL, KNIGHT, SAGERET and PUVIS, who all lived late in the 18th or early in the 19th century. As far as KOELREUTER is concerned Ernst MAYR has kindly informed me that KOHLBRUGGE was wrong.

⁸⁹ C. DARWIN *On the Origin of Species*. London 1859, p. 52.

⁹⁰ C. DARWIN, op. cit., e. g. pp. 55, 59, 133, 152 and 155. See also Neal C. GILLESPIE *Charles Darwin and the Problem of Creation* (Chicago, 1979).

⁹¹ See Frank SULLOWAY *Geographic Isolation in Darwin's thinking*. *Stud. Hist. Biol.* vol. 3, pp. 23–65,

and John BEATTY *Speaking of Species: Darwin's Strategy*, in David KOHN (ed.) *The Darwinian Heritage*, op. cit., pp. 265–281, and in ERESHEFSKY *The Units of Evolution*, op. cit., pp. 227–245. According to Ernst MAYR in the article *Darwin's Principle of Divergence*, in *JHB* vol. 25 no. 3 (Fall, 1992) DARWIN later fell back on a more typological treatment of the species.

⁹² *The Correspondence of Charles Darwin* vol. 6, 1856–1857 p. 309.

⁹³ C. DARWIN *On the Origin of Species* op. cit., p. 6.

⁹⁴ See note 1.

species of the same genus may have sprung from the same mother."⁹⁵ Later the American historian of botany Edward L. GREENE even asserted that LINNAEUS was an evolutionist, but that he did not dare to make his views public.⁹⁶

What was the difference between LINNAEUS and DARWIN? Obviously, according to the quotations above, they both believed in common descent of certain species. GREENE's view goes much beyond LINNAEUS' plain statements. In the context of a theistically oriented worldview LINNAEUS changed taxonomical level for the created kinds in the Genesis account. By this move he stressed even more the importance of genera and all speciation after the divine creation occurred by hybridization. DARWIN, for his part, rejected the concept of theistic creation, and entertaining an alternative *Weltanschauung* he insisted that all modification in the evolution of life occurred by natural forces such as natural selection, i. e. "natural forces" in a non-Linnaean sense of the word "natural" and in sharp contrast to supernatural.

DARWIN's own scientific position on creation as a young natural scientist was not that well supported by field experience. LINNAEUS, who lived in the previous century, had a much more sophisticated view on the created kinds and on their historical development after creation. The old fixity view DARWIN later saw as his foremost object of attack, but the young DARWIN's crea-

tionist view of species was in his own time old-fashioned and heavily influenced by Greek thought. Not very surprisingly, DARWIN himself quite early in his life turned from that extreme form of idealistic creationism; which the greatest among the taxonomists, Carolus LINNAEUS, had adjusted as early as 1742 when it seemingly clashed with empirical data. The views of the mature LINNAEUS' took DARWIN by surprise in 1867. Probably he had always looked upon the Swedish botanist as a stalwart upholder of the fixity of species and never thought of the possibility of a new reasonable synthesis within the framework of theistic creation.

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Über den Ursprung der 'Arten' Geistesgeschichtliche Wurzeln des Artbegriffs

Zusammenfassung: In einem Brief vom 15. 12. 1867 an den schwedischen Biologen Sven LOVÉN verlieh der englische Geologe Charles LYELL seiner Dankbarkeit darüber Ausdruck, daß er von LOVÉN über das Art-Konzept von LINNAEUS in Kenntnis gesetzt wurde. In der Spätphase seines wissenschaftlichen Wirkens hatte LINNAEUS seine Auffassung von der Unveränder-

lichkeit der Arten endgültig aufgegeben. Seine reichhaltige Erfahrung als Taxonom hatte ihn dazu geführt, die geschaffenen Arten doch als begrenzt veränderlich anzusehen. Beiläufig erwähnt LYELL in diesem Brief die Überraschung seines Freundes Charles DARWIN, als dieser über LYELL von der Meinungsänderung LINNAEUS' erfuhr.

⁹⁵ On p. 325 in *Principles of Geology* (London, 1872) LYELL inserted a footnote with the Latin quote of LINNAEUS: "Tot species dici congeneres quot eadem matre sint progenitae."

⁹⁶ Edward L. GREENE *Linnaeus as an Evolutionist*.

Proc. Washington Acad. Scis. XI (1909), 21ff. This piece of information with reference is taken from John C. GREENE *The Death of Adam. Evolution and its impact on Western thought* (1959), p. 355, n. 13.

Tatsächlich hatte Charles DARWIN bis dahin geglaubt, daß LINNAEUS die Arten zeit seines Lebens für unveränderliche, festgelegte und voneinander unterschiedene Einheiten gehalten hatte. Dieses Mißverständnis hat das Bild von LINNAEUS und seinen Zeitgenossen über zwei Jahrhunderte lang geprägt. In allgemeinen Lehrbüchern und speziellen Monographien wurden und werden die Ansichten von LINNAEUS häufig als genau so unveränderlich und festgefügt dargestellt wie die damalige Auffassung von der Artkategorie selbst; doch wie aus allen Ausgaben seiner *Philosophia botanica* hervorgeht, verlieh LINNAEUS seinen Zweifeln an der Konstanz der Arten deutlich Ausdruck. Er veränderte im Laufe seines Lebens seine Auffassung von der Schöpfung der Arten und schlug eine neue Hypothese vor, welche besser mit den empirischen Daten harmonierte.

Die nähere Untersuchung der Ursachen für die verbreitete Fehldarstellung der Ansichten LINNAEUS' und der Überraschung DARWINs, als er den wahren Sachverhalt erfuhr, ist eines der Ziele dieses Kapitels. Offensichtlich war Charles DARWIN sich über den Wandel der Ansichten LINNAEUS' nicht bewußt, obwohl er im Besitz der *Philosophia botanica* war.

Das Hauptziel dieser Arbeit ist es jedoch, die Aufmerksamkeit des Lesers auf die geistesgeschichtlichen Wurzeln des Artbegriffs sowie auf einige grundsätzliche Ideen von LINNAEUS zu lenken. Diese könnten auch von Bedeutung für die moderne Taxonomie sein.

Ursprünglich vom Glauben an die Konstanz geschaffener Arten ausgehend hielten sowohl LINNAEUS als auch DARWIN im späteren Verlauf ihres Lebens die Abstammung bestimmter Ar-

ten von gemeinsamen Vorfahren für möglich.

DARWINs Einstellung zum Artbegriff, welche er von seinen Zeitgenossen übernommen hatte, waren in seinen jungen Jahren noch nicht durch eigene wissenschaftliche Arbeiten gestützt. Sie waren jedoch schon zu seiner Zeit überholt; Carolus LINNAEUS hatte weit differenziertere Vorstellungen zur Definition der Arten und ihrer historischen Entwicklung geäußert. Der größte aller Taxonomen erkannte schon 1742, daß das auf griechischem Gedankengut beruhende Art-Konzept zu empirischen Daten im Widerspruch steht. Im Kontext seiner theistisch orientierten Weltanschauung bleibend hatte LINNAEUS deshalb die taxonomische Kategorie für die "Arten" gewechselt. Er hielt später die Gattungen für geschaffene Einheiten, innerhalb derer Artbildung durch Hybridisierung stattfand und stattfindet. DARWIN erkannte über hundert Jahre später den Widerspruch zwischen dem Artbegriff griechischer Prägung und empirischen Daten ebenfalls, verwarf im Gegensatz zu LINNAEUS jedoch jegliche Schöpfungsvorstellung und entschloß sich, die verfügbaren Daten im Rahmen einer materialistischen Weltanschauung zu deuten.

Als DARWIN, lange nachdem er seine Allgemeine Evolutionslehre entwickelt hatte, von den wirklichen Ansichten LINNAEUS' zum Artbegriff erfuhr, zeigte er sich überrascht. Vermutlich hatte er LINNAEUS immer nur als den unentwegten Hüter der Lehre von der Unveränderlichkeit der Arten angesehen und niemals die Möglichkeit erwogen, die Gesamtheit der empirischen Daten wie dieser im Rahmen einer sachlich angemessenen theistisch orientierten Weltanschauung zu deuten.