To the

Academy of Natural Sciences
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THE

TERRESTRIAL

AIR-BREATHING MOLLUSKS

OF

THE UNITED STATES, &c.

THE

TERRESTRIAL

AIR-BREATHING MOLLUSKS

OF

THE UNITED STATES,

AND THE

ADJACENT TERRITORIES OF NORTH AMERICA:

DESCRIBED AND ILLUSTRATED BY

AMOS BINNEY.

EDITED BY

AUGUSTUS A. GOULD.

VOL. I.

BOSTON:
CHARLES C. LITTLE AND JAMES BROWN.
MDCCCLI.

CAMBRIDGE:
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TO THE

Academy of Natural Sciences

OF PHILADELPHIA;

TO WHOSE FOUNDERS IS DUE THE FIRST EFFECTIVE IMPULSE GIVEN TO THE STUDY OF THE NATURAL SCIENCES IN NORTH AMERICA, AND WHOSE LABORS HAVE BEEN MAINLY INSTRUMENTAL IN DEVELOPING THE NATURAL HISTORY OF THE COUNTRY,

THIS WORK IS RESPECTFULLY INSCRIBED BY

THE AUTHOR.

EVERY SPECIES OF ANIMAL IS POSSESSED OF BEAUTIES PECULIAR TO IT-SELF. THE MORE MAN CONSIDERS THEM, THE MORE THEY EXCITE HIS ADMIRATION, AND THE MORE THEY ENGAGE HIM TO ADORE THE AUTHOR OF NATURE, WHO HAS MADE EVERY THING IN WISDOM, WHO HAS SUB-JECTED EVERY THING TO HIS POWER, AND WHOSE GOODNESS GOVERNS THE WHOLE. *St. Augustin.*

IS NOT THE SMALLEST WORM THE WORK OF THE SUPREME BEING, AS WELL AS THE MOST PERFECT ANIMAL? AND IF GOD HAS JUDGED IT NOT BELOW HIM TO CREATE IT, WHY SHOULD IT BE THOUGHT A WEAKNESS IN A REASONABLE MAN TO MAKE IT THE OBJECT OF HIS RESEARCH? *Lesser.*

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NOTICE.

In the last Will of Dr. Binney is the following clause: "Having, for several years past, been collecting materials at my leisure for the publication of a work concerning the Terrestrial Mollusca of the United States of America, a large portion of which is ready for the press, and for which numerous engravings have been prepared, my will is, that in case of my decease before the same shall be published and distributed, my executors shall employ some competent person or persons to prepare the same for the press, and shall publish the same at the expense of my estate."

At the request of the executors, I have endeavored to fulfil the wish above expressed. The plan laid out by him has been strictly followed, though in some instances contrary to my own opinions, and it has been departed from only where observations since his decease have rendered it imperative. The consequence is, that there are a few discrepancies between the first and second volumes. The work was found to be less complete than had been anticipated, very few descriptions having been finished except in the genus Helix, and none of the generic descriptions except those of the Limacidæ. Many new species have also been added from the collections which he had caused to be made in the South-western States and Texas, but which his health had not permitted him to examine. The passages for which I am responsible are indicated by the annexation of the letter "G." A number of the plates also remained to be designed or engraved. It was the intention to have had the work issued very soon after the decease of Dr. Binney; but the scattered state of the materials, at various places in this country and in Europe, and the difficulty of procuring suitable artists, have caused most perplexing delays.

I cannot hope to have produced the work such as he would have made it. My comparative ignorance of a subject to which he had given so much of the attention of a mind deeply in love with his subject, and thoroughly prepared for a full and philosophical treatment of it, would forbid this. Nor can I pride myself on possessing that delicate artistical taste with which he was so well endowed, and which is so necessary in the details of such a publication. But so far as a general knowledge of his design, together with a sincere wish to do justice to the memory of a friend, could avail, they have been given to the work.

A. A. GOULD.

BOSTON, 1850.

MEMOIR.

Amos Binney was born in Boston, October 18, 1803. At the age of ten years, he was sent to the Academy at Hingham, where he received his education preparatory to entering college. At the age of fourteen, he entered Brown University, and was graduated in 1821. He then engaged in the study of medicine, under Dr. George C. Shattuck, of this city, and attended medical lectures at Dartmouth College. At this time his health failed him. He had urgent cough, pain in the side, and other alarming pulmonary symptoms, and was obliged to suspend his studies. By the advice of his medical attendants, he undertook a journey on horseback, which he accomplished in the summer of 1823, proceeding in this way to Cincinnati and home. At Cincinnati he had an attack of fever which wellnigh proved fatal. No relief was gained from this journey; and in the following May he fled, as it were in despair, to Europe. He there visited England, France, Italy, and Germany, directing his attention principally to the Hospitals and to the great collections of science and art, and returned home in December, 1825, greatly relieved of his disease; though he ever afterwards felt the relics of it, and had one or two violent paroxysms of palpitation of the heart, threatening to be fatal. He then resumed his medical studies, and took the degree of Doctor in Medicine at Harvard University, 1826.

Though intensely interested in the study of medicine on account of its bearing upon natural science, the practice of the profession he had chosen was by no means congenial to his taste; and as he deemed the past history of his health adverse to a professional life, and, still further, as Providence seemed at that time to present to him prospects of an advantageous connection in business, he forthwith abandoned the medical profession for mercantile pursuits. His earlier enterprises in trade were not encouraging. The consequence was, that he was led to direct his attention to real estate and mining operations, in which his father was also extensively engaged, and all of which soon devolved upon him by the death of his father. In these operations he was eminently successful, and rapidly accumulated a fortune.

In the midst of his extensive business he was never unmindful of science. This was his passion; and all his leisure moments were devoted to it, in preference to mingling in general society, for which he had very little taste; and he always looked forward to the time when he should retire from business, become a patron of science and art, and make science his occupation. In the winter of 1836–7, having accumulated what he regarded as a competence, and having invested it profitably as he supposed, he counted that the anticipated era had thus early arrived. But the well-remembered business disasters of 1837 came; and so far from being able to retire from business, he was obliged to give himself exclusively to it, and with redoubled zeal, for the next five years, in order to meet the crisis and save his estates from the general ruin. Having successfully accomplished this and much more, he again felt that, with a competence before him, he could withdraw from business cares, and devote himself more especially to science and art; and, next after his own family, to make the Boston Society of Natural History and the Boston Athenæum the objects of his solicitude and bounty. But alas! his long-cherished anticipations were not to be realized. His health soon began to decline. Intermittent headache of a severe and unmanageable character, had already robbed him of half the enjoyment of life; and other difficulties now supervened. He retired for relief to the country, hoping that quiet would restore him. Finding this unavailing, he resolved to try what had once before proved so salutary to him, — the effect of a sea voyage, and a visit to Europe, which he had many years designed, for the purpose of becoming acquainted with the scientific men and scientific collections of the old world, and of purchasing a well-appointed scientific library, — all of which was to be subservient to the cause of science in general, in America, rather than to his individual gratification. With these ends in view, and with every facility for accomplishing his scientific designs, he sailed from New York for Havre in October, 1846. He obtained no relief during the voyage; and after stopping a few days at Rouen and a short time in Paris, during which his bodily sufferings and his nervous irritability increased, he urged onward for Italy. He tarried a short time at Florence, but became still more ill. In passing the Apennines, the chilly and penetrating "mistral" which prevailed, and the bleakness of the lodging-houses, were too much for him, in his sensitive condition; and the consequence was a violent attack of pleurisy. Convinced that it would be certain death to remain under such exposure, he made a desperate effort to reach Rome; and, though every jolt of the carriage caused a groan, he arrived there on the third day. The most energetic treatment was here employed, and at first with marked relief; but a relapse took place, and he suffered intensely. Again the disease seemed to have been subdued, and he was encouraged that he would recover; suddenly and unexpectedly, however, he sunk, and died, February 18, 1847. His earthly remains, in accordance with his wishes, were brought home, and committed to their destined resting place at Mount Auburn.

In person, Dr. Binney was above the middle stature, erect, robust, and well-formed. His complexion was dark, with very dark hair and eyes. His features were full and well-formed. His dress was elegant and scrupulously neat; his manners were dignified, and bespoke the gentleman. His voice was deep-toned, full, and melodious, and his enunciation was remarkably distinct. His imposing mien, and the grave and positive tones of his voice, conveyed a first impression that he was haughty and inaccessible. He was himself at a loss to know why he had acquired this reputation, inasmuch as he felt entirely unconscious of indulging any thing corresponding to it in his heart. In his opinions he was decided, but not obstinate. Though naturally indolent, according to his own confession, he was ever busy, as it is evident he must have been to have accomplished so much at so early an age. He was elegant and refined in his tastes, and passionately fond of the fine arts. His discrimination as a connoisseur is well evinced by his numerous and well-selected books, pictures, engravings, sculptures, and other specimens of the fine arts. He was most happy in his domestic relations; an excellent father, unspeakably anxious to train up his children, both by example and precept, in all their duties to God and man. An extract from his journal will exhibit the burden of his mind on this point. He says, "May my children especially imbibe principles of honor and religion, and may it be their high aim to acquire and deserve the name of *christian gentlemen.* May it be said of my house, not that 'all the sons were brave and all the daughters virtuous,' but that all the sons were upright and honorable, and all the daughters good!"

Dr. Binney loved the works of nature, not as objects of scientific interest only, but as the beautiful manifestations of Divine Wisdom, adapted, at the same time, to afford the well-disposed mind gratification of the purest and deepest kind. As a lover of nature, he viewed with delight the whole landscape; as a naturalist, he loved to study the relations of individual objects. And he loved art, because it is the nearest material approach which man makes towards the handiwork of the Creator. His love for Natural History was early manifested. When quite a child, his chamber was garnished with stones, shells, strings of birds' eggs, and such other objects as are likely to attract juvenile observation. He commenced a collection of shells while in college. The interest of his father in mining tended early to direct his attention to the study of minerals; but perhaps nothing contributed so much to enkindle his interest in the wonders of nature as his visit to Cincinnati, soon after leaving college. The fossiliferous rocks of that region could not but attract his attention; and during his stay there, he spent most of his hours, so far as his strength admitted, in lying upon the rocks, and in chiselling out the fossil remains. Most of the Silurian fossils now belonging to the Natural History Society, were obtained by him at that time. His first visit to Europe contributed greatly to foster and enlarge the taste already formed for Natural Science; and he availed himself of the opportunity to procure many shells from the Mediterranean, and many valuable minerals.

In February, 1830, there was a meeting of gentlemen, which resulted in the formation of the Boston Society of Natural History. Dr. Binney was one of the number, and was appointed one of a committee of five to recommend measures for its organization, and the best means of interesting the public in its favor. In connection with the late Simon E. Greene, Esq., he undertook to call on gentlemen likely to be favorable to the proposed objects of the Society, and obtain their coöperation. At a subsequent meeting, he was appointed on the committee to draft a Constitution; and it is understood to have been mainly done by him. His name is one of those mentioned in the act of incorporation. At the first meeting for the choice of officers he was elected one of the Curators, and has held some office in the Society ever since. He was Treasurer, 1832 – 4; Corresponding Secretary, 1834 – 7; Vice President from 1837 – 43, when he was elected President.

The nucleus of the Society's Museum was contributed by him. In July, 1831, he gave two hundred specimens of minerals, one hundred specimens of foreign organic remains, and two hundred specimens of fossils from Ohio. He also deposited his collection of shells, consisting of about fifteen hundred species, and at that time by far the most complete collection in this country. In 1840, these shells were given to the Society, together with about one hundred specimens of mounted American birds, on certain conditions, which were at once complied with.

The Journal of the Society had his special regard. It was modelled by him; and the first paper printed, was written by him. Besides this, which was upon the Fusus Aruanus of Chemnitz, he contributed several others; all of them upon the Terrestrial Mollusks of the United States, which he made a special study. As long ago as 1835, he commenced a monograph of this group of animals, and published it, from time to time, in the Journal. Besides his papers published in the Journal, he read others to the Society, of no less interest and importance, on various subjects, in which he displayed most just and discriminating views of the claims of Natural Science, and of the spirit and aim with which it should be prosecuted.[1]

[1] The following are some of the papers found on his files: —

Report on the Journal of the Academy of Natural Sciences, Vol. VII. Part 2, 1837.

Remarks on the Reports on the Birds, Fishes, and Reptiles of Massachusetts. November, 1839.

Observations on the Appearance of the so-called Sea Serpent at Nahant, as seen by himself, August, 1839, with sundry Documents.

Criticism on Schlegel's Notice of Dr. Holbrook's Herpetology, Vol. I. September, 1840.

Remarks on two Paleontological Works of Michelotti. October, 1842.

Observations, during two successive summers at Nahant, on the Habits of the short Sun-fish, (*Orthagoriscus mola.*) December, 1842.

Remarks on the American Species of Pupa. April, 1843.

Remarks on the Descriptions of New Fresh Water and Land Shells, by Isaac Lea.

On the Hydrarchos and the Mastodon, (published in the Daily Advertiser, September, 1845.)

Remarks at the Annual Meetings of the Boston Society of Natural History. 1844 and 1845.

Remarks on the Fossils from the Strata of the Bluffs at Natchez, on the Mississippi River. April, 1846.

The great work, however, to which he chiefly devoted himself, was the one which follows, being an amplification of his Monograph on the Terrestrial Mollusks of the United States. It was his intention to publish something that, in completeness and in the style of its mechanical execution, should be unsurpassed by any similar work. He therefore spared no pains and no expense to render it as perfect as possible. He obtained characteristic and living shells of every species and variety; he procured the best artists to figure and engrave both the animal and the shell; many of which were repeatedly drawn or engraved before he was quite satisfied with the result; — he had thorough and accurate dissections made of all their anatomical minutiæ, by the skilful hands of Drs. Wyman and Leidy; and he kept most of the species in captivity for months, that he might be able to observe their habits, the variations they exhibited, and the changes they underwent by age, food, etc. To carry out fully his design, he employed an experienced collector to spend one winter in Florida and the adjacent Keys, and another in the Southwestern States, including Texas; and thus he was prepared to give not only the descriptive characters of the whole group, but its geographical and geological relations, and many other generalizations of much interest and importance. He carried the manuscript with him to Europe, intending to have some of the unfinished plates executed there. This most valuable work was left so nearly complete that it may be regarded as essentially his work.

His last and his greatest effort in behalf of science was, to carry into effect a purpose, long since formed, of obtaining, through the liberality of the Boston public, a building for the Society of Natural History, which should amply accommodate its present and prospective collections. In his anniversary Address, in 1846, he set forth in the most lucid and convincing manner, the wants of the Society, the absolute uselessness of adding to its collections in consequence of a want of the means for their preservation and display, and the claims which the objects and labors of the Society had upon the public. By a vote of the Society, this address was afterwards printed and circulated, as an appeal to an enlightened and liberal public; and it will ever stand as an enduring memorial of his just appreciation of the claims of science, of his clear and unaffected style of writing, and of his devotedness to the interests of the Society. Not only did he do this, but voluntarily undertook to solicit the necessary subscriptions, in which he had so far succeeded as to put his final success beyond a doubt, when disease arrested him.

He was a member of all the scientific bodies in this country; — the American Philosophical Society; the American Academy of Arts and Sciences; the Academy of Natural Sciences of Philadelphia; the New York Lyceum; the Natural History Societies of Hartford, Salem, Portland, and many others.

He was also one of the prominent members of the American Association of Geologists and Naturalists. He had read several very interesting papers at its sessions, most of which were destined to form a part of his work on the Terrestrial Mollusks. When, at the session of the Association in Boston, in 1844, it was proposed by several of our most intelligent citizens, that the valuable papers which had been read should be printed, and liberal contributions were volunteered by them for the purpose, Dr. Binney was made chairman of the publishing committee.

In conformity to his wishes, the work was carried out in a style far superior to what was contemplated, and proved also much more voluminous, while the sales were very limited. The cost, of course, far exceeded the means of publication; and the residue, amounting to a large proportion of the whole, was contributed by him.

At the session held in Boston in September, 1848, he was to have presided over that distinguished body, and expected much gratification to himself on that occasion, in the anticipation that the citizens of Boston would, by their hospitality and energy, render it a profitable and happy occasion to those who might favor them with their presence.

It was not, however, for his direct, actual scientific labors and acquirements that Dr. Binney stood in his most important relations to science. Others have, probably, labored more constantly, more zealously, and have made more progress than he. But he held a position which very few occupy. He stood between science and the public to whom it must look for countenance and support. Fully alive to its claims, having a clear, philosophical appreciation of the difference between true and false science, and having himself made respectable attainments in the fundamental principles of natural science, and even in all its separate branches, he was at the same time the man of business, the man of fortune, the man of prospective leisure, and the man who had consecrated that leisure to the interests of science and art.

Not the least among the items for which science is indebted to Dr. Binney, must we reckon his superb library. It numbers many hundred volumes, and at his death was undoubtedly the most important library of works on zoölogy in America. It was by no means the largest; but it contained more of the modern works, on those topics which are essential to the study of natural history in its present state, than any other one library in the country. Many of the books are splendid, rare, and very costly works; and all are in elegant binding. These he granted free use of, to all who desired it; and indeed it had become indispensable, in the investigation of any important topic in zoölogy, to consult his library; and for this purpose it was visited by gentlemen from all parts of the Union.

Having frequent occasion to travel, and thus visiting every quarter of the Union, he formed an acquaintance with almost every man who had any pretensions to science; and he did much to encourage them, and to bring them in contact with each other. At the same time, his eye was always open, and on the watch for any thing that might be of importance to the Museum or to the Journal of the Natural History Society.

While a member of the Legislature, in 1836–7, he used his endeavors to sustain the State Geological Survey, then in process by Prof. Hitchcock, and was principally instrumental in having attached to it the Commission for the Zoölogical Survey also, the results of which have been so important. He also secured for the Natural History Society an appropriation from the Legislature, which, small as it was, was infinitely important at that time.

To the Natural History Society, he was, at the same time, the patron, the fellow-laborer, the President. He stood with it, and yet with the world, a link to bring them in contact. Having been instrumental in its organization, having watched and fostered it through its days of feebleness and small things, and having passed through its various offices till he had become its head, — his name, his fame, his labors, and his fortune were identified with the Society; and in its social relations he was in a position to render services which no survivor has the power of rendering. He had hoped that by his visit to Europe he should be enabled to form acquaintances with scientific men, and their modes and facilities for investigation; to learn the best arrangement for a cabinet, and the best modes of preserving objects; to negotiate exchanges, and make large additions to his library; by which his future connection with the Society, especially at the juncture when plans for the permanent arrangement and preservation of the Cabinet were likely to be needed, might become of the greatest possible advantage.

Nor was he less qualified, or less disposed, to promote the interests of art among us. Ill as he was in Europe, he never lost sight of the two institutions which he had determined to foster; and he was daily seeking to obtain collections for the one, and rare books and paintings for the other. Several arrangements with this view had been entered into, which were interrupted by his illness, and more or less defeated by his death.

It is due both to him and to the history of American Art to record, that with a view to the encouragement of American Artists, he had proposed to four of the most prominent painters of his native country to execute for him two pictures each, at generous prices. They were to choose their own subjects, and not be limited for time; the only stipulations being, that the pictures should be of certain dimensions, and the subject of one of each was to be from history, either American, or written by an American; and they were requested to produce such works as would give to the world a pledge of their ability, and on which they might hope to rest a reputation with posterity. The four artists selected were Huntington, Rothermel, Leutze, and Terry. The following pictures have resulted; namely, "Henry VIII. and Catherine Parr," by Huntington; "Noche Triste," from Prescott's Conquest of Mexico, by Rothermel; "Spaniards storming a Mexican Teocalli," also from Prescott's Mexico, by Leutze; and "I think," from Prescott's Ferdinand and Isabella, by Terry.

Similar propositions were made to the American sculptors, Powers and Crawford, and also to other artists, for statuary in bronze.

Such was his life, his attainments, his aims. And when, with his generation, the memory of Dr. Binney, as a man, an enterprising citizen, a father, and a friend, shall have passed away, his name must ever appear among the pioneers of Science in America, as one of its most substantial supporters, and as having contributed materially to the enlargement of its boundaries.

CATALOGUE OF AUTHORS.

ALPHABETICAL

CATALOGUE OF AUTHORS

WHOSE WORKS ARE REFERRED TO IN THIS VOLUME.

WITH THE TITLE AND DATE OF PUBLICATION.

N. B. The leading words only of the title of each work, and those often abbreviated, are given in the references in the text. When the author's name alone is given, it is to be understood to refer to the single work in this list.

AMERICAN AUTHORS.

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Fresh-Water and Land Shells of Vermont, with figures, contained in Thompson's History of Vermont; also published separately, pp. 20, 8vo. 1842.

ANTHONY, JOHN G. Cincinnati, Ohio. Description of *Bulimus vermetus.* On the cover of Haldeman's Monograph of the Limniades, No. 3. July, 1831.

BINNEY, AMOS. Boston, Mass. *A Monograph of the Helices inhabiting the United States*, with figures. Boston Journal of Natural History, Vol. i. pp. 466 — 495. May, 1837. Vol. iii. pp. 353 — 394, July, 1840, and pp. 405 — 438, November, 1840.

Descriptions of some of the species of naked air-breathing Mollusca inhabiting the United States. Same Journal, Vol. iv. pp. 163 — 175. Same in pamphlet form, January, 1842

Description of a species of Helix newly discovered in the United States. In the same Journal. Vol. iv. p. 241.

Conrad, Timothy A. Philadelphia, Penn. *American Marine Conchology, or descriptions and colored figures of the Shells of the Atlantic coast of North America.* 8vo. pp. 72, 16 plates. Philadelphia, 1831.

New Fresh-Water Shells of the United States, with colored illustrations, and a Monograph of the genus Anculotus of Say, also a Synopsis of the American Naiades. 12mo. pp. 76, 8 plates. Philadelphia, 1834.

De Kay, James E., M. D. New York. *A Report on the Zoölogy of New York*, containing a Catalogue of the Animals of that State, being a part of the Annual Report on the Geological Survey for 1840, pp. 7—36. Document of the Assembly of New York, No. 50. Albany, January, 1840.

Zoölogy of New York; or the New York Fauna. Part V. Mollusca. 4to. pp. 270, 40 plates. Albany, 1843. Published by order of the Legislature of New York.

Gould, Augustus A., M. D. Boston, Massachusetts. *A Monograph of the species of Pupa found in the United States*, with figures. Boston Journal of Natural History, Vol. iii. pp. 395—404. July, 1840, and Vol. iv. pp. 351—360. Jan. 1841. Same in pamphlet form.

Results of an Examination of the Shells of Massachusetts, and their Geographical Distribution. Same Journal. Vol. iii. pp. 483—494. November, 1840.

A Report on the Invertebrata of Massachusetts, comprising the Mollusca, Crustacea, Annelida, and Radiata, pp. 373, 8vo. with figures. Boston and Cambridge, 1841. Published by order of the Legislature of Massachusetts.

Green, Jacob, M. D. Professor of Chemistry in Jefferson College, Pennsylvania. *Note* annexed to a Memoir, containing a description of *Helix Pennsylvanica.* Contributions of Maclurian Lyceum, No. 1, p. 8. Philadelphia. January, 1827.

Notes of a Naturalist. Doughty's Cabinet of Natural History, Vol. ii. p. 291, and Vol. iii. p. 35. Philadelphia, 1833.

Haldeman, S. Stehman. Columbia, Pennsylvania. *A Monograph of the Limniades and other Fresh-Water Univalve Shells* *of North America.* With colored figures. 8vo. Philadelphia, 1840 — 1843. Eight numbers have been published.

Enumeration of the fresh-water Mollusca common to North America and Europe, with Observations on Species and their distribution. In the Boston Journal of Natural History, Vol. iv. pp. 468 — 484. 1844.

Kirtland, J. P., M. D. Cleveland, Ohio. *Report on the Zoölogy of Ohio*, contained in the Second Annual Report on the Geological Survey of the State of Ohio, pp. 157 — 200. 8vo. Legislative Document. Columbus, Ohio, 1838.

Lea, Isaac. Philadelphia. *Observations on the Naiades, and Descriptions of new species of that and other Families:* with colored figures. Transactions of American Philosophical Society, Philadelphia, Vol. iv. pp. 63 — 121. 1834; and Vol. v. pp. 23 — 120. 1837.

Descriptions of new Fresh-Water and Land Shells. Same Transactions, Vol. vi. pp. 1 — 111, with colored figures, 1838. Also Papers under the same title in the Proceedings of the same Society, viz.: No. 13, October, 1840; No. 17, March, 1841; No. 19, July, 1841.

Linsley, Rev. James H. Stratford, Con. *Catalogue of the Shells of Connecticut*, pp. 16. In American Journal of Science, Vol. xlvii. No. 2. Same in pamphlet form, New Haven, 1844.

Mighels, J. W., M. D. Portland, Maine. *Catalogue of the Marine, Fluviatile and Terrestrial Shells of the State of Maine and adjacent Ocean.* Boston Journal of Natural History, Vol. iv. pp. 308 — 345. April, 1843.

Phillips, John S. Philadelphia. *Description of a new American species of the genus Helix.* Journal of the Academy of Natural Sciences of Philadelphia, Vol. viii. p. 182. Also in Proceedings of the same, No. 3, June, 1841.

Plummer, John T., M. D. *Scraps in Natural History. Shells about Richmond, Wayne County, Indiana.* In American Journal of Science, Vol. xlviii. pp. 92, 94.

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PREFACE.

The following pages, prepared during intervals of leisure, have served to occupy the attention of the author, and have constituted his amusement amid the active engagements of business. He has esteemed himself fortunate in being able to find, in the study of Natural History, a relief to the over-burthened mind, a solace in trouble, and a protection from the all-absorbing cares which are incidental to mercantile pursuits. If to the healthful exercise of body and mind which he has himself enjoyed in their preparation, he shall be able to add the approbation of those who are engaged in similar investigations, it will be as ample a recompense as he has ever proposed to himself. He offers them to the naturalists of the United States without any other pretension than that of being actuated by a sincere desire of rendering them accurate and faithful, in every particular, and, so far, worthy of acceptance.

In bringing together and reviewing the labors of others in the same department of science, he has endeavored to do strict justice to all, to acknowledge his obligation for information received from each, and to indicate the source from which it is derived. If there are any omissions, in this respect, they have arisen from inadvertence and not from design. It will be noticed that in several instances he differs in opinion from those who have preceded him, and that he considers several species, described by them, to be merely varieties of, or even identical with, animals before known. In thus exercising his own judgment in opposition to that of persons for whose opinions he entertains the highest respect, he trusts that he has done it in a manner which cannot give just ground of offence. He has no regard for his own views, except so far as they shall be found consistent with truth, and he expects that they will be controverted by others with the same freedom. whenever they are supposed to be erroneous.

The work contains descriptions of all the air-breathing mollusks of the United States, living upon the land, including both the aboriginal and those foreign species which, having been from time to time introduced, have now become naturalized to the soil; and of such species belonging to the countries adjacent as are known to the author. Our knowledge of these animals is brought down to the date of publication; and it is hoped that the work will be found to be as complete as any record of an actively progressive science can be. In its preparation, all the American authorities have been consulted, and for the benefit of European naturalists, some of whom appear to be inexcusably ignorant or wilfully neglectful of what has been done for Natural History in this country, a catalogue of American authors, whose works have been used in compiling these pages, is given; a catalogue of the foreign works, referred to, is also added. A full synonomy of the native species is attempted, and it will probably be found to be pretty complete; but for the introduced species a few references only to well known works are given.

Great care has been taken to investigate the history of each species in order to designate it by the name applied to it by its first discoverer. The rule adopted is to give priority to *the first published description* or to *the first published name accompanied by a recognizable figure,* and to reject all claims based upon the publication of a *name only,* as these, if allowed, would inevitably lead to doubt and inconvenience, and in the end would afford opportunity for unfairness and fraud. The date of the first publication of the species is appended to the name of the work in which it appeared. The operation of the rule will restore to American authors many species which were first described by them, but which have long had a place in the works of MM. Ferussac, Lamarck and Deshayes under the names of foreigners who did not know them until after they had been described in this country.

It is one of the aims of this work to point out the errors, and to supply the omissions, of those and other distinguished naturalists; but although the author hopes to make his own work more useful thereby, he is far from presuming that it can bear a favorable comparison with theirs in any other respect than in giving a more full and correct account of the species belonging to his own country.

It is proper to state here, that when the work was nearly ready for publication the annexation of the republic of Texas to the United States enlarged the area of the author's investigations, by the addition of a region of many thousand square miles in extent to the vast territory already included in the field of his inquiry. He endeavored to meet the exigency by employing a competent naturalist to explore the accessible parts of that State during the early part of 1846; but it cannot be expected that the results of that exploration can exhibit more than an incomplete view of the species living there. A wide field of investigation is left for the future naturalist, both in Texas and in the whole extensive and but partially-explored region west of the Mississippi river.

The author takes pleasure in making this public acknowledgment of his obligations to those gentlemen who have kindly furnished him with materials used in the preparation of the work. To R. E. Griffith, M. D., late of the University of Virginia, a cotemporary of, and fellow-laborer with Mr. Say, he is indebted for much valuable information respecting this class of animals, which has been the especial object of his attention. It is a cause of regret that he should not have persevered in a design, conceived several years since, of publishing a work on the same general plan as the present, for the judicious execution of which he is peculiarly well qualified, both by study and observation. To Professor C. B. Adams, of Middlebury College, Vermont, he owes the loan of his entire collection of his American terrestrial mollusks, which have been of important service in the comparison and diagnosis of species, and for many facts concerning these observed by him in Vermont. To S. S. Haldeman, of Columbia, Penn., he is under obligations for specimens collected by him during a journey through the southern and south-western States, and for much information respecting the distribution of species. To John G. Anthony, Esq., of Cincinnati, Ohio, for valuable aid and many facts, derived from his own observation, concerning the species found in the neighborhood of that city. To J. Hamilton Couper, Esq., of Hopeton, near Darien, Georgia, for his obliging attention in transmitting his observations on the habits of *Glandina*, together with the living animal, and a beautiful drawing of it; and also for the species common in the lower parts of Georgia. To Prof. Jeffries Wyman, for information on the anatomy and habits of the animals; and to Prof. J. P. Kirtland, of Cleveland, Ohio; Dr. J. W. Mighels, of Portland, Me.; Dr. Edmund Ravenel and Prof. Lewis R. Gibbes, of Charleston, S. C.; Prof. W. B. Rogers, of the University of Virginia; Isaac Lea, Esq., of Philadelphia; John C. Jay, Esq. and B. W. Budd, M. D., of the city of New York; Dr. T. R. Ingalls, of Greenwich, N. Y.; Dr. W. Newcomb, of Troy, N. Y.; Prof. G. W. Benedict, of Burlington, Vt.; and T. J. Whittemore, Esq., of Cambridge, Mass., for their active kindness in affording the opportunity of examining species which, without their aid, would not have been procurable.

To Dr. A. A. Gould, of Boston, he presents his thanks, for frequent and various aid and advice, often asked for, and always bestowed with alacrity and liberality; and to John S. Phillips, Esq., of Philadelphia, for his unremitting attentions in superintending the preparation of the plates, mostly engraved and colored in that city — a labor of good will, which has required time and patience that no one except a gentleman thoroughly imbued with a desire to promote the cause of Natural History could have performed, and without which, the work could not have appeared.

To the venerable Alexander Lawson, the engraver of the Birds of Wilson, the author's acknowledgments are due for his efforts to render the illustrations, mostly engraved by him, worthy of his own reputation as an accurate zoölogical engraver, and worthy of the confidence of naturalists.

The author is gratified in announcing that the anatomical details of the species, together with the dissections and drawings, are exclusively due to the labors of Joseph Leidy, M. D., of Philadelphia. They constitute the most novel and important accessions to science contained in the work, and are an honorable evidence of a skill and industry which entitle him to a high rank among philosophical zoölogists.

Before commencing the descriptive part of the work, the author has found it convenient to enter upon some general considerations connected with the subject, for the purpose of tracing the relations of the animals he is about to describe, but more especially of recording those facts and observations, connected with the general subject, which he has derived from the study of the species belonging to this country. These are arranged under distinct heads, and are treated of in the following chapters of the Introduction.

INTRODUCTION.

"Notitiam autem naturalium, terræ alicujus indigenarum, œconomiæ meliori ejus instituendæ nonnihil suppeditare, certum est."

O Fabricius

"Modo ad augmentum scientiæ naturalis quædam notatu non indigna, neque lectu injucunda, contulisse dicar."

I.

OF THE RISE OF SCIENTIFIC ZOÖLOGY IN THE UNITED STATES, WITH NOTICES OF NATURALISTS PARTICULARLY CONNECTED WITH THE SUBJECT OF THIS WORK.

The impulse given to the study of Natural History in Europe, at the close of the last and the commencement of the present century, by that eminent school of naturalists and philosophers which arose in France, contemporaneously with its great political Revolution, imparted to the Natural Sciences an importance which they never before possessed. A crowd of gifted and ambitious minds, freed by that event from the shackles of established opinion, and thus enabled to direct their energies to such ends as suited their respective inclinations, entered upon a new career of intellectual exertion. With untiring perseverance, they investigated the past and present conditions of all organized existences, and interrogating nature in the very recesses of her temple, drew from her responses a philosophy which swept away the received theories of that day, as completely as the new political institutions took the place of the antiquated government to which they succeeded.

The earth, which had been to man a sealed book, was opened, and, read by the light of the new philosophy, disclosed the history of its own creation. The order of events, in the production and succession of animal life upon its surface, began to be understood. The relations of different beings to each other were studied, and all were seen to be mutually dependent. Order and system were thus substituted for confusion, and philosophical zoölogy became one of the prominent subjects which claimed the attention of the speculative and the learned.

The active interest in this science, originating in France, gradually extended to such parts of the continent of Europe as were influenced by the French language and literature, or were occupied by her armies, which were often attended by commissions of scientific men, and sometimes numbered, among their officers, naturalists of the highest merit. In England, when in consequence of the wars growing out of the French Revolution, and continuing until the dethronement of Napoleon, a state of non-intercourse with France existed, the new impulse was not felt until a later date. When it was received, however, it produced a decided impression, and was soon followed by a rapid advance in this department of knowledge. Its results have been the training of a numerous body of scientific naturalists, among whom are some of the most distinguished men of the present age.

At the period first alluded to, the United States, then not long emerged from colonial subjection, was engaged in organizing and establishing new political institutions. The people, thinly spread over a vast territory, were busied in developing its resources, or were engrossed by the excitements resulting from the unsettled condition of public affairs, and the frequent collisions with foreign powers, which disturbed the peace of the country for twenty-five years, until the termination of the war with England, in 1815. At the close of that conflict, which finally established for the country a rank among nations, and left it in repose, the movement which had sometime before been communicated from Europe, began to produce sensible effects here.

The state of society was not, at that time, suited to the favorable reception, much less to the rapid diffusion of science. Wealth was so equally distributed, that few were rich; and, although a respectable degree of intelligence was common, all the energies of the people were spent in pursuits immediately connected with the practical utilities of business. As a consequence of this condition of things, few were willing to cultivate science for its own sake, and most of these were persons who had not yet become engaged in the serious labors of life. It was by the *young men* of that period, therefore, that the Zoölogy of the modern school was welcomed to North America, and the earliest efforts made to promote its study. Their exertions were at first of the most unpretending character, but they sufficed to attract the attention of those possessing similar tastes, and led to the establishment of institutions in our principal cities, between the years 1812 and 1820, devoted to the cultivation of Natural History. Some of these could not sustain themselves, and became extinct; but others were more successful, and have continued, with various prosperity, to the present time. These, together with societies established in the interval, have exercised, and yet maintain, an important influence on the public mind. Through their efforts, scientific information is no longer confined to the professedly scientific, but has become familiar to the intelligent part of the community, and leisure is found by many to cultivate its various branches. The public, ceasing to condemn that, the immediate utility of which it cannot understand, now cheers, with its approbation and aid, undertakings of a purely scientific character; and the government extends to them, occasionally, an uncertain and hesitating patronage.

The institutions referred to served as nuclei, around which gathered those who were interested in zoölogical studies; and the investigation of the zoölogy of the country, then but imperfectly known through the works of Europeans, was soon commenced by the young naturalists who composed them. Beyond their limits there appears to have been but little encouragement for such pursuits, and hence the names of nearly all the early naturalists of the United States may be found connected with the history of these associations. As the materials collected by them acquired importance, it became desirable to make them known, and the publication of their respective transactions was undertaken.

The Academy of Natural Sciences of Philadelphia issued the first number of its Journal in 1817. The Annals of the New York Lyceum of Natural History appeared in 1823. The Contributions of the Maclurian Lyceum in 1827, and the Journal of the Boston Society of Natural History in 1834. Besides these, which are exclusively appropriated to Natural History, there are others of a mixed character, in which considerable prominence has latterly been given to the same class of subjects; such are the Transactions of the American Philosophical Society, and the Memoirs of the American Academy of Arts and Sciences. Several private Journals also in the same interest, have from time to time appeared; none of which, however, have obtained a permanent establishment, except the American Journal of Science and Arts, edited by Professor Silliman, which commenced its career in 1819, and yet enjoys a vigorous existence. This work contains numerous and valuable contributions to zoölogy, and has always exercised a wholesome and effective influence in diffusing correct ideas of the value of all the Natural Sciences. It is in these publications alone, that we must look for the great mass of original materials available in the compilation of any work on the zoölogy of the United States; and they are the sources often resorted to in the preparation of these volumes.

During the last ten years, however, several important works of a different character have appeared. A general and growing conviction, in the public mind, that the application of scientific knowledge to the investigation of the natural resources of the country would hasten the discovery of new sources of prosperity, and disclose the best and most economical mode of developing and improving those already known, induced the Legislatures of more than half the States of the Union, to establish scientific Commissions for the examination of the Geology and Mineralogy of those States respectively. In some of them the Commissions were directed to collect information respecting Zoölogy and Botany. In accordance with this authority, extensive and elaborate works on the Zoölogy of Massachusetts and of New York have been given to the public, at the expense of those States, and catalogues of the species, with short notices of the animals of other States, have also been prepared. These have contributed much to elucidate the general subject, and, especially, have added largely to what was before known of the geographical distribution of species.

The two classes of publications which have been mentioned, are believed to comprise all the materials, of any importance, relating to the particular department of Zoölogy here treated of, except the article entitled *Conchology* in the third American edition of Nicholson's Encyclopedia, which bore the date of 1819, and contained descriptions, by Mr. Say, of several native land-shells. In this exception must also be included the papers of Mr. Rafinesque, which will be presently noticed, but which, for reasons hereafter given, are not deemed worthy of any consideration. The next paper succeeding the article on Conchology, also by Mr. Say, published in the Journal of the Philadelphia Academy, is dated in January, 1821. These are the two earliest publications relating to this subject; and, although their date is so recent, they anticipated all foreign publications, and secured the priority of the descriptions and names contained in them. The same good fortune has attended the later publications here, so that it may be said, that with a few exceptions, American species have been first described by American naturalists. The exceptions are, descriptions by MM. Müller, Ferussac, and others, of species common to the Antilles, and some parts of the shores of the Gulf of Mexico, as well as to the United States; and by Mr. Rackett, of a single species from Canada, published in the Linnæan Transactions in 1822. It seems remarkable, considering the frequent intercourse between this country and Europe, and the activity that already prevailed among European naturalists in procuring new objects from foreign countries, that so few American species fell into their hands previous to the time when the American publications commenced. Indeed, they seem to have been better known to Mr. Lister in 1770, than to M. Lamarck in 1822, the former having given figures of nine or ten of them, against descriptions of only five by the latter.

The titles of the various papers, memoirs, catalogues, and more elaborate works, relating to the terrestrial mollusks, may be found in the catalogue of American authors contained in the preceding pages. On reference to it, it will be seen that the laborers in this branch of Natural History have been numerous, and that a respectable amount of materials has been accumulated. No attempt has hitherto been made to combine these into a work upon American Conchology, or upon the particular branch of it which is now presented. In bringing together these materials for the first time, it would be interesting and proper to give some history of them and of their authors, and thus to trace the science from its first dawnings in this country to the present time ; but there are circumstances which render it inexpedient to do so. It is only within a few years that any considerable attention has been given to such subjects, and consequently, these publications are so recent, that with few exceptions, their authors are yet upon the stage, and have not yet passed the active period of life. Such an account would almost necessarily partake of a critical character, and would therefore place the author in the position of a self-appointed judge of the labors of his contemporaries and friends, an office which he would not willingly assume, and for which he is but ill qualified. There are, however, two names, both connected with the rise of Natural History in the United States, and both having exercised an influence in its promotion, but with far different results in usefulness to science, and in honor to themselves, about which it is necessary to make some remarks, and to which the objections above indicated do not apply. These are the names of THOMAS SAY, and of CONSTANTINE SCHMALTZ RAFINESQUE. The latter indeed, not an American, but for a quarter of a century a resident in the United States.

Mr. Say, a native of Philadelphia, the son of a physician, but himself for some years a merchant, seems to have been the earliest scientific naturalist, of the modern school, which the country has produced. He possessed a well-balanced mind, powers of accurate observation and discriminating perception, and a facility of expressing his thoughts in a brief and condensed style. He was trained to habits of industry and perseverance; his temper was mild and equable; and his manners were so modest and retiring as to excite remark. His acquirements as a naturalist were due to his private studies alone; for at the period when his character was forming, there were few or none engaged in kindred pursuits, — no associations of naturalists, in the bosom of which he could find sympathy and support, and few libraries to which he could resort for knowledge and assistance. The great zoölogical names which have illustrated the nineteenth century had not then appeared, or, in consequence of the disturbed relations of this government with European powers, their works were mostly unknown here. But, notwithstanding the deficiency of his means and opportunities, he possessed himself of the learning and accomplishments of the day, in a much greater degree than could have been expected in his position; and was ready and prepared, at the commencement of the new career of science on which his country entered soon after the termination of the European wars, to make that advance in the branch of knowledge to which he had devoted himself, which has forever associated his name with the history of Zoölogy in the United States, and which ought to entitle him to the honor of being styled its founder. His published works, commencing about the year 1817, continue through a period of eighteen years until his death in 1834; and embrace descriptions of a vast number of animals until then entirely unknown, or but imperfectly understood. The invertebrated classes received the greater part of his attention, and his contributions to their history must, necessarily, form an important portion of the means of any writer who shall seek more fully to elucidate them. The major part of the subjects described in this volume were first described by him; and so fully had he occupied the ground, that the additions to our knowledge of species made during the twelve years, since his decease, have not exceeded the number contributed by him, although within that time many new inquirers have commenced their investigations, and large districts of country, which he never examined, have been explored. His descriptions are for the most part so accurate, and his observations so just, that there is little left to his successor except to bring them together in their proper order. Some obscurity, indeed, attends several of his species, in consequence of his not having uniformly placed specimens in a public depository for reference; for, when objects resemble each other so closely as do several species of the genera Helix and Pupa, it is very difficult to distinguish them by description alone; and differences of opinion will arise as to which, among analogous species, corresponds with a particular description. As, however, American naturalists have felt it to be a pleasure, as well as a duty, to render full justice to the merits of Mr. Say, by verifying and confirming his discoveries, nearly all the species described by him, though some of them were for a time lost, have been re-discovered and restored; and with a few exceptions only, they are retained as well defined and authenticated. A particular account of the contributions made by him, and also by other authors, to each genus, will be given in the remarks on the respective genera.

The character and career of M. Rafinesque, though offering points of resemblance to those of Mr. Say, are in most respects strongly contrasted with them. He was of French origin, but born in a suburb of Constantinople, and bred to the mercantile profession. He early imbibed a taste for the study of natural objects, which grew with his years, and finally so far absorbed his thoughts as to unfit him for other pursuits. He visited the United States on a trading voyage in 1803, and remained until 1805. He was known at that time as a botanist, and made the acquaintance of the few botanists and naturalists then existing in the country. On returning to Europe, he established himself as a merchant in Sicily, where he continued until his final departure for the United States in 1815. During this interval, he was industriously employed in investigating the natural history of that island, and published numerous works on botany and various branches of zoölogy, the most important of the latter relating to ichthyology. There is no published evidence that he had at this time much acquaintance with the mollusks, although by his own statement, his collection of shells amounted at the period of his embarkation from Sicily, to the incredible number of 600,000 specimens! On reaching the coast of the United States he suffered shipwreck, by which his collections, manuscripts and library, the fruits of the labor of years, were lost, and his property was so much impaired, that he never recovered from the blow, but sunk into a state of poverty and even of destitution, in which he continued until his death in 1840.

It is conceded on all hands, that the writings of M. Rafinesque, previous to his departure from Sicily, indicate the possession of considerable talent, and a degree of sagacity which placed him in some respects in advance of his contemporaries. It is stated indeed by one of his partial friends, that he anticipated by ten years, a large proportion of the generic and sub-generic ichthyological distinctions which were subsequently taken up in the *Règne Animal.*[1] But it is at the same time evident, that his judgment was even then unsound, his discriminative perceptions of uncertain force, and that his mind was too easily captivated by new and original views, without sufficiently establishing the facts on which they

[1] *Swainson.* Cabinet Cyclopedia. Fishes, Amphibians and Reptiles, Vol. i. pp. 60—62.

were based. The leading fault of his character as a naturalist was, a belief in the specific difference of all natural objects which present any variations among themselves, even of the most unimportant characters; and a passion for combining into new groups, according to real and obvious affinities, when such existed, or to fancied or trifling ones in their absence, all the objects which came within his observation. His groups consequently were of very unequal value; and while some of them were combined according to their natural and fixed relations, others were brought together by resemblances perceived only by himself. He possessed, however, a peculiar facility in the formation of the language of nomenclature, and his generic and specific terms might, with advantage to science, be imitated by some of the naturalists of the present day. The adoption in one of his works of this motto,

"De Linné le génie il a choisi pour guide,"

shows that he imitated the brief and comprehensive style of Linnæus; but in his hands it often became obscure, and rendered it difficult to recognize the subjects of his descriptions.

M. Rafinesque appears to have been well received in the United States. His claims to a standing as a naturalist were at once admitted, and he immediately commenced taking an active part among the few who were investigating its natural history. His name frequently appears in the record of the early proceedings of the Lyceum of Natural History in New York, and many papers on botanical and zoölogical subjects were published by him in the journals of the day. In 1818 he visited the country west of the Alleghany mountains, and was soon after appointed Professor of Natural History in Transylvania University, at Lexington, in Kentucky. The results of his visit to the West were exhibited in several memoirs sent to Europe for publication, and in others which appeared in this country. About this time the faulty qualities of his character began to increase, and gradually overshadowed the more useful ones.[1] He

[1] His personal habits and manners were at this time very peculiar and eccentric, and indicated that diseased state of the mind, which, at a later period, became more marked and decided. Mr. Audubon, in one of those graphic episodes which relieve the scientific monotony of the early volumes of his *Ornithological Biography*, has given a very amusing account of a visit made to him by M. Rafinesque, at his residence on the banks of the Ohio river, in Kentucky. He entitles his episode, the "Eccentric Naturalist," and mentions Mr. R. under the fictitious name of M. de T—. It may be interesting to make a few extracts.

"'What an odd-looking fellow!' said I to myself, as, while walking by the river, I observed a man landing from a boat, with what I thought a bundle of dried clover on his back. 'How the boatmen stare at him! Surely he must be an original.' He ascended with rapid step, and, approaching me, asked if I could point out the house in which Mr. Audubon resided? 'Why, I am the man,' said I, 'and will gladly lead you to my dwelling.' The traveller rubbed his hands together with delight, and drawing a letter from his pocket, handed it to me without any remark. I broke the seal and read as follows: 'My dear Audubon — I send you an odd fish, which you may prove to be undescribed, and hope you will do so in your next letter. Believe me always your friend, B.'

"With all the simplicity of a woodsman, I asked the bearer where the odd fish was; when M. de T. smiled, rubbed his eyes, and with the greatest good humor said, 'I am that odd fish, I presume, Mr. Audubon.'

"Clean clothes were offered, but he would not accept them, and it was became entirely neglectful of what had been accomplished by other naturalists, rarely mentioning their names or

with evident reluctance that he performed the lavations usual on such occasions, before he sat down to dinner."

"He chanced to turn over the drawing of a plant quite new to him. After inspecting it closely, he shook his head, and told me no such plant existed in nature. I told my guest that the plant was common in the immediate neighborhood, and that I would show it to him on the morrow. 'And why to-morrow, Mr. Audubon? Let us go now.' We did so; and on reaching the bank of the river, I pointed to the plant. I thought M. de T. had gone mad. He plucked the plants one after another, danced, hugged me to his arms, and exultingly told me that he had got, 'not merely a new species, but a new genus.'

"When it waxed late, I showed him to the apartment intended for him during his stay, and endeavored to render him comfortable, leaving him writing materials in abundance. I was indeed heartily glad to have a naturalist under my roof. We had all retired to rest. Every person I imagined was in deep slumber, save myself, when of a sudden I heard a great uproar in the naturalist's room. I got up, reached the place in a few moments, and opened the door, when, to my astonishment, I saw my guest running about the room naked, holding the handle of my favorite violin, the body of which he had battered to pieces against the walls in attempting to kill the bats, which had entered by the open window, probably attracted by the insects flying around his candle. I stood amazed, but he continued running round and round, until he was fairly exhausted; when he begged me to procure one of the animals for him, as he felt convinced they belonged to a 'new species.'

"M. de T. remained with us for three weeks, and collected multitudes of plants, shells, bats, and fishes." "We were perfectly reconciled to his oddities, and finding him a most agreeable and intelligent companion, hoped that his sojourn might be of long duration. But one evening, when tea was prepared, and we expected him to join the family, he was nowhere to be found. His grasses and other valuables were all removed from his room. The night was spent in searching for him in the neighborhood. No eccentric naturalist could be discovered. Whether he had perished in a swamp, or had been devoured by a bear or a gar-fish, or had taken to his heels, were matters of conjecture; nor was it until some weeks after, that a letter from him, thanking us for our attention, assured me of his safety."

quoting their works, and he treated every object which he met with, even the most familiar and best known, as if then for the first time discovered. His passion for constituting new genera and species increased to a confirmed monomania, under the influence of which, old genera were divided and subdivided, the number of species prodigiously enlarged, and new animals, never seen except by himself, were announced. To provide materials for his creations, he relied not solely on his own observation, but resorted to the vague accounts of travellers, and the still more uncertain authority of vulgar rumor, in both of which he credulously confided; and however extraordinary it may seem, some of his species and even genera have no better foundation. He adopted also, the practice of sending to naturalists in Europe, with his own specific names appended, objects which had been already characterized here, and were known and recently published by American naturalists. It was in this way, undoubtedly, that M. Férussac was induced to apply M. Rafinesque's names to several species of Helix previously described by Mr. Say; an unfortunate compliance with M. Rafinesque's pretensions, which has caused much confusion.

These proceedings of M. Rafinesque very soon caused other naturalists to withdraw their confidence, and, sooner or later, to relinquish all intercourse with him. As his opinions no longer possessed authority, his writings, now become very numerous, were refused admission into the journals. The same reasons prevented his success as a teacher. He rapidly lost the position which he had held, and was thus compelled to retire into obscurity. But, he was not the less devoted to his favorite science, nor less industrious, and he poured forth from his retreat a multitude of flying leaves in which, with harmless egotism, he magnified the importance of his own discoveries. He ascribed his reverses to the machinations of secret foes, and to the disposition among mankind to "compel genius to slumber or to crawl;" and, to the end, considered himself to be a most deserving, though unrequited laborer for the promotion of human knowledge.[1]

[1] The character and works of M. Rafinesque have been here considered only as connected with zoölogy. His whole life might however be cited as a continuous example of perverted talent, and would afford materials for a very amusing and interesting biography. In his last years he became a dreaming schemer, and projector of various joint-stock financial, mercantile, and literary undertakings. In his retirement he meditated gigantic labors, and projected voluminous works in various branches of literature and science, which he had neither the intellectual ability, nor other means to accomplish. He appears to have been entirely satisfied with himself, and characterizes the younger men, who were putting themselves in advance, and bearing away the honors of science, as a "crowd of young, unskilled, inexperienced or incompetent candidates, who push forward and are preferred to the modest and able men who have labored for years with skill and zeal." He entertained hopes that some of the various State surveys which were commenced about the time he published his autobiography, would, as he expresses it, "call him to another field of utility," but in this he was again doomed to disappointment, and to find that he was entirely forgotten. The closing paragraph of his *Life of Travels* is an amusing instance of his vanity, and presents a summary view of his own acquirements and powers as understood by himself. "Versatility of talents and of professions is not uncommon in America," says he; "but those which I have exhibited in these few pages may appear to exceed belief; and yet

As, for reasons which may be gathered from the preceding remarks, the genera and species of the pneumobranchiate mollusks proposed by M. Rafinesque, are considered to be destitute of authority, and entirely unworthy of notice, no mention will be made of them in the text. But, to shield the author from a charge, from any quarter, of having designedly *suppressed* them, a brief account of all of them known to him, is here added. In a memoir published in the *Journal de Physique*, Paris, June, 1819, M. Rafinesque proposed no less than seventy new genera of North American animals, among which eight were formed out of the genus Helix. These are founded, upon only slight variations of the aperture of the shell, and so similar are some of them to each other, that where he saw reasons to create generic distinctions, others, at the present day, can see only such differences as belong to varieties of species. The genera proposed by him at that time, were the following: —

ODOTROPIS. "Lip reflected, umbilicus covered, tooth upon columella.

it is a positive fact, that in knowledge I have been a Botanist, Naturalist, Geologist, Geographer, Historian, Poet, Philosopher, Philologist, Economist, Philanthropist. — By profession a Traveller, Merchant, Manufacturer, Collector, Improver, Professor, Teacher, Lawyer, Draftsman, Architect, Engineer, Pulmist, Author, Editor, Bookseller, Librarian, Secretary, . . . and I hardly know myself what I may not become as yet; since whenever I apply myself to anything *which I like*, I never fail to succeed if depending on me alone, unless impeded and prevented by lack of means, or the hostility of the foes of mankind."

MESOMPHIX. "Umbilicus expanded, exhibiting the volutions.

TRIODOPSIS. "Umbilicus large, lip thick, aperture narrowed by three teeth, one upon each lip and one upon the columella.

XOLOTREMA. "Differs from the preceding by absence of umbilicus; or, it is small and covered by the reflected lip; aperture transversal, linear; the inferior tooth a lamellar carina.

CHIMOTREMA. "Aperture transverse, extremely curved, resembling a simple fissure.

TOXOTREMA. "Differs from the preceding by the emarginate lip.

STENOTREMA. "Differing from the two preceding by a thick emarginate lip, and a second lip flattened to the spire and uniting with the true lip; a transversal carina above.

APLODON. "Aperture rounded, columella with a single tooth; umbilicated.

In his *Enumeration and Account of Remarkable Objects* in his own cabinet, published at Philadelphia in 1831, Toxotrema and Stenotrema were changed to Toxostoma and Stenostoma; two new genera, Trophodon and Odomphium, and one sub-genus, Menomphis, were indicated by name, and the two following genera were characterized: —

MESODON. "Differs from Helix by lower lip with a tooth.

OMPHALINA. "Differs from Helix by no lips, but an umbilicus.

In the last-named paper, M. Rafinesque describes two species of Agatina, for such was the orthography he adopted for Achatina.

"*Agatina variegata. Raf.* 1820. Six spires, smooth, yellowish, variegated with brown spots near the sutures, first spire with some narrow colored strias, concentric. Nearly two inches; from Louisiana.

"*A——— fuscata. Raf.* 1822. Eight spires, smooth, reddish brown, with broad longitudinal black bands on the spires, of a lanceolate flexuose shape. Over two inches; from Texas."

Persons acquainted with our Helices, will readily distinguish nearly all the species on which M. Rafinesque founded the above genera, for it is apparent that he had actually before him American specimens, and did not depend upon his memory or imagination. It is singular, however, that with his fondness for publishing species with the contraction "*Raf.*" appended, he nowhere *described* these Helices. Descriptions may, indeed, exist unnoticed in some of the loose fragments which heralded his pretended discoveries; but this is not likely. The probable explanation of the fact is, that he became acquainted with most of the species in Philadelphia, (in the winter of 1818 and 1819, after his return from his first visit to the West,) where they had already been announced by Mr. Say: a supposition which is supported by the fact, that in two letters from him to the New York Lyceum, published in the *American Monthly Magazine and Critical Review*, in September and October, 1818, which were intended as a sort of prodromus of his discoveries in the West, he nowhere speaks of having collected land shells, although the fluviatile species, divided as usual into several genera and sub-genera, occupy considerable space. As he could not, without a gross infraction of that comity practised among naturalists, which secures to each his own discoveries, and which even he was not prepared, at that time, entirely to disregard, openly assume the species described or made known by Mr. Say, he could publicly gratify his mania for genera-making only by the construction of these new genera. But, he gave to the specimens in his own cabinet, specific names which he thought more appropriate than those of Mr. Say, and they gradually found their way to his correspondents abroad, and particularly to M. Férussac, with these names attached.

In his *Annals of Nature* for 1820, M. Rafinesque proposed three new genera and several species, viz.: —

GENUS PHILOMYCUS.

PHILOMYCUS. "Differs from Limax by no visible mantle, the longer pair of tentacula terminal and club-shaped, the shorter tentacula lateral and oblong. The name means, friend of fungi, on which they feed.

"*Philomycus quadrilus.* Gray, back smooth, with four longitudinal rows of black spots, long tentacula black and approximated; rather attenuated behind, tail obtuse. On the banks of the Hudson, length over half an inch.

"*P*———. *oxurus*. Fulvous gray, slender, back wrinkled longitudinally; tentacula brown, the lateral ones very small; tail acute, carinated above. Length two thirds of an inch, in New York.

"*P*———. *fuscus*. Entirely brown, tentacula thick, back smooth, tail compressed, acute. In Ohio, length one fourth of an inch.

"*P*———. *flexuolaris*. Fulvous, back variegated, with flexuose brown lines, slightly wrinkled transversely; attenuated behind, tail obtuse. Length from one to two inches, it may change its shape. Found on the Catskill mountains. There are many other species of this genus in the United States.

GENUS EUMELUS.

Eumelus. "Differs from Limax by no visible mantle, the four tentacula almost in one row in front and cylindrical, nearly equal, the smallest pair between the larger ones. Name mythological.

"*Eumelus nebulosus*. Body nearly cylindrical, rounded at both ends; back smooth, crowded with gray and fulvous spots intermixed of the same tinge, without spots beneath; tentacula brown. Length about one inch, in Ohio and Kentucky.

"*E*———. *lividus*. Livid brown above, grayish beneath, antennæ black, obtuse behind, back smooth and convex. Length one inch, in Ohio, Indiana, and Kentucky.

GENUS HEMILOMA.

Hemiloma. (Univalve Land Shell.) "Spire raised and smooth: opening obliqual elliptic, with an anterior raised half margin on the inside lip, a little twisted; columella decurrent on the whorl obliquely and with a very small umbilicus. The name means half margin.

> "*Hemiloma ovata.* Ovate, very obtuse, smooth, six spires, breadth two thirds of the length. Found near Lexington in a nearly fossil state; whitish, length three sixteenths of an inch.

In the same paper he also describes a species of Limax, viz.:

> "*Limax gracilis.* Body slender, head and lower tentacula fulvous, neck gray, upper tentacula brownish, mantle dark fulvous, back smooth brown, beneath dirty white; tail brown, obtuse above, mucronate and acute beneath; probably a real Limax. Yet it has the two long tentacula inserted above the neck, while the small ones are terminal and all slightly club-shaped. It may, perhaps, form a sub-genus Deroceras. Length over one inch. Kentucky, in the woods.

The shell upon which the genus Hemiloma was founded has not been recognized; it was probably a fossil. There is reason to believe, that Philomycus and Eumelus originated in the defective and careless observation of M. Rafinesque. Certain it is, that no other observer has yet found naked slugs with the four tentacles in one row and nearly equal, with the two long ones inserted above the neck, or without a more or less developed mantle. A hasty examination of small individuals of the animal, which in this work is included in a genus for which the author has proposed the name of Tebennophorus, might readily deceive any one who did not suspect their peculiar characteristics, as the mantle is often so closely pressed to the body, that the line of separation is not visible. Such an error would account for the principal characteristic of these two genera. But, whether M. Rafinesque was deceived in this way or not, it is apprehended that under the circumstances, these genera cannot be received, although endorsed by the adoption of M. Férussac. Whenever animals with the characteristics which he records, shall be discovered, it will be time enough to renew his names.[1]

Having thus briefly reviewed the character of these two authors, and criticized the works of one of them, it remains only to repeat, that the result of the labors of each, upon this branch of natural history at least, has

[1] M. Rafinesque seems to have been conscious, that he might be obnoxions to the charge of publishing, as his own, discoveries that were already well known, and he pleads his defence, in anticipation. He says, "The difficulty of ascertaining sometimes, whether my discoveries are totally new, will not prevent me from offering those which I consider such. If a few shall afterwards prove otherwise, the blame, if any, must lay with those European compilers who give us now and then, their bulky, costly, and learned Cyclopedias, Dictionaries of Natural History, and Systems, without following the wise linnean plan of detailing *all* the former discoveries." "In such a state of science I shall not be prevented from publishing my new species, because it *may* happen that one out of fifty may be previously noticed in some costly and inaccessible work." Having thus easily disembarrassed himself of one of the chief obligations of a zoölogical writer, to wit, that of fully investigating the works of his predecessors, he thus defines the principles which guided himself. "The principles of these tracts shall belong to the true linnean school of improvement. I shall follow all the improvements that the worthy Linnæus would have adopted, if he had lived in this age; but I shall carefully avoid any deviation from the fundamental, rational and everlasting rules of nomenclature, and descriptive history." *Annals of Nature.*

been very different. The one has left a favorable record of himself throughout; while of the other, only traces enough remain, to mark his errors.

The other principal contributors to the elucidation of this branch of zoölogy will be named in the general remarks on the respective genera, and a particular account of their contributions to the history of the genus will be given.

II.

OF THE IGNORANCE AND NEGLECT OF AMERICAN LABORS IN ZOÖLOGY EXHIBITED BY EUROPEAN NATURALISTS.

The discovery and description of animals before unknown, is one of the evidences of the zeal and industry of a naturalist; and to be known among the few persons engaged in this branch of science as possessing these qualifications, is unfortunately, in this country at least, his only reward. To perpetuate this evidence, the right of naming the species has been conceded to the discoverer by common consent; and in all systematic and descriptive works on Natural History, his name is, by universal practice, appended to that of the species, and in this manner becomes as extensively known as the animal itself. He who omits the name of the discoverer, and still more, he who substitutes the name of another in its place, does the former a manifest injustice, as it deprives him of a right which is the only recompense of his labor. He also does an injury to science by adding a new name to an object already named, thus increasing the multitude of terms, and enlarging a synonymy which is already burthensome and inconvenient. Some of the most distinguished European conchyliologists are obnoxious to the charge of forgetting these wholesome rules, and not only of neglecting the rights of American naturalists, but of taking from them, and transferring to others, the little credit they might derive from a just appreciation of their efforts. To show that this assertion is not without foundation, and that the labors of our naturalists in this department have been so frequently overlooked as to indicate a design to neglect them, or an indifference to their rights, and then to prove that there is good reason for complaint, it will be sufficient to review the species of Helix which were first described by Mr. Say, and which were published by him antecedent to the appearance of the works of MM. Lamarck and Férussac. Mr. Say published, in the Journal of the Academy of Philadelphia, previously to, and in the month of, January, 1821, descriptions of *twenty-three* well-ascertained species. In 1822, M. Férussac published his *Tableau Systèmatique de la Famille des Limaçons*, in which he indicated by *name only*, without descriptions or figures, *seventeen* of the same species; of these, ten appeared under Mr. Say's names, two under new names ascribed to M. Rafinesque, and five were assumed by M. Férussac himself, and his own names appended. In April, 1822, appeared the second part of the sixth volume of the *Animaux sans Vertèbres* of M. Lamarck. This work was, in point of fact, published before the above-named work of M. Férussac, and its author referred to the contents of that work in anticipation of its actual appearance. In it, *five* only, out of the twenty-three species are described, and all of them under names different from Mr. Say's, two of them being adopted from M. Férussac, and three altered arbitrarily from Mr. Say's names, which M. Lamarck's own references proved that he should have been acquainted with. In 1830, M. Deshayes published a continuation of Bruguière's *Histoire Naturelle des Vers*, in the *Encyclopèdie Méthodique*. Here, under the article Helix, *ten* of the same species are described. For three of them only, Mr. Say's names are retained, (one of these being ascribed to M. Férussac, and another to M. Rafinesque,) two appear under names of M. Férussac, two under those of M. Lamarck, and one under that of M. Rafinesque; one name is changed arbitrarily, and one is given as a new species, under a new name. In 1838, in the second edition of the *Animaux sans Vertèbres*, M. Deshayes noticed *twelve* of the same species, five of which are under Mr. Say's names and ascribed to him, three under those of M. Lamarck, three under those of M. Férussac, and one under that of M. Rafinesque. The annexed table will exhibit, at one view, the species described by Mr. Say, and the names applied to them by the other authors referred to.

TABLE OF TWENTY-THREE SPECIES OF HELIX,

DESCRIBED BY THOMAS SAY, ANTERIOR TO, AND DURING THE EARLY PART OF THE YEAR 1821,

SHOWING THE SYNONYMS SUBSEQUENTLY APPLIED TO THEM BY EUROPEAN AUTHORS.

No.	Mr. Say. Specific names. 1821.	M. Ferussac. Prodrome Gen. 1822.	M. Lamarck. Anim. sans. Vert. 1822.	M. Deshayes. Encyc. Method. 1830.	M. Deshayes. Lamarck, 2d edit. 1838.
	HELIX.	HELIX.	HELIX.	HELIX.	HELIX.
1	albolabris.	albolabris.	bonplandi?	———	bonplandi?
2	tridentata.	tridentata.	———	tridentata.	tridentata.
3	alternata.	alternata.	scabra.	scabra.	scabra.
4	thyroidus.	thyroidus.	———	thyroidus.	thyroidus.
5	labyrinthica.	labyrinthica.	———	———	———
6	hirsuta.	hirsuta.	———	hirsuta.	hirsuta.
7	perspectiva.	perspectiva.	———	patula.	perspectiva.
8	lineata.	lineata.	———	———	———
9	auriculata.	auriculata.	———	———	auriculata.
10	septemvolva.	septemvolva.	planorbula.	planorbula.	planorbula.
11	multilineata.	———	———	———	———
12	appressa.	linguifera.	linguifera.	linguifera.	linguifera.
13	palliata.	denotata.	———	notata.	denotata.
14	inflecta.	clausa.	———	clausa.	clausa.
15	clausa.	———	———	———	———
16	elevata.	knoxvillina.	———	———	———
17	interna.	———	———	———	———
18	chersina.	———	———	———	———
19	gularis.	———	———	———	———
20	ligera.	rafinesquea.	———	———	———
21	solitaria.	———	———	———	———
22	concava.	planorboides.	———	———	———
23	profunda.	richardi.	richardi.	richardi.	richardi.

It would be wrong to impute to either of the distinguished gentlemen who have been named, any intentional injustice to Mr. Say. M. Férussac indeed, ascribed to him all the species whose descriptions *he had seen*, previous to the publication of his own work, and those only, although it was in his power to have procured all of them. M. Lamarck had no definite no-tion of the wrong he was doing, and his practice was in this particular very loose. M. Deshayes, in the *Encyclopèdie*, seems to have been careless in looking up his authorities, and had not awakened to the importance of reforming the nomenclature by restoring original names, for which he has since proved himself to be an able and zealous advocate. But it may be said, without justly incurring reproach, that neither of them seems to have considered it to be necessary, to provide himself with the means of making such references to American authors, as was proper and essential in order to render his own works more accurate, and to guard against injustice to others. Indeed, so late as 1839, M. Deshayes, in his continuation of M. Férussac's work, in giving the synonymy of *Helix septemvolva* ascribes the specific name to M. Férussac, overlooking entirely the fact that Mr. Say had published the species four years in advance of M. Férussac, as plainly appeared from the dates of the respective works to which M. Deshayes referred in his own description. It may be said, in excuse, that the writings of American naturalists, scattered as they are through various periodical publications, are procured with difficulty in Europe. This is probably true, to a considerable extent, but it is no more true than that similar European publications can hardly be obtained here. They *can* be obtained by those who deem them sufficiently important to warrant some trouble in procuring them; and the author who undertakes a general work, like those named, without having the means of knowing what progress has been made in the science in every country, is but ill prepared for his task. His work cannot be either accurate, or complete, and must be destitute of that full authority, which a thorough investigation of all existing information on the same subject alone can give. In this way the utility of the works of MM. Férussac, Lamarck, and Deshayes is very much impaired; all of them being exceedingly incomplete and unsatisfactory in American species.

Besides the species which were published by Mr. Say at the distant period before mentioned, numerous others have, in the interval of twenty years, been established by him and other American authors, very few of which, it is believed, have found a place in any foreign systematic work. The result of this omission has been what might be expected; insulated naturalists in various parts of Europe, obtaining from time to time, through travellers and friends, some of the common mollusks of this country, and finding them to be unnoticed in the standard works of reference, have considered them to be unknown. It seems never to have occurred to them, that these shells might have been described on the spot where they exist, or, indeed, that there could be native naturalists to describe them. They have therefore published the species, with as little apprehension of having been anticipated, as if they had been brought from the most remote and uncivilized countries. In this manner, well-known species have been named anew, varieties have been erected into species, and localities which have been carefully explored for twenty years, and whose productions are as well known as those of the neighborhood of London, have been considered as fertile of novelties as a newly discovered land. The errors which have thus arisen are so numerous, that it would be impossible, and useless if it were possible, to notice them all; but the writings of MM. Rossmässler, Menke, and Des Moulins, where treating of American species, afford instances sufficient to confirm the remark. This ignorance of American authorities appears to have continued to the present time. M. Pfeiffer, in his *Symbolæ*, published at Cassel in 1841 and 1842, gives descriptions of about twenty of Mr. Say's species, some of them, as he seems to suppose, for the first time. They were originally described in this country twenty-five years ago, and of nearly all of them several other descriptions, with figures, have been published from time to time. This evil is likely to increase, until a systematic effort is made on the part of American naturalists to correct it. The remedy is, to rely more upon themselves, and less upon the savans of other countries; to assume that they are as likely to understand the things before and around them as those who are so far removed; and to claim the same notice and respect for what is done in the United States, as is accorded to the labors of naturalists in Europe. If these volumes should aid in exciting this spirit they will not have been entirely useless.

III.

OF SOME OF THE OBSTACLES IMPEDING THE STUDY OF ZOÖLOGY, AND THE MEANS OF OVERCOMING THEM.

One of the opprobria of zoölogy, at the present day, is the great number of nominal species, of almost every class of animals which have been described and published, and which have been brought forward without sufficient attention to the relative importance of the characters on which specific distinctions should be based. Hence it happens that, in approaching the study of this science, we are compelled to possess ourselves, at the outset, of a mass of useless and cumbersome learning, which, under the name of *synonymy*, consists of little else than the accumulated misapprehensions of preceding writers as to the value of specific differences, and the record of the errors which they have thereby been induced to commit. We cannot pass this shapeless mass without notice, for its very bulk challenges attention; nor can we avoid it, for it obtrudes itself at every point. The very necessity that exists, of investigating the errors of others, in order to render our own labors more correct, condemns us to examine thoroughly all they have done; and the more carelessness and haste their works exhibit, the more imperious in this respect is our duty. The unwelcome and growing burden of synonymy is thus imposed upon Natural History, there to remain, until it shall be cast off by some much needed reform in the artificial arrangements of the present system. Perhaps there is no branch of zoölogy in which this evil has already become so unmanageable as in that of the testaceous mollusks; and for this reason, we have thought that a few remarks on the subject, tending to explain the causes which have led to its existence, and pointing out the manner in which they may be avoided, might, in some degree, prevent its increase in this particular department, and among the naturalists of the United States.

We do not intend to discuss the question, what constitutes a species? for that would lead us too far from the end we propose; but, in common with most naturalists, we shall take it for granted, that certain individuals, possessing a common organization and similar external characters, derived from a common and similarly endowed source, and propagating other individuals identical in structure with themselves, do now exist, and will continue to exhibit the same characters until they and their posterity become extinct. It is to these individuals, considered collectively, that we apply the name of *species*. Every species may be considered to possess two kinds of characters, one essential and depending upon organization, the other contingent, and modified by the external circumstances under the influence of which it exists; and while the type of the species, or the unity resulting from the totality of its characters, remains constantly the same, nature permits a great amount of variation in the subordinate particulars, which radiate, as it were, in every direction, and at greater or less distance, from the specific centre. If we consider the physical condition of the terrestrial mollusks, we are prepared to find in them the maximum development of such variations; for, owing to their limited locomotive powers, individuals are confined to a very narrow range, and during their whole lives, and often during a succession of generations, are subjected to absolutely the same influences. Yet, in the course of time, they have spread to great distances from each other, and now occupy very different localities. Hence, while one set of individuals is exposed to the continued action of one agent, other sets, occupying other localities, may be acted upon by other and very different ones, and in each locality a considerable but different modification of the specific character may consequently take place. We have only to suppose the existence of a certain number of localities, each distinguished by the presence of different causes, operating through a period of some duration on the species occupying it, and the result will almost necessarily be the production of as many well-marked varieties. Such is in fact our experience in respect to many of our native species; for individuals from various and distant localities, especially from those differing in climate, soil, or geological structure, are rarely identical in external character, but almost always present striking differences in the size, thickness, or weight of the shell; the elevation or depression of the spire; the smoothness or roughness of the epidermis; the prominence and number of the striæ of increase; the diameter of the open axis of the shell, known as the umbilicus; and in the number and magnitude of the tubercles, folds, and other testaceous deposits which are often formed in the aperture, and upon the columella of the shell. These modifications are so constant, in some species, that the practised eye can thereby distinguish the stations, or rather the section of country, from which individuals exhibiting them are respectively derived. The same remark is true as regards the marine mollusks used for food. The dealers recognize the localities of some of them by variations which often escape the naturalist; and they sometimes know that distinctions which he considers structural and constant, are due only to physical influences. It is well known that there is a tendency in nature to continue, to successive generations, those modifications of form which have, in the first place, been introduced by accidental causes, and thus to continue, for a time, what have been called permanent varieties. But these, it is believed, return, sooner or later, to their original type.

Now the naturalist, occupying perhaps an insulated position, and familiar with a given species only as it exists in a single section, where its characters are uniformly the same, cannot *a priori* suppose it to assume other appearances elsewhere; and when a strongly-marked variety is presented to him, he of course considers it to be a new species, closely allied indeed to the one with which he is acquainted, but yet distinct. He hastens to make it known by publication, and thus falls into an error similar to those which have given occasion for these remarks. It is the local naturalist especially, who is most likely to commit this kind of mistake; for in the paucity of materials for comparison usually at his command, he cannot have the means of arriving at a more correct judgment.

These remarks lead to certain inferences, which, if well founded, are worthy of serious attention, and which, combined with other considerations, ought to govern the conduct of naturalists. In the first place, we see that the diagnosis of species which rests exclusively upon external characters is, from their mere uncertainty, not wholly to be relied upon. The shell is an extraneous product of the animal, a substance foreign to it in some respects, and formed only for shelter in times of danger, and the protection of the soft parts from external injuries. It possesses no vitality, and its characters are, therefore, as we have seen, subject to change and even to obliteration, to a degree that never happens to organs partaking of the vitality of the animal. Scientific certainty and exactness require characters which are not liable to change, and which we can seek only in the organization of the animal. This alone remains always the same; for notwithstanding the speculations of M. Lamarck and his followers, there is not a shadow of evidence tending to prove the slightest permanent change, in the structure of a single animal, since the creation of the world. Species, genera, and even whole groups of animals have been created, and have become extinct; but, so far as we know, the organization of the most insignificant species has undergone no change. The permanent characters drawn from this source, combined with those of the shell, will enable us successfully to discriminate between species, and we may obtain collateral aid from the observation of their structural functions, their instincts, and their habits; and thus, while seeking to exhibit their distinctions alone, may do much towards completing their natural history. The requirements of science can no longer be satisfied by a single Linnæan phrase; the characteristics of the whole organized being are needed; and the description of the shell alone, ought never to be admitted, except when that of the animal itself cannot be obtained. The naturalist who has it in his power to acquire a knowledge of the animal, as well as of the shell, should be held in every case so to do, and to make both known together.

Conchology, considered as the study of the imperishable portions of a class of animals, has been, and will continue to be, a most important auxiliary to the elucidation of geology; but without the reform we have indicated, it cannot be much longer considered as a branch of zoölogy. It must give way to the more philosophical investigation of the mollusks as living beings, whose organization and relations must occupy the attention which has hitherto been given to minute and comparatively unimportant particulars of the shell alone. A pursuit which, under the name of a science, has often served to give dignity to trifles, and which has caused a false estimate of the character and importance of all zoölogical studies, in the minds of many, will thus fall to its proper level, and take its rank as one of the scientific nugæ which, in times past, have amused the minds and occupied the learned leisure of its adepts. Our successors will look back with astonishment to the period when persons, busied with the collection, arrangement, and classification of these external envelopes, often without the ability of distinguishing the animal of one genus from that of another, and some of whom, in a long career, never saw a single one of the animals whose products they were so familiar with, were considered to be naturalists, when they were in fact mere collectors.

There is one excuse, however, which may be urged for the very general reliance which has been placed upon characteristics founded on variations of the shell, and that is, the prevalent idea, sanctioned by some leading names, that every difference in the shell is necessarily produced by a corresponding difference in the structure of the animal. This principle, which is exceedingly plausible at first sight, ought, if true, to be followed by another axiom which depends upon it, namely, that great diversities of the animal structure are attended by great differences in the shell; and both ought to be confirmed by well-known facts. But, in truth, neither of these principles is practically of much value in the diagnosis of species, and every one familiar with shells, knows, that very considerable differences occur in all the particulars we have named, while the animal remains unchanged; and on the other hand, it is equally well understood that considerable modifications of the animal structure may exist, without anything like a corresponding amount of variation in the shell. A remarkable instance of this occurs in the marine genera *Lottia* and *Patella*, in which the shells resemble each other very nearly, but in which a separation of the two genera has been justified by important differences in the animal structure alone. In the branch which we are considering, though not particularly among the species of this country, the naturalist can find no differences of animal structure to sustain the generic distinctions which, if he relied upon variations of the shell, he often would found upon these external characters.

The second remark which we make, as resulting from the preceding observations, is, that no one is in a position to establish species with confidence, even as now practised on external characters alone, until he has thoroughly investigated each of them under all its different aspects. In order to do this, he who proposes additions to the list of our species should possess, or have the opportunity of examining, complete series of specimens embracing those of every age, from the egg to maturity, and from every section of the country in which they occur. He should ascertain to what circumstances they are subjected in different localities, and be able to mark the different modifications which correspond to differences of temperature, soil, elevation, humidity, and to the kind and quantity of food. He should be acquainted with their retreats, and their habits, so far as these are likely to affect their external characters. It is only after he shall have made a careful comparison of all the variations which he notices, that he will be able fully to understand the species, and to decide definitively and correctly upon its varieties. If he finds the characters of his proposed species melting gradually into those of one already well established; or, in other words, if the interval between them is filled up step by step, by variations which, though differing but little from each other, serve to connect the extremes, he ought to consider the two to be specifically identical; for if any other practice should be adopted, there would be absolutely no limit to the number of species, and every department of zoölogy would consist only of the history of well-marked individuals. And besides all this labor, he should furthermore be able to refer to the works treating of American species, so that he may ascertain whether his results have not been anticipated by others. And, if he would be worthy of entire confidence, he must not confine his observation to the cabinet. One who knows species only as they appear in his own drawers, can have but an imperfect idea of the innumerable deviations, from every type, that nature permits. Specimens in cabinets are usually selected for their size, beauty, and perfection, or for some remarkable peculiarity about them, — those whose characters are strong and well defined, being always preferred, while the intermediate forms, a thousand times more numerous than the others, but presenting nothing notable, are neglected. The tendency to order and classification, which the study of Natural History creates, induces the in-door collector to separate and arrange his specimens according to their resemblances. With *his* materials he finds that distinctions are easily established, that the bounds of species and varieties are well defined, and that groups are marked by determinate and fixed characters. The limits of each division seem to him to be constant and not to encroach upon each other. As it is in his cabinet, so he supposes it to be in nature. He accordingly speculates, refines, and generalizes, and ends by establishing a system which, because consistent with his own experience, he thinks equally supported throughout. When the same person changes the scene of his observation from his own cabinet to the field and the forest, and becomes acquainted with numerous living individuals, he soon perceives that the divisions are much less abrupt than he had supposed. He finds that the changes of type are gradual and almost insensible, and that some of the forms that had appeared to him definite and fixed, blend by degrees with others which he had considered to be distinct. He necessarily abandons many of his preconceived views as to specific distinctions, and is obliged to modify all of them more or less by his new experience. Every naturalist should therefore test his opinions by an intimate acquaintance with living species existing in their natural conditions. It is true that but few of our naturalists could heretofore comply with these preliminary requisitions, and perhaps the most complete collections in the country, public or private, have not been sufficiently ample to afford the means of making so thorough a comparison as we consider to be necessary; yet the rules we lay down are good ones, and, if observed so far as circumstances will permit, will be of great service to science. If our naturalists had been guided by them during the short career of American zoölogy, we should now be free from an amount of error in respect to our own species, which, in the period of twenty-five years, has created a synonymy wellnigh as confused as that which in Europe has been accumulating more than twice that length of time. The excuse for error which formerly existed, in the want of means for learning what *is* correct, can no longer be received, for the facilities arising from ample collections of shells and books, and from intercourse with a numerous and well-informed body of naturalists, are now nearly as great in this country as in Europe.

There are, however, other causes tending to the continual introduction of spurious species, independent of the selection of a secondary class of characters on which to establish them, and these arise from the usages of the science itself, and from opinions which are held by some of its authors. We shall briefly mention two of them. The custom of appending the name of the earliest describer of a species to that of the species itself, although it is, in the present state of zoölogy, necessary and proper, has in this connection inconvenient results. It is certainly a standing evidence of progress, but the working zoölogist is apt to attach too much importance to it, and to imagine that his own diligence, and perhaps his scientific reputation, are measured by the number of species which he discovers and describes. At the present time, when every subject of science is attracting the attention of many minds, and the competition is particularly active in zoölogy, he is justified in supposing that delay may deprive him of the priority of his discovery. Influenced at once by a praiseworthy desire of establishing his own claims, and by the fear of being anticipated, he hastens to bring forward his description, often without giving himself sufficient time to verify the certainty of his discovery. The result in such a case is frequently a supposititious species. The proper correction of this procedure must arise from the reflection, that an ill-established species cannot stand, that sooner or later the error must be discovered, and that a false judgment in this respect will be held to betray inaccuracy, or insufficient powers of discrimination. He should furthermore be encouraged to keep back his discoveries until he is fully satisfied of their accuracy, by the assurance that, in the final opinion which is to fix his reputation, a single species well established, with its place and relations ascertained, will redound more to his honor than a thousand erroneous ones. These remarks are intended only for the ingenuous and well-meaning naturalist, but it is greatly to be feared that there have been others who, for the sake of a little temporary reputation, have thrust themselves without qualification among the laborers of Natural History, and have deluded themselves with the idea, that because they could write *nobis* after false species, others would be blind to their demerits. The career of such persons must always be short; they are the false coin of science, and will sooner or later be stamped as uncurrent. The other of the causes alluded to is, the hypothesis, held by some persons, that the animals of the respective continents, however near their affinities may be, are in every case specifically distinct from each other; and hence, as there are animals of certain families on both continents which cannot be distinguished from each other by any well-marked characters, it has resulted, that species possessing apparent identity of external form and of organization, have been recorded as different animals. As every rational basis for the distinction of living beings is thus taken away, the advocates of this theory have been driven to seek extra-zoölogical foundations on which to establish it. In one instance the tone of voice has been considered sufficient to separate the well-known bird *Corvus Corone* of the United States from the same bird in Great Britain. In a zoölogical family intimately allied to that of which we treat, to wit, the air-breathing fresh-water mollusks, or *Limneadæ*, much difficulty has arisen from this source. In this family, both generic and specific forms seem to be almost entirely independent of climatal and other common influences. and the amount of variation among the species is so small that many forms, occurring on both continents, present an uniformity of characters, that would cause them to be considered identical, if confined to one continent only. Hence different names have been imposed on what we cannot but consider to be the same thing. The terrestrial genus *Succinea*, bearing in many respects a strong resemblance to the *Limneadæ*, is, like them, everywhere very uniform in its external characters, and it is almost impossible to define from them alone, in what our species differ from those of Europe. The question of the identity of these closely allied species must eventually be decided by their anatomy, but in the mean time we believe it to be perfectly safe to adopt this axiom, that species, whencesoever derived.

possessing the same characters, are identical. We view this to be a more rational course than to consider them to be the *analogues* of each other, a convenient but indefinite mode of expression, which may be used to cover every degree of similitude from a general analogy to a close affinity hardly admitting of distinction.

Closely connected with this subject is that of a proper selection of specific terms for new objects ; for next in importance to a good description and figure, is an appropriate and characteristic name. The use of specific names was adopted as a substitute for the characteristic phrase, consisting often of many words, which, before the time of Linnæus, naturalists were obliged to cite whenever they alluded to a species. As one word thus took the place of an entire sentence, it was desirable to select one that expressed some prominent trait of the object named, and, if possible, that trait by which it was distinguished from all others of the same genus. Such a word aids the memory by recalling the characters of the species, and being in the Latin language, conveys its meaning in every country where that language is understood. This practice, so obviously consistent with good taste, good sense, and utility, was received with general approbation, and almost immediately adopted among the rules of nomenclature. In process of time, however, innovation commenced, and distinguished naturalists were occasionally complimented by the attachment of their names to particular species. There seemed at first to be no impropriety in this usage; for the naturalist who had labored for years in elucidating the history of a particular class of animals, without any other reward than that arising from the gratification which the pursuit itself furnished, might well deserve to have his name connected with that department of knowledge which he had promoted. Indeed, there was acknowledged to be a beautiful propriety in distinguishing a genus of plants by the name of Linnæus, the great reformer of botany, or a species of birds by that of Wilson, their eloquent and graceful historian; and in other similar examples. Names derived from persons even of much less celebrity as naturalists might not be productive of any practical inconvenience, and the custom was therefore so far sanctioned as to be admitted as an occasional exception to a general rule.[1] It was, however, a great error to permit any departure from the original rule, and its infraction has been followed by consequences very much to be regretted. In our own country, where there is but little of that conservative feeling which tends to the preservation of those usages and principles which past experience has proved to be wise and useful, and where innovations of all kinds are entered upon rashly, and often, as it would seem, from a mere love of change, and where the influence of the personal example of the most

[1] The exception is thus stated by Mr. Swainson, in his System of Nomenclature: "Species may be *occasionally* named after *persons*, provided they have been distinguished in that branch of zoölogy."

distinguished leaders of science is very feeble, the wholesome restraints of zoölogical nomenclature have been broken down, and naturalists have created rules for themselves. A multitude of barbarous terms, derived from the names of persons and places, have been introduced, outraging in their composition both propriety and good taste, inconsistent with the object proposed by the establishment of specific names, and subversive of the best interests of science. Among the names selected for this distinction are those of some of our most able zoölogists, who are worthy of this or of any other honor, but there are many more of collectors and amateurs, and of persons totally unconnected with any branch of zoölogy, who have no claims, except that of the partiality of friends, to be placed in such association. The temple has even been desecrated by the money-changers, and the names of shell-dealers and petty hucksters have been admitted to the same honors as those of Wilson and of Say. The indiscriminate use of these names defeats the intentions of those who apply them. An honor which is so common as to be borne by every one, ceases to be an honor, and persons of general celebrity as naturalists, cannot feel themselves flattered by being classed in the same rank with the numerous unknown persons with whom they are thus associated. Besides, to give the intended compliment any value, the reader must be told to whom the author intends to offer it; and thus specific descriptions, besides comprising the characters of the object described, must be burthened by an additional clause establishing the identity of the person commemorated.

Another evil, of a still more grave character, inasmuch as it affects the reputation of those concerned, has resulted; the motive of these friendly compliments has been questioned, and they have been supposed to arise more from a desire to gratify a certain small vanity than from any expectation of promoting thereby the advance of zoölogy. We do not ourselves coincide in this last opinion, because we know too well the honorable sentiments of some who have fallen into the practice which we condemn, to suppose that they are actuated by motives so unworthy. We believe, on the contrary, that they have adopted it from an amiable wish to gratify their friends, without having sufficiently reflected upon the abuses of which it is susceptible, or upon the serious objections to which it is liable. But we cannot approve the practice or pass it by without reprehension, because the motives of those who have adopted it are correct. We are convinced that it is itself erroneous; we know that its abuses have become intolerable, and we think that they ought forthwith to be abated.[1] To effect this,

[1] We do not wish to be understood to imply, that American zoölogists alone are obnoxious to this charge, but only that this reprehensible custom has been adopted in a more wholesale manner in this country than in Europe. In proof of this we will mention some of the most remarkable examples. In a series of memoirs by one author, published in the 5th,

the practice itself must be *wholly abandoned.* We invoke the attention of zoölogists to the subject, and ask their aid in endeavoring to effect a change.

Having spoken thus freely of some of the evils which impede the progress of zoölogy, alluded to their causes, and suggested such remedies as are practicable in the department which we have undertaken, — having, moreover, condemned certain practices which prominent zoölogists of the time receive with favor, — we are quite prepared to be subjected to the test of our own rules. It may be, that we have not been governed by the principles which we recommend to others. Of this we leave others to judge. If it should be so, however, it will not detract from their utility, but only show that we have erred with the best intentions, and that instances often arise in which not only ourselves, but the best-informed zoölogists may form incorrect conclusions. We do not

6th, 7th, and 8th volumes of the Transactions of the American Philosophical Society, more than one hundred instances occur of the use of specific terms derived from the names of the author's friends and correspondents, and these mostly applied to the species of one family of mollusks. In a memoir in the seventh volume of the Journal of the Philadelphia Academy of Natural Sciences, the name of an English botanist is applied in the same manner no less than twelve times in as many different genera of shells. The geologists, we fear, have been seduced by these bad examples, for one of the most distinguished of them, in a memoir in the Transactions of the American Geological Association, having occasion to propose five new species, has "*dedicated*" four of them to other geologists. Names derived from countries, mountains, rivers, &c., which are also objectionable, are used with great freedom, and numerous examples of them occur in the same memoirs.

expect to cause a reform, but we hope that, among the numerous young zoölogists who are now coming forward, there may be some who may concur in the justice of our opinions, and whose career may be, either through conviction or unconsciously, influenced thereby; and we shall be happy if in a single instance we shall prevent a repetition of the evils which we have mentioned.

As to the application of our own principles to the species treated of in this work, we would remark, that among our generally acknowledged species, there are some which seem to us to be separated from others on insufficient grounds, and that our inclination is in every such case to reunite them. In some of these instances our opinion is confirmed by the opinion of gentlemen whom we consider to be better qualified than ourselves to decide; in such, of course, there is no doubt. In others, that sanction is wanting or doubtfully yielded; yet our own convictions are too strong to permit us to hesitate. But in another class of cases, we are opposed by the unanimous opinion of all those zoölogists who are familiar with the subject. Here, we yield our own belief to the common sentiment. We do it the more willingly, because time cannot fail to develop further facts which will establish the truth; and because multiplied observations on the characters and habits of species are necessary, and investigations must be made in some unexplored parts of our country before we shall possess the materials for forming a final opinion on all doubtful points. We shall express our own opinion on these species, when treating of the different genera, and shall give a list of those nearly allied, which seem to us to need further examination.

IV.

OF CLASSIFICATION.

THE ANIMAL KINGDOM, a term intended to embrace the infinite multitude of living beings that people and animate the globe, that fill the air, the earth, and the waters with life, is, by the original laws of its organization, separated into several distinct divisions. In each of these, there prevails a common principle of structure, or unity of composition, variously modified and complicated, which pervades all the animals contained within it, and which is independent of, and distinct from, that which governs the composition of the others. The limits and boundaries of the different divisions have not been so thoroughly investigated, as to determine the exact relations which obtain among them, or their comparative rank according to the perfection of their organization and functions. Indeed of many of the lower animals very little is yet known; but, the constant accessions which are daily made to our knowledge of their intimate structure render it certain, that very important modifications of the received opinions in regard to some of them, will hereafter be adopted. Two primary divisions have been, for half a century, generally recognized by naturalists, viz.

1. That including the VERTEBRATE ANIMALS, or those endowed with an internal bony skeleton, the *constant* feature of which, is the *vertebral column;* and possessing a brain, spinal marrow, and a system of nerves connected with them.
2. That including the INVERTEBRATE ANIMALS, or those destitute of the structure belonging to the preceding; the nervous system being only *ganglionary.*

These great primary divisions are founded, essentially, upon differences in the conformation of the nervous system, and separate the animals possessing a common sensorium or brain, and cerebral nerves, together with a ganglionary system, from those which possess a ganglionary system only. The first is characterized in the most definite manner, and the animals included in it, are constituted on the same general plan of organization. It has usually been subdivided into four great classes, Mammals, Birds, Reptiles, and Fishes. But there are indications from the recent investigations into the structure of the Marsupial animals, which may lead to their establishment as a class between the Mammals and Birds; and there are not wanting reasons for the division of the Reptiles into two independent classes. But whatever changes may take place in the grouping of the component parts of the division, the division itself must be retained with nearly its present limits. The second division is characterized in a much less positive manner. It embraces beings of very various structure, possessing but few characteristics in common, and created on plans of organization so widely different, that nothing brings them together in the same group except the negative quality of wanting those properties which distinguish the first. In some of them, the nervous system remains undiscovered, and if it exists, is less developed than in the ganglionary animals. This classification, which is not altogether philosophical, is therefore liable to be re-modelled, as the progress of knowledge shall require it, and may be said to be, at present, in a rather unsettled state. Various propositions have been made by different naturalists, each influenced by his peculiar theoretical views, for its subdivision into natural classes, but none of these have met with general acceptation. It is certain, however, that the *Invertebrata* will be recognized to contain several distinct divisions, each holding a rank equally as independent as the vertebrate animals, distinguished by a principle of conformation equally definite, and removed to a greater or less distance from them, according to the perfection of the structure and functions of the animals contained in it.

The order and system impressed by the Divine Will on all created things, indicated to the early philosophers, as clearly as to those of our own time, that some principle of arrangement must prevail in the constitution of animated beings; and hence their attention was given to its investigation. Guided by only a very limited knowledge of their structure, and observing, what is very obvious, that there is a superior and an inferior extreme in their organization, and a gradation from the one point to the other, it was inferred that they are all arranged in a regularly descending series, and constitute an unbroken chain from the highest to the lowest. It was seen after a time, however, that this is true only in a very general sense, and that it regards the great classes rather than inferior groups, the degrees of the scale being very irregular, and the intervals between some of them of vast extent. Such a hiatus occurs between the two great divisions we have just named, the distance between the animals lowest in rank in the vertebral classes, and the most highly organized invertebral animals being almost infinite. In passing from one to the other the transition is immediate from beings possessing a brain and highly developed nervous system, distinct organs of sense, an internal bony skeleton which is a part of the living structure, renewed, from time to time, like the other tissues of the body, and extensive powers of locomotion, and endowed, moreover, with intelligence, to those in which there is neither a brain nor cerebral nerves, where the organs of sense are for the most part wanting or singly or doubtfully developed, the body composed of a soft and flaccid substance protected in some classes by an external covering of hard and dense structure, but distinguished from bone by its want of vitality, and the power of locomotion restricted commonly within very narrow limits, and in which intelligence is replaced by instinct.

The impossibility of arranging animals in an uninterrupted Linnean series being now acknowledged, and every practical attempt to construct such an one having failed, the attention of naturalists has been turned in another direction, and much time has been given to the investigation of the structural and functional relations of the several groups and species to each other, with a view of deducing from them the true principle of natural arrangement. For this purpose their affinities and analogies have been studied, their external appearance and minute internal anatomy have been examined, and the whole economy of their lives has been sought out. A comparison of these, aided by acute observation and ingenious reasoning, has resulted in the promulgation of several hypotheses which have been put forth, each as illustrating the plan followed by nature in the creation of living beings, and which should therefore be adopted as the basis of zoölogical classification. The authors of some of these, though admitting a generally descending series, have supposed that there are collateral lines, more or less numerous, diverging from the main series, but continuing parallel to, and after an interval of greater or less extent, merging again with it.

Others, and the most numerous class, have conceived that, at whatever point we commence, we shall, by tracing the gradations of organization and the connecting affinities of groups, arrive at the same point again;

that the natural arrangement therefore is represented by a series of circles, constituting together a net-work, of which the meshes or subordinate circles touch at their circumference other circles, having near relations with them ; the whole uniting to form a great circle. According to this idea, the animal kingdom consists of a *certain number* of grand divisions arranged in a circular form, each of these circles consisting again of the same number of classes forming another circular series within the preceding. These again are divided and subdivided into others representing orders, families and genera. The number of parts constituting each of these circles is supposed to be the same. Thus, for instance, in one of these systems five genera are included in each family, five families in each order, and so on to the grand divisions, which are also five. The authors and advocates of the *systems* are by no means agreed as to the governing number adopted by nature, three, four, five, and seven, having been respectively proposed. They are all known as *circular systems*, and receive their peculiar designation from the *number* proposed, as ternary, quinary, &c.

It cannot be denied that every animal has other animals clustered around it by various relations, and that any system of grouping founded on these relations, tends apparently to a circular arrangement. But it is equally true that every attempt to discover the governing principle which presides in the arrangement has been hitherto unsuccessful. Notwithstanding that much learning and ability have been devoted to the subject, the analogies relied on, in all these systems, are of very unequal value, being oftentimes remote and almost imperceptible, and not infrequently fanciful and absurd. The reasoning is fallacious, sometimes transcendental, and in the main unsatisfactory, and the general opinion of naturalists is adverse to the theories themselves.

Of the animals composing the great invertebrate division, those known by the name of MOLLUSCA,[1] the mollusks, or soft-bodied animals, decidedly out-rank the others by the perfection of their respiratory, circulatory, assimilating, and reproductive functions, while the functions of animal life, excepting those of locomotion, are as highly developed as in either of the other departments. They have consequently been usually placed, in the order of arrangement, next after the vertebrate animals, and they are formed according to a peculiar type or system of organization.

From the time of M. Cuvier, who was the first to demonstrate the leading modifications of structure prevailing among the Mollusks, and to found thereon a truly philosophical classification, showing their several distinctions and relations, many other methods have been brought forward by distinguished naturalists. Some of these display great learning and ingenuity, in the formation of the terms applied to the various subdivisions, and if mere words could become a substi-

[1] The word is derived from the Latin *molluscus*, signifying *soft*.

tute for knowledge, might eclipse the claims of that great man. But, when analyzed, they are found to be, in their general outlines, essentially the same as the method proposed by him, the new one being merely a new nomenclature, with changes in the arrangement of the subordinate parts, and such new grouping of genera, as more recent anatomical investigations have rendered necessary. Some difference there is, also, in the opinions held concerning the comparative rank and value of the different sections, and the limits of the division itself, some authors including among the Mollusks one or more classes of animals which are excluded by others, and elevating to the rank of distinct classes groups which, by others, are placed in the subordinate position of orders and families. With these changes and limitations, the primary subdivisions remain as proposed by M. Cuvier in 1798, the minor parts having been from time to time modified by the labor of himself and other authors who have treated of these animals as a class.

It is not intended, here, to give a particular account of the classification of the Mollusks as at present received, but it is essential to the correct understanding of our subject, so far to exhibit it, as to show the position which the animals described in this work hold, the peculiarities which characterize them as a body, and the relations which they bear to each other, and to the other families of the same type of organization. No method of classification hitherto published, indicates correctly in all its details, the present state of this science, and hence, no one of them is followed in full, in this work; but, such of the views of different authors as are acceptable to us, are with some alteration adopted here. The Mollusks are thus defined by M. de Blainville:

MOLLUSCA. *Animals with two equal, symmetrical halves; the body with its appendages soft, not articulated, enveloped in a skin or muscular membrane (mantle) of various form, upon or within which is developed a calcareous shell of one or more pieces. Circulation complete, with white blood; heart essentially aortic and above the intestinal canal. Respiration aquatic, or aerial. Nervous system composed of a cerebriform ganglion above the œsophagus, communicating with the ganglia of the different functions, those of locomotion being lateral.*

They were divided by M. Cuvier into three Classes.

Class I. CEPHALOPODA. In which the locomotive organs are attached to the head.

Class II. GASTEROPODA. In which locomotion is performed by an expansion of the ventral disk forming a sort of foot.

Class III. ACEPHALA. In which a distinct head is wanting.

The second class, which includes the animals herein described, is characterized by M. Rang, as follows:

CLASS II.

GASTEROPODA.

ANIMAL. *Body free, without limbs to aid progression; but with an abdominal expansion or foot suitable for crawling, and in a small number for swimming; head distinct, bearing commonly one or more pairs of tentacles, and almost always eyes variously situated upon or near the tentacles; respiratory organs branchial, very variable in their form and position.*

SHELL. *External, internal, or wanting, almost always a single piece, conical or spiral when external, and more or less rudimentary when internal, sometimes operculated. Inhabiting the sea, fresh water, and land.*

The subdivisions of this class, or the ORDERS, have, in nearly all the methods, been founded upon differences in the structure of the respiratory apparatus, and the genera are grouped into them, according to their supposed relations in this particular, and without reference to their other characters. But, the arrangement of the genera is not the same in any two of them, and the same terms being used by different authors with a different practical application, considerable confusion prevails in this part of the classification. Many of them being imperfectly known, their places must remain uncertain and subject to change, until more accurate knowledge of their structure shall be obtained; and it will not be until all of them have been investigated, that any system can be proposed, which, so far as these sub-divisions are concerned, will have any chance of permanence. The following arrangement, used in the sense of the authors whose names are appended, is therefore to be considered as merely a provisional one, to be varied from time to time, and possibly to be entirely abandoned, by substituting another founded upon a different organ or organs, and expressing, perhaps, more correctly, their natural relations. Recent observations render it certain, indeed, that much error prevails relative to the mode of respiration, and to the organs by which it is performed in this class. The number of orders might be, even now, reduced by combining two or more together.

ORDERS.

1. Pneumobranchiata. Lamarck, and Gray. Organs of respiration consisting of branchial vessels spread like a network over tho internal parietes of a cavity in the anterior part of the body, communicating with the air by a small orifice on the right side. Respiring air.

2. Cervicobranchiata. Blainville. Organs of respiration situated in a large cavity above the neck, opening largely forwards.

3. Siphonobranchiata. Blainville. Organs of respiration consisting of one or two pectiniform branchiæ, contained in a cavity in the anterior part of the back, and communicating with the surrounding medium by a tubular canal attached to the columella.

4. Asiphonobranchiata. Blainville and Deshayes. Organs of respiration the same as in the preceding, except that they are not prolonged into a tube, but have sometimes an appendix or inferior lobe performing the same office.

5. Scutibranchiata. Blainville. Organs of respiration protected by a sub-spiral or simply covering shell.

6. Inferobranchiata. Cuvier. Organs of respiration in form of lamellæ or folds, under the projecting border of the mantle.

7. Cirrhobranchiata. Blainville. Organs of respiration in form of numerous long filaments borne by two radical lobes above the neck.

8. Monopleurobranchiata. Blainville. Organs of respiration on one side only.

9. Nudibranchiata. Cuvier. Organs of respiration consisting of naked arborescent tufts arranged symmetrically on the side and back.

10. Nucleobranchiata. Blainville. Organs of respiration in form of symmetrical tufts grouped with the digestive organs into a mass or nucleus on the upper and posterior part of the back.

11. Cryptobranchiata. Deshayes. Organs of respiration often not apparent.

This classification is better exhibited in the following tabular form:

TYPE.	CLASSES.	ORDERS.
MOLLUSCA.	I. Cephalopoda . .	
	II. Gasteropoda . .	Pneumobranchiata. Cervicobranchiata. Siphonobranchiata. Asiphonobranchiata. Scutibranchiata. Inferobranchiata. Cirrhobranchiata. Monopleurobranchiata. Nudibranchiata. Nucleobranchiata. Cryptobranchiata.
	III. Acephala . . .	

As the immediate subjects of this work are comprised within one section of the pneumo-branchiate mollusks, namely, that containing the species living upon the land, it will not be necessary to give any account of the order as a whole, beyond that contained in the preceding definition, except to indicate such of our native genera, as are by the best authorities admitted into it, and their natural groupings into families. This is done in the following tabular view. It is proper, however, to notice, that there is much reason to doubt whether the family of *Auriculadæ* is truly pneumo-branchiate, and that the characters of the genus *Ancylus* have not been determined by anatomical investigation. The other genera are well known, with the exception of one proposed by the author.

		FAMILIES.	GENERA.
Pneumobranchiate Mollusca.	SECT. I. Terrestrial. Living upon the land.	Limacidæ .	Vaginulus.
			Tebennophorus.
			Arion.
			Limax.
		Helicidæ .	Vitrina.
			Succinea.
			Helix.
			Bulimus.
			Glandina.
		Pupadæ . .	Cylindrella.
			Pupa.
			Vertigo.
		Helicinadæ .	Helicina.
			Cyclostoma.
	SECT. II. Aquatic. Inhabiting the waters.	Limneadæ .	Limnea.
			Planorbis.
			Physa.
			Ancylus.
		Auriculadæ .	. Auricula.

The characters by which the families are distinguished, differ in importance, but the genera contained in them respectively, are so nearly allied by a common peculiarity as to afford obvious and convenient divisions.

The impossibility of arranging animals in an uninterrupted Linnean series, descending from the most perfect to those of the simplest organization, has long since been acknowledged, and every practical attempt to construct such a series has been a failure. Of late years, the attention of naturalists has been turned in another direction, and much time has been given to the investigation of the structural and functional relations of the several groups and species to each other, with a view of deducing from them the true principle of natural arrangement. For this purpose their affinities and analogies have been studied ; their external appearances and their minute internal anatomy have been examined ; and the whole economy of their lives has been sought out. A comparison of these, aided by acute observation and ingenious reasoning, has resulted in the promulgation of several hypotheses, which are put forth, each as the true plan or system followed by nature in the creation of living beings, and which should therefore be adopted as the basis of zoölogical classification. The authors of some of these, though admitting a generally descending series, have supposed that there are collateral lines, more or less numerous, diverging from the main series, but continuing parallel to it, and, after an interval of greater or less extent, merging again with it.

V.

OF THE GEOGRAPHICAL DISTRIBUTION OF GENERA AND SPECIES, AND THE EXISTING CAUSES INFLUENCING IT.

The causes affecting, and the laws regulating the distribution of species upon the earth, together with the modifications of character produced by their influence, have been much discussed of late; but the facts hitherto recorded are too few in number, and the field of observation is too restricted, to permit any except very general inferences to be drawn from them. In the United States especially, it would be premature to attempt to define even the limits of species, so long as extensive portions of the country remain unexplored by naturalists, and so little attention is given to this subject; but, a few remarks based upon the present state of our information may be hazarded, although at the risk of being proved to be in part erroneous by future investigation. We proceed, therefore, to mention various causes which have been supposed to exercise an influence upon the diffusion of genera and species, and upon the multiplication and perfection of individuals; and to consider their respective importance, as shown by their effects upon the indigenous species of land mollusks. It is necessary to premise, however, that our remarks on these causes are derived solely from observation in this country, and relate only to their influence on the species existing here.

Geographical features of the country. The effect of the combined influences which determine the range of these animals is, to confine each species to a certain natural station or habitation; in other words, to restrict it within geographical limits more or less definite, beyond which it never extends; and hence their range *appears* to be very closely dependent upon the geographical character of the country. It is proper therefore to inquire in the first place, how far they are in reality restrained by merely geographical causes, and whether the geographical features of the country exercise of themselves a positive influence on their distribution; and in order to a correct understanding of the subject it seems to be necessary to give a brief sketch of the principal geographical outlines of the region to which our notice is limited.

The territory of the United States is bounded on the north by the Great Lakes and British America, on the east by the Atlantic Ocean, on the south by the Gulf of Mexico and the Republic of Mexico, and on the west by that State and the Pacific Ocean. It extends from 67° W. to 125° W. from Greenwich, through fifty-eight degrees of longitude; and on the Atlantic coast from 25° N. to 45° N. through twenty degrees of latitude, and on the Pacific coast from 42° N. to 49° N. through seven degrees of latitude. The distance from the Atlantic to the Pacific Ocean, through this tract, is estimated at 2500 miles, and between the extreme north and south points at 1400 miles. It has a maritime frontier of more than 4000 miles, and a lake coast of 1200 miles. Its superficial contents are supposed to exceed 2,200,000 square miles, only one half of which is included within the boundaries of the organized State and Territorial governments. The whole country east of the Mississippi, and for a considerable distance west of that river was, with the exception of an inconsiderable portion of prairie, originally covered with a dense forest; and the labors of two hundred years have cleared and opened for cultivation probably less than one-eighth part of it. The magnitude of the whole area will be more fully realized by reflecting that it is eleven times greater than the kingdom of France, and considerably exceeds that of the whole of Europe, with the exception of the Russian empire.[1]

Its great geographical features are derived from two principal systems of mountains which traverse it, and divide it into three distinct regions. The first system

[1] For details respecting the physical features of the country, the author is indebted to a valuable work on the *Climate of the United States, by Samuel Forry, M. D.*, 8vo. New York, 1842.

consists of the ranges known as the Rocky Mountains, running nearly parallel with the coast of the Pacific Ocean, of various elevation, but the highest peaks rising beyond the limits of perpetual frost and snow. These separate the waters running into the Pacific Ocean from those flowing into the Mississippi River, and Gulf of Mexico. The second system consists of the Appalachian ranges, which rise from an elevated table-land that makes up nearly half of their whole elevation, the summits occasionally reaching an altitude of six thousand, or even six thousand five hundred feet above the sea, but presenting a mean height of from two thousand to two thousand five hundred feet. They extend in a north-east and south-west direction from near the St. Lawrence river to Alabama, and form a barrier between the waters that flow westward to the Mississippi river and the Gulf of Mexico, and those that flow directly into the Atlantic Ocean. At their southern extremity they incline towards the south-west, and terminate before reaching the Gulf of Mexico, thus permitting the low alluvial lands of the southern Atlantic coast to unite with the lands of the same character. which form the southern part of the valley of the Mississippi. The great regions formed by these parallel systems are the following:

1. The Pacific Region, extending between the coast of the Pacific Ocean and the Rocky Mountains. Of this, as well as of the elevated platform or table-land from which these mountains

rise, but little zoölogical information has been received.

2. The Central Region, or vast plain extending from the Rocky Mountains on the west, to the Appalachian Mountains on the east. Being watered by the Mississippi River and its tributary streams, it is commonly known as the great valley or basin of the Mississippi. It is for the most part underlaid with horizontal strata of secondary limestone, and in its eastern and northern parts contains coal formations of great extent. Its rivers are of great volume and length, and the Mississippi River, rising near the western extremity of Lake Superior, and running southwards to the Gulf of Mexico, divides it into two parts.
3. The Atlantic Region, extending from the Appalachian chain on the west, to the Atlantic Ocean. This is for the most part a gently sloping plain, extending from the base of the mountains to the ocean. The northwestern, or more elevated portion, is based principally on primary strata, while the division nearer the sea is underlaid by horizontal cretaceous and tertiary, composed of marls, calcareous clays, and sand.

As the physical characteristics which we have indicated, rather than described, are very marked, and distinguish a country of very great extent, they probably afford as many facts tending to show the influence of this class of causes, as are to be found elsewhere; and hence we may look upon any inference which may be properly drawn from them here, as one of general application.

Mountain ranges, and particularly systems of mountains, are of course among the most effective natural barriers to the extension of animals on the surface of the globe ; but the completeness of the effect is in proportion to their height and continuity, and is modified by the respective locomotive powers of the species which they restrain. A low range of mountains which would completely intercept the progress of fishes, and other animals inhabiting the waters separated by them, would hardly place an obstacle in the way of quadrupeds or birds, which have the means of surmounting them. A higher range, which would yet not impede the birds, would begin to limit the quadrupeds. It would define the range of the smaller species, and those of feeble locomotive powers, which are confined by their habits to the immediate neighborhood in which they are born ; while the larger and more powerful species, accustomed to roam over extensive tracts of country in search of food or for change of climate, would scarcely be checked in their migrations. It does not appear, from any circumstance noticed in the condition of the terrestrial mollusks, that any height of mountains which could be surmounted by quadrupeds, would oppose an insuperable boundary to them, or that there is anything in their organization to prevent their compassing the highest elevations, provided the other circumstances are such as are consistent with their economy. For, although their powers of progression are of a very low order, they are not by their instincts restricted to a particular local habitation, nor have they any regular places of breeding or of shelter, but on the contrary, seek such as may happen to suit their purposes, and be near when needed. Hence, although no individual animal can be supposed to have made any considerable progress, yet, as every one has receded further and further from the point of departure, it may be conceived that, in the course of the countless generations which have existed, they may have extended to vast distances from the original focus of the species, if indeed there was but one focus, a fact which is likely to remain undetermined. We might expect then, a very wide and almost unlimited distribution of these animals, if there were no other counteracting circumstances to restrict it; and, if such did not exist, our expectations would probably be realized. But, as with the elevation of the ranges of mountains the atmospheric temperature is reduced, the character of the vegetation changes, and the geological structure almost always assumes a new form, the conditions of life on high levels become very different from those existing below, and the influences resolve themselves mainly into those of climate. These operate in a very different manner from the obstacles we have before spoken of, and affect directly the means of procuring food, the power of reproduction, and the ability of sustaining life itself; and hence they are of the utmost importance in the consideration of this subject. The facts, in relation to the zoölogical influence of the two systems of mountains within the United States, accord fully with these views. The Rocky Mountains, rising through the level of vegetable barrenness to that of perpetual snow, are, at their highest elevations, unsuitable to the existence and support of animal life; and constitute a barrier impenetrable to nearly every class of animals. The country westward of those mountains is therefore separated zoölogically, as well as geographically, from that eastward of them; the species common in the more eastern divisions are there replaced by other and different forms; and it is thus a distinct zoölogical region. The Appalachian ranges on the other hand, of moderate elevation, covered for the most part to their summits with forests, and presenting no limit to the support of animal life, are easily penetrated at many points through their defiles, and present but few obstacles to the extension of species. They constitute no zoölogical barrier to the land-mollusks, although they do to some other animals; and if, owing to their altitude and the consequent diminution of temperature, individuals are less numerous upon their summits than in the valleys, this effect is climatic alone. Of the native species inhabiting the Atlantic Region, with the exception of those of the tertiary section in the south and south-eastern parts of it, nearly all have been noticed in the Central Region; and, so far as observation extends, both species and individuals are quite as numerous in the insulated valleys among the mountains, and upon their slopes, as in the country on either side of them. This remark cannot of course apply to the introduced species, which to this time, with one or two exceptions, are confined to the Atlantic Region alone. There are, however, in the Central Region, several species which hitherto have not been detected in the Atlantic Region ; but this observation, if it should continue to hold good after more extended investigation, may probably be explained by other than geographical causes. And there is at least one species, which, in its progress from the west eastward, seems barely to have reached the confines of the Eastern Region. This is *Helix profunda*, common in the Central Region, but hitherto only found eastward of the Alleghany Mountains in a single locality, on the Juniata River, in Pennsylvania. Neither do our rivers and lakes appear to present any positive obstacle to the extension of species, for we do not know an instance where the two banks of a river exhibit any considerable difference in this respect, both species and individuals being in general equally numerous upon both sides of them. Even the Mississippi River, separating the country into eastern and western sections, and nearly insulating the eastern section lying between the Great Lakes and the Gulf of Mexico, has no restraining effect, and the Great Lakes themselves have not prevented many, and perhaps all, of the species common to the country on their southern border from extending to their northern shores; they being nearly as abundant in some parts of Canada as in the United States.

Leaving out of consideration the ocean, which of course confines whole tribes and orders of animals within one area, it would seem necessarily to result, from the preceding facts and observations, that *merely* geographical features do not much affect the distribution of species; and that their territorial range, under similar and favorable conditions, is, irrespective of geographical limits, very wide. The vast area between the Rocky Mountains and the Atlantic Ocean may, for these animals, be considered as one zoölogical district; and it may be assumed that they are diffused throughout the whole of it, except where they are restrained by climate, or by other general or local causes.

The following tabular view exhibits the distribution of the species mentioned in this work, according to the geographical divisions before defined, so far as understood at this time. The species believed to have been introduced from other countries are printed in italic letters.

TABLE OF DISTRIBUTION OF SPECIES IN THE SEVERAL GEOGRAPHICAL REGIONS.

Species noticed in the Pacific Region only.	Succinea nuttalliana, rusticana. Helix californiensis, columbiana, labiosa, loricata, nickliniana, nuttalliana, sportella, strigosa, townsendiana, tudiculata, vancouverensis.
Species noticed in the Central Region only.	Succinea luteola. Helix albocincta, berlanderiana, buffoniana, clausa, cumberlandiana, demissa, elevata, exoleta, gularis, interna, lasmodon, leporina, limatula, maxillata, multilineata, pennsylvanica, rotula, saxicola, solitaria, spinosa, sub-plana, texasiana. Bulimus dealbatus, superastrus. Glandina vanuxemensis. Vertigo decora. Helicina occulta, chrysocheila.
Species noticed in the Atlantic Region only.	Vaginulus floridanus. Arion *hortensis*. Limax *agrestis*, *variegatus*. Succinea campestris. Helix *aspersa*, *cellaria*, *hortensis*, jejuna, *lucida*, multidentata, ottonis, rhodocheila, selenina. Bulimus *decollatus*, *undatus*, fasciatus, subula, virgulatus. Cyclostoma dentatum. Pupa incana, modica, pontifica. Cylindrella campanulata, jejuna, lactaria. Achatina gracillima, pellucida.
Species noticed in both Central and Atlantic Regions.	Tebennophorus carolinensis. Limax campestris. Vitrina *pellucida*. Succinea avara, aurea, ovalis, obliqua, *putris*. Helix albolabris, alternata, appressa, arborea, auriculata, chersina, concava, dentifera, electrina, fatigiata, fuliginosa, hirsuta, inflecta, indentata, inornata, intertexta, labyrinthica, ligera, lineata, lucubrata, major, minuscula, mobiliana, monodon, palliata, perspectiva, profunda, *pulchella*, pustula, sayi, septemvolva, striatella, suppressa, thyroidus, tridentata. Bulimus *lubricus*, exiguus, fallax, harpa. Glandina truncata. Pupa armifera, badia, contracta, corticaria, rupicola. Vertigo gouldii, milium, ovata, pentodon. Helicina orbiculata.

Climate. In a territory so extensive as that embraced within the United States, there is ample opportunity to test the effect of climate ; and the topographical character of the country aids in defining the bounds of this influence, and in enabling us the more readily to appreciate its amount. It may be said, in general, that the country presents a great diversity of climate, varying from that of the northern district, where frost and snow prevail nearly six months in the year, and the alternations of temperature are rapid and excessive, the extreme range of the thermometer exceeding 130° of Fahrenheit, to that of peninsular Florida, where the seasons blend imperceptibly with each other, vegetation is never dormant, and flowers succeed each other without interval.

The mean summer and winter temperature of the two most northern and the two most southern military posts, the last of these being an insular one, together with that of the most south-western post, taken from Dr. Forry's work, will illustrate the subject, and show that we have within our limits a range of climate as excessive in its extremes as those of Moscow and of Cairo.

PLACES.	N. lat.	W. lon.	MEAN TEMPERATURE.				Extremes		Annual Range.
			Annual.	Summer.	Winter.	Difference.	Maximum.	Minimum.	
	deg. m.	deg. m.	deg. m.	deg. m.	deg. m.	deg. m.	deg.	deg.	deg.
Fort Brady, Wis.	46 29	81 52	41 39	63 18	21 07	42 11	87	–23	110
Houlton, Me.	46 10	67 50	41 21	62 93	16 74	49 16	94	-24	118
Tampa Bay, E. F.	27 57	82 35	73 42	81 25	64 76	16 49	92	35	57
Key West, E. F.	24 33	81 52	76 09	81 39	70 05	11 34	89	52	37
Fort Jessup, La.	31 30	93 47	68 03	82 48	67 99	29 29	96	19	77

The general effect of climate, irrespective of other influences, is undoubtedly a reduction of the number, both of genera and species, towards the north ; and a manifest diminution of the number, size, and perfection of individuals. Thus, while in the northern sections *Glandina*, *Helicina*, *Cyclostoma*, and the polygyral forms of Helix entirely disappear, and only one of the native species of true *Bulimus* remains, the single genus *Vitrina* begins to be observed. At the same time, although in the southern sections the genera are more numerous, and only two northern genera, *Tebennophorus* and *Vitrina*, are known to disappear, yet, the great genus *Helix* becomes less numerous in species, thus indicating that its focus is in the more temperate portion of the central region. This result however, is affected by elevation and other causes as well as latitude, species being continued on the Appalachian table lands, as far south as Georgia and Alabama, when they have already disappeared on either side in the same latitude. And while the northern species show a tendency gradually to run out, towards the south, their places are supplied to some extent by other forms. Thus, the *polygyral Helices*, which form a very distinct division of this genus, and by some have been thought to possess characters sufficiently marked to constitute a genus by themselves, occurring but rarely in the latitude of the Ohio river, become more common towards the south, until, on the borders of the Gulf of Mexico, they exist in vast numbers, to the exclusion of nearly all the species, which further north occupy the country. *Helix fallax*, if it be considered a legitimate species, is another similar instance. It appears first, sparingly, north of the Ohio, where it can hardly be distinguished from the analogous *Helix tridentata;* but in the sandy parts of the south it is greatly multiplied, and entirely takes the place of the latter species.

But, although distribution is mainly influenced by climate, there are many other minor causes which greatly modify its effect, and determine the number, both of genera and species, in particular localities, and even over large tracts of country. Among these are the following.

Geological Structure. The influence of this cause is very important, and admits of no doubt. The soils formed from the débris of calcareous strata are those which support the terrestrial mollusks in the greatest numbers, and on which individuals attain the greatest size and beauty. It would seem, therefore, that the calcareous matter of the soil is in some way essential to the perfection of the shell. Soils formed from primary rocks, on the other hand, are those on which they are least numerous, and where the shell is in general smaller and less ponderous. We doubt not that individuals brought from primitive and from calcareous regions may be respectively distinguished by the greater or less development of, and the amount of calcareous matter in, the shell. As to the other geological formations, we have not been able to perceive any appreciable differences in the influence which they exert, but from all of them it is less favorable. The coal formations have been said to be nearly as favorable to their multiplication as calcareous strata. We are not prepared to deny this entirely, but certainly, in every part of the coal-field of the eastern part of Ohio which we have visited where limestone is wanting, these animals are not more numerous than in the primary region of Vermont, other circumstances in both being apparently equal. The only inference therefore which seems to be justified is, that the presence of calcareous matter in the soil produces a positively favorable effect on the increase of the terrestrial mollusks; the effect of the other geological formations being only negative, and, so far as observation goes in this country, not definite.

Vegetation. A vegetation composed entirely of coniferous trees produces a positively unfavorable influence. Hence, in our pine forests, these animals are always comparatively rare, and in the northern primary sections may be said to be entirely wanting. In the Southern States, where extensive pine forests prevail, but with a favorable climate and a calcareous soil, neither species nor individuals are numerous, and the latter are reduced in size. It seems necessary, indeed, that deciduous trees and plants should predominate, in order to their considerable multiplication and extension.

Humidity and Dryness. Humidity is one of the conditions necessary to their existence, and therefore it is that they are more numerous in humid localities than elsewhere. For the same reason, they prefer the bottom of ravines, and the damp and shady recesses of the forest, and choose for their places of shelter strata of wet and decaying leaves, and the lower surfaces of wood and stones in contact with the soil, or even bury themselves in the soil. For though they have the ability to retire into their shells and of hermetically closing the aperture, yet this power seems to be provided as a defence against occasional or accidental changes, and not against constant or long-continued effects. Hence, they are rarely found to occupy positions that are permanently arid; and in regions subject to long-continued drought, and upon soils which easily give up their moisture, they are not met with except in low situations, near the margins of streams, ponds and swamps. For the same reason they are not common on soils which become hard and impenetrable on drying, and are wanting in sun-burnt wastes and in sandy deserts. The vicinity of waterfalls, within the influence of the spray and mist arising from them, is a favorite locality of many species. Excessive moisture, on the other hand, is very prejudicial, for they cannot exist in swamps, or upon grounds subject to be overflowed with water, and they are destroyed by inundations. The genera, however, and even the species, differ considerably in these particulars. *Glandina* occupies habitually wet and swampy grounds, and *Succinea* and some species of *Pupa* are often found upon ground in the immediate vicinity of.

and saturated with water, localities not habitable by other genera. *Helix multilineata* is one of the species said to inhabit wet meadows.

Elevation. Although all our species, as has been said, may be supposed to have surmounted very considerable elevations, yet they do not constantly inhabit the highest levels, such positions being, by reason of climatal influences, less favorable to them than less elevated situations. There are, however, some species which, although diffused throughout almost every part of the country, are found more commonly than others, in the higher regions of the mountains, and which appear to occupy them by choice. It would seem, therefore, that elevation exercises an influence independent of climate. We are not aware that many facts have been observed which support this opinion, and the only species which we can mention with confidence as being frequently noticed in such situations is *Helix inornata*, which, both in New York, Vermont, and Massachusetts, we have procured from the highest ridges. This native species bears some resemblance to *Helix alliaria*, which Mr. Forbes cites as an inhabitant of the highest elevations in Great Britain.

But, notwithstanding these remarks, the general influence of elevation corresponds with that of increasing northern latitude, and is decidedly climatal. The height of the most elevated mountains in the United States, eastward of the Rocky Mountains, however, is so inconsiderable, that they enjoy for a short period, at least during the summer, a temperature which is sufficiently mild to permit any of the species to exercise their usual functions, and to reproduce their kind, although the length and severity of the winters retard their maturity and prevent a rapid increase of numbers. Hence, species are less numerous, and individuals are reduced in size and beauty, on the highest levels, in the same manner as they are in northern localities. A striking instance of this effect is seen in the mountainous region of New Hampshire and Vermont, where *Helix tridentata*, and *H. sayi*, although frequently met with, do not reach one half the magnitude which they attain in the lower levels of western New York and Ohio.

The observations hitherto made on this interesting subject are few, and do not authorize any confident inference; but so far as they go, they show that nearly all the species which inhabit the country on either side of the mountains, exist also on the high table-lands, and that if there are any species peculiar to the extreme high points, they must occupy very limited localities on the few peaks which rise more than 5000 feet above the sea. It is not unlikely indeed, that the genus *Vitrina*, which has been found elsewhere at high elevations, may be discovered in these situations.

The relations which the different levels of elevation bear to the parallels of latitude, although as interesting to the zoölogist as to the botanist, have not yet been made the subject of examination in this country. But the Rocky Mountains, towards and beyond which the tide of population is already rolling, offer, in the great extent of their table-land and in the height to which they rise, a vast field of research to future naturalists, where they will be able to solve many of the most important questions connected with the geographical distribution of the terrestrial mollusks of our country; and only a few years will elapse before these mountains will be accessible, with comparative ease, to those who may wish to explore them.

Having thus noticed the most important agents which are supposed to influence the extension of these animals, it may be proper to give such general results respecting their actual distribution, as seem to be justified by our present scanty knowledge, and to be in accordance with the preceding principles. And if, as before observed, but little confidence can be placed in such general inferences, they may nevertheless be useful by exciting further investigation, and may lead the way to more certain information. The facts hitherto observed in relation to species, indicate the existence of several distinct zoölogical divisions or sections of country, of which the topographical characters are in general well marked, and in which, respectively, causes are seen to exist adapted, according to our views, to exercise the influences we have named. It is not pretended that the productions of each of these, even in the limited department of the terrestrial mollusks on which alone they are founded, differ entirely from those of the others; but, while they are more or less blended in general, there are certain species which are peculiar to each. And notwithstanding that these sections may be defined with some particularity, their limits are necessarily in a considerable degree arbitrary; and it will require many years of patient and industrious observation, and the accumulation of a great number of facts, before they can be laid down with certainty. Beginning at the southern extremity and proceeding northwards, they occur in the following order.

SECTION 1. *The Peninsula of Florida*, and the adjacent islands, extending from 24° 30′ to 30° north latitude, and at the nearest point being about one hundred and thirty miles distant from the northern shore of the island of Cuba. This section, surrounded by the ocean on every side except the north, is but little raised above it, no part rising more than one hundred and fifty feet above its level. The interior of its southern part is an immense morass intersected by sluggish streams, while its northern portion is in some parts a level, and in others an undulated country with a sandy soil, and, except near the streams and ponds, and in the islands or insulated thickets of verdure locally called *hammocks*, where deciduous trees prevail, covered with pine trees and an undergrowth of dwarf palmetto. The climate is peculiar; summer and winter present no great extremes, and meet each other by slow and insensible changes; the beautiful vegetation and verdant foliage of the tropics are ever present; and with the temperature of Cuba, are enjoyed many of its productions also. Its zoölogy has never been thoroughly investigated, but a careful exploration of its most southern portion, including the islands of the coast, has demonstrated that many of the land-mollusks indigenous to Cuba, are found both on the main land and the islands, and that others which are derived from a more distant source, also exist there. Among the former are *Pupa incana*, *Cylindrella lactaria*, *Cyclostoma dentatum*, *Bulimus undatus* and *fasciatus;* and among the latter, *Bulimus virgulatus*, and *Helix rhodocheila*, *selenina*, *ottonis*, &c. There are other species which, so far as is at present ascertained, are peculiar to this section. Such is *Vaginulus floridanus*. Dead and worn specimens of other Cuban species are also sometimes seen in collections, and represented to have been procured in Florida, but the evidence that they actually were, is not entirely satisfactory. The other species indigenous to this section are the same which are found in the next northern section. The influence of a mild climate approaching that of the intertropical regions, and very favorable to the multiplication of species, is counteracted, in some degree, by the excessive humidity of large tracts, and by the general prevalence of a sandy soil. For this reason, though in some situations they exist in multitudes, there are extensive portions where it is almost impossible to discover a single one; and, in general, it may be said, that individuals are multiplied whilst species are restrained. The marked characteristics of this section, and its near approach to a tropical climate, lead us to expect that when it shall have been thoroughly explored it will be found to contain more than the twenty-eight species now supposed peculiar to itself, as well as other introduced species. It possesses a peculiar interest as the connecting point between the Fauna of North America and that of the West Indian islands.

SECTION 2. *The Tertiary Region of the Atlantic Coast and the Gulf of Mexico.* This embraces the eastern parts of North and South Carolina and Georgia, the whole of Florida not included in the preceding section, the southern parts of Alabama and Mississippi, the whole of Louisiana, and parts of Arkansas and Texas. It extends from the ocean to the point where the rivers, falling over the last rocky ledge, reach the level of tide-water; and is a low and humid region characterized by extensive swamps and marshes, sluggish streams, and wide inlets from the sea. On the streams, the soil is but little elevated above the water, vegetation is vigorous and prolific, and extensive and almost impenetrable cane-brakes prevail. On the higher grounds the soil is chiefly sandy, and vast tracts, extending for hundreds of miles, are covered by magnificent open forests of gigantic pines. Here the traveller may journey for days and weeks among the monotonous scenery, and will in vain seek relief or change in the unvarying landscape,

> "Where to the north — pine trees in prospect rise,
> Where to the south — pine trees assail the skies,
> Where to the east — pine trees obstruct the view,
> Where to the west — pine trees forever grew."

To a favorable climate there is here superadded the concurrent geological influence of a substratum of soft and crumbling limestone, which modifies the sandy soil, the vegetation remaining unfavorable. This section is, in its lower and more humid parts, the peculiar habitat of the genus *Glandina*, which has not been noticed north of it. Here also exist in great numbers *Helicina orbiculata*, and the *polygyral* species of *Helix*. These last are most abundant on the sea islands, and near the inlets from the sea. In the sandy plains is found the species of Helix called by Mr. Say *fallax*, by the influence of climate very numerous in individuals, but through the effect of a poor and sandy soil, much reduced in size. *H. lucubrata*, *H. selenina*, and *H. mobiliana*, so far as is known, are found here only; so also is *Succinea campestris*. Off-shoots from this section extend into that next north of it, *Helicina* and one at least of the *polygyral helices* having been noticed as far north as the Ohio River. The species belonging to the section next north are found more or less abundant where the two sections blend, and extend to a considerable distance into this section.

In the southern part of this section, the State of Texas is included, the climate of which exceeds considerably in its mean temperature that of the parts of the same section on the Atlantic. After crossing the Mississippi River, several species appear which either do not exist, or are very rare on the eastern side; these increase in size and development as we proceed in a south-western direction, until they are found in the most mature condition in the western part of Texas. Prominent among these are *Bulimus dealbatus*, which is very abundant, *H. Buffoniana* and *H. berlanderiana*. *Helix texasiana*, a modification of the tridental forms, also appears, and seems to constitute a connecting link between *Helix tridentata* and its varieties and the polygyral forms so common throughout the rest of this section. While these new forms are developed, the common forms of *Helix septemvolva* and *auriculata* diminish sensibly in frequency, as we proceed towards the south-west along the shores of the Mexican Gulf, and at length become very rare or disappear entirely. Among these is *Helix septemvolva*, a species more or less common in the low lands of the whole coast from South Carolina to Louisiana inclusive. These circumstances indicate a transition to another fauna, and it is therefore reasonable to suppose that, as regards the terrestrial mollusks, Mexico is a distinct zoölogical region.

SECTION 3. *The Southern interior Section.* In this section is included the territory north of the preceding, its western part lying between it and the Ohio River, while its eastern part extends northerly, though not well defined on its northern boundary, as far as North Carolina or the southern part of Virginia. It is for the most part broken into mountains or hills, is watered by large and rapid rivers, and numerous streams and brooks, and is covered with forests of deciduous trees. The climate, geological structure, soil, and vegetation, are in general favorable, and accordingly, both species and individuals are numerous. As before mentioned, some of the species of the preceding section extend into this, and almost all of those belonging to the next succeeding section are common to it; but it has its own peculiar species which prevail particularly in the mountainous parts of its most southerly portion. Among these are *Helix spinosa*, *H. major*, *H. cumberlandiana*, *H. subplana*, *H. gularis*, *H. rotula*, *H. leporina*, and *H. lasmodon*. The physical conditions of this section are peculiarly conducive to the development of testaceous variation; hence we find here the carinated and heavily-ribbed *Helix palliata*, the deep-ribbed *Helix alternata*, and others. In it the genera *Limax* and *Tebennophorus* are very abundant. This section, already distinguished by a larger number of peculiar species than either of the others, has been but partially explored. Being in its greater part a mountainous region, subject to climatal influences different from those of the country north of it, it may be expected to furnish a still larger number of yet unobserved species, and would doubtless well reward the industry of any naturalist who should thoroughly reconnoitre it. Like the preceding, it extends beyond the Mississippi River, but its limits are there unknown.

SECTION 4. *The Northern interior Section.* This includes the country between the Ohio River and the Great Lakes, and between North Carolina and New York and Vermont. Its character is much like that of the preceding section, except that its winters are longer and more severe. Its boundaries on the north-east and north-west are not well defined, and it extends like the preceding, west of the Mississippi River. The influences operating within this section are of the most favorable kind, except the climate, which, though considerably severe in winter, is in the northern part meliorated by the presence of the great body of the waters of the lakes. Soil, vegetation, and geological structure combine with the climate to produce, in the southern part of this section, as well as in the northern part of the preceding, a greater amount of circumstances and conditions propitious to their existence and increase, than exist elsewhere. *Vaginulus*, *Glandina*, *Helicina*, the larger species of *Bulimus*, and *Cyclostoma*, restrained by climatal influences, have disappeared ; but the majority of the species of *Helix*, *Succinea*, *Pupa*, and *Vertigo* flourish in great numbers, and all the naked slugs, both native and introduced, with the exception of *Vaginulus*, are found. It would seem to be the great central focus of all these genera, from which they radiate into the other sections. Very few species have as yet been noticed ; *H. lucida*, an introduced species, and *Pupa badia*, *decora* and *gouldii*, are perhaps the only ones.

Section 5. *The North-western Section.* The country west and north-west of the Great Lakes and extending to the 49th degree of north latitude. This section is described to be " literally a wilderness of lakes, islands, and peninsulas ; a mazy waste, so inhospitable and irreclaimable, as to mock the art and enterprise of man, and bid defiance to his industry." It is characterized as the coldest climate of the United States ; the winters being long and severe, the change from summer to winter being rapid, and the extremes of temperature very great.

The extreme range of the thermometer extends from 38° below zero, Fahr., to 100° above, making one hundred and thirty-eight degrees; and the mercury often remains below zero for many days together. The summer heat, though never long continued, is excessive. The prevailing rocks west of Lake Superior are primary, the soil is thin and poor, and the vegetation stunted. Operated upon by these causes, the species which prevailed in the preceding section become less and less numerous as the secondary region east of Lake Superior runs out farther west, and finally disappear. The genus *Vitrina* is, however, indigenous to it, and *Helix inornata*, which is believed to reach a more northern as well as a more elevated position than any other species, is also found in it. Here appears also the singular little *Bulimus harpa*, which is unknown farther south. This section is but little known.

Section 6. *The North-eastern Section.* This lies between the St. Lawrence River and the Atlantic Ocean, and comprises the northern parts of New York and Vermont, and all New Hampshire and Maine; the British provinces of New Brunswick and Nova Scotia are also included within it. Its summers are short, and its winters long and severe, exhibiting extreme reductions of temperature, but modified by its proximity to the ocean. In Nova Scotia, which is almost insular, the winters are said to be much more mild than in the same parallel of latitude in Canada. In its general character, as affected by climate, the section resembles the preceding, and though separated from it by a great extent of intermediate territory, the most peculiar species of the two are the same. This is an instance of the tendency of similar causes to reproduce the same forms in localities widely separated, though upon the same continent. In it the influences are unfavorable, and the species gradually run out towards the north-east, until, in Nova Scotia, the only one of our larger species common to the more southern sections, known to prevail, is *Helix alternata*, probably the most universally diffused species of our whole catalogue. The number of individuals is also greatly diminished, and they never attain the same size and beauty which they reach in more favorable situations. In many parts of this section, land shells are never seen, and throughout the whole of it they are more or less rare. But, while such is the operation of climate and soil on our native species, *Helix hortensis*, a species undoubtedly introduced from Europe, has made a successful lodgment, and is the most abundant species throughout the greater part of Nova Scotia, the islands north and east of it, parts of Lower Canada, New Brunswick, and on several small islands on the coast of Maine and Massachusetts, but does not extend to more southern and temperate parts. The genus *Vitrina* also belongs to this section, as does also *Bulimus harpa*.

The distribution of the genera and species in each of the preceding sections is exhibited in the synopsis on pages 128, 129; the species supposed to be introduced from foreign countries being printed in italics. The catalogues are, of course, imperfect, and additions and alterations will be made from time to time.

In addition to the causes mentioned before, as exercising a general influence, there are others operating in a more limited sphere, and acting only at particular times, the effect of which, nevertheless, is for the time being very important, and they are therefore deserving of remark. They may be denominated occasional or accidental causes.

Sudden and extreme Vicissitudes of Temperature. The terrestrial mollusks resist changes of temperature better than many others by the defences they construct over the mouth of the shell, as well as by retiring into protected situations. There is, however, a limit to their powers of resistance, and sudden and extreme depressions of temperature, particularly in those parts of the country where such changes are uncommon, are very fatal to them. In the winter of 1834 and 1835 a sudden and severe frost continuing for several hours, destroyed all the orange trees in the Territory of Florida, causing a most serious loss to the inhabitants. At the same time, the tide being at ebb, the marine mollusks living above low water mark were nearly exterminated, and immense numbers of the terrestrial species were killed. We have noticed the surface of small islands on the coast of Florida literally covered with the bleached remains of Helix and Helicina that were destroyed at that time. It must have required several years to restore the species to the same position in point of numbers which they held before that occurrence. Cold, not very extreme in degree, but continued for a longer period than usual, gradually produces results of a similar character.

SYNOPSIS OF GENERA AND SPECIES

SECTION I.	SECTION II.	SECTION III.
Vaginulus . floridanus.	. . . . . .	. . . .
. . .	. . . . . .	Tebennophorus . . carolinensis.
. . . . . .	. . . . . . Limax . . . . agrestis.	. . . . Limax . . . . campestris, *variegatus*.
. . .	. . . . . .	. . . .
Succinea . luteola.	Succinea . . . campestris, luteola, munita.	Succinea . . . aurea, avara, obliqua, ovalis.
Bulimus . exiguus, fasciatus, subula, virgulatus, zebra.	Bulimus . . . dealbatus, *decollatus*, exiguus, fallax, *lubricus*.	Bulimus . . . dealbatus, *lubricus*, exiguus, fallax, superastrus.
Achatina . gracillima, pellucida.	. . . . . .	. . . .
Glandina . truncata.	Glandina truncata, . vanuxemensis.	. . . .
Helix . . auriculata, jejuna, labyrinthica, minuscula, mobiliana, ottonis, pustula, rhodocheila, selenina, septemvolva.	Helix . . . . albocincta, alternata, arborea, auriculata, berlanderiana, buttoniana, chersina, clausa, contracta, demissa, fallax, fatigiata, gularis, hirsuta, indentata, inornata, labyrinthica, lucubrata, major, minuscula, mobiliana, plicata, pustula, *pulchella*, saxicola, selenina, septemvolva, suppressa, texasiana, thyroidus, vultuosa.	Helix . . . . albolabris, alternata, appressa, arborea, chersina, clausa, concava, cumberlandiana, demissa, elevata, exoleta, electrina, fatigiata, fallax, fuliginosa, gularis, hirsuta, indentata, inornata, interna, intertexta, inflecta, labyrinthica, lasmodon, ligera, lineata, leporina, lucubrata, minuscula, monodon, maxillata, major, multilineata, multidentata, palliata, pennsylvanica, perspectiva, profunda, sayi, plicata, *pulchella*, rotula, solitaria, spinosa, striatella, subplana, suppressa, thyroidus, tridentata.
Pupa . . contracta, incana, pontifica, rupicola.	Pupa . . . . rupicola, contracta, variolaria.	Pupa . . . . armifera, contracta, corticaria, rupicola,
. . .	Vertigo . . . milium.	Vertigo . . . . milium, ovata, pentodon.
Cylindrella . lactaria, jejuna.	. . . . . .	. . . . . .
. . .	Helicina . . . orbiculata.	Helicina . . . . orbiculata, rubella.
Cyclostoma dentatum.	. . . . . .	. . . . . .

IN EACH GEOGRAPHICAL SECTION.

SECTION IV.	SECTION V.	SECTION VI.
. . . .	. . . .	. . . .
Tebennophorus . . . . carolinensis.	. . .	Tebennophorus carolinensis.
Arion *hortensis*.	. . .	. . .
Limax . . . . . *agrestis*, campestris, *variegatus*.	. . .	Limax *agrestis*, campestris.
. . . .	Vitrina *pellucida*.	Vitrina *pellucida*.
Succinea . . . . . avara, aurea, obliqua, ovalis, *putris*.	. . .	Succinea avara, obliqua, ovalis.
Bulimus . . . . . *lubricus*, fallax, exiguus.	Bulimus . *lubricus*, harpa.	Bulimus *lubricus*, exiguus, harpa.
. . . .	. . .	. . .
. . . .	. . .	. . .
Helix . . . . albolabris, alternata, appressa, arborea, *cellaria*, chersina, clausa, concava, demissa, dentifera, electrina, elevata, exoleta, fallax, fuliginosa, hirsuta, *hortensis*, indentata, inflecta, inornata, interna, intertexta, labyrinthica, ligera, limatula, lineata, *lucida*, minuscula, monodon, multidentata, multilineata, palliata, pennsylvanica, perspectiva, profunda, *pulchella*, sayi, solitaria, striatella, suppressa, thyroidus, tridentata.	Helix . . chersina, hirsuta.	Helix albolabris, alternata, arborea, *aspersa*, chersina, concava, dentifera, electrina, *hortensis*, indentata, inornata, labyrinthica, lineata, minuscula, monodon, *pulchella*, sayi, striatella, thyroidus, tridentata.
Pupa . . . . . . armifera, badia, corticaria, contracta, rupicola.	. . .	Pupa contracta.
Vertigo . . . . . . decora, gouldii, milium, ovata, pentodon.	. . .	Vertigo ovata, pentodon.
. . . .	. . .	. . .
. . . .	. . .	. . .
. . . .	. . .	. . .

The winter of 1842, which was very severe, produced a similar effect on the naked mollusks of the coast of Massachusetts. The species which usually are very abundant there were hardly observed during the succeeding year. Oysters, spread by the fishermen on oyster banks for preservation, were destroyed at the same time in great numbers. Thus a series of long and uncommonly cold winters, or of cold and dry summers, reduces their numbers to such a degree that scarcely an individual is seen where thousands were met with before. On the other hand a succession of warm and moist seasons increases their numbers incredibly.

Inundations of Rivers. Tracts of land, but little raised above the level of high water, occur on the borders of nearly all our large rivers. On the lower parts of the Ohio and Mississippi rivers especially, they constitute a wide, level, alluvial territory of great extent, comprising many hundred square miles. The periodical melting of ice and snow in the spring, and heavy rains in the mountains where they have their sources, cause such an increase in the volume of their waters, that they occasionally rise above their banks and overflow the low lands in their vicinity. These inundations are usually limited to a narrow region, and speedily subside; but when, by a simultaneous operation of these causes over a wide extent of country, all the head waters pour their tribute at the same time into the main trunks, the mass of water becomes irresistible, and breaking through every barrier, it spreads out into a vast inland sea. The body of water is then so great, that weeks elapse before it can be drained off through the usual channels, and the country remains during this time covered with it. When these inundations are thus excessive and long continued, which usually only happens after intervals of years, they must in a great degree destroy animal life, and reduce, if they do not exterminate, the species most exposed to them. Thus the undue extension of these animals is checked in a region otherwise particularly adapted to their increase, and they are kept within more restricted numerical limits.

Another and very different influence of rivers in their ordinary action is to bring down into the plains and lowlands, and thus aid in distributing, the species occurring in the more elevated regions. We may suppose that a species, having by its own powers attained the summit of a range of mountains, may, when aided accidentally by the current of rivers, be very rapidly diffused through the country on the other side; and thus a much shorter period of time be required for its extension than would have been necessary under other circumstances.

Fires. It was the custom of the aboriginal inhabitants of the country to burn over, annually, large tracts of land, by setting fire to the rank, dry grass and herbage on the prairies and in the more open parts of the woods. This practice, repeated every autumn, insured a fresh and luxuriant growth of plants in the ensuing spring, and thus afforded ample pasturage for their game. It prevented also the growth of trees upon the prairies, and of underwood in the forests, and tended to preserve them in their then existing condition. The conflagration of the combustible mass was of course fatal to the smaller animals, and in such tracts the mollusks were, and still are, comparatively rare. As, under the proprietorship of lands by the present population, this practice has, with few exceptions, become obsolete, it may be expected that the land-shells will gradually spread over the tracts formerly exposed to fires, and become as numerous there as elsewhere in the same region. Indeed, there is no doubt that this result has already taken place to a considerable extent, in those States where extensive prairies exist, and that they will continue to multiply until such lands come under the dominion of agriculture. On the other hand, the accidental spreading of fires, in seasons of drought, over wooded tracts, may, from time to time, diminish their numbers in places subject to this contingency.

Agriculture. The influence which at this time is producing the most marked changes in the number and distribution of the land-mollusks, proceeds from the operations of man in opening the forest for cultivation, and adapting the country for the abode of civilization. As the forest falls, light and heat are admitted, the moist places are dried up, the mollusks are deprived of their natural protection, and brought under the action of agents to which they are unaccustomed, and which tend to their gradual extinction. The omnivorous hog, which accompanies man in all his migrations, seeks them out in their most secluded retreats, and uproots them from the soil itself; and the domestic poultry find in them a favorite food. Fires, which from year to year are applied to consume the trees felled by the axe, aid in the work; and finally comes the plough, which completes their extermination. Thus, they mostly disappear as the settlement of the country proceeds, until in the older and most populous districts, they are nearly extinct or are represented only by the smaller species, existing under favorable circumstances, and in the most retired localities. So, too, in the well-wooded regions of the West not actually subjected to the operations of agriculture, where they were until lately known to be very numerous, the universal practice of rearing great numbers of hogs, which roam at large in the forest, has diminished their numbers and rendered them much less common. No species, however, is likely to become extinct from this cause alone, for many escape these various dangers, and some portions of land remain uncultivated; and when suffered to rest for a time unmolested, they increase very rapidly.

Destruction by Animals. The increase of individuals is kept in check by the depredations of other species of the same family, and even by other individuals of the same species. Other kinds of animals also prey upon them. We have frequently noticed that when in a state of confinement, *Helix concava*, itself not an abundant species, will generally destroy other species which are kept with it; and the animal of *Glandina truncata*, which we have occasionally had in captivity, has uniformly destroyed those of the other genera and species placed within its reach. In the same manner *Limax variegatus*, when kept a few days without food, has devoured the weaker *Limax agrestis*, leaving no vestige of them except the rudimentary shell. We have also been informed, on what we consider to be good authority, that a foreign species, believed to be *Helix nemoralis*, which existed formerly in great numbers in Charleston, S. C., was completely exterminated by *Bulimus decollatus*, a foreign species also, which now flourishes there in abundance. In this case, however, the destruction of the one species, though subsequent to the introduction of the other, might not have had any connection with it. Birds also make great havoc among them, where the woods are so far opened as to permit the entrance of such of them as do not usually frequent the forest. They seize the shell with their beaks, and bearing it to a prostrate tree or log, break it with repeated blows of the point of the bill, and extract the soft animal. It is not uncommon to find numerous broken shells about a spot in the woods which has been selected by the bird as the seat of its operations. The little heaps of shells in the woods are by some supposed to be due to the agency of squirrels, and not of birds, but probably it is merely because they are found, like the shells of nuts which are known to be eaten by the former, near to logs. Frogs also, and toads, in their excursions upon land, frequently meet with and prey upon them, and it is quite a common occurrence to find the shell of a *Helix* in the stomach of a frog. Some of the aquatic mammalia feed upon and destroy great numbers of the *Naiades*, and there would, therefore, be nothing improbable in the supposition that some of the smaller terrestrial quadrupeds feed upon the land-mollusks. Indeed, we have been informed that a species of field-mouse, probably a *Sorex*, burrows in the deep snow that covers the ground in the winter, and seeking the torpid *Helices* in their retreats, drags them to the surface and devours them, leaving the broken shells scattered upon the snow.

Proximity of the Sea. Among the causes affecting the distribution of land-shells which have been noticed in other countries, the vicinity of the ocean has been supposed to exercise very considerable influence. In Great Britain it has been stated, that species are more numerous, individuals multiplied to a greater extent, varieties more common, and the shells larger, more developed, and marked with more brilliant colors, on *sea-banks* than elsewhere. It seems to be thought, though it is not so stated in terms, that the ocean produces a direct influence in this case, and no intimation is given of its being an indirect climatal effect. It is said also, that tho presence of sand aids the multiplication of individuals. If these effects were the result of the causes named, we might expect to find them occurring in similar localities elsewhere; but, in this country at least, the observed facts do not support such a conclusion. On the contrary, so far as the author's personal observation and inquiry have extended, it has appeared that the land-shells are much less numerous near the sea than in the interior, and that they are particularly deficient immediately upon the sea-shore, upon what may be termed *sea-banks*. The influence of the sea, as well as of large bodies of fresh water, tends to meliorate the climate of the country bordering upon them, and hence, perhaps, the sea-shore of Great Britain is a *more* favorable habitat than the interior, although this influence modifies the climate of the whole island in a greater or less degree. Our experience, too, as to the presence of sand, is entirely opposite to that noticed in Great Britain, sandy banks near the sea and elsewhere being destitute of shells, and all soils in which siliceous sand predominates supporting them only in small numbers. Indeed, pure sand creates a mechanical obstacle which these animals cannot overcome: its loose dry particles adhere to their wet mucous surface, incrust them entirely, and prevent their locomotion. They vainly endeavor to free themselves from it, by secreting more mucus, and in this way soon become exhausted, and die.

There is, however, a class of facts in the United States, which at first view seems to confirm the English observations. Ten years since, we observed great numbers of *Helix hortensis* on a small uninhabited island comprising less than an acre of surface, near the shore of Cape Ann, in Massachusetts. Dr. Mighels has observed the same species very abundant on an island, of only a few rods in extent, in Casco Bay. *Helix septemvolva* and *Helicina orbiculata* occur in such quantities as almost to cover the ground upon small islands on the coast of Florida. The diminutive islands called the *Brothers*, in Lake Champlain, near Burlington, furnish the shells of that district in abundance. Oak Island,[1] a little wooded islet a few miles eastward of Boston, surrounded by extensive salt marshes and at high water by the sea, was, a few years since, covered by myriads of *Bulimus lubricus*, and *Vertigo ovata*. And very recently, on throwing a bridge from Goat Island, at Niagara Falls, to an islet near it, the surface of which measures but a few hundred square feet, and which had been previously inaccessible, it was found to contain the *Helices* and *Succineæ* of the neighborhood so plentifully, that hundreds might have been taken in a few moments. In all these cases, the fact that individuals were greatly multiplied above their numbers on the adjacent main land, was striking and beyond doubt. The locality, in each instance, being situated within the

[1] The railroad from Boston to Salem now passes through this island, and connects it, in two directions, with the main land. This will probably effect an entire change in its peculiar molluscous fauna, or rather cause the extinction of these animals.

immediate influence of large bodies of water, it would not have been unreasonable to have considered this influence, the only one apparently common to all of them, as the cause of the great multiplication of individuals; and hence to have inferred, that the proximity of the sea or of the Great Lakes was favorable to their increase. But, as other islands, seemingly subject to the same influences, are totally destitute of shells, and the main land in their immediate vicinity maintains them only in scanty numbers, we must necessarily seek some other cause adequate to explain the facts. According to our views, we find it in the circumstance that either these islands are from their position inaccessible, or from their diminutive extent unworthy of attention, and hence not subjected to agriculture, and not inhabited by man and the domesticated animals which accompany him. The mollusks are therefore in undisturbed possession, and being free from the attacks of enemies, they multiply to such an extent as the climate and facility of obtaining food will permit; and consequently, in process of time, become very abundant. These facts, then, do not corroborate the opinion held abroad as to the influence of the sea.

Local causes. There are probably other causes of a local character not understood, but affecting the increase of individuals in particular circumscribed spots, promoting the increase of species and individuals in some localities, and restraining it in others. Such causes may exist in the intimate composition of the soil, or in the character of the plants; and it is likely that both of them have their influence. The mechanical properties of the soil also have an influence, as in the instance of sand, to which we have alluded. So too, a soil composed of stiff clay which on a few hours exposure to the sun becomes baked and rigid, and cannot be penetrated by them, is equally unfavorable. There are other localities where individuals multiply infinitely. Mr. Anthony, of Cincinnati, Ohio, informs us, that in his walks around that city, himself and a friend collected during a single week, above five thousand specimens of *Helices*, the time devoted to the walks being taken from the intervals between business hours, and good and mature specimens only being selected. Professor Adams states that he collected, in one hour, more than one thousand specimens of *Helix minuscula*; and Dr. Gould found *Bulimus lubricus* so abundant upon Oak Island, that many hundreds could be taken from the ground with a single handful of decaying leaves.

Although some few species seem to occupy somewhat limited localities, not having as yet been found over any very broad region, yet the range of most species is very extensive; and, what is worthy of remark, the widest distribution is to be noticed in the smallest species. The smaller species are also tenfold, and probably a hundredfold more numerous than the larger. This circumstance is somewhat difficult of explanation. Both their number and their broad range may perhaps be owing to their very diminutiveness, on account of which they more readily find shelter and escape observation, thus being exempted from many destructive agencies.

There are some species, upon the distribution of which, climate, vegetation, geological structure and other general causes, seem to exercise but very little influence, as is shown by the universality of their diffusion throughout the country. *Helix labyrinthica*, for example, is equally abundant, and as much developed, upon the sides of the primary hills of Vermont and Maine, in the rigorous climate of 45° north latitude, where snow covers the ground three or four months of the year, as it is 20° further south, upon the tertiary levels of southern Florida only a few feet above the sea, where it enjoys a climate of almost tropical mildness. The same remark may be made of *Helix minuscula*, *Pupa contracta*, *P. rupicola* and *P. exigua*, and perhaps of other minute species.

VI.

OF ZOÖLOGICAL FOCI, OR POINTS OF ORIGIN WHENCE GENERA AND SPECIES ARE DERIVED.

THE distribution of species, as treated of in the preceding chapter, has thus far been considered only as influenced by existing causes, whose operation is known. These, however, will hardly account for the present condition of all the species, or rather, some of them as it would seem, occupy their present positions, notwithstanding the restraining influences, which, if the preceding views are correct, should have limited them within more narrow bounds. The species alluded to, are those which occupy different and widely distant countries and continents, and which have already been discovered upon so many points of the earth's surface, as to indicate an almost universal diffusion. The researches which are now continually undertaken, to elucidate the zoölogy of almost every part of the world, frequently bring to our knowledge instances of the wide range of species, which had been noticed previously only in a single country; and the number of these is already large. The most striking example among them occurs in *Helix pulchella.* This diminutive species is spread throughout the continent of Europe; it is common in the north of Africa, and in some parts of the south of Asia:[1] it is found in Cuba, and others of the West Indian islands; and is abundant in nearly every part of the United States and Canada. The various positions which it is thus found to occupy, and the dissimilar circumstances in which it exists, together with the difference of climate and other physical agents to which it is subjected, and the vast distances both of land and ocean which intervene between these localities, render it doubtful whether its general dispersion is not due to other causes than those which have been named, and whether, indeed, it can be explained on any acknowledged principles. Its condition in this country tends to increase these doubts. Its occurrence might, of course, be expected, in any country which has been closely connected with Europe by commerce, but this would be no reason for meeting it in the interior of North America, far removed from the settlements of white men, and in places still inhabited by the aboriginal races, and only occasionally visited by the wandering hunter. Yet, in 1820, on the arrival of Major Long's exploring expedition at Council Bluffs, on the Missouri River, five hundred miles above its embou-

[1] Specimens of *Helix pulchella* were brought to this country by Mr. Lyell, which were obtained by Lieut. Lyell, in the neighborhood of Candahar. They differ in no respect from common European and American specimens.

chure into the Mississippi, and more than fifteen hundred miles from any maritime port, Mr. Say discovered it in considerable numbers. Its existence in this case involves some important consequences, for, if we consider it to be of foreign origin, and take the period of its introduction to have been some time since the first permanent colonization of this continent by Europeans, and suppose the point at which it was introduced to have been upon the sea-coast, it is necessary that the animal should have travelled more than twenty thousand times its own length every day while in motion, and to have been in progressive motion one fourth of the whole time for two hundred years, in order to have reached this locality; and if its progress has been aided by accidental transportation to some point on the Mississippi River, the result will not be the less improbable. Now when we reflect, that it is only sixty or seventy years since the first settlements of white men were made west of the Alleghany Mountains, and that it is scarcely forty years since the country beyond the Mississippi River was reached in their progress, and bear in mind that the accidental transportation of such animals could only have occurred by the merest chance, and that in their natural progress they must have overcome numerous and steep mountains, and crossed wide and rapid rivers, the difficulties in the way of this mode of explanation seem to be insuperable. It is true, that the historical period within which this continent has been known, comprises probably but a small part of its whole existence, and that the action of known causes through a period of indefinite duration, might have produced even a more general diffusion, but, as an impenetrable veil hangs over everything that preceded the historical epoch, and we know of no facts which corroborate this latter suggestion, we cannot place much reliance upon it. We must seek then for other causes, to explain the general dispersion of this and other cosmopolite species.[1]

Of the origin and mode of creation of organized beings, we of course can know nothing, through our own limited faculties. The subject is beyond our comprehension, and Divine Providence has vouchsafed to us no revelation concerning it. The Mosaic account of creation informs us that after the surface of the earth was prepared for the support of animal life, the different classes of animals were created at different periods of time, and our own experience, drawn from observation of the fossil remains of former animals, which have been preserved in the strata of the earth's crust, fully corroborate this account. But, we are limited to these very general facts, and must found our views of the local origin, and the subsequent dispersion of species over the earth upon such observations as we possess, and such reasonings as we can base upon them.

[1] A similar course of remark might be pursued in relation to *Bulimus lubricus*, and *Vitrina pellucida*, the former abundant and generally diffused in the country, the latter rare and found only in insulated situations, but in every case directly upon the route followed by hunters and fur-trappers, from the earliest settlements.

There are two theories, which have mainly divided the opinions of naturalists. The first supposes that the existing races of animals were of simultaneous creation at a common centre or focus, from which they have spread over the whole earth; the other considers that there were several distinct centres or foci, from which the species radiated into — and thus formed, the zoölogical circles or regions which are now apparent. The first supposition, though possible, is seen at once to be attended with many physical difficulties, and has but few supporters; while the second, commends itself to the minds of almost all. In surveying the zoölogy of the earth, we find groups of distinct animals, of the different classes, occupying regions which are defined by natural boundaries, and limited to these regions alone; and the discovery of new continents and islands has, in every case, revealed animals peculiar to each of them. The existence of distinct zoölogical regions has hence come to be an axiom in the philosophy of zoölogy, and the theory of distinct foci of animal origin has thus been greatly fortified. But in all the speculations of naturalists on this subject, and in all their attempts to deduce the limits of the various regions, from the actual distribution of animals, attention has been given almost solely to the large animals, and mostly to the vertebrata, and consequently the regions as laid down by authors, are co-extensive with the wide range of these species. It is manifest, however, that the ranges of the different classes of animals differ very much among themselves, and that the quadruped that seeks its food, according to the change of seasons, throughout the greater part of a continent, and the bird which, guided by its instinct, spends its summers in the polar regions, and its winters between the tropics, are subjected to very different laws of distribution from the insect whose range is often strictly local, or the mollusk, whose limits are defined by the causes we have described. The higher classes of animals, indeed, are unaffected, or but slightly restrained, by many of the causes which, to the inferior classes, constitute insurmountable obstacles; and consequently, the geographical space which they respectively occupy, or the circles within which they habitually move, are of very different extent. It would seem to result, from this reasoning, that, in seeking to ascertain and define the various zoölogical regions, we must make a distinct apportionment for each distinct class of animals: and that the spacious regions ranged by the higher animals, must be divided and subdivided into others of more limited extent, which shall represent the more limited spheres of the less diffused species. It follows, also, that within each of these minor spheres or zoölogical sections, the original focus of all the species contained within it, must have been located. We believe that these ideas will be found to be consistent with facts everywhere observed. In applying them to North America, we find, that its temperate parts are considered to constitute a peculiar zoölogical region, characterized, among other animals, by the bison among quadrupeds, and the wild turkey among birds; and for these two classes of animals it is probably correctly defined; but for the terrestrial mollusks, some other division is necessary; for the most widely diffused among them does not occupy so large a space, and several groups of species are much more limited, as we have endeavored to show. It will be objected to this theory of distinct zoölogical centres, that it cannot be natural, because it concerns only one department of animals; and that, as nature acts through general laws, these separate plans of diffusion are inconsistent with this principle. The objection, in our view, has but little weight; the laws of nature are known only by their results, and as we see that different classes of animals have different capacities and different powers of action, and of resisting action, we must believe that they were formed to be subject to different influences; and that their diffusion may, without any inconsistency of purpose, have been regulated by different plans. And the generally received opinion, of the successive creation of the different classes of animals, after intervals of greater or less durations, adds strong confirmation to our theory; for, admitting this to be true, the centres from which sprung the various mollusks were established, and the causes influencing their extension and distribution were in operation, for an indefinite period in advance of even the existence of the animals of the higher classes.

There are difficulties which it seems to us can hardly be overcome on any other supposition. If all the species had been created at one time and at one place, they ought to be found to have made nearly an equal advance. and to be pretty equally dispersed over the earth, for we know of nothing in their organization that should give any considerable advantage in this respect to one over another. The species of the two hemispheres should also be in general the same. If all the species then, originated on the eastern continent, how has it happened that those that have reached the western continent, have in general, left none of their kind behind them; or that peculiar species exist in small islands or groups of islands far removed from other land? If it be said that in the long lapse of ages, species once universally diffused have become extinct in particular regions, and that the survivors are confined to more limited ranges, we ask how it happens that the testaceous remains discovered by geological research, differ as much from existing species as the recent species of the two continents differ from each other. It seems to us that the facts taken for granted in these objections are inconsistent with any other theory than that of different foci of creation, and that this theory is sustained by all that we know of the geological revolutions of the earth, and of the condition of the species formerly existing upon it.

Having thus adopted the theory of distinct zoölogical centres, and admitting that as successive portions of the earth's surface emerged from the waters, and became adapted to sustain the different classes of animals, those races which were fitted for the then existing physical condition of things, were brought into being by the prolific hand of nature, we find no difficulty in supposing that under the same or similar conditions, the same species may have been created at different centres. In this way the presence of any species in every part of the earth may be accounted for, and thus only can we satisfactorily explain the diffusion of the species that have been under consideration.

The zoölogical sections which, in accordance with these ideas, we have ventured to propose, are given merely as suggestions, indicated by the present state of information. It is desirable that the subject should be fully investigated, and the correctness of the proposed divisions tested. Should they be proved to be untenable, we shall very willingly relinquish them, and adopt such other views as may be found more consistent with facts.

VII.

OF THE INTRODUCTION OF FOREIGN SPECIES INTO THE UNITED STATES.

THE frequent commercial intercourse subsisting between various countries is producing, slowly but surely, important changes in the fauna of many districts; and must presently render it difficult to distinguish their indigenous animals from those that have been imported. Nowhere is international commerce more active, than between the western and southern nations of Europe and the United States: and hence we are peculiarly liable to the introduction of animals from that part of the world. Considerable additions to our catalogues of the lower animals, particularly of insects, have already been made in this way, and it has therefore become desirable, that an accurate determination of our native species, in every department, should be had, previous to any further increase from this source. For this reason, we have endeavored to ascertain the facts relating to the introduced species of land-shells, whether derived from this source or others, both for the interest connected with the subject, and that they might serve as points of comparison for future observers. Among the species which are common to this and to other countries, we shall mention *Helix pulchella* and *Bulimus lubricus*, as being of foreign origin, and as having been introduced; but this we do, rather in deference to received opinion, than because we are satisfied of the fact; for, in truth, so generally are they diffused over the country, that we are inclined to believe, as may be inferred from our remarks on a former page, that they are as truly native species as many others which have never been considered to be otherwise.

The process of introducing foreign species is constantly going on. The animals sometimes, but more commonly their eggs, are transported in the soil of boxes of plants, or about the roots of trees and shrubs imported for horticultural purposes, or in the cavities of woods used in the arts. Another common mode of introduction is among the ballast of vessels, collected on the shores of foreign countries, and often discharged on our own. Some of the larger European species, and particularly *Helix aspersa*, are sometimes shipped to this country as an article of commerce, and are used for food by foreign residents. Others are brought as objects of curiosity, and are preserved in gardens, and conservatories. Individuals introduced in some of these modes, escaping or preserved by accident, are thus enabled to colonize the species in new localities, where, if favored by propitious circumstances, they obtain a permanent footing, and extend themselves gradually in the country. Of these, *Limax agrestis*, and *L. variegatus*, *Helix aspersa*, *H. cellaria*, *H. hortensis*, *H. lucida*, and *H. pulchella*, and *Bulimus decollatus*, *B. zebra*, *B. fasciatus*, *B. virgulatus* and *B. lubricus*, are examples. Others strive in vain to establish themselves; the climate or some other cause is fatal to them, and after some increase, they diminish and become extinct. Of these, *Helix nemoralis*, *virgata*, *pisana*, and *lactea*, and *Bulimus acutus*, are recorded as having been noticed in the United States at different times; and it is only by adopting the supposition of their subsequent extinction, that we can give credit to these observations, for it is nearly certain, that none of them now exist within our territory.

Oceanic currents also aid in bringing to our shores foreign species, and have been the means of introducing and naturalizing them. The Gulf Stream is a prominent example of this. This great body of water, flowing from the Gulf of Mexico into the Atlantic, passes between the Peninsula of Florida and the Island of Cuba, and after turning the southern point of Florida, sweeps along its eastern shore. It is sometimes driven close to the northern coast of Cuba, and sometimes forced much further north, according to the direction and force of the wind. Various counter currents, due also to the influence of the wind, diverge from the main stream, among which is noticed a current which, after a northerly wind has prevailed for several days, sets in a south-westerly direction near to the Florida Reef. The principal stream and the currents originating in it, bear upon their surface various vegetable and other productions brought by rivers into the Gulf, or swept from its shores, and these are frequently deposited upon parts of the coast very distant from their origin. In this way seed-vessels from the Spanish Main, trunks of trees and fragments of wood of unascertained origin, and numerous objects from the northern shore of Cuba, are frequently found on the shore of Key West, and on the beach of Cape Florida and the shores and islands to the north of it.[1] These circumstances are adequate to account for the transmission of land-shells from the Island of Cuba, and even from more distant places, to the main land and islands of Florida; and to this source we ascribe the origin of *Helix rhodocheila*, and *Bulimus virgulatus*, which are probably derived from the Bahamas, but possibly from the Spanish Main, and of *Helix ottonis*, *Bulimus fasciatus*, *B. zebra*, *B. subula*, *Pupa incana*, *Cyclostoma dentatum*, and *Cylindrella lactaria*, all undoubtedly from Cuba, which, having found a congenial soil and climate in the southern part of the peninsula of Florida, are now flourishing there in great numbers. To the same cause may

[1] A few years since a bottle was picked up on Tavernia Key, near Cape Florida, containing a note stating that it was thrown overboard off the Moro Castle. A Cuba barge, of the kind used in lading and unlading vessels in Matanzas, was lately found stranded on the beach at New River, twenty-five miles north of Cape Florida. Small objects from Cuba are often found on the shore of Key West.

possibly be due the passage of some of the smaller species, of universal diffusion in the United States, to the Island of Cuba. Among these are *Helix minuscula*, *Pupa contracta*, and *P. rupicola*, which from their general distribution on the continent, may be supposed to have originated there rather than upon the island.

We cannot help thinking, too, that such currents have had some agency in introducing *Helix hortensis* on our north-eastern coast, at some former period, although we are not aware of the existence of one, capable of producing such an effect. This species is found, within our limits, only in the States of New York and Vermont on the boundary of Canada, and in the north-eastern States from Massachusetts to the British provinces along the borders of the sea. In the first-named localities, its presence is accounted for, by its extension under usual circumstances from Canada, where it is said to be common. On the sea-coast, some other explanation is necessary. Commencing at what appears to be its southern limit, it occurs on the sandy soil at the extreme end of Cape Cod; it then disappears in the intermediate country, and is next found on a small, rocky, uninhabited island, on the shore of Cape Ann; proceeding further east, it is lost until it again appears on a small island of a similar character in Casco Bay, Maine. Along this extensive line, it is nowhere found inland, and, with the exception of the locality on Cape Cod, never on the main land, although the islands referred to are in close proximity to it. In New Brunswick it begins to occur in the interior, and in Nova Scotia is said to be the most common of the larger species. That it should occur on the extreme point of a cape extending far into the sea, and on desolate islets along the coast, is consistent with the supposition of its having been borne there by currents; while the common mode of distribution, by numerical increase and extension, or by direct introduction through commercial agency, from Europe, does not explain why it is found in such unfrequented spots only, on the borders of the sea alone, never upon the main land, and on some islets, but not on others. Our own hypothesis is, that having been very early introduced into the French province of Acadia, (and also into Canada) by the European colonists, and become numerous there, it has been borne along the coast by counter currents and eddies, to the places which it now occupies, where, being protected from other animals, and from the operations of agriculture, to which it would have been exposed on the main land, and under the influence of a climate rendered mild by the proximity of the sea, it has multiplied to a great extent.[1]

[1] Since the above observations were penned, the author has again visited, after an interval of nine years, the locality upon Salt Island, Cape Ann. This island, which at extreme low water is connected with the main by a narrow sand-bar, is a mass of granite elevated not more than sixty or seventy feet above the sea; its seaward side is bold and precipitous, and being open to the assaults of the waves, is denuded of soil to the very summit. Its landward side, protected by the crest of the island from storms coming from the ocean, has a thin superstratum of soil, which supports a rank growth of coarse grass and low shrubs, the latter affording a

That this hypothesis of the agency of currents is no violent one, is proved by common experience. A single log of timber, removed from the bank of a river by the rise of its waters during a *freshet*, and borne by them to the ocean, and driven by winds, tides, and currents, might carry with it, and deposit upon other shores, the eggs of mollusks, or even the living animals themselves, provided they were not too long exposed to the elements. It is difficult to estimate their powers of endurance under such circumstances, or to limit the amount of exposure which they might bear, but they are unquestionably such as to enable them to sustain life for several days, in the case we have supposed. The eggs of snails have been subjected to a high temperature in an oven, until, being totally deprived of moisture, they were friable between the fingers; they have been repeatedly frozen and thawed again; they have been suffered to remain a con-

constant shade. On this part of it, apparently not exceeding an acre in extent, *Helix hortensis* formerly existed in such numbers that hundreds could be obtained in a few moments. On approaching the island at this time, smoke was seen rising from it, and presently a rude hut erected on the sheltered side, boats drawn up on the strand, nets spread upon the bushes to dry, and lobster-traps scattered about, became visible, and announced that a fisherman had taken possession of it. The usual consequence of the presence of man and his companions has followed. *Helix hortensis* is greatly reduced in numbers, and must very soon become extinct. After a diligent search of nearly an hour, only four or five living specimens could be found. It may be well to mention in this place, that the same effect has followed the connection of the small island near Niagara Falls with Goat Island. Within two years after admission was thus gained to it, the mollusks were nearly exterminated.

siderable time immersed in water, and yet, on being placed in favorable circumstances, have been found to retain their vitality, and have matured and produced young. They would not be exposed to severer trials when floating upon a log in the ocean, and their chances of surviving would be as good. Logs and trunks of trees which have drifted from a great distance, may often be seen upon our sea-beaches; and we remember, on one occasion, to have seen Nantasket beach, at the mouth of Boston harbor, strewn with logs which had been driven from the rivers of Maine by easterly winds of several days continuance.

The limits of species, and particularly of the introduced species, are gradually enlarging, and though their progress must necessarily be slow, it is susceptible of satisfactory proof. Unless of native origin, as we have suggested, the time of their introduction must be taken to be a period subsequent to the colonization of the country, which is comparatively a recent date, and yet some of them have extended over a large part of the country, as *Helix pulchella*, and *Bulimus lubricus*, and are extremely abundant. The fact that the distant regions to which these species seem to have extended, are in the track of the early French voyagers and colonists, along the great Lakes and about the upper Mississippi, is quite significant; and shows that they might have been introduced into those parts directly, with the effects of the colonists, in the same manner as we suppose them to have been introduced on the Atlantic borders. Others are met with only adjacent to the sea, or rather not very far removed into the interior, as *Helix cellaria*, and *Limax agrestis*, which in many localities are very common. The extreme distance from the sea-shore at which we have hitherto noticed them, has not exceeded one hundred miles. Others again, as *Limax variegatus*, occur in the cities and other limited localities separated by considerable distances from each other, whither they have been transplanted by accident; and yet another class are confined to a single locality, beyond which they have not yet advanced, as *Bulimus decollatus* in gardens in Charleston, S. C., and *Helix lucida* in the vicinity of Albany, N. Y., where they have probably been introduced in packages of imported plants. As all these are probably destined to a still further extension, the present range of each is important as a point of comparison in future investigations.

The annexed table exhibits a list of foreign species, which have been stated by authors to occur in the United States, or the countries adjacent, with an indication of the present condition of those now existing. It is quite probable that some of the species, said to be extinct, have never in fact occurred here; and that others, which now seem to be identical with foreign species, may be found essentially different when examined more accurately, and the difference may become still more obvious on a careful comparison of the animals.

Foreign species now first ascertained to be found in the United States, are not included in the table.

TABLE OF FOREIGN SPECIES RECORDED BY AUTHORS AS OBSERVED IN THE UNITED STATES.

NAMES OF SPECIES.	AUTHORS REFERRED TO.	PRESENT CONDITION AND LOCALITIES.
Arion hortensis.	Binney.	Boston and vicinity.
Limax agrestis.	Gould. Binney.	Atlantic States, not more than 100 miles from the sea.
——— variegatus.	Say. Férussac.	Cities in Eastern and Middle States.
Vitrina pellucida.	Say. Adams. Mighels.	N. E. and N. W. Sections.
Succinea amphibia.	Forbes.	Not uncommon.
——— putris.	Férussac.	
Helix aspersa.	Gray. Forbes. Humb. and Bonp.	Charleston, S. C. Maine.
—— bonplandi.	Lamarck.	Probably inhabits the peninsula of Florida. H. albolabris supposed a variety of this by Lam.
—— cellaria	Binney. Gould.	Common in Eastern and Middle States, in cities.
—— depicta.	Grateloup.	Not existing in U. States.
—— hortensis.	Binney. Gould.	Islands on coast of Mass. and Maine; borders of Canada.
—— lactea.	Say.	Extinct.
—— lucida.	Ingalls.	Numerous at Greenbush, New York.
—— nemoralis.	Gray.	Extinct.
—— nitida.	Férussac. Gray.	Probably H. arborea.
—— pisana.	Gray. Forbes.	Probably H. rhodocheila
—— pulchella.	Say. Gray.	Very common.
—— variabilis.	Gray. Forbes.	Extinct.
Bulimus acutus.	Fér. Gray. Forbes.	Extinct.
——— decollatus.	Say. Gray.	Charleston, S. C. only.
——— lubricus.	Gould. Adams.	Common.
——— radiatus.	Férussac.	Probably B. dealbatus. Say.
——— undatus.	Say.	Florida.
——— virgineus.	Say.	Florida.
——— octona.		Greenhouses and conservatories.
——— acicula.		
Partula otaheitana.	Des Moulins.	Never existed in U. States.

There is another branch of this subject which demands attention, as connected with the introduction of foreign species, and that is, the distribution in the neighboring countries and islands, of those species which are usually admitted to be indigenous to the United States. In the dearth of zoölogical information concerning that part of North America south of the United States, we find but few facts recorded which illustrate the subject, and hence we can present nothing of much interest. We have reduced the observations into the form of a table, which will show at one view all that we have been able to gather. We include in it *Bulimus zebra* and *B. fasciatus*, because, although we believe, from their appearance in our territory only on the southern point of the peninsula of Florida and on the small islands closely adjacent, that they were accidentally introduced from the neighboring island of Cuba, others may not be of the same opinion, and it may be interesting to ascertain their range as well as that of the other species. In the British provinces at the north of the United States, the observations are still fewer in number, and we are acquainted with only a single local list (and that a very meagre and incomplete one,)[1] of the land-mollusks occurring in any part of the British North American possessions. We know, however, from authentic information, that many of the species indigenous to our fourth zoölogical section, are also common to the peninsula of

[1] Mrs. Sheppard's, in the Transactions of the Literary and Historical Society of Quebec, Vol. i. p. 88. 1829.

Upper Canada ; and, if we may judge by the climate and physical characters, they must be as abundant there as in the northern parts of the United States. But, as we are not able to particularize species, or their localities, or the extent of their range north of Lake Erie, we have omitted them in the table. The few species known to extend north of the St. Lawrence River, are included in it.

We are aware that no important deductions can be drawn from this table in its present imperfect condition, and therefore offer it with some hesitation. But as the facts which would go to complete a table of this kind, must necessarily be collected before we can determine with accuracy the species which are indigenous to the United States exclusively, we have thought it expedient to furnish the outline, in the hope that others would, ere long, provide the materials for filling it up. It is also not improbable that some of the species, now supposed to be identical with extra-limital ones, may prove to be different. The same facts might also have an important bearing upon the question of the local origin of the several species. For the species contained in the table, we have given such authorities as are known to us ; where none are named, we have relied either upon our own personal knowledge, or upon the information of persons whose accuracy we could not doubt.

TABLE OF DISTRIBUTION OF SPECIES INHABITING THE UNITED STATES, IN OTHER PARTS OF AMERICA.

SPECIES.	DISTRIBUTION.	AUTHORITIES.
Vitrina pellucida. . . .	Greenland.	Forbes.
Succinea putris. . . .	Canada, near Quebec. .	Sheppard.
Bulimus dealbatus . .	Mexico.	
——— fasciatus. . .	The Antilles, Trinity. .	Férussac.
	Mexico.	Humb. and Bonp.
	Brazil.	D'Orbigny.
	Yucatan, and Central America.	
——— subula. . .	Cuba.	
——— zebra. . . .	The Antilles, Barbadoes, Cayenne.	Férussac.
Achatina gracillima. .	Cuba.	Pfeiffer.
——— pellucida. . .	Cuba.	Pfeiffer.
Helix alternata. . . . Sub nomine *dubia*.	Canada, near Quebec. .	Sheppard.
	Nova Scotia. Common.	M'Culloch.
—— auriculata. . . .	Mexico.	
—— fallax. . . . . Sub nom. *triodonta*.	Mexico.	Jan.
—— minuscula. ? . . Sub nom. *lavalleana*.	Cuba.	De la Sagra.
—— monodon. ? . . Sine nomine.	Canada, near Quebec. .	Sheppard.
—— ottonis.	Cuba.	Pfeiffer.
—— saxicola. . . .	Cuba.	Pfeiffer.
—— selenina. . . .	St. Croix.	Griffith.
Glandina truncata. . .	The Antilles.	Fér. De la Sagra.
	Mexico.	
	Central America. . . .	
Pupa rupicola. . . . Sub nom. *servilis*.	Cuba, St. Croix. . . .	Gould.
—— contracta. . . .	Cuba.	Gould.
—— incana.	Cuba.	
Cylindrella lactaria. . .	Cuba.	Gould.
Helicina orbiculata. . .	. . . .	
Cyclostoma dentatum .	Cuba.	

VIII.

OF THE DISTRIBUTION OF GENERA AND SPECIES IN THE UNITED STATES, COMPARED WITH THAT OF EUROPE AND SOUTH AMERICA.

The distribution of the terrestrial mollusks in the United States, as compared with the temperate parts of Europe, presents some curious results. The following table shows the number of species found under the several genera:

GENERA.	NUMBER OF SPECIES.	INTRODUCED SPECIES.
Vaginulus	1	1
Tebennophorus	2	0
Arion	1	1
Limax	3	2
Vitrina	1	1
Succinea	8	1
Bulimus	11	2
Helix	71	5
Achatina	2	2
Glandina	2	1
Pupa	8	2
Vertigo	5	1
Cylindrella	2	1
Helicina	3	1
Cyclostoma	1	1
Total	121	22
Deduct introduced species	22	
Indigenous species	99	

The whole number of species hitherto ascertained, within the bounds of the United States east of the Mississippi River, excluding species found elsewhere also, is ninety-nine.

The first reflection that arises, on examining this table, is, the comparatively small number of species which it exhibits. The number inhabiting the corresponding climatal parts of Europe, of equal territorial area, is more than twice as great; and the limited extent of the British Islands affords at least an equal number. This inequality of numbers may perhaps be partly explained by the supposition, that many species remain yet undiscovered; but, considering the attention which has already been given to our conchology, we can hardly expect that the whole difference should be made up by future researches. A further approximation of numbers may also be gained by cutting off some of the nominal species of European *Limaces*, which seem to be established on very slight external characters, and will hardly maintain their places; but when this is done, the difference remaining will still be very considerable. We confess that we do not perceive the means of reconciling the disparity of distribution, which strikes us as the more remarkable, because the species live in this country more in their natural condition than they can do in the cultivated parts of Europe, and because a large portion of our territory seems to be, by its climate and geological structure, and other physical circumstances, peculiarly adapted to their growth and increase. The only circumstance which we perceive, wherein the European localities can be supposed to have the advantage is, the more equable and gradually changing temperature which they enjoy; the changes of temperature in many parts of this country being frequent, rapid, and excessive.

We notice, also, the remarkable deficiency of the *Limacidæ*, of which *Tebennophorus* is the only unequivocally native genus, while *Arion* and *Vaginulus* are each represented by a single introduced species, and *Limax* has two introduced species and one somewhat doubtful native. The whole appear to have been formerly represented by *Tebennophorus*, which is believed to be peculiar to North America, and differs essentially from its allied genera by its external form and internal structure. It may be remarked, however, that as the animals of this family are nocturnal in their habits, and their places of resort are but little open to common observation, it is almost certain that other species will be discovered. The genus *Clausilia*, which, in Europe, comprises numerous species, is without a representative, and, so far as we know, does not occur either upon the continent of America, or the adjacent islands. Its place is supplied by *Cylindrella*, which is common in the Antilles. *Vitrina* contains only a single species, identical with the most common European species, and by many thought to be introduced. Of the other genera common to both lists, *Succinea* is more numerously represented here than in Europe; *Pupa*, *Vertigo*, and *Bulimus*, much less so, although our proximity to the regions where *Bulimus* prevails would induce us to expect to find it more numerous; and *Helix*, making allowance for a few deductions from some of the foreign lists, maintains nearly an equal representation. The most considerable differences, however, indicated by the comparison, arise from the introduction into our catalogue of the genera *Vaginulus*, *Glandina*, *Cylindrella* and *Helicina*, which are believed to be entirely wanting in Europe, and the very distinct section of *Helix*, which includes the *polygyral* species. All these are due to our near approach to the tropical parts of our continent, within which they all prevail. *Glandina*, it is believed, is peculiar to the coasts and islands of the Gulf of Mexico, the alluvial regions north and south of it, and the larger West Indian Islands; while *Helicina* and *Cylindrella*, as well as *Cyclostoma* are most numerous in the Antilles, from which most probably our species, with one exception, were derived. The sub-genus *Helicodonta* of Férussac, which is numerous in species, as we shall hereafter have occasion to observe, is also characteristic of the American continent and islands, but is not, like the preceding, more predominant near the equator than elsewhere. We shall notice the peculiarities which distinguish our native species, and the particulars in which they differ from those of other countries, in our general remarks upon each genus. We give here a comparative table showing the number of species of the several genera of terrestrial mollusks in the United States, and in various sections of Europe. It is derived from authentic catalogues of local authors, and exhibits forcibly our numerical deficiencies in species. A single local catalogue of the North of Africa is added.

COMPARATIVE TABLE OF TERRESTRIAL MOLLUSKS IN THE UNITED STATES AND IN EUROPE.

COUNTRIES.	AUTHORS.	Tebennophorus.	Parmacella.	Testacella.	Limax.	Vitrina.	Succinea.	Bulimus.	Helix.	Pupa.	Clausilia.	Glandina.	Helicina.	Cyclostoma.	TOTAL.
United States, East of River Mississippi	. . . .	3	0	0	4	1	8	13	71	13	2	2	3	1	121
Great Britain .	Alder . .	0	0	1	7	1	2	5	36	13	5	0	0	1	71
Scotland . .	Forbes .	0	0	0	7	1	2	4	24	9	2	0	0	0	49
Ireland . . .	Thompson	0	0	1	6	1	2	4	30	9	2	0	0	1	56
Germany . .	Pfeiffer .	0	0	0	6	3	2	7	58	16	17	0	0	2	111
Sweden . . .	Wilson .	0	0	0	9	1	1	3	20	6	4	0	0	0	44
Russia, with Caucasus	Krynicki .	0	0	0	0	1	2	9	47	16	15	0	0	0	90
Switzerland .	Charpentier	0	0	0	7	4	2	5	40	21	11	0	0	0	90
Province of Brabant, N. of Belgium	Kickx .	0	0	0	8	2	1	6	22	12	6	0	0	1	58
France . . .	Michaud .	0	0	1	12	4	2	10	79	27	11	0	0	7	153
Department of Pas-de-Calais, N. of France	Bouchard-Chantereaux	0	0	0	8	1	3	4	21	7	6	0	0	2	52
Department of Puy-de-Dôme, S. of Centre	Bouillet .	0	0	1	10	3	2	4	27	9	5	0	0	1	62
Department of the Landes, S. of France	Grateloup	0	0	1	8	1	2	5	30	5	3	0	0	1	56
Department of Finisterre, W. of France	Collard-des-Cherres.	0	0	1	3	1	1	3	24	7	3	0	0	2	45
Italy . . .	Jan . .	0	0	0	2	3	2	6	66	13	10	0	0	2	104
Province of Como, North of Italy	Porro . .	0	0	0	3	3	2	3	29	14	5	0	0	3	62
Sicily . . .	Philippi .	0	3	0	0	1	1	7	41	1	4	0	0	3	61
Portugal . .	Morelet .	0	1	1	14	1	4	6	28	7	1	0	0	1	64
North of Africa	Terver .	0	0	1	4	0	1	5	42	4	0	0	0	2	49

In the preceding table, the numbers for Scotland, Germany, Sweden, Russia, Switzerland, and Italy, are copied from Mr. Forbes's Report: in the other instances, they are taken from the authors named in the table itself. *Tebennophorus* includes *Vaginulus*, *Limax* includes *Arion*, *Bulimus* includes *Achatina*, *Pupa* includes *Vertigo*, and *Clausilia* includes *Azeca* and *Cylindrella*. *Cyclostoma*, which was not given by Mr. Forbes, is added. Besides exhibiting the numerical relations which our species bear to those of Europe, this table also shows the local distribution of the genera. While *Limax* is most numerous in species towards the north, though not in the extreme north, its numbers diminish towards the south, until, in Sicily, it appears to be replaced by *Parmacella*. *Vitrina*, *Succinea*, and *Bulimus* are pretty equally diffused. *Clausilia* is shown to predominate most towards the north, and *Cyclostoma* with equal certainty to prefer the south. *Pupa*, while it flourishes most in northern latitudes, is at the same time, partial to mountainous districts. The sixteen species which it comprised in Russia and Germany, are reduced to seven in the south of France (Landes), and to only one in Sicily; the limited and mountainous territory of Switzerland affords many more species than the whole extent of Germany, which is further north; and the small province of Como, situated a little south of the Alpine ranges, in northern Italy, contains as many as all the rest of Italy. The genus *Helix* is most plentifully distributed towards the south. In

Italy and Sicily it comprises two-thirds of all the terrestrial species, while in Sweden and Scotland, and in Switzerland, where elevation produces the effect of a high latitude, its species are less than half of the whole number. The only countries on the list, that have been thoroughly investigated, are Great Britain and France. The disproportionate number of species shown to belong to the latter, is due in part to its thorough exploration, but in a greater degree to its extent, which reaches from the Mediterranean to the North Sea, and to the singular variety of its surface, which, although in general by no means mountainous, yet includes parts of the mountain ranges of the Pyrenees, the Jura, and the Alps, and therefore partakes of a greater diversity of climate and elevation than any other country of Europe. The effect of these peculiarities upon its fauna is very apparent, the northern species, except *Clausilia*, all the southern species, and all those affecting mountainous regions, being in excess. The value of tables of this kind is very evident from this example. A complete series of them, including especially those of limited districts which present strongly-marked topographical or climatal peculiarities, would be invaluable in affording the means of deducing the laws of geographical distribution.

When we commenced our introductory remarks, we did not expect to extend this division of our subject beyond a comparison between our species and those of Europe; but, an opportunity having occurred of examining the valuable work of M. De la Sagra, on the

Natural History of Cuba, we cannot forbear making use of some of the interesting information that it affords, and also of facts contained in the memoir of Dr. Pfeiffer on the pneumobranchiate mollusks of the same island. In this connection also, the results of the observations of M. D'Orbigny in South America, in their relation to the distribution of the terrestrial species on this continent, gain an additional importance. We compare therefore the genera of Cuba, and of South America, with those of the United States. It is not to be supposed that these lists are equally complete with that of the United States; indeed it may be taken for granted that they are much less so. Being the work of foreign travellers, who resided but a short time in those countries, many species must have necessarily escaped notice, however careful their researches may have been; and whenever the subject shall be resumed by native naturalists, the gleanings may be expected to equal in number the first harvest. But they probably represent pretty nearly the proportion in which the respective genera prevail, and may, therefore, serve our present purpose.

It is proper to observe, before introducing the following table, that the researches of M. D'Orbigny were mostly confined to that part of South America which lies north of the twenty-fifth degree of south latitude, and that a large majority of his species appear to have been collected in Bolivia, Peru, and Colombia, on the western side of the continent.

GENERA.	NUMEER OF SPECIES.			
	Cuba. By De la Sagra.	Cuba. By Pfeiffer.	South America. By D'Orbigny.	United States.
Tebennophorus	0	0	0	2
Vaginulus	1	0	2	1
Arion	0	0	0	1
Limax	0	0	2	3
Vitrina	0	0	0	1
Succinea	1	0	4	9
Bulimus	12	11	91	11
Helix	22	16	26	79
Glandiua	2	4	0	2
Pupa	9	4	4	8
Vertigo	0	0	0	5
Cylindrella	0	4	0	3
Helicina	0	8	4	3
Cyclostoma	0	4	2	1
Total	47	51	135	129

We notice, in the first place, the South American list. Here *Vitrina*, *Vertigo*, and *Glandina*, all the genera of the *Limacidæ* except *Vaginulus*, which replaces *Tebennophorus*, being, like that species, entirely covered with a mantle, are wanting. *Succinea* holds a smaller numerical proportion than in North America. *Bulimus* predominates in the astonishing proportion of ninety-one in a total of one hundred and thirty-five; holding about the same rank there, that *Helix* maintains in the southern part of Europe. *Helix* is reduced to a sixth part of the whole number. *Pupa* remains very subordinate, and *Helicina* and *Cyclostoma* are merely represented. In the Cuban list of M. De la Sagra, *Tebennophorus*, *Vitrina*, and *Vertigo* are wanting; and a single *Vaginulus* represents the whole family of *Limacidæ*.

Helix makes up less than one half, and *Bulimus* about one third of the whole number. *Helicina*,[1] a genus not numerically strong, is very predominant; and *Cyclostoma* is considerably numerous. *Clausilia* appears in the list of M. Pfeiffer, but it comprises only species which are not true *Clausiliæ*, and for which, more recently, he has constructed the genus *Cylindrella*.

The facts exhibited in the tables which we have given, and derived from the other sources mentioned, suggest certain general inferences concerning the geographical distribution of the genera which are worthy of notice, and deserving of being tested by observation in other parts of the world. They indicate, that native species of the European genera of the *Limacidæ*, namely, *Limax*, *Arion*, and *Testacella*, are wanting in the tropical

[1] We have not seen that part of the work of M. De la Sagra, which treats of *Helicina*, but the monograph of this genus by Mr. Sowerby, (*Thesaurus Conchyliorum*,) gives descriptions of seventy-two species, of which seventeen are set down as belonging to Cuba, fourteen to the Antilles and other West Indian islands, and thirteen more to the adjacent parts of the continent of America. Bolivia, on the western coast of South America, is said to furnish three species, and the Philippine islands six. A single species is ascribed to Opara, in Polynesia: and to this we may add nine others, collected by the United States Exploring Expedition. The localities of the remaining species are unknown. We make a similar remark concerning *Cyclostoma*, the species of which Mr. Sowerby has also collected into a monograph. Of one hundred and thirty-three species, whose habitat is known, thirty-two belong to the West Indian islands, forty-two to the East Indian Archipelago, thirteen to the African islands, five to Polynesia. (to which we add nine from the Exploring Expedition,) four to the islands of the Mediterranean, seven to Europe, nine to Asia, eight to Africa, and thirteen to America. Some of the species ascribed to the continents, probably only occur upon the islands adjacent

and temperate portions of the American continent and islands, their place being supplied by the genera *Tebennophorus* and *Vaginulus*, the first in North and the second in South America, the Antilles and that part of Florida adjacent to Cuba. The only exception to this remark is, a single and somewhat doubtful species of *Limax*, common in the United States.[1] At the same time, the climate is favorable to several species of foreign origin, which are rapidly spreading through the country. *Vitrina* only appears in America north of 44° north latitude. *Helix*, a genus common to all the continents and large islands, is most abundant in temperate latitudes of the northern hemisphere, towards their southern limits, and gradually diminishes in the number of its species, both in approaching the equator, and in going into higher latitudes. *Bulimus* affects mostly the inter-tropical latitudes, where it takes the place of *Helix*, while in the temperate latitudes of North America and of the eastern continent it is reduced to a very small number of species. In South America, however, which seems to be the great numerical centre of the genus, the species abound as far as 25° south latitude. The European form of *Pupa*, differing however in specific characters, is common to North America, and extends in a few species

[1] The territory belonging to the United States, on the Pacific Ocean, south of 49° north latitude, is also known to produce one or more species of *Limax*, drawings of which were made by the artists of the United States Exploring Expedition. We do not know whether the species have been determined or not.

to the West Indian islands, in which other peculiar forms of the genus prevail. *Glandina* is an American genus, and confined to the limits which have been already mentioned. *Helicina* is also an American genus, though not exclusively so, the central focus of which is the Antilles, whence it is diffused through the other West Indian Islands to the adjacent parts of the continent on the sea-coast, as far as 25° north latitude. In the Philippine Islands this genus re-appears under geographical conditions similar to those which distinguish the American localities; that is to say, the position of this group of islands and its relations to the neighboring continents of Asia and Australia, bear an extraordinary resemblance to those of the Antilles in respect of the continent of America. On all the principal groups of islands throughout the Pacific, this genus is found, though very essentially modified in form from the American types. In conclusion, the genus *Cyclostoma* seems to range around the whole circumference of the globe within 20° both north and south of the equator, avoiding for the most part continental stations, and finding the conditions most favorable for its existence in the innumerable islands with which this belt of the globe is studded. It is diffused more numerously in the eastern than in the western hemisphere, in about the same proportion as the islands themselves are more numerous there. A single species being often confined to a small group of islands, or even to a single island, and the species in general being very much separated, and, as it were, scattered geographically, there does not appear to be any centre where the genus is more predominant than elsewhere. In this respect it differs apparently from the other genera, which may be said to have each, one or more climatal or topographical centres. In the dispersion of this genus among the islands of the sea, a remarkable contrast is presented to the distribution of the superior classes, and particularly of the mammalia, the latter being, in general, entirely wanting in small islands remote from the continents, while in those adjacent to them, they consist of the species belonging to the main land.

IX.

GEOLOGICAL RELATIONS.

UNDER this head we propose to make only a few remarks on the geological conditions in which such of the existing species as are found also in a fossil state occur, and to draw, from the few facts collected, such inferences as to their former condition on the earth's surface in the regions where they occur, as these facts may seem to warrant. The conclusions which depend upon the situation in which fossil terrestrial shells are found, are however, much less worthy of confidence than those derived from the marine fossils. The latter may reasonably be supposed to have lived and died in the localities which they now occupy, while the former have only been preserved by being removed from their original positions, and subjected to conditions entirely different from those under which they existed during life. The substance of all land-shells possesses so little solidity, and their texture is so frail, that when they are deprived of the protection that the animal itself affords them, the operation of the elements soon decomposes and destroys them; hence, in a short time after the death of the animals, scarcely a vestige of their shells is to be found. The formations which contain them, and in which alone they have been found thus far, are those which have been deposited in the estuaries and bays at the mouths of ancient rivers, or in the beds of lakes. The streams and rivers which discharged their waters into those reservoirs were filled with the washings of the countries through which they flowed. The shells and other substances borne along by their currents, on reaching the sea or lake in which they terminated, were deposited in still water, and being immediately covered by succeeding deposits, remained protected from disturbing causes until the beds and strata which contained them underwent the fossilizing process. But it may have happened that a river, rising in a high latitude, and flowing towards the equator, like the present Mississippi, may only have reached its outlet within or near the tropics. It may have received tributaries through its whole course, some of which, uniting with it near its mouth, may have passed through regions enjoying a tropical climate. The waters of such a river would of course be freighted with the animal and vegetable productions of regions very remote from each other, and of very different climes, and they would be deposited promiscuously together. Genera and species peculiar to mountainous countries would be found side by side with those belonging to lowlands and marshes; while those which in life were habituated to a high temperature would be intermingled with others which had lived under the influence of an almost constant winter. And farther, besides the terrestrial shells of such different characters we might also find the *Limniadæ* of shallow waters, the *Naiades* of deeper streams, and the various species of *Cyrena*, *Gnathodon*, and *Neritina* of the mouths of rivers, all mingled together with the truly marine genera. It is manifest that in the confusion of species which such a deposit would present, but few legitimate inferences could be drawn as to the former climate and condition of that part of the earth's surface where they occur, or as to the changes of habit and locality of the species themselves, or in fact as to any point except their contemporaneous existence, and their affinities to the species which are now extant.

It has been held that as the presence of certain species coincides in general with temperature, the occurrence of certain fossil forms in a particular geological formation indicates that the climate of the locality was, at the period of deposition, similar to that in which the same or analogous living species are now known to exist. The preceding remarks show how erroneous this opinion is likely to be when founded upon the occurrence of the terrestrial and fresh-water species; for the place of their origin and its climate must be in a great degree uncertain, and while it may coincide with their present condition it may on the other hand differ very materially from it. It has also been suggested that as vegetable remains have been detected in very ancient formations, it might have been expected that the animals which feed upon vegetables, and especially the herbivorous land-mollusks would have existed contemporaneously with them, and that their remains should now be found in the same strata; but that as they do not appear in any of the formations older than the tertiary, and but very sparingly in that, they could not have existed antecedent to, and were far from numerous during the tertiary period. Hence, as a further inference from these inferences, it has been stated, that the present time is the period of their greatest numerical development, and that their actual numbers far exceed those of any former era. These conclusions also ought to be received with great caution, for the premises on which they are founded are very uncertain. We have seen that the remains of these animals, by reason of their frail and perishable nature, soon decay, and we must take it for granted that only a small part of their whole number is washed into rivers and carried away by their currents. The deposites which finally receive them can therefore represent but very feebly their former numerical condition, and a very general diffusion of species upon the earth's surface is quite consistent with the existence and deposition of only a small number of their remains. The condition of the species at particular epochs cannot therefore be correctly inferred from such facts, and the suggestions we have alluded to deserve only the credit which is due to plausible conjectures.[1]

There is, however, a class of minor formations of the tertiary period, in which the testaceous remains point to more certain results. These we have mentioned as deposited in the beds of lakes. When the body of water from which the deposit in these instances took place was small, it could of course only contain the productions of the lake itself, and of the region immediately around it. Hence species occurring together in such formations must have not only existed contemporaneously, but must have occupied the same geographical region, and have been subjected to the same physical influences. The inferences which may be drawn from them are therefore more to be relied upon.

Shells of many of the terrestrial species, apparently in a fossilized condition, are often met with in collections, and are said to be brought from the western and south-western parts of the country. They indicate the existence of the most recent tertiary or post tertiary formations, but nothing certain is known of them. Dr. David D. Owen, of New Harmony, Indiana, has discovered an extensive deposit of this kind in Pusey county, on the

[1] This view of the subject is strongly corroborated by facts brought to light by the valuable researches of Professor Hitchcock. He has given to us unequivocal proofs of the existence of birds, in the most ancient mesozoic period through the evidence of their foot-tracks in the sandstone of the Connecticut River valley. The number of species he has now made us acquainted with is not less than seventy, and yet not a single bone of any one of these has yet been discovered

Wabash River, in that State. It is a fine sandy marl of a yellowish-white color. It occurs on the upland, from twenty-five to fifty feet above the bottom land, and is reached at the distance of from six to ten feet from the surface, and has been penetrated to the depth of twenty-five feet without passing through it. It appears also on the opposite side of the Wabash in Illinois at about the same level, and near Shawneetown, forty miles distant, in descending into the bottom land, in a similar position. Dr. Owen has learned that a similar deposit in an analogous position exists opposite to St. Louis, above the American bottom on the Mississippi river, and there are said to be indications of a like formation at Big-Bone Licks, on the south side of the Ohio River, about twenty miles below Cincinnati. The Wabash deposit contains, in vast numbers, terrestrial and fluviatile shells of the same species as those now existing in the surrounding country; they occur also, as we are informed, in strata of marl below the deposit in which the bones of the *Mastodon* are found.[1] Whether all these are parts of one continuous deposit, or whether they point out the location of several small basins in which a contemporaneous deposition took place, is not yet ascertained. The fossils which they contain prove, accord-

[1] The number of land and fresh-water shells occurring in the Wabash deposit is very great. In a small parcel of the marl which we have examined, the following species were noticed. *Helix hirsuta, monodon, labyrinthica, lineata, thyroidus, clausa, inflecta. Pupa armifera, contracta. Helicina occulta;* together with several species of *Limnea, Planorbis. Amnicola, Valvata.*

ing to the opinions at present received among geologists, that the epoch of their deposition corresponded with the time when the surface of the earth in that region was diversified with lakes of considerable extent, and that it was antecedent to the period when, by the lifting of their beds, the surface attained its present position, or when by some relative change in the level of the land, the lakes were drained of their waters. We have said that these deposits contain the species of terrestrial and fluviatile shells inhabiting the surrounding country. Of the species indigenous to that section, nearly two thirds have already been found in a fossil state (although but little attention has been given to them) and their identity is beyond all doubt. There is, however, a single apparent exception to the general remark, in a species of *Helicina*, which Mr. Say, supposing it to be a recent species, described under the specific name *occulta*, and which is one of the most common species among the fossils. As the genus *Helicina* belongs mostly to intertropical regions, and has rarely been met with in a recent state in so high a latitude as that occupied by these fossils, a good deal of importance has been attached to its occurrence here as indicating such a change of climate as has been alluded to. But this supposition creates more difficulties than it obviates, for the numerous species of other genera found in company with the species in question, and which live at this time in the same district in which the fossils are situated, must, according to this view, have also been adapted to a warmer climate than the present, though they do not now exist in southern latitudes, and therefore a very considerable change in their habits must have since taken place. Notwithstanding the facility with which the terrestrial mollusks accommodate themselves to the physical influences which act upon them, such a change is not consistent with what we know of their history, and hence the most reasonable conclusion is, that the climate in which they have lived, from the days when the multitudes which now compose the mass of the fossil beds were in the enjoyment of life upon the surface of the earth, to the present time, has remained essentially the same.

The question of the identity of this fossil, with any living species of *Helicina* is also interesting, as upon its solution, perhaps, may depend the opinion we may form as to the comparative remoteness of the period when all the fossil species of the formation flourished. If it should be considered to be specifically distinct from any other known living form, or in other words to be an extinct species, we should refer its existence to a more ancient date in the tertiary period than would otherwise be assigned to it. If on the other hand it should prove to be identical with an existing species, it would date back only to the most recent epoch. This point we have established to our own satisfaction by carefully comparing specimens of the fossils of the Wabash deposit with the few specimens we have seen of the only species of *Helicina* which inhabits the country north of the tertiary section of the coast of the Gulf of Mexico, and which was described by the late Jacob Green, M. D., as *Helicina rubella.* We cannot doubt the identity of the two, as they are as nearly alike as the soft and crumbling fossil can be to the shell whose surface yet retains its original character. The recent shell is extremely rare, and is found in only a few collections, and in this respect offers a strong contrast to the fossil, which must have been very numerous. One of the most evident facts taught to us by geology is the constant succession of zoölogical species. They come into existence one after another, increase and flourish for a longer or a shorter time, and then gradually die out and disappear. That there are laws which regulate and limit their continuance we cannot doubt, although they are not understood by us ; neither can we doubt that they are yet in operation, and that in accordance with them species do now sometimes become extinct. The abundance of the species under consideration, at the time of its deposition in the fossil beds, and its rarity now, suggest the thought, that having then reached its greatest numerical development, it has since slowly declined, and is now in a condition of zoölogical senility antecedent to its entire extinction.

The light which is afforded by geology, in elucidating the former zoölogical condition of the earth, is a beautiful illustration of the manner in which one science often ministers to another. Without the aid which has been derived from our knowledge of the animated creation, geology, indeed, would hardly have attained the certainty of a science, but it is from time to time amply repaying the benefit, by making known the condition of the animal kingdom at remote periods of time. We are thus enabled to obtain glimpses of the state of the earth when races of animals very different from those now living inhabited it, and to note their successive appearances and decline, until at length we reach the time when animals which are still extant began to prevail. The results afforded by such observations are among the most wonderful presented to us by science. They tend to enlarge our ideas of the power of the Creator, while they multiply infinitely our conceptions of the unlimited variety of created things, and of the immeasurable duration of their existence.

Guided by the light reflected from geological science, we may feel rationally authorized to draw from the preceding facts and considerations the following inferences. That our existing species of land mollusks were living at a period which, though recent in a geological sense, was anterior to the last geological revolution, when the surface of this portion of the earth was brought to its present condition, and to the existence of the higher orders of animals which now inhabit it, and even to that of the extinct mammalians which are known only by their gigantic remains. That, during the period of the deposition of the newest tertiary beds they were at least as numerous as at present, and that consequently, the existing epoch cannot be considered as that of their greatest development. That, in the interval of time between the two periods, the immense extent of which we have no means of estimating, very few, and perhaps none of the then existing species (as indicated by the fossil deposits) have become extinct; and that consequently, the term of their specific existence is of great length. That, although the numbers contained in the Wabash deposit indicate that, at the time of their deposition, the species had been a long time in existence, none of their remains have yet been discovered in earlier formations.

X.

HABITS AND FACULTIES.

THE animals of this order, indigenous to the United States, are essentially inhabitants of the forest. It is there, under the deep shadows of a dense foliage, where the sun's rays hardly penetrate to the surface of the earth, and where the ground is covered with the mouldering trunks of trees and thick layers of decaying leaves, that they find a constant moisture, a twilight interrupted only by darkness, abundance of vegetable and animal food, and the means of shelter and protection. These constitute a combination of circumstances very favorable to their increase, and hence they may be discovered, in situations where these conditions exist, in every part of the country where they can be found at all. But when, with these, are conjoined a mild climate, and a calcareous soil, the maximum of favoring influences is reached, and large numbers are produced. It is in the great valley of the Mississippi, based throughout nearly its whole extent upon horizontal limestone formations, that these combined causes operate over an extensive region, and there, consequently, the species proper to it exist in multitudes. In the parts of the country which have been long cultivated, and are nearly deprived of their forests, they have mostly disappeared, and only survive in places where some shelter of wood or stones is still afforded to them. They everywhere avoid cultivated fields and open pastures, and are never found in gardens,[1] or about or within houses or other buildings. In this respect, they present a remarkable contrast to the same animals in Europe, which not only are very common in open and cultivated tracts, but are particularly numerous in fields and gardens, where some of the species commit much mischief, and in cellars, drains and other similar situations, in immediate contiguity with man. The species which have been introduced from Europe, and naturalized in this country, are distinguished by the same habits as the stock from which they are derived, and differ as much from the native species. Thus, *Helix hortensis*, and *H. pulchella* live in open and exposed situations destitute of shelter, except that afforded by grass and shrubs. *Helix cellaria* occupies gardens and cellars. *Limax variegatus* inhabits cellars and damp places about drains, and *L. agrestis* is common everywhere in gardens, fields, cellars, and houses. It infests the road side, and the neighborhood of our

[1] There is a single exception to this remark in *Helix fallax*, Say, which we observed a few years since living in great numbers in gardens, in Charleston, S. C. in company with *Bulimus decollatus*.

dwellings, and has in some places become the pest of the horticulturist.

Whether this difference of habitat arises from original constitution, or is the consequence of the long continued operation of external causes, is a curious subject of inquiry. The preference for the forest over the open country exhibited by the native species, even in situations where both have been for a long time equally accessible to them, seems to indicate that the former supposition is correct; and this opinion is strengthened by the disappearance of nearly every species with the progress of agriculture. If their habits were not insuperable, they might be expected to have been somewhat modified ere now, and to have become adapted to the new physical conditions to which they are subjected. That they have not been, suggests the thought, that like the aboriginal race of men, and some of the larger quadrupeds, they are destined to give way before the advance of civilization, and to have their places filled by foreign species. On the other hand, there are some facts which tend to show that accidental causes may have produced a slow and gradual revolution in the habits of the European species, corresponding with the changes which, within the historical period, have taken place over the surface of the greater part of Europe; and that in process of time, the same influences will produce similar results on the habits of the North American species. All those parts of Europe which are now the most populous were covered with forests, at no very distant period, and all the terrestrial mollusks were then, like ours at the present time, living in the forest. The progress of agriculture there was very slow compared with its advances in this country, and thus time was given to the animals to accustom themselves to the change; and they have thus, by slow degrees, adopted their present habits. In the United States, the advance of agriculture in newly settled parts is very rapid; large tracts of forest are almost simultaneously subjected to the axe and to fire, and a very few years produces an entire change in the vegetation of a whole section. Consequently these animals are at once exterminated, or the few that survive are brought suddenly under the influences of new circumstances, which, from the abruptness of the change, are fatal to them, but which, if imposed upon them more gradually, might have been sustained. A few spots and some limited tracts of land, remaining unchanged, in the midst of cultivation, protect some individuals of every species; and it is from this comparatively small number, thus preserved, that their subsequent increase is derived. But, at this period, the field is equally open for the multiplication of those foreign species which accompany man as for the native species, and it is not surprising that the former, whose habits are already adapted to the existing state of things, should increase more rapidly than the latter. The native species however, become gradually familiarized with the circumstances around them, and some few of them advance, and after a time establish themselves in the open country, where they seek such shelter as they can find. This transition is very slow, but there are sufficient indications, in the exceptions which are found to the general habits of the species in this particular, to show that it is going on: and therefore, it is reasonable to believe, that when a period shall have elapsed as long as that since the south and west of Europe were covered with forests, our species will have become able to sustain themselves in the open country, and will have spread themselves in great numbers over those populous parts where they are now wanting. The power of adaptation to new circumstances, which is a prominent quality of nearly all the shell-bearing species of this order, and which, combined with a remarkable tenacity of life, enables them to resist successfully the many dangers to which they are exposed, is illustrated in the extremes of their mode of life on the two continents. We know of no other instances of animals living in a natural condition, not domesticated nor accompanying man, where the same diversity of habitat in analogous species exists. The presumption of changes which shall approximate the habits of both, in proportion as the physical circumstances of both approach each other, is therefore not a violent one. But it is by no means certain that all the species will survive the violent change to which they are at first exposed. Those of them which are in a state of decline and nearly run out, and those which are strictly local in their habitats will be least able to sustain themselves, and their entire extinction will be very likely to follow.

All the species are nocturnal or semi-nocturnal in their habits. In the day-time they seek such shelter as may be at hand, and retreat into dark holes and crevices, or hide themselves under the fallen trunks of trees, fragments of wood, leaves and stones, or bury themselves wholly or partially in the earth. There they remain inactive until evening twilight, when, except in seasons of drought, they sally forth in numbers; and in favorable situations, such as ravines and low places in the forest, may be seen crawling over the surface of the ground, and sometimes climbing the stalks of plants, and the trunks of trees. They are probably active during the whole night, during which they all seek their food, and those species which are noxious to man commit their depredations in the garden and orchard. At this time too, their sexual meetings take place. Soon after daylight, they retire to their retreats, and remain very close until night approaches again. They also come forth when the atmosphere is charged with moisture, and after light showers.

There is a difference in the places of their retreat. The *Limacidæ* are oftenest found attached to the lower surface of wood and stones lying in contact with the ground, or to the damp walls of cellars, and, in the forest, concealed under logs. So soon as, from the increased dryness of the atmosphere, these places no longer retain moisture, they abandon them for others, and in seasons of drought they penetrate deeply into the earth. The *Helicidæ*, in the forest, are observed under prostrate timber, to the lower surface and crevices of which they adhere by a mucous attachment during the day, in hollows under the roots of trees, and under the layer of decaying leaves which cover the ground. In situations where such places of shelter are not found, they half bury themselves in the soil, at the roots and under the shade of thick tufts of plants. Numbers frequently resort to the same retreat, but this in the *Helicidæ* seems a mere matter of accident, while in the introduced species of *Limacidæ* it appears to indicate a gregarious habit, as they prefer to crowd together and lie in close contact with and upon each other.[1] These last are said by some to occupy permanently the same retreat, but the assertion is probably incorrect. They often, and perhaps generally, remain in the immediate vicinity of the place where they procure their food, and hence they often resort to the same place of shelter; and as many of them have frequently been observed in the same place, they have been thought to be the same individuals. But when one set of individuals is destroyed another soon takes their place, and whenever a new shelter is provided, by accidentally placing fragments of wood in suitable situations, it is immediately resorted to by them. The native genus *Tebennophorus* is in no manner gregarious; it lives in the forest, mostly buried in decaying and rotten wood, and no more than two are usually found

[1] The promiscuous mingling of individuals of *Limax agrestis* and *Limax variegatus* in their respective retreats has often reminded us of the familiar positions in which swine place themselves for sleep.

together. In cloudy weather, when the atmosphere is charged with moisture, and during light showers, all the species come forth in the day time; but on a change of weather, immediately return again, and during rains remain in their retreats. Long continued or excessive rains, however, inundate their hiding places, drive them out, and force them to resort to trees.

We have seen, in a preceding part of this work, how numerous are the agencies which are continually tending to destroy the lives of individuals, and to exterminate whole species. Being all of them slow in their motions, without means of escape from enemies, destitute of instruments of offence or of defence, and some of them unprovided with a covering, it would seem as if their existence must be very precarious, and that they must be easy victims to the unfavorable circumstances around them. Such would be the case undoubtedly, and these causes would interfere with the diffusion of species and derange their distribution in a greater degree than they actually do, if there were not counteracting properties in the animals themselves which modify and limit the destructive tendency. These conservative properties are, their prolific generative capacity, their insensibility to pain, their extreme tenacity of life, and their extraordinary power of reproducing important organs which have been cut off or destroyed by accident.

The number of eggs produced varies in the genera and species in the same proportion as the dangers to which they are exposed are greater or less. Thus, in the *Limacidæ*, whose means of protection, and whose chances of preservation are much less than those of the *Helicidæ*, the number is much greater than in the latter. The number of eggs produced by two individuals of *Limax agrestis* kept in confinement by M. Leach, was in the course of rather more than a year seven hundred and eighty-six. It usually amounts to at least three hundred per annum. The other species, though not equally prolific, multiply greatly; and each pair of the various species of *Helicidæ* produce, annually, from thirty to one hundred eggs, and perhaps more. The young of the *Limacidæ* complete their growth and reproduce their kind sometimes within the year of their birth, and always as soon as the second year; and the species of the other families are believed not to require a much longer time to attain maturity. This rapid increase replaces the numbers annually destroyed, and maintains the species in their relative importance.

Their extreme tenacity of life is manifested in every stage of growth, from the egg to the mature animal. The eggs of *Limax* have been so entirely desiccated that their form has disappeared, and there remained only a thin skin, friable between the fingers. In this condition they have been kept for years; and yet a single hour's exposure to humidity was sufficient to restore their form and elasticity.[1] They have been dried in a furnace eight successive times, until they were reduced to an almost invisible minuteness, yet in every interval have regained

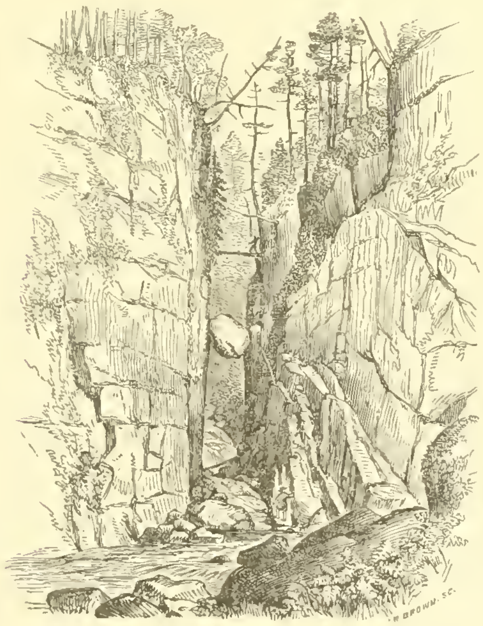
[1] Bouchard-Chantereaux, loc. cit. p. 15.

their original bulk in a moist situation.[1] In all these instances the young have been developed in the same manner as in other eggs not subjected to the experiment. In the northern part of the United States we have frequently observed the eggs of the *Helicidæ* in the forest covered with snow, protected only by a single leaf, where they had remained through the winter months, constantly exposed to a temperature much below the freezing point. The *Helicidæ* themselves withstand the cold of the severest winters in the same situations; and *Succinea* has been frozen in a solid block of ice, and yet escaped unharmed. Helices, when frozen in a state of confinement, though they sometimes recover so far as to move about with some activity, usually survive but a short time.

The power of reproduction of parts of the body is more astonishing still. It is well established by experiments on thousands of Helices, that the tentacles, when cut off, grow out again, — that considerable parts of the locomotive disc may be amputated, and the new parts immediately bud out, and supply their place. The great length of time they can subsist without food is another exemplification of their great tenacity of life. Those species, especially, which live in dry and exposed situations have this power of endurance to a remarkable degree. A friend received specimens of *H. desertorum* which had been collected in Egypt, had been shipped to Smyrna, thence to Constantinople, thence to Rio Janeiro, and

[1] Leuchs, loc. cit.

finally to Boston, — occupying a period of about seven months, — which appeared in full vigor when taken from the papers in which they had been enveloped. They were laid away in a drawer; and on being examined three years afterwards, some of them still came out in tolerable vigor.



XI.

SPECIAL ANATOMY OF THE TERRESTRIAL GASTEROPODA OF THE UNITED STATES. By JOSEPH LEIDY, M. D. OF PHILADELPHIA.

INTRODUCTION.

When the researches were commenced in the winter of 1844, of which the following chapters are the result, it was the proposition of Dr. Binney for the author to give a complete anatomical and physiological description of the terrestrial Gasteropoda of the United States, including the special and general anatomy, with the embryology of the several genera. Before the special anatomy was fairly completed, the death of Dr. Binney put a stop to the work; and, a different course of observation having occupied the author's attention, the subject is now published, after a long delay, in its present incomplete state, from notes taken at the time.

The animals dissected are as follow: —

Limax; *L. variegata*, *L. agrestis*, *L. campestris*.

Arion; *A. hortensis*.

Tebennophorus; *T. carolinensis*.

Vaginulus; *V. floridanus*.

Helix ; *H. albolabris*, *H. thyroidus*, *H. sayi*, *H. tridentata*, *H. fallax*, *H. palliata*, *H. ligera*, *H. intertexta*, *H. suppressa*, *H. auriculata*, *H. elevata*, *H. profunda*, *H. concava*, *H. fuliginosa*, *H. perspectiva*, *H. alternata*, *H. cellaria*, *H. exoleta*, *H. multilineata*, *H. hirsuta*, *H. solitaria*, *H. dentifera*, *H. arborea*, *H. pulchella*, *H. berlanderiana*, *H. gularis*, *H. inflecta*, *H. texasiana*.

Bulimus ; *B. fasciatus*, *B. decollatus*, *B. virgulatus*, *B. dealbatus*, *B. caribbæorum*.

Pupa ; *P. incana*.

Succinea ; *S. obliqua*.

Glandina ; *G. truncata*.

Chapter I. — General remarks upon the exterior form and structure of the terrestrial naked Gasteropoda.

Upon examining a Limax or an Arion, we find it composed of a thick, vermiform body, with a broad, ribbon-like, pedal disc, running the whole length of its inferior surface. The anterior, obtuse extremity forms the head ; and from it protrude four retractile tentaculæ, upon the outer side of the tip of the two superior, or longer of which, is placed the eye. The mouth is situated at the antero-inferior part of the head ; and immediately below it is a deep depression, or blind sac. The posterior part of the body forms the tail, and is acute. Upon the antero-superior part of the body is placed the mantle, which covers the pulmonary chamber, and contains within it a rudimentary, laminar, calcareous testa. The anterior part of the mantle is free and movable, and the head, indirectly through the retractor muscle of the buccal body, is capable of being retracted beneath it. On the right edge of the mantle the pulmonary orifice exists; and at the posterior side of the latter the anal aperture is placed. Upon the right side of the head, a short distance posterior to the superior tentacula of that side, the genital orifice is situated. The body has two distinct cavities; the pulmonary chamber, containing a vascular net-work upon its surface, the heart, the renal organ, and the rectum; and the visceral cavity, separated from the former by a muscular partition, containing the digestive and generative apparatus and the nervous centres.

In *Tebennophorus* the mantle covers the whole upper surface of the body, and encloses no testaceous rudiment. Its anterior edge is unattached, and the head is retractile beneath it. The pulmonary chamber is placed beneath the anterior part of it; and the muscular membrane bounding the visceral cavity in a great part of its extent, is but loosely attached to the outer integument.

In *Vaginula*, the body appears broad from the mantle, which encloses the whole body except the comparatively narrow pedal disc, forming a lateral, angular projection as it is inflected inferiorly to the margin of the pedal disc. In transverse section it is semi-elliptical, as represented in figure 4. The mantle contains no testaceous rudiment. The head can be but slightly protruded. The respiratory orifice is situated on the right side of the tail, between it and the extremity of the pedal disc. The anal aperture opens at the posterior margin of the latter orifice. The generative apparatus has two distinct external apertures, distant from each other. The male genital orifice is placed just beneath the mouth, between it and the blind sac, inclining to the right. The female orifice is situated upon the inferior part of the left side of the mantle, midway between the head and tail.

As usual, the body has two cavities, of which the pulmonary occupies a position at the right posterior part, beneath the mantle, and extending backwards on the right to the tail.

Chapter II. — General remarks on the terrestrial testaceous gasteropoda.

A testaceous gasteropod resembles a slug with the greater portion of the viscera squeezed out upon the back, and arranged in a turbinate manner. The turbinate mass is always an exact mould of the testaceous covering of the animal; its length in the spiral direction holds no proportion with that of the foot, or that part of the body which the animal protrudes from the shell, and differs very much, not only in different genera, but also in different species of the same genus. With an increase in length a proportionate decrease in breadth is observable, and vice versa. In *Pupa* it reaches its maximum length and narrowness; in *Succinea* it has the minimum length, and the greatest proportionate breadth.

When the foot is protruded from the shell, every part of the exterior surface of the turbinated mass is still in contact with the interior surface of the latter, and is retained so by means of the comparatively capacious pulmonary chamber. When the foot is retracted, it is at the expense of the latter cavity; so that the pulmonary chamber of the testaceous genera is as much larger than that of the naked genera as the size of the foot superadded, whilst the extent of the pulmonary net-work of blood-vessels remains the same.

The testacea have a muscle which is peculiar, namely, the retractor-muscle of the foot, which has its origin, in common with the retractors of the tentaculæ and buccal body, from the columella of the shell. Narrow at its commencement, it increases in breadth, splits into several bands, and diverges as it descends to get its insertion into the whole of the inner margin of the excavation of the foot, excepting anteriorly, where its place is occupied by the retractor of the buccal body.

The head occupies the anterior portion of the foot, and in *Helix*, *Bulimus*, *Pupa*, and *Succinea* offers nothing peculiar from that of *Limax*. In *Glandina* a third pair of tentacular appendages exists. These are non-retractile, auriculate in form, and originate just postero-inferiorly to the base of the inferior, retractile tentaculæ, and project horizontally backward.

The body of the testacea, like that of slugs, has two great cavities. The visceral cavity includes the greater part of the turbinated mass, and the excavation of the foot. The pulmonary chamber occupies a position on the outer side of the lower one to three whorls of the turbinated mass. The collar apparently takes the place of the mantle in slugs. In all the genera it is attached around the base of the turbinated mass, and is perforated on the right side by the pulmonary orifice. On the outer border of the latter the anal aperture is placed.

As in slugs, the genital orifice is situated on the right side of the head, just posterior to the tentaculæ.

Chapter III. — On the tegumentary covering of the terrestrial Gasteropoda.

Besides a testa capable of enclosing the whole body, which most of the terrestrial Gasteropoda possess, they have a thick envelop, composed of mucous and muscular membrane. The exterior, highly irritable and contractile investment consists of an actively secreting mucous membrane, (Figs. A, B, C, 1) with a substratum of interlaced muscular fibres (2). In the naked genera it is pretty

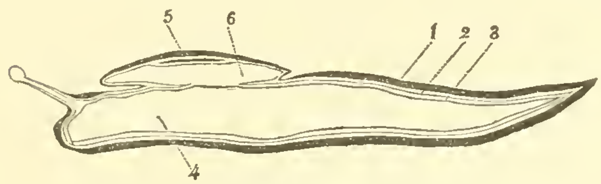


Figure A.

Fig. A is a diagram representing the disposition of the coverings of the body in *Limax* and *Arion*. 1. mucous lamina; 2. muscular substratum; 3. muscular peritoneum; 4. visceral cavity; 5. rudimentary testa; 6. pulmonary chamber.

uniformly developed throughout, but is thickest upon the pedal disc, the tail, and the upper surface of the mantle, and thinnest upon the head, tentaculæ, and reflected border of the mantle.

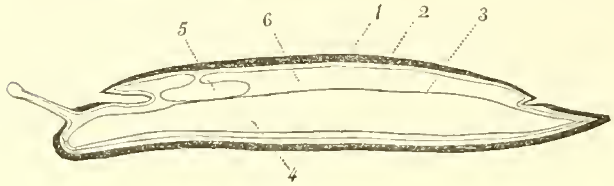


FIGURE B.

In the testaceous genera, upon the part of the body corresponding to the interior of the shell, it appears as if the mucous layer had been pushed downwards to form the collar (fig. C, 1*) ; but it may be still traced over the surface of the turbinated portion, as a delicate, tessellated epithelium.

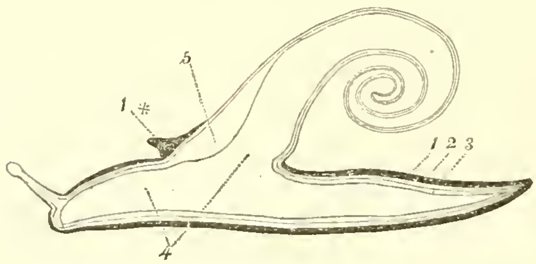


FIGURE C.

The mucous glands are very numerous in the mucous

FIG. B, disposition of the tegumenta in *Tebennophorus*. 1. mucous lamina; 2. muscular lamina; 3 peritoneum; 4. visceral cavity; 5. pulmonary chamber; 6. interval between the two muscular layers.

FIG. C, disposition of the tegumenta in *Helix*, *Bulimus*, &c. The references are the same as in figs. A and B, except 1*, which is the collar.

layer; its epithelial cells are flattened, from three to six sided, granular, and with large, round nuclei.

The muscular substratum (figs. A, B, C, 2) of the mucous lamina is composed of unstriped fibres, arranged transversely, obliquely, and longitudinally. It is inflected outwards beneath the mantle, in *Limax* and *Arion*, to form the outer parietes of the pulmonary chamber. Between this portion and the mucous layer is placed the rudimentary testa (fig. A, 6). In *Tebennophorus*, it is inflected inwards (fig. B, 5) beneath the anterior portion of the mantle, to form the parietes of the pulmonary cavity. Its transverse fibres predominate within the tentaculæ, its longitudinal fibres, in the exterior pulmonary parietes of the testaceous genera, and especially accumulate on the outside of and parallel to the rectum, so as to serve as an efficient agent in the retraction of the collar, and an aid in the expulsion of matters from the rectum.

Interior to the musculo-mucous investment of the body is a second covering, (figs. A, B, C, 3) which may be considered as a sort of peritoneum. It is a muscular membrane, and encloses the digestive and generative apparatus. It is usually pretty closely attached to the outer tegument, except in *Tebennophorus carolinensis*, in which the two are separated in all parts of the body, except above the pedal disc, where they are firmly blended together, as in all Gasteropoda. It forms the partition or diaphragm between the visceral and pulmonary cavities. This membrane is composed of transverse and longitudinal, unstriped, nuclear fibres, and is the origin of the especial retractor muscles of different organs.

Chapter IV. — of the digestive apparatus.

Limax. The orifice of the mouth is bounded by a pair of contractile lips, is situated at the anterior part of the head, and opens into the cavity of the buccal body. When the latter is retracted by its peculiar muscle, the oral orifice becomes lengthened into a canal by the inversion of a portion of the external integument.

The buccal body is an irregularly oval-shaped, muscular organ, resembling in appearance a gizzard, and contains within it the masticatory apparatus. Just within the upper lip, attached to the entrance of the buccal body, is the dental plate, a crescentic, corneous lamina, used for cutting the food. Its anterior face is convex, and presents several vertical ridges. Into its upper convex edge, a band of muscular fibres is inserted, by the contraction of which the inferior, concave, cutting edge is advanced beyond the line of the upper. The middle of the cutting edge is extended into a short, conical toothlet. This plate is brought into view when the animal is eating, by the advancement of the buccal body. The floor of the cavity is occupied with a gouge-shaped, muscular tongue, the tip and upper surface of which are free, and are covered by a corneous lamina studded with a great number of conical dentures, with the points projecting backwards, arranged in transverse rows. These teeth preserve the same form in the lines from before backwards; the central line always differs from the others, and the teeth also vary gradually in form and size as they pass off from the central line laterally. They also vary slightly in form in different species. This lamina protrudes from the buccal body posteriorly, into a short, rounded, protuberant, blind sac, within which it appears to undergo a constant growth, as it is worn away by attrition anteriorly; for its use appears not only to facilitate the passage of the food onwards to the œsophagus, but also to act as a sort of rasp for triturating it, by means of the powerful muscles composing the buccal body. Into the posterior, inferior part of the buccal body, below the blind sac of the lingual lamina, is inserted, in a transverse, curved line, its retractor muscle. This muscle has its origin, in common with the retractors of the tentacles, from the muscular investment of the visceral cavity, posterior to the pulmonary cavity, and to the right of the rectum.

The œsophagus proceeds from the upper, posterior part of the buccal body backward to the stomach. It is short, and dilates gradually into the latter.

The stomach is a capacious, membranous receptacle, when extended being two-thirds the length of the animal. In *L. variegata* and *L. agrestis*, anteriorly it is dilated, and elongated-oval in form, posteriorly it is intestiniform. In *L. campestris*, it is nearly uniformly cylindrical throughout. Where the stomach terminates in the small intestine, it makes a turn forward with the latter, producing, in *L. variegata* and *L. campestris*, a sort of cul-de-sac posteriorly. Into the angle formed by the stomach and intestine, on each side, opens a biliary duct, which, in *L. agrestis*, however, are more removed toward the small intestines.

The intestine forms a single convolution among the lobes of the liver, and then passes obliquely forward from the left to the right side, to join the rectum. It is capacious, and pretty uniformly cylindrical throughout.

About the middle of the oblique portion going to join the rectum, in *L. agrestis*, opens a short, cylindrical cul-de-sac. In *L. variegata* the intestine, upon reaching the retractor muscles of the buccal body and tentacles, winds around their origin, turns backward a short distance, and then again forward to the rectum, producing in this way a sigmoid flexure. From the termination of the latter in the straight portion, there proceeds backward as far as the termination of the visceral mass, a long, cylindrical cul-de-sac.

The rectum is short and straight, and penetrates into the pulmonary cavity, upon the right side of which it proceeds to the pulmonary orifice, at which it terminates by the anal aperture.

The salivary glands are two in number, flat, oval or irregular in outline, of a grayish pink hue, and are situated upon the anterior parietes of the stomach. They are composed of several lobuli, which are conglomerated. From each gland proceeds a duct, along the œsophagus to the buccal body, into which they open on each side of the entrance of the œsophagus. In *L. campestris*, the two glands are conjoined, so as to form a collar around the commencement of the stomach.

The liver, by far the largest viscus in the body, occupies a position at the posterior part of the latter. It is of a brownish color, and consists of two principal lobes, an anterior and a posterior, which are further divided, the anterior into three or four, and the posterior into two lobes. Each lobe is composed of a number of lobuli held together by bloodvessels. From the convergence of branches, an hepatic duct is formed for each principal lobe, which opens in the side of the angle formed at the termination of the stomach in the intestine. The posterior cul-de-sac of the stomach usually contains some bile, which is a thin, glairy, drab-colored fluid.

Arion. The digestive apparatus offers but little peculiarity from that of Limax. The retractor muscle of the buccal body is not so strong, and is divided into two lateral bands. The œsophagus is narrower and longer. In the form of the stomach and absence of a cul-de-sac to the small intestine, it resembles *Limax campestris*. The rectum, in its course to the pulmonary orifice, perforates the renal organ.

Tebennophorus. The buccal body has a conspicuous curve downwards, and the buccal pouch of the lingual lamina is longer than in Limax or Arion, and curves upwards from the postero-inferior part of the buccal body. The retractor muscle of the latter is split into two bands as in Arion, but one stronger. There are also two small retractor muscles to the lower lip. The œsophagus is comparatively long. The stomach is cylindrical and sacculated, and, posteriorly with the small intestine, forms a wide cul-de-sac. The small intestine is like that of *L. campestris* and Arion. The salivary glands occupy a position on each side of the œsophagus. The ducts are tortuous.

Vaginula. The buccal body possesses no retractor muscle. The dental plate is broad, and, upon the anterior surface, has a pectinate appearance, from the numerous ridges upon it. Its cutting edge is devoid of the conical toothlet. The œsophagus is moderately long and capacious. The stomach is cylindrical and sacculated, and posteriorly forms a deep, capacious cul-de-sac, independent of the small intestine. It is strongly muscular and shining, the transverse muscular fibres being very distinct. The anterior hepatic duct opens into the angle formed by the cul-de-sac and the intestine, the posterior into the fundus of the latter. The small intestine is pretty uniformly cylindrical, and holds the usual course to near its termination in the rectum, when to reach the latter it turns abruptly backward, and joins it on the right side, just posterior to the middle of the body. The rectum is straight, and proceeds backwards, along the right side of the body, within the pulmonary cavity, and terminates between the extremity of the tail and the pedal disk, at the side of the pulmonary orifice. The salivary glands are arborescent, or fasciculated in appearance. The ducts are short and delicate. The lobuli of the liver are looser, or more separated, than in the preceding genera.

HELIX. The buccal body has the same appearance, generally, as in the slugs. The retractor muscle is much stronger, and has its origin in common with the retractor of the foot and tentaculæ, from the columella of the shell; at its insertion it forms a semicircle around the posterior inferior part of the buccal body. The pouch of the lingual lamina is always a prominent object. In *H. cellaria* and *H. concava*, the buccal body is proportionately nearly twice the length of that of the other species. The dental plate varies in some degree in different species: in *H. ligera*, *H. intertexta*, &c. it is smooth anteriorly, and in the middle projects downwards into a large, conical toothlet; in *H. albolabris*, *H. tridentata*, &c. the anterior surface presents a number of curved ridges, each of which projects inferiorly as a sort of toothlet.

The œsophagus is generally long and narrow. In some species it is unusually long and contracted, as in *H. concava*, *H. cellaria*, *H. hirsuta*, *H. perspectiva*, etc.; in others it is long, and dilated in the middle, as in *H. auriculata;* in many it is capacious, and gradually passes into the stomach, as in *H. exoleta*, etc.

The stomach is usually cylindroid, and more or less sacculated. The posterior cul-de-sac is always present.

The small intestine comes off from the stomach at a very acute angle, and into the latter two hepatic ducts empty. It is pretty uniformly cylindrical, and forms, as in slugs, a single convolution or a sigmoid curve, among the lobes of the liver, and penetrates to the pulmonary cavity at its right posterior angle. The rectum, in all the testaceous genera, corresponds in length to the pulmonary cavity, the right side of which it occupies to the pulmonary orifice, at the outer border of which it terminates by the anal aperture. It is cylindrical, usually wider than the small intestine, and is frequently somewhat sacculated. Upon the outer side of the rectum, running its whole length, is a band of muscular fibres, the object of which is, apparently, the retraction of the collar, the shortening of the rectum, and the expulsion of its contents.

The salivary glands are generally elongated, oval, with lobed edges. They are usually united together and situated on the œsophagus, or commencement of the stomach. When the œsophagus is narrow they surround it ; when dilated, they occupy one-half or two-thirds of its surface. The salivary ducts are long and large.

The liver is four lobed, three of which lobes are anterior or inferior, and the fourth posterior or superior. The fourth lobe, conjoined with the testicle, forms the very summit of the turbinated mass. The ducts from the anterior lobes converge to form a single trunk, which, with that from the posterior lobe, open into the junction, or angle, of the cul-de-sac of the stomach with the intestine.

Bulimus. The digestive apparatus in *B. dealbatus*, *B. decollatus*, and *B. virgulatus*, resembles that of *H. auriculata;* the œsophagus is long, narrow, and dilated in the middle; the stomach is cylindroid, and more or less sacculated. The stomach of *B. fasciatus* resembles that of *Limax variegata*, being large and capacious anteriorly, cylindrical and sacculated posteriorly. The rectum is capacious and sacculated.

Pupa. A characteristic of this genus is the very great proportionate length of the viscera, corresponding to the numerous whorls of the shell. The retractor muscle of the buccal mass is long and strong. The dental plate has two central, conical toothlets in its cutting edge. The œsophagus is very long and narrow. The stomach is very long, and even forms a fold upon itself. The rectum is very long and sacculated; the muscle on its outer side is well developed.

Succinea. A characteristic of this genus, the reverse of Pupa, is the great breadth and shortness of the viscera. The dental plate has an upper, quadrangular piece, superadded to the ordinary, crescentic plate. The stomach resembles that of *Limax variegata.* Its mucous membrane presents several longitudinal rugæ. The small intestine does not undergo the same relative diminution with the other viscera. The rectum is very short, and, from the transverse position of the pulmonary cavity, it is placed along the right of the breadth, instead of the length of the latter, as usual. The salivary glands are situated one on each side of the commencement of the stomach; their ducts, just before opening into the buccal body, become dilated.

Glandina. The oral orifice is triangular, and bounded by three papillated lips, one upper and two lateral. The buccal body is a very long muscular cylinder, a little curved downward at the posterior part. There is no cul-de-sac for the lingual lamina protruding behind; and the retractor muscle is divided into three fasciculi, one central and passing into the buccal body posteriorly, the others lateral and inserted as usual. Externally, it has a very thin investment of longitudinal muscular fibres, continuous with those of the retractor muscle and the origin of the especial muscles of the tongue. This layer is very delicate and transparent; and at the anterior third of the buccal body, laterally and inferiorly, it presents several fasciculi, which pass to the tegumentary lips. Beneath the exterior covering, and readily seen through it, is a thick and strongly fasciculated, transverse layer of muscular fibres. When the buccal body is laid open the oral orifice is found to be continuous with a triangular canal with smooth sides, running one-third its length. At the posterior superior termination of the canal, is the opening of the œsophagus and orifices of the salivary ducts. There is no dental plate. The posterior two-thirds of the buccal body is occupied by a long oval organ, composed of numerous, strong fasciculi of muscular fibres, arising laterally and inferiorly at the posterior part of the buccal body; the former passing inwards and forwards, the latter forwards to the anterior extremity of the organ, which is free, and projects into the triangular, oval canal. The lateral fasciculi leave between them superiorly an interstice, at the bottom of which is found the lingual lamina, in the form of a tube, closed posteriorly, and open and reflected downwards and backwards upon the anterior, free tip of the organ. Into the posterior extremity of the lamina, the middle fasciculus of the retractor muscle of the buccal body is inserted; and, just anterior to this insertion, a small, attrahent fasciculus, arising from the roof of the buccal body, posterior to the orifice of the œsophagus, which gets to the lamina by means of the interstice of the muscular organ superiorly. The teeth of the lingual lamina are arranged diagonally, from the middle line, in parallel rows, passing from within outwards.

The œsophagus issues from a fissure at the upper posterior line of the anterior third of the buccal body. It is long and cylindrical, and rather wider at its termination than at its origin. The stomach is irregularly cylindroid, and has a cul-de-sac at its commencement, projecting anterior to the entrance of the œsophagus. The small intestine is capacious.

The salivary glands are conjoined, so as to form a circular collar around the posterior part of the œsophagus. The salivary ducts are long, and enter the same fissure of the buccal body at which the œsophagus issues. The anterior lobes of the liver are comparatively very small, while the posterior lobe is correspondingly large; and to the whole there is but a single duct.

Chapter V. — Observations on the Tissues of the Digestive Apparatus.

The mucous membrane of the alimentary canal is usually smooth throughout. In the stomach it frequently presents a number of transverse folds, corresponding to the contractions which produce the sacculated appearance of the organ; and in several species of different genera it presents a few longitudinal rugæ, as in *Limax variegata*, *Bulimus fasciatus*, *Helix exoleta*, etc. In its whole extent it is formed of a columnar epithelium and a nucleolated-nucleated basement membrane. The columnar cells of the epithelium are long and pyramidal, the upper part or base being broad, and the attached extremity very narrow. They are filled with a very fine, indistinct, granular matter, intermingled with coarser, highly reflective granules. Each contains an oval, granular nucleus, with a minute nucleolus.

The muscular investment of the intestinal canal is strongest upon the stomach and rectum. In *Vaginulus*, *Pupa incana*, etc. it is strong and shining upon the stomach. It consists of two layers, an internal transverse and an external longitudinal. They are both composed of white, shining, strap-shaped bands, with the extremities pointed and closely adapted to each other. None of the transverse bands surround the stomach, all being much too short. They are indistinctly granular in structure, and each contains one or two elongated nuclei.

The lobules of the salivary gland are composed of the dilated commencements of the ducts, lined with soft, granular cells, which are oval in form, and contain a round, granular nucleus with a minute nucleolus. The basement membrane of the salivary ducts is amorphous. The epithelial cells lining the trunks bear considerable resemblance to those found in their follicular commencement. Outside of the basement membrane, twine narrow, muscular fibres in various directions. They are nucleated, and where the nuclei exist are wider than at the intervening parts.

The lobuli of the liver are composed of the rounded commencement of the biliary ducts, and are lined with polygonal cells, which become globular on the removal of pressure. The hepatic cells contain a fine, granular matter, fine and large oil-globules, and a round, nucleolated nucleus.

Chapter VI. — of the generative apparatus.

All the terrestrial Gasteropoda under consideration are monœcious, or hermaphroditic, though none are capable of self-impregnation. They are also all oviparous.

Limax. The testicle is a round, or oval body, partially concealed by the liver; it is brown in color, and has the appearance of being composed of rounded acini. In *L. variegata*, it is lobulated. The epididymis is an undulated, or moderately tortuous tube, leading from the testicle to the inner side of the junction of the ovary with the prostate gland. It opens into a groove upon the inner side of the interior of the oviduct which is continuous, at its inferior extremity, with the vas deferens. Opening into the termination of the epididymis, and lying against the inner side of the ovary, is a small, compound, follicular body, which appears to be common to all the terrestrial Gasteropoda. The prostate gland is a white, or cream-colored body, occupying the inner side of the whole length of the oviduct. It has a transverse, striated appearance, and numerous openings into the groove leading from the epididymis to the vas deferens.

The vas deferens is a comparatively short tube, passing from the prostate gland to the penis. In *L. variegata*, it joins the summit of the latter; in *L. agrestis* and *L. campestris*, it enters near the base.

The penis, in *L. variegata*, is a long, cylindroid, irregular body, lying at the right anterior part of the visceral cavity, and joining at its termination a short cloaca. Into its summit is inserted the retractor muscle, which has its origin from the muscular investment of the visceral cavity, just posterior to the position of the pulmonary cavity. The interior of the penis is lined by mucous membrane, its exterior of muscular membrane. In *L. agrestis* and *L. campestris*, the organ which corresponds to the penis of *L. variegata* becomes of a somewhat problematical character. In *L. agrestis*, it is an elongated, conical organ, with a protuberant base. Its summit is divided into three cœca; the retractor muscle is inserted into its side. Upon the interior it presents several longitudinal folds of mucous membrane, and at its lower part, corresponding to the protuberance of the base, an oval, pointed papilla. In *L. campestris*, the organ is spiral, and has but a single pointed summit.

The ovary is a large, white, semi-elliptic organ, usually more or less curved and lobulated, and situated at the summit of the oviduct. In *L. agrestis* and *L. campestris* it is always two-lobed, or double. The oviduct is a long, wide, soft, white, tortuous, sacculated tube, passing from the ovary to the vagina. The neck or portion immediately joining the vagina, commences usually where the prostate gland terminates, and is contracted to less than half the calibre of the upper portion of the tube. Its interior surface exhibits a number of transverse folds, corresponding to the contractions which produce the sacculated appearance of the organ, and upon the inner side upon each side of the spermatic groove, or longitudinal fold.

The generative bladder, in *L. variegata*, is a large pointed, oval receptacle, opening by a very short, wide tube or duct, into the vagina. In *L. agrestis* it is large, elongated oval, and opens by a short duct into the angle formed by the junction of the vagina with the male portion of the generative apparatus. In *L. campestris* it is a small oval sac, with a longer, narrow duct, opening into the tube leading from the penis to the cloaca.

In all three species of *Limax*, the cloaca is a short canal opening at the generative orifice on the right side of the head.

Arion. The generative apparatus resembles more that of *L. variegata* than the other species. The penis is cylindrical, dilated at base, and has its retractor muscle inserted into the latter point. The generative bladder is large, oval, pointed at summit, and has a very short but muscular duct, joined midway by the vagina. At the latter junction is inserted a second retractor muscle. The cloaca is long and dilated in the middle.

Tebennophorus. The testicle lies upon the right side, partly concealed by the liver; it is round and lobulated. The epididymis is more tortuous than in the preceding. The vas deferens is very long, tortuous, and muscular. It joins the penis at its summit, and has the retractor muscle inserted into it the length of the penis above the latter. The penis is irregularly cylindroid, bent at its summit.

The ovary is exceedingly lobulated. The oviduct is tortuous, wide, and very much sacculated. The prostate gland is longer than in *Limax* or *Arion*. The generative bladder is large, globular, or nearly so. Its duct is rather less than half the length of the oviduct. At its junction with the neck of the latter, an oval, muscular organ exists, the dart sac. Within the latter at the bottom, is a hemispherical papilla, upon the summit of which is placed a white, calcareous, calcarate dart. At the junction of the vagina, common to the neck of the oviduct, duct of the generative bladder, and the dart sac, with the penis, there are two short retractor muscles inserted. The cloaca is narrow and cylindrical, and has surrounding two-thirds of its middle, a thick, glandular organ. Interiorly, the penis, cloaca, etc. have a longitudinally rugous surface.

VAGINULUS. A remarkable peculiarity of this genus is the removal of the male and female portions of the sexual apparatus from each other. The former, except the testicle and prostate gland, occupies the usual position, but opens externally between the mouth and olfactory orifice; the latter is placed in the middle inferior part of the visceral cavity, and opens exteriorly on the right side, inferiorly just posterior to the middle of the body.

The testicle is situated between the posterior part of the stomach and the liver, on the right side. It is not lobulated, but has the same aciniform arrangement as in the preceding genera. The epididymis is moderately tortuous, and becomes the vas deferens at the junction of the ovary with the oviduct. The vas deferens takes a remarkable course to get to the penis. It is, at first, attached for a short distance to the commencement of the oviduct, which it leaves, and then winds around its lower extremity, where it is joined by a comparatively very small prostatic gland. It continues its attachment to the lower part of the oviduct to the junction of the latter with the duct of the generative bladder, where it receives a small duct from the duct of the latter organ, and then passes nearly to the external female orifice, where it turns abruptly forwards between the muscular peritoneum and the right edge of the podal disk, and continues this course to the head. It now turns abruptly backwards to the right, and again appears within the visceral cavity, and passes to the base of the penis.

The penis is a conico-cylindroid, contorted organ, contained within a thin, muscular sheath. Its apex presents a small, round papilla, or glans ; and into its base is inserted the retractor-muscle, which arises just anterior to the pulmonary cavity. The lower part of the preputial sheath of the penis is joined by the common duct of a highly developed, multifid vesicle. This latter organ consists of twenty-five long, narrow, cylindrical, blind tubes, contorted at their termination, and opening separately into a common tube, containing, in the specimen examined, attached to its bottom, a narrow, cylindroid organ, which, probably, may have been an uncalcified dart.

The tube formed by the præputium and the duct of the multifid vesicle, as previously mentioned, opens exteriorly immediately beneath the mouth. The ovary is small and unusually lobulated. The oviduct is a narrow, cylindrical tube, which winds forwards and then back again so as to form a double spiral, after which it makes a curve downwards, and is joined by the duct of the generative bladder. The latter organ is globular ; its duct is short, gradually increases in breadth, and is spirally twisted. From the duct, as previously mentioned, passes a small offset to the vas deferens. The common duct of the bladder and oviduct, or vagina, is cylindrical, and, just before terminating, is joined by a short, wide tube, derived from a large, oval sac, which is filled with a delicate, reticulated substance. This sac is peculiar to *Vaginulus;* its use is problematical.

The position of the female orifice of generation has been already stated.

HELIX. The testicle, very unlike that of slugs, is imbedded or commingled with the parenchyma of the posterior or superior lobe of the liver; and, instead of having an aciniform appearance, it is composed of fasciculi of short cœca. It is usually of a lighter color than the liver. The epididymis is long, and generally very much convoluted, and contains a white, silky, tenacious, substance, often distending the tube to a considerable degree, composed of spermatozoa. At its junction with the prostate gland, it always receives the duct of a small accessory gland, composed, in different species of Helix, of from three to nine acini.

The prostate gland is generally larger than in the Limaces; in *H. exoleta* it is unusually large.

The vas deferens generally corresponds in length with the curve passing from the termination of the prostate gland downwards to the cloaca, and thence to the summit of the penis. In *H. exoleta* and *H. albolabris* it is considerably longer, and in the latter presents several large convolutions. In *H. intertexta*, *H. ligera*, *H. gularis*, and *H. suppressa*, it is much shorter. Generally, it is a white, narrow, cylindrical, frequently undulated tube. Sometimes it is distinctly and strongly muscular, as in *H. albolabris*, *H. tridentata*, *H. elevata*, etc. In *H. fuliginosa* its lower part is dilated to the diameter of the penis, and is strongly muscular. In *H. albolabris*, *H. tridentata*, and *H. exoleta*, at its commencement it presents a dilated and glandular appearance. In *H. solitaria* it is much dilated, annulated, and glandular at its termination. In all instances except in *H. cellaria* and *H. alternata*, it joins the summit of the penis; in the two latter it joins the penis at the side, very near the summit.

The penis varies very much in form and size; most usually it partakes of a conico-cylindroid form. In *H. sayi*, *H. texasiana*, *H. inflecta*, and *H. auriculata*, it is very large and long, cylindrical, collapsed, and flaccid. In *H. concava* it is long, clavate, and bipartite at the summit. In *H. alternata*, *H. perspectiva*, and *H. solitaria*, it is short, stout, and clavate. In *H. albolabris*, *H. tridentata*, *H. multilineata*, *H. arborea*, *H. dentifera*, and *H. palliata*, it has a thick, preputial membrane, originating around its base, and rising upwards so as to envelop it for one or two-thirds of its extent. In *H. profunda* the base of the penis protrudes into a sheath joining the cloaca, in the form of a cone with its apex bent upon itself. In *H. ligera*, *H. intertexta*, and *H. sup-*

pressa, it is wholly enveloped in a sheath derived from a tubular offset from the duct of the generative bladder.

The muscular tunic of the penis is thick and strong. The internal lining mucous membrane usually presents a number of large rugæ, longitudinal and oblique; frequently there is but a single, large, longitudinal fold, as in *H. alternata*, *H. albolabris*, etc. At the point of entrance of the vas deferens there is generally one or two pendant, valve-like folds of the lining membrane.

In *H. albolabris*, *H. tridentata*, and *H. multilineata*, the surface of the membrane is everywhere distinctly papillated; in the others it is smooth.

The penis of *H. cellaria* on the outside presents a row of minute, round, glandular bodies.

The retractor muscle is in all cases, except in *H. solitaria*, inserted into the summit of the penis, or into the vas deferens near its termination in the latter. In the excepted case, it is inserted into the side of the penis, above its middle. In *H. multilineata* there are some accessory fibres passing from the latter to the preputium; in *H. profunda* to the base of the penis; in *H. albolabris*, *tridentata*, etc. from the vas deferens to the preputium. The penis joins at its base the cloaca.

The ovary has the same general form and color as in slugs, but rarely presents any thing more than a trace of lobuli, usually having a uniform, homogeneous appearance. The oviduct does not differ from that of the slugs. Its neck is usually narrow, and of variable length, and is joined at the lower part by the duct of the genital bladder, to form the vagina. In *H. concava* and *H. multilineata*, the neck is long, dilated at its lower part, and strongly muscular, and its internal surface presents a number of longitudinal rugæ. In *H. profunda* and *H. fuliginosa*, it is long, cylindrical, and strongly muscular.

The genital bladder, constantly existing, presents considerable variation in the form, size, and length of the duct. It is generally subrotund, oval, or pyriform in shape, and large. In *H. solitaria* the duct is wide, as long as the oviduct, and dilated at its lower part. In *H. perspectiva* it is as long as the oviduct, and narrow. In *H. alternata*, *H. ligera*, *H. intertexta*, *H. concava*, *H. suppressa*, and *H. gularis*, it is rather more than half the length of the oviduct. In the remaining species generally, the bladder reclines upon the lower part of the prostate gland, and its duct is about the length of the neck of the oviduct. In *H. multilineata* it does not reach the prostate gland, and so gradually passes into its duct as to be a mere, long, cœcal tube. In *H. berlanderiana* the duct of the bladder is as short as that of Arion. Usually, the surface of the bladder is smooth; in *H. profunda* and *H. exoleta* it is transversely folded; in *H. fuliginosa* it is regularly, longitudinally folded. In *H. concava* and *H. multilineata*, the duct of the bladder at its termination dilates, and is strongly muscular. In *H. solitaria* the lower third is dilated. In *H. fuliginosa* and *H. profunda*, it is strongly muscular the greater part of its extent. In *H. albolabris*, *H. palliata*, *H. tridentata*, etc. it is dilated to the size of the bladder, is strongly muscular, and internally presents a number of regular, longitudinal folds, sometimes undulated at the sides, extending to the lining of the bladder in the form of line-like plicæ. In *H. ligera*, *H. intertexta*, *H. gularis*, and *H. suppressa*, an offset from the duct of the bladder passes down, and encloses the penis, dart sac, and cloaca.

The vagina, or common duct of the oviduct and duct of the genital bladder, holds no correspondence with the length of the penis; it is always shorter, usually not more than one-third the length, and is also narrower. In *H. fuliginosa*, it is surrounded by a thick, glandulous body.

In *H. ligera*, *H. intertexta*, *H. gularis*, and *H. suppressa*, there exists, opening into the cloaca, a curved, cylindrical, strongly muscular dart sac, longer and narrower than the penis. The bottom of the tube, for one-fourth the length of the latter, is occupied by the papilla from which arises the dart. The muscular layer, for more than half the length of the tube, at the middle of the latter, closely envelops the dart, and terminates abruptly below in a sort of papilla, from which the point of the dart projects into the lower part of the tube. The dart is a very long, narrow, curved, cylindrical, tubular, flexible, calcareous spiculum, terminating in a sharp, spear point. At the base of the dart, there opens into the dart sac, in *H. ligera* and *H. suppressa*, a single, short, pyriform follicle, the simplest homologue of the multifid vesicle. In *H. intertexta* and *H. gularis*, there is a pair of such follicles, but longer. Into the summit of the dart sac is inserted a retractor muscle, originating from the angle formed by the division of the duct of the genital bladder into two parts. Opening into the tube which leads from the penis to the cloaca, in *H. Berlanderiana*, is a cylindrical, curved, muscular organ, about one-half the length and as thick as the penis, which is probably a dart sac, although in the specimen dissected no dart was found. In *H. concava*, opening into the cloaca, is a short, rounded, muscular cavity, probably a dart sac, which, however, in the individuals dissected, were also destitute of the organ.

The cloaca, or common receptacle of the termination of the male and female organs of generation, is a short, wide, muscular tube, holding no relationship with the length of the penis, and opening exteriorly on the right side of the head.

In many species of Helix, the anatomy of the generative apparatus is so very similar, that they appear to differ in nothing but size. Thus, *H. albolabris*, *H. tridentata*, *H. dentifera*, *H. palliata*, *H. arborea*, and *H. fallax*, are alike; *H. intertexta*, *H. gularis*, *H. suppressa*, and *H. ligera* are also alike, except that the two latter have but a single vesicle to the dart sac, while the former have a pair. *H. auriculata*, *H. texasiana*, and *H. inflecta*, are alike, and also *H. thyroidus* and *H. pulchella*.

It is a very remarkable fact in the special anatomy of the generative apparatus of the genus Helix, that while the flagellate form of the penis and those accessory organs, the dart sac and multifid vesicles, are so common in European species, they are very rare in American species. In not one of the latter does the flagellate form of penis exist. A rudiment, or simplest condition of the multifid vesicles, only exists in four species; *H. intertexta* and *H. gularis*, in which there is a single pair of follicles, and *H. ligera* and *H. suppressa*, in which there is but one short follicle. The dart sac exists certainly in only the four latter species, probably in *H. berlanderiana*, and doubtfully in *H. concava*.

BULIMUS. In *B. fasciatus* the penis is long, cylindrical, and strongly muscular. The vas deferens joins it near the summit; and the retractor muscle, which is very long, is inserted into the latter. The oviduct is long, and its central part presents the peculiarity of being colored brown. The genital bladder is ovate, situated near the ovary, and its duct is narrow, and as long as the oviduct. The vagina is broad and muscular. At the base of the penis, there opens a short, cylindrical duct, derived from a single, multifid vesicle, which presents six or seven rounded or ovate divisions. There is no dart sac.

In *B. dealbatus* the penis is very long; its upper portion is narrow and very tortuous, and flagellate in appearance; although the true flagellum, or the free portion of the summit of the penis beyond the insertion of the retractor muscle, is very short. The lower third of the penis is dilated, and presents an annular constriction;

at its base it is enveloped by a short prepuce. The vas deferens follows the course of the penis nearly to its summit. The genital bladder is oval; its duct as long as the oviduct.

In *B. virgulatus* the penis is long, irregularly cylindroid, and has its base enclosed in a short prepuce. The vas deferens terminates in, and the retractor muscle is inserted into, its summit. The genital bladder is oval; its duct is not more than one-third the length of the oviduct, and dilates as it passes downwards.

In *B. decollatus* the penis is short, conico-cylindroid, and simple. The vas deferens enters near its base; the retractor muscle is inserted into its summit. The genital bladder is small; its duct is narrow, and not longer than the neck of the oviduct.

Pupa. In *P. incana* the penis is short, narrow, and cylindrical. The vas deferens is of a very great length when compared with what it is usually in the other genera. Its lower part, about the length of the penis, is dilated to the size of the latter organ, is strongly muscular, and terminates at the base of the penis. The retractor muscle is inserted into the summit of the latter. The lining membrane of the penis presents a single, longitudinal fold. At the base of the penis is a short, muscular sac, or protuberance, probably a dart sac, although the individual dissected possessed no such instrument. The genital bladder is oval; its duct is as long as the oviduct, and midway receives a long, narrow duct, derived from a granular, glandular organ combined with the testicle in the posterior lobe of the liver.

Succinea. The testicle is not separated into distinct fasciculi by the parenchyma of the liver as in Helix, but forms a single mass. The epididymis is very much convoluted, and appears always to be distended with spermatic matter. The prostate gland is unusually short, occupying the upper half only of the length of the oviduct, and is thick, clavate, and more or less colored by pigmentum nigrum cells upon the surface. The penis is long, cylindroid, curved downward at its upper part, and is joined at its summit by the vas deferens. The retractor muscle is inserted into the penis a short distance below its summit. The genital bladder is large and globular ; its duct is nearly as long as the oviduct, and is narrow. The vagina is moderately long and muscular. The cloaca is short.

Glandina. The testicle is an oval mass, separated from the liver as in the Limaces. The epididymis appears from a hilum in the side of the testicle ; at first but slightly tortuous, it becomes convoluted just before ending. Its accessory glandula is large. The penis is long, large, and clavate, very gradually enlarging from the base to the summit. The vas deferens, which joins the latter point, is long, moderately tortuous, and wide. The retractor muscle is inserted into it near its termination in the penis. The bladder is oval, constricted ;

its duct is as long as the oviduct. The vagina is moderately broad. The cloaca is short. The exterior generative orifice is on the right side of the head, considerably posterior to the inferior tentaculæ.

Chapter VII. — General remarks upon the junction of different portions of the generative apparatus, and the structure of its tissues.

The testicle was mistaken by Swammerdam, Cuvier, and others for the ovary, and the latter organ and prostate gland for two portions of the testicle. A microscopic examination of these different organs at once, very easily settles their true nature; although, even without this mode of analysis, we would suppose the epididymis would indicate the character of the gland of which it is the duct, and leave the remaining two organs to be considered as belonging to the female apparatus. In Helix, the structure of the testicle consists of dense fasciculi of short cœcal pouches, which are simple, bifurcate, or trifurcate. These contain polygonal spermatophori, which are finely granular with a round nucleus, or filled with granular globules of uniform size, or with coils or bunches or fasciculi of spermatozoa. The epididymis always contains, more or less, and is frequently distended with, a white, silky, filamentous substance, composed of spermatozoa. The latter consist of very delicate and, comparatively, enormously long filaments, terminating, at one extremity, in a thickened head. They vary in length in different species of these gasteropods. The head assumes two principal forms; it is either sigmoid and pointed, as in *H. albolabris*, *H. multilineata*, etc., or else it is spiral and pointed, as in *H. alternata*, *H. solitaria*, etc. In the vas deferens, the spermatozoa may often be detected in movement, which is slow and vibrating in character.

The prostate gland, although situated along the tract of the oviduct, evidently belongs to the male apparatus, as is proved by its emptying solely into the vas deferens in Vaginulus, and in its being placed between the termination of the epididymis and the commencement of the vas deferens only, as is very conspicuously observed in Succinea. In structure, it is composed of closely packed, tortuous, tubular, simple follicles, lined with short, thick, pyramidal epithelia, which are densely granular, and contain a round, nucleolated nucleus. The object of this organ probably is to dilute the very tenacious spermatic matter as it oozes from the epididymis into the spermatic groove on the inner side of the oviduct.

In all the terrestrial gasteropods examined, there was found a small, glandular body, from which proceeds a short duct to join the termination of the epididymis. It consists of from two to nine rounded follicles joining a common duct, and, from the constancy of its existence, must be deemed important.

The ovary is soft and homogeneous in appearance; viewed by the microscope, it is found to be almost wholly composed of immature ova, polygonal cells with a germinal vesicle and macula.

The sides of the oviduct are soft, and in great measure composed of a tissue consisting of large, polygonal cells, with from one to five small, round nuclei.

The organ denominated genital bladder, from its opening into the vagina, or at the termination of the latter, and in Vaginulus from its belonging almost wholly to the female organs, must be considered rather as a portion of the female apparatus than a prostatic sac, as it is called by Owen. By many authors, this has been termed the spermatheca, from its supposed function of holding spermatic fluid received from the male organs; and with some reason; for in several instances I have found it to contain a tenacious mass, which upon microscopic analysis was found to be composed of spermatozoa. This cannot, however, be considered wholly as its use; for it secretes a mucoid matter, which may probably facilitate the passage of the ova through the vagina and cloaca. The mucoid matter within the bladder is frequently found to contain immense numbers of an infusorial parasite, which I have described under the name of Cryptoicus.[1]

The epithelium of the bladder consists of very long, caudate, columnar cells, with elliptical, granular nuclei, and a small, round nucleolus.

[1] Journ. Acad. Nat. Sci. N. S. Vol. I.

Chapter VIII. — OF THE RESPIRATORY AND CIRCULATORY APPARATUS.

The lung of the Terrestrial Gasteropoda is a simple cavity, with an orifice communicating with the exterior, upon the right side of the body. The surface of this pulmonary cavity in part of its extent, and more particularly near the pulmonary orifice, is covered by a close intertexture of blood-vessels. The blood of the body is conveyed directly to the lungs by two principal vessels, the pulmonary arteries, which join the capillary rete of the pulmonary surfaee. From this rete passes off the pulmonary vein to the heart, which is systemic, and consists of an auricle and ventricle. The auricle receives the pulmonary vein ; from the ventricle passes off the aorta, to be distributed throughout the body.

Limax. The pulmonary cavity is situated beneath the mantle, and has nearly the same size and form. It is separated from the visceral cavity by the muscular peritoneum, but contains the rectum, renal organ, and heart. The pulmonary orifice is situated at the antero-inferior edge of the mantle, on the right side of the body. When open it appears round ; it is closed by means of circular, muscular fibres. The pulmonary rete is principally displayed upon the roof of the cavity, and from it converge three principal trunks, to form the pulmonary vein which passes to the auricle of the heart.

The heart, enclosed within a pericardium, is situated near the middle of the pulmonary cavity. The auricle and ventricle are pyriform, and placed base to base. The sides of the latter are considerably thicker than those of the former, and present internally several well-marked fasciculi, crossing in different directions. Between the auricle and ventricle is a double valve. From the apex of the ventricle passes off the aorta, which pierces the muscular peritoneum, and divides into two principal branches, — one passing to the sub-œsophageal ganglia devoted to the viscera in the anterior part of the visceral cavity, the other passing to supply the viscera posteriorly. Upon the right of the heart, attached to the roof of the pulmonary cavity, is placed a large, glandular organ, considered as the kidney; from the whole of its right margin proceeds a duct backwards, which then curves to the side of the rectum, at the left side of which it remains attached to the pulmonary orifice.

Arion. The pulmonary cavity is situated as in Limax. Its whole interior surface presents an intricate rete, from which converge six or seven pulmonary veins to the auricle of the heart.

The renal organ forms a complete circle around the heart, and is perforated by the rectum, in the course of the latter to the pulmonary aperture.

Tebennophorus. The pulmonary cavity is situated beneath the anterior portion of the mantle. It is formed by an inflection of the muscular layer of the integument of the body. The renal organ is placed to the right of the heart, and at its posterior part is perforated by the aorta.

VAGINULUS. The pulmonary cavity is situated between the muscular peritoneum and the integument of the body. Its principal portion is placed upon the right side, anterior to the middle, but extends to the left side, over the back, and along the right side to the pulmonary aperture, between the tail and posterior extremity of the podal disc. The heart is placed in the anterior portion of the cavity. The auricle receives a vein from the right and another from the left side. The renal organ is placed posterior to the heart, between the passage leading from the pulmonary cavity to its orifice, and the course of the rectum.

HELIX. In this genus, as is also the case in all the testaceous genera under examination, the pulmonary chamber is comparatively very large, for reasons already stated, and occupies a position on the outside of the lower one or two whorls of the turbinated mass of the viscera. In front, it is bounded by the collar, in the right side of which is the pulmonary orifice. The floor of the cavity is formed, as in slugs generally, by the muscular peritoneum. The roof, or outer wall, is occupied on the right side by the rectum, posteriorly by the heart and renal organ, and anteriorly by the pulmonary rete of capillary vessels. The pulmonary rete is most developed in the vicinity of the pulmonary orifice ; and from it in a line with the latter, along the course of the rectum, proceeds backward a single pulmonary vein to the heart. The renal organ is elongated, pyramidal, and is placed to the right of the heart and pulmonary vein. Its duct commences upon the right border of the gland, courses backward to the rectum, along the inner side of which it passes to the pulmonary aperture.

The remaining testaceous genera present nothing peculiar in the character of the pulmonary or circulatory apparatus.

General Remarks. The heart, in warm weather, beats about fifty-five times in a minute, but to some extent appears to be under the control of the animal, for if disturbed or irritated it pulsates much slower.

In composition, the heart consists of distinctly granulated, unstriped, muscular fibres, with oval nuclei, which are hardly visible before the application of acetic acid to them.

The interior of the heart and aorta is lined with a tessellated epithelium ; and the exterior of the former and interior surface of the pericardium are covered by the same. The cells are granular, with distinct, round, or oval, granular nuclei, and a minute nucleolus.

The pericardial epithelium separates its peculiar fluid very freely, the pericardium frequently appearing distended with the liquor pericardii. In Helices, it frequently contains numbers of an entozoon, which I have named *Distoma vagans.*[1] The blood-vessels, especially in the liver, exhibit a white, opaque appearance, which is dependent upon the deposit in the sides of the vessel of innumerable, oil-like granules.

The blood contains numerous blood-corpuscles, which vary in size, are granular, and exhibit numerous radiating, projecting points of variable length, — frequently greater than the diameter of the corpuscle.

The pulmonary cavity is lined with a tessellated epithelium, the cells of which are faintly granular, with a few coarser granules, and a distinct, round or oval, granular, nucleolated nucleus.

The renal organ is a gland which exhibits a foliated, or plicated appearance, within a capsule. The surfaces of the plicæ communicate with the duct existing along the whole right border of the organ, and are covered with polygonal, organic cells, every one of which contains a large, white, round, opaque mass, resembling uric acid in appearance.

Chapter IX. — On the Nervous Centres, and the Distribution of the Nerves.

The nervous centres consist of three distinct sets of ganglia, which are all placed within the anterior part of the body or head.

The first set, or supra-œsophageal ganglia, form a trans-

[1] See Journal Acad. Nat. Sci. New Series, Vol. I.

verse band, above or in front of the buccal body, usually at its anterior part, but varying in the latter position, to some degree depending upon the movements of the buccal body. When the latter is protruded, the band of ganglia is thrown back to the commencement of the œsophagus; when retracted it is placed just behind the upper lip. It consists of two symmetrical halves united by a short, transverse commissure. Each half is composed of several ganglia, aggregated to a greater or less degree in different genera and species. Sometimes they are so aggregated, or are so covered by enveloping tissue, as to appear a single mass; in others five or six distinct masses may be readily counted.

The second set, or sub-œsophageal ganglia, form a circular mass, placed infero-posteriorly to the buccal body, in the excavation of the foot. It is asymmetrical, and is composed of several ganglia, more or less aggregated together; from four to seven masses can generally be counted. It is usually more developed upon the right than the left side, and passes through all the shades of color, in different genera and species, from white, yellow, to orange. Through the opening formed by the arrangement of the ganglia into a circle, passes the cephalic branch of the aorta. The supra-œsophageal and sub-œsophageal ganglia are connected together on each side of the buccal body by a double commissure, which varies in length in different genera; thus, in Helices, etc., it is generally so long as to allow of much movement of the supra-œsophageal ganglia forward with the buccal body, while in Vaginulus it is so short that the two sets of ganglia form a close ring around the anterior part of the buccal body.

The third set of ganglia are the stomato-gastric, consisting of two minute, lateral masses, united by a short, transverse commissure, and always placed upon the buccal body immediately postero-laterally to the commencement of the œsophagus. The stomato-gastric ganglia are connected with the supra-œsophageal on each side, by means of a long, delicate commissure, which is more or less loose, and permits a free movement of the former ganglia with the buccal body to which they are fixed.

From the supra-œsophageal ganglia pass off on each side, — 1st, a minute branch along the course of the supra-sub-œsophageal commissure; 2d, three or four small branches to the retractor muscles of the tentaculæ; 3d, a large branch, the superior tentacular nerve; 4th, one or two small branches to the base of the superior tentacle, for its integument; 5th, the inferior tentacular nerve; 6th, small branches to the integument of the lips.

From the sub-œsophageal ganglia pass off, — 1st, numerous branches on each side, to the podal disk, and laterally to the integument; 2d, a branch on the right side to the penis; 3d, a branch to the vas deferens and prostate gland; 4th, on each side a branch to the retractor muscle of the buccal body; 5th, a large one to each side of the collar and pulmonary chamber; 6th, a branch which follows the posterior aortic vessel, which gives off branches to the muscular peritoneum ; 7th, branches to the origin of the tentacular retractors ; 8th, branches to the oviduct, ovary, testicle, stomach, intestine, and liver.

From the stomato-gastric ganglia pass off on each side, — 1st, a nerve to the external muscular structure of the buccal body ; 2d, two branches which penetrate posteriorly into the buccal body ; 3d, a branch to the salivary duct and gland ; 4th, a branch to the œsophagus and stomach ; 5th, branch to the interior of the buccal body anteriorly.

The above distribution of the nerves has been principally derived from dissections of Glandina and *Helix albolabris.* In the former genus, upon what is the nerve to the inferior tentacle in the other genera, there is formed, near the base of the tentaculæ, a ganglionary enlargement, from which passes off the true, inferior tentacular nerve of this animal, and two other large branches to the third, or external tentacle.

The nervous centres are composed of ganglion globules, varying very much in size ; some are very large, others are not more than one-eighth the diameter of the larger ones and nuclear bodies. The globules are more or less polygonal, from mutual pressure, are distinctly granular, and contain a nucleus which is comparatively of enormous size. The latter usually fills one-half or two-thirds of the cell or globule, is more distinctly and darkly granular, and contains from one to seven small, round, transparent nucleoli. The separate nuclear bodies resemble the nuclei of the ganglion globules, but are much smaller, and contain but a single nucleolus. The nerve fibres pass through the ganglionary centres, among the globules in every direction; but none of them appear to originate or terminate in the latter. None of the ganglionary cells are caudated.

The nerves consist of bundles of tubuli, containing an oleo-albuminous matter, which in the fresh nerve is semi-fluid, faintly granular, homogeneous, and translucent, but after the matter is pressed out of the tubuli it separates into two portions, one of which is a tenacious, fluid substance, containing the other in the form of oil-like globules of no determinate size. The wall of the tubuli is amorphous and transparent, and has attached to it, and projecting externally, oval, granular, nucleolated nuclei.

The nerves, especially in those emanating from the supra-œsophageal ganglia, are enveloped in a sheath formed of large, elongated, polygonal, transparent cells, containing in the centre an oval nucleus surrounded by a mass of coarse, granular bodies, which are endowed with a very active molecular movement.

Chapter X. — On the Organs of Especial Sense.

Touch. The soft, mucous integument is very irritable; but tactile sensibility is most developed in the tentaculæ, which are two pairs of tubular prolongations of the external integument, from the anterior part of the body or head. The superior pair of tentaculæ are several times longer and thicker than the inferior pair. They are conico-cylindroid in shape, with the free extremity or point dilated, or bulbous, in the outer side of which the eyes are placed. The inferior pair are short, conico-cylindroid, and slightly bulbous at the point.

The integument is thick at the base of the tentaculæ, but gradually becomes thinner as it approaches the free extremity, where it is delicate and transparent. The color is the same on the general investment of the body, except at the free extremity of the tentaculæ, where, from its transparency, the structure beneath shows through, and appears whitish. On the superior tentaculæ it is rougher than upon the inferior, from the polygonal folds being deeper. It is but loosely attached to the parts within, except at the free extremity, where it becomes firmly united.

The retraction of the tentaculæ takes place by means of the contraction of the retractor muscle, which forms within the tentaculæ a cylindrical tube, and is inserted into the integument at their free extremity, so that when they are retracting the integument becomes inverted, and the point of the tentacula first disappears from view and, in protrusion, is last to appear. The latter movement takes place through the relaxation of the retractor muscle, and the gradual contraction of the circular, muscular fibres forming the basis of the integument, commencing at the base of the tentaculæ and proceeding towards the free extremity, by which course of movement the latter is pushed out.

Within the tube of the retractor muscle of the tentaculæ, passes to the free extremity of the latter the tentacular nerve. When the tentaculæ are retracted, the nerve becomes tortuous, and spiral, but when fully protruded it is nearly straight, or merely undulated.

Near the free extremity of the superior tentaculæ the nerve undergoes a sudden constriction, and then dilates into a gangliform enlargement, from the outer side of which proceeds a small division of the tentacular nerve, as the optic nerve, to the eye. The gangliform enlargement is composed, on the exterior, of the nerve-tubuli of the tentacular nerve, and on the exterior, of a soft, white, finely granular matter, containing, in the exterior layer, round, granular, nuclear bodies. Anteriorly, the enlargement undergoes a constriction, and then dilates into the large, bulbous mass of the extremity of the tentaculæ. This latter mass is white, soft, and finely granular. Upon its exterior, the nerve-tubuli of the exterior of the first gangliform enlargement diverge, and divide into a number of large branches, which laterally subdivide into numerous smaller branches, and thus inclose the granular mass.

The inferior tentaculæ present the same nervous structure, except that there is no well-marked constriction between the tentacular nerve and the first gangliform enlargement, nor between the two enlargements, nor is there any optic nerve.

The space between the tentacular nerve and the retractor muscle, is filled with a filamentous tissue, containing round, granular, nucleolated nuclei, and large, round or elliptical, transparent cells, with nuclei similar to those which lie free in the tissue.

The integument of the tentaculæ is very freely supplied with nerves from the supra-œsophageal ganglia.

TASTE. If existent, it is probably dependent upon nerves distributed within the buccal body, and derived from the stomato-gastric ganglia. The structure of the lingual lamina precludes any idea of its existence there.

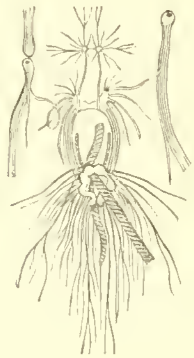
SMELL. The presence of this sense is undoubted, though there is much discrepancy of opinion as to its situation. I have suspected that it probably may be placed in the blind sac, or depression, which opens just below the mouth. This sac varies in its degree of development in the different genera; in Limax it is a superficial depression; in Vaginulus it extends backwards beneath the buccal body for half an inch, is conical in shape and yellowish-white in color; in *Bulimus fasciatus* it extends back, in the excavation of the foot, to the tail, and is folded several times upon itself.

HEARING. The acoustic apparatus consists of a pair of transparent, vesicular bodies, placed upon the postero-inferior part of the sub-œsophageal ganglia, one on each side. They are placed in a depression of the ganglia, formed by a separation of the nerve-tubuli as they pass from and into the latter, immediately upon the ganglionic globules. Their interior is filled with a transparent fluid, containing numerous otoconites, which vary in size, are oval in form, transparent, composed of concentric layers of carbonate of lime, and frequently have a small cavity in their centre. During life, and for a short time after the death of the animal, the otoconites are endowed with a peculiar vibratory movement, by which they are disposed to accumulate into a mass in the centre of the auditory vesicle. After the cessation of the movement, they become diffused through the fluid of the vesicle.

Sight. The eyeball is placed beneath the integument, on the outer side of the constriction which exists between the gangliform swellings at the free extremity of the superior tentacula. The optic nerve is derived from the inferior part of the first gangliform enlargement, is tortuous or undulating, and reaches the eyeball at its posterior part. Its course is frequently indicated by a deposit of pigmentum nigrum.

The eyeball is globular, and is invested exteriorly by a transparent tunic, corresponding to the sclerotica and cornea.

The choroidea forms two-thirds of a sphere, and is inflected anteriorly into a sort of depressed disk, perforated in the centre. It consists of a delicate, translucent membrane, with a deposit of a single layer of irregularly rounded, or oval, black pigment cells. The interior of the choroidea contains a clear, consistent vit reous humor ; but the character of the retina I did not detect at the time. Whether a crystalline lens exists or not I am in doubt ; at the time of making the investigations, in several instances I thought I discerned it very distinctly ; but in other instances, even when larger species were examined, if it existed it escaped my observation.



REFERENCES TO THE PLATES.

PLATE I.

Limax variegatus.

Fig. I. The integument laid open, with the viscera in situ. 1. Buccal body; 2. salivary gland; 3. stomach; 4. intestine; 5. termination of intestine in the rectum; 6. blind tube from the termination of the intestine; 7. oviduct; 8. pulmonary chamber; 9. heart; 10. renal organ; 11. left superior tentacle; 12. sub-œsophageal ganglia; 13. left stomato-gastric ganglion; 14. liver; 15. origin of the retractor muscle of the penis.

Fig. II. The viscera dissected apart. 1. Buccal body; 2. stomach; 3. intestine; 4. termination of do.; 5. blind tube from do.; 6. salivary glands; 6.* salivary duct; 7. liver; 8. hepatic duct; 9. testicle; 10. epididymis; 11. prostate gland; 12. penis; 13. retractor of do.; 14. ovary; 15. oviduct; 16. genital bladder; 17. pulmonary chamber; 18. aorta; 19. cephalic branch of do.; 20. visceral branch of do.; 21. sub-œsophageal ganglia; 22. left superior tentacle.

Fig. III. The generative apparatus. 1. Testicle; 2. epididymis; 3. prostate gland; 4. penis; 5. retractor of do.; 6. ovary; 7. oviduct; 8. genital bladder; 9. cloaca.

Fig. IV. The pulmonary chamber laid open and magnified four diameters. 1. Floor formed by the muscular peritoneum; 2. pulmonary orifice; 3. rectum; 4. anal aperture; 5. renal organ; 6. duct of do.; 7. pericardium laid open; 8. heart; 9. pulmonary vein; 10. pulmonary arteries; 11. aorta.

Fig. V. Testa.

Fig. VI. Dental plate.

PLATE II.

Figs. I.—IV. Arion hortensis.

Fig. I. Organs in situ. 1. Buccal body; 2. stomach; 3. intestine; 4. termination of do.; 5. liver; 6. testicle; 7. ovary; 8. oviduct; 9. cloaca; 10. pulmonary chamber; 11. heart; 12 retractors of the penis and vagina.

Fig. II. Genitalia, two diameters. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. prostate gland; 5. penis; 6. ovary; 7. oviduct; 8. genital bladder; 9. cloaca; 10. retractors of the penis and vagina.

Fig. III. Digestive apparatus. 1. Buccal body; 2. retractors of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary glands; 9. ducts of do.; 10. liver; 11. duct of liver.

Fig. IV. Pulmonary chamber, magnified. 1. Floor of the cavity; 2. pulmonary orifice; 3. pulmonary arteries; 4. auricle; 5. ventricle; 6. pericardium; 7. aorta; 8. renal organ; 9. intestine; 10. anus.

Figs. V.—VI. Limax campestris.

Fig. V. The digestive apparatus. 1. Buccal body; 2. its retractor; 3. stomach; 4. intestine; 5. terminal portion of do.; 6. anus; 7. salivary glands; 8. liver.

Fig. VI. Generative apparatus. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. accessory gland of do.; 4. prostate; 5, 6. penis; 8 oviduct; 9. genital bladder; 10. cloaca.

Figs. VII.—IX. Limax agrestis.

Fig. VII. Body laid open, and viscera dissected apart. 1. Buccal body; 2. stomach; 3. intestine; 4. blind tube of do.; 5. salivary glands; 6. liver; 7. testicle; 8. epididymis; 9. prostate; 10. receptacle of the penis; 11. trifurcate gland of do.; 12. sac of penis; 13. retractor muscle; 14. ovary; 15. oviduct; 16. genital bladder; 17. pulmonary chamber.

Fig. VIII. Lower portion of the genitalia. 1. Prostate; 2. receptacle of penis; 3. trifurcate gland of do.; 4. sac of penis; 5. retractor; 6. oviduct; 7. bladder; 8. cloaca.

Fig. IX. Receptacle of the penis laid open. 1. penis; 2. longitudinal folds of the receptacle; 3. trifurcate gland.

PLATE III.

Tebennophorus carolinensis.

Fig. I. Integument laid open, and the viscera in situ enclosed within the muscular peritoneum.

Fig. II. Muscular peritoneum laid open; the organs in situ. 1. Pulmonary chamber laid open; 2. muscular peritoneum; 3. buccal body; 4. stomach; 5. liver; 6. intestine; 7. testicle; 8. ovary; 9. oviduct; 10. dart sac; 11. heart; 12. renal organ; 13. pulmonary orifice.

Fig. III. Digestive apparatus and pulmonary chamber. 1. Buccal body; 2. retractors of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. rectum; 7. salivary glands; 8. ducts of do.; 9. liver; 10. ducts of do.; 11. pulmonary chamber; 12. pulmonary veins; 13. renal organ; 14. heart.

Fig. IV. Generative apparatus. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. prostate; 4. penis; 5. retractor of penis; 6. ovary; 7. oviduct; 8. genital bladder; 9. dart sac; 10. cloaca; 11. glandular structure of do.; 12. right superior tentacle.

Fig. V. Penis, dart sac, etc. laid open. 1. Penis; 2. folded lining of do ; 3. vas deferens; 4. dart sac, containing the dart; 5. neck of oviduct: 6. duct of bladder; 7. cloaca.

Fig. VI. The dart, enlarged.

Fig. VII. Glandular layer of the cloaca, enlarged.

Fig. VIII. Globular form of the genital bladder.

Fig. IX. Spermatozoa, highly magnified.

Fig. X. A bunch of imperfect spermatozoa from the testicle, highly magnified.

Fig. XI. Granules from the testicle, highly magnified.

Fig. XII. Imperfect ova from the ovary, highly magnified.

PLATE IV.

Vaginulus floridanus.

Fig I. Integument laid open; the viscera in situ. 1. Buccal body; 2. salivary gland; 3. stomach; 4. intestine; 5. rectum; 6. liver; 7. testicle; 8. multifid vesicle; 9. heart.

Fig. II. Viscera separated. 1. Buccal body; 2. stomach; 3. intestine; 4. salivary glands; 5. liver; 6. course of rectum, renal duct, and pulmonary passage; 7. testicle; 8. epididymis; 9. receptacle of penis; 10. multifid vesicle; 11. ovary; 12. oviduct; 13. genital bladder; 14. parenchymatous sac of the vagina.

Fig. III. Part of the digestive apparatus. 1. Œsophagus; 2. stomach; 3. intestine; 4. liver; 5. hepatic ducts.

Fig. IV. Genitalia. 1. Testicle; 2. epididymis; 3. vas deferens; 4. prostate; 5. receptacle of penis laid open; 6. penis; 7. retractor of penis; 8. base of multifid vesicle; 9 ovary; 10. oviduct; 11. genital bladder; 12. parenchymatous sac of vagina laid open.

Fig. V. Visceral cavity, with the greater portion of the viscera removed. 1. Buccal body; 2. salivary glands; 3. œsophagus; 4. rectum; 5. pulmonary passage; 6. pulmonary cells between the integument and muscular peritoneum; 7. pulmonary artery from the left side; 8. heart; 9. renal organ; 10. renal duct; 11. penis, seen within its receptacle; 12. base of the multifid vesicle; 13. parenchymatous sac of the vagina; 14. vagina; 15. sub-œsophageal, and 16. supra-œsophageal ganglia; 17. olfactory sinus.

Fig. VI. Dental plate: a. size of nature; b. magnified, with the retractor muscle attached.

PLATE V.

Bulimus fasciatus.

Fig. I. The viscera dissected apart. 1. Buccal body; 2. lingual pouch; 3. retractor of buccal body; 4. stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary glands; 9. ducts of do.; 10. liver; 11. position of the testicle commingled with the posterior lobe of the liver; 12. epididymis; 12.* vas deferens; 13. accessory gland of the epididymis; 14. prostate; 15. penis; 16. retractor of do.; 17. multifid vesicle; 18. ovary; 19. oviduct; 19.* glandular portion of do.; 20. genital bladder; 21. pulmonary chamber; 22. pulmonary aperture; 23. pulmonary artery; 24. pulmonary vein; 25. pericardium; 26. auricle; 27. ventricle; 28. aorta; 29. renal organ; 30. renal duct; 31. orifice of do.; 32. supra-œsophageal ganglia; 33. stomato-gastric ganglia; 34. sub-œsophageal ganglia.

Fig. II. Buccal body laid open, enlarged. 1. Upper lip; 2. lower lip; 3. dental plate; 4. sides of buccal cavity; 5. tongue; 6. entrance of œsophagus; 7. œsophagus; 8. salivary ducts; 9. lower part of buccal body; 10. retractor muscle.

Fig. III. The muscular tongue, with the tubular prolongation of the lingual lamina into the lingual pouch.

Fig. IV. Dental plate: a. magnified; b. size of nature.

Fig. V. Excavation of the foot. 1. Buccal body turned forward; 2. retractor muscle; 3. attrahent fasciculi; 4. lingual pouch; 5. retractors of the foot; 6. olfactory sinus.

PLATE VI.

Helix albolabris.

Fig. I. The animal, with the pulmonary chamber (1) laid open and turned back from the visceral mass (2); 3. the mouth; 4. the cloaca, voluntarily protruded.

Fig. II. The viscera, all dissected apart. 1. Buccal body; 2.

retractor of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary glands; 9. liver; 10. testicle; 11. epididymis; 11.* vas deferens; 11.** accessory gland of epididymis; 12. prostate; 13. penis; 14. retractor of do.; 15. ovary; 16. oviduct; 17. genital bladder; 18. pulmonary chamber; 19. pulmonary vein; 20. heart; 21. renal organ; 22. its duct; 23. anus; 24. cephalic branch of aorta; 25. supra-œsophageal ganglia.

Fig. III. Genitalia. 1. Testicle; 2. epididymis; 2.* vas deferens; 2.** dilated commencement of do.; 3. accessory gland of epididymis; 4. prostate; 5. penis; 6. prepuce; 7. retractor muscle; 8. ovary; 9. oviduct; 10. genital bladder; 11. muscular organ on the duct of do.; 12. cloaca.

Fig. IV. Penis, etc. laid open. 1. Vas deferens; 2. retractor of penis; 3. penis; 4. a longitudinal papillated fold of the lining membrane; 5. prepuce; 6. bladder laid open; 7. muscular organ at its base; 8. neck of oviduct; 9. orifice of do.; 10. cloaca.

Fig. V. A second appearance of the interior of the organ at the base of the bladder (1). 2. Longitudinal folds; 3. neck of oviduct; 4. orifice of do.

Fig. VI. Portion of oviduct laid open, exhibiting the spermatic groove, and, within it, the orifice of the prostate gland. 1. Epididymis; 2. accessory gland; 3. spermatic groove; 4. side of the oviduct.

Fig. VII. Pyramidal epithelia from the prostate gland, highly magnified. 1. Mass of cells; 2. isolated cells.

Fig. VIII. Imperfect ova from the ovary.

Fig. IX. Dental plate, much magnified.

Fig. X. Eye, much enlarged.

Fig. XI. Portion of renal organ, moderately magnified.

PLATE VII.

Fig. I. H. cellaria; II.—V. H. alternata; IV., VII. H. perspectiva; VIII. H. palliata.

Fig. I. Viscera of H. cellaria, dissected apart. 1. Buccal body; 2. retractor of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary gland; 9. liver; 10. duct of do.; 11. testicle; 12. epididymis; 12.* vas deferens; 13. prostate; 14. penis; 15. retractor of penis; 16. ovary; 17. oviduct; 18. genital bladder; 19. vagina; 20. pulmonary chamber; 21. heart; 22. renal organ.

Fig. II. Viscera of H. alternata. 1. Buccal body; 2. œsophagus; 3. stomach; 4. intestine; 5. rectum; 6. salivary gland; 7. liver; 8. testicle; 9. epididymis; 10. prostate; 11. penis; 12. retractor of do.;

13. ovary; 14. oviduct; 15. genital bladder; 16. pulmonary chamber; 17. heart; 18. renal organ; 19. renal duct; 20. pulmonary aperture.

FIG. III. Dental plate, magnified. 1. Muscle; 2. the plate.

FIG. IV. Penis laid open. 1. Penis; 2. thick longitudinal fold; 3. vas deferens; 4. retractor of penis.

FIG. V. Spermatozoa, highly magnified.

FIG. VI. Digestive apparatus of H. perspectiva. 1. Buccal body; 2. retractor of buccal body; 3. œsophagus; 4. stomach; 5. intestine; 6. salivary gland; 7. ducts of do.; 8. hepatic ducts.

FIG. VII. Genitalia. 1. Testicle; 2. epididymis; 3. accessory gland of do.; 4 prostate; 5. penis; 6. retractor of do.; 7. ovary; 8. oviduct; 9. genital bladder; 10. cloaca; 11. right superior tentacle.

FIG. VIII. Dissection of H. palliata. 1. Buccal body; 2. stomach; 3. intestine; 4. rectum; 5. anus; 6. salivary gland; 7. liver; 8. epididymis; 8.* vas deferens; 9. accessory gland of do.; 10. prostate; 11. penis; 12. retractor of do.; 13. ovary; 14. oviduct; 15. genital bladder; 16. retractor of buccal body; 17. pulmonary chamber; 18. heart; 19. renal organ; 20. supra-œsophageal ganglia.

PLATE VIII.

FIGS. I.—VI. HELIX MULTILINEATA.

FIG. I. Digestive apparatus. 1. Buccal body; 2. retractor of do.; 3. lingual pouch; 4. stomach; 5. intestine; 6. salivary gland; 7. hepatic duct.

FIG. II. Genitalia. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. accessory gland of epididymis; 4. prostate; 5. penis; 6. prepuce; 7. retractor of penis; 8. ovary; 9. oviduct; 10. genital bladder; 11. vagina; 12. cloaca; 13. right superior tentacle.

FIG. III. Penis (1) laid open to exhibit the papillary structure on its inner surface; 2. prepuce; 3. vas deferens; 4, 5. neck of oviduct and vagina laid open; 6. bladder; 7. orifice of bladder.

FIG. IV. Portion of the inner surface of the penis, magnified two diameters.

FIG. V. Spermatozoa, highly magnified.

FIG. VI. Spermatozoa in coil.

FIGS. VII.—X. H. SOLITARIA.

FIG. VII. Digestive apparatus. Same references as Fig. I.

FIG. VIII. Genitalia. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. accessory gland of do.; 4. prostate; 5. penis; 6. retractor of do.; 7. ovary; 8. oviduct; 9. bladder; 10. cloaca.

Fig. IX. Spermatozoa and granules from the epididymis, highly magnified.

Fig. X. Portion of the renal organ at its commencement, exhibiting the relation of the duct at its outer edge.

Fig. XI. Helix Berlanderiana.

Fig. XI. Genitalia of Helix Berlanderiana. 1. Testicle; 2. epididymis; 3. accessory gland of do.; 4. prostate; 5. penis; 6. double retractor of do.; 7. sac of the dart?; 8. ovary; 9. oviduct; 10. bladder; 11. cloaca.

PLATE IX.

Figs. I.—III. H. profunda.

Fig. I. Digestive apparatus. 1. Buccal body; 2. retractor of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. salivary gland; 7. ducts of do.; 8. hepatic ducts.

Fig. II. Inferior part of the genitalia. 1. Prostate; 2. vas deferens; 3. penis; 4. retractor of do.; 5. prepuce; 6. oviduct; 7. bladder; 8. vagina; 9. cloaca; 10. tentacle.

Fig. III. 1. Vas deferens; 2. penis; 3. retractor of do.; 4. prepuce laid open; 5. glans penis; 6. genital bladder and duct laid open, exhibiting the interior, longitudinal folds; 7. neck of oviduct; 8. vagina; 9. cloaca; 10. tentacle.

Helix fuliginosa.

Fig. IV. H. fuliginosa, with all the viscera dissected apart. 1. Buccal body; 2. retractor of do.; 3. œsophagus; 4 stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary gland; 9. ducts of do.; 10. liver; 11. testicle; 12. epididymis; 13. accessory gland of do.; 14. prostate; 15. penis; 16. retractor of do.; 17. ovary; 18. oviduct; 19. bladder; 20. glandular structure surrounding the vagina; 21. pulmonary chamber; 22. heart; 23. renal organ; 24. retractor muscle of the foot; 25. supra-, 26. sub-œsophageal, and 27. stomato-gastric ganglia.

Figs. V. VI. H. auriculata.

Fig. V. Digestive apparatus. 1. Buccal body; 2. lingual pouch; 3. retractor of buccal body; 4. œsophagus; 5. stomach; 6. intestine; 7. salivary gland; 8. ducts of do.; 9. hepatic ducts.

Fig. VI. Genitalia. 1. Testicle; 2. epididymis; 2.* vas deferens; 3. accessory gland of epididymis; 4. prostate; 5. penis; 6. retractor of do.; 7. ovary; 8. oviduct; 9. genital bladder; 10. vagina; 11. cloaca.

Figs. VII.—IX. Auditory apparatus of H. pulchella.

Fig. VII. Inferior ganglia of the sub-œsophageal mass, highly magnified, with the auditory vesicles attached.
Fig. VIII. Side view of one of the auditory vesicles.
Fig. IX. Otoconites, very highly magnified.

PLATE X.

Figs. I.—III. H. exoleta.

Fig. I. Digestive apparatus. 1. Buccal body; 2. lingual pouch; 3. retractor of buccal body; 4. stomach; 5. intestine; 6. salivary gland; 7. ducts of do.; 8. hepatic ducts.
Fig. II. Genitalia. Same references as Fig. VI. Pl. IX.; 2.** glandular commencement of vas deferens.
Fig. III. Penis laid open. 1. Longitudinal folds; 2. vas deferens; 3. valvular folds; 4. retractor of penis; 5. vagina; 6. orifice of do.

Figs. IV. V. H. elevata.

Fig. IV. Viscera dissected apart. 1. Buccal body; 2. œsophagus; 3. stomach; 4. intestine; 5 rectum; 6. anus; 7. salivary gland; 8. liver; 9. testicle; 10. epididymis; 11. accessory gland of do.; 10.* vas deferens; 12. prostate; 13. penis; 14. retractor of do.; 15. ovary; 16. oviduct; 17. genital bladder; 18. pulmonary chamber; 19. pulmonary vein; 20. heart; 21. renal organ; 22. duct of do.; 23. pulmonary orifice; 24. supra-, 25. sub-œsophageal, and 26. stomato-gastric ganglia.
Fig. V. Penis laid open. 1. Longitudinal folds of interior; 2. vas deferens; 3. retractor of penis.

PLATE XI.

Figs. I.—IV. H. Sayi.

Fig. I. Digestive apparatus. 1. Buccal body; 2. retractor of do.; 3. lingual pouch; 4. œsophagus; 5. stomach; 6. intestine; 7. salivary gland; 8. salivary ducts; 9. hepatic ducts.

Fig. II. Genitalia. Same references as Fig. VI. Pl. IX.

Fig. III. Portion of the oviduct laid open. 1. Transverse folds of the sides; 2. spermatic groove.

Fig. IV. Dental plate, largely magnified.

Figs. V.—VI. H. hirsuta.

Fig. V. Viscera dissected apart. 1. Buccal body; 2. œsophagus; 3. stomach; 4. intestine; 5. rectum; 6. anus; 7. salivary gland; 8. liver; 9. testicle; 10. epididymis; 11. accessory gland of do.; 10.* vas deferens; 12. prostate; 13. penis; 14. retractor of do.; 15. ovary; 16. oviduct; 17. genital bladder; 18. pulmonary chamber; 19. heart; 20 renal organ.

Fig. VI. Accessory gland of the epididymis, highly magnified.

Figs. VII.—IX. H. thyroidus.

Fig. VII. Digestive apparatus. Same references as Fig. I.

Fig. VIII. Genitalia. Same references as Fig. VI. Pl. IX.

Fig. IX. Penis laid open. 1. Longitudinal folds; 2. valvular fold; 3. vas deferens; 4. retractor of penis; 5. orifice of vagina.

PLATE XII.

Figs. I.—III. H. intertexta.

Fig. I. Genitalia. 1. Testicle; 2. epididymis; 3. accessory gland of do.; 2.* vas deferens; 4. prostate; 5. penis; 6. retractor of do.; 7. sac of the dart; 8. glandular pouches; 9. ovary; 10. oviduct; 11. genital bladder; 12. duct of do. to the vagina; 13. division of the duct, enclosing the lower part of the genitalia; 14. retractor of the dart sac; 15. portion of the duct of the genital bladder, enclosing the cloaca; 16. cloaca.

Fig. II. Lower part of the genitalia laid open. 1. Penis; 2. portion of the duct of the genital bladder, which encloses the lower part of the genitalia, laid open; 3. vas deferens; 4. neck of the oviduct; 5. duct of the bladder; 6. the portion of do. to the vagina; 7. dart sac; 8. glandular pouches; 9. dart; 10. orifice of the vagina.

Fig. III. a. the dart, the size of nature; b. do. much magnified.

Figs. IV.—VII. H. ligera.

Fig. IV. Digestive apparatus. 1. Buccal body; 2. retractor of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. salivary gland; 7. hepatic duct.

FIG. V. Genitalia. Same references as Fig. I.

FIG. VI. Animal with the penis and lower portion of the dart sac.

FIG. VII. Dental plate.

FIG. VIII. Genitalia of H. suppressa, magnified seven diameters. Same references as Fig. I.

FIGS. IX.—XI. H. CONCAVA.

FIG. IX. Digestive apparatus. Same references as Fig. I. Pl. XI.

FIG. X. Genitalia. Same references as Fig. VI. Pl. IX., except 11, which is probably a dart sac; 12. cloaca.

FIG. XI. Dental plate, much magnified.

PLATE XIII.

FIG. I.—III. SUCCINEA.

FIG. I. Viscera dissected apart. 1. Buccal body; 2. stomach; 3. intestine; 4. rectum; 5. anus; 6. salivary gland; 7. ducts of do.; 8. liver; 9. testicle; 10. epididymis; 11. accessory gland of do.; 12. prostate; 13. penis; 14. ovary; 15. oviduct; 16. genital bladder; 17. pulmonary chamber; 18. heart; 19. renal organ.

FIG. II. Genitalia. Same references as Fig. VI. Pl. IX.

FIG. III. Dental plate. a. Natural size; b. magnified; 1. muscle; 2. dental plate; 3. accessory plate.

FIG. IV. Nerve centres of Helicina orbiculata, highly magnified. 1. Supra-œsophageal ganglia; 2. stomato-gastric ganglia; 3. sub-œsophageal ganglia; 4. auditory vesicles.

FIG. V. Spermatozoa from the epididymis, very highly magnified.

PLATE XIV.

GLANDINA TRUNCATA.

FIG. I. Animal deprived of its shell. 1. Turbinate mass of viscera; 2. anterior third of the buccal body protruded as in eating; 3. mouth; 4. generative aperture; 5. superior tentacles; 6. inferior tentacles; 7. external tentacles.

FIG. II. Viscera dissected apart. 1. Buccal body; 2. œsophagus; 2.* exit of do.; 3. stomach; 4. intestine; 5. rectum; 6. anus; 7. salivary gland; 8. ducts of do.; 9. liver; 10. hepatic duct; 11. testicle; 12. epididymis; 13. accessory gland of do.; 12*. vas deferens; 14. prostate; 15. penis; 16. retractor of do.; 17. ovary; 18. oviduct; 19. genital bladder; 20. vagina; 21. cloaca; 22. pulmonary chamber; 23. pulmonary vein; 24. heart; 25. aorta; 26. renal organ; 27. duct of do.; 28. orifice of do.; 29. retractor muscles of buccal body, tentacles, and podal disk; 30. supra-œsophageal ganglia; 31. stomato-gastric ganglia; 32. superior tentacles retracted; 33. Distoma sacs.

Fig. III. Inferior view of the protruded portion of buccal body. 1. Mouth; 2. external tentacles.

Fig. IV. Diagram of nervous centres. 1. Sub-œsophageal ganglia; 2. supra-œsophageal ganglia; 3. stomato-gastric ganglia.

PLATE XV.

Fig. I. Genitalia of Bulimus dealbatus. 1. Testicle; 2. epididymis; 3. accessory gland of do.; 4. prostate; 5. vas deferens; 6. penis; 7. retractor of do.; 8. ovary; 9. oviduct; 10. genital bladder; 11. vagina; 12. cloaca.

Fig. II.—IV. Pupa incana.

Fig. II. Viscera dissected apart. 1. Buccal body; 2. retractor of do.; 3. œsophagus; 4. stomach; 5. intestine; 6. rectum; 7. anus; 8. salivary gland; 9. liver; 10. pulmonary chamber; 11. collar; 12. pulmonary aperture; 13. pulmonary vein; 14. heart; 15. aorta; 16. renal organ; 17. duct of do.; 18. testicle; 19. epididymis; 20. accessory gland of do.; 21. prostate; 22. vas deferens; 23. penis; 24. retractor of do.; 25. dart sac (?); 26. ovary; 27. oviduct; 28. genital bladder; 29. an accessory gland joining the duct of the genital bladder by the duct 30; 31. retractor muscles; 32. sub-œsophageal ganglia.

Fig. III. Penis laid open. 1. Penis; 2. longitudinal fold; 3. retractor of penis; 4. vas deferens; 5. orifice of do.

Fig. IV. Dental plate, magnified.

Figs. V. VI. Bulimus decollatus.

Fig. V. Digestive apparatus. 1. Buccal body; 2. lingual pouch; 3. retractor of buccal body; 4. œsophagus; 5. stomach; 6. intestine; 7. salivary gland; 8. ducts of do.; 9. hepatic ducts.

Fig. VI. Lower portion of the Genitalia.

Figs. VII. VIII. B. virgulatus.

Fig. VII. Digestive apparatus. Same references as in digestive apparatus of Fig. II.

Fig. VIII. Genitalia. Same references as Fig. I.

PLATE XVI.

Fig. I. Nervous system of Glandina truncata, magnified. 1. Supra-œsophageal ganglia; 2. sub-œsophageal ganglia; 3. stomato-gastric ganglia; 4. nerve to the upper lip; 5. to the integument of the superior tentaculæ; 6. to the lateral lips; 7. supra-œsophageal, stomato-gastric ganglionic commissure; 8. superior tentacular nerve; 9. an accessory branch; 10. nerve to the inferior and external tentaculæ; 11. ganglionic enlargement of do.; 12. inferior tentacular nerve; 13. external tentacular nerves; 14. nerves to the buccal body; 15. to œsophagus and stomach; 16. to salivary ducts and gland; 17. supra-œsophageal, sub-œsophageal, ganglionic commissures; 18. nerves to podal disk; 19. nerves to collar and pulmonary chamber; 20. to retractor of buccal body; 21. follows course of aorta, and supplies the oviduct, ovary, testicle, etc.; 22. supplies integument, collar, pulmonary chamber, and retractor muscles, at origin; 23. to penis; 24. to cloaca and integument in vicinity; 25. numerous branches to integument on each side, and podal disk; 26. to retractor muscles; 27. to tail and podal disk; 28. large branch to integument on each side.

Fig. II. Supra-œsophageal and stomato-gastric ganglia of Helix albolabris. 1. Supra-œsophageal ganglia; 2. stomato-gastric ganglia. 3. supra-œsophageal, sub-œsophageal, ganglionic commissures; 4. supra-œsophageal, stomato-gastric, ganglionic commissures; 5. superior tentacular nerve; 6. inferior tentacular do.; 7. to commencement of olfactory sinus; 8. inferior part of mouth and buccal body; 9. to integument of lips; 10. integument at side of mouth, and generative aperture on the right side; 11. recurrent branch to superior tentacular muscle; 12. to retractor of podal disk; 13 to buccal body; 14. to œsophagus; 15. to salivary glands.

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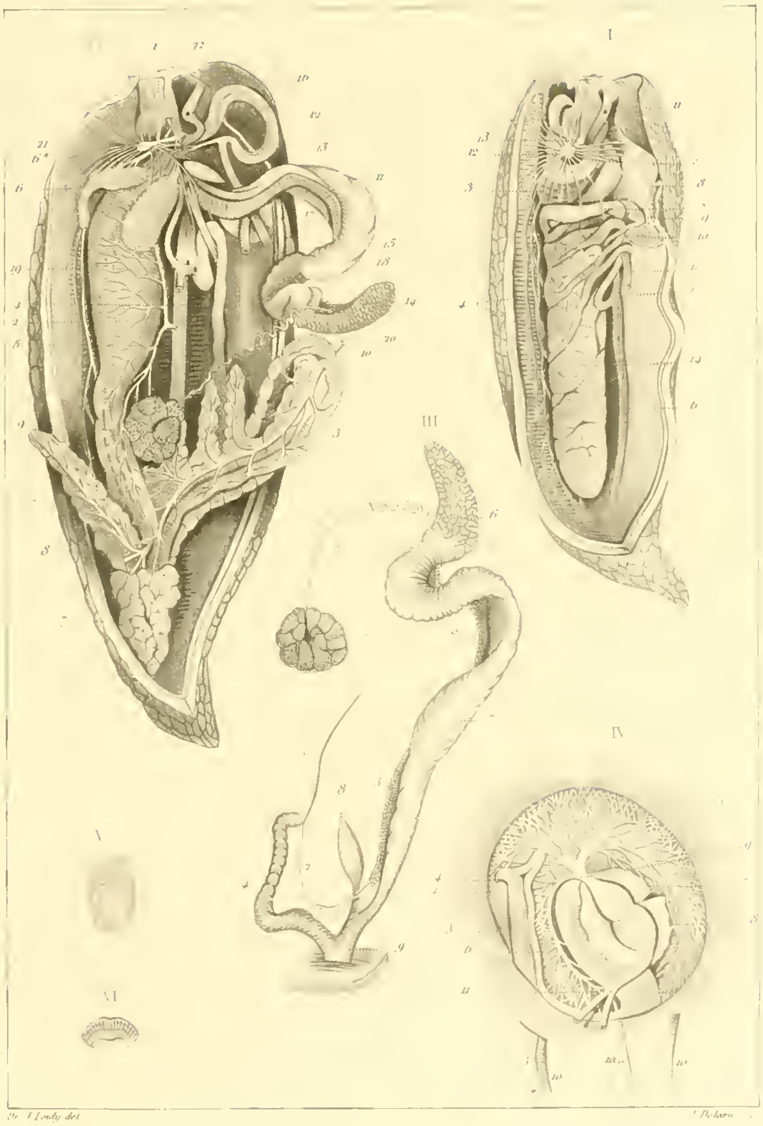
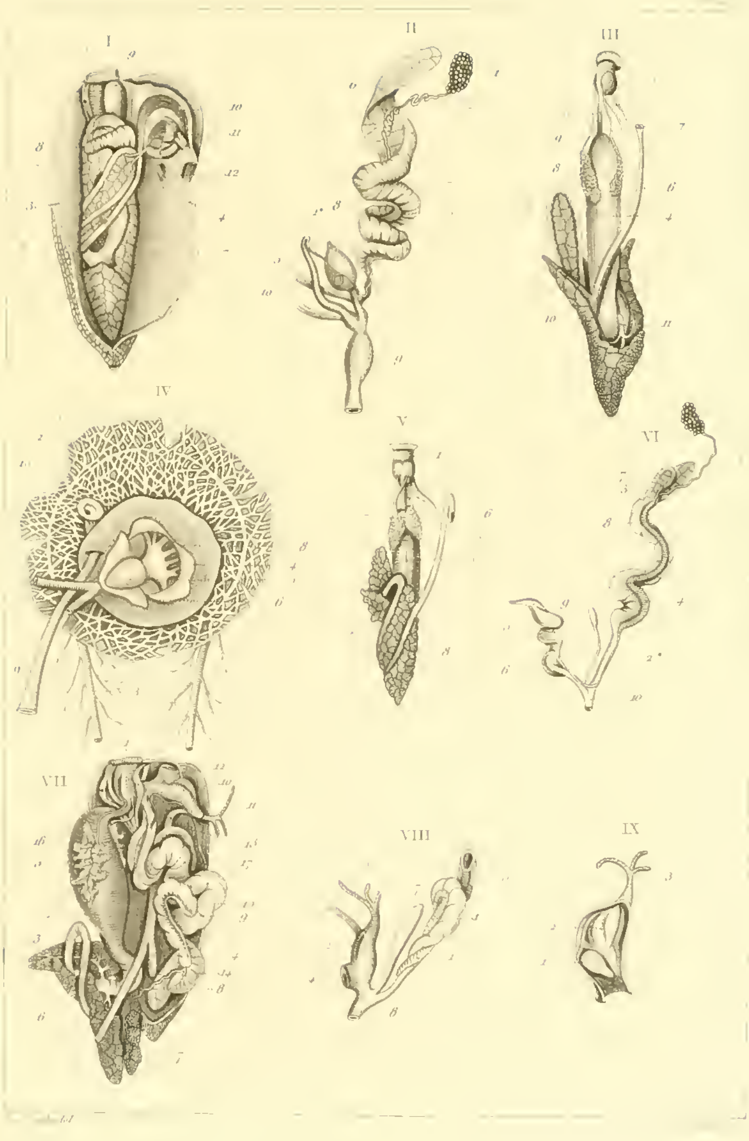
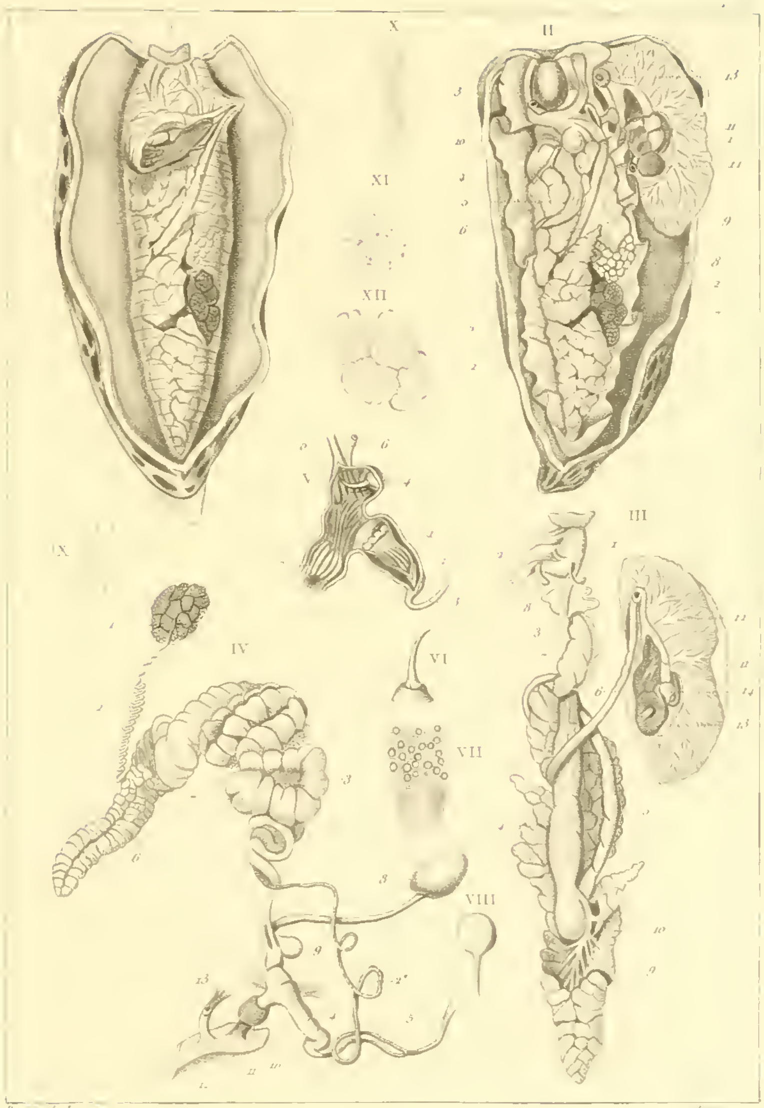


Limax variegatus Drap.



I–IV *Arion hortensis* V, VI *Limax ampe*[illegible]

VII–IX *L. agrestis*



dy del

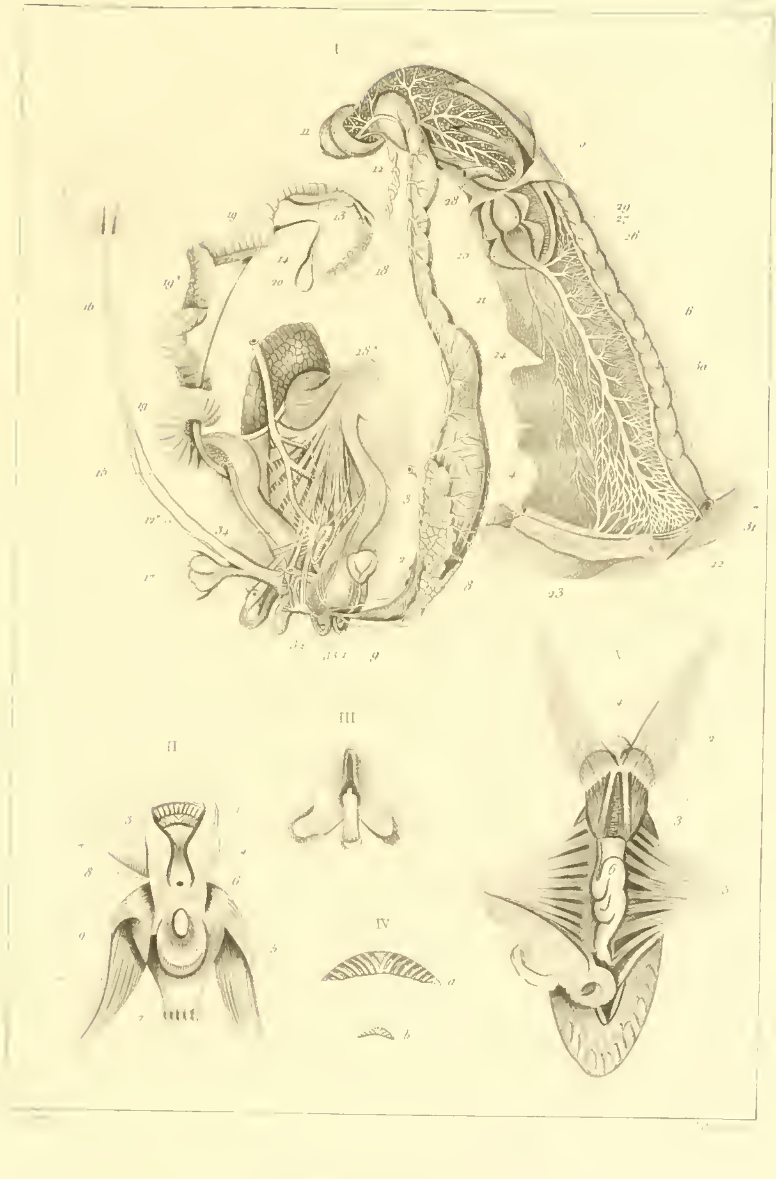
[illegible] carolinensis

[illegible]

Dr. J. Leidy del. J. Delarue sc.

Vaginulus floridanus

Imp. de J. Delarue



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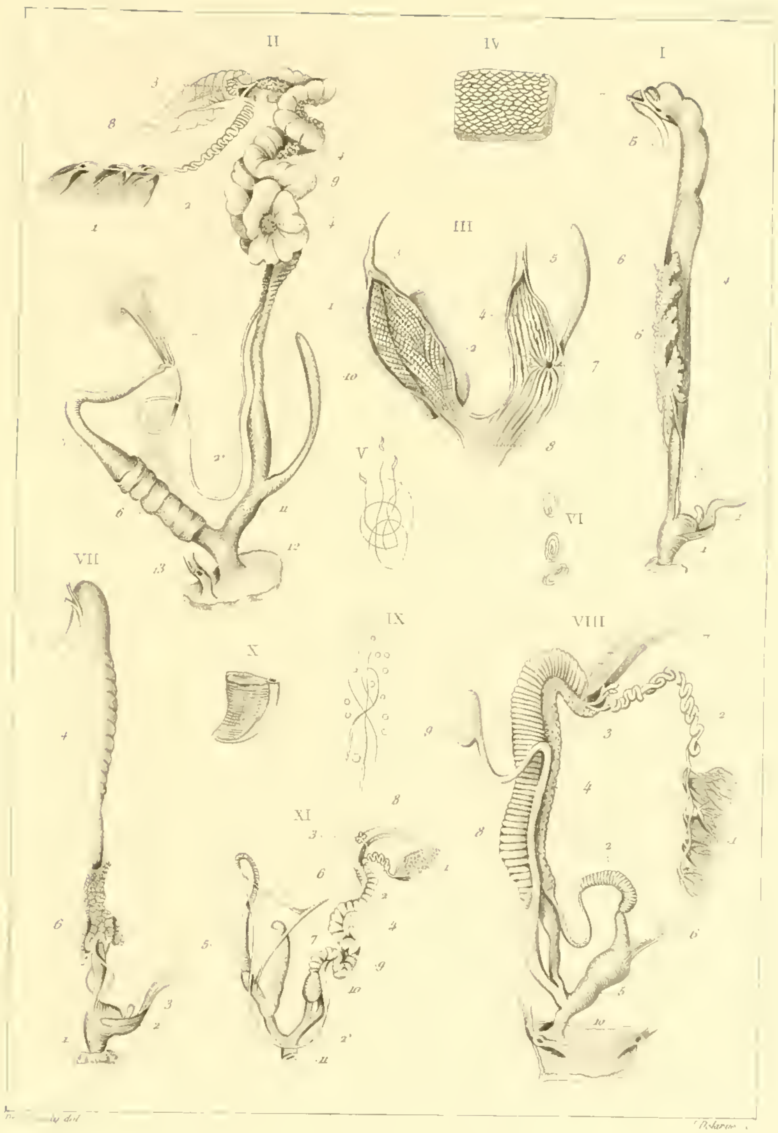
Pl. I

I. H. cellaria II – V. H. alternata

VI. VII. H. perspectiva VIII. H. palliata



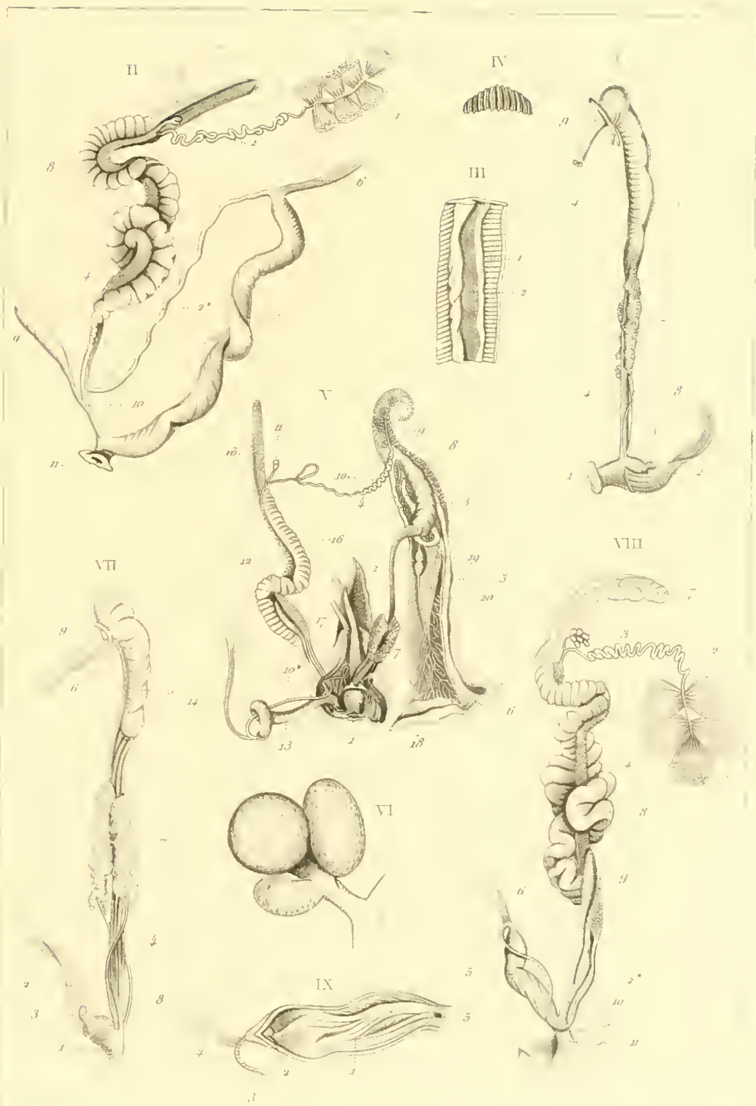
I – VI H. multilineata VII – X H. solitaria

XI H. Berlandieriana

I–III. *H. profunda*　　IV. *H. fuliginosa*

V, VI. *H. auriculata*　　VII–IX. *H. pulchella*

I – III *H. exoleta* IV V *H. elevata*



dy del. J. Pekin

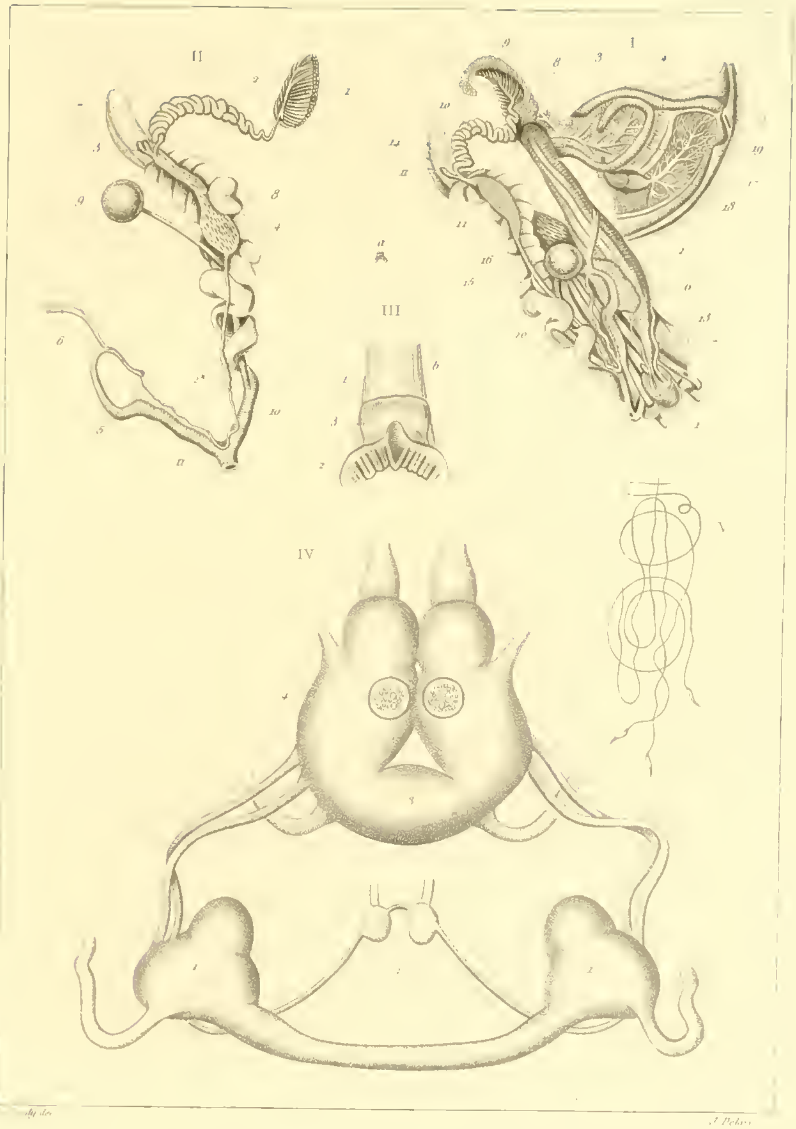
I – IV. H. Sayi V, VI. H. hirsuta

VII – IX. H. thyroidus

Imp. de J. Pelarue R. de la Montagne S^te Geneviève

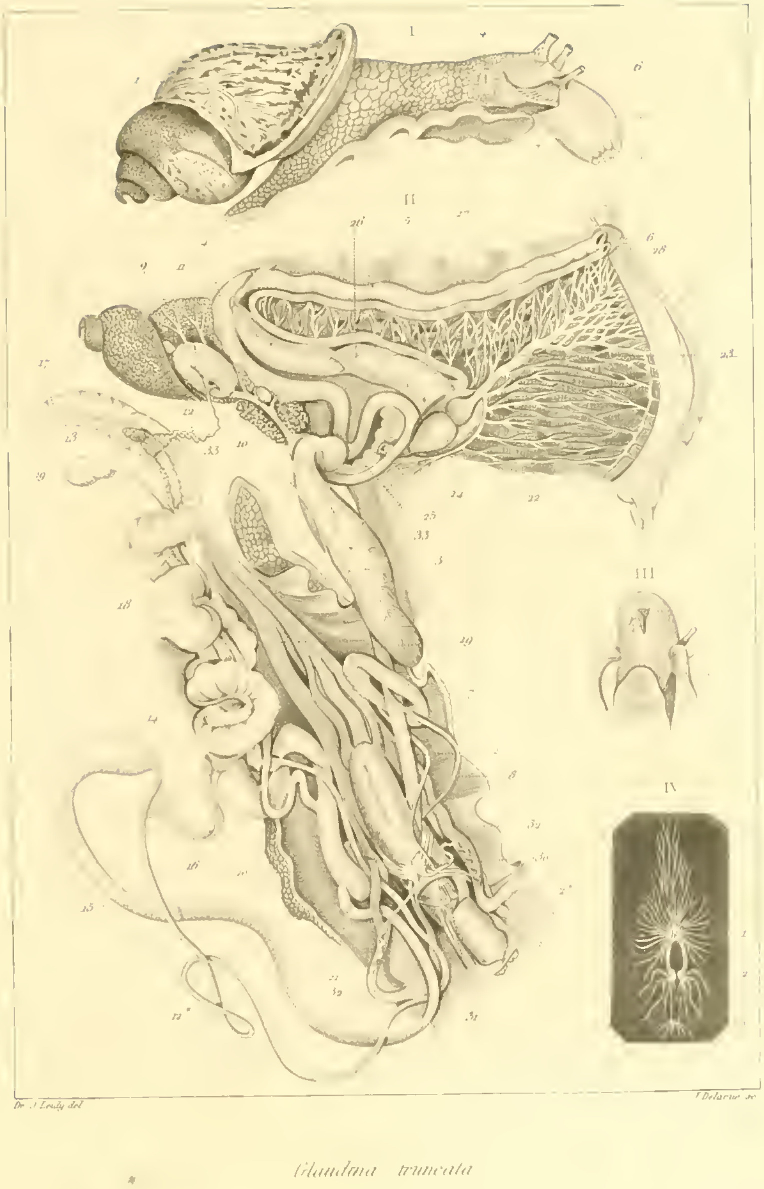
I — III H. interfecta   IV — VII H. lycta

VIII H. Stepprosa   IX — XI H. cotucana



I – III *Succinea ovalis* IV *Helicina orbiculata*

V *Helix albolabris*

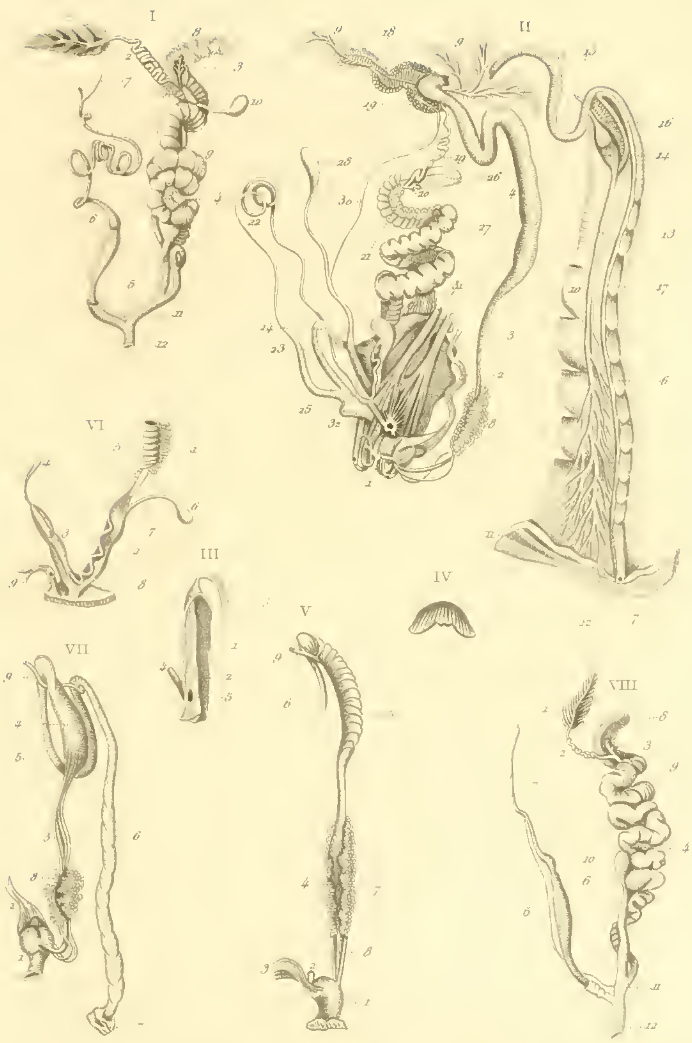


Dr. J. Leidy del.

J. Delarue sc.

Glandina truncata

Imp. de ...



J. Delarue

I. *Bulimus dealbatus.* II – IV. *Pupa incana.*

V, VI. *Bulimus decollatus.* VII, VIII. *B. virgulatus.*

Imp. de J. Delarue, R. de la Montagne Ste Geneviève, 10.

I *Glandina truncata* II *Helix albolabris*

Imp. de J. Delarue