Evolution Before Darwin: The Musings of Constantine Rafinesque

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Constantine Rafinesque

In the history of biology, Constantine Rafinesque (1783-1840) and Charles Darwin (1809-1882) represent what are probably polar opposites among 19th century naturalists. Both were true intellectual geniuses, exceptionally broad in their knowledge and interests; both wrote prolifically; both took their initial inspiration from the science of taxonomy — the naming and cataloging of biological diversity; and both were famed as explorers of the untamed wilderness. However, they could not have been more unlike in their intellectual approach to science, nor the impact of their research on contemporary and future biological thought.

Rafinesque is in many ways a unique character in the annals of North American natural history. His name is given brief, if any, mention in modern encyclopedias and biographical dictionaries of science and scientists. Peattie (1936) called him "the most widely celebrated unknown man in science, equaling in brilliant obscurity Roger Bacon or Paracelsus." Born in Constantinople of European parents, educated in Italy and France, Rafinesque emigrated to the then-youthful United States in 1802, searching for fame and fortune. Neither wealthy nor aristocratic, he lived off the generosity of his friends and patrons; what money he accumulated was spent to finance his travels and publications. He resided at various times in New York and Philadelphia, meeting and corresponding with nearly all the well-known scientists of the period. The only academic position he held was between 1819 and 1826, at Transylvania University in Lexington, Kentucky, described by Peattie (1936) as "a backwoods Oxford." The taming of the American West had begun, and Rafinesque was there to explore far and wide for new species of plants and animals. Geology, botany, mammology, herpetology, conchology, prehistoric Indian mounds, fossil Ice Age animals and the languages of Native Americans all attracted his attention. He wrote voluminously on every subject imaginable. Students at the university thought of him as "a man of peculiar habits and... very scientific... his room in the College [was] filled with butterflies and bugs and all sorts of queer things" (Call, 1895). It was said that he never went on a field expedition without carrying along his trusty umbrella (good advice for Oregon botanists, as well)!

The scientific passion of Rafinesque's life was natural history, a dominating field of biology in those days. The sublime goal of natural history was to discover, describe and name the "works of nature" in all their glorious diversity. The course of 18th century biology had already been shaped by Rafinesque's predecessor Carl Linnaeus (1707-1778), the pre-eminent figure in Swedish science. By his energy and genius, this man had single-handedly initiated the science of taxonomy in its modern form. Linnaeus established for Rafinesque, and for the whole of Western (European-dominated) science, an inspiring intellectual goal — to develop a classification system for all of nature. During this historical Age of Exploration, when European power and civilization were spreading to every corner of the globe, it was assumed that human rationality could finally discover the pure order of nature. The secret of life was in the relationships of living organisms. By discovering the pattern of life, humankind could hope to discern the very mind and purpose of the Creator. Small wonder, then, that from such a perspective the followers of Linnaeus would devote their lives to discovering and naming the entire earth's flora and fauna.

In Rafinesque's case, the devotion to science was there but the rewards were not. Merrill (1949) remarked, "It is doubted if in the entire history of descriptive biology there is any other author who has suffered more from the weight of authority... The leading biologists of his time, both in Europe and in America, ignored his numerous nomenclatural proposals to an extraordinary degree, whether he was correct in his conclusions or not." Yet he was a prolific author, with a bibliography of over 1,000 published books and articles! In botany alone, he proposed nearly 2,700 new generic names (Merrill, 1949), yet only about 30 of these are in use today. The rest have either been relegated to synonymy (i.e., the genus involved had already been named by a taxonomist prior to Rafinesque); or in cases where he was truly the first to name various accepted genera, Rafinesque's proposed names have been officially "rejected" in favor of later-published generic names.

Rejection of over 90 Rafinesquian generic names occurred by action of International Botanical Congresses early in the 20th century, but it was indirectly due to the neglect of Rafinesque's work by his contemporaries in the 1800's. The belated discovery of his taxonomic proposals (buried, as they were, in his 1,000-plus obscure publications) meant that too many well-known plant names would have to be changed; so the botanists voted simply to reject — that is, ignore — much of his pioneering work. Some Oregon genera that were named first by Rafinesque but are now called something else are: *Camassia (Cyanotris* Raf.), *Castanopsis (Balanoplis* Raf.), *Chlorogalum (Laothoe* Raf.), *Chrysopsis (Diplogon* Raf.), *Hesperochiron (Capnorea* Raf.), *Lithophragma (Pleurendotria* Raf.), *Piptochaetium (Podopogon* Raf.), *Stenanthium (Anepsa* Raf.), *Stephanomeria (Ptiloria* Raf.), and *Suksdorfia (Hemieva* Raf.). On the other hand, a check of Peck's **Manual of the Higher Plants of Oregon** (1961) turned up the following names by Rafinesque which we do recognize and use: *Agoseris* (Asteraceae); *Clintonia* (Liliaceae); *Cymopterus, Lomatium, Osmorhiza,* and *Oxypolis* (Apiaceae); *Distichlis* and *Sitanion* (Poaceae); *Olsynium* (Iridaceae); *Paxistima* (Celastraceae); and *Polanisia* (Capparidaceae).

In comparing the relative influence of Charles Darwin and Constantine Rafinesque on the history of biological thought, we can see how certain personal characteristics of the two men played a dominant role. Rafinesque's intellect was impatient and flighty, revealing its genius in breadth of knowledge but not in depth. His mind roamed freely through the sciences of his day — anthropology, archeology, botany, entomology, geology, history, linguistics, medicine, meteorology, paleontology and zoology. But his writings appear to be almost totally unorganized; they skip from subject to subject, with ideas, observations and theories all thrown together willy-nilly. Rafinesque seemed incapable of ever settling on a single theory or subject and studying it in convincing detail. His reputation among fellow naturalists of the early 1800's was that of a crank and crackpot. Nobody felt it was worth the trouble to sift the wheat from the chaff in Rafinesque's voluminous writings. In fact, he was ridiculed for his almost insane compulsion to name and rename every plant and animal as "new to science;" his publications and ideas were simply ignored.

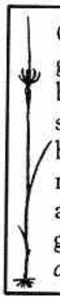
Darwin, as is well known, received the wholehearted approval and respect of his scientific contemporaries. Although personally modest and retiring, he possessed a disciplined and penetrating intellect along with an unsurpassed ability to deduce general principles from diverse facts and observations. In 1876, Darwin wrote of himself (Darwin, 1892): "My mind seems to have become a kind of machine for grinding general laws out of large collections of facts." Instead of wasting his mental powers, as Rafinesque did, Darwin concentrated his efforts on marshalling evidence for his two great discoveries — organic evolution and natural selection — and on presenting a case so convincing that it initiated a revolution in biological thought.

In his autobiography, Darwin states that it was "about 1839" when he "clearly conceived" his theory of evolution by means of natural selection. His famous book **On the Origin of Species...** (Darwin, 1859) was published 20 years later. Historians have made much of the fact that glimmerings of evolutionary theory can be found in writings of various pre-Darwinian naturalists — for example, George Louis Buffon, Jean Baptiste Lamarck and Charles's grandfather, Erasmus Darwin (Eiseley, 1958). In hindsight, and with our knowledge that Darwin's basic premises concerning evolution have been abundantly confirmed by over 130 years of biological research, it is indeed interesting to read the words of these earlier biologists whose theories never "caught on" as Darwin's did. Peattie (1936) wrote that Darwin's great advantage was timeliness and "publicity." He expressed it this way (p. 158): "Careful looking has shown that Darwin had about a hundred forerunners. In all ages and in all languages sages have tried to put over the concept of evolution. They found no takers until the angelic origin of man himself was assaulted; the storm that this created in Victorian England gave the concept all that an idea, be it a Red Cross drive or a California cult, requires for success. That is publicity." Beyond this, however, I believe that Darwin succeeded because he not only produced a brilliant theory, but also a convincing mechanism — natural selection — by which biologists could conceive of "how it happened" as well as "what did happen" during the history of life.

Rafinesque's evolutionary musings, as I call them, appear in a characteristically brief and unadorned note, occupying less than two columns of type, in the 1833 spring issue of a periodical entitled "Atlantic Journal and Friend of

Rafinesque named Clintonia for DeWitt Clinton, Erie Canal builder, governor of New York, and naturalist. Our queen's cup bead lily, *C. uniflora*, graces moist conifer woodlands in the mountains. FAL

Rafinesque switched *Pachystima, Pachistima,* and now *Paxistima* (see page 16), from the holly genus *Ilex*. Loved by Oregonians as Oregon boxwood, professional collectors eagerly seek its hardy evergreen foliage for the florist's trade. FAL



Our beautiful purple-eyed grass or grass-widows grows best in soil pockets on rocky slopes and flats. We must become accustomed to its new name, *Olsynium douglasii*, another of Rafinesque's genera, and not *Sisyrinchium douglasii* (see page 17). FAL

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VOL. I. PHILADELPHIA, SPRING OF 1833. No. 5.

124. Principles of the Philosophy of new Genera and new species of Plants and Animals.

Extract of a letter to Dr. J. Torrey of New York dated 1st Dec. 1832.... I shall soon come out with my avowed principles about G. and Sp. partly announced 1814 in my principles of Somiology, and which my experience and researches ever since have confirmed. The truth is that *Species and perhaps Genera also, are forming in organized beings* by gradual deviations of shapes, forms and organs, taking place in the lapse of time. There is a tendency to deviations and mutations through plants and animals by gradual steps at remote irregular periods. This is a part of the great universal law of PERPETUAL MUTABILITY in every thing.

Thus it is needless to dispute and differ about new G. Sp. and varieties. Every variety is a deviation which becomes a Sp. as soon as it is permanent by reproduction. Deviations in essential organs may thus gradually become N. G. Yet every deviation in form ought to have a peculiar name, it is better to have only a generic and specific name for it than 4 when deemed a variety. It is not impossible to ascertain the primitive Sp. that have produced all the actual; many means exist to ascertain it: history, locality, abundance, &c. This view of the subject will settle botany and zoology in a new way and greatly simplify those sciences. The races, breeds or varieties of men, monkeys, dogs, roses, apples, wheat.,.. and almost every other genus, may be reduced to one or a few primitive Sp. yet admit of several actual Sp. names may and will multiply as they do in geography and history by time and changes, but they will be reducible to a better classification by a kind of genealogical order or tables.

My last work on Botany if I live and after publishing all my N. Sp. will be on this, and the reduction of our Flora from 8000 to 1200 or 1500 primitive Sp. with genealogical tables of the gradual deviations having formed our actual Sp. If I cannot perform this, give me credit for it, and do it yourself upon the plan that I trace.

C. S. R.

Knowledge." This peculiar journal was written and financed entirely by Rafinesque himself and consisted of 212 pages in eight parts, issued during 1832 and 1833, and offered for sale at a price of two dollars! The subtitle given in Volume I, Number I, well illustrates the grandiose plans that Rafinesque had for his journal: "A Cyclopedic Journal and Review of Universal Science and Knowledge: Historical, Natural, and Medical Arts and Sciences: Industry, Agriculture, Education, and Every Useful Information: with Numerous Figures." The article in question appears on pp. 163 and 164, with the title: "Principles of the Philosophy of New Genera and New Species of Plants and Animals." Rafinesque states that it is an extract of a letter which he wrote to Dr. John Torrey (1796-1873), a leading American botanist of the time, on December 1, 1832. Presumably Torrey frequently received letters from Rafinesque on botanical matters, but whether he paid any attention to this particular one is not known. Like his close colleague Asa Gray (1810-1888) of Harvard University, Torrey probably had no notions of evolution, prior to the popularization of the subject by Darwin (1859).

Let us examine some of the ideas expressed by Rafinesque in his 1833 publication. (The terms "G." and "Sp." in line 3 stand for *genera* and *species*. Rafinesque coined the term somiology to mean the science of classification both in theory and practice. However, A.P. de Candolle introduced the widely used term taxonomy for this branch of science a few years earlier.) Rafinesque stated his opinion that species and genera are not fixed and permanent; rather, they develop and change gradually through time. He even used the word "mutations," which is a key principle in the modern genetic explanation of evolution. His words "by gradual steps at remote irregular periods" can be read to mean he appreciated the great amount of time required for evolutionary change, and he sensed there had been past changes in the rate of evolution; i.e., that periods of more rapid change alternated with periods of slow change. A concept quite similar to this is now explicit in evolutionary theory; namely, the idea of "punctuated equilibrium" (Gould and Eldredge, 1977). Also, it is now accepted that earlier periods of evolutionary stasis coincide with stable, long-persistent environmental conditions, whereas bursts of evolutionary change in organisms occur after catastrophic environmental disruptions of various kinds (particular attention having been given to the impact on the earth of one or more asteroids/comets 65 million years ago, when dinosaurs and many other animal groups became extinct).

In the second paragraph, Rafinesque states "Every variety is a deviation which becomes a Sp. [species] as soon as it is permanent by reproduction." This principle was basic to Darwin's thinking, as well; in modern terms, it refers to the so-called "biological species concept," which despite many exceptions is a widely used definition of species today. In a "biological species" (really a "genetic species") any given individual is potentially capable of mating with any individual of the opposite sex; however, members of different species are expected to be unable to interbreed. In these terms, each natural species is "permanent by reproduction," as Rafinesque says. Most 19th century naturalists, including Rafinesque and Darwin, were well aware of the many domestic breeds of animals and cultivated varieties of plants that had been produced by agricultural breeding and selection throughout human history. In his writings on evolution, Darwin (1868) made good use of the analogy between such domesticated types, which are "true-breeding" due to human selection, and naturally-occurring varieties and races which may become true-breeding new species through the workings of natural selection. Studies of evolution today go far beyond these early ideas. Formation of new species through divergence of evolutionary lineages is called "speciation." Knowledge of speciation processes derives from studies of population genetics, differing modes of reproduction (including inbreeding, outcrossing, asexual propagation), isolating mechanisms (e.g., genetic, chromosomal, ecological, behavioral, geographical), hybridization and mathematical models for the evolutionary effects of mutation rates and selection coefficients.

"Deviations in essential organs may thus gradually become N.G. [new genera]," says Rafinesque. To him, essential organs were those of the flowers and fruits; in a later work (Rafinesque, 1836, p. 18) he wrote: "Genera are the groups of species that have similar floral characters and sometimes a similar habit. Whenever a species has different floral forms it must be a peculiar genus." He himself had noted many such "deviations" (Rafinesque, 1836, p. 16), such as "in a garden a Tulip with 5 petals only and 5 stamens," "a *Tecoma* [note: a vine of the family Bignoniaceae] bearing a capsule with 3 valves, the generic character is bivalve," and "*Asters* and *Solidagos* with the ligules mixt (sic) with the florets." Rafinesque could not tolerate genera in which there was variation in numbers of floral organs; therefore, he could easily imagine how a species might vary and become permanent for an abnormal number of petals, stamens, carpels, etc. To him, this would constitute the origin of a new genus. If the stabilized deviations were less significant, "such as mere color of flowers, size of stem, leaves, etc." (Rafinesque, 1836, p. 16), this would produce a new species. By operating from this taxonomic philosophy, he had no difficulty in naming the 2,700 new genera ascribed to him by Merrill (1949).

Returning to Rafinesque's ideas on evolution, there is set forth in the second paragraph (figure 2) a concept of "primitive species." These are the smaller number of ancestral species which, by the processes of mutation and stabilization, gave rise to the much larger number of present-day (he uses the word "actual") species. If evolution as we now conceive it involves a change through time, from ancestors to descendants, then Rafinesque is here expressing a very similar idea — a genealogy or family tree of living organisms. To paraphrase his views, we might say that all present species of monkeys evolved from one original "primitive species" of monkey; all dogs from one original species of dog; all roses from an original rose; all wheat from an original wheat, etc., *ad infinitum*. The way evolution really works goes deeper than Rafinesque could have possibly imagined. Ancestral wheat evolved from an earlier-existing grass, grasses from some earlier-existing monocotyledon, monocotyledons from some earlier-existing angiosperm, angiosperms from some earlier-existing gymnosperm, and so on, back to the very beginnings of life on earth.

Rafinesque's concept of earth's history was limited by the geological knowledge of his day. Cuvier (1815), among others, was a powerful proponent of the theory of "catastrophism" as an explanation of geologic history as revealed in rocks. "Catastrophism, so far as its biological aspect is concerned, is essentially a device to preserve the leading tenets of Christian theology and at the same time to give these doctrines a scientific cast" (Eiseley, 1958, p. 67). Multiple series of catastrophic upheavals were assumed, the latest of which was the Noarchian Flood of the Bible. Prehistoric life had been successively exterminated, then recreated; or if the catastrophies were not world-wide, then survivors had migrated into the devastated regions to start life anew. Non-catastrophic theories to explain geological history had also been put forward (Hutton, 1795), but these were mainly rejected as being incompatible with dominant religious beliefs of the time. Rafinesque appears not to have been bound by a particular dominant geological theory (1833, pp. 191-193), but he did agree that successive water-deposited strata had exterminated earlier (fossil) forms of life. We may assume, therefore, that in his evolutionary theory, all the single "primitive species" of monkey, dog, rose, wheat, etc. were the survivors of — or were created after — the most recent catastrophic world-flood.

Finally, I would call attention to those parts of Rafinesque's musings that best demonstrate his qualities as a true scientist. In paragraph two, he states: "It is not impossible to ascertain the primitive Sp. that have produced all the actual; many means exist to ascertain it: history, locality, abundance, etc." His final paragraph speaks about a proposed research effort which could produce "a reduction of our flora from 8,000 to 1,200 or 1,500 primitive Sp. with genealogical tables of the gradual deviations having formed our actual Sp." In these brief sentences, he sets out a clear-cut plan of research, including methods (comparative morphology, biogeography, demographics) and goals (to chart the genealogy — hence, evolution — of some 8,000 American plant species). If only Rafinesque could have put aside all distractions and concentrated his intellect on this one subject long enough to write a definitive treatise on it, what a great impact that might have had on the biology of his day! Consider the fact that it took Darwin 20 years of concerted effort just to produce his 1859 book, which he viewed as only an "abstract" of a larger encyclopedic study on evolution.

Peattie (1936) may have been right that Darwin's timing and "publicity" made the difference in his success. Rafinesque's ideas, even if he had fully elaborated upon them, might have come too early and hence lacked impact. The history of science is not one of ideas alone, as though these had some ethereal existence apart from the all-too-human individuals whose intellectual powers we propose to honor. Ideas do complete, surely, but what interests us more are the people whose minds have created science's view of life and the universe. Rafinesque remains an enigma, but we understand him a little better, as a person and scientist, from this analysis of a few words he put on paper nearly 160 years ago.

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