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CONTENTS

Linnæus as a Zoologist: DR. J. A. ALLEN .. 953

Scientific Books:—
Hydrates in Aqueous Solution: PROFESSOR LOUIS KAHLENBERG. *Lodge on Electrons or the Nature and Properties of Negative Electricity:* PROFESSOR H. A. BUMSTEAD .. 962

Societies and Academies:—
The Geological Society of Washington: DR. FRED E. WRIGHT. *The Philosophical Society of Washington:* R. L. FARIS. *The Anthropological Society of Washington:* J. M. CASSANOWICZ. *The Chemical Society of Washington:* J. A. LECLERC. *The Torrey Botanical Club:* DR. C. STUART GAGER. *The Iowa Anthropological Association:* J. H. PAARMANN 965

Discussion and Correspondence:—
The First Species Rule—an Objection: DR. F. A. BATHER. *The Great Inferior Tusked Mastodon of the Loup Fork Miocene:* CHARLES H. STERNBERG. *Concerning Steno:* C. K. W. 970

Special Articles:—
On Sun-spots: PROFESSOR CARL BARUS. *Does the Mammalian Heart obey the Law for Chemical Reaction Velocities as influenced by Temperature?* CHARLES D. SNYDER. *The Flanking Detrital Slopes of the Mountains of the Southwest:* PROFESSOR WILLIAM P. BLAKE..... 972

Quotations:—
The Presidency of the Massachusetts Institute of Technology 978

Current Notes on Meteorology and Climatology:—
Meissner's 'Meteorologische Elemente'; 'Internationaler Meteorologischer Kodex': PROFESSOR R. DEC. WARD 979

Academic Salaries 980

Scientific Notes and News 981

University and Educational News 984

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LINNÆUS AS A ZOOLOGIST[1]

CAROLUS LINNÆUS, later known as Carl von Linné, was born at Roeshult, in the province of Smaland, Sweden, May 13, old style, 1707, and died at Hammerby, near Upsala, on January 10, 1778. His grandfather was a farmer; his father, a clergyman. Young Linnæus, the future naturalist, was intended by his parents for the ministry, and his early education was conducted with this end in view. At the age of ten, he was sent to the Latin school at Vexio, but after seven years at this school he was found to be so deficient in his scholastic studies that his parents thought of apprenticing him to a shoemaker.

While at Vexio, much of his time was devoted to the study of plants and insects, an inclination apparently favored by his master, who was himself greatly interested in botany. Fortunately young Linnæus was rescued from his threatened degradation by Dr. John Rothman, a physician of Vexio, who recognized his superior abilities and appreciated his interest in natural history. He took him into his own home, where for a year Linnæus continued his botanical studies, aided by the advice and library of his patron. At the age of twenty he entered the University of Lund, where he soon found himself without means of support, through the death of his patron and friend, the kind-hearted physician of Vexio. Fortunately he soon won the friendship of Dr. Kilian Stobæus, the pro-

[1] Read at the exercises of the New York Academy of Sciences in commemoration of the two hundredth anniversary of the birth of Linnæus.

fessor of botany and medicine, who made him a member of his family. Here he had access to books and to a small museum of natural history, and found much leisure for exploring the neighboring country and for collecting objects of natural history. At the end of a year he went to Upsala, where, under Rudbeck and Roberg, he advanced rapidly in medicine and botany. Here he won the friendship of the renowned Olaf Celsius, whom he later characterized as the best botanist in Sweden, and of Artedi, a fellow student, who afterwards became the founder of ichthyology. During his whole course at Upsala, it is said that he did not hear a single public lecture on either anatomy, botany or chemistry, but he and Artedi, in good-tempered rivalry, were devoting their energies to natural history, Linnæus to plants, birds and insects, and Artedi to amphibia and fishes. Linnæus here also began the preparation of his epoch-making works on botany and of the first edition of his 'Systema Naturæ,' published a few years later in Holland.

In 1732, at the age of twenty-five years, he was commissioned by the Upsala Academy of Sciences to make a tour of exploration in Lapland in the interest of natural history. He left Upsala on the twelfth of May, and after an absence of five months returned to Upsala on the tenth of October. This remarkable journey of 4,600 miles was made partly on horseback, partly by boat and partly on foot; it extended northwestward across the Norwegian Alps to the coast of Norway beyond the Arctic Circle; the return journey was made by way of eastern Finland. It was an undertaking of great hardship and much danger, being performed alone, aided only by local guides employed to conduct the way from one point to another. On his return a report of his journey was presented to the academy, but it remained in manuscript until translated and published in English by Dr. James Edward Smith, the first president of the Linnæan Society of London, in 1811.[2] The botanical results, however, were published separately by Linnæus himself, in 1737.

The following year was spent at Upsala, where he attempted to eke out his scanty means of support by giving lectures on botany, mineralogy and chemistry. This proved contrary to one of the statutes of the university, to the effect that no one should give public lectures who had not obtained his doctor's degree, which statute was invoked against him by Rosen, the successor to Rudbeck in the professorship of medicine and anatomy, who was jealous of Linnæus's abilities and attainments. Deprived of this financial resource, he took some of his pupils on excursions into the neighboring mountains, where he met the governor of the province of Dalecarlia, who sent him to explore and report on certain copper mines in which he was interested. While on this journey he gave lectures at Fahlun on mineralogy and assaying. Here he made the acquaintance of Dr. Moræus, a learned and wealthy physician of the district, and his two daughters, to one of whom he became betrothed; the father, however, insisted on deferring the marriage till Linnæus had completed his professional studies and obtained his medical degree. For this purpose, in the spring of 1735, he jour-

[2] The herbaria, library (about 2,500 volumes), manuscripts and correspondence of Linnæus were offered by his widow and daughters, 'by the advice of friends,' to Sir Joseph Banks, 'for the sum of a thousand guineas'; Sir Joseph, not feeling inclined to the purchase, recommended it to the consideration of his friend Doctor (later Sir) J. E. Smith, by whom these treasures were secured and transferred to England (Turton, 'Life and Writings of Linnæus,' 1806, p. [39]), and later passed into the possession of the Linnæan Society of London, founded in 1788 through the efforts of Dr. Smith, who was its first president. (See Jardine's 'Naturalist's Library,' Vol. I., 1833, p. 58.)

neyed to Lubek and Hamburg, and later to Holland, where, in June, he received from the University of Harderwyk the degree of doctor of medicine. At Leyden he became acquainted with the leading men of science of that city, which soon led to his engagement by Dr. George Cliffort, a wealthy burgomaster of Amsterdam, to take charge, at a liberal salary, of his extensive museum and botanic garden. Later he was sent by him to England to secure rare plants for his garden, with a letter of introduction from the great Boerhave to Sir Hans Sloane. He thus came in contact with the botanists of London, where, however, his reception was not always cordial.

On his return to Holland he was offered the position of government physician to the Dutch colony in Surinam, which he prudently declined, and became an assistant to his friend Van Royen at the botanic garden in Leyden. After a brief visit to Paris, he returned to Stockholm in September, 1738, where he determined to settle as a physician. Notwithstanding his fame abroad and his skill as a botanist, the pecuniary returns from his profession were at first small, but they gradually increased, and, obtaining some government patronage, his marriage to Miss Moræus was celebrated on June 26, 1739.

He remained only three years in Stockholm, during which period he helped to found the Royal Academy of Sciences of that city and served as its first president. In 1741, under an order from the government, he made a journey through Öland and Gothland. In the same year, he was called to the chair of botany at the University of Upsala, a position to which he had long aspired and which he filled for thirty years, when impaired health compelled him to resign his official duties and to discontinue his literary labors. The University of Upsala, through the fame of Linnæus, became widely renowned as a seat of learning, and attracted students from various parts of Europe. During these years of almost uninterrupted activity, most of Linnæus's numerous botanical and other works were published, the material for which reached him in ever-increasing abundance, not only from distant parts of Europe, but from Siberia, China, India, Egypt, South Africa and North and South America.

Academic honors were showered upon him by all the learned societies of Europe; a gold medal was struck in his honor by the nobles of Sweden, and in 1757 he was created by King Frederic a Knight of the Polar Star and admitted to hereditary nobility. Foreign courts made overtures for his presence, and his own country neglected no opportunity to do him honor. His death in 1778, after six years of invalidism resulting from an attack of apoplexy, was recognized as a national calamity; the University of Upsala went into mourning, and the king ordered a medal to be struck in his memory.

Although cramped by poverty during the earlier part of his career, prosperity did not long withhold her smile; not only were the nobles of his country his patrons, but he was an especial favorite of both King Frederic and his queen. Through various emoluments showered upon him he was able, later in life, to purchase a large estate and to construct for himself a museum, wherein he gathered the largest collection of botanical treasures that at that time had anywhere been brought together. He was happy in his domestic relations, and lived to see his son succeed to his chair at the University of Upsala.

Although Linnæus's publications relate mainly to botany and medicine, they cover the whole realm of natural history. His earliest contribution to science is generally considered to be his 'Florula Lapponica,' the first part of which appeared in the

Transactions of the Swedish Academy in 1732.[3] This was followed by the first edition of his 'Systema Naturæ,' published in Leyden in 1735. The 'Fundamenta Botanica' followed in 1736, and was later enlarged and republished as the 'Philosophia Botanica,' in 1751. During the next ten years various other botanical publications appeared in rapid succession. His 'Fauna Suecica,' published in 1746, was his first special work relating to zoology. It is also notable as being the first work especially devoted to the entire fauna of any country. It was republished, with many additions, in 1761. Other botanical and several medical works followed during the next seven years, including his monumental 'Species Plantarum,' published in 1753. In the same year also appeared the 'Museum Tessianum,' consisting chiefly of descriptions of minerals and fossils, the latter mainly shells and corals, and in 1754 the 'Museum Adolphi Friderici,' relating exclusively to exotic animals. This was a folio with 33 plates, the most extensive and most elaborately illustrated of all of Linnæus's works. Two important medical works appeared in 1760, and his third zoological work, the 'Museum Ludoviciæ Ulricæ,' in 1764, a thick octavo, to which was annexed the second part of the 'Museum Adolphi Friderici.'

During these thirty years of marvelous scientific activity, Linnæus also contributed many papers to the transactions of the Upsala and Stockholm Academies and to the 'Amœnitates Academici.' The latter, in ten octavo volumes, consists of dissertations or academical theses, mostly by his students, selected, edited and published by him, and thus may be regarded as of equal authority with his own writings. Seven of these volumes were published during his lifetime and contain a number of his own minor papers.

This brief outline of Linnæus's life, his opportunities, and the published results of his scientific labors, affords the basis for the consideration of Linnæus as a zoologist. As has been shown, he was primarily a botanist; he was also a mineralogist, an entomologist and a conchologist, but only incidentally a vertebrate zoologist. In this field his interest was less strong, his opportunities for research the most restricted. His zoological writings, exclusive of a few minor papers, are comprised in the 'Fauna Suecica,' the 'Museum Adolphi Friderici,' the 'Museum Ludoviciæ Ulricæ' and the several editions of his 'Systema Naturæ.' The first edition, appearing in 1735, was a folio of only 12 pages, consisting merely of a conspectus of his 'Systema,' in tabular form. The second edition, published in 1740, was an octavo of 40 pages, in which were added, for the animal kingdom, the characters of the groups. The sixth, published in 1748, was greatly enlarged, the zoological part alone consisting of 76 pages, illustrated with six plates, or one for each of his six classes of animals. The tenth, published in 1758, was in two octavo volumes, of which the zoology formed the first volume, consisting of 824 pages. The twelfth, and the last edition revised by the author, was issued in three volumes, the first of which, containing the zoology, and comprising 1,427 pages, appeared in 1766. Thus in thirty-three years this work grew from a brochure of 12 pages to a work of 2,400 pages.

The first edition of the 'Systema' was published when the author was only twenty-eight years old, during his sojourn in Holland; he had never previously been beyond the confines of southern Sweden, except on his journey to Lapland and Finland in 1732, and he had had access to no large

[3] His 'Hortus Uplandicus' is said to have appeared one year earlier. See 'List of the Works of Linnæus,' in Jardine's Naturalist's Library, Vol. I., 1833, p. xvii, foot-note.

collection of animals. Thus his resources for such an important undertaking were extremely limited, being restricted to his own considerable first-hand knowledge of the fauna of Sweden, to the few specimens of exotic animals he had been able to see in Lund, Upsala and Stockholm, and to the scanty literature of the subject there available. When the second edition appeared, in 1740, he had spent less than three years and a half in foreign countries, mainly in Holland with single brief visits to London and Paris, but his interests on these occasions were botanical and not zoological.

The sixth edition (the third revised by the author), published in 1748, was in effect a synopsis of the fauna of Sweden, filled in, as regards the fauna of the rest of the world, by compilations from his predecessors. Strange as it may seem, outside of the tropical genera *Simia, Bradypus, Dasypus, Myrmecophaga* and *Manis,* this edition enumerates only thirteen species of mammals not found in Sweden. Only 140 are recorded for his whole class 'Animalium quadrupedium,' one third of which are Scandinavian.

This analysis could be extended to other classes with practically similar results. The class Insecta, for example, includes only 13 species that are not also recorded in the 'Fauna Suecica,' showing how limited was his knowledge of the world's fauna at 1748.

The tenth edition (the fourth revised by the author), published in 1758, is *the* epoch-making work in the history of zoology, as in this the binomial system of nomenclature for the whole animal kingdom is introduced for the first time. The work is also greatly enlarged, and the classification greatly improved, especially that of the mammals, which class is now for the first time aptly designated Mammalia. The ordinal term Primates is substituted for Anthropomorpha of the sixth and previous editions, the sloths (genus *Bradypus*) are removed from it, the genus *Lemur* is added, as a new genus, and the bats are transferred to it from the Feræ. A new order, Bruta, is made up of his former third order Agriæ, now suppressed, and of such other extremely heterogeneous elements as the elephant, the manatee, sloths, anteaters and the scaly anteaters. The order Feræ consists of six properly associated genera; the armadillos, insectivores and bats, formerly included in it, being removed elsewhere. His fourth order, Bestiæ, is a new group, composed of the pigs, armadillos, opossums and insectivores. The fifth order, Glires, is a natural group, except for the inclusion of the genus *Rhinoceros,* now most strangely placed with the squirrels and mice. His sixth order, Pecora, is retained as in the previous editions, and is also a natural group. The seventh, Belluæ, is a new ordinal group, consisting of the genera *Equus* and *Hippopotamus,* transferred from the here disrupted order Jumenta of previous editions. The Cete, now removed by him from the fishes, form his eighth and last order. This reconstruction of the ordinal groups is a great improvement; five new genera are added, two old ones eliminated, and the number of species is increased from 140 to 185. In some of the other classes there are similar radical changes, but there is not time to refer to them.

The twelfth, and the last edition revised by the author, published in 1766, shows many improvements over the tenth. It is greatly increased in bulk through the addition of many new genera and a large number of new species. The classification is also judiciously modified at many points. Taking again the class of mammals for illustration, the number of orders is reduced from eight to seven, through the suppression of the grossly unnatural order Bestiæ and the transference of its genera to other associations, with, however, the

retrograde change of placing the insectivores and the genus *Didelphis* among the Feræ. The Glires are modified by the removal of the genus *Rhinoceros* to the order Belluæ, and the addition to it of *Noctilio,* a genus of bats. The order Bruta is the same incongruous association of elephants, manatees, sloths and anteaters as in the tenth edition.

The orders of mammals, as now left, correspond in several instances very nearly with those of our modern systems, notably the Primates, Glires, Pecora and Cete. The Feræ of the tenth edition corresponds to the modern Carnivora, but in the twelfth he made the mistake of putting back into it the marsupials and the insectivores. His order Belluæ being essentially the modern suborder Perissodactyla, his order Bruta is the only grossly incongruous association of types.

The only previous classification of mammals with which Linnæus's need to be compared is Ray's, published in 1693, whose system, taken as a whole, is far more artificial than Linnæus's. Naturally there are some striking coincidences of grouping, and in the characters employed by the two authors. As to the latter, Ray so well covered the field that there was little left for Linnæus to add, since during the interval between Ray and Linnæus not much was learned about the anatomy and relations of the ordinal groups of mammals. Doubtless Linnæus was influenced, in his removal of the cetaceans from the fish to the mammal class, by the systems of his contemporaries, Klein (1751) and Brisson (1756), in which respect only are their systems better or less artificial than his. Inasmuch, however, as Brisson divided mammals into eighteen orders instead of seven, he escaped some of the grotesque combinations made by Linnæus; on the other hand, he gave undue emphasis to relatively unimportant differences.

Linnæus's classification of birds is closely modelled upon that of Ray, and his departures from it are seldom improvements. His lack of knowledge of ornithology is strikingly apparent through his repeated association of very unlike species in the same genus, as where a penguin is combined with a tropic-bird to form his genus *Phaëthon,* and another species of penguin with an albatross to form his genus *Diomedea.* In the tenth edition, he recorded only about 550 species of birds; in the twelfth, this number was raised to nearly a thousand, mainly on the basis of Brisson's great work, which appeared in 1760. The greater part were based on the writings of previous authors; probably less than one fourth of them being known to him from specimens.

His class Amphibia contained four orders, of which the fourth consisted of cartilaginous and other wholly unrelated fishes, and shows how slight was his acquaintance with the lower classes of vertebrates. His first order, Reptilia, includes such diverse animals as turtles, lizards, salamanders, frogs and toads. The snakes formed his second order Serpentes.

His arrangement of the fishes was originally based on that of Artedi, whose 'Ichthyologia' Linnæus published while sojourning in Holland in 1738, after Artedi's untimely death by accidental drowning.

His class Insecta is nearly equivalent to the modern subphylum Arthropoda, as it includes the Arachnida and the Crustacea.

His class Vermes was the waste-basket of his system, including all the forms of animal life that were neither vertebrates nor insects, which he distributed into five orders, some of them as heterogeneous in character as the class itself. The second order, Mollusca, comprised all sorts of soft-bodied animals, mostly marine, as slugs, sea-anemones, ascidians, holothurians, cuttlefishes, starfishes, sea-urchins and jelly-

fishes. The animals now commonly known as Mollusca formed his third order Testacea.

It is not, however, just to judge Linnæus's work by the standards of to-day. The above comparison of the zoological part of the 'Systema Naturæ' with our present knowledge of animals is not to be taken as a disparagement; we merely note the progress of zoology during the last century and a half of the world's history. Linnæus was a born systematist; his energy and industry were enormous; his isolation promoted independence and originality. He devised new classifications, and thoroughly systematized not only the knowledge of his predecessors, but the vast increment he himself added. He inspired his students with his own enthusiasm, taught them his own advanced methods, and influenced a goodly number of them to undertake natural history explorations in distant and zoologically unknown parts of the world.

In special lines of research he was far behind several of his contemporaries, notably Brisson in respect to both mammals and birds. But he nearly doubled the number of known forms of reptiles, amphibians and fishes, and increased many fold the number of species of cœlenterates, on the basis of wholly new material gathered through his own efforts.

Disgusted with the needlessly detailed accounts and repetitions that characterized the writings of most of his predecessors, he unfortunately adopted the extreme of condensation, thereby adding greatly to the difficulties of his successors in determining to just what forms the thousands of new names he introduced really belonged. Many of his species, based on the accounts given by previous authors, were also composite, often containing very diverse elements. But this detracts little from his credit. As one of his appreciative biographers has tersely put it: "He found biology a chaos; he left it a cosmos."

Linnæus's beneficent influence upon biology was hardly less as a nomenclator than as a taxonomist. He not only invented a descriptive terminology for animals and plants, but devised a system of nomenclature at once simple and efficient, and which for a hundred and fifty years has been accepted without essential modification.

Linnæus divided the three kingdoms of nature into classes, the classes into orders, the orders into genera, the genera into species, under which latter he sometimes recognized varieties. Of these groups, as he understood them, he gave clear definitions, but they were in most cases much more comprehensive than the limits now assigned to groups of corresponding rank. His genera correspond in some cases to groups now termed orders, and frequently to the modern idea of family; in some cases they contained species now placed in separate orders. Prior to Linnæus, these groups had less definite significance, and were often designated by a phrase instead of a single word. Species were indicated only by a cumbersome diagnosis, intended to express their chief distinctive characters. For this Linnæus substituted a single word, an innovation the merits of which were at once almost universally recognized. But Linnæus reached this solution of a grave inconvenience somewhat slowly, and not till 1753 did he fully adopt the *nomen triviale*, when he introduced it into botany in his 'Species Plantarum,' which is taken by botanists as the point of departure for the binomial system. In the following year, 1754, he introduced it into zoology, using it throughout his 'Museum Adolphi Friderici' for all the animals catalogued or described in this superb work, namely, 39 species of mammals, 23 of birds, 90 of reptiles and amphibians, 91 of fishes and 64

of invertebrates, or for an aggregate of 307 species of animals. Four years later, in the tenth or 1758 edition of his 'Systema Naturæ,' he adopted it for the whole animal kingdom, which date is now generally taken as the beginning of the binomial system for zoology. The importance and utility of this simple innovation in a matter of nomenclature are beyond estimate, and if Linnæus had done nothing else for the advancement of biology he would be entitled to a conspicuous niche in the temple of fame and to the gratitude of all subsequent workers in this field. He for the first time gave technical standing to the systematic names, both generic and specific, of all the plants and animals known at the dates when he introduced the *nomen triviale* into the nomenclature of botany and zoology.

It is of interest in this connection to note the number of species of animals known to Linnæus at the date of publication of the last edition of the 'Systema Naturæ,' the number known to him personally, and the number recorded respectively from North America and from South America.

Of mammals, the whole number of species recorded is 190, of which three fourths are based on the descriptions of previous authors. Only 48 were American—12 from North America and 36 from South America. The five North American mammals known to Linnæus from specimens were the raccoon, star-nosed mole, common mole, flying squirrel and chipmunk. The number of species at present known from North America is 600, excluding subspecies. The number for the world, including the extinct as well as the living, is about 10,000, as against less than 200 recorded by Linnæus.

Of birds about 925 are recorded of the 15,000 known to-day. The 200 known from America are divided about equally between North America and South America, only 50 of which were described from specimens.

The amphibia and reptiles number collectively about 250, of which about one third are American, 40 per cent. of the latter being North American and 60 per cent. South American. The North American include three salamanders, the box-turtle, the six-lined lizard, the blue-tailed lizard and 14 snakes. The greater part of the 20 North American species of reptiles and amphibians known to him personally were based on specimens transmitted by his former student, Dr. C. D. Garden, from the Carolinas, and on a few sent from Pennsylvania by Peter Kalm, also one of his students. Thus the greater part of the snakes of the eastern United States became known to Linnæus prior to 1766.

About 500 species of fishes are recorded, of which 100 are American, divided about equally between North and South America. Forty of the nearly 60 North American species described are based on specimens sent from the Carolinas by Dr. Garden, the others mainly on specimens in the museum of King Frederic.

There is not time to notice in detail the various classes of Cœlenterates. A few words about insects will serve as a general illustration for this phylum. Linnæus recorded about 2,400 species, the greater part of which he was the first to describe. About 300,000 are now recognized. Of the insects known to him, 65 per cent. are recorded in the second (1761) edition of his 'Fauna Sueccia,' and many of the remainder are European, so that his knowledge of exotic species was exceedingly restricted. Of Coleoptera he recorded about 800 species; the number now known is estimated at 12,000. Of Lepidoptera he recorded about 800; 7,000 are now known from North America alone. Of Diptera he recorded 278 species, of which 200 were from Sweden; 12,000 are now known from North America.

Linnæus's system of classification was based on a few external characters, and

was recognized by himself as artificial and provisional. It was intended only as a stepping-stone to better things, when the structure and affinities of animals should become better known. The statistics already given indicate how limited was his knowledge of the world's fauna; his classification of animals shows how little he knew of their structure, and how often he was misled by superficial resemblances. Yet his 'Systema Naturæ' was the working basis of all naturalists for the next half century;[4] twelve editions were published during his lifetime, and it was later translated into several of the continental languages. To such an extent was it regarded as final by many subsequent naturalists that when his groups began to be changed and new genera interpolated it was deemed by some of them little less than sacrilege. When convenience demanded subdivision of the larger genera, owing to the great number of new species that had become known since 1766, it was quite common to consider the new groups as 'sections,' and to give them merely vernacular names, or, if their authors were bold enough to designate them by Latin names, they were commonly called subgenera.

It was not till near the close of the eighteenth century that there arose a new class of naturalists, the anatomical school, led by the elder Geoffroy and G. Cuvier, who studied the internal structure of animals as well as their external parts. It was, however, many years before the new systems began to displace or greatly to modify the long-accepted and strongly intrenched Linnæan methods of grouping animals.

The great advance in biologic knowledge since the time of Linnæus can not be easily measured; it can be suggested by noting the fact that comparative anatomy, embryology, histology, paleontology, evolutionism and many kindred lines of research have nearly all had their origin or principal development within the last century, all converging for the solution of the genetic relationships of animals and the origin of life. Linnæus, in an oration delivered in 1743,[5] held that each species of animal originated from a single pair, citing as incontrovertible proof the Mosaic account of the creation. It is indeed a long look back to the middle of the eighteenth century when his labors marked a new era in the history of biology. In commemorating to-day the two-hundredth anniversary of his birth, we honor ourselves by showing our esteem for the greatest naturalist of the eighteenth century.

J. A. ALLEN

[4] Turton, in his 'Life and Writings of Linné,' says: "To this system may be justly applied the nervous observations of Dr. Johnson, in his delineation of the character of Shakespeare. 'The stream of time, which is continually washing away the dissoluble fabrics of other systems, passes without injury by the adamant of Linné.'" —William Turton, 'A General System of Nature' * * * by Sir Charles Linné, Vol. VII., 1806, p. [42].

[5] In his oration 'De telluris habitabilis incremento,' delivered and first published in 1743 and republished in 1744, and again in the second volume of the 'Amœnitates Academicæ' in 1751, he gives his reasons for believing: "That at the beginning to the world, there was created one single sexual pair of every species of living thing.

"To the proofs of this proposition," he continues, "I request those who are my auditors to lend a favourable ear and willing attention.

"Our holy Faith instructs us to believe that the Divinity created a single pair of the human kind, one individual Male, the other Female: The sacred writing of Moses acquaint us that they were placed in the Garden of Eden, and that Adam there gave names to every species of animal, God causing them to appear before him.

"By a sexual pair I mean one male, and one female in every species where the individuals differ in sex: * * *—J. F. Brand's translation, in 'Select Dissertations from the Amœnitates Academicæ,' 1781, pp. 75, 76.